

ORDINARY MEETING.

FRIDAY, JANUARY 4TH, 1884.

HENRY HICKS, Esq., M.D., F.G.S., President, in the Chair.

The list of donations to the library since the last meeting was read, and the thanks of the Association were returned to the donors.

The following were elected members of the Association :—

Aubrey Fellows, George F. Harris, G. W. Moore, John A. Ollard, C. W. Osman, C. Ridley, jun., J. Tomasin, Mrs. J. Tomasin, Miss Emily White.

H. Goss, Esq., F.L.S., F.G.S., and J. Starkie Gardner, Esq., F.G.S., were elected Auditors.

The following paper was then read :—

FOSSIL PLANTS.

BY J. STARKIE GARDNER, F.G.S.

Those who combine the studies of geology and palæontology, and there are few here who do not, embrace such a vast variety of subjects that scarcely anything within the range of natural science can come amiss. Ours alone of all the sciences enjoys the peculiarity of necessitating in its pursuit some slight knowledge of all others and according to the direction of his particular studies, a geologist may perforce find himself an astronomer, a chemist, microscopist, physicist, zoologist, botanist, an antiquary, or a geographer. A mere accident may at the outset lead to the selection of one particular line, to the exclusion, more or less, of all others; for it becomes more and more evident that specialists alone can hope to do original work. Such accident fortunately led me many years ago to turn my attention to fossil plants, and has since provided me with months of enjoyable outdoor exercise. It is rare, however, that this especial branch is taken up. Botanists, with very few exceptions, give no encouragement to palæontologists, and seldom do anything towards assisting to reconstruct the vegetation of the past, though questions of distribution and evolution, which are utter enigmas to them at present, can only be attacked from this side. Few botanists with the reputation of a Brongniart

have, like him, shown an equal interest in the past and in the living plant-worlds. The science has had no Cuviers or Owens to reconstruct whole forests from their scattered *débris*; yet there has been no lack of those professing themselves able to do so. It is an easy pastime, with an immunity from contradiction or criticism, to give names to scores of fossil leaves, by instinct as it were; but this is not the kind of work that is needed, or that I hope ever to see undertaken in England. We want skilled botanists, who have passed their lives in studying special groups of plants, to extend their studies to the fossils of the same groups. For my part, I am no botanist, and it has consequently taken me more than three years to study enough to be able to describe only a section of the British Eocene Coniferæ, for I read a paper here on that subject in May, 1881; and when I say that I hoped to show you to-night over a thousand drawings of British Eocene plants yet to be described, you will perceive how great is the task, and how long I must hope to live if I am to discharge it conscientiously. My present object, however, is not to enlist volunteers from our ranks to describe, but to collect. Though the material appears so abundant, it is, in reality, wholly insufficient. When we get the leaf of a plant we have not got the plant itself, nor all the organs of the plant we may reasonably hope to find in a fossil state, and without more organs than one the greatest uncertainty must ever exist. I have quadrupled the material I had upon which to commence the Coniferæ, yet each time I collect something belonging to them turns up that is of value, and there are yet numerous doubtful points to explain. It is constantly happening that some fruit or other organ comes to light that completely upsets preconceived ideas. Thus the association of a little triple-winged seed, said to be that of an elm, showed a group hitherto recognised as Cinnamons to belong to a genus of the *Smilacæ* (*Dioscorea*), and I might quote very numerous other examples.

To turn from a profitless subject, however, to what I hope may become a profitable one, it has been a continual source of regret to see year by year how completely indifferent geologists in this country are to so important a branch of palæontology. Mr. Whitaker, of the Geological Survey, who, from having professionally surveyed the London Basin, might have been expected to have met with unusual finds, declared a year or two since at the Geological Society that he had never in his life himself found any

fossil fragment referable to the Mammalia in the Eocene ; but there are probably few here who could say that they had never found any remains of a plant in the Eocene. Far from that, collectors must be constantly turning them up and turning their backs upon them as not worth picking up ; for whether it is that so many from their chemical state vexatiously go to pieces in our cabinets, often injuring their neighbours, or whether it is due to the absence of books by which they can be named, certain it is that unless a plant presents an unusually attractive appearance, it is not preserved.

Science has in consequence to deplore the loss of material, the most magnificent perhaps, for reconstructing the Eocene Floras of our latitudes, that has ever existed in any country. Our area having remained the delta of a vast river throughout the immense Eocene period, with its many changes of climate, formed a more favourable receptacle for the imbedding of plants under the most varied conditions than probably any other in the world, and had we and the past generation of geologists taken the trouble to preserve them, there would by now have been in our possession an absolutely unrivalled series of fossil herbaria of the Eocene period.

Though my remarks are confined to the Eocene Floras, yet, in order to understand them, we must go back a little farther. We must take up the subject with the Wealden Flora, which, although not rich in itself, is so identical with that of the preceding Jurassic period, that when all are united we seem to have a very fair insight into the composition of the Flora that grew in our area in those remote times ; and as much by what is absent as by what is present, we see that it is utterly unlike, and almost as utterly disconnected from the earliest of our Eocene Floras as are the true Carboniferous Floras. This strange Flora, composed almost entirely of gymnosperms, can be traced upwards in our area through the Lower Cretaceous to the Chalk. Hardly any Neocomian bed but what has contributed something, either fragments of ferns, or some variety of what may be designated "fir-cones," while the Gault of our country has yielded quite a number of cones, and foliage of gymnospermous plants of many species. Now, although some of these have been found very repeatedly, not a trace of anything approaching a dicotyledon has ever been discovered. Even so late as in the Chalk Marl, if a plant turns up, it is Jurassic in type, such as a flower I found in the Grey Chalk of Dover, shown by Saporta to be a *Williamsonia*, or a cellular plant I ob-

tained from Weymouth, a cone from Blackdown, or the coniferous woods from the Chalk. There is, so far, no change in the plant-life of our area, and if any grand developments were going on elsewhere, at the rapid pace that has been surmised, our Cretaceous land-area was too insular to participate in them. It is, anyhow, a very singular and inexplicable fact that richly dicotyledonous Floras in America and even in Europe are apparently assignable to the same age as our Neocomian, our Greensands and Chalks, which with us contain only a Jurassic Flora. I must say, however, that I am far from admitting the evidence as to the age of these beds to be conclusive, but it would be utterly impossible to enter into so vexed a question here. Enough that as if to compensate for the poverty of our Cretaceous Flora, we possess of Eocene plants a series completely unrivalled, whether as to the variety, the preservation of the species, or the absolute certainty of their relative ages.

At the very base of our Eocenes, below the mottled clay, there is a Flora, splendidly preserved and of great variety, which must for thirty years or more have been dug out or buried under rubbish in the brick-pits near Reading, without so much as a leaf having been preserved until two years ago. Prof. Prestwich, in 1854, caused a few specimens to be figured ('Quart. Jour. Geol. Soc.,' Vol. x, pp. 88 and 163, pl. 4) that were found in a neighbouring railway-cutting; but they convey no idea of the handsome appearance of the *Platanus* leaves, with their fruits, of a large succulent leaf described by Heer as a poplar, and of the numerous other leaves and fruits which I have found in only three or four days' digging.*

A resident showed me a magnificent piece of a leaf, of a form called *Corylus*, or hazel, by Heer, which he had picked up one Sunday, stating that he might have got quantities had he been provided with means of removing them, but that he did not go again.

Leaves have been found of much the same age and in equally fine preservation at Newhaven; but though specimens were figured a generation ago in 1817 by Sowerby ('Brit. Min.,' Vol. v, p. 185, pl. 500), and in 1822 by Mantell ('Geol. Suss.,' pl. 8, p. 262), these leaf-beds have been allowed to drop into the sea, without so much as a specimen being preserved in the interval, until I chanced to rescue almost the last blocks of them some three or four years

* Now in the British Museum.

ago. I must confess to having myself unduly neglected Reading, for my avocations permit but few holidays; and when I am able to take them I must plead to a preference for collecting on such a glorious sea-coast as that at Bournemouth to spending the days in brickyards.

The Flora of the marine equivalents of these beds, the Thanets, has on the contrary been collected when met with; but these occasions are so extremely rare that, beyond fossil woods, only about half a dozen cones are known, and some of these were already in Lindley and Hutton's possession in 1833, and I only know of one specimen having been found, by Mr. Dowker, in anything like recent years. Now, although the Geological Survey examined and described the whole of the London Basin, which is very rich in plant-remains, not a single plant of this age has been saved or preserved in the Survey Collections at the Jermyn Street Museum.

The Woolwich Flora is even in worse case. For example, a rich Flora was cut through at Dulwich many years ago, and though some interest was taken in it at the time, scarcely a leaf now remains to show what it was like. I have also come across traditions of considerable plant-beds, borne out by the occasional preservation of beautifully marked fragments from Mottingham, Charlton, and Lewisham, and I have myself found them at Bromley and in the recent cutting at Croydon. But here again no one has thought to collect more than mere examples, a few fragments sufficing to allay their interest, or, where more have been kept, they have been collected without any knowledge or experience. I have unfortunately personally had to neglect these Floras, from the same causes that operated against collecting more largely at Reading, yet they reveal entirely distinct Eocene periods, and are thus of the greatest interest.

The *Reading Flora* is older and differs from that of Woolwich, marking an altogether more temperate period, and is, we may safely say, identical with some of the so-called Miocene Floras from Greenland. Sir J. Hooker, in reply to Prof. Prestwich, long since remarked upon their temperate aspect, stating that the plants appeared to him to be such as might grow in our latitudes at the present day, an opinion so far amply confirmed. Negative evidence is, however, especially captivating and dangerous in this branch of palæontology, as I shall presently show, but when accepted with becoming caution, it is more than valuable,

it is indispensable. The utter absence of all *Proteaceæ* and *Myricaceæ*, families so universally distributed in later Eocene deposits, of the large-leaved figs, the aralias, the tropical ferns, and, above all, of palms, is a fact too significant to be passed over in estimating the climate. The prevailing leaves are *Platanus*; a species called *Populus Zaddachi* or some near ally, but which is not a poplar; a large compound leaf, probably, from the number of bean-pods found in the beds, papilionaceous, and likely to be an *Acacia*; and a number of willow-like and other leaves which the prevalence of associated fruits may enable us to determine later on.

The *Newhaven Flora* is allied to the Reading Flora by many of its leaves, and especially by the so-called poplar, though this is of much smaller size, as if the climate were less favourable to it, and the Flora is interesting as containing plants also common to that at Dulwich, and would thus appear, if a generalisation may be based on slender evidence, to be rather newer than the Reading Flora, and to link it with the next.

The *Woolwich Flora* is an assemblage of still disconnected handfulls of plants from various localities which chance alone has preserved. It was not till I had collected for two or three afternoons in the Park Hill cutting at Croydon, so recently described by Mr. Klaassen,* that I was able to see that any connection might be established between them; but I am now convinced that it may be done. The Croydon and Dulwich plants seem to be on one horizon and resemble each other so far as the scanty remains preserved from the latter allow us to judge. Both are, at all events, distinguished by the presence of palmetto leaves and certain others peculiarly serrate. A prevailing plant from Lewisham, in Prof. Prestwich's collection, is a *Lygodium*, a fern which usually has somewhat the same habits as our native polypody, and which ranges as far north as the southern United States, where it no doubt grows with similar palmettos. These afford a slight, though sufficient, connection; for, in my experience, the teachings of such indications and the inferences drawn from them are seldom afterwards reversed. The Bromley plant-bed has, so far, nothing that I can definitely pronounce to be common to other localities, but lithologically it so exactly resembles the Woolwich plant-beds, about which next to nothing is known, that I cannot place it on any other

* *Vide supra*, pp. 226-248.

horizon. *Platanus* and hazel-like leaves connect it with the Reading horizon, but its chief leaves are peculiar, and may later on be determined with a considerable degree of precision.

It is remarkable that these Floras are completely new and undescribed, and, so far as I know, are unrepresented in Europe. They confirm a hitherto only suspected fact, that the temperature during the deposition of the lowest group of Eocenes in Britain was similar to, or not much higher than that of the same latitudes at the present day. I believe, but state my belief with all reserve, that the supposedly Miocene Flora of Mull was of a not remotely different age. The pine-cones and *Osmunda*-stem that have been found in the Thanets, though the former are of extinct kinds, do not contradict the other evidence. The Woolwich Flora marks a temperature gradually increasing towards the tropical conditions that prevailed during the deposition of at least a part of the London Clay.

The *London-Clay Flora* consists exclusively of pyritised fruits and stems, and is therefore different to any other known fossil flora of equal extent. With the exception of Dr. Bowerbank's collection, which may still be consulted in the British Museum, and the large number of fruits sent me by Mr. W. H. Shrubsole, I know of none which have been preserved with any care, and I should be glad to hear if any such exist. They were known and collected as far back as 1709, essays having been written upon them repeatedly since then, and the ripeness of these fruits, at the time they were imbedded, leading to the publication in the 'Philosophical Transactions' of the quaintly heterodox contention that the Deluge must have occurred in autumn instead of in spring. A list of the fruits is given, none, or hardly any of which it is almost needless to say, ever occurred at Sheppey.* Bowerbank determined a few of the fruits correctly, but outside this all is romance. For further details I must refer to the introduction to 'The Monograph on British Eocene Ferns,' by Baron Ettingshausen and myself in the Palæontographical Society's publications.

From the vast quantities of fruits which have been collected—and I have myself several thousand—it might be anticipated by geologists visiting Sheppey, that one has only to take a bag to the right spot to fill it with choice specimens; but, if this is the belief, disappointment will ensue, for a day's collecting will pro-

* 'Phil. Trans.,' Vol. i, p. 396, Pl. 6.

bably yield but a few indifferent specimens of the commoner forms, unless the search is very diligent. The only plan likely to succeed in a brief excursion is to visit the cottages on the cliff and inquire for fossils, which are always picked up by the copperas and cement-stone collectors, and in this way a number may be bought during a day's visit for little money. Returning by the beach, if the tide serves, the collector should select spots where finer particles of pyrites have drifted, light his pipe, and sprawl, for I know no other term so apt, when many rare seeds, etc., will probably reward his search. He should not fail to call upon Mr. W. H. Shrubsole in the High Street, as a large proportion of the fruits did, and may now, find their way into his possession. Having brought them home and washed them, I should recommend them to be boiled in paraffin-wax, and dried on blotting paper, when they will, I believe, if kept in a perfectly dry place, last for many years. Some two or three years' collecting has put me in possession of nearly a butt of *Nipadites*, the prevailing fruit. It is a perpetual regret that from the time of Bowerbank, at least, until recently, treasures that would have been invaluable in this line of research, have been irrecoverably lost. *Arthrotaxis* and *Podocarpus* are known from single fruits of my own saving, the two forms of *Callitris* from a few rare specimens, *Pinus* and *Ginkgo* from three or four only. That these might have been largely supplemented had anyone troubled to preserve what was picked up, it is needless to say. At Swale Cliff, Herne Bay, we have similar fruits from a lower horizon, and of slightly more temperate aspect, and lower down still, east of Swale Cliff, and at Harwich, we have nothing but pyritised twigs and splinters of wood, evidently the result of a longer drift seaward. At Herne Bay the commonest fruit is the alder-cone, and I have upwards of a hundred of them, a fruit never found at Sheppey; but it shows how relative a term common is, that, though I have repeatedly searched along Swale Cliff, whence they are all obtained, I have never myself picked up one. There is much to say about this Flora, did time permit. It is conspicuous by the total absence of any fruits larger than a walnut, except the *Nipa*, yet it is of tropical, or at least subtropical character. They were evidently drifted into the sea-reaches of an estuary much larger than the Thames, and mingled with a marine fauna and remains of crocodile, turtle, serpents, toothed birds

of great size, &c., showing that the land teemed with a rich and varied life.

None of these plants reappear in the later Eocenes, though *Nipa* is met with in abundance on the Hampshire shore. The shingles of the Lower Bagsshot are naturally destitute of fossils, but the white pipe-clays of fresh-water origin of this age, which come in towards the Dorsetshire limits of the Eocene Basin, take up the tale, with, perhaps, but a slight break in time. I can never think of these, however, without regret, for it is within my own knowledge that perhaps the most marvellous Tertiary Floras that earth has, or can ever be expected to yield, have literally been made into drain-pipes or kneaded into some kind of pottery. No geologist troubled to collect, and the owners of the quarries, seeing plants in such abundance, postponed collecting until there were no more, and only a few have been preserved here and there that happened to have been taken as curiosities by the pseudo-scientific visitor. A few I have come across: some magnificent pieces of palms, acacia-pods, palmate leaves, &c.—but, alas! how fragmentary—were shown me by Mr. Mansel-Pleydell, only the other day, at Blandford: some very large palmate leaves from Corfe were presented by a lady to the Oxford Museum: some broken palms are at Jermyn Street; and this is all. To make matters worse, the thin bed of plants at Alum Bay, on the edge only of the great plant-bearing basin, has at last been washed away by the sea, and although several collections were made and preserved from it, they were not made by botanists, and the essential plant-characters were not kept. Moreover, it never possessed anything approaching the richness or the luxuriant plant-growth preserved in the more important beds on the same horizon to the west. On my last visit, when I could not get more than some half-dozen scanty specimens in all, I found, for the first time, a twig with the fruit attached, proving the well-known conifer of Alum Bay to be a *Podocarp*, together with an exceptionally good specimen of its foliage. This Lower Bagsshot Flora can in future, so far as I can see, only be collected at Studland, but the clays there are so twisted, compressed, and penetrated by rootlets that specimens are of relatively little use or beauty, and they have to be dug for under a grass-covered slope. The all but complete loss of the Flora is lamentable, as from its proximity in age to the Sheppey fruits, its superior beauty and preservation, and completely distinct character, it would have

surpassed all the others in value. Its chief characteristics are the large Fan- and Feather-Palm, great *Ficus*, *Acer*, and *Aralia* leaves, *Comptonia* and other *Proteaceæ*, and *Podocarpus*. It is the first Flora that we find definitely represented on the Continent of Europe, its counterpart occurring in the "Grès du Soissonnais" of the Paris Basin, but in coarse grit, and without any of the beauty of preservation that characterised the exquisite impressions in pure white pipe-clay that have literally "gone to pot."

The Flora which has been most thoroughly collected is that of the *Middle Bagshot* age from the Bournemouth cliffs. I call it *Middle Bagshot* because of the thorough physical break between the beds in which it is contained, and those of the *Lower Bagshot*. The two Floras are completely dissimilar, only an occasional type serving here and there to link them, even in a slight degree, together; yet, while there is so complete a break between it and the Flora immediately preceding, there is no break between it and the succeeding Floras. It therefore forms a base for the *Middle Bagshot* series, which contain, a little higher up, the well-known *Bracklesham Fauna*. Instead of the perfectly pure, milk-white pipe-clays of the lower series, with their white, or blood-red, quartzose sands, we have less pure, buff-coloured, or dark, laminated clays, and buff or grey sands of quite different aspect. The leaves are only worth collecting from about a quarter of a mile of cliff near *Poole Harbour*, or from immediately west and east of the pier. They occur in numerous beds at both places, which are separated by nearly three miles of cliff, which apparently formed the river channel, without fossils or with only imperfectly preserved ones. The leaves and fruits from these two localities differ very materially from each other, being mainly those of forest trees from the more westerly situation, and leaves of forest trees of different kinds, with many palms and ferns, at the other. Although the western beds are certainly the oldest, this difference seems less due to a lapse of time, during which a relatively more temperate climate might have prevailed, than to the station whence the plant-remains were derived having been drier and more elevated. These cliffs have been my collecting ground for twenty years, and I can only roughly estimate the results at some 20,000 specimens which I have thought necessary to keep, exclusive of those discarded. They fill 144 drawers, now deposited in the *British Museum*, yet the variety is by no means exhausted.

The handiest tool for an ordinary collector is a light pickaxe, and the best way to commence is to walk along the shores and split open any clay blocks that may have fallen down, and, if any fossils are met with in this way, to trace the bed in the cliff and work down with a spade upon it. If any serious collecting is contemplated, the latter tool will be a necessity. Having cleared away the super-incumbent clay or sand, a shelf of the leaf-bearing clay is exposed, and this should be worked with an old table knife, the clay being flaked up with a downward cut. If there is any strongly-marked leaf beneath, it will form a cleavage plane and show itself, and a very little practice will enable one to wholly expose it without injury, and if it should be attached to a branch, to trace out the latter. Should the branch extend farther into the cliff than the area exposed for working, a newspaper should be laid over the part already exposed, and the cliff worked back as far as necessary. No matter how many pieces it may break up into before it can be basketed—and the basket should be wide and flat—every fragment should be carefully saved and pieced together at home, and no portion of a specimen, however large it may prove, be avoidably left behind. A blunt pen-knife will best clear the leaf from matrix, and when the margin is completely clear and the apex and stem traced to their uttermost limits, the specimen should be lightly brushed with a weak solution of gelatine dissolved in boiling water. These remarks apply equally to collecting from all the older leaf-bearing Eocene beds previously mentioned. The alternations of solid clay and sometimes sand indurated by iron, resting upon the loosest grits, render the cliffs peculiarly treacherous, and I have experienced some very narrow escapes. In one instance a considerable excavation that was the result of two months' constant work, was filled by a landslip with only a few seconds' warning, and so rapidly that I and a companion, although having time to get clear of the course of the great blocks that tore by, were buried up to our armpits in sand, and were only dug out in time to avoid a still greater fall that occurred a few seconds later. My tools are still buried underneath. In the winter of the same year, when icicles were hanging from the cliff, a fine conifer which I and my brother were exposing, was suddenly buried in sand, and we became aware that a landslip had taken place so near as to have escaped us by only a few inches. Still, notwithstanding these drawbacks, there is no place or occupation likely to restore a person to health more

quickly than these. In former days one could go bare-foot all day and bathe at the moment when the exertion of digging had made a plunge a longed-for delight, while inland the country could be ridden over almost everywhere on horseback. Rain seldom stopped work, and the sheltered cliffs, exposed full to the noonday sun, seemed to carry summer on from early spring to late autumn without intermission. The rapid extension of the town has now robbed fossilising of much of its former charm.

There is no need, even if it were possible, to go deeply into the constituents of this Flora now. The types are mainly Central American, or are now to be found luxuriating on the eastern shores of Asia, while others, again, range through the islands, and are found growing, exactly as they grew at Bournemouth, on the north-east coast of Australia. The Bovey Tracey beds, described as Miocene, undoubtedly belong to this formation, and some of the beds are so exactly paralleled at Bournemouth that specimens from either are wholly indistinguishable the one from the other. They seem to extend into the London Basin, for the only leaf that I have yet seen from this area, one shown me by Prof. Prestwich, is of an essentially Middle Bagshot species, though coming from the nearly unfossiliferous clayey sands ascribed to the Lower Bagshot. Owing to upheaval and contortion, they run into the Lower Bagshots along the base of Worbarrow Downs in a very perplexing way. Their most remarkable peculiarity is the absence of any associated animal life. A few macerated insect-remains, a feather, and a few helicoid shells are the only traces I have ever met with; and this is the more extraordinary, since the Hordle cliffs in the next bay, which are only a section through a delta formed by the same river at a little later period, teem with every variety of animal-remains. East of Bournemouth the Flora is continued up into a series of marine deposits, and is then associated with Mollusca and Crustacea, betraying littoral conditions of life. In some places these beds abound with fruits and seeds, which should be especially sought for after wet weather, when fresh specimens are invariably washed out. *Nipadites* are in greatest abundance, and seem to have been stranded in large quantities. It is impossible to surmise what treasures may have been lost to science by the want of interest in geology shown by the residents, and even by visitors. The Bournemouth Flora was known more than forty years ago, yet no collections of consequence, except my own, exist from the locality. In the meantime, beds

containing plants no longer to be met with, have disappeared through the wasting of the cliffs, and only occasional bits of them that happen to have been preserved serve to show how much has been lost. Thus a bed which formerly contained in great abundance and extraordinary preservation the only known Eocene *Gleichenia*, and a number of other plants equally special to it, had almost vanished before I began to collect, and has now quite gone; and so, no doubt, with many others.

In the purely marine division of this formation, which occupies considerable portions of the coast of eastern Hampshire, and is named after the hamlet of Bracklesham, near Selsea, the Flora has been hitherto represented by rare pine-cones or *Nipadites*, and a few other fruits. I have this year made an addition to the known Flora from Bracklesham in the form of a species of *Posidonia*, a marine genus of phanerogamous plants. It has been identified by Mr. Carruthers, and is interesting as being the first fossil representative of the only species which has not creeping stems, and which at the present day occurs on the coasts of Australia and of the Mediterranean, and nowhere else. It may be seen at low water near Selsea, dotted over the surface of the *Cyprea-Bowerbankii* bed. The recent species appears to grow in 20 to 60 feet of water, and the well-known hair-balls, matted balls of vegetable tissue from the size of an egg to that of a cricket-ball, which sometimes strew the shore near Marseilles, are the *débris* of this plant. Its discovery helps to an understanding of the conditions under which the Bracklesham beds were formed, and throws some light on what is now the very singular distribution of the species. All fossil plants from our Eocene marine deposits require a great deal of attention before they can be preserved, and should be repeatedly dressed with dilute size before being put away, and must even then be kept in a very dry cabinet.

Towards the base of the *Barton series* at High-Cliff fir-cones are sometimes washed out in great abundance, and Mr. Keeping tells me that on one occasion he thinks he might have collected twenty; but as at that time he was collecting specimens for sale, and there was no likelihood of their being purchased, he left them. I have often seen fragments myself, but have never obtained any very satisfactory specimens.

The *Lower Headon* at Hordle is singularly rich, as is well known, in mammalian and reptilian remains, as well as in fresh-water

shells. It is evidently a section across a river-delta, and certainly formed by the same great Eocene river. We should expect in such deposits to come across plant-remains, nor need we be disappointed, for some of the darker and more clayey beds contain them in abundance. They are far from attractive, however, though exceedingly interesting as filling a gap in our long sequence; but at uncertain intervals a plant-bed is exposed on the beach, which yields fine specimens. Mr. Keeping has enriched the Woodwardian Museum with several pieces of a large Feather-palm and other leaves, all apparently of Bournemouth species. Beautiful fruits and cones are washed out by every shower, and some of the beds are quite full of seeds. One zone, quite thickly peppered with seeds as large as grains of mustard, extends through the Hordle as well as the Headon-Hill cliffs, and it would be very interesting to find what plant shed its seed in such incredible profusion at one especial period, and then vanished.

I know of no plants from the *Middle Headon*, but Mr. Keeping has a few rare examples from clays included in the Upper Headon series of Headon Hill, and is convinced that he might have found many more had he specially searched for them. These are also Bournemouth types. We must of course not omit mention of the "*Chara* limestones" and other *Chara*-bearing bands of the Headon and Osborne series.

The next Flora is that which has been so extensively collected by Mr. J. A'Court Smith from the *Bembridge series* at Gurnet Bay. Plants occur in the clays, but the great bulk of the collection is from a hard septarian band which seems full of plant-remains and of insects. The matrix is so compact and grainless that only those who, like Mr. Smith, have had great experience, are able to cleave it in the right places, and few can therefore hope to be successful. The leaves are all small, and seem to be of Bournemouth species.

There are well known zones of plants and seeds at *Hempstead*, nearly all of them, except a Cypress and a Palm, being of truly aquatic habits. These later Eocene or Oligocene Floras in our country have been very imperfectly studied, and much valuable work remains to be done. The Hempstead Beds terminate our series, and there is a great gap between them and the fossil plants next in age, which occur at Bacton on the east coast, and are of Pliocene or even more recent date.

These English Eocene Floras are supplemented by those Tertiary

Floras of Ireland and Scotland which have been described as Miocene, but no treatise on British Eocene Floras could be deemed satisfactory without especial reference to them. There is in fact nothing known about them which does not rather favour the opinion that they are Eocene, while nothing can be advanced in support of the theory that they are Miocene. I have lately several times visited Ireland and Scotland with a view to study them, and if possible, to set the question of their age at rest. The Irish, and especially the Scotch, plant-beds bear a considerable relationship through their Floras to those of England, but still more so to those of Greenland. As relatively little is known about them I will describe them somewhat in detail.

The plant-beds are included in the lava-flows which have spread over Antrim and the adjoining parts of Londonderry and Tyrone. These now form an elevated plateau, bounded by noble escarpments with precipitous flanks, rising to elevations of 1,000 to 1,500 feet. These lavas have been grouped into three classes, the oldest of which includes highly silicated felspathic trachytes, porphyry, pearl-stone, and pitchstone, without any included fossils. The second comprises basic beds of amygdaloid with bands of bole, volcanic ash, &c., and contains the plant-beds. The third is a series of massive sheets of columnar basalt, and is without fossils.

The whole is evidently a portion, and forms the extreme southern limit of the stupendous outpours of lava which were erupted from fissures during the Tertiaries, and which formerly extended in an unbroken mass from Greenland, through Iceland and the Faroes, to Scotland and Ireland. It is thought by Hull that a considerable time may have elapsed between the three basaltic formations enumerated above, and, supposing the plant evidence to be conclusive in respect of the Miocene age of the middle series, he surmises that the earliest may have been of Eocene age.

Confining our attention to the plant-beds, we observe that they have only been met with in the middle series of basalts. The plants occur in bauxite, in lignite, in clay iron-ore, and in the form of silicified wood. Irish bauxite is a nearly white aluminous earth, which adheres to the tongue when dry, and never becomes plastic when wet. It is quarried in the neighbourhood of Glenarm, a romantic spot on the Antrim coast, and certain layers were formerly dug through which abounded in exquisitely preserved plant-impressions of a dark colour on a nearly pure white ground. It is unfortunate that at the time of working,

no one, not even the Survey officers who were then on the spot, thought it worth while to collect, and except a few stray fragments in the Survey Office in Dublin and elsewhere, none seem to have been preserved. I visited Glenarm with Mr. Swanston, and found the mine disused in consequence of the opening out of richer beds farther west, and it then formed an underground lake, and was completely inaccessible. By digging in the old spoil-bank, which is now a crumbled talus-heap, we found a few fragments of large leaves, and I am happy to say that the courteous owners of this mine and Mr. Sutherland have munificently undertaken to have it drained for me by the early spring, so that I am sanguine of being able to thoroughly investigate the Flora, which is by far the most varied and best preserved of all those included in the volcanic series.

The Lignites are above the Bauxites, and often rest upon them. The thickest beds are from two to five feet in depth, and occur at Ballintoy, a few miles from Glenarm. They are compact, and glisten, and the leaves, almost exclusively belonging to *M'Clin-tockia Lyelli*, are but faintly marked. It is full of compressed trunks of trees, the structure of whose wood is perfectly distinct. Portlock mentions the occurrence of amber in lignites in the face of Craignashoke in Ballynascreen parish. Lignites and bituminous woods imbedded in a loamy earth are met with at many other places in the basaltic area.

Silicified wood has been picked up from time immemorial on the shores of Lough Neagh, and its occurrence has given rise to many pretty fables, the waters of the Lough being long credited with a mysterious petrifying power. Boate, in 'Ireland's Natural History,' 1650, surmised that these pebbles were originally wood, and converted into a stony substance. In a later edition, 1726, silicified trunks are mentioned that could not be moved by a team of oxen, and from which branches were broken off as thick as a man's leg. The derivation of this wood has long been a puzzle, and it has been thought to come from the Boulder Clay, and from the Pliocene Clays of Lough Neagh. These are blue, grey, or purple stiff clays, extending over an area of ten miles * in length

* Dr. J. Scoules, 'Journ. Geol. Soc. Dublin,' Vol. i, p. 231, 1837. Lignite is found in clay or sand forming a circuit of 20 miles round Lough Neagh. Borings at Portmore went through two beds of black wood or coal 25 feet thick, a third 9 feet, and a fourth was bored to a depth of 18 inches, when the rods failed.

and four in breadth, and have been pierced to a depth of 294 feet in the Townland of Armaghmore, including 30 feet of drift. They occupy the shores of the Lough from Sandy Bay to Arboe Point, and include thin laminated sandstones and bands of lignite, which, according to Hull ('Phys. Geol. and Geog. Ireland,' 1878), contain remains of *Sequoia*, *Alnus*, *Quercus*, *Fagus*, and *Salix*. Kinahan believes that the silicified wood is derived from these beds, a view published by Barton as early as 1757, but the evidence appears to me to point to the Boulder Clay as its immediate source. Its ultimate source is in any case the bole-ore from the basalts to the north, and Mr. Gray has obtained identical wood *in situ* from the iron-mines of Bushmills, on the Antrim coast, and it is known from several localities in the Ballymena district. Very little is now left on the shores, the larger specimens having all been removed to adorn neighbouring cottage gardens. It appears to be all coniferous, though there are doubtless many kinds, and it is bleached white exteriorly, but the interior of the larger blocks is still deeply stained by iron, and can be fashioned into table tops or other objects of great beauty. Mr. McHenry ('Mem. Geol. Soc. Ireland,' 1871, p. 17) called attention to the association with these blocks of rounded nodules of ironstone, which, on being broken open, disclosed leaves in beautiful preservation, and with perfectly distinct venation. There are several varieties of these nodules, though all are highly ferruginous, some being very compact, others highly vesicular, some red, some pale grey, and all more or less worn. Some are evidently fragments of once laminated beds, and others are merely nodular concretions. The plant-remains contained in them fracture in all directions, and it is difficult to expose them properly. They appear to differ as a whole from those of the Ballypally iron ores, and to be derived from the Pliocene clays. They resemble the similar ironstone nodules from the Bacton Pliocene in a truly remarkable degree. Mr. Swanston and I found several specimens on the shores of the Lough, and traced them up the Glenavy river, extracting one or two from the Boulder Clay itself. They are now very rare, a second visit, including a most careful search round the shores of Goat Island, having proved quite barren. It is to be hoped that local geologists will look out for them, and more especially that the numerous beds of bole or laterite exposed on the flanks of hills all over the plateau will be carefully examined.

We now come to the plant-beds contained in the iron-ores themselves. These beds are all situated to the north or north-west of Lough Neagh, and are, according to Duffin, about 800 feet above the base of the basaltic formation on the east side of County Antrim, while between Larne and Antrim there appears to be about 600 feet of basalts below them and 400 feet above. Traill places their horizon at 30 to 40 feet below the lignites of Ballintoy. On the coast near the Giant's Causeway the bright red colouring of the bole can be seen on three horizons between the sheets of columnar basalt, but little short of 350 feet of rock intervening between the highest and the lowest of them. They have hitherto yielded no plant-remains on this coast, notwithstanding the hope expressed by Jukes in 1862 ('Student's Manual of Geology') that some of the ash-beds or clays of the Giant's Causeway might contain leaves or other fossils. It seems the universal opinion that the fossiliferous clays of Ballypalidy are on the same horizon as the other ochres or boles, and according to Gray they are met with in the following regular sequence :—

4. Pisolitic iron.
3. Bole.
2. Ochre.
1. Lithomarge.

The following section after Duffin is taken from Kinahan's 'Geology of Ireland,' 1878, p. 168 :—

Glacial drift	...	...	...	...	...	12 feet.
Conglomerate beds, occasionally having thin beds of arenaceous clays and plant remains...	...	...	...	...	...	10 to 12 feet.
Plant-bed, reddish yellow ferruginous arenaceous shale	...	...	...	...	...	5 feet.
Dark shale with plant-fragments and pieces of lignite, the latter increasing in quantity downwards,	...	...	...	...	...	3 feet.
Lignite	...	...	...	...	...	1 foot.
Amygdaloidal dolerite...	...	...	...	...	...	1 foot.
						—
						Total 34 feet.

Hull is disposed to consider the whole of the iron-ores as of lacustrine origin, formed in shallow water, and in a depression of the basaltic area due to the sinking of the surface at the close of a second period of volcanic activity. The iron he believes was brought

down by streams, and was furnished by the decomposition of the basalt, whence it was dissolved out as carbonate and reprecipitated as oxide. This view is probably correct, though it would be important to ascertain whether any similar kind of sediment is now forming in the small lakes which are so constant a feature in volcanic areas at the present day. That the horizon of the boles marked a period of volcanic quiescence is only relatively correct, for not only did some of the most considerable lava flows occur, as seen in the Causeway sections, between the formation of one bed of bole and another, but the finely sedimented clay-ironstone of Ballypalidy is full of cinders, which seem to have been imbedded while almost red hot, and showers of ash frequently fell during their deposition. It is to be inferred that exhalations of gas took place in the bed of these pools, for some of the beds are full of vesicular cavities, and there is throughout a total absence of aquatic life, which may have been due to such a cause. The beds with cavities occur towards the base of the boles, and are mostly rather coarse peperino-like tuffs, speckled with yellow and black. The cavities are often mistaken for the prints of cones or fruits, but the impressions of cones, which are quite abundant on a little higher horizon, are far less deeply marked. When the pine-cones were imbedded with the scales closed the outer form is perfectly preserved, and the cavity only occupied by more or less decomposed lignitic matter, but when the scales were gaping the matrix has infiltrated, and the outer form is almost lost. In this condition they require very careful examination, for cones with thin scales, such as those of *Abies*, *Larix*, and *Picea*, with many varieties of Pine, which would easily escape notice, might be represented among them. So far, however, I have only detected with certainty two very well marked and beautiful species of Pine, one of which seems to have possessed very long and the other moderately long leaves in twos. It is a matter of satisfaction that in these cases all the organs are preserved. The next most abundant plant in these beds is a *Cryptomeria*, the foliage of which has always hitherto been referred by authors to *Sequoia*, and a *Cupressus* with the common type of imbricated foliage, and cones which have been erroneously associated with the *Cryptomeria* foliage, and also described as *Sequoia*. A rarer conifer is one of the *Torreya*s of the Greenland Tertiary Floras, and there are a few others, and traces of ferns which are also of Greenland species. The dicotyledons are few, and I

have not as yet made any comparisons with them. One is a fine water-lily, and others are evergreens, though none are of large size. A very abundant fruit, found with the pine-cones, is the one called a *Magnolia*, from Greenland, by Heer, with every probability of accuracy so far as outward appearance goes, though the absence of any leaves in these beds that could possibly be referred to *Magnolia* suggests caution. The association of such heavy fruits as these, and the presence of fir-cones and needles mingled with the broader leaves of trees, shows conclusively that deposition took place in quite still water, as otherwise their varying powers of flotation would have caused them to be imbedded apart, as in all the freshwater Bagshot deposits. The chief interest of the Flora lies in its absolute identity with some of those of the Tertiary deposits of Greenland, while others it no more resembles than it does that of Mull. It is quite apparent that the so-called Miocene series of Greenland is made up of beds of many ages and kinds, and containing Floras quite distinct from each other. There is at present no evidence whatever as to the correct position of these Antrim beds in the Tertiary series, and they may be greatly older than the Miocene age to which they have so unhesitatingly been assigned. They do not correspond with any of the English Eocene beds, and seem to be newer than the Bagshots.

The *Mull Flora* has been so well described that only a brief allusion to it is necessary. The island is mountainous and very beautiful, and the plant-bed is situated on a headland that is romantic and not too accessible. The plant-remains, which are black and glistening, are in a dark shaly matrix and belong to a considerable number of species. The most abundant is the still existing North American fern, *Onoclea sensibilis*, and next in order comes coniferous foliage which may belong to a *Thuja* like that of Antrim. Among dicotyledons the most characteristic are a *Platanus* and a *Corylus*, and other deciduous leaves with serrate margins. The *Sequoia* of the *S. sempervirens* type, figured by Edward Forbes, seems a rare fossil, and there are few if any other evergreens. The *Thuja*-like foliage and *Corylus* have been found in the Isle of Canna in a similar matrix. The whole Flora is identical with some of the Greenland Floras, and seems to belong to an older series than those from Ireland. It might, in fact, be referred with a high degree of probability to the Lower Eocene period.

The absence of any fruits or cones contrasts with the Irish beds, and seems to imply that deposition took place in moving water.

The only other district, I believe, in Great Britain in which Tertiary plants older than the Pliocene, have been found, is Bovey Tracy in Devonshire. This large deposit, with its flora, was described in the 'Philosophical Transactions' many years ago, but, however excellent the geology in this work may be, the palæontology is full of errors. It is small wonder that, with the subject so handled, the deposits should have been assigned to a formation totally different from the nearly identical and not far distant Eocene deposits of Dorsetshire. I have not yet worked through them personally, as I hope to do, but there is not the smallest room for doubting their identity with some of the Bagshot deposits of the Bournemouth and Poole districts to the east of them.

Having now reviewed all the sources whence Tertiary plants have been obtained in Great Britain, we see what vast areas and varied scenes their collection in the field will lead us to explore.

What can be more enjoyable or healthful than to wander along the Hampshire coast-line, watching the marvellous fossil treasures slowly revealed as the ebbing tide ripples away at Selsea, and, as Cowries, Volutes and giant cockles are bared to view, to picture the vast estuary, long passed away, whose billowy waters were on this very spot the home of the formidable white shark and the blue shark and many kinds of rays, and whose upper waters were the haunt of innumerable crocodile and turtle. Its distant shores were fringed with palm and fenny swamps, whose spoils, the fruits of *Nipa* and a thousand others, were borne by myriads in its currents far out to sea, to become water-logged and sink. Still farther, on perhaps gently undulating ground, were dark belts of impenetrable virgin forest, and discernible beyond in the haze of remote distance under the cloudless sky, were the mountains of Devon and Cornwall, whose wasted remnants furnish the still romantic scenery of Dartmoor and of Exmoor, of the Prawle and the Lizard, and all the wild uplands of Cornwall, but which then formed the last spurs of an Alpine chain of Atlantis. All that combined to make this scenery can be unearthed by us if we will. At Bracklesham and Stubbington, or in the shade of the great chalk cliffs at White cliff Bay, we may pick from the salt mud of the estuary the bones and teeth of fish, the dead shells, corals, and water-logged fruits, and vainly marvel as to what shifts of currents caused now

Nummulites, now *Turritellas*, now *Carditas*, and now *Pectens* to flourish suddenly in millions and then to disappear for ever from the spot. If we would learn the secrets of the upper tidal waters we may dig for bones of crocodile among the myriad river-shells of Hordle; or we may lose ourselves among the terraces and undercliff of Headon Hill, the site of lakes left isolated by a change in the river-bed, and whose slowly formed limestones were the grave of the great West Indian snails which must have revelled in the luxurious vegetation, and of serpents and of mammals; or we may search along the deserted stretch of Hempstead Cliff and Gurnet Bay, whose innumerable alternations of marls, sands and clays teem now with layers of gnats, flies and their larvæ, now with rush, palm and water-lily, now with tropical *Melania*, *Potamides* and *Cyrena*, or the more familiar river-snails and *Unios*. Again, if we would penetrate still farther and form an herbarium from the trees of the forest belt, we have but to dig with pick and spade in the sunny cliffs of Bournemouth, or follow up the plant-beds over the moors to Brownsea Island or secluded Studland, by boat across Poole Harbour, by Upton and Lytchett and Creech Barrow, to many a tile-pit of crimson or snow-white pipe-clay set in the heart of a coppice or on a perfectly bleak moorland; or to wander, and try to reconstruct what has been, in the pits under Worbarrow Downs, where the digging has been on so vast a scale that the ground seems to have been convulsed and is dotted with miniature lakes of bright blue or green water; or to trace them almost through to Dorchester, and finally only to leave them under the shadow of the granite masses of Dartmoor. Nor is collecting nearer home, though deprived of much of the picturesque scenery belonging to what is called the Hampshire Eocene Basin, without a great deal of charm and interest. There is always the certainty that when you do find any well-preserved fossil plants at all, you will find them in quantity, and the strong probability that you will bring back much that is new to science, and which might otherwise have been lost. To discover a new, or re-discover an old plant-bearing deposit is therefore of the utmost importance, and it becomes for these reasons more fascinating to collect from them than from any other kind of fossil-bearing bed, and I cannot express to you how thoroughly absorbed I become when I am on a good vein. Fossil leaves are found in such regular laminae, owing to their deposition at the fall of the year only (for if you remark any tide-way you will see scarcely a leaf

floating about between February and June, while the water is full of them during the autumn months) that the layers form regular planes of cleavage, and you have only then to select from among them the best specimens, looking out especially for fruits or flowers, and to cut them out of the yielding clay, in order to get as many as can possibly be removed. Even the brick-pits of Reading or Bromley become interesting under such circumstances, while the scenery of the cliffs of Reculvers, Newhaven, and especially Sheppey, compare not unfavourably with those of the Hampshire coast. The Eocenes of the London Basin cannot, indeed, be studied without many a ramble over the heaths and moorlands and downs of Surrey and Berkshire; and varied scenery in out-of-the-way nooks of Kent and Essex must become familiar before their story can be unravelled. Going north to search for the nearly contemporaneous spoils of what was then another continent, we meet with sterner scenery, and it would be difficult to find anything wilder in its way than the basaltic plateau of Antrim and Derry. A good deal of it is very desolate, and it becomes almost mountainous in places, while its sea face, often resting on chalk which the lava-flows have baked into marble, occasionally towers into sublime headlands such as those near the Giant's Causeway and Fairhead. This country also possesses interest to other students, for everywhere is evidence of prodigious glaciation, and it must have been occupied at one time by a jökul, as ice-caps are called in Iceland, for there are not only extensive moraines, but the beds of great torrents coming down from it with their enormous masses of rolled shingle, such as are only met with in glaciated regions. Our plant-beds may be followed through the still more romantic scenery of the Western Isles of Scotland, the singularly weird Faröes, or Iceland, and be pursued even to the confines of the Pole itself. We may trace them south through France from the Channel coast, through Languedoc to the Mediterranean, and on through Italy, or eastward through the Alps to the remotest ends of Austria, and even find them cropping out in Greece; while finally, if we would study the more nearly related living Floras in their present habitats, Central America, Eastern Asia, and Northern Australia are among the countries which must be visited. For my part, my only acquaintance with a sub-tropical flora has been in Madeira, and I shall never forget the pleasure that exploring the deep gorges on the northern side of the Isle afforded me, and the

effect of virgin forests, virgin still owing to their inaccessibility, entirely composed of large evergreen, laurel-like trees, clothed with innumerable parasitic ferns. I cannot tell whether I may not some day have the good fortune to visit still more distant forest scenery, and if I do the fall of every leaf and twig will be of interest.

I have here confined myself to but one aspect of the wide subject of fossil plants, and I hope I have succeeded in rousing interest, especially among younger collectors, and that treasures such as those that have been irrecoverably lost during the last few years at Corfe, Hordle, Bromley, Lewisham, Newhaven, Croydon, Dulwich and Glenarm, will, in future, if brought to light under similar circumstances, be as carefully preserved as the Mollusca have been from sections exposed for even briefer periods, as those of Portsmouth, Clarendon Hill and Brockenhurst. This has been my object to-night. Other and wider problems are just touched upon in the Introduction to a part of the 'Eocene Flora' published this year by the Palæontographical Society. The results of collecting fossil plants I must leave to a future time.

ANNUAL GENERAL MEETING.

FRIDAY, FEBRUARY 1ST, 1884.

HENRY HICKS, Esq., M.D., F.G.S., President, in the Chair.

The following Report was read by the Secretary :—

REPORT OF THE GENERAL COMMITTEE FOR THE YEAR 1883.

The Census of the Association on December 31st, 1883, was as follows :—

Honorary Members	...	...	...	...	...	15
Ordinary Members—						
<i>a</i> Life Members (Compounded)	...	...	...	...	...	97
<i>b</i> Old Country Members (5s. Annual Subscription)						17
<i>c</i> Other Members (10s. Annual Subscription)				...		369
Total	...	...	...	...	...	498

During the past year forty-eight new Members were elected.

Three Members have died during the past year, viz., Mr.