"Bulletin of the Museum of Comparative Zoology at Harvard College," Cambridge, Massachusetts, Vol. VI., No. 11, 8vo., 1881. From the Museum.

"Proceedings of the Academy of Natural Sciences, Philadelphia" Yearly volumes for 1876, 77, 78, 79, —, 81, 8vo. From the Society.

"Memoires de l' Académie Imperiale des Sciences de St. Pétersbourg," Tomes xxiii. to xxix. and xxx., Nos. 1, 2, and 5, 4to., 1875-82.

"Bulletin de l' Académie Impériale des Sciences de St. Pétersbourg," Tomes xxi. to xxvii. and xxviii., No. 1, 4to., 1875-82. From the Academy.

"On Chilostomatous Bryozoa from Bairnsdale," (Gippsland). By Arthur Wm. Waters, F.G.S. From the author.

PAPERS READ.

ON THE FOSSIL FLORA OF THE COAL DEPOSITS OF AUSTRALIA.

BY THE REV. J. E. TENISON-WOODS, F.G.S., F.L.S., VICE-PRESIDENT LINNEAN SOCIETY, NEW SOUTH WALES.

In the month of August 1880 a paper was read before the Royal Society of New South Wales from Dr. O. Feistmantel, on the fossil flora of Eastern Australia and Tasmania. This essay comprised a most valuable series of observations on all that was known on the subject of our Australian coal plants, for though it only professed to deal with those of eastern colonies, it included the paleontological flora of Victoria as well. It was a brief epitome of all that was then known of our fossil flora. Dr. Feistmantel, however, laboured under the disadvantage of having only the specimens collected from a comparatively restricted area and numerically few. Had he been able to visit the fields from which the specimens were taken he would have observed that the flora of each particular locality included a much larger number of species

than were contained in his lists. He states that his observations were founded on a collection forwarded to him in 1876 by the late Rev. W. B. Clarke, F.R.S., and on another smaller collection sent in 1878 by the same gentleman, and on several specimens sent to him by Mr. C. S. Wilkinson, F.G.S., government geologist of New South Wales. These picked specimens do not give a complete idea of the flora, and it may be safely asserted that comparisons instituted between one locality and another on small collections are more or less fallacious. Since the publication of the papers referred to I have visited a great many of the coal bearing districts in Queensland, and have made extensive collections. I have found that Dr. Feistmantel's list can now be largely extended. I refer to this list in particular because it is the only one of the kind published in English. It is simply a brief summary of a larger work published in German entitled "*Palaeozoische und mesozoische Flora des östlichen Australiens*,"* and which is inaccessible to most English readers. It is rarely met in the colony and is not yet in any of our public libraries. In the course of this essay it will be seen how largely I have availed myself of this most valuable work. I propose now to go a little further into the subject, and place within reach of Australian students, not only what relates to Australian coal plants, but also a general view of their scientific classification. At present there is no English modern work which will take the place of Schimper's expensive volumes and plates, and moreover to study the fossil flora of Australia scientifically would require a large and costly library. It is to be hoped that what I now publish will supply the want, while it extends the knowledge of the flora. I shall commence with the History or Literature.

* Cassel 4to, published in two parts as portions of a serial work entitled *Paleontologische Beiträge* of which Feistmantel's work forms Part III, 1878, with 18 plates, and Part IV, 1879, with 12 plates. The plates are numbered 1 to 12 in the second part, with a second enumeration (connecting the work with the first part) from 19 to 30. Reference is always made in the essay to the second enumeration. Readers must be on their guard about the typographical errors which are very numerous and not half included in the errata. Dr. Feistmantel being in India was unable to correct the press.

HISTORY.—The first notice of any coal plants of Australia would appear to be by A. Brongniart, who, in his History and Table of Fossil Plants, notices *Phyllothea australis* and some other plants as coming from Australia, but without any further information. * He also gives a description of *Glossopteris browniana* † also an Australian Fossil.

In the Edinb. New Phil. Journ. for September, 1832 and January, 1833, p. 155, we find a notice of the fossil coniferous woods of Australia by Mr. William Nicholl. The specimens were received from the Rev. C. P. N. Wilton, who collected them from Newcastle, Macquarie Lake and other places.‡

In 1845 Prof. Morris gave the first special notice of Australian Fossil Flora in Strzelecki's Physical Description of New South Wales and Van Dieman's Land.§ In this essay he described fossils from Newcastle, New South Wales, and Jerusalem in Tasmania. In summarizing the result of a study of the carboniferous flora, he thought that at the carboniferous period the Australian plants were perfectly distinct from those of the northern hemisphere. He was the first paleontologist who called attention to the resemblance between the local plants of Australia and those of India. He pointed out that there was not only a remarkable analogy of form in some species, but an actual identity in others. It is to be remarked that Professor Morris's *Pecopteris australis* is now regarded as *Alethopteris* and *P. odontopteroides* as *Thinnfeldia*.

In 1847 Prof. M'Coy gave an elaborate report on the Fossil Botany and Zoology of the rocks associated with the coal of

* Prodomus d'une Histoire des Vegetaux Fossiles, p. 152, 8vo. Paris, 1828.

† Histoire des Vegetaux Fossiles 2 vols., 4to. Paris, 1828. Vol. 1, p. 322.

‡ See also The London and Edinburgh Philosophical Magazine for 1832 (vol. 1), p. 92, where there is a paper entitled "Sketch of the Geology of six miles of the south-east coast line of the coast of Newcastle in Australia, with a notice of three burning cliffs on that coast. By the Rev. Charles Pleydell Neall Wilton. M.A., of St. John's College, Cambridge. Fellow of the Cambridge Philosophical Society and Chaplain of Newcastle." After this long title it would seem that a foot-note by the Editor saying that the paper was communicated by the author is somewhat unnecessary.

§ London: Longman, 1845, p. 245.

Australia.* In this report many new species of ferns, &c., are described and figured and their relations discussed at length. The author's descriptions will be considered hereafter, he regarded the plants as of Oolitic age. He summarizes his conclusions thus: "With such evidence as I have mentioned, I do not think it improbable that a wide geological interval occurred between the consolidation of the fossiliferous beds which underlie the coal and the deposition of the coal measures themselves; that there is no real connection between them, but that they belong to widely different geological systems, the former referable to the base of the Carboniferous system, the latter to the Oolite, and neither showing the slightest tendency to a confusion of type."†

From these conclusions, the Rev. Mr. Clarke dissented, and maintained that there is no break whatever between the various beds, but that the fossiliferous rocks are interpolated by the coal beds containing the peculiar plants described. In a paper contributed to the *Annals and Mag. of Nat. Hist.* for Sept. 1848,‡ he enters into proofs of the correctness of his opinion. These are—

1. That Mr. Jukes, after an examination of the Illawarra coast in 1845, then agreed with him that there was no break in the series.
2. That Professor Dana, though differing from Mr. Jukes, saw in the low cliff at Black Head in the midst of the organic remains as described by M'Coy from that locality, the identical fossilized wood described by Mr. Jukes. It was in and above the coal.
3. At Moree (not far from Raymond Terrace), Mr. Clarke found paleozoic fossils associated with impressions of *Glossopteris lineata*.
4. At Anvil Creek good coal is overlaid by a sandstone containing Spirifers and other fossils described by M'Coy; also at Page River, Mount Wingen.
5. Stems and leaves of ferns occur also in fossiliferous beds on the Allyn and various parts of the Hunter River district.
6. At Parramatta casts of shells have

* *Annals Mag. Nat. Hist.* Vol. xx, p. 145, &c.

† *Annals and Mag. Nat. Hist.*, vol. 20, p. 311.

‡ Remarks on the identity of the epoch of the coal beds and paleozoic rocks of New South Wales, p. 209 of 2nd vol. for 1848.

been found in quarries at the very top of the great sandstone, and between it and the Wianamatta beds, which are in the Illawarra escarpment, full 800 feet above the level. And these Wianamatta beds, at Clarke's Hill and elsewhere in the Cowpasture country abound with ferns. The author concludes by saying, "So long as the fossil wood of the coal measures and leaves and stems of *Glossopteris* occur in the same rock, specimens with the *Spirifers*, *Productæ*, *Cornularia*, &c., which I maintain they do. . . . I must take the liberty of expressing my belief from what I have seen and know from actual and careful and repeated examination of a very extensive region during several years, that there is no break in our Australian series of deposits, and that if the paleozoic fossils are of the lowest Carboniferous age, so the age of the coal plants is nearly identical with it."

In this summary three things will surprise geologists of the present day, namely :—Mr. Clarke states that he has found rock impressions of ferns (*Glossopteris*) and *Spirifer*, *Productus* and *Cornularia* on the same rock specimens. 2. All the formations from the coal to the Wianamatta are included as one. 3. The age assigned is the lowest Carboniferous.

The views of Mr. Jukes here referred to were published in the 3rd vol. of the "Quart. Journ. Geol. Soc. Lond. p. 224. *

He described a series of deposits near Sydney about 2000 feet thick which he termed paleozoic. The lowest of the series was called Wollongong sandstone, thick bedded, fine grained often calcareous, containing many concretionary nodules from one inch to two feet in diameter. This was 300 to 400 feet thick with *Stenopora*, *Spirifer*, *Productus*, &c. Above these are 200 feet of strata with coal represented as *not likely to be important*. Then shales and sandstone 400 feet. Then 700 to 800 feet of white or light yellow sandstones, varying from fine grained to coarse, containing quartz pebbles, resembling, as Mr. Jukes thought, the millstone grit and lower coal measures of England. On the whole

* Notes on the Paleozoic formations of New South Wales and Van Diemen's Land by Professor J. B. Jukes.

are shales 300 feet thick, with a few small fragmentary impressions and pieces of leaves, and occasional fish remains. Mr. Jukes believed that there was a perfect conformability in the whole series, and a gradual transition of their divisions into each other.

About the date of the letter of Mr. Clarke to the Annals of Natural History he sent a paper to the Geological Society of London *

In this he took exception to the statement of Count Strzelecki in his work that there was an entire absence of such plants as *Sigillaria*, *Calamites*, *Lepidodendron* and Conifers in the Australian coal beds. After some remarks on the similarity of our coal beds to those of India he gives the following list of coal plants stated to be found in the carboniferous deposits of New South Wales: *Pecopteris*, *Neuropteris*, *Odontopteris*, *Cyclopteris*, *Sphenopteris*, *Glossopteris*. Genus, intermediate between *Teniopteris* and *Glossopteris*, *Halonina*. Cannæform plants: *Calamites*, *Phyllothea*, *Zeugophyllites*, *Equisetum*, *Lycopodites*. New genus of plants with wedge formed stems: *Lepidodendron*, sometimes *Lepidostrophi*, *Ulodendron*, *Sigillaria*, and *Stigmara*, *Coniferae*. He then gives the localities where they are found, stating that *Lepidodendron* occurred on the Paterson and that *Calamites* abound not only at Newcastle but over the Hunter and Illawarra coal regions. He concludes thus "We find also that there is a gradual passage from a fauna usually supposed to belong to the lowest Carboniferous beds of Europe to one still lower in the geological scale in which in Europe no true coal beds have been discovered. And if we adopt the view long ago presented to my mind that the Australian system is the equivalent of the Devonian or embraces that and the Carboniferous formation together, we shall still be met with the fact that Silurian forms are mingled in abundance with a flora supposed to be younger." From this Mr. Clarke suggests that we cannot place our formations on a parallel with any European epoch, but that what was the Silurian

* On the Genera and Distribution of Plants in the Carboniferous system of New South Wales. Proceedings June 16, 1848, vol. 4, p. 60.

Devonian, Carboniferous in Europe, formed one uninterrupted and conformable series of deposits in Australia.

We suppose that some of the fossil plants indicated in Mr. Clarke's list are instances of mistaken identification, because subsequent investigation has not confirmed their existence. Mistakes as to locality, &c., from which specimens were obtained must explain the assertion that *Lepidodendron*, *Ulodendron*, *Lycopodites*, and *Neuropteris* occur in connection with our coal deposits.

In 1849 Professor Dana published* a description of some Australian coal plants. It is remarkable that he regards Morris's *Zeugophyllites elongatus* as *Noeggerathia*, a conifer. The descriptions given by Dana are very elaborate, and the discussions equally so, but he does not believe that there is no break between the paleozoic marine fossils and the plant remains. In 1850 Mr. Jukes published his sketch of the physical structure of Australia, in which he repeated the opinions previously put forth as to the general conformability of the coal and other deposits, and that they all formed one great paleozoic formation without any break. Mr. Jukes believed that we had not any mesozoic formations in Australia, either terrestrial or marine. The work did not throw any light on the paleontology of our coal plants, though many are mentioned by name.

Previous to the year 1851 the Rev. W. B. Clarke sent a *Lepidodendron* to Prof. Sedgwick, and in June of that year Prof. M'Coy wrote from Cambridge to Mr. Clarke stating that the specimen was *L. tetragonum* of the English coal fields, and adding that it was the first *Lepidodendron* seen from Australia.†

With the exception of the *Lepidodendron* all the species described and published by the above authors were included in the second edition of Dr. F. Unger's *Genera et Species Plantarum Fossilium*. Leipsic, 1850. Many of them in Baron A. de Zigno's *Flora Fossilis Formationis Oolithicæ*. Padua, 1856 to 1860.

* United States Exploring Expedition, Vol. X., Geology Appendix, p. 714. Philadelphia, 1849.

† Clarke, *Sedimentary Formations*. 4th edition, 1878, p. 21.

In the latter part of the year 1857 a select commission was appointed by the Parliament of Victoria to examine into the coal fields of that colony. In the evidence published with the report there is much information about coal and the coal plants of Australia, but the opinions given as to the age of both are conflicting. A short time subsequently searches for coal were instituted near Geelong in Victoria, and on the Wannon River in the western part of that colony. The origin of that search was the occurrence of shales with imperfect plant remains in a rock which bore much resemblance to Jurassic strata in Europe. The result of borings was the discovery of fragments of Cycadaceous plants (*Podocarpites*), ferns (*Tæniopteris*, *Alethopteris*) and at the Wannon a Unio (*Unio dacombi*, M'Coy). All these discoveries were recorded in the local papers, the *Geelong Advertiser* and the *Portland Guardian* of various dates in 1859.

In 1860 a long discussion took place between the Rev. W. B. Clarke and Prof. M'Coy as to the age of the beds to which these fossils should be referred. The papers containing this are published in the Transactions of the Royal Society of Victoria for 1860. Prof. M'Coy maintained that the fossils were of Oolitic age, and that as so many were identical with fossils found in the Newcastle seams of New South Wales, the whole should be referred to the same geological horizon. Mr. Clarke combated both conclusions, but the controversy turned more particularly on the significance of *Tæniopteris*.

In the following year Mr. Clarke published a paper on the relative position of certain plants in the coal bearing seams of Australia.* The occasion of the paper was statements by Count de Zigno that—1. Mr. Clarke had reported the discovery of *Sigillaria*, *Lepidodendron* and *Stigmaria* in the coal beds of New South Wales. 2. That these determinations had not been verified. 3. That instead, a series of ferns had been found, which with types analogous to those of India, recalled the Jurassic flora of Scarborough†.

* Quart Jour. Geol. Soc., London. Vol. 17, p. 354.

† Some Obs. on the Flora of the Oolite, Quart. Journ. Geol. Soc., London. Vol. 16 (1860), p. 111.

In reply Mr. Clarke refers to Mr. Selwyn's opinion, that true Carboniferous or Devonian plants occurred in Eastern Victoria and Tasmania immediately underlying the coal-bearing beds and conformable to them. He reiterates that such fossils as he specified had been found in New South Wales, Queensland and Victoria, and gives the localities. He repeats that they are in beds which are conformable to the coal measures—an error which will be subsequently referred to. He also states that the Carboniferous marine fauna of New South Wales including such forms as *Pachydomus*, *Spirifer*, *Orthoceratite*, is intercalated with beds containing *Glossopteris*, *Vertebraria* and *Phyllothea*—a statement which all subsequent observation has confirmed in New South Wales, Queensland and Tasmania. *Tæniopteris daintreei* of M'Coy, was not described until many years after, but references are made to it and the associated plant remains in the Inter-Colonial Exhibition Essays of Prof. M'Coy* and in a note on the same subject in the Annals Mag. of Nat. Hist. for 1862. In 1865 some mention is made of plant remains by Mr. C. S. Wilkinson, in his Geological Report of the Cape Otway district.†

A further contribution to the knowledge of the subject was made by Mr. W. Keene, Inspector of Coal Mines for New South Wales, in a paper on the Coal Measures of that colony, read before the Geological Society of London.‡ In the following year Mr Selwyn, the Government Geologist of Victoria, published an Essay on the Geology and Physical Geography of the Colony of Victoria, in which there were also references to the plant remains.§ At page 20 he says, "I am inclined to believe that the Victorian 'carbonaceous' series is newer than and above the Sydney sandstone."|| It may, perhaps, represent what Mr. Keene, in his paper on the Coal Measures of New South Wales

* On the Ancient and Recent Nat. Hist of Victoria, by Prof. M Coy. Melbourne, 1861.

† Geological Survey of Victoria. Melbourne, 1865.

‡ Quart. Journ. Vol. xxi. May, 1865.

§ Melbourne : Inter-Colonial Exhibition Essays, 1866. Small 8vo.

|| By this term Mr. Selwyn probably indicated the Hawkesbury sandstone, which he supposed to be the same as the coal-bearing strata. It is, however, distinct, often unconformable and, as I believe, an eolian deposit.

(in the Quarterly Journal of the London Geological Society, May, 1865) designates "False Coal Measures" (Wianamatta strata of Clarke). In any case all the evidence hitherto obtained, both paleontological and geological, tends clearly to show that the "carbonaceous," or coal-bearing rocks of Victoria, are newer than paleozoic, and that a great break or unconformity exists between them and the beds that contain *Lepidodendron* and other paleozoic plants in eastern Gippsland."

I need not follow the coal controversy through all the different publications in which it appeared, nor need I give here more than a very brief summary of its stages. The position of Professor M'Coy was, that he did not believe that the beds which furnished the paleozoic marine shells, and those in which *Glossopteris*, *Vertebraria* and *Phyllothea* occurred, were one geologically. He thought that there must be break between them which would give a paleozoic age to the shells and an Oolitic age to the coal plants. Mr. Selwyn's investigations in Tasmania, gave support to this theory. That gentleman in his report, stated he thought that the Jerusalem beds with *Thinnfeldia*, *Zeugophyllites* and *Alethopteris* were conformable to the beds containing true carboniferous marine fossils. He subsequently found that they were unconformable. Mr. Clarke maintained that there was no unconformability in New South Wales. This appears in various papers and letters, notably one on the coal seams of Stony Creek, West Maitland district New South Wales.* As early as 1863 Mr. Daintree had (August 29), written to the Editor of the "*Yeoman and Advertiser*" in Melbourne, stating that having examined the beds at Russell's shaft, Stony Creek, he was convinced that *Glossopteris*, &c., were really intercalated with marine strata containing paleozoic fossils, about whose Carboniferous character there would be no possible doubt. This fact was confirmed in the many subsequent publications of Mr. Clarke, principally letters to the local journals, and his little work on the Sedimentary formations of New South Wales. I must refer my readers to the work itself for details of

* Trans. Roy. Soc., Victoria, 1864, Art 6.

the various arguments. The first edition was published in 1867, as an essay in the Catalogue of the Natural and Industrial Products of New South Wales, forwarded to the Paris Exhibition of 1867.*

But probably the most important advance in the knowledge of Australian Coal Plants was that made by the publication of Daintree's Essay on the Geology of Queensland.† In this Mr. Daintree points out the distinction which must be made between coal plant beds containing *Glossopteris* and others with *Tæniopteris*. The former he stated is in Australia, paleozoic and the latter mesozoic, and that the two kinds of fossils are never mingled in the same beds. The selection of *Tæniopteris* is unfortunate because it is not common and probably included distinct genera according to the classification then adopted. *Thinnfeldia* is a much better typical fossil of the mesozoic beds, and it is never found associated with *Glossopteris*. It is very common and prevails everywhere in Oolitic plant beds. In an appendix to the paper Mr. Carruthers figured and described some Devonian, Carboniferous and Oolitic plants. He did not however, agree with Mr. Daintree in separating the coal formations of Australia into epochs represented by *Glossopteris* and *Tæniopteris*, but thought they might belong to one great period not earlier than the Permian. But Mr. Daintree pointed out that in West Maitland, New South Wales, *Glossopteris* was found in beds distinctly underlying some containing *Spirifer* and other forms which were certainly Carboniferous. This observation has since as already stated been abundantly confirmed, but it was lost sight of at the time. To Mr. Daintree's investigations must be assigned the credit of co-relating the Jerusalem (Tasmania) beds, with those of Ipswich in Queensland, in which no *Glossopteris* is found or the associated marine Carboniferous fauna.

* A second edition was prepared for the Report of the International Exhibition at Sydney in 1870, and on the Industrial Progress of New South Wales for the same year. A third edition was printed for the Philadelphia Exhibition in 1875, and a fourth and last edition for the year 1878, when the veteran geologist was in his 80th year.

† Quart. Jour. Geol. Soc., Lond. vol. 28, 1872, pp. 271, 356.

In the Progress Report of the Geological Survey of Victoria for 1874, Mr. Brough Smyth, at p. 24, states that he found associated together *Pecopteris* (*Alethopteris*) *australis*, one of the characteristic forms of the Jurassic coal beds of Australia, with *Glossopteris browniana*. This identification was confirmed by Professor M'Coy. On the strength of this, Mr. Smyth considered that the whole of the coal of New South Wales and Tasmania is mesozoic, adding, "In New South Wales and Tasmania the coal-bearing rocks lie on limestones, and the fossil fauna contained in these limestones may without doubt be regarded as belonging to the marine paleozoic Carboniferous period," p. 26. In making this statement, Mr. Brough Smyth contradicted all the observations of those who stated that the coal not only lay upon the marine Carboniferous fauna, but was intercalated between. In a geological map published subsequently, he reiterates the above opinion by coloring all the Newcastle coal deposits as carbonaceous, and not carboniferous. No facts were given to confirm these opinions except the discovery of *Glossopteris* as above stated.

In 1876, there appeared in the Geological Magazine* an article from the pen of Dr. Feistmantel on the Gondwana series of India. Speaking of the fossils of the Damuda group, he says—"From the occurrence of the genus *Glossopteris* in these beds they were for a time brought into connection with Australian coal measures, and declared paleozoic." He points out the error of this because, 1, in the Damuda group *Glossopteris* is associated with Triassic plants which do not occur in Australia at all. 2. Because in India *Glossopteris* is never associated with marine paleozoic fossils which do occur in Australia. He adds that "*Glossopteris* grew first in Australia" during the Carboniferous epoch, survived in India, passing perhaps through China when India was in connexion with the European Triassic Continent. (Note at p. 490.)

With reference to *Phyllothea*, he says—it is known in Australia mostly only from the Newcastle coal-field above the marine fauna and from mesozoic rocks in Victoria together with *Tæniopteris*, &c.

* First article in the November number, p. 481.

Phyllothea (Brongniart) however, is best developed in Europe in the Italian Oolite, in which one form has all the genuine characters ; and nothing of this kind is known anywhere in Carboniferous strata. I may add that the difference in form between *Phyllothea australis* and some *Calamites*, is trifling, and it would not be any great violation of the generic characters of either, to call the *Phyllothea* referred to, an Australian *Calamites*. I do not think that the Newcastle species is the same as the one found in the shale of the Hawkesbury sandstone. This will be explained further on.

In 1876 Dr. Feistmantel published some notes on the age of some of the Fossil Floras in India * In this and subsequent publications of the Indian Geological survey he reviewed the question of the age of our coal plants, some more of which had been found unrepresented in the Indian beds. His observations on this subject were continued to the present year, and were scattered through numerous publications, notably the Records of the Geological Survey (Paleontologia Indica, three volumes of which refer to the fossil flora), and the journal of the Asiatic Society. More complete references will be found in the course of this monograph in connection with the plants he dealt with.

From the year 1874 until the present day Professor M'Coy of the Melbourne University, has published various parts of a Prodomus of the Paleontology of Victoria. In these he has figured and described many of the coal plants of Victoria, though payable seams of coal have never been found in that colony. The fossils there published are species of Cycads, Ferns, and Lycopods, The figures and descriptions leave nothing to be desired, and the subject has been treated in an excellent manner. In dealing with such forms as *Pecopteris* (*Alethopteris*) *australis*, *Teniopteris daintreei*, and *Podozamites*, the author justly refers the beds in which they occur to the Oolitic period. He considers them of the same age as those of Newcastle, New South Wales, even though

*Records Geol. Survey India, IX, Parts 3 & 4, also Jour. Asiatic Soc., vol. 45.

these fossils have never been found in the Newcastle beds. But one *Glossopteris* had been found associated with the same fossils in Tasmania, and as *Glossopteris* is the common form in Newcastle he thus correlates the whole.

In 1878 the Rev. W. B. Clarke published the 4th edition of his *Sedimentary Formations of New South Wales*. This was decidedly the most valuable of all this geologist's writings because of the appendices with which it was illustrated. In Appendix XIII, a list is given of all Australian fossil coal plants known to the author. In Appendix XVIII, there is a tabular view of the schemes of arrangement by different authors of the paleozoic fossils of the New South Wales sedimentary rocks. Mr. Clarke's final view was confined to regarding all above the Newcastle series as "supracarboniferous." There is in Appendix XX, a correlation of Australian fossils, exclusive of marine, by Dr. O. Feistmantel, from a MS. letter of February 1878. There are also extracts from letters of the same paleontologist pointing out the resemblances and differences between the Australian and Indian coal beds, the latter being regarded by him as probably of Triassic age.

In the same year, 1878, Mr. W. T. Blandford, F.R.S., deputy superintendent of the Geological Survey of India, published a paper entitled "The paleontological relations of the Gondwana System," a reply to Dr. Feistmantel.* In this paper Mr. Blandford controverts the age assigned by Dr. Feistmantel to some subordinate members of the Gondwanas, and lays much stress on the paleozoic age of the Australian coal, which has fossils in common with the Indian beds, and which consequently should be considered paleozoic also.

In this year also appeared at Cassel, the first part of the work of Dr. Feistmantel on the Australian Paleozoic and Mesozoic Floras. This has been already referred to. The second part appeared in the end of 1879, and in 1880 the same author gave an abstract of his views to the Royal Society of N.S.W., in a paper mentioned previously.

* Records of the Geol. Survey of India. No. 1, 1878, Vol. XI., p. 145, &c.

In 1879 there appeared in Brisbane, Queensland, published by the Government printer, a report of Mr. R. L. Jack, Government Geologist, on the Bowen River Coal Fields. In this the author enumerates *Glossopteris browniana*, *Phyllothea hookeri*, and other plants intercalated with beds containing *Spirifer*, *Productus*, and other Brachiopoda, besides corals, and encrinites of recognized Carboniferous age.

The report of Mr. C. S. Wilkinson, the Government Geologist, for 1880, contains references to fossils from coal formations in the northern portions of the colony of New South Wales.

I have not included in this list the catalogue of Australian fossils by R. Etheridge, jun., and of the works in which they are mentioned, but it will be useful to consult it where a good knowledge of the synonymy can serve as a guide.

In 1881, the third volume of the Fossil Flora of the Gondwana system appeared. In this, Dr. Feistmantel gives his final views of the relations of the upper Newcastle seams. He regards them as mesozoic (lower Trias), and very nearly on the same horizon with the Bacchus Marsh sandstone, and the Indian Kaharbari coal beds.

This includes nearly all the literature of the subject of any importance. There have been a few more recent discoveries of additional species of coal plants made by myself, which have been recorded in the Transactions of the Royal Society and Linnean Society of New South Wales for last year.

AUSTRALIAN COAL FORMATIONS.

Upper Devonian.—Iguana Creek, North Gippsland, Victoria. Red rubbly rock with slate-colored calcareous veins and patches, overlaid by claret-colored micaceous grits, and hard olive flags with plant impressions of *Archæopteris howitti*, *Sphenopteris iguanensis* and *Cordaites australis*. The whole group is composed of—1, coarse conglomerates; 2, sandstones; 3, shales. They lie unconformably on the middle Devonian, and pass quite conformably into the lower Carboniferous.*

* See Report of Progress Geological Survey of Victoria, No. III, 1876, p. 237. In this report there is a most elaborate description of the Devonian rocks of North Gippsland by Mr. Alfred Howitt.

LOWER CARBONIFEROUS.

Queensland.—Slates and breccias, with yellow, pink, and brown sandstones and quartzites, containing plant impressions and casts of *Lepidodendron nothum*, *L. veltheimianum*, *Calamites radiatus*, *C. varians*, *Cyclostigma australe*. Conoona River, Broken River, Mt. Wyatt, Medway River, Bobuntangen.

New South Wales.—Back Creek (Barrington Diggings), Manning River; Goonoo Goonoo Creek; Smith's Creek, near Stroud, Rouchel River, Canowindra, Cowra.

Victoria.—Red and yellow micaceous carboniferous sandstones, lying unconformably on the upturned edges of true Devonian rocks, with *Lepidodendron australe*, Avon River, Gippsland, five miles above Bushy Park.

PERMIAN ?

Queensland.—Bowen River, a tributary of the Burdekin, ferruginous sandstones with coal seams, *Glossopteris browniana*; blue shale with *Glossopteris*, *Phyllothea*, and other plant remains, intercalated with marine beds containing *Productus clarkei*, *Strepatorhynchus crenistria*, *Fenestella*, &c., and dioritic laccolites, which have destroyed the coal.

New South Wales.—Arowa, with *Rhacopteris inequilatera*, *Glossopteris lineata*; Greta Creek and Anvil Creek, (both close to each other) with *Annularia australis*, *Glossopteris primæva*, *G. browniana*, *G. elegans*, *Nöggerathiopsis prisca*; all underlying marine beds, with *Spirifer glabra*, *Aphanaia mitchelli*, *Productus*, *Conularia*, &c. Sandstones, conglomerates, sometimes of large size and rounded pieces of shale, blue and black ironstone bands and coal seams; Stoney Creek with *Glossopteris browniana* var. *præcursor*; Wingen.

Victoria.—Not known.

Tasmania.—The Mersey coal field, Don River, Spring Bay, Valley of the Derwent. Various species of *Glossopteris*, *Phyllothea hookeri*, *Vertebraria australis*.

NEWER COAL. TRIAS ?

Queensland.—Dawson River basin, Comet River ? I have seen no fossils from this locality, but I visited a coal seam near Blackwater which appeared to be continuous with the Dawson basin. The most of the country is overlaid by trap of tertiary origin. Tolmies Range or plateau, raises the Comet basin 600 feet above the Dawson. The sandstones are of the nature of the Dawson and Newcastle basin. I should think borings might meet with coal seams anywhere between the Dawson and Comet, where thick beds of trap rock do not offer an obstacle. Cooktown ? Oakey Creek.

New South Wales.—Newcastle, ferruginous sandstones with coarse waterworn conglomerate ; at the base finer conglomerates ($\frac{1}{2}$ -inch pebbles) occasionally blue shales, with *Phyllothea australis*, *Vertebraria australis*, *Glossopteris browniana* and six other species, *Sphenopteris lobifolia*, var. *exilis*, *Caulopteris adamsi*, *Nöggerathiopsis media*. Mulimbula, near Newcastle, with the same species and *Zeugophyllites elongatus* ; Raymond Terrace, same as Newcastle. Blackman's Swamp, west of Sydney, *Glossopteris browniana*, *G. tæniopteroides*, *G. Wilkinsoni* ; Bowenfels, species of *Glossopteris* and *Vertebraria* with *Gangamopteris clarkei*, *Brachyphyllum australe* ; Guntawang (193 miles west of Sydney), *Gangamopteris angustifolia* ; Illawarra, *Glossopteris* many species, and *Noggerathiopsis spathulata*.

Victoria.—Bacchus Marsh sandstones with *Gangamopteris angustifolia*, *G. spathulata*, *G. obliqua*. These beds are classed by Feistmantel with the Newcastle beds on the evidence of these fossils. No others have been found.

Tasmania.—The upper and lower coal have not been distinguished in Tasmania, though doubtless both are represented.

RHÆTIC OR LOWER LIAS.

Queensland.—Burnett River.

New South Wales.—Talbragar River, Ballinore, near Dubbo, with *Walchia milneana*, *Merianopteris major*, *Alethopteris currani*, Clifton, Darling Downs.

Victoria and *Tasmania* not known

UPPER LIAS ?

Queensland, Burrum River, near Maryborough. I have seen no well preserved plant remains from these beds, but they seem to me to be beneath the Ipswich coal seams and above those of Burnett river (60 miles away). Darling Downs near Toowoomba, underneath basaltic rock, the same flora as above with *Sagenopteris rhoifolia*, Talgai with *Otozamites mandeslohi* and *Sagenopteris rhoifolia*, and near Leyburn.

JURASSIC.

Queensland.—Ipswich coal basin has an area extending about 50 miles round Moreton Bay. Fossils—*Equisetum rotiferum*, *Phyllothea concinna*, *Vertebraria equiseti*, *Sphenopteris elongata*, *aneimoides*, *flabellifolia*, *A. fl. var. erecta*, *Trichomanides laxum*. *T. spinifolium*, *Thinnfeldia indica* or *media*, *T. australis*, *T. odontopteroides*, *T. falcata*, *Cyclopteris cuneata*, *Alethopteris australis*, *Teniopteris daintreei*, *T. carruthersi*, *Angiopteridium ensis*, *Podozamites lanceolatus*, *Brachyphyllum mamillare*, *Cunninghamites australis*.

New South Wales.—Clarence River. *Teniopteris daintreei*, *Alethopteris australis*. Carbonaceous shales, conglomerates, and sandstones of great thickness but no coal of value.

Victoria.—The shales belonging apparently to this formation occupy (according to the late Government geologist, Mr. A. R. C. Selwyn, F.R.S.*) four distant areas. Wannon and Glenelg, 349 square miles, Cape Otway, including Barrabool Hills and Indented Heads, 1882 square miles; Cape Patterson to Traralgon and Latrobe Valley, 1436 square miles, Welshpool 315 square miles. Very few sections have yet been found that show clearly the relation of this carbonaceous formation to the older strata upon which it rests. In a few instances it is clearly seen to have been deposited on granite, the detritus of which, not much waterworn, enters largely into the composition of some of the beds. In one case in the Valley of Latrobe, near Traralgon, it is found resting on the upturned edges of the auriferous Silurian rocks, and the

* See notes on Phys. Geo., &c., of Victoria, p. 17.

lower beds of the carbonaceous formation consist of thick masses of an angular brecciated agglomerate of small fragments apparently derived from the adjacent Silurian strata. A great similarity in general mineral and lithological character obtains throughout these rocks in the several districts. Alternating masses of hard and thick bedded sandstone and argillaceous shale, occur in all parts of the series, and occasionally thin bands of hard grey or brown calcareous rocks are met with, so that there are no distinctive or characteristic groups of beds which would render their co-ordination possible in widely separated localities. The prevailing color of the strata, especially of the sandy beds, is a dull greenish gray, occasionally passing into brown. The shales are commonly dark grey, blue or almost black; and the latter often contain a good deal of sulphide of iron. Not unfrequently large portions of thick branches or trunks of trees are met with, horizontally imbedded. Calcareous spar occurs either in veins or forming a thin coating on the faces of the joints, and concretionary nodules of carbonate of iron. The beds are often spread horizontally over large areas, with never a greater dip than 20 degrees. There is much diagonal or false bedding. Thin and variable seams of coal are found of poor quality, and never permanent as far as they have been explored. The fossils are *Phyllothea concinna*? *Podozamites barclayi*, *P. longifolius*, *P. ellipticus*, *Tæniopteris daintreei*, *Alethopteris australis*, *Sphenopteris* sp.

Tasmania.—Jerusalem basin, with the above fossils and *Thinnfeldia odontopteroides*, *Zeugophyllites* (*Podozamites*) *elongatus*.

Spring Hill.—The same fossils. Mr. Brough Smyth, found *Glossopteris browniana* associated with the same fossils, from some of these beds. Position uncertain.

Queensland.—Desert sandstone, an eolian formation, in isolated patches all over the colony. Fossils: Coniferous wood converted into brown coal and jet. Lies above Jurassic coal.

New South Wales.—Hawkesbury sandstone, a similar formation all over the colony, but principally massed in the Blue Mountains. Fossils: *Thinnfeldia odontopteroides*, *T. indica*? (Dubbo). Equisetaceous stems. Lies above Triassic coal.

Victoria.—I am strongly inclined to think that some of the carbonaceous beds of Victoria represent these beds.

Tasmania.—Not known. I have not included any of the Wianamatta beds in this list, as I am uncertain of their true position. They appear to contain the same flora as the Hawkesbury rocks, and cannot be distinguished from them.

POSITION UNCERTAIN.

Queensland.—Plant beds at Rosewood, west of Rockhampton, with *Ptilophyllum oligoneurum*, *Vertebraria towarrensis*, *Sequoiites* (?) *australis*, *Pecopteris*, *Equisetum* and *Ptilophyllum* have hitherto been known only from India.

General Summary.—It will be seen from the foregoing history of the literature of our plant fossils, that the controversy was narrowed in the end to very small limits. It was simply this :—Are the characteristic plants of the Newcastle coal found under the marine paleozoic fossils. Unless we reject all evidence, we must come to the conclusion that they are. Secondly, the question is :—Have these plants a mesozoic facies? We must certainly answer in the affirmative. This is to say one species, *Glossopteris browniana*, is found in beds as high as the Jurassic in India, and is a common fossil in lower mesozoic formations there. The genus is also well represented in the mesozoic rocks. The other instance of mesozoic forms in the Newcastle beds are doubtful. *Vertebraria* is probably the root of an Equisetaceous plant, and these roots present much the same appearance in every formation, and, therefore, are not important in this question. *Phyllothea* is probably the plant of which *Vertebraria* is the root. The *Phyllothea* of the Newcastle coal is closely allied to *Equisetum* but with very long terete leaves round the sheath. This is the only way we have of identifying it. Stems alone without the leaves are such as might belong to several different plants. It may be safely affirmed that the Newcastle species of *Phyllothea* is confined to the upper and lower coal, and that any identification above that depends upon the stems which may have belonged to

other species. Finally there is a conifer named *Brachyphyllum australe* found at Bowenfels, with *Glossopteris browniana*. The genus is mesozoic, but this species differs in important particulars from the mesozoic form.

So the question narrows itself into the occurrence of *Glossopteris browniana*. It is found in India in the Lias and Jurassic beds, but only one instance has been related of its occurrence in the Jurassic in Australia. That is Mr. Brough Smyth's instance from Jerusalem in Tasmania. On the other hand we have a well marked Oolitic flora in the beds just named in Ipswich, Queensland, and in many places in Victoria. The fossils of this formation, such as *Thinnfeldia*, *Alethopteris*, *Tœniopteris*, *Equisetum* and *Podozamites* are never found in any of the Newcastle series. There is no confusion of type whatever between the two formations except in the case of *Gl. browniana*. We may explain this by supposing one of the two things. 1. The persistence of this type through a very long period of time in Australia, where we have the traces of its earliest existence, and finally dying out in India. 2. Or we may suppose that the coal of Australia represents an accumulation during a vast unbroken period, beginning in the Permian and terminating in the Jurassic epoch. If this has been the case, there are wanting many leaves of the history. The break is very nearly complete between our Trias and Jurassic.

Dr. Feistmantel, whose experience among the coal plants of Europe, India, and Australia is very great, is inclined to regard our upper Newcastle beds as Trias. The marine fossils beneath them are more Carboniferous than Permian, and though the coal plants are evidently different, they are not like the Carboniferous. It is hard to account for this anomaly. In the present day, the Australian Flora is several epochs behind Europe; then it must have a little in advance.

The eastern side of Australia from north to south is very rich in coal, and, what is unusual, the Jurassic beds produce abundance of good fuel in compact workable seams. The resources in this

respect of New South Wales and Queensland are comparatively inexhaustible. These mineral riches must surely lead in a remarkable degree to great future commercial prosperity.

LIST OF FOSSILS.

Before commencing the diagnosis I should state something as to the manner in which the coal fossils occur in the various beds. As a rule, though plant impressions are abundant above and below every coal seam, they are seldom perfect enough for determination. There is an exception to this in the case of *Glossopteris browniana*. It is most abundant on the shale above all the coal seams about Newcastle, and always beautifully preserved in black coal impressions on a blue ground showing the net venation well. There are also brown impressions on a buff-colored rock. In the Ipswich coal seams (Queensland) the plants are often most abundant in a black shale. It is in this manner *Podozamites distans*, is often found, and *Thinnfeldia*. But the latter with other ferns are found as yellow, red, or pale brown impressions on a hard blue slaty rock. In this the venation is rarely well preserved. The red impressions are entirely formed of per-oxide of iron easily falling into powder, in which nerve marks are never preserved. This is common at Rosewood (Ipswich).* At the same place there is a dull yellow very soft clay with numerous black impressions of plants, well preserved but brittle. In the Bundaberg coal seams the fossils are black shining imprints on a hard blue shale. At Tivoli the plants are in a soft grey shale with cuts like clay or breaks into fine powder. The *Vertebraria* fossils in this are only impressions of the same colour with rarely a little coal entangled in the marks; the other fossils consist of impressions of plants of a pale brown. At Darling Downs, near Toowoomba, the fossils are all in limonite or ironstone concretions, evidently derived from a volcanic rock. They are either leaf

* I must put readers on their guard about this name. There are two places called Rosewood in Queensland, and both distinguished by rich plant beds. They are nearly 400 miles apart—one is a railway station about 10 miles from Ipswich, the other on the railway 25 miles from Rockhampton.

impressions of a bright red colour on a brown stone, or bright yellow on a red ground. At Rosewood, Rockhampton, the impressions are in a hard siliceous chert without a trace of carbonaceous matter. In this the impressions are sharp and very hard with the venation beautifully displayed.

In the determination of plants I have followed closely the system and nomenclature of Schimper in his *Paleontologie Vegetale*. Some of the plant remains have involved me in considerable doubt, but in giving names and descriptions I am far from supposing that my views of their character will be accepted by more experienced fossil botanists. I think, however, something has been done when a name and a diagnosis has been recorded, so that similar fossils may be recognized elsewhere.

LIST OF FOSSILS HERE DESCRIBED.

EQUISETACEÆ.

Phyllothea australis. Brongn.

P. ——— *ramosa*. M'Coy.

P. ——— *hcokeri*. M'Coy.

P. ——— *concinna*. nobis.

P. ——— *carnosa*. nobis.

Equisetum rotiferum. nobis.

Vertebraria equiseti. nobis.

Vertebraria towarrensis. nobis.

V. ——— *australis*. M'Coy.

Calamites radiatus. Brongn.

C. ——— *varians*. Germar.

Annularia australis. Feistm.

Sphenophyllum sp.

FILICES.

Sphenopteris lobifolia. Morris.

S. ——— *alata*. Brongn.

S. ——— var. *exilis*. Brongn.

S. ——— *hastata*. M'Coy.

S. ——— *germanus*. M'Coy.

- Sphenopteris plumosa*. M'Coy.
S. ——— flexuosa. M'Coy.
S. ——— iguanensis. M'Coy.
S. ——— elongata. Carruthers.
S. ——— crebra, nobis.
S. (Aneimioides) flabellifolia. nobis.
S. (Aneimioides) var. erecta. nobis.
S. ——— glossophylla. nobis.
Trichomanides laxum. nobis.
T. ——— spinifolium. nobis.
Trichomanides baileyana, nobis.
Aneimites iguanensis. M'Coy.
Archæopteris howitti. M'Coy.
A. ——— wilkinsoni. Feistm.
Rhacopteris inæquilatera. Goeppert.
R. ——— intermedia. Feistm.
R. ——— röemeri. Feistm.
R. ——— septentrionalis. Feistm.
Neuropteris (Aneimidium ?) australis, nobis.
Thinnfeldia media. nobis.
T. ——— australis. nobis.
T. ——— odontopteroides. Morr.
T. ——— falcata. nobis.
Odontopteris microphylla. M'Coy.
Cyclopteris cuneata. Carruthers.
Pecopteris tenuifolia. M'Coy.
Alethopteris australis. Morr.
A. ——— currani. nobis.
A. ——— concinna. nobis.
Merianopteris major. Feistm.
Tæniopteris daintrei. M'Coy.
T. ——— carruthersi. nobis.
Macrotaeniopteris wianamattæ. Feistm.
Angiopteridium ensis. Oldham.
Glossopteris browniana. Brongn.
G. ——— linearis. M'Coy.

- Glossopteris ampla* Dana
G. ——— reticulata. Dana.
G. ——— elongata. Dana.
G. ——— cordata. Dana.
G. ——— tæniopteroides Feistm.
G. ——— wilkinsoni Feistm.
G. ——— elegans. Feistm.
G. ——— primæva. Feistm.
G. ——— clarkei. Feistm.
Gangamopteris angustifolia. M'Coy.
G. ——— spathulata. M'Coy.
G. ——— obliqua. M'Coy.
G. ——— clarkeana. Feistm.
Sagenopteris rhoifolia. Presl.
S. ——— tasmanica. Feistm.
Gleichenia dubia. Feistm.
G. ——— lineata. nobis
Jeanpaulia bidens. nobis.
Caulopteris adamsi. Feistm.

LYCOPODIACEÆ.

- Lepidodendron australe.* M'Coy.
L. ——— nothum. Unger.
L. ——— veltheimianum. Sternb.
Cyclostigma australe. Feistm.

CYCADACEÆ.

- Podozamites barkleyi.* M'Coy.
P. ——— ellipticus. M'Coy.
P. ——— longifolius. M'Coy.
P. ——— lanceolatus. Lindley & H.
Zeugophyllites (Podozamites?) elongatus. Morr.
Ptilophyllum oligoneurum. nobis.
Otozamites mandeslohi. Kurr.
Nöggerathiopsis spathulata. Dana.
N. ——— prisca. Feistm.
Cordaites australis. M'Coy.

CONIFERÆ.

Brachyphyllum australe. Feistm.

B. ——— mamillare var. *crassum.* nobis.

Sequoiites ? australis, nobis

Walchia milneana. nobis

Cunninghamites australis. nobis.

Araucarites polycarpa. nobis.

It will be seen from the foregoing list that some European and Indian forms have been added to the Australian coal flora. This is especially observable in the Jurassic beds. *Brachyphyllum mamillare* var. *crassum* and *Podozamites lanceolatus*, Europe. *Angiopteridium ensis* and *Merianopteris major* of India, are instances, and no doubt others will be found. The occurrence of the genus *Ptilophyllum* in Australia is very remarkable. It will be seen that our continent is particularly rich in species of *Thinnfeldia* and Ferns of a similar type in the Jurassic rocks, while we are equally rich in species of *Glossopteris* in the earlier periods. Altogether the fossil botany of Australia reveals a former connection of its flora with Europe through India, when the vegetation of the earth was much more uniform than it is now.

EXPLANATION OF TERMS USED IN THE DIAGNOSIS OF FOSSILS.

Rhizome.—The fleshy, scaly, prostrate stem, producing roots from the under side, and fronds from the upper, beginning with the

Stipes or main stem, which generally branches into sub-divisions, each of which is called a *Rachis*. The frond may be one entire leaf, when it is called *simple*, or once sub-divided (*pinnate*), twice, thrice, or more often (*bi-pinnate*, *pinnatifid*, *multifid*, &c.).

In compound fronds the primary divisions are called the *pinnæ*, and if more than once divided the ultimate divisions are termed *pinnules*.

Costa.—The midrib of simple fronds or *pinnæ* or *pinnules*.

Veins.—The secondary nerves which emerge from the *costa*.

Venules.—First sub-divisions of the veins.

Veinlets.—Secondary sub-divisions.

In some families the costa is central, and in others it is not in the centre and is called lateral.

Evanescent.—Not reaching the apex or margin.

EQUISETINÆ.

The plants which compose this class (says Schimper) are only at present represented by one genus, that of the *Equisetums* or Horse-tails, which itself is not directly related to any other type of vascular cryptogams. There exists but one genus in the present day with only a few species, which are united together by very concise characters, and they do not pass by any degrees into any other genus. These plants play a very insignificant part in the world's vegetation just now, but in the coal period and lower mesozoic it was not so. Both in species and individuals the Equisetaceæ played a most important part. In fact the great mass of the coal is supposed to have been formed by them.

The fossils are divided into two orders, the Equisetaceæ and the Calamiteæ. The former is thus defined: herbaceous or arborescent plants; stems rising from an underground articulate branched rooting rhizome, nearly always fistular. *Rhizome*—underground, jointed, branched, rooting. *Stems*—jointed, nearly always hollow. *Joints*—separated by a diaphragm. *Leaves*—connate into a sheath, rarely separate at the ends, forming a cylindrical covering often grooved lengthwise, externally permeated by a double series of alternating lacunæ. *Branches* arising beneath the base of the verticillate sheath, simple, in whorls, or wanting. *Reproductive organs*—arising from a lobed fugacious prothallus. *Fructification*—in a terminal spike. Receptacles pedicillate, verticillate under hexagonal shields. *Sporangia*—in groups round the perpendicular pedicels, opening laterally.

The greatest development of this *family* is in the Carboniferous and Permian formations. There it is represented by a great number of genera and species which have no forms at all like them in the present vegetation, such as *Calamites*, *Asterophyllites*

and *Sphenophyllum*.* They are the coal-forming plants of the Carboniferous period and some of the names are used by Prof. Geinitz as typical of certain zones. There is no evidence of the existence of any of the three named genera after the Permian period. Dr. Feistmantel is of opinion that even the genus *Equisetum* was present in the coal formation. Of its presence in the mesozoic strata he says there can be no doubt, but in that case it is associated with genera which are not found in the coal measures.

The mesozoic *Equisetaceæ* are confined to the genera *Equisetum*, *Schizoneura* and *Phyllothea*. *Schizoneura* has not yet been found in Australia: of *Phyllothea* I shall treat subsequently. *Equisetum* is a genus which has not hitherto been found in Australian coal deposits; I have now to record its occurrence abundantly at the Walloon mine, Ipswich, Queensland.

Before describing the species it is necessary to remark that Messrs. Morris and Oldham did not consider that they were justified in using the word *Equisetum*, as they were not sufficiently sure of the identity between the fossil and living genera. They employed the term *Equisetites* (Flora Rajmahalensis tab. II and XXXV.), but gave only a figure without any description. Saporta and Schimper, and according to Feistmantel, many others, use the word *Equisetum*, which I employ in the sense they do.

As the genus *Equisetum* or Horsetail (French *Prêle*, German *Schachtelhalm*), is not known in Australia, a few words about it may be useful. They are leafless branched plants, with a striated stem in the outer sheath of which a very large quantity of silica is secreted. The stem is easily separated into joints, where it is found that each joint has a whorl of teeth forming a sheath. It is fistular, having many longitudinal cavities in its circumference, but is coated externally with a layer of hard woody tubes, from

* These are the views of Brongniart, Suckow, Feistmantel and others but Prof. Williamson and Prof. Renault (Paris) both regard the two last named genera as nearer Lycopods than any other plant. See Feistmantel, "Jurassic Flora of the Rajmahal group, p. 10 (62.)"

which plates of a similar nature project towards the centre partially dividing the longitudinal cavities, much like the divisions in many reeds, canes, and grasses, except that they are not quite closed. There are no leaves, properly speaking, but the shoots are repeatedly divided with whorls of branches and branchlets at the articulations. The fructification is in a terminal spike, consisting of numerous closely packed peltate scales, bearing capsules (sporangia) of one kind underneath, very much like the peltate fructification of Liverworts (*Marchantia*). The sporangia are from six to nine to each peltate scale of the fruit spike and they are placed round the margin of the mushroom like top of the scale, parallel with its stalk. The spores in the sporangia are very minute and numerous, and they split when exposed into four elastic filaments called elaters, which is what happens in the Liverworts.

This peculiar kind of jointed leaf is not unlike the *Casuarina*, or sheoak of the colony, and the heads of fructification resemble some Cycads, but the resemblance is merely external, for the plants have little else in common. But on the other hand the natural affinities of the plants are with Ferns, and the spores germinate like them, producing a prothallus which bears archegones and antheridia. The structure of the root and stem is very different from that of Ferns. In an early stage there is a central column of cellular tissue in the rhizome, from which eight plates radiate, being connected with an external cylinder of the same nature, having between them distinct cavities, which is the structure observed in many fossil *Calamites*. But the vessels are annular and not scalariform as in Ferns.

The Horsetails are found in most parts of the world except Australia and New Zealand. As a rule they grow in moist or marshy places, but some flourish well in loose shifting sands, and one is said to grow to a height of between 20 and 30 feet (*E. giganteum*). They never reach the size of our fossil Horsetails.

The closest resemblance exists between the fossil and living genera. The mode of fructification of *Calamites binneyi*, Carr. is

similar in plan to that of the living *Equisetum arvense*, L., but there are two elaters instead of four, and the peltate scales are protected by paleaceous glumes.

The genus *Equisetum* is thus defined by Linnæus*.

EQUISETUM (No. 1284).

Fructificationes in spicam ovato-oblongam digestæ. Singula orbiculata basi dehiscens pluribus valvulis, apice plano peltato connexis.

This, it will be perceived, makes no reference to the form of the plant, but only to the spike and the sporangia. It was included amongst the Filices.

The definition of Schimper † remedies this. It is "*Fructus spicæformis cylindræus, oblongus, seu ovatus, sporangiorum receptaculis peltoidis. Folia in vaginam connata.*"

There are nearly twenty species of this genus described from Mesozoic strata, besides some of modern age. The Mesozoic forms are from the Trias, Lias and Oolite, the latter principally.

EQUISETUM ROTIFERUM, n.s., pl. vi., fig. 5, 6. Stem cylindrical, closely and faintly grooved, joints approximate below, distant above. Leaves carinate, connate into a sheath, the teeth of which are short, flat, rounded, of equal width throughout, adpressed to the stem. The diaphragmata of the joints and leaf scars of the branches are very distinct, round, with radiate lacunæ, varying from 18 to 30, and a central orifice. Fructification unknown.

Very abundant in the grey fire clays above the first seam at the Walloon mine near Ipswich, Queensland ‡ The casts of the diaphragmata are especially numerous, and have a singularly

* *Genera Plantarum*, p. 554. Edit. cur. Reichard, Frankfort on the Maine, 1778.

† *Paleontologie vegetale*, Vol. I., p. 259.

‡ The Walloon mine is about 10 miles west of Ipswich and rather more than that distance from the Bundamba and other seams, which are the oldest Ipswich coal mines, and the seams from which most of the fossils previously described have been taken. The relations between the two beds have not been ascertained, but I have no doubt that they all belong to one carbonaceous deposit, and there seems to be no break.

pretty and ornamental appearance. The following is the explanation of their structure: In the stems of Equisetaceæ there is a double series of lacunæ or longitudinal empty spaces, the exterior of which corresponds to the external ribs, and the interior to the grooves. In Lindley and Hutton's Fossil Flora, vol. 3, p. 186 (plate 180), there is a figure of one of these diaphragmata magnified. It was described by them as *Equisetum laterale*, though with the observation that the authors were by no means sure that it was an *Equisetum*. "What is most remarkable," say the authors "at irregular distances between the articulations are found little round disks with lines radiating from a common centre, something in the way of the phragma of a *Calamites*. These disks which look like the scars left behind the branches that had fallen off, are not stationed at the axils or articulations, but appear at uncertain intervals along the internodes, and are found less frequently on the stem than loose in the shale, without any apparent connection with the plant. This is a singular fact, and would lead one to think that the disks hardly belong to the stems with which they are found associated.

With regard to the same I translate the following from Schimper (vol. 1, p. 285). "The radiating disks that are seen in so many specimens above the articulations, and which have given the species its name, have been figured and described by authors without explanation, or as the scars of the branches. But they are only the impressions of the diaphragmata, either reversed or somewhat pressed out above. The same thing is constantly seen in *Annularia* and even in *Equisetum*, amongst others in *Equisetum münsteri*, where the large circular impressions have been equally taken for branch scars. The description given by the authors of the fossil flora agrees well with the character of diaphragmata, and not with those of scars. M. Andre * figures a diaphragm surmounting a reversed diaphragm. Many of these disks are scattered over the same piece of stone. M. Andre considers these as isolated

* Foss. Flora Siebenburgens u. des Banates, plate VI. *Equisetites lateralis*.

scars. But we never see isolated scars, whereas isolated diaphragmata of *Equisetum* of all sizes are very common in the upper Lias of France and Germany (Grès bigarré and Keuper)." But the most convincing thing of all is that we find such diaphragmata loose in the stems of living *Equiseta*. In places where these plants grow abundantly in the loose damp mould around the roots abundance of these disks of every character may be seen.

In the present species it will be noticed that there is only one circle of radiated lacunæ, and a central tube which corresponds to the second. In the figure of Lindley and Hutton there are two concentric circles and no central hollow. In the figures given by Feistmantel of *Equisetum rajmahalensis** (*Equisetites*, Morris and Oldham), at fig. 3 there is represented a diaphragm which is on the same plan as our fossil. There is an outer radiating circle of lacunæ and an inner central hollow. The species are, however, different. The outer ring of lacunæ was in this fossil small and bead-like, and it does not appear in the impressions, because it is along the outer line of spaces that the separation of the diaphragm took place. Traces of it may be seen in those specimens which are well preserved, and where the diaphragm is seen in position, which is rare. One such instance is given in fig. 2 of Feistmantel's plate, already referred to.

The size and shape of these diaphragmata show what were the dimensions and form of the stems. They were perfectly round, and the internal furrows were close together, about 25 in a stem two-thirds of an inch in diameter. There are stems broader than that, but they have been flattened out. In the largest specimen in my possession there are three or four internodes, and some of them are as long as twice the width of the stem.

The line of division between the connate teeth of the sheath can be traced to the base of the internode. The leaves are thus seen to be longer than the width of the stem, and they are marked at their margins by a fine raised line. They are of equal width for

* Memoirs of the Geological Survey of India. Paleontologia Indica. Fossil Flora of the Gondwana system. Oldham and Feistmantel, Vol. I., plate 11, fig. 3.

their whole extent, and the free ends are obtusely pointed, rounded or even flat; but this may depend on the state of preservation of the specimens, for none of the fragments were well preserved. The color of the fossils being so near to that of the shale, made it more than usually difficult to determine the more delicate details of structure.

From all the specimens I have seen, I cannot come to any other conclusion than that the stems were smooth and not fluted in any way, except on the outside of the spathe or sheath above the diaphragm, where the separate teeth make divisions or grooving.

Other parts of this plant, such as the rhizome, roots and fructifications have not been found with certainty, and therefore no well-founded comparison can be made. It is very near to *E. rajmahalensis*, which is also considered to be closely allied to *E. münsteri*, Stbg. In this species, the stem does not seem to be fluted in some specimens, but there is a manifest difference in the diaphragmata, and the teeth of the spathe are keeled, which is not the case in our fossil. *E. münsteri*, is now recognized as identical with many subsequently named species, such as *E. moniliformis* Prsl., *E. alternatus*, Prsl, *Calamites liaso-keuperianus*, Braun. It is very common in the Rhætic strata of Europe, but also ascends into the Lias. *E. rajmahalensis*, is referred by Feistmantel to the Liassic period.

In the rocks of the same period of Europe we have, *E. gamingianum* Etting., and *E. ungeri*, Etting., both of which have smooth stems, but the first has very narrow teeth, and the second has them, though broad, produced into a long rigid subulate point. I do not think it necessary to institute any other comparisons, with such species such as *E. arenaceum*, as they diverge widely from our type.

PHYLLOTHECA Brongt.

In the same family of *Equisetaceæ*, is placed the genus *Phyllothea*, which is distinguished from *Equisetum* by the sheath being prolonged into long linear leaves. The distinction may be better borne in mind by the following table.

Equisetum.—Sheath undivided, terminating in short adpressed teeth.

Phyllothea.—Sheath terminating in long linear narrow teeth, diverging from the stem in whorls.

Brongniart in his definition, speaks of them as simple straight articulate stems, surrounded at regular intervals by sheaths applied to the stem as in *Equisetum*, but terminating in long thread-like leaves, which replace the short teeth of the Horsetails. These leaves are erect, or more often spread out horizontally, or even reflected. The leaves are linear, acute, without any distinct neuration, and at least, twice as long as the sheath. The sheaths themselves show faint longitudinal grooves which disappear towards the base, and which seem to correspond to the intervals between the leaves, as the grooves on the sheaths of *Equisetum* correspond to the intervals between the teeth. The stem in the space, which separates the teeth, appears smooth, but on the fragments of larger ones which probably belonged to older individuals of the same plant, there are regular striæ, almost like those seen on *Calamites*.

In Lindley and Hutton's Fossil Flora (Vol. II., p. 89) the following passage occurs:—"A little known plant called *Phyllothea australis*, found in the coal of New South Wales, is described by M. A. Brongniart as consisting of simple, straight, articulated stems, surrounded at intervals with sheaths pressed close to the stem, as in *Equisetum*, but terminated by long linear leaves, which stand in the place of the short teeth of the sheath of *Equisetum*. We have ascertained from the examination of specimens communicated by Prof. Buckland, that in some respects M. Brongniart's description of *Phyllothea* is inaccurate, and that the leaves instead of springing from the edge of a sheath arise immediately from the stem, as in the fossil under consideration (*Hippurites gigantea*), so that the two would appear to be nearly allied. But in addition to the whorl of distinct leaves, in *Phyllothea* there is a sheath originating within them, and closely embracing the stem, to which it gives the appearance of the barren shoot of an *Equisetum*, with its whorls of slender branches on the outside of a toothed sheath."

Prof. M'Coy * confirms the original observation of Brongniart, and shows how the mistake of Lindley and Hutton had arisen. There can be little doubt that the sheaths are as Brongniart originally stated. But Prof. M'Coy also pointed out another peculiarity in *Phyllothea*, which was that the branches instead of arising outside the sheath, as in *Equisetum*, arise from within, and are therefore in a certain sense axillary. According to T. Schmalhausen's figures † of the Siberian forms, the branches originated above the articulation of the stem. Prof. M'Coy also thought that he perceived some remains of an inflorescence like *Casuarina*, but this has not been confirmed by any botanist.

The relations of *Phyllothea* are of the closest kind with *Equisetum*, from which the genus cannot be said to differ in any thing except the form of the leaf. Associated with *Phyllothea sibirica* are small radiating ribbed disks, like those previously described in our own *Equisetum rotiferum*. The species is distinguished by shorter and less reflexed leaves than other species, rendering the resemblances to *Equisetum* still closer. It was described and figured by Prof. O. Heer, in 1876 and 1878, from specimens collected in the Government of Irkutsk, Siberia, from Jurassic beds. ‡

The genus is most numerous and widely distributed in the Jurassic beds, but it ranges down to the paleozoic formations, and probably the oldest rocks in which it has been found are the Newcastle beds. There are eleven species described, but of these some are mere varieties. Thus the three Australian plants are but two. There are two mentioned as from India, and seven from Siberia, all from Jurassic beds, but in widely separated localities.

The Indian specimens of *Phyllothea* are confined to two species, *P. indica*, Bunbury, and *P. robusta*, Feistmantel. The first is from Nagpùr, but the specimens are few and incomplete. They are fragments of foliated stems and branches. These

* Ann. of Nat. Hist., Vol. XX., p 153.

† Beiträge zur Juraflora Russlands, Mem. de l'Acad. Imp. des Sciences de St. Petersburg, 7th series, Pl. XXVII., pp. 12, 46, 62.

‡ See Nachträge zur Juraflora von Irkutsk p. 4. Flora Floss, Arctica, vol. V.

are partial sheaths, and the leaves are somewhat short (rarely exceeding two-thirds of an inch), but generally longer than the sheaths, at first erect, then spreading out, and at last reflexed. The sheaths are furrowed, the furrows corresponding with the leaflets, and therefore numerous, but no specimen has been found complete enough to determine the exact number. This species is more worthy of attention as it closely resembles the Australian plant. The second Indian one, *P. robusta* Feistm., is entirely different, with short spatulate leaves *

All the Indian and Australian species of *Phyllothea* and some of the Siberian ones have one important character in common, and that is that the stems are ribbed, and the ribs and furrows are not alternating but in juxta-position. In this they differ from *Calamites*.

Three species of *Phyllothea* have been described, viz.:—*P. australis*, Brongniart, *P. ramosa*, M'Coy, *P. hookeri*, M'Coy. All these apparently are reduced to one by Feistmantel,† but I shall give the diagnosis of all.

P. australis, Brongniart, Prodr. p. 152 and 175. Stem erect, simple or branched, joints somewhat approximate, leaflets twice as long as the sheaths, narrow, erect, or reflected.

See M'Coy loc. cit., p. 156; Morris in Strzelecki, p. 250; Dana, United S. Explor. Exp. Geol., p. 710.

The observations of Brongniart on this plant, refer to the genus which he created to receive it. He pointed out at the time, the close affinity between the fossils and those of *Equisetum*, from which it was always to be distinguished by the foliaceous appendages to the sheaths.

* See Nagpur Plants, Quart. Jour. Geolog. Soc., London, vol. XVII (1862), p. 355, Pl. 10 and 11. Ramiganj Plants, Feistmantel, Jour. Asiatic Soc., Bengal, vol. 45, p. 346-347. Paleontologia Indica, fossil flora of the Gondwana Syst., vol. 3. Flora of the Damuda and Panchet divisions, pp. 65 to 69, plate 12A.

† Notes on the Fossil Flora of E. Australia, Proc. Roy. Soc. N. S. Wales, 1880. Sydney, Govt. Printing Office.

P. ramosa M'Coy. *loc. cit.* Stem branched smooth or striated, sheaths half the length of the internodes, leaves thin linear flat, twice to three times the length of the sheath, with a very fine indistinct midrib.

The specimens figured by M'Coy had branches arising from nearly every joint. He states that the stems were perfectly smooth, being striated only at the joints with a delicate striation in some species down the internodes. Subsequent examination of many specimens has not confirmed this distinction. The stems are always striated, but the appearance of this seems to depend entirely on the state of preservation.

P. hookeri M'Coy *loc. cit.* Pl. xi. fig. 4, 5, 6, 7. Stem simple coarsely sulcated and ridged longitudinally; sheaths very large, loose, subinfundibuliform, each sheath extending from one articulation to the next, so as to conceal the stem, leaves about twice the length of the sheaths, thick, narrow, with a strong prominent midrib.

"This species, says the author, is easily known from the two former by its great loose sac-like sheath, completely concealing the stem, its long, thick, strongly ribbed leaves and by its stem when stripped of its sheath being coarsely and regularly sulcated, precisely as in *Calamites cistii*. Although abundant, I have never seen the trace of a branch. Some of the flattened stems attain a width of two inches."

A large collection of specimens shows such gradations of one form into another of all these species that it becomes impossible to separate them. *P. hookeri* is no more than a luxuriant growth of *P. australis*, and possesses no character which is not attributable to mere richness of growth.

It should be remarked that the plant has been quoted from a great number of places where the identification has been made from stems alone. This is very misleading. Dr. O. Feistmantel has been careful to point out* that without leaves it is always unsafe to make any such identification. He says—"There occur

* Paleon, Indica. Foss. Fl. vol 3. Damuda and Panchet Div. p. 63.

(Damuda division) with the leaved stems many without leaves or partly so. Most of these stems were generally designated as *Phyllothea*. My opinion, however, is that they mostly belong to *Schizoneura*," When we have leaved specimens closely associated with such stems their similarity quite justifies us in placing them with *Phyllothea*. But when the stems have been found in widely distant localities and from certainly different horizons, such as Mount Victoria, Dubbo, Geelong, Clarence River and Ipswich, near Brisbane, I think that without the distinct *Phyllothea* leaves we are not justified in saying that the stems are Equisetaceous. For my own part, after a careful search, I have never found any true and characteristic *Phyllothea* in the Ipswich coal beds, though such plants are always stated to be there; and I have myself taken it for granted that the stems I found belonged to that genus. In the Proceedings of the Linnean Society, N.S.W., vol. vii., p. 95, I have quoted *Phyllothea* (*indica* ?) as from the Cooktown and Burrum River coal beds, and I now wish to state that, after a careful examination, there is no evidence that these specimens belong exclusively to *Phyllothea*.

As far as my knowledge goes, perfectly reliable species of *Phyllothea* are rarely found except in Lower Australian or Paleozoic coal measures. In Queensland, the Ipswich coals are characterized by *Equisetum*. I do not say that *Phyllothea* does not occur amongst the strata indicated; but except in the Hawkesbury shales no leaved specimens have been found to place the matter beyond a doubt.

P. indica and *P. hookeri* are quoted by Mr. Jack as occurring in the Bowen River (Q.L.) coal beds, associated with Paleozoic fossils.*

P. australis F. M'C (sic) is quoted by Mr. R. Brough Smyth, in the Progress Report of the Geology of Victoria,† as from the Bellerine beds, near Geelong, which, according to Prof. M'Coy, are Upper Mesozoic. No description is given, nor figures. The specimens seen by me had no leaves upon them.

* Rep. on the Bowen River Coal Field. Parliamentary Paper, Queensland, 1879, p. 33.

† Melbourne, 1874, p. 35.

Phyllothea concinna, n.s., plate IX., fig. 2. Stems neatly striated with 15 to 18 ribs terminating in linear leaves which, though slightly curved, do not spread, but lie almost parallel to the stem.

Common in the shales of the Hawkesbury sandstone at Sugar-loaf Hill, and along the canals and tunnels of the waterworks.

I distinguish this species (1) by the broad stems, (2) the closeness and neatness of the ribs, (3) the leaves scarcely spreading, (4) leaves not half the length of *Phyllothea Australis*.

Phyllothea carnososa, n.s., plate 9, fig 2. I name thus a species of which I have seen only one faint impression from the Walloon Mine. It is imperfect, but shows a close succession of verticillate leaves, which radiate very slightly from the stem. They are close obtuse, about half a millimetre wide and 5 long. They form 5 cup-shaped divisions on a stem 35 mill. long and 10 wide. It seems allied to *P. robusta* of the Indian Lias (See Feist. Gond. Syst., Vol. III., p. 68, pl. xiv. A, bis, fig. 1 and 2.) This is also closely allied to *P. schtschurovski*, of the Siberian Jura. The shale specimen from which the figure was taken has fallen to pieces.

VERTEBRARIA.

This peculiar plant was erected into a genus by Prof. Royle in his Botany and Nat. Hist. of the Himalaya Mounts.* It was for two fossil plants from Burdwan, but no description or definition is given. Prof. Morris in his examination of the Australian coal plants, in Strzelecki's work already referred to, mentions (p. 253) the occurrence of the same fossils (*Vertebraria indica* and *V. radiata* among the Newcastle coal plants. Prof. M'Coy was the first to give any definition of the genus. Prof. Dana subsequently described two of the same fossils from Australia under the name of *Clasteria*.

* Illustrations of the Botany and other branches of Nat. Hist. of the Himalayan Mountains and of the Flora of Cashmere. By Dr. Royle, F.R.S., 4to. London, 1833 to 1838. Page xxix, Pl. H. 11, figs. 1 to 7. See also Feistmantel's Jour. As. Soc., vol. 45. p. 347.

The plants have the appearance of jointed stems, with generally a line of division down the centre. The joints on each side of the division do not correspond with one another, and they are very irregular in size and shape. In transverse sections these stems are cylindrical, and then the central division is seen to be one of a series of radiate longitudinal partitions which divide the stem into eight or nine cuneiform portions. Prof. M'Coy stated that it was suggested to him by an eminent botanist that the cylindrical fossil might be considered a stem, the central axis being the pith, and the radiating divisional lines the medullary rays, and the intervening cuneiform masses the wedges of wood. Prof. M'Coy however would not accept this view, as he justly says from the ease with which the fractures took place along these lines of division, and the evenness of the surfaces produced. He noticed also something like a fine neuration in the transverse wedge shaped masses, showing clearly dichotomous veins. From these circumstances he was disposed to view the plant as closely allied to *Sphenophyllum*, in which there is a jointed stem surrounded by vertical whorls of six to eight wedge shaped leaves with dichotomous veins. He thought that the main difference between *Sphenophyllum* and *Vertebraria* consisted in the greater approximation of the whorls of leaves in the latter, the internodes being so very short that the whorls of leaves are brought into contact, or nearly so. He therefore provisionally defined the genus thus:— "Stem slender, surrounded by densely aggregated whorls of verticillate cuneiform leaves, having a dichotomous neuration."* To the above he continues "we might add that the number of leaves in a whorl depends on the species, and that from the whorls being so close as nearly to touch each other, the fossils have the appearance of lengthened cylinders, breaking readily in a horizontal and vertical direction, the former coinciding with the surfaces of the leaves, the latter coinciding with the vertical prolongations of the lines separating the leaves of each whorl, the former producible in indefinite number, at distance of about a line from each other ;

* Loc. cit., p. 146.

the latter having only a small definite number, depending on the number of leaves in a whorl. The leaves themselves are flat, rather thick, dilated at the top in such proportion that there is no space left between the edges of the adjacent leaves. It is very possible that together with *Sphenophyllum* these may have been freshwater aquatic plants allied to the recent *Marsilea*, in which we see a quaternary arrangement of cuneiform leaves, with dichotomous veins, but the affinity is not very strong."

Prof. M'Coy considered that the Australian specimens were distinct from either of those figured by Prof. Royle, and he named them *Vertebraria australis*, giving the following diagnosis:—"Leaves constantly eight in each whorl." He adds that the fragments were of various lengths, with a pretty uniform diameter of about seven lines. The radiating dichotomous veins are never strongly marked, apparently from the original softness of the texture of the leaf. In many cases we observe between them, an obsolete concentric plication, probably from the same cause, and which may explain the nature of certain vertical striæ, visible on the perpendicular fracture, crossing the horizontal lines which mark the edges of the leaves."

This ingenious explanation of the nature of *Vertebraria*, did not meet with general acceptance. Not only was there no analogy for anything like these cylindrical masses of leaves, but the divisions themselves did not resemble any known leaf.

Prof. Dana confessed his inability to suggest any explanation of these singular forms. He says: "we do not pretend to understand their nature, or explain by any hypothesis, their structure. They are broad linear, three-eighths to seven-eighths of an inch wide, with the sides parallel, and from the appearance of the fossil, it is apparent that they must have been hollow, as remains of both an upper and an under integument can be distinguished. They consist of two unsymmetrical longitudinal halves, In one specimen, each half has a transverse elevation at distant intervals, and between these elevations, a transverse depression. The elevations and depressions are unlike in their length of interval in the two halves. In another specimen the structure is different,

the stem appears to be broken across either one or both halves, at intervals of half to one inch; and on close examination, it is found that a carbonaceous film here intersects the stem (or one-half of it) extending into the clay beneath, and causes the appearance of fracture. Besides the stem is angularly depressed at intervals along the centre. On another example figured, the stem looks as if crumpled into a series of large angular depressions. The name *Clasteria* (from *κλαστος* broken) alludes to this broken appearance. It is especially remarkable that the stem which has the form first referred to at one extremity, changes to the second, showing that although so different, all these forms are parts of one and the same individual. The impressions are very thin, as in *Phyllothea*. The idea of their having some connexion with seed-bearing vessels or pods, is suggested by the form, but no analogy can be appealed to by the writer to sustain it.”*

Sir Charles Bunbury was the first to suggest the true nature of these forms.† He showed how one of these fossils must be the root or rhizome of some plant. Dr. O. Feistmantel‡ pointed out another important fact in connection with *Vertebraria*, that it was not found associated with any other plant. He pretty clearly proved that all *Vertebraria* are roots, and that most probably they were roots of an Equisetaceous nature. He adds these important remarks.§

“*Vertebraria* is in India a wide-spread fossil, both as regards vertical and horizontal distribution. I think there is only one species of *Vertebraria* in India, i.e., *V. indica*, Royle, while *V. radiata* is a cross-section of *V. indica*. There are two varieties so to speak. One which appears a more tender plant and is more branched, and another variety, which represents rather the stems. This latter is more generally distributed, while the former appears to be more common in the Kamthi representative of the Ramiganj group, although the other form also is not absent. The Australian

* Append. Geol. U.S. Explor. Exped. p. 719.

† Quart Jour. Geol. Soc. loc. cit.

‡ Jour. Asiatic Society of Bengal., loc. cit.

§ Pal. Indica, loc cit., vol. 3., part 2. p. 71.

form shows the closest analogy to our Indian *Vertebraria*. About the identity of the genera there is no doubt; the species are perhaps different. Dana's *Clasteria* is nothing else but *Vertebraria*. It represents the longitudinal section of the same plant of which *V. australis* as figured by M'Coy, formed the transverse section, an analogous case to that of India where *V. indica* was the longitudinal section and *V. radiata* the transverse section of the same plant. In Australia it is described from the upper coal measures only. Unger placed both the Indian and Australian *Vertebraria* with *Sphenophyllum*. This is an error which everybody will perceive from the figures. Quite lately *Vertebraria* (?) *petschorensis* was described by Schmalhausen (loc. cit. p. 53, tab. VII., figs. 14 and 18) from Jurassic beds of the Petschora country (Oranetz, on the right bank of the Petschora river), but so far as I can judge from the drawings, his specimens do not show much relation with the Indian or Australian *Vertebraria*."

Dr. Feistmantel goes on to say that the one Indian species of *Vertebraria* is known from all divisions of the Lower Gondwana beds, and from almost all horizons, which would according to the same author make them the equivalents of our Hawkesbury rocks and shales.

If we take it as established that *Vertebraria* is an Equisetaceous root, I think the fossils might be expected to have as wide a range as the Equisetinæ. Such is the case in Australia. They have been hitherto regarded as restricted to the Newcastle beds, where they are generally underneath strata containing *Phyllothea*. These *Vertebraria*, I think, can be distinguished from those associated with *Equisetum*. I have found *Vertebraria* in all the lower shales of the Ipswich coal measure, which I shall refer to presently. First, however, let me mention what is known of the rhizome of a true *Equisetum*.

Taking the figures as given by Schimper from Bischoff (D. Krypt. Gewächse, tab. III.), we find that in the living *Equisetum arvense* Linn, there is a long creeping root with distant parallel grooves, diaphragmata, and sheaths, all on a larger and coarser scale than on the living stem. At intervals there are

bulbs or tubers in chains of one, two, and three. But though there is a general resemblance in the structure to the *Vertebraria*, there is an almost identity of character between the same fossils and ascertained roots of fossil *Equisetaceæ*. Thus in *E. braunii*, as figured by Schimper, we find a series of short articulations with parallel grooving very similar to some forms of *Vertebraria*.

Regarding, therefore, these fossils as roots, it seems almost useless to distinguish them with generic and specific names. Such organs must resemble each other closely even where the species are different. We have no evidence that *Vertebraria indica* and *Vertebraria australis*, though so much alike, belonged even to the same genus of plants. Nay it is extremely probable that they did not, for among the common Equisetaceous plants in Indian strata *Schizoneura* is associated with *Vertebraria indica*, while *Shizoneura* is unknown in the Newcastle beds, and *Vertebraria australis* is associated with *Phyllothea australis*.

I shall distinguish the *Vertebraria* common in the blue clay at the Walloon Mines as *V. equiseti*, premising, of course, that I believe it to be the rhizome of *Equisetum rotiferum*, nobis.

Vertebraria equiseti. Plate, 1; fig. 3. Roots found in broad finely striated masses, three or four inches long, with occasional transverse divisions half an inch or so across. These root masses have little or no carbonaceous matter amongst them. They seem to be impressions of a mass of roots flattened out into the clay. Three different kinds of roots can be distinguished—one is a broad striated stem half an inch in diameter with transverse divisions at irregular intervals. 2. A narrow cylindrical stem with parallel striations and no diaphragmata. 3. Stems with a central longitudinal division and irregular transverse diaphragmata, which occasionally correspond at each side of the longitudinal line and occasionally do not. In the upper portions of these roots there are very distinct impressions of sheathing scales.

Occasionally oblong tubers such as those represented in *E. parlatorii*, Unger (see Schimp Pal. Veg. Atlas, plate 8, fig 14) may be met with, but they are always detached from the roots and

lying alongside them looking very much like "knots" in the stems. There is one structure very apparent in all the stems, and that is the transverse striæ. These are close and minute so that it requires a hand lens to observe them. Sometimes they have the appearance of overlapping scales.

Found in grey clay below the coal in the Tivoli mine, amidst a number of carbonaceous fibres and rootlets, which go by the name *Filicites*.

Vetebraria towarrensis. Plate 1, figs. 1, 2, 4, n. s. I designate by this name certain plant impressions of roots which are very common in a formation full of vegetable remains at Rosewood about 24 miles west from Rockhampton, Queensland. The beds are in sight of the Towarra ranges and form part of the country of the Towarra tribe, and hence the name. They are broad stems with deep or regular longitudinal grooves, but with slight transverse divisions which are irregular, at long distances apart, or absent. The fine transverse striæ are not seen as on the other species. In some of the specimens the parallel lines are regular, in others they curve, twist and fold over one another. The impressions are broad like those of Tivoli, evidently derived from a mass of roots. The transverse divisions are no more than like cracks on the roots, and they are also thick and well-defined.

These remains unlike the Indian *Vertebraria* are intimately associated with numerous impressions of *Ptilophyllum oligoneurum* nobis, and various other plants to be hereafter described. There are several other fossil roots.

There are many other places in Queensland where I have noticed root impressions but have not been able to submit them to detailed examination. These localities are :—Burrum River, Upper Burnett River, coal beds beyond Blackwater, 128 miles west of Rockampton, coal beds west of Cooktown. I do not suggest any name for such impressions, but I suppose the term *Vertebraria* should be restricted to those forms in which the transverse divisions give rise to a series of joints such as to suggest the idea of a vertebral column.

Order II. CALAMITEÆ. Brongniart.

This order is distinguished from the Equisetaceæ by the verticillate leaves entirely free or confluent at their base, and by the sporangiferous spikes being axillary like those of Lycopods. Some of the genera of this order have been named and classified in the early history of paleontology from fragmentary fossils, but as investigation has gone on, better and more numerous specimens were discovered, and just as in the case of the different portions of the *Lepidodendron* genus, they have proved to be different portions of the same plants. Thus Ettingshausen has proved that *Asterophyllites* are the branches and branchlets of *Calamites*, and the spikes known under the name of *Volkmannia* are the fruit bearing portions of the same genus. It is to Mr. Binney, of Manchester, that we owe the knowledge that the capsules enclosed in the spikes are not anthers, but sporangia.

CALAMITES.—Suckow (including *Calamites*, *Equisetites* (in part), *Asterophyllites*, *Volkmannia*, *Bechera*, *Bruckmannia*, *Bornia*, of Sternberg and Goeppert, and the *Calamites*, *Equisetites*, (part), *Calamodendron*, *Asterophyllites*, of Brongniart, Bunbury, Binney, Dawson, and others.

Tree-like plants, rising from a subterranean rhizome, stem simple, somewhat conical, jointed and gradually narrowed, branches in whorls, with forked branchlets. Bark smooth, or more or less distinctly sulcate, internodes of varying length, but generally shorter as they descend. Inner lining always sulcate and constricted at the joints. Internal structure similar to *Equisetum*. Cauline leaves extremely fugacious, wholly unknown but usually represented by minute, convex, ovate scars on the inner wood. Branch leaves longer and more numerous than the cauline, of equal length, free or confluent at the base, linear or narrowed or slightly dilated above, acuminate, ribbed, entire, sub-erect, or reflexed. Sporangiferous spikes, verticillate from the axils of the leaves, disposed in corymbs along the branches or at their extremities, oblong or elongately cylindrical, small for the size of the plant. Bracts, alternating with the sporangia, verticillate, lanceolate, erect above, below uniting into a disk.

Sporangia-bearing stalks, peltate, and arranged in whorls of six ; sporangia, four to each stalk, borne on the under side of the peltate leaves ; spore cases, with cellular walls ; spores spherical, with thread-like elaters.

The fruit-spike or cone bears a very strong resemblance to *Equisetum*, but in the latter all the leaves of the cone are fruit-bearing, while in *Calamites* some are fruitful, and others are like the ordinary leaves of the plant.

Calamites abound in the Carboniferous rocks, and no doubt the great mass of the coal was formed by them. They may be said to have died out at the close of the palæozoic period, though some are still found amongst the lower members of the mesozoic strata. We have only two quoted from Australia, and those are from the lowest group of our coal strata, Smith's Creek, near Stroud.

Calamites (Bornia) radiatus.*—Brongniart, Hist. of Veget. Foss., 1, p. 122 (quoted by Schimper as *Bornia*, vol. 1, p. 335). This species belongs to the subdivision *Bornia*, distinguished amongst *Calamites* by its interrupted, non-alternating ribs, its free leaves, which on the branches are once or twice-forked, divided above, ovoid elliptic spikes, scutellæ with a scar on the centre of the external face. It is thus characterised :—Leaves of branches very long, linear, free, often forked. Cauline leaves shorter.

The fossil is very wide-spread, being found in the lower coal and Devonian rocks of Europe and those of America. (See Dawson's Devonian Plants, Quart. Jour. Geol. Soc., vol xviii., p. 309 ; also, Schimper, atlas, pl., xxiv., where many figures are given of stem, leaves and fruit.)

In Dr. Feistmantel's work already quoted,† there are three figures given of this fossil, representing some leaves and certain portions of the stem. It should be mentioned that, except

* See Proc. Roy. Soc. N.S.W. 1883, pl. 12, pp. 7, 8.

† Nachtrag zur Fossilien Flora Australiens, Paleontographia pars. pl. vi, vii, xxiv, xxi. It is to be borne in mind that this work is published in parts and the numerals refers to the number of plates in the part. Dr. Feistmantel inserted a second enumeration having reference to the essay on the Australian Fossil Flora as a whole. To this second enumeration I have already referred.

to an experienced eye, or without some fruit spikes, these fossils might be mistaken for *Phyllothea australis*. They belong, however, to a much lower horizon, and the leaves will be found to be dichotomous, which is never the case in *Phyllothea*. *Calamites varians* is quoted by Feistmantel (loc. cit., p. 145) on the authority of De Koninck. The passage referred to is as follows:— * “Before commencing the study of the numerous animal forms belonging to the Carboniferous period, I will glance at some contemporary plant remains received at the same time and also often in the same rocks from the Rev. W. B. Clarke. I should state, previously, that the specimens sent to me, not above twenty in number, were in such a bad state of preservation that, notwithstanding the immense experience of M. Crepin, who was kind enough to examine them, or the abundant materials for comparison which he had at his disposal in the Brussels Museum, he was unable to determine any species with certainty. According to him, nevertheless, some specimens came very near to *Lepidodendron veltheimianum*, Sternberg, others to *Bornia radiata*, A. Brong. and others, to *Calamites varians*, Germar: these constitute the dominant forms. All these plants are contained either in a hard and compact greyish yellow or greenish limestone, or else in friable, easily powdered grey or brownish sandstone. Many are associated with marine animal remains, such as the stems of *Crinoids*, *Productus*, *Conularia*, &c. By their characteristics they cannot be said to belong to the Carboniferous formation properly speaking, but to the period which preceded it, being preserved in the rocks on which the Carboniferous strata rest. The principal localities in which these different fragments have been collected are the Murree quarries (Loders’ Creek), Russell’s Shaft, Glen William, and Burrageood.”

Calamites varians Germar (*C. approximatus*, Schlott, of Schimper). This species is distinguished by the very short intervals in the basal part of the trunk becoming suddenly elongated in the upper part. The shoots of the basilar portion were rather stout,

* Recherches sur les Foss. Paleoz. N. Galles d. Sud, Australie, 3 part, p. 142.

and disposed quincuncially. The scars are large and round, and the ribs near converge towards them with their upper and lower extremities. The same thing is seen in the leaf scars, but then the converging ribs are less numerous, and there are never more than three. From the Drummond Range I have a very fine series of these plants, as will be seen from the accompanying specimens and figures, which place the nature of the fossils beyond any doubt. The occurrence of this species has been known for some time, through the labours of Dr. Feistmantel, but the discovery of the roots and stems was first recorded in a paper by the author,* who received many specimens from Mr. Phillips, at Bobuntungen. These roots and stems seem to abound in the strata, and there are some portions of the stone which is made up entirely from the stems. Nevertheless, leaves are rarely found associated with them; in fact none of the more tender plants—such as Ferns, or organs of plants—are found in these strata where *Lepidodendron* occurs. In the neighbourhood of the shales, leaf impressions and those of Ferns may be found; but these I have not as yet been able to examine.

The strata I regard as lower Carboniferous, and they are very extensively developed in this locality, where the whole eastern face of the range is composed of beds dipping by a regular and slight inclination to the westward.

ANNULARIA (Brongniart).

Herbaceous plants. Stem articulate, subulate, divided by a solid diaphragm at the joints; branches pinnate and bi-pinnate; leaves, many in oval whorls, lingulately, elongately, and spathulately lanceolate, somewhat thick, with a central nerve, horizontal or recurved; spikes distichous or verticillate, cylindrically elongate, rachis thick, with short sulcate internodes; bracts numerous, rising erect, flat below, then erect and lanceolate. Sporangia axillary, globose, or lenticular.

These were probably herbaceous aquatic plants, whose leafy branches floated. The internodes were hollow and separated by

* Roy. Soc. N.S. Wales, 1882. Read at the meeting, Dec. 6. In this paper are the figures here referred to.

solid diaphragmata with a thick margin which often leave impressions in the form of a ring, and hence the name. The leaves never form a sheath as in *Equisetum*, but unite at their base with the ring. Only one species of this genus, which is a characteristic coal fossil, has been described from Australia.

Annularia australis (Feistmantel).—(Loc. cit. p. 154. Tab. VII.—XXV.—Stem slender, articulate; leaves verticillate up to ten in number, spreading, incurved, membranaceous, lanceolately spathulate, with a persistent median nerve, 18 millim. long.

This fossil, which is unique, was found at Greta (30 miles west of Newcastle), in beds below the lower marine paleozoic beds. The specimen was found on a slab with a leaf of *Glossopteris browniana*, which shows the actual contemporaneity of that fossil with such a truly paleozoic form as *Annularia*. The present species somewhat resembles *A. longifolia*, Brongt., but the leaves are not so long or stiff, have a thinner cuticle, farther apart from one another, and are blunt at the end.

SPHENOPHYLLUM, Brongniart.

This genus is distinguished by its wedge-shaped, often divided leaves, less numerous than *Annularia* and furnished with fine forked veins; grooves on the stem not alternating, and the articulations form an acute ridge which is so constant that they can be identified even without leaves. Spikes narrow, long, and cylindrical. Bracts numerous, curving down at first from the rachis and then suddenly bent upwards at an acute angle in which a single spore case is fixed. Thus while the general structure is that of *Equisetum* the fructification closely approaches the Lycopods. Fossils characteristic of the coal period.

A remnant of what appears to be a species of *Sphenophyllum* is figured by Dr. Feistmantel, in the part of his work referred to. Pl. ii, fig 1 (p. 73). There is but one whorl of five, broadly cuneiform, finely nerved, split leaves, with a narrow stem, not showing any very distinct sulcations. The ridges of the articulations are not very marked. Altogether the specimen was so insignificant that Dr. Feistmantel did not consider it sufficient to name it. From Port Stephens (Stroud?)

DOUBTFUL SPECIES.

Before leaving the Equisetaceæ, I note the occurrence in the Rosewood (Rockhampton) beds of certain fragmentary impressions, which I regard as belonging to the stems of *Equisetum* or *Calamites*. They are finely ribbed stems with transverse partitions, often three inches in width. The only form to which I can compare them is *Equisetum mougeotti*, Brong. (See Schimp. vol. i., p. 278, and Atlas pl. 12, figs 1, 2, 3 and 4) which is a Trias fossil, from the Vosges (Gres bigarrée). The ribs of our fossil are close, fine, about 20 to an inch. I have seen no specimens perfect enough to show a good series of the partitions, so cannot say whether they were close or distant, neither are there any buds visible. To distinguish it I name it as follows :

Equisetum? latum, pl. 2, fig 1. Broad stems two to three inches wide with numerous small close ribs. Common on sandstone or fine conglomerate, Rosewood (Rockhampton).

FILICES OR FERNS.

Ferns are herbaceous plants with a creeping, climbing, or erect stem, consisting of a subterranean rhizome, stem, and leafy expansions curled upon themselves. Fructification on the under surface or margin of the frond, minute, densely clustered in spore cases (sporangies) full of microscopic doubly coated spores, destitute of an embryo, but capable of developing a small leafy expansion. Prothallus bearing the essential organs of reproduction.

I shall pass over other details for which any ordinary botanical handbook may be consulted, to come at once to the subdivisions which are adopted for the fossil species. I will merely observe now that as the fructification is rarely preserved, and generally only leaves and portions of leaves, two characters become most important. One is the form of the nerves or venation of the leaves ; the other is its mode of attachment to the rachis. The following general classification of Ettingshausen is the one followed here, as it is adopted by Schimper who points out that it is merely a development of that proposed by Ad. Brongniart in

1828.* According to this system (Ettingshausen's)†, there are five orders of extinct ferns namely :—1. SPHENOPTERIDEÆ ; 2. NEUROPTERIDEÆ ; 3. PECOPTERIDEÆ ; 4. TÆNIOPTERIDEÆ ; 5. DICTYOPTERIDEÆ.

SPHENOPTERIDEÆ.

Including *Sphenopteris Hymenophyllum*, *Eremopteris*, *Coniopteris*, *Steffensia*.

Fronds petiolate, simple or divided, pinnate, bi-tri-pinnatifid, Pinnules connate or lobate. Lobes dentate or subdivided. Costa fine and delicate, often bifid or free at the top, veins diverging above, or produced to the sinus of the lobes or teeth. Venules either indistinct or only proceeding from the lower part of the secondary nerves.

SPHENOPTERIS, Brongniart.

As the species of this genus are over a hundred it has been found convenient to divide them into families according as they approach to such living forms as *Cheilanthes*, *Davallia*, *Dicksonia*, &c. The most of the Australian specimens belong to the family *Sphenohymenophylleæ* or *Sphenopteris*, approximating to the living *Hymenophyllum* which is thus described. Rachis winged ; leaves finely membranaceous, veins pinnate, single in each segment, branches dichotomous. Sori indusiate at the apex of the lobes.

Sphenopteris lobifolia. Morris in Strzel. p. 246, pl. 7, fig 3 and 3a. Frond bi-pinnate, pinnæ somewhat linear, elongate, alternate. Pinnules membranaceous, those of the lower pinnæ equal, ovate, oblong, contracted at the base, approximate, with three nearly equal rounded lobes on each side, and a terminal obtuse one. Veins proceeding into each to be divided near the midrib, upper one furcate. The pinnules towards the apex of the frond are rather sharply three-lobed and decurrent, the veins becoming forked in each lobe.

* Histoire des vegetaux fossiles, vol. I, p. 148 : Also Tableaux des gen. de vegetaux fossiles, 1849.

† Die Farnkräuter der felzwelt zur Untersuchung und Bestimmung der in der Formation der Erdrinde eingeschlossenen Ueberreste von vorweltlichen Arten dieser Ordnung. Wien, 1865. By M. Const. d'Ettingshausen. With 180 beautifully executed plates, giving the neuration of many hundred species.

Obs.—This appears to have been a very delicate fern: the pinnules are very slender, or membranaceous, and variable in shape according to their position on the frond. Locality: Newcastle quoted also from Mulubimba. I have found it on the Dawson River Q. L. (near Cracow Creek), and I think I recognised it from the Bowen River coal fields (Q. L.) among some specimens from Rosella, two miles above Havilah crossing “A marine bed containing *Goniatites woodsii*, De Konn., *Productus cora*, D’Orb., *Streptorhynchus crenistria*, Phillips, intercalated with the fresh-water series.”*

Sphenopteris alata, Brong., Hist. veg. foss., p. 361, pl. 127. Frond tripinnate, rachis winged, pinnae pinnate, above pinnatifid with decurrent sessile pinnules, lower pinnatifid, with three to six bluntly toothed segments, upper ones inciso-dentate, veins either simple or forked, diverging slightly into each lobe from the costa at an acute angle. Hawkesbury River, Brongniart, Mulubimba. M’Coy.

This species was referred to *Hymenophyllites grandini*, Göpp by Göppert, which belongs to the old Carboniferous of Germany. Prof. M’Coy, however, denies that either the one or the other which follows are identical with that form.

With reference to this species Dr. Feistmantel makes the following remarks in his Fossil Flora of the Gondwana system. † “I have to point out some confusion which arose about this species. In his paper on “Sedimentary Formations in New South Wales, published in Mines and Mineral Statistics, 1874, page 186, the Rev. Mr. Clarke correlated this *Sphenopteris alata* with the Carboniferous form known at first by the same name‡ and later as *Sphenopteris* (*Hymenophyllites grandini*). The matter stands however, as follows:—The Australian species was at first dis-

* Report on Bowen River coal mine by R. L. Jack, F.G.S., Parliamentary Paper, Brisbane, 1879, p. 34.

† Vol. III., part II. Flora of the Damuda and Panchet Divisions, Page 77.

‡ The same mistake is made in the last edition of Sedimentary Formations (1878) See p. 74, and Appendix IX, p. 22.

cribed as *Pecopteris alata*, Brongt., and was subsequently placed with *Sphenopteris (alata)* by Sternberg, and is at present quoted as such. The European Carboniferous form to which Mr. Clarke referred was at first described as *Sph. alata*, Brgt., and was later quoted by Göppert as *Hymenophyllites grandini*, and now by Schimper as *Sphenopteris grandini*, Goep. Now both Morris and M'Coy who mention *Sphenopteris alata* mention it in Brongniart's sense of *Pecopteris alata*, the Australian form, and not in the sense of the original *Sph. alata* or the present *S. grandini* of the Carboniferous. The latter (Brongniart, Hist. Veg. Foss. pl. 48, fig. 4) is totally different from the Australian *S. alata*, Brongt. sp. (op. cit. p. 127, p. 361), and it was with the latter I have compared the upper portion of one Indian *Sphenopteris polymorpha*."

Sphenopteris alata, var. *exilis*, Morris (loc. cit. p. 246.) Frond somewhat triangular with a tri-pinnatifid base, margin of the rachis alate, pinnules either contracted at the base or confluent, decurrent, irregularly lobed, lobes entire or dentate, veins slender, pinnate. *Obs.*—This interesting species appears more nearly allied to *Sphenopteris* than *Pecopteris*, and is easily distinguished by the slender and decurrent pinnules, the membranaceous or alate membrane of the principal rachis, as observed in recent species of *Hymenophyllum*. Associated with the last species and *Glossopteris browniana* in a light-coloured shale from the Hawkesbury River. The museum of the Geological Society, London, contains specimens of the two above species.

Sphenopteris hastata, M'Coy, Ann. Nat. Hist. l. cit. p. 149. Bipinnate, pinnae long, acutely lanceolate with a broad alate margin, pinnules elliptical, obscurely undulate, dentate, having three obsolete lobes on each side, veins bi-pinnate, two branches reaching each lobe of the margin. *Obs.*—The lengthened oval form, slightly indented margin, and simple neuration of the pinnules, fully distinguish this from any published species of the genus. The average length of the pinnae is about $1\frac{1}{2}$ inch, width 4 lines, average length of the pinnules 3 lines. Not uncommon in the shale of Mulubimba, M'Coy.

Sphenopteris germana, M'Coy, loc. cit. p. 150, Bi-pinnate, pinnæ oblique, alternate, elongate, ovate, with a narrow membranaceous margin, pinnules oval, deeply pinnatifid, lobes very oblique, elliptical, generally three on each side, and the apex of the pinnules 3-lobed, veins bi-pinnate, three branches reaching the margin of each lobe. *Obs.*—It is extremely difficult (says Prof. M'Coy) to distinguish this species from the *Pecopteris murrayana* of the Yorkshire Oolitic coalfields, with which it is nearly identical in form and neuration. The oval outline of the pinnules is the most obvious character, contrasting with the trigonal wide-based leaflets of the English plant. This, together with their more oblique setting on the rachis, more oblique, narrow, and deeply-cleft lobes, and the decurrent, narrow, alate margin to the straight rachis, will, I think, be sufficient to distinguish the species in the shale of Mulubimba.

Sphenopteris plumosa, M'Coy, loc. cit. Bi-pinnate, pinnæ curved, elongate, narrow, plumose, margin slightly alate to the rachis, pinnules close, oblique, ovate pointed, deeply cleft into about four oblique mucronate lobes on each side, exclusive of the largely trilobed apex, veins strong, much branched, so that about six branches reach the margin of each of the lobes of the lower side, and seven to each of those of the upper margin. *Obs.* The number of the lobes of the pinnules and complexity of the neuration will readily distinguish this species. The average length of the leaflets, five lines. Rare in the shale of Mulubimba.

Sphenopteris flexuosa, M'Coy, loc. cit. Bi-pinnate, pinnæ long, with a strong flexuous naked rachis. Pinnules large, moderately oblique, unequal, ovate, sides cut into two very large unequal rounded lobes on each side. Apex tri-lobed. Veins strong, much branched, seven branches reaching the margin of each lobe, and three going into each of the three lobes of the apex. *Obs.* This strongly-marked species is not sufficiently allied to any known form to render a comparison necessary. The average length of the pinnules is about eight lines, width four lines. In a bed of brown clay, Mulubimba.

S. iguanensis, M'Coy, Decades Paleont. Victoria. Dec. IV, p. 22. Pl. XXXVI, fig. 35.—This species belongs to the subgenus *Eremopteris*, of Schimper, for such species of *Sphenopteris* as have the frond dichotomously pinnate, pinnae irregularly pinnatifid, lacinate lobes elongate, obovate or sub-cuneate, veins dichotomously radiating from the base. *S. iguanensis*. Dichotomously bi-pinnatifid, segments of usually five to seven lobes, oblique, elongate, cuneate, confluent at base, apices crenulo-lobate by small acutely angular indentations. Veins slender, numerous, forked, diverging from the base usually about three to each lobe, a few towards the middle stronger than the rest, but no distinct midrib. Rachis rather thick. Length of pinnules, one to two inches, greatest width usually about 4 lines. Obs. The pinnules or lobes are smaller, narrower, diverge at more acute angles, and are much less deeply divided than in the *Sp. artemesifolia*, Brongt., of the lower Carboniferous rocks of Northumberland, to which it is most nearly allied, and which is the type of Schimper's exclusively paleozoic *Eremopteris*. Common in hard olive upper Devonian flags of Iguana Creek, Victoria.

S. elongata, Carruthers, Proceed. Geol. Soc. Lond, 1872, p. 355, pl. XXVII, fig. 1 (Append. II to Daintree's paper on the Geology of Queensland.) Frond dichotomously divided, each division irregularly pinnate, pinnae simple, bi-furcate or irregularly pinnate, segments narrow, linear, slightly tapering upwards to the somewhat blunt apex, the costa sending out simple veins which run along the middle of each segment. Obs. With *Pecopteris* (*Thinnfeldia*) *odontopteroides* this is one of the most abundant forms. Some specimens have small oval markings scattered irregularly on either side of the midrib. These probably indicate the form and position of the sori, which are the same as in some of the simple linear species of *Polypodium*. Tivoli coal mine.* I find the same oval markings on many different Ferns, and am inclined to refer them to other causes. My own inclination is to place the fossil with *Trichomanides*.

* I can hardly confirm this about the fossil being common; in fact I should say that it is rather uncommon, and confined to certain horizons. It is met with at Thomas's Aberdare mine as well.

Sphenopteris crebra, n.s., plate 3, fig. 4.—Frond evidently tender and membranaceous, bi-pinnate, pinnæ wide, alternate, slightly oblique, oblong quadrate, pinnules so close together as not to be easily distinguished, faintly pinnatifid, lobes a little more oblique than the pinnæ, oblong ovate, with a slightly undulating margin; costa sending off veins which fork once, and the venules reaching the margin.

Ballinore Coalfield, Talbragar River, N.S.W.

The spreading contiguous pinnæ, and the very faint lobes, will easily distinguish this species from the preceding, or from any found in the Newcastle or Ipswich beds.

Sphenopteris (hymen.) baileyana, pl. 4, fig. 2, n.s.—Frond bi-pinnatifid, membranaceous, rachis winged, pinnules alternate, almost simple, broad at the base, becoming regularly narrower at each lobe, so as to form an almost conical leaflet, emerging at an open angle, and curving upwards, the lower shorter, the upper longer and spreading; lobes linear, narrow, rounded, very slightly segmented, much longer in the upper pinnules, the terminal lobe produced; costa conspicuous, reaching the apex; veins very fine, emerging at an acute angle, bi-furcating immediately, sending a venule to the end of each lobe. Rosewood, Ipswich, one specimen.

This fossil might be compared with some living species of *Hymenophyllum*, but the peculiar stout, slightly lobed pinnæ give it a character not easily referable to any recent or fossil form.

Sphenopteris—Aneimioides.—This subdivision of the genus *Sphenopteris* is founded on the general resemblance to *Aneimia*, a well-marked genus almost confined to America, with fertile and barren fronds, the fertile being a copiously branched panicle, and the barren having numerous radiating free forked veins. The definition of Schimper for this subdivision of the *Sphenopterideæ* is as follows:—

Pinnules somewhat broad, narrowed below, ovately lobed, lower lobes 3 to 4 in number, superior entire, coarsely toothed or sinuate, all roundly obtuse or sub-acuminate; costa of the pinnules well marked, evanescent, veins and venules numerous, diverging in a somewhat arcuate manner from a sub-erect base. Dichotomous.

In one respect the fossil now to be described does not correspond, and that is that the median nerve is scarcely to be distinguished from the others.

Sphenopteris (*Aneimioides*) *flabellifolia* n.s.. Frond delicate, small, bi-pinnate, rachis terete, somewhat thick, pinnæ, oblong cuneate, contracted at the base to a delicate petiole, lower edge entire, upper divided into linear cuneate lobes of varying width, the edges straight or rounded, some of the pinnæ much elongated; costa inconspicuous; veins fine, close, numerous, straight, radiating.

This remarkable fossil, which has strong resemblance to *Archæopteris* occurs abundantly in a blue shale on the Burnett River, Queensland, about half-way between Bundaberg and five coal seams which abut on the river. It probably belongs to the same coal formation, but whether the shale is an upper or lower member of it I am unable to say.

Sphenopteris (pl. 2. fig. 2) (*Aneimioides*) *flabellifolia*, var. *erecta*.—On the same stone as the foregoing, Ferns are found of smaller size and regularly pinnate, the pinnæ lobed or segmented symmetrically at both sides. It seems a very different form, but on looking closely the venation and general shape of the lobes is seen to be the same.

Sphenopteris (?) *glossophylla*, n.s., pl. 4, fig. 4. Frond very small, with a somewhat thick rachis, repeatedly forking and bearing small, entire, alternate ovate leaves on which the venation cannot be seen. One specimen at the Talbragar mines, near Dubbo, N.S.W., where it is associated with Triassic (?) conifers.

I know of nothing either living or fossil to which this singular little fern (?) can be compared. I have given it a name for the convenience of reference.

SUB-GENUS TRICHOMANIDES.

Frond simple or divided, bi or tri-pinnate, primary rachis narrow, or terete. Pinnules very delicate, dichotomously divided, lobes narrowly linear or filiform, simple or forked. Sori unknown, but doubtless as in all the *Trichomanideæ* (*Hymenophyllum*, *Trichomanes*, &c.) indusiate at the extremity of the elongated lobes.

Trichomanides laxum, n.s., pl. 10, fig. 2. Rhizome creeping, long, slender, sending up at distinct irregular intervals delicate membranaceous, pinnate fronds. Pinnæ emerging at an acute angle, linear or cuneate, bi-furcating with one simple free vein to each lobe. Rosewood scrub, Ipswich, not common.

This fossil cannot be distinguished from *Trichomanes*; one indusium and receptacle at the end of a lobe showing the simple cup of that genus. There is some resemblance in the form to the preceding species of Carruthers, but this species is much smaller and evidently consisted of short pinnate fronds proceeding at irregular intervals from the slender creeping rhizome. This fossil has intimate relations with our existing flora.

Trichomanides spinifolium, n.s., pl. 3, fig 7, evidently somewhat stiff, spreading, dichotomously dividing, bi-pinnate, pinnæ opposite or nearly so, long, linear and together with the rachis membranaceously winged, pinnules nearly opposite or alternate, very short and quite acute, the apical one long, and linear, veins thick, simple free. No sori or indusium visible.

This beautiful species is distinguished by the rigid aspect, the close numerous pinnæ, the shortness and acuteness of all pinnules, except the terminal one which is disproportionately long and linear. Rosewood, near Ipswich.

ANEIMITES. Dawson.*

Frond many times dichotomously divided with squarrose divisions and squarrosely pinnate. Pinnæ angularly flexuous. Pinnules somewhat remote, broadly spathulate, petiolate, trilobed or remaining nearly entire, veins dichotomous. Fertile pinnæ and pinnules subcircinately recurved, short and with a leafy expansion.

Aneimites iguanensis, M'Coy. Report of Progress of Geol. Survey of Victoria, No. 2, Melbourne 1875, p. 73. The only record of this species which I can find is in a letter from Prof. M'Coy to Mr. Brough Smyth, published in the above report. He states that having examined the fossils from Iguana Creek, which had

* Quart. Jour. Geol. Soc. Lond. vol. xvii., p. 5.

been submitted to him, he recommended that the beds in which they occur should be colored as Upper Devonian. He said further that amongst the fossils there was a new species of *Archæopteris* which he named *A. howitti*, a new species of *Aneimites* named *A. iguanensis* and a species of *Cordaites* named *C. australis*. There was no description given, but subsequently in the fourth decade of the Paleontology of Victoria, plate 36, and p. 21 to 23, descriptions were given of *Archæopteris howitti*, and *Cordaites australis*, together with the *Sphenopteris iguanensis* already described, but no further mention of the *Aneimites*.

Family NEUROPTERIDÆ.

Fronds simple, once or more pinnate. Pinnæ and pinnules foliaceous and generally rather large, entire, veins numerous with many forks diverging arcuately and reaching the margin either directly from the rachis or from the costa. Only a very few specimens are known with organs of fructification.

ARCHÆOPTERIS. Dawson, loc. cit.*

Bi-pinnate, pinnæ alternate, pinnules obliquely obovate, imbricate, opposite, with narrow decurrent base, a pinnule often on the rachis between bases of pinnæ; veins fine, divaricating, dichotomous. Fertile pinnules in the midst of the infertile ones; sori ovate, in bunches at ends of much divided veins. Common in Upper Devonian beds of Europe, N. America, and rare in the lower Carboniferous.

A. howitti, M'Coy, Pal. Vict. loc. cit. Pinnæ upwards of four inches long, and about one and a-half inches wide. Pinnules subopposite, imbricate, obliquely ovato-rhomboidal, narrowed to the base which articulates to the petiole so as to appear slightly decurrent on one face, and obliquely inserted on the other. Terminal pinnules nearly the size and shape of the lateral ones, but equilateral. Average length of each pinnule, 1 inch, 1 line;

* The genus was erected by Schimper (see Pal. Veg. vol. 1, p. 475), who named it *Palæopteris*. This was a name already used by Geinitz, and the above as a substitute was suggested by Dr. Dawson.

width, 6 lines. Veins slightly radiating, slender (about 14 in. 3 lines across the middle), with two or three dichotomous branches from base to upper margin, edges only slightly lacerated.

Obs.—This species is most allied to the Canadian *A. jacksoni*, from the upper Devonian beds of Gaspé, from which it differs in its larger and broader pinnules, and to the *A. hibernica*, from the upper Devonian of Kilkenny and Berwickshire, from which its shorter, broader and more closely set imbricated pinnules and smaller pinnæ distinguish it. The fertile pinnules have not been found as yet. Abundant in the upper Devonian olive flags of Iguana Creek.

A. wilkinsoni, Feist. Paleoz. u. Mes. Flora d. Ost. Australiens, p. 148. Pinnate, rachis narrow, somewhat striate, sometimes forked; segments of the pinnules sub-alternate, oblong ovate, pinnatifid segments or slits sub-alternate, cuneiform, narrowed at the base, decurrent, incised, lobes denticulate, the terminal ones bi-tri-lobed with incised dentations. Veins very close flabellately dichotomous.

Obs.—This form approaches nearest to *A. lyra*, Stur. and *A. dissecta*, Goep., but in the latter the pinnæ are longer, the segments or slits are wider apart, are longer and more slender. Locality, Smith's Creek, near Stroud, horizon probably lower Carboniferous.

Another species of *Archæopteris* is spoken of by Feistmantel (loc. cit. p. 148) and figured (Tab. IV, XXII, fig 4), but the specimen is too imperfect to be determined. From the same locality.

RHACOPTERIS, Schimper.

Fronde pinnate, rachis rigid, grooved in the middle. Pinnæ elongate broadly linear. Pinnules sub-horizontal, somewhat remote, contiguous or sub-imbricate, spreading, oblong rhomboidal, more or less deeply incised and flabellate, lobes narrow, straight, or slightly removed. *Obs.*—The incisions are in the direction of the veins, and each ligule comprises one or two branches. The name refers to the incision of the pinnules. The genus is confined to the Devonian or Lower Carboniferous.

R. inaequilatera, Goeppert (as *Cyclopteris* Flora d. Silur-Devon. und unt. Steinkohlform), p. 72, tab. XXXVII, pp. 6, 7, and 8. Schimper (as *Palæopteris*). Paleon. veg. vol. 3, p. 485. Frond pinnate, pinnæ subimbricate, spreading very much, inequilateral, upper side broadly rounded, truncate at the base at a right angle. Petiole short, straight, decurrent. Veins united at the base, spreading widely and dichotomously divided.

Obs.—This species is identical with one found in Europe in the Lower coal measures (Silesia), where, however, it is rare. It is somewhat common in the beds at Smith's Creek and at Arowa. Dr. Feistmantel gives many figures, and states that he believes that Prof. M'Coy's *Otopteris ovata* (Ann. Nat. His. loc. cit.) is this species. From the figures one would say that they were identical. Prof. M'Coy points out in his description that the genus was the same as Goeppert's *Adiantites*, and Unger's *Cyclopteris*, but he referred it to *Otopteris*, because of its pinnate leaves. The species is also considered by Feistmantel to be the same as one not determined by Stur.*

R. intermedia, Feistmantel (loc. cit. p. 75, Tab. 11.) Rachis thick with a prominent mesial angle, pinnules alternate, pedunculate, oblong, rhomboid, incised into cuneate segments, the centre longest, incisions scarcely marked above. Margins of the segments denticulate, veins numerous, forking, radiating in the segments. Port Stephens (Stroud)? In the form of the rachis this resembles very much *R. transitionis* and *R. machanecki*, Stur.

R. septentrionalis, Feistmantel, loc. cit. p. 147. Tab. IV (XXII) fig. 5. Rachis as in the last species, pinnulæ subalternate, with short petioles, suberect, oblong near the rachis deeply lobed and thence sub-flabelliform, lobes subrhomboid, deeply incised, segments rounded above. Veins indistinct.

Obs.—This form is also somewhat like *transitionis*, Str., but it is in every respect thinner and more slender. Smith's Creek, Stroud.

R. römeri, Feist. loc. cit., p. 147. At plate 11 (xx), fig. 2 and 2a., Dr. Feistmantel gives the outline of a plant from the same

* Culmflora d. Mähr. Schles. Dachschiefers, p. 75.

locality, which he formerly described as a *Sphenopteris*, and which he now somewhat doubtfully refers to *Rhacopteris*. The species is identical with one from the coal measures of Silesia by its subquadrate, deeply lobed pinnæ and dichotomous veins. The rachis is also grooved.

NEUROPTERIS, Brongniart.

Fronds pinnate or bi-tri-pinnate generally twice or thrice divided. Pinnules entire, constricted at the base and not uncommonly cordate with a short pedicel, rarely inserted by the whole width of the base, costa more or less distinct, only occasionally continuous beyond the middle of the pinnule, thence dividing into veins which emerge at a very acute angle, curved, diverging, numerous, slender, dichotomous, produced to the margin in parallel venules, and never anastomosing.

This is a large and natural genus, and is said to be peculiar to the true Carboniferous epoch. When the costa entirely disappears it may be confounded with *Odontopteris*, and when the same nerve is continuous to the apex of the pinnules it is equally difficult to separate it from *Pecopteris*, especially as this genus has the veins very numerous and emerging at an acute angle. Then recourse must be had, says Brongniart, to the shape of the pinnule, which in the greater number of species of *Neuropteris* is contracted and rounded at the base and *never decurrent* or confluent.*

Amongst existing forms the resemblances are to *Pteris*, *Blechnum*, *Lomaria*, &c. Only once has the fructification of *Neuropteris* been observed, and that shows no analogy with any living Fern.

Neuropteris sp.—Fragments of a fern somewhat resembling *N. gigantea* Sternb, were found by me at Bobuntungen in Queensland. I have not the specimens now to refer to, and therefore cannot give more details. Doubtless, more will be found. A figure of the species named will be seen in Lindley and Hutton

* "The median pinnules must be here understood. The basal and terminal ones are often so much modified as to lose their normal form." Schimper, Note, vol. 1. p. 431.

Fossil Flora, plate 52. Sternberg Flor. d. Vorw. 4, p. 16, 5, p. 72; Brongniart Prod. p. 54, and Hist. d. Veg. Foss. 1, p. 240, plate 69.

The Rev. W. B. Clarke mentions *Neuropteris* as occurring at Newcastle, but no such fossil was found in his collections or amongst those sent to Europe. It was probably a mistaken identification.

Neuropteris australis, n s., plate 8, fig. 4, 5. Frond pinnate with a thick, broad, conspicuously grooved rachis. Pinnæ ovate and lingulate, the lower ones, moderately and irregularly lobed and obtuse, unsymmetrical, the upper ones, ovate, acuminate with an acute apex, the apical pinnules, trifoliate, with lobes broadly rounded, all affixed to the rachis by a somewhat broad petiole. Veins rather thick and prominent, radiating from the base, the venules running almost parallel in a curve to the margin. Length of lower pinnules, 15 to 20 millim.; breadth, 8 to 10 millim. Upper ones gradually diminishing in length and breadth to the summit of the frond.

This species of Fern differs from *Thinnfeldia* in the shape and arrangement of the pinnæ, which are not decurrent, and diminish in size towards the apex, where they become ovate-lanceolate and finally trifoliate, in a way that is never seen in any of the other fossils we have in Australia. There does not seem to be any signs of the bifurcation of the frond.

The first specimen I received of this interesting fossil was obtained by the Rev. J. Milne-Curran, from the gravel of the Bell River, near Wellington, N.S.W. The fossil was in ironstone, and evidently derived from some of the limonite nodules such as are obtained from the Hawkesbury rocks. There is only one living form to which it could be referred, namely, *Aneimia* (Swartz). This genus is distinguished by forked radiating free venules, without a median vein, which make it stand alone amongst living forms. It is not represented in Australia, but is in Africa, and almost confined to the tropics.

I venture to suggest that the connection between these forms may be worth attention. There is a fossil genus connected with

them which has been named *Aneimidium*, by Schimper, and which can scarcely be separated from living forms, except in this, that the veins are closer and more numerous. There are two species known from the Wealden of North Germany. The diagnosis of the genus is thus given:—Fronds pinnate, pinnae coriaceous, simple, oblong, ligulate, symmetrically, and unsymmetrically obovate, base inserted, gradually narrowed. Neuration distinct, thickened towards the base, often forking, and all the venules free and reaching the margin.

“The great resemblance which these species manifest to several species of *Anemia*,* and the almost complete correspondence of the venation has induced me to give to these plant remains of the Cretaceous period the name of *Aneimidium*.”—Schimper, Pal. Veg., vol. 1, p. 485.

If we were sure of the horizon to which this species of *Neuropteris* belongs, its presence might cause interesting speculation. It has been found simply in a waterworn stone in the river bed. There are no known paleozoic plant beds near, and its aspect is certainly not that of a paleozoic fossil. The formation on which it rested was a marine Devonian limestone, with corals.

THINNFELDIA.—Ettingshausen.†

Fronds pinnate, segments or pinnae oblong, ovate lanceolate, decurrent, and confluent at the base, coriaceous, costa divided into many veins, venules and veinlets, before reaching the apex; veins emerging at a slight angle, diverging in ascending, and often forking, venules or veinlets reaching the margin. Stomata in both sides of the lobes. *Obs.*—The frond is generally dichotomous, and is with the leaves of a thick and fleshy habit. It belongs in Europe to the lower Lias and Rhætic formations.

* From ἀνείμων, without clothing (a priv. ἔμα, vesture), in allusion to the naked inflorescence. Many writers on Ferns, such as Smith, Moore, Hooker, write *Anemia*, which is the orthography of Swartz, the founder of the genus.

† Begründung einiger neuen nicht genau gekannten Arten der Lias u. d. Oolith flora. (Abhand. d. k. k. geol. Reichsanst., I. 3, No. 3. p. 1.)

According to Dr. Feistmantel there has been much doubt about the position of these plants.* It is not a common genus, though with us the specimens are so numerous. By Braun† it was placed amongst ferns, but in the family PACHYPTERIDÆ. By Ettingshausen it was regarded as a conifer near *Phyllocladus*. Andræ also placed it amongst conifers, but with *Taxineæ* with *Pachypteris*.‡ Schenk classed it with *Cycadopteridæ*. In the work of Schimper referred to (vol. I., p. 494) the author takes *Cycadopteris*, *Pachypteris*, and *Thinnfeldia*, and places them all amongst *Neuropterideæ*, in which Dr. Feistmantel says he is probably right adding "We have another systematic position of this genus by M. Saporta ; in his Jurassic plants of France (Paleont. Francaise, N. 8, p. 340, ff.) he placed *Thinnfeldia* amongst the *Odontopterideæ* ; but I believe this is not quite right, unless the diagnosis of *Odontopteris* (Brongniart) be altered, for we have in all known species of *Thinnfeldia*, Ettingsh., a distinct costa merging in venules on the apex, which does not occur in *Odontopteris*. There are seven species described from Europe, viz :—*T. decurrens*, Schenk, *speciosa*, Ett., *obtus*a, Schenk ; *rhomboidalis*, Ett., *saligna*, Schenk, *laciniata*, Schenk, and *incisa*, Saporta, all from Rhætic or Lias. There are two described from India, viz. :—*T. indica*, Feistm., and our common *T. odontopteroides*, Morr.

? *Thinnfeldia media*, n. s. (an var. *indica*? F. loc. cit., p. 87. Pl. xxxix, fig. 1, 1a ; xlv., fig. 1, 2, 2a ; also Records Geol. Surv. Ind., ix., 2, p. 35, 1876 ; *Pecopteris salicifolia*, Old. and Morr. Rajmahal Flora Pl. xxvii., fig. 2). Frond pinnatifid or bi-pinnate (?), pinnæ nearly opposite lanceolate, acuminate, on the margin sinuate, the lower ones shorter, the upper more or less nearly auricled, the lower ones more or less decurrent, the costa dividing into many veins ; these veins are forked. Stalk thick striated. This is the diagnosis of *T. indica*.

* See vol. 1, Foss. Flora, Gond. Syst. Part 2, Jurassic (Liassic) Flora of Rajmahal Group, p. 85 and 33, of the work, 34 of the part.

† Braun verz. d. Petref. m. d. Kreiss z. B. 1840. k. k. Geol. Reichsanst. Abh. II. 1855, p. 43.

‡ Fl. d. Grench, 1867, p. 105.

Dr. Feistmantel remarks that the form of the pinnæ, the venation, and the thickness of the rachis all agree with *Thinnfeldia*. He says that it might almost be identical with *T. decurrens*, Schenk, a Rhætic and Liassic plant, differing only in these points :—1. The rachis is thicker ; 2. The lower part of the base of pinnæ not so distinctly decurrent ; 3. The pinnæ are thinner. He unites this species with *Pecopteris salicifolia*, Morr.

Found in the sandstones at Dubbo, where it is associated with *Thinnfeldia odontopteroides*. The sandstones are without doubt the same as the Hawkesbury sandstone, which I regard as an aerial deposit. I have also recognized occasional fragments of this Fern in ironstone. The differences in this species will appear from the following diagnosis :—(Bi-pinnate?) pinnæ quite close, nearly opposite, broadly lanceolate, broadly obtuse, the lower ones shorter, attached by the whole of the base where it is only very slightly constricted. Veins only faintly visible, but there are traces of a costa in nearly all the pinnules which is evanescent. Rachis very thick.

While the venation is so indistinct we cannot be sure that the fossil is a *Thinnfeldia*. It bears some resemblance to *T. indica*, Feistmantel and more to *T. decurrens*, Schenk, a Rhætic and Liassic plant of Europe, differing only in the form of the pinnæ, which are more obtuse. I think I have also recognized varieties of this Fern in ironstone nodules, which have evidently been derived from the Hawkesbury rocks by weathering. The decomposition of the plants has given rise to a nucleus by deoxidizing the ferric oxides in the felspars contained in the sandstone, as stated in the paper on the Hawkesbury sandstone in the Roy. Soc. N. S. Wales for 1882. A careful examination of these nodules generally manifests some fragments of plant remains.

Thinnfeldia odontopteroides.—Morris (1845) Physical Des. N.S.W., Strzelecki, as *Pecopteris* p. 249, pl. vi., figs. 2, 3, 4 ; 1847, *Gleichenites odontopteroides*, M'Coy, A. and M. Nat. History, vol. xx, 2nd Ser., p. 147, 1850, Idem. Unger., Genera et species plant. fossilium, p. 208 ; 1869, *Cycadopteris* (?) *odontopteroides*, Schimper, Trait. de Paléont. végétale, vol. i., p. 488 ; 1869, *Alethopteris* (?)

odontopteroides, Schimper, *ibid*, p. 569 ; 1872, *Pecopteris odontopteroides*, Carruthers, Qu. J. G. S., London, vol. xxviii., p. 335, Tab. 27, figs. 2, 3 ; 1875, *Odontopteris*, Crépin, Bull de l'Acad. Royale de Belgique 1875, vol. xxxix, 2 Serie, pp. 258-263, figs. 1-5 ; 1877, *Thinnfeldia morrissi*, Feistmantel, N. J., Mineral, &c., 1877. p. 179 ; 1878, *Pecopteris odontopteroides*, Etheridge (R.), Catalogue of Australian Fossils, p. 98 ; 1878-79, *Thinnfeldia odontopteroides*, Feistmantel, Flora des oestl. Australiens, Palæontographica, Supplement iii. Hef. iii., pp. 105, 165 ; 1878, *Cycadopteris*, M. Zeiller in Guide du Géologue à l'Exposition Universelle (Paris) de 1878, &c. ; 1880, *Thinnfeldia crassinervis*, Gein., and *Pecopteris odontopteroides*, Morr., probably identical, A. G. Nathorst in Ofvers. of Kongl. Vet. Akad. Stockholm, Förhandl., 1880, No. 5 (Review in botan. Centralblatt, No. 2, page 328, 1881). *Thinnfeldia odontopteroides*, Feistmantel, Fossil Flora of Damuda and Panchet div., p. 85, pl. xxiii., A, figs. 7, 9, from whence the foregoing synonymy is for the most part taken.

This widely spread fern, which is a very common fossil in Australia and Tasmania though rare apparently in India, was first described by Morris from very imperfect and very incomplete specimens and so to a certain extent was the figure of Carruthers (Geol. of Queensland, loc cit., p. 355). The numbers of specimens since found gave every facility to Dr. Feistmantel for the following diagnosis. Frond of varying size from small to large, simple or dichotomously divided. Simple fronds, pinnate, pinnatifid, pinnae long, pinnules rhomboid-ovate, here and there dentate, connate at the base, lower basal ones inserted on the rachis, semi-elliptic, or connected with the following pinnule. Dichotomous fronds pinnatifid or pinnate pinnatifid ; pinnae in the undivided portion and near the division close and short, those of the branches longer ; pinnules variable, sometimes obliquely ovate, oblong, sometimes quadrately ovate, entire, or obliquely truncate above, or indentate ; on the frond pinnate pinnatifid, lowest basal pinnules, even those remote and those in the upper part fixed to the rachis. Veins, rising partly from one which is almost median, coming from the basal part of the leaf at the

rachis, and forking frequently, and some also forking coming direct from the rachis.

In this diagnosis Dr. O. Feistmantel has included all the different variations to which the species is subject. He has paid much attention to it, and it is best perhaps to give an abridgement of his own remarks as they stand in the descriptions of the Damuda and Panchet divisions of the Gondwana systems (India*), and as they are summarized in the paper read before the Royal Society of New South Wales in 1880. After stating that he believes he can identify this peculiar fossil amongst the Lower Gondwana plants he remarks that this species has undergone numerous trans-migrations from one genus into another, its proper place not being finally settled yet. Professor Morris did not like to decide on its systematic position, but from the dichotomy of the leaf Professor M'Coy placed it provisionally with *Gleichenites*, and so on with other authors whose opinions will be quoted presently. When Professor Geinitz sent me in 1876 his paper on the Rhætic plants of the Argentine Republic (Cassel 1876), I was at once struck with the similarity of his *Thinnfeldia crassinervis* with *Pecopteris odontopteroides*, and quite recently I find the same view expressed by Herr Nathorst, † who even thinks that both these plants are identical, after having seen the specimens from Queensland which are described by Mr. Carruthers. I have myself had an opportunity of examining several specimens from various localities in Australia, and although sometimes differing in appearance, yet from all the other characters they have, I think that they are to be considered identical. Considering the differences they present from *Odontopteris*, *Ctenopteris*, and *Pachypteris*, it appeared to me best to place this fossil with *Thinnfeldia*.

The differences to which Dr. Feistmantel refers are those between the very large fronds from Mount Victoria and the short, neat, and fern-like forms in the coalbeds of Ipswich. The species, however, abounds in the Tivoli mine, and every intermediate form can be

* Mem. Geol. Survey India. Fossil flora of the Gondwana System, vol. 3, part 2, p. 86.

† Ofvers Kongl. Vet. Akad., Stockholm, Forhandl, 1880, No. 5 (see also Nuren in Botan, Centralblatt, No. 2, p. 328, 1881.

obtained on the same piece of black shale. It must have been a very large plant, and grew to immense size, even in the poorest sandy soil. It is found in the Hawkesbury sandstones in very poor sand, and no traces of a vegetable deposit any more than an oxidation of the iron around the plant impressions, and in some of the laminations. Fine specimens have been obtained from the sandstone quarries at Dubbo, which is nearly 200 miles from Mount Victoria.

The following observations are from the Jour. of the Roy. Soc., N.S.W., 1880, p. 113.

Thinnfeldia odontopteroides, Fstm. (Morr. sp.) (pls. xiv, fig. 5 ; xv, 3, 7 ; xvi, 1 ; ix a, x a, and xi a).—Prof. Morris described in Strzelecki's above-mentioned work a fossil plant from the Jerusalem basin, as *Pecopteris odontopteroides*, Morr., without being, however, able to justify this determination. Prof. M'Coy placed later the same species with *Gleichenites*. Mr. W. Carruthers quotes it from Queensland again as *Pecopteris odontopteroides* and gave two figures. M. Crépin, who described several specimens from Tasmania, classed it with *Odontopteris*, and compared it with *Odontopt. alpina*, Gein., considering the beds from which it came as Carboniferous. But its association, as mentioned before, on the same specimens with *Sphenopteris elongata*, Carr., leaves no doubt about the correlation of these Tasmanian beds. I could compare specimens from Queensland and Tasmania, and also from the Wianamatta and Hawkesbury beds in New South Wales. The comparison has shown that in the specimens from all the localities there occurs a dichotomy of the frond pretty regularly as in the genus *Thinnfeldia*, under which name I have described it in my above-mentioned memoirs. For the support of this view I quote its great resemblance to *Thinnfeldia crassinervis*, Gein., from the Rhætic beds of the Argentine Republic.

Dr. Feistmantel calls attention to the fact that this is a characteristic species of the mesozoic coal in Australia. It is certainly never found in the Newcastle beds. It is very common as already stated at the Tivoli mine, associated with *Equisetum rotiferum*, at Bundamba, in fact in all the Ipswich coal basin. It is found

in the Hawkesbury sandstone, or the similar ariel sandstone, extending far to the westward, in fact over the continent. This sandstone is of different ages. Some of it over-lies the Cretaceous rocks, though as far as I know *Thinnfeldia odontopteroides* has not been found in strata which are clearly above the Cretaceous.

Thinnfeldia odontopteroides var. *falcata*. plate 8, fig. 1. Frond graceful and somewhat of the same size as *T. odontopteroides* simple and dichotomously divided, pinnate pinnatifid, pinnæ long and curved broadly lanceolate, *becoming long and falcate as they ascend the rachis*, entire, opposite, very close but not connate, base broad, and inserted by its whole length upon the rachis, becoming close and short, but always lanceolate at the apex, at the base or near the dichotomous division. Veins nearly the same as *T. odontopteroides*, but the costa though forking continually is more conspicuous, diverging from the rachis at a very acute angle; some nerves also forking, running direct from the rachis. Plant evidently coriaceous, rachis broad and stout with a conspicuous double groove, abundant at the Rosewood scrubs about ten miles from Ipswich, where it is associated with the *Alethopteris australis*, *Thinnfeldia odontopteroides*, *Sphenopteris elongata*, and other common forms of the Tivoli coal flora. It is by far the most abundant form, and well preserved, showing the workings and venation very distinctly.

Though Dr. Feistmantel would seem in his diagnosis of *T. odontopteroides* to have given almost every variety of form, yet the peculiarities of this species stand distinct and marked. It was evidently a Fern of stouter habit than its congener, probably not so large in growth. The rachis is always grooved and more slender, and the terminal pinnules form a long lanceolate pair in some specimens. I do not, however, exclude the possibility that this may be a variety of *T. odontopteroides*, but if it be so it is a new and distinct one which deserves to be marked.

ODONTOPTERIS. Brongniart.

Fronds pinnate, generally bi-pinnate at the apex, pinnæ pinnate and pinnatifid, the apical ones single, sub-opposite and sub-alternate, linear lanceolate; pinnules obliquely inserted by the whole

base, decurrent, free, but towards the apex more and more confluent, and the terminal ones united, slender, ovate-acuminate, rarely somewhat rounded, the lowest ones seated partly on the primary and partly on the secondary rachis of two forms, either narrow at the base, broadly cuneate, and more or less deeply emarginate above, or obcordate. Veins all arising from the rachis, extremely fine, dichotomous, diverging as they ascend. No costa. Fructification unknown.

This is a Carboniferous genus which has no immediate relation to any Fern either extinct or existing, except perhaps *Neuropteris*; but in *Odontopteris* the pinnules are always inserted on the whole base, decurrent, and often confluent, while in *Neuropteris* they are always constricted or somewhat pedicellate. In the latter, too, there is always a median nerve, from which all the others take their origin, while in *Odontopteris* they all arise directly from the rachis. Again, the basilar pinnules of the genus just named are very different from the others, which is not the case in *Neuropteris*, whose pinnules are obtuse or rounded at the summit, while the former are often pointed and bent, or falcate. Goeppert cites some instances of the genus having been found above the true Carboniferous, but Schimper believes this to be a mistaken identification. It will be seen, however, that M'Coy's species now cited is from the so-called Wianamatta beds at Clarke's Hill, near Cobbity.

Odontopteris microphylla, M'Coy, (Ann. Nat. Hist., vol xx, p. 147, not figured).—Bi-pinnate, pinnæ alternate, oblique narrow, about three lines wide and two inches long; pinnules alternate oblique, slightly connate at the base, obtusely elliptical, their length only equalling the width of their base, no midrib, secondary neuration indistinct.

Obs.—"The only *Odontopteris* approaching this elegant species by its alternate pinnæ, and very short connected pinnules, is the *O. schlotheimii*, Br., from which it is distinguished by the smaller size, much narrower and more oblique pinnæ, and by the pinnules being proportionately smaller and elliptical instead of being broadly rounded. The latter character also separates it from the

so-called *Pecopteris desnoyersii*, Br., of the Oolithe à Fougères, Mamers, Sarthe. Common in the fine sandstone of Clarke's Hill, N.S.W."

CYCLOPTERIS. Brongniart.

Frond simple, pedicellate, flabelliform or reniform, symmetrical, membranaceous, margin sub-entire, crenulate, or fringed; veins arising from the base, forking frequently, radiating, slender, all reaching the margin.

This genus connects the Sphenopterideæ and Neuropterideæ. No pinnate form is included in it. It is related to species of *Hymenophyllum* with a simple frond such as *H. reniforme*, which grows in N. Zealand.

Cyclopteris cuneata. Carruthers (Quart. Jour. Geol. for 1872. Append. to Daintree's Essay, p. 355, pl. 29, fig. 5.)—Form of the entire frond unknown, pinnae entire, large cuneate, narrowed at the base, with the distal margins rounded, veins delicate, once or twice dichotomously divided, sometimes anastomosing once in their length in the middle of the pinnae.

"Notwithstanding the slight anastomosis of the veins, these separate pinnae, which are not very frequent, represent a very distinct species of the genus *Cyclopteris*. Locality, Tivoli Coal Mine."

Dr. O. Feistmantel thinks this is not a complete frond or leaflet, but a wedge-shaped fragment broken off by chance. This is certainly my opinion after having examined the type specimen which is preserved in the Brisbane Museum. The fragmentary character and the anastomosis of the veins inclines me to agree with Dr. Feistmantel in not regarding this as a *Cyclopteris*. Possibly it may belong to some fern of the net-veined order (Dictyopterideæ). See further remarks on some fossils of this kind from the Ipswich coal beds. Some fragments of *Sagenopteris* may resemble it.

PECOPTERIDEÆ.

Frond undivided, simple, or pinnate many times in a beautiful manner. Pinnules often entire, but here and there sub-divided and with a dentate margin, base wholly adnate, rarely constricted,

sometimes confluent. Costa persistent to the apex, pinnately ramose; veins dichotomous diverging to the margin at a more or less open angle. Venules simple, forking twice or thrice, rarely anastomosing. When sori are present they are marginal or disposed towards the middle of the pinnule, punctiform, oval or linear.

This order is established entirely upon the venation, and unites the characters of very different living genera and families. On this account the classification of the various forms in one intelligible system has hitherto failed

PECOPTERIS, Brongniart.

Veins emerging from the costa in a more or less open angle, diverging arcuately, simple or dichotomous, venules often forked.

Pecopteris tenuifolia, M'Coy (Ann. Nat. Hist., vol. 20, p. 152, Pl. IX., fig. 6.) Bi-pinnatifid (?) pinnules and rachis very slender, each about half a line wide; pinnules very long, oblique, linear, apparently simply united to the rachis by their entire base, one very strong costa running throughout, veins unknown. *Obs.*—"If this be truly a *Pecopteris* it is distinct from all others by its very narrow linear leaflets. The only plant I have seen at all resembling it is the *Zamites obtusifolius* from the shale of the Oolitic coal fields, Blackheath, Richmond, United States, exhibited some weeks since by Mr. Lyell to the Geological Society. The specimens alluded to of this latter plant seem imperfectly preserved, but still show on some portions of the pinnules a neuration running parallel with a strong midrib. This great costa seems to me to be incompatible with *Zamites*, so that although I point to the resemblance between the American and Australian plants, I prefer placing the latter provisionally in *Pecopteris*, as I have seen no trace in my imperfectly preserved specimens of a parallel venation, and even if it should hereafter be found to exist, I conceive it would be necessary to form a new genus intermediate in form, venation, and, I think, mode of attachment of the pinnules to the rachis between *Zamites* and *Pecopteris*, for the reception of these two plants. One specimen has occurred in the fine sandstone of Clarke's Hill, N.S. Wales."

ALETHOPTERIS, Sternberg (as limited by Schimper.)

Frond bi- or tri-pinnate. Pinnules coriaceous, simple, often quite entire, base wide, decurrent, free or simple, margin reflexed or revolute (covering sori?) Costa, immersed in a groove above, but prominent behind; veins, prominent or flat, simple or forking once, the venules diverging and reaching the margin.

The genus which comes nearest to this amongst existing forms, is the common *Pteris* or Brake, excluding those species which have a reticulate venation (*Lonchopteris*). Schimper is of opinion, that it is impossible to establish any clear line of demarcation between *Alethopteris* and *Pecopteris*, though they form characteristic groups sufficiently distinct.*

Alethopteris australis, Morris (in Strzelecki as *Pecopteris*, p. 248, Pl. viii., fig. 1, 2, 2 a.). Frond bi-pinnate, pinnae oblique, alternate, rather distant; pinnules thin, falcate, and rather obtuse, oblique and somewhat incurved, more or less adnate to the rachis, and sometimes decurrent, dilate at the base or auriculate. Costa, slightly flexuous, evanescent towards the apex, veins oblique, bifurcate or dichotomous. *Obs.* This fern belongs to the Neuropteroid division of *Pecopteris* and bears much greater resemblance to the *P. whitbiensis* and *P. tenuis* of the Oolitic series of England, than to any other species described by Brongniart as occurring in the coal measures. The frond appears to have been bi-pinnate with oblique alternate pinnae, the pinnules thin, somewhat falcate and obtuse, the margins of which vary slightly in form; being either sinuous or entire, according to their position on the frond. This fossil bears considerable analogy to the *Pecopteris lindleyana*, figured in Professor Royle's illustrations.

* Feistmantel in his papers in the Indian Geological Survey, says that this genus is especially distinguished by having the pinnae inserted in the stem by their whole base, and by their basal portions being generally joined together. See Foss. Flora, Gondwana, vol. 2, p. 22. I am afraid however, that in some species, variability may be seen in this particular. But the generic distinction is of value, because the genus *Pecopteris* would be so large and unwieldy without it.

Professor M'Coy describes this species as a *Pecopteris* in the Decades of the Paleontology of Victoria. (pl. xiv., fig 3, p. 17). stating that it is the same species as *P. Scarburgensis*, Bean MSS., which Mr. Leckenberg considers intermediate between *P. insignis* and *P. ligata* of the same Yorkshire Oolite beds. The only difference appears to be in the slight apical serration of the pinnules in the European species. Professor M'Coy also remarks that the veins usually fork only once, which is the case with the European and Australian species, while a secondary marginal branching is rare, though in the figure given by Morris from the Jerusalem (Tasman.) coal it appears to be common. This however is sometimes the case in the English Oolitic plants. Professor M'Coy's species came from Bellerine near Geelong, Morris's specimens came from the Jerusalem basin in Tasmania. Very common in all the Ipswich, Q. L., coal basin, Darling Downs, Clarence River, New South Wales. The Queensland specimens have at times an obtusely serrated margin, and there are also varieties very close to our common *Pteris aquilina* of world wide distribution. In form and venation the fossil and living species are certainly closely allied, but Professor Heer * and Professor Schimper † have shown by the discovery of the fructification, that the sori were obliquely placed along the veins and not marginal as in *Pteris*. *A. whitbyensis* Goepp., is therefore referred to by Heer, as *Asplenium whitbyense*. It is so nearly allied to our fossil that the two can hardly be considered even as varieties. If we regard them as one, it is one of the most wide-spread fossils known. In addition to the large area over which it can be traced in Australia, it has been found in Yorkshire, Switzerland, S. Prussia, Persia, Siberia, the Amur countries, and Japan. It is distinctly a Lower Jurassic species.

Alethopteris concinna, n.s. Pl. 9, fig. 1.—Frond bi-pinnate, with rather long rounded and obtuse leaflets; costa faint, veins numerous and close, emerging at an acute angle, forking once, the venules very close and parallel, reaching the margin.

* Flora fossilis artica vol. iv.

† Handbuch der Paleontologie, Zittel and Schimper (1879), vol. 2, p. 97.

Locality? I suspect this is from Ballinore Mine, Talbragar River, from the nature of the matrix, but it may have come from Ipswich, Q. L. The rounded and obtuse leaves, and the closeness of the veins and venules, distinguish this species

Alethopteris currani n.s., Plate 6, fig. 4.—This fossil, if I may judge from the small fragment, appears to have belonged to the division *Pecopteris acrostichides* of Schimper, in which the frond which is pinnate and bi-pinnate, has the pinnules adherent by the whole base and confluent. The veins are slender, costa disappearing near the apex, the veins forking. Of the sori, nothing is known, and the relations may have been as in other members of the genus, with *Asplenium*. In this case, the secondary pinnules only are seen, in the apex of what has been probably a portion of the frond. The pinnules are falcate, oblique, oblong lanceolate, slightly serrated at the upper edge, rounded at the apex into a blunt point, nearly opposite, adherent by the whole base, confluent. Costa of the pinnules emerging from the rachis at a very acute angle; veins few, conspicuous, forking once, the venules reaching the margin at the re-entering angle of the serrations, apical pinnules acute. Length of fragment, 25; greatest width, 15; length of longest pinnule, 10; width of base, 6; all millimetres.

Ballinore coal field. The only species to which I can compare this, is to the preceding *A. whitbiensis*. The differences however, are very great. The pinnules and median vein are very much more oblique, the rachis stouter, and the pinnules are also lobed, broader, the whole frond large, but more tender and membranaceous.

MERIANOPTERIS. Heer.*

Sterile fronds tri-pinnate, elegant, secondary pinnae elongate, segments of pinnae inconspicuous, costa arcuate, veins dichotomous, the lowest two from contiguous pinnules bending towards each other and anastomosing.

This diagnosis is applied by Dr. Heer, to distinguish two species of Ferns from the Upper Lias in Switzerland. The principal

* O. Heer, Flora Fossilis Helvetiæ, 1877.

characteristic is the arching and anastomosis of the basal secondary nerves of contiguous pinnules. They are small Ferns, but Dr. Feistmantel found one of much larger size in the Ramiganj coal plant beds in India, which he described in his essay on the Flora, Damuda and Panchet Divisions.* I have found what I believe to be the same fossil in the Ballinore coal beds in N. S. Wales. It is thus described.

Merianopteris major. Feist. loc. cit. Frond large, tri-pinnate, secondary pinnae somewhat broadly elongate, only a little narrowed towards the apex, pinnati-sect or pinnatifid, pinnules or lobes rounded at the apex and very thin-leaved, costa distinct, and somewhat curved at the apex of the veins, the two lowest divide on emerging and join with the same of the adjoining leaflets in a pointed arch, while the others are placed more towards the upper portion of the pinnule, pass out at a very acute angle from the costa, are also dichotomous, and somewhat flexuous.

The state of preservation in the Indian and Australian forms shows a large but very thin-leaved and tender Fern. From the figures in Feistmantel, one would conclude that the pinnules are united, and the arching vein spreads from one leaflet to the other in the manner indicated. This occurs more rarely in the Australian fossils. The pinnules are sometimes quite distinct, as I have figured in the plate, which is a little larger than nature, the leaflet three times natural size. There are specimens in which the anostomosing nerves quite correspond with Feistmantel's definition, and I have no doubt that in all other respects they are the same. The Indian beds are regarded as Lias. The Fern is not uncommon but probably not so common as *Alethopteris currani*, in these strata.

TÆNIOPTERIDÆ.

Fronds stipitate, simple, oblong, lanceolate and broadly elongate, entire or pinnate, pinnae linear, lingulate, more or less acuminate, shortly pedicellate or sessile. Rachis and costa conspicuous, veins

* Op. cit. Vol. III., part 2 & 3, p. 83. Plate 19 A, figs. 9 & 11. (There is a mistake in the reference page opposite the plate, 9 to ii., being printed instead of 9 to 11.)

emerging at an acute angle but immediately becoming horizontal or oblique; simple and dichotomous. Sori transversely oblong, submarginal, or rounded and scattered over all the lower part of the surface or in series along the venules.

This order is founded entirely on the neuration and would include amongst living Ferns the *Marattiaceæ*, the *Aspidiaceæ*, and probably the *Acrostichiaceæ* (Schimper). The fructification is certainly that of *Marattia* in some cases, and that of *Acrostichum* in others, except that in the latter the sori are distributed over the terminal under surface of the frond, as we see in our common Stag's-horn Fern (*Platynerium*) and the equally common Queensland swamp Fern *Acrostichum aureum*.

It has already been stated what great importance was attached to one species of *Tæniopteris* from the fact that it was chosen as the typical fossil of certain coal deposits in Australia. The late Mr. Daintree stated that *Tæniopteris* and *Glossopteris* were characteristic fossils of different formations in Australia, and were never found associated in the same beds. *Tæniopteris*, he thought was indicative of Australian carbonaceous beds of mesozoic age and *Glossopteris* was characteristic of our paleozoic coal deposits. The Rev. Mr. Clarke also laid stress upon the *Tæniopteris* fossils, so that the name came prominently forward in the discussion between himself and Prof. M'Coy.* On this account it may be necessary to state briefly what are the latest views on the subject of these fossils.

The genus, *Tæniopteris*, was established by Brongniart in 1828 for Ferns with simple entire leaves, a stiff thick costa and perpendicular veins either simple or forked at the base. In 1838 Count Sternberg divided the genus into two groups—1. With simple fronds and 2., with pinnate fronds, and he enlarged the definition, making it include all Ferns with simple large stipitate fronds, entire or dentate, or profoundly pinnatifid or pinnate. Many different genera were then united which have been subsequently separated. The history of the changes which ensued

* See Trans. Roy. Soc. Victoria, 1860, page 89; also, Art. III, page 96, Art. XIII, page 209 and Art. XIV, page 215.

need not be specified as they have no immediate bearing on the Australian fossil flora. In all of them the characters of *Tæniopteris* were regarded as of generic value only, and the Ferns were included with the *Danæacée* which belongs to the *Marattiaceæ*. In 1869 Schimper erected the characters of *Tæniopteris* into one of his five orders of Ferns which are—1. *Sphenopterideæ*; 2. *Neuropterideæ*; 3, *Pecopterideæ*; 4, *Tæniopterideæ*; 5, *Dictyopterideæ*. The definition of Schimper for the *Tæniopterideæ* is that which is given above. It is divided into seven genera—1. *Tæniopteris*, simple scolopendrifrom fronds with horizontal or oblique veins and unknown fructification. 2. *Angiopteridium*, Pinnate fronds with the fructification of the living *Angiopteris*. In all formations from the Trias to the present day. 3. *Marattiopsis*, long linear dentate pinnæ with narrow filiform costa and oblique veins. A tertiary genus like our own *Marattia fraxinea*. 4. *Oleandridium*, simple lanceolate elongate or lingulate coriaceous fronds with the fructification of *Aspidium*. Rhætic to tertiary. 5. *Macrotæniopteris*, a large *Tæniopteris* with sometimes a dentate margin and fructification of *Aspidium*. Rhætic, Oolitic and Tertiary. 6. *Danæopsis*, a Triassic form like the living *Danæa*. 7. *Danæides*, Pinnate fronds with the veins emerging from a narrow costa at a right angle with ex-annulate sporangia, which are situate at the under side near the margin, &c.

From these definitions it will be seen that all the Ferns of the family where the fructification is not known are referred to *Tæniopteris* or *Macrotæniopteris*, and these include simple fronds with either horizontal or oblique veins.

TÆNIOPTERIS, Brongniart.

Frond simple and in habit like *Scolopendron*. Costa conspicuous above, sub-terete underneath, veins generally conspicuous, slender, numerous and close, dichotomous a little above the base; venules simple or dichotomous, parallel, with an occasional intermixture of simple nerves.

In this genus the veins emerge from a very prominent costa at almost a right angle. They are very close, curved or straight,

simple, or forking once or twice, and there are never any venules. Some authors thought that the genus may possibly be a Cycad allied to *Stangeria*, but there are very many objections to this view.

Tæniopteris daintreei, M'Coy (Paleon., Vict. Pl. xv, figs. 1 and 2, p. 15); frond very long, linear, parallel-sided; substance thick, edges straight, costa very strong, veins extending at right angles from the midrib to the lateral margins, a few straight and simple, the greater number once forked at a variable distance between the midrib and lateral margin, total width of frond four lines, about ten or eleven lateral veins in the space of two lines at the margin, both of ordinary specimens, four lines wide, and one specimen nearly two inches long, but only one and a half lines wide throughout.

This species has been found in two places in Victoria, viz., Murndal on the Wannon river in Western Victoria, and at the Barrabool mills near Geelong. In the latter place it was associated with *Alethopteris australis*, Morris, and according to Professor M'Coy with *Phyllothea*. But I venture to suggest that as the identification of *Phyllothea* depended upon the stems alone, without the characteristic long linear sheath leaves, it may be doubted whether it was the same species as those of the Newcastle beds. We have seen that the stems of this genus *Schizoneura*, *Equisetum*, and other Equisetaceæ cannot be distinguished from each other without leaves. It may then be affirmed that *Tæniopteris* is a plant of the mesozoic flora, and is never found in the Newcastle beds, or associated with any Newcastle or paleozoic plants.

T. carruthersii, nobis (*T. daintreei* Carruthers. Proc. Geol. Soc., London, April 1872, p. 355). Frond simple (?), broad linear, costa somewhat thick, veins leaving it at an *acute angle*, then passing out at right angles to the margin, once or twice dichotomously divided. Tivoli coal mine Ipswich, Queensland.

The venation and general form of this plant differ very much from Professor M'Coy's *Tæniopteris daintreei*, with which Mr. Carruthers identified it. It is a larger plant and the veins, which are much finer and more numerous, frequently emerge from the midrib obliquely, which they never do in M'Coy's species. Both

are found in the Tivoli mine, and as Dr. Feistmantel has already suggested the distinctness of the species, I venture to give the one first figured and described by Carruthers, the name of that illustrious paleontological botanist. I have compared specimens from the Wannon, Victoria, side by side with the Ipswich plant, and can affirm that they are quite different.

MACROTÆNIOPTERIS. Schimper.

Large and handsome fronds more or less broadly and elongately lingulate, obtuse or acuminate, entire or rarely irregularly pinnately incised.

The distinction between this genus and *Tæniopteris* is only in the large and handsome form of the fronds. They are very like our Australian Bird's-nest ferns (*Asplenium nidus*.) They are common in the Oolitic coal of Richmond, Virginia, in the Lias of Europe, and in the Lias and Oolitic coal measures of India. They also reach the Tertiary formations.

Macrotæniopteris wianamattæ Feistm. (Paleoz. u. Mesoz. Flora des Ost Australiens p. 107. Pl. 13, f. 2.) Frond elongately obovate, simple, base attenuate, apex ? Rachis thick, grooved, or striated. Veins emerging at an angle of from 20 to 25 deg., close, near the rachis from 6 to 8-tenths of a millim. apart, slender, dichotomous towards the margin. See plate 10A. This fossil is quoted from the Wianamatta, above the Hawkesbury sandstone. I have some similar specimens near Ipswich, but the dichotomy of the veins is near the rachis and it may be a distinct species.

ANGIOPTERIDIUM.* Schimper 1869.

Frond pinnate, pinnæ articulate and finally deciduous. Sori when visible convex—linear, marginal, bivalvate like *Angiopteris*.

The leaves of these Ferns were formerly classed as *Tæniopteris*, and then some of them were removed to the Cycads as *Stangerites*. The present genus was established by Schimper as noted above, who showed that the specimens on which he founded his division

* Pal. Veget. Vol. 1., p. 602. Also, Feistmantel. Rajmahal Flora.

were really Ferns but differing from *Tæniopteris* in having deciduous pinnæ. I need scarcely say that the living Ferns which these species most resemble never have deciduous leaves.

Angiopteridium ensis. Oldham. Fossil Fl., Rajmahal Hills. (Foss. Fl. Gondwana, vol. 1, p. 35, pl. 6, figs 8, 9, 10.)—Fronde pinnate, pinnæ elongate, linear ovate, acuminate at the apex; costa thick, rapidly diminishing; veins prominent, often forked once or twice, emerging obliquely from the costa.

This variety is easily distinguished from the other forms by the obliquity of the secondary nerves, by the rapid thinning out of the midrib, and by the generally subovate or lanceolate form of the pinnule and the forking of the veins near the edge of the leaflet. A false serration is another distinguishing feature.

I know of nothing to prevent my referring the fossils which are found at Rosewood, near Ipswich, Q.L., to this form, as it corresponds exactly with the figures and with the description. I must confess that I should at first been inclined to regard the specimen as a Fern very near in habit to *Blechnum*.*

The affinities of this species are Jurassic and Rhætic.

Sub-order. DICTYOPTERIDEÆ.

Nerves *reticulate*, fronds many times pinnate or pinnatifid.†

A. With a midrib.

a. Costa conspicuous, frond simple. *Glossopteris*.

b. Costa inconspicuous, except in the middle, frond quadrilobate. *Sagenopteris*.

B. Without a costa. *Gangamopteris*.

GLOSSOPTERIS. Brongniart.

Fronds simple, elongately elliptical, acuminate, entire, coriaceous, petiolate, rachis broad, gradually tapering up to the apex. Veins emerging from the rachis at an acute angle, from which to the middle of the leaf they form a hexagonally rhomboid net; thence to the edge somewhat more free, dichotomous, not so often anastomosing, and forming very large rhomboidal areolæ. Sori rounded

* See also p. 172, and pl. 1, fig. 6a, 7a, op. cit. (Liassic Flora Rajmahal), where Feistmantel reviews the genus and species.

† In Schimper and Zittel's Paleonologie this is only a sub-order of Tæniopterideæ.

M. Brongniart states that the partial reticulation of the secondary nerves, near the rachis, is the characteristic peculiarity of this genus, but M. Schimper points out after Morris, that this is not strictly correct. The anastomosis is continuous to the margin, but is less frequent. I have remarked that in *Sagenopteris* the case is different. The anastomosis is frequent only near the costa, and subsequently the veins become nearly parallel, only sending an occasional small branch to unite with one another. Detached leaves of *Sagenopteris* are in many respects, like some species of *Glossopteris*, and this may afford a means of readily distinguishing them.

The genus *Glossopteris*, as already mentioned, derives a special interest in Australia, because it is so well represented, and because it has been the subject of so much controversy. In India also it has been a source of paleontological dispute, and this has led to a thorough examination of its position at the hands of Dr. Feistmantel.* I avail myself of many of his remarks in the following summary. The genus has a very wide range in geological time, from the Carboniferous to the Jurassic, with one species in a tertiary formation. It is equally wide spread horizontally. Besides being extensively found in Australia and Tasmania, it occurs in Africa in the Karoo formation (Beaufort and Stormberg beds), in strata of supposed Triassic age. In India, it begins in the Talchir series (Trias), becomes more numerous in the Karharbari, reaches its highest development in Damuda series, goes on into the Panchet, and passes into the upper portion of the Gondwana system (upper Lias and lower Jura), and occasional solitary instances are found with a still higher position. In Russia, a species is quoted from the "Klinische" sandstone, which is of Cretaceous age.† In Asia Minor, there are coal beds near Eregli, the ancient Heraclea Ponti, Bithynia, from which two

* Foss. Flora, Gondwana Syst. vol. iii., Flora Damuda and Panchet Divisions, p. 94.

† Nouv. Mem. Soc. Imper. d. Naturalistes, Moscow, vol. xiii., p. 221, pl. 19, fig. 1.

species of *Glossopteris* have been described by Schlehan,* but as no figures or descriptions were given Dr. F. doubts the identification especially as in Tchiacheff's "Asie Mineure" (1867) they are not mentioned by Ad. Brongniart, who described the fossil plants in that work. But Schlehan was probably right, as R. Etheridge recognized a species of *Glossopteris* amongst the fossils brought by Admiral Spratt from the same coal formation.† It is remarkable that this species (*Glossopteris sphenophyllum*) was found amongst such a truly Carboniferous flora as *Lepidodendron*, *Calamites*, *Sphenophyllum*, *Neuropteris*, *Sigillaria*, and *Stigmaria*, thus giving an earlier origin to net-veined simple Ferns than was ever previously claimed.

In a monograph of the Tertiary Flora of Novale, Messrs. Visani and Massalongo have described a *Glossopteris* (*G. apocynophyllum*), in which the figure and diagnosis well coincide with the definition of Brongniart.‡ This is the latest stratum to which the genus has been traced. Dr. Feistmantel throws a doubt on the identification, but for no sufficient reason.

The fructification of some species is known—all Indian fossils. It consists of round sori in longitudinal rows between the margin and midrib, which would indicate a relation to the living *Polypodium*. Mr. Carruthers, however, says that with regard to the Australian species he thought he observed certain indications of a fructification in the form of sori running along the vein nearer the margin than midrib. Dr. Feistmantel thinks that this would indicate a relation to *Antrophyum*, but that, I may observe, has no midrib, and the veins, though reticulate, are uniform. However, as Dr. F. justly remarks, the observation of Mr. Carruthers is of the utmost importance, as it indicates that *Glossopteris browniana*, of India, and the fossil which bears the same name in Australia, are not only *different species*, but *belong to entirely*

* Versuch einer geognost. Beschreibung der Gegend zwischen Amasry und Tyrila-Asy, 1852.

† See Spratt and Etheridge on the coal-bearing deposits of Erekli, Q. Jour. Geol. Soc., Lond., vol. 23 (1877), p. 524.

‡ Mem. d'Acad. di Torino. 3 Ser., vol. 17.

different genera. In the case of *G. angustifolia*,* there is a longitudinal intramarginal vein indicating a fructification like *Pteris*, our commonest living Fern. The fossil is not known in Australia.

Twelve species and a variety are recorded from Australia, and these distinctions depend entirely on the shape of the leaf, and the mode of the reticulation. Such distinction would not be specific in living ferns, but in paleontological botany we cannot always have well-marked and numerous specific features; yet in proportion as they are slight, we must exercise the greatest caution in recognizing such forms as characteristic of different horizons or localities.

Glossopteris browniana. Brongniart Prodrômus (p. 54; Veg. Foss., p. 223, t. 62. Morris in Strzelecki, p. 247, Pl. vi., fig. 1, 1a. M'Coy; Ann. Nat. Hist., Vol. 20, p. 150. Feist. Ost. Aust. Pal. und Mesoz. Flora p. 91, Pl. viii, figs. 3, 4., x. 1, 2, 5, 7., xi. fig. 1.) Frond simple, spatulate, or oblong lanceolate, entire, attenuate at the base; costa thick, canaliculate, gradually contracting towards the apex, veins oblique, anastomosing, hexagonal near the rachis and elongate near the edge. Of this species Morris makes the following observations. He says that it is abundant in the coal beds of Australia, and if they should turn out to be coal measures (paleozoic) it would be exceptional, as in the same period in England and America, there is no evidence of Ferns with simple fronds and reticulate venation. He remarks that this species forms the type of Brongniart's genus *Glossopteris*, but two other species were referred to it from the Oolite series of Sweden and England. The one from England, *G. phillipsii*, while agreeing with *G. browniana* in the venation, appears not to have been a simple frond, but digitate, four or five pinnulæ arising in a fan like form from a common rachis. Goeppert in consequence made it form one of the sections of his genus *Acrostichites*, but it was obviously a *Sagenopteris*.

* The second of the two forms originally described by Brongniart. Hist. 1, p. 227, pl. 63, fig. 1.

The young or smaller pinnulæ of *G. browniana* are generally lanceolate, the larger ones more spathulate and obtuse; the midrib is large at the base and gradually contracts to the apex, the veins are distinct, parallel near the base, but soon after become oblique and regularly anastomose.

Prof. M'Coy says with reference to the same species (loc. cit. p. 150) "I think I recognise both the Indian and Australian forms of this species (var. A and B of Brongniart) in nearly equal abundance among the specimens examined, and some of the fronds are of a size far exceeding any hitherto published, some of them being six inches wide, which in the proportion of the small perfect examples would indicate a frond of more than two feet in length. I believe I have ascertained the rhizome of this species, which is furnished with ovate clasping (or at least very convex) subcarinate scales, having a divaricating, reticulated neurulation, resembling that of the perfect frond, but much less strongly marked. These scales are of large size, some of them being nearly an inch in length, and terminating at the apex in a long, flat, linear appendage about one line in width, which occasionally gives off small lateral, flat, membranaceous branches, nearly at right angles, the whole perfectly resembling, except in size, the rhizomal scales of *Acrosticherium*, *Laromanes* and *Hymenodium*, as figured in Fée's "Memoire sur la Fam. des Fougères," and when combined with great similarity in form, habit, and neurulation, would warrant us in presuming a strong affinity between these genera."

Glossopteris linearis, M'Coy, loc. cit., p. 151, pl. 9, figs. 5, 5a. Leaves very long, narrow, with nearly parallel sides, costa very large, veins fine, forming an angle of about 50° with the costa, anastomosing occasionally from thence to the margin. *Obs.*—"It is only with the *G. angustifolia*, Br. from the Indian coal fields of Ramiganj, near Rajmahal, that this long parallel-sided frond would be confounded, and it is distinguished easily from that species by the fineness of the neurulation, which is as remarkably delicate as that of the other is coarse. The neurulation of *G. angustifolia*, is also distinguished by its great obliquity, forming an angle of about 30° degrees with the costa, while the veining of the present species

is not more oblique than that of *G. browniana* or *G. milsoniana*. In this species also, from the anastomosing being continued up to the margin, it results that the veins are little closer at the margin than at the middle of the leaf, while in *G. angustifolia*, the anastomosing is continued to the central portion, and the dichotomosing goes on to the margin, where in consequence the neuration is finer and closer than towards the costa. None of the specimens are perfect at the extremities, the largest being three inches long and seven lines wide at the basal fracture, and diminishing about two lines in that length, towards the distal end, being about eight lines wide in the middle. Disconnected fragments show that the base diminishes insensibly to a lengthened petiole, as in *G. browniana*, and that the apex is elliptical and pointed. Very abundant in the grey shale at Wollongong. Not uncommon in the hard siliceous schists of Arowa, N. S. Wales." Abundant also in Newcastle.

Glossopteris ampla Dana (l.c. p. 717, pl. 13, fig. 1,) also Feist. (l.c. p. 91, Pl. 11, fig. 2, pl. 12, 17.)—Frond very large, widely ovate, entire, undulating, obtusely acuminate, costa thick, extending to the apex; veins, extremely fine and close, leaving long narrow reticulations, which are longest towards the margin. Locality—Newcastle, Illawarra.

Glossopteris reticulata, Dana (l.c. p. 717, Pl. 13, fig. 2,)—Frond large, oblong-elliptical, the width not exceeding a third part of the length, gradually attenuate towards the apex; veins, broadly reticulate to the margin. Locality—Newcastle. This is a rare form.

Glossopteris elongata. Dana (l. c. p. 717.) Frond narrowly elongate, lanceolate, attenuate at the base; costa somewhat thick, distinct; veins neatly reticulate. Locality, Newcastle.

Glossopteris cordata. Dana. (l.c., p. 718., pl. 13, fig. 5.) Frond distinctly cordate towards the base, lobes rounded; costa, thick; veins reversed at the base, diverging from the costa, neatly reticulate, with narrow oblong interspaces. Locality, Illawarra.

All the above four species of Dana are considered by Feistmantel to be only varieties.

Glossopteris tæniopteroides. Feist. (l. c., p. 92, pl. 9, fig. 1, 1a.) Frond simple, elegant in form, oblong, ovato-spathulate, attenuate at the base, costa, valid, striate or grooved. Veins emerging at nearly a right angle, giving at first sight the appearance of a *Tæniopteris*. Under the lens the venation is seen to form an oblong, narrow, obliquely acute parallel network which is sometimes indistinctly polygonal. The costa is stiff and straight. Only one specimen was known to Dr. Feistmantel, which came from Blackman's Swamp coal beds.

Glossopteris wilkinsoni, Feist. (l. c., 92, pl. 13, fig. 1, 1a.) Frond extremely narrow, sub-parallel, strap shaped. Costa distinct, produced at the apex; veins sub-horizontal, dichotomous, anastomosing usually once near the apex, forming an oblong network, with a few smaller meshes towards the margin of the rachis. Locality, Blackman's Swamp.

Glossopteris parallela. Feist. (l. c., p. 93, pl. 9. fig. 2, 3, 4.) Frond very long, simple, elongately ovate, apex unknown, costa distinct, grooved in the middle. Veins emerging at an angle of 30 deg. in the lower portion and at an angle of 20 deg. in the upper portion of the frond, dichotomous, parallel, but anastomosing, forming a distinct oblong polygonal net, which is narrower towards the margin.

This is a very peculiar and characteristic form, says the author, not only from the form of the leaf, but also from the venation and form of the net-work which appears as if it were parallel. Göppert referred a form of this kind to *G. browniana* var. *biloba*, which Ettingshausen considered as a *Polypodium*, and named *P. goepperti*.

Glossopteris elegans. Feist. (l. c., p. 155, pl. xxvi, pl. viii 2nd part—fig. 2, 2a).—Frond of medium size, oblong spathulate, with a costa which becomes merged in the tissue above; below it is formed of pairs of areolar spaces, which are oblong; above these are similar spaces, but shorter and somewhat polygonal. Veins arising at an acute angle from the median areolar spaces, dichotomous, anastomosing, and forming an oblong network.

There is no Indian or Australian form which resembles this in the peculiar character of the midrib. From Greta, N.S. Wales, under the marine paleozoic beds.

Glossopteris primæva. Feist. (l. c., p. 79, pl. 5, fig. 3, 3a).—Fronde spathulate, costa thick, grooved veins, emerging at an angle of from 20 to 30 deg., parallel, dichotomous, anastomosing, forming a polygonal network, which is wider and shorter near the rachis, narrower and longer near the margin.

Locality—Greta, N.S.W., from the lower coal. It is also known from Damuda in India.

Glossopteris clarkei. Feist. (l. c., 79, pl. 5, fig. 4, 4a).—Leaves oblong ovate, obtusely acuminate, costa distinct, grooved in the middle. Veins parallel, dichotomous, free for the greater part of the leaf, like a *Tæniopteris* anastomosing only at the margin, twice or thrice forming a rhombo-polygonal network. Locality—Under the marine beds, Rix Creek, N.S. Wales.

Glossopteris browniana, var. *præcursor*.—Leaves small, long, spathulate, costa distinct, fading away towards the apex; veins emerging at an acute angle, curved, forked, anastomosing, forming a sub-equal elongate, polygonal network. (Feistm., l. c., p. 79, pl. 5, fig. 4-7.) Under the first marine beds of Stoney Creek, N.S. Wales.

GANGAMOPTERIS, M'Coy.

Fronde simple or impari-pinnate, middle pinnae spathulate, symmetrical, semi-elliptically pointed above, gradually tapering towards the base; lateral pinnae variable, very acute, tapering from base or obliquely ovate, to trigonal or flabelliform, broad above, gradually narrowed towards the oblique adherent base, which is never auriculate, but moderately wide and embracing, no costa, veins coarsely reticulate, many arising from the base, branching as they diverge towards the margin, and frequently anastomosing to form an irregular polygonal network.

This genus was formed by Professor M'Coy in the *Decades of Paleont. of Vict.* (p. 11, pl. 12 and 13), the name being derived from γαγγαρον, a small round net, and πτερίς a fern. A species

which was referred doubtfully to *Cyclopteris* by the Professor in 1847 (See Ann. Nat. Hist, l. c.) from the Newcastle beds is claimed for this genus, described with some from Bacchus Marsh in Victoria as follows :

Gangamopteris angustifolia, M'Coy, (Pal. Vict. loc. cit., also Ann. Nat. Hist., loc. cit., pl. 19, fig. 3 and 3A). Very long, narrow, unequal sided, very gradually tapering towards the apex from the widest portion near the base, base slightly contracted, embracing and obliquely truncated, length often nine or ten inches, width rarely exceeding one inch.

From the upper coal measures, New South Wales, and the Bacchus Marsh sandstones, Victoria, where it is common. In the Indian Talchir group and Kaharbari beds.

Gangamopteris spathulata, M'Coy (l. c., p. 12, pl. 13, fig. 1, 1A). Spathulate, symmetrical, equal sided, semi-elliptically pointed above, tapering towards the base to a slender petiole, length $4\frac{1}{2}$ inches, width about $1\frac{1}{2}$ to 2 inches. This is the rarest of the three forms in the Bacchus Marsh sandstones.

Gangamopteris obliqua, M'Coy (l. c., p. 13, pl. 12, fig. 2, 3, 4). Wide, inequilateral, oblique, sub-trigonal, widest near the broadly rounded distal end, gradually tapering towards the base, which is not petiolate, but obliquely truncated, with a moderately wide, sessile base of attachment. Length commonly about four or five inches, width near apex about three and a half inches, width near base, commonly about nine lines.

"This is the most variable and common of the three forms, abundant in the sandstone quarries of Bacchus Marsh." Both the above have representatives in the Indian Talchir divisions (Feistmantel), and they are found at Guntawang, Mudgee, New South Wales.

Gangamopteris clarkeana, Feist. (l. c., p. 93, pl. 15, fig. 9). Frond spathulately rounded, of medium size, coriaceous, entire, symmetrical, rounded above but greatly attenuated towards the base, whence the somewhat thick and distant veins radiate, forking and forming an oblong network.

At first sight this resembles M'Coy's *G. spatulata*, but on examination the nerves are seen to be thicker and wider apart. Locality, Bowenfels, New South Wales.

SAGENOPTERIS, Presl.

Fronde quadri-lobate arising from a terete stipe, lobes free to the base, articulate, deciduous, extremely variable even in the same frond, being hastate, cultriform, rhomboidal, oblong-lanceolate, and unsymmetrical, coriaceous, thickened at the articulation. Costa immersed in the tissue at the base, but distinct towards the middle: veins arising at an acute angle but diverging in ascending, anastomosing, forming a hexagonal rhomboidal network. Epidermis unequally rectangular above, polygonally areolate below, and pierced with stomata.

Schimper regards this genus as an approach towards the Marsiliaceæ, even though the stomata exclude it from that order. The fern has no living analogue and stands quite alone in the extinct cryptogamic flora. It is known only from the Lower Lias to the Middle Oolite in Europe, and all Australian specimens are from the Upper or Mesozoic coal basins of Ipswich Q. L., and Jerusalem, Tasmania.

Sagenopteris rhoifolia. Presl. in Sternberg. (Flora. d. Vorw., 11., p. 165, tab. xxxv., fig. 1. Schimper, vol. 1, p. 640, Tab. xlv., fig. 2-8; Feist. op. cit. pl. xii., a., figs. 1-4-7. Frond very variable both as to the shape and size. Pinnæ narrow at the base, articulate, spathulate, obovate, or oblong acuminate, rarely oblong lanceolate or sub-rotundate, inequilateral, very rarely sub-symmetrical, the middle leaves larger than the lateral ones, and quite entire. Ordinary length about 32 mill., with a diameter of 16 mill. The internal margins of the lateral fronds somewhat expanded, furnished here and there with a broad indistinct dental lobe.

This fern is identical with Goeppert's *Acrostichites*, Brongniart's *Glossopteris elongata*, *nilssoniana*, and *Phyllopteris nilssoniana* as also Münster's *Glossopteris latifolia*, ita. Schimper. It occurs in the argillaceous schists of Bayreuth, Kulmbach, and Bamberg,

which are Rhætic. Also in the lower Lias with *Ammonites angulatus* near Coburg, &c. It is a fern of almost infinite variability, as no two specimens are found to correspond in the shape or dimensions of the leaves. Schenck, in his classical work on the fossil plants of the beds intervening between the Keuper and the Lias, gives numerous details on this interesting plant and proves by a multitude of examples from all the known localities where it occurs, that there is but one species. The most extreme forms graduate insensibly from one to another. So far, it had only been found in one place in Australia, but I found some fine specimens on the Darling Downs, near Toowoomba, associated with a peculiar coal flora. They are figured on pl. 9, fig. 4.

Sagenopteris tasmanica. Feistmantel (l. c., p. 111, pl. 15, fig. 10). — Frond compound digitate (?), with linear lobes attenuate at the apex; costa distinct and rounded, veins emerging at an acute angle, forked, and once (so it seems in the fragments) anastomosing.

This somewhat doubtful species has a resemblance to *S. phillipsi*, Lindley and Hutton, of the English Oolite, Jerusalem basin, Tasmania.

GLEICHENIACEÆ.

Sori subrotund, disposed in the under side of the leaflets, often radiate, in series or immersed in a hemispherical pit, 3 or 6 capsular on the dorsal surface or apex of the veins, or placed in a minute raised punctiform receptacle. Capsules sessile, with an oblique excentric ring, splitting longitudinally. Spores, spherically tetrahedral. Fronds dichotomous, rarely simple, pinnate, smooth, pilose, or with a colored powder.

GLEICHENIA, Swartz.

Veins pinnate, simple or rarely dichotomous, ending in an obtuse apex. Capsules (where there are four) decussately disposed, sessile, coherent, immersed. Frond dichotomous, branches bi-pinnate, pinnules small, coriaceous.

Living species inhabiting Australia and the Cape. They are found fossil in the Oolite and Cretaceous beds in India and Europe. *G. bindrabunensis* of India, is extremely common in the Oolitic

formation of Bindrabun (Rajmahal). It is very like our common *G. dicarpa*, but appears to have been regularly tri-pinnate, instead of dichotomous.

Gleichenia dubia, Feist. (l.c. p. 106, pl. 15, fig. 8.)—Fronde dichotomous, pinnate, rachis moderate in size, terete, pinnae remote, alternate, obcvate-elongate, inciso-lobate, nerves indistinct. Dr. Feistmantel only states Wianamatta beds as the locality, which makes the horizon doubtful for the reasons I have given.

Gleichenia lineata n.s. Plate 3, fig. 6, pl. 8, fig. 2.—Fronde small, coriaceous, with a strong thick rachis, dichotomously divided, pinnate, bi-pinnate. Pinnules entire, linear, attached by almost the whole of the base, but slightly contracted at the lower portion, somewhat distant, not decurrent. Upper edge, convex, lower, slightly concave, but in a few pinnules divided into deep rounded lobes,* apex acute, emerging from the rachis at an angle of about 35 degrees; veins not prominent, costa not forking and quite persistent to the apex; veins not very visible in any of the specimens, but apparently grouped and numerous, emerging at an acute angle and bifurcating. There appear to be two venules emerging at the very base of the pinnule. Rachis conspicuously marked with a single deep dark median groove.

Rosewood scrub, near Ipswich, Queensland, where it is abundant, but preserved in a red ferruginous oxide in purple slate, whence the venation is difficult to trace. In consequence of the indistinctness of the nerves I regard this only provisionally as a *Gleichenia* very closely allied to the common *G. flabellata*, R. Br., which is found on the east coast of Australia, from Cape York, on the extreme north, to Tasmania, in moist shady places. I am unable to point out any well-defined mark by which this fossil could be distinguished from the living species named, but as yet the venation is obscure.

* But this may be a monstrosity, as it is seen on a few pinnae of only one specimen.

Ord. OPHIOGLOSSACEÆ.

Herbaceous Ferns. Fronds springing from a subterraneous rhizome, erect, biform, binate. Sporangia sessile, unilocular or sub-bilocular, exannulate, coriaceous, united to each other and bivalvate.

In this order, but amongst the plants about whose true position there is much uncertainty, Schimper places the following genus.

JEANPAULIA. Unger.

Fronds coriaceous, arising from a cylindrical stem, flabelliform, segments, which are linear, forking repeatedly, entire, more or less elongate. Veins numerous rather prominent, equal, parallel, dichotomous with the divisions of the frond. Superior epidermis formed of elongate rectangular or oblique cells. Lower side of hexagonal cells with an undulating margin, and numerous stomata. Fruit ovate-pisiform.

These plants have been placed by Braun, Unger and Brongniart amongst the Rhizocarps near Marsiliaceæ. By Schenk they were classed as Ferns by the side of *Baiera* and *Hausmannia*. Lindley and Hutton doubtfully placed them among Algæ, adding :—" We place it amongst *Solenites* rather more for the sake of giving the plant a station and a name, than because we have any reason for considering it of the same nature, further than its similarity of appearance."* Schimper adds that having collected abundance of specimens from a schistose sandstone, with plenty of what he considered to be the fruits, he was able to identify them with certain fossils of a similar nature from the Oolitic beds of Whitby.

There are two species described, one from the Rhætic beds of Europe near Bayreuth, Bamberg, Erlangen and Schnaitach and Forchheim, in Franconia. The other (which has much narrower segments) from the Oolite of Scarborough. Schimper thinks that *Sphenopteris longifolia*, Phillips† is the same species as that found in Franconia, *Jeanpaulia münsteriana*.

* Fossil Flora, Vol. 3, plate and page 209.

† Geology of Yorkshire, plate 7, fig. 17.

Jeanpaulia bidens n. s. Plate 4, fig. 3. Frond broadly flabellate, segments somewhat short, often becoming broader towards the apex and ending in a short wide bifurcation, or in a curved falcate, acute or acuminate point. Veins not conspicuous, numerous (6 to 10) parallel, not branching. The longest of the segments in the specimen figured is 55 millim., and the width is from 3 to 6 millim.

The resemblance of the form of this fossil to some species of *Helminthostachys* is great, but the parallel venation reminds one more of *Schizaea*. Probably we have nothing amongst living Ferns which can be compared to this singular plant. The species described differs from *J. münsteriana* in the brevity, widening and bifurcation of the segments. The specimen figured was found in the Burnett River coal seams, Queensland.

FRAGMENTS OF FERNS.

Paleontological botanists divide the fragments of Ferns into four sections, viz. :—1. *Spiropterides*, or young fronds either rolled up or not as yet completely developed. 2. *Rachiopterides*.—Fragments of petioles or of rachis. 3. *Phthoropterides*.—Petioles of ferns generally contained amongst, or in an envelope of adventitious roots. 4. Stems of Ferns. In the last section we have :—

CAULOPTERIS, Lindley and Hutton.

Trunk erect, cylindrical. Scars of the petioles flat, elliptical or ovate. Cicatrices of the vascular bundles, round, concentrically disposed, or borne in longitudinal impressions. These stems or trunks, says Schimper, have their analogues amongst the tree ferns of the present period, such as *Cyathea* and *Alsophila*.

Caulopteris adamsi. Feistmantel, loc. cit. p. 94, pl. 12, figs. 1 and 2. Trunk of a tree of medium size, marked on the surface with the scars of branches or leaves. Scars disposed spirally and quincuncially, transversely oblong-oval, somewhat prominent, the sides marked with a decurrent line, the internal surface covered with minute vascular cicatrices.

This species was dedicated to Mr. P. F. Adams, Surveyor-General of N. S. Wales. The specimens were imperfect, and on the whole the peculiarities of the species were such that Dr. Feistmantel was far from satisfied that it should be referred to the genus *Caulopteris*, yet as the details were too indistinct and scanty for the erection of any new genus, he knew no existing form with which it could be classed, except the one to which he referred it. It was found in Newcastle, but there are no particulars as to the mine or the horizon.

ORDER. LYCOPODIACEÆ.

Stem or rhizome bearing true leaves, either linear, or small and one-nerved, or reduced to minute scales. Spore-cases solitary or few together, sessile in the axils of the leaves or of the bracts of a terminal spike, either all similar or of two kinds, larger ones *macrosporangia*, containing a few larger spores or *macrospores*, and smaller *microsporangia*, containing numerous smaller, often microscopic *microspores*, the differences now generally admitted to be sexual.

The order, as far as existing species are concerned, is spread over nearly the whole globe, and three of the Australian genera have nearly as wide a range; two others are both in the New and the Old World, chiefly tropical or southern; the remaining two extend to N. Zealand, one of them also being in the Pacific Islands. I need not refer to the wonderfully important part taken by this order in former periods of the earth's history, especially in the earliest Carboniferous flora. Not only did this Order predominate but also its members assumed the proportions of large trees and formed immense forests, which are now entombed, and preserved for man in the form of coal. Australia has been no exception to this, though the fossil species that we have are found more in connection with the Devonian rocks than with coal.

LEPIDODENDRON. Sternberg.

Large trees with dichotomous branches, surface closely covered with alternately arranged, rhombic scars, having a vascular cicatrix near the middle or upper angle. Leaves linear or peltate, fruit a strobilus or cone at the extremity of certain branches.

Sub-genus — BERGERIA, Presl. Scars nearly flat, obovate, rhombic or quadrate with a very small oval vascular cicatrix near the upper angle.

This genus belongs to the Paleozoic rocks, and various portions of the same plant have been formed into *Stigmaria* (roots), *Lepidostrobus* (cones or fruit spikes), *Sigillaria* (fluted trunks of some species). *Cyperites* (foliage), *Knorria* (casts of stems), *Sternbergia* (pith) and other genera.

Lepidodendron (*Bergeria*) *australe*, M'Coy, Pal. of Vict, p. 37, pl. IX). Stem about two inches in diameter, having rhombic scars, with straight thick boundaries, about four inches long and three and a half inches wide, with a very small oval, rounded, vascular cicatrix, rarely near the middle, or more usually excentric towards the upper angle, and often connected with the appearance of a vertical shallow rounded sulcus; branches one inch in diameter, having similar scars three lines long, and two and a half lines wide, upper and lower angles of the scars usually slightly more acute than the lateral ones, very rarely the lateral ones more acute.

"The species here figured is scarcely distinguishable from the *L. tetragonum*, Sternberg, of the European Carboniferous deposits by any definable character, so that my inclination was to indicate it as variety *australe* of that species, and I do not see any reason for supposing it referable to the little Devonian *L. nothum*, Unger, nor the probably identical *L. gaspianum*, Dawson, nor the *L. chemungense* of Hall, from the Devonian sandstones of New York. Hall's figure of the latter plant is not much less than the narrow part of the right hand branch of our figure, but it shows the scars nearly five times more numerous, and scarcely one-fifth of the size and all the figures of the Devonian species mentioned indicate the much smaller, more numerous, and much more acute, longitudinally elongate leaf scars as constant characters, together with a central vascular cicatrix." Common in the red and yellow micaceous carboniferous sandstone of the Avon River, Gippsland. This sandstone rests unconformably on the upturned edges of true Devonian rocks with characteristic fossils. Professor M'Coy

thinks that his species is identical with the Queensland *Lepidodendron*, recognized by Carruthers as *L. nothum*, Unger, but Dr. Feistmantel and others think that they are different.

Lepidodendron nothum, Unger (see Carr. in Jour. Geol. Soc., 1872, p. 350, pl. 26, fig. 1 to 14, also Feistmantel, pl. 15, fig. 9). Scars of the leaf contiguous, rhombic, with a single and generally central vascular scar; leaves small, peltate and imbricate, on long slender petioles, fruit produced on the apices of the thick branches, a single sporangium, almost sessile, borne on the middle of the petiole of the leaf, roots stigmaroid.

In the paper of Mr. Carruthers referred to, full details as to the structure of this plant are given from abundant specimens brought by Mr. Daintree from Queensland. There it is so common that a full series of specimens are easily found, giving a knowledge of the roots, leaves, and fruit scales of this species. Thus many doubtful points in the structure were cleared up. Mr. Carruthers believes it to be identical with Dr. Dawson's *Leptophlæum rhombicum*, and thus the species has a range all over the world. In Queensland, Mr. Daintree obtained it from Mt. Wyatt, Canoona, and the Broken River, all in Northern Queensland. Prof. M'Coy quotes it from Gympie, probably misunderstanding the report of Daintree. I have not been able to find it in the rocks of Gympie, where, however, there are many plant remains, which seem to be like *Cordaites australis*, M'Coy. It was found on the Drummond Range, at the end of the central railway. (Bobuntungen, Medway River, &c.) It is in a light brown or yellow micaceous sandstone, forming the escarpments of all the eastern face of the range, and dipping away to the westward. The strata show much false bedding, and oblique laminae like the aerial rocks of the Hawkesbury. Also in many places in N.S. Wales in (presumably) Devonian rocks, as at Cowra, Canowindra, on the Lachlan River; Goonoo Goonoo Creek, on the Liverpool Plains.

4. *Lepidodendron veltheimianum*. Sternberg. Flor. d. vol 1, part 12, pl. 52, fig. 2. See also Schimper, "Paléontologie Végétale, vol. ii, p. 29, atlas, pl. 59, figs. 6, 7, 8. Schimper gives a large list of references and synonyms, which I need not quote here. See

also Feistmantel, "Paleozoische and Mesozoische Flora des östlichen Australiens"—Cassel, 1878 and 1879, p. 151, pl. 5, figs. 2 and 3 (though doubtfully referred to this species); pl. 7, fig. 2; pl. 23, figs. 2 and 3.

Apparently a moderate-sized tree, with dichotomous branches, covered with a network of very narrow leaf scars; leaves narrowly lanceolate, spreading, slightly incurved; scars of the branches erect, rhomboid, close, with an obovate cushion acuminate at the base, keeled, furnished with a transverse rhomboid cicatrix; scars of the trunk oblong rhomboid, apex and base long and acuminate, subinflexed, and after the disappearance of the little cushion, fusiform.

This plant is characteristic in Europe of the lower coal formations, corresponding to the Carboniferous Limestone. It has been found in many places in Silesia, in the *Posidonomya* schists at Magdeburg, in the Hartz Mountains, at Nassau, in the valleys of Thann and Niederburdach; in France, in the Upper Vosges, and in the coals of the black forest. This fossil is also, according to M. Geinitz, the same as *Ulodendron ornatissimum*.

In the 3rd edition of the late Rev. W. B. Clarke's "Sedimentary Formations of New South Wales" (1875), at p. 17, mention is made of a species named *Lepidodendron rimosum*, of which in 1878 Feistmantel, gave a fig. (*loc. cit.*), remarking that it seemed more to resemble *L. veltheimianum*. Before this, 1876, as I have stated previously, Professor de Koninck had submitted about twenty plant specimens sent to him by the Rev. W. B. Clarke to the eminent Belgian paleontologist, M. Crepin of the Brussels Museum. Though the specimens were in a very bad state of preservation, he was able to recognize *L. veltheimianum*, besides *Calamites radiatus* and *C. varians*, all of which we shall see are found in the Drummond Range. Dr. Feistmantel was not aware of Mons. Crepin's determinations at the time he pronounced upon his specimens, so that the independent testimony of two such eminent and experienced authorities gives additional weight to the identification. Mr. Clarke's fossils are quoted by De Koninck as from the quarries of Murree, Russell's Shaft, Glen William,

Burragood, and the Ichthyodorulite Range. Dr. Feistmantel's examples came from the strata of Smith's Creek, near Stroud and the Rouchel River.

Amongst the numerous examples found in the Drummond Range, there are many compressed branches which have formerly been cylindrical, and instead of having the lozenge-shaped depressed leaf-scars with a raised margin, are marked with impressions of distant narrow-pointed leaf-like scales. They exactly correspond with the figure given by Feistmantel in the above work, at plate 23, figs 2 and 3, and which are lettered *Knorriastadium* (?) and *Lepidodendron veltheimianum* (?), the doubtful note in both cases being that of Dr. F. They came from Smith's Creek, New South Wales. I think there can be but little doubt, from the mode in which they are associated, that they belong to the same plant. There are also smaller stems, of which I figure one example which seems to me like the internal casts of the smaller branchlets. The surface is covered with raised cushions, which are closely quincuncial. The cushions rise gradually towards the apex, and have an imbricated appearance. In the larger examples the cushions are longer and very much narrowed. I think we have in these, internal casts of the branches. If we suppose the external scars to be raised in such a way as to give rise to a corresponding depression in the internal cylinder, then the casts would present the appearance noticed above. Moreover, they are ill-defined, and without any leaf impressions, just as internal depressions would be. The stone is quite fine enough to retain the most delicate marks where they exist. The shape of these casts also confirms this explanation, for they are always more or less cylindrical, or the casts of cylinders which have been compressed. Whenever the exterior of the branches is exhibited, it is on the surface of concave casts.

CYCLOSTIGMA. Haughton.

The plants thus distinguished were first brought to the notice of science by Dr. Haughton, in a paper published in the *Annals of Nat. History* for 1860 (3rd ser., vol. v., p. 444), entitled

“On *Cyclostigma* : a new genus of fossil plants from the old red sandstone of Kiltorkan.”*

Cyclostigma australe. Feistmantel, *loc. cit.* p. 76. A tree trunk with slender terete branches, cushions or raised scars subglobose, pitted, approximate, spirally disposed, impressions oblong oval, rather deep, situate in the upper portion of the oblong ovate tubercle. The species was found in two places in New South Wales, according to Dr. Feistmantel, named Goonoo Goonoo Creek, near Tamworth, and at Smith's Creek. Dr. Feistmantel was of opinion that the species was so near *C. kiltorkense* that he could see little difference, but lest he should make a false identification in a plant where the details are so few and simple, he preferred to give it another name. He gives figures of a few specimens at pl. i, fig. 6, a doubtful identification, pl. iv., fig. 3, pl. v, fig. 1, pl. xxii, fig. 1. Amongst the Drummond Range specimens I have only one which can be referred with any probability to this species, and in this case the impressions are so faint and worn that I figured it as a *Stigmaria* (*Cyclostigma*?). I quote from the Rev. Dr. Haughton's paper somewhat fully, because his description corresponds so well with the strata of the Drummond Range that lithologically they may certainly be said to belong to one formation. The rose pink sandstone in which some of the fossils are embedded, and the golden yellow colour of others, is especially remarkable.

“The fossil plants of the yellow sandstone of the county Kilkenny occur, as they do in other parts of Ireland, in the sandstone lying immediately under the great mass of the Carboniferous limestone, which constitutes the most important member of our Irish fossiliferous rocks. They are found at Jerpoint, about a mile and a half south of the Abbey, on the roadside near the cornmill, on the road to Ballyhale, about 90 feet below the

* Other species have since been described by Heer, *Fossil Flora de Burren-Insel*, p. 43, pl. xi; by Lesquereux, *Geol. Survey of Arkansas*, p. 318, pl. iii, fig. 3; and Dawson, *Fossil Plants, Geol. Survey of Canada*, p. 43, pl. xiii, figs. 92 to 96.

lowest bed of limestone, in rocks composed of red, white, and blue limestone, with triboliths formed of pink quartz, rounded pebbles grooving the hone stone ; and above the plant beds a remarkable white grit conglomerate is found. The plant-beds, on the same geological horizon, are also found in the railway cuttings at Ballyhale. They are found, however, in the greatest abundance, and in the best state of preservation, on the top of Kiltorkan Hill, near the railway station of Ballyhale. I believe the plant-beds on the summit of this to form an 'outlier,' and to occupy the same geological position with respect to the limestone as the beds at Jerpoint and those of the railway cutting. The fossil plants here found have never been described except casually. They consist of remains of a large Fern, called *Cyclopteris hibernica*, by Professor Forbes, associated with a large bivalve, named by him *Anodon jukesii* ; of undescribed dermal plates of a cartilaginous fish, probably a species of *Coccosteus* ; and of numerous unknown plants closely allied to *Lepidodendron*, and so named by Professor Forbes and M. Brongniart, the latter of whom has named a remarkable species, preserved in the Museum of the Royal Dublin Society, *Lepidodendron griffithsii*. Others of these fossil plants have been named *Knorria* ; and a large undescribed group remains, to which I propose to give the name of *Cyclostigma*."

Mr. Carruthers, in his appendix on the fossil plants (see Daintree on the Geology of Queensland, *loc. cit.*), says :—" Among the Devonian fossils presented by the Rev. W. B. Clarke to the Society's museum there is a fragment of a lepidodendroid plant which I cannot separate from that found at Kiltorkan, to which Dr. Haughton gave the name of *Sigillaria dichotoma*, and afterwards of *Cyclostigma kiltorkense*, and which, after receiving many other aliases, should be named, I believe, *Syringodendron dichotomum*, as being a species of that genus as amended by Brongniart in his 'Histoire,' and again in his 'Tableau.' "

In the Nat. His. Review, vol. 6 (1859), there are four plates (pl. 38, 39, 40, 41), giving different details of the *Cyclostigma*, showing the whorled and spiral structure of the leaves, &c.

LYCOPODIUM.

Stems leafy, hard, branching, creeping, prostrate or erect. Leaves small, entire, or minutely serrate, inserted all round the stem, usually in four rows. Spore-cases all of one kind, flattened, one-celled, two-valved, sessile in the axils of the upper leaves, or of bracts usually smaller or broader than the stem leaves, and forming terminal or lateral spikes. Spores all minute and powdery.

The genus is widely spread over every part of the globe. Of the eleven Australian species three are generally distributed in the New and in the Old World, the seven others are in New Zealand, five of them extending to the Pacific Islands, and two to South America.

There are seven fossil species, and if we include the *Lycopodites*, which are, however, plants of uncertain position, three more must be added to the list. Of the seven fossil species, six belong to the coal formation, and the seventh, about which there is some doubt, comes from the middle Jurassic. Amongst living Lycopodiaceæ a distinction is made between those which have the spore cases and spores all of one kind (*Lycopodium*) and those in which they are of two kinds (*Selaginella*). The plants of the latter genus are moreover smaller and weaker than *Lycopodium*, and have distichous lanceolate leaves.

With reference to the fossil species of *Lycopodium*, Schimper says (op. cit. vol. 2, p. 7) that under the name of *Lycopodites*, and *Selaginites* the most heterogeneous plants have been described, such as the branches of *Knorria*, *Lepidodendra*, conifers and the rhizomes of young fronds of Ferns. For this there is an excuse as some of the rhizomes of Ferns which grow above ground are divided by dichotomy, and covered with leaf-like hairs or scales, and they resemble certain species of *Lycopodium*, especially when they are preserved as impressions on clay. Moreover, many conifers have a pinnate ramification very similar in appearance to those of *Selaginella* and *Lycopodium*. But Schimper adds that certain marks will always enable us to detect the differences. Whenever

the branching of conifers presents a pinnate structure the principal axis is always straight simple, never dichotomous, and the branchlets decrease gradually and regularly from the base to the summit. In the first condition they are always simple, but when they branch in their turn it is by axillary distichous branchlets which develop themselves in turn in these branches of the second order as they have done in the first instance. On the other hand whenever species of *Lycopodium* or *Selagenella* appears to be pinnate from the alternate inequality of the branches at the point of bifurcation, this stem is in reality a Sympodium which is easily distinguished in the young state, or at its superior extremity by a regular zig-zag outline whose re-entering and salient angles correspond to the points of dichotomy. The absence of lateral buds in Lycopods naturally excludes lateral or axillary branches. The germ-like projections which are noticed in some species of *Lycopodium* and *Selago*, and which at first sight seem to resemble lateral or axillary buds, are in fact enlargements which sometimes take the place of spore-cases, of which they are probably the morphological equivalents. The leaves of the two branches which result from dichotomy are, in the case of Lycopods, homodromous, or running in the same spiral direction; whereas, in the case of conifers they are antidromous, or run in the opposite direction to the principal branch. Bearing these distinctions in mind I think that some of our so-called conifers, which have been passed over as imperfectly preserved specimens of *Brachyphyllum* are in reality *Lycopodites*. I am not at present in a position to describe any of the specimens to which I refer. Some in my possession from the Ipswich coalfields are too fragmentary for determination. I merely record the fact of there being some doubtful evidence of *Lycopodites* for future investigation.

ORDER. CYCADEÆ.

Flowers unisexual, without any perianth. Male flowers forming catkins or cones, consisting of numerous spirally arranged imbricated scales (or stamens), more or less cuneate, bearing on the concealed portion of their under surface, numerous sessile or

rarely stipitate anther-cells, each opening in two valves, the upper imbricate and exposed part of the scales hardened and often much thickened, the apex truncate or more less produced into an incurved or recurved point or lanceolate appendix. Female cones consisting of numerous scales, imbricate at least when young, either with one pendulous ovule (or carpel) on each side of the thickened and hardened apex, or with three or more erect ovules (or carpels) in marginal notches below the flattened acuminate, and usually dentate or pinnatifid apex. Fruiting-cone enlarged, and either remaining imbricate with two pendulous seeds to each scale, or the scales with marginal seeds spreading as the central shoot is developed within the cone. Seeds naked (or nuts) with a thick or hard outer coating or integument, and a fleshy albumen, in a central cavity of which the straight embryo is suspended by a long folded cord. Cotyledons two, undivided. Palm-like plants, with a thick globose, and underground or erect and cylindrical woody stem, simple or rarely slightly branched, marked with the scars or bases of the old leaves. Leaves forming a crown at the apex of the stem, once or twice pinnate. Cones sessile or very shortly pedunculate, within the crown of leaves.

The Order extends over tropical America, sub-tropical and southern Africa, and tropical Asia. Of the three Australian genera, one is also in Asia and Africa, the other two are endemic. The theoretical significance of the outer coating of the ovules and seeds, whether carpellary or seminal, is, as in the Coniferæ, still the subject of contention.

ZAMITES. Brongniart.

(As amended by Schimper including *Zamia* and *Zamites* of Brongniart in part and *Crossozamia* of Powell)*

Leaves very variable in size and shape, either ovate-oblong acuminate, or oblong or linear and oblong acuminate; all regularly pinnate. Pinnæ more or less horizontal and inserted perpendicularly into the rachis, lanceolate, linear lanceolate,

* Matériaux pour servir à la Flore fossile des Terres-Jurassiques de la France. Par. M. Powell, 1849.

oblong, acuminate or obtuse, base contracting suddenly and fixed to the anterior side of the rachis by a more or less distinct callosity; solidly coriaceous. Nerves distinct, straight, parallel, ending abruptly at the apical margin of the leaflet.

In this genus are grouped Cycads with straight parallel nerved leaflets abruptly constricted at the base, fixed at the centre of that base on a callosity. They are mesozoic plants which make their appearance in the Oolitic period, and continue to the present day. It is not certain that the fossils are in every case true Cycads, as the fructification has seldom or never been seen. The female cone of *Zamites epibius*, Saporta, and some few others have been found.

In this genus Dr. Feistmantel includes *Podozamites*, regarding the latter as a sub-genus. It was recited by Braun and is adopted by Schimper, M'Coy and others, and on that account I think it better to continue to give it generic distinction. Up to this no true *Zamites* have been found in Australian plant beds.

PODOZAMITES. Fr. Braun.

Leaves of medium size. Leaflets distant, spreading, oblong, ovate, and linear-oblong, apex obtusely acuminate or rounded, gradually narrowed towards the base, subpedicellate, pedicel articulate, deciduous. Nerves dichotomous at the very base, then simple, erect, parallel, then converging towards the apex.

This genus differs from *Zamites* proper in the oval, oblong, or elongate leaflets, more or less obtuse above and gradually narrowing below, inserted on a pedicel at an acute angle, with nerves dichotomous at their origin, but rarely dividing afterwards, inwardly curved and converging towards the top. Three species are already described.

Podozamites barkleyi, M'Coy (Pal. Vict., p. 33, pl. 8, figs. 1, 2, and 5.) Fronds from one and a half to two and a half inches wide, rachis thick, about one and a half lines wide, pinnules close set, narrow linear, elliptically pointed at the distal end, about one inch five lines long and one line wide in var. *gracilis*, and one inch

three lines long, and one and a half lines wide in var. *latior*, abruptly contracted to the base, the narrowed lowest portion of which is obliquely inserted in two very slightly alternate or nearly opposite rows, basal portion with about ten or twelve narrow, equal, rounded, longitudinal ridges, which usually become obsolete towards the distal half, on which often only three large ridges or undulations can be seen; the surface has about 50 to 70 longitudinal striæ in the width of a pinnule. The bases of the pinnules are nearly opposite, and from their narrowness, seem rather widely separated, though only far enough apart to allow the edges of the broader portion to nearly touch the adjoining edges of the next ones.

“There is some slight variation in the amount of alternation or opposition of the pinnules in different specimens. . . . Also, as in the recent examples, the upper surface is more nearly smooth and the lower surface of the pinnules more distinctly ridged. At first sight in size and shape this nearly resembles the common *Zamia hastula* of the Yorkshire Oolite coal beds, but is easily distinguished by its smoother surface, and the contracted base of the pinnae or leaflets.” Found in a shaft sunk for coal between Geelong and Queenscliff, associated with *Alethopteris australis*. The species is dedicated to Sir Henry Barkly.

Prof. M'Coy points out the strong resemblance of the plants to conifers, to which order Dr. O. Feistmantel considers they should be referred. We must await the discovery of cones or fruits to decide the question.

Podozamites ellipticus. M'Coy (l. c., p. 35. pl. 8, fig. 4.) Fronds about $2\frac{1}{4}$ inches wide; rachis very thick, about 2 lines wide; pinnules elliptical, scarcely touching, varying in size from $1\frac{1}{4}$ inches long and $3\frac{1}{2}$ inches wide, to 1 inch, 1 line long and 2 lines wide; substance thick, usually showing only three obtuse ridges, but sometimes 11 smaller, the whole covered with a very fine longitudinal striation; base of pinnules contracted and inserted obliquely on the rachis in a slightly alternate order or nearly opposite.

“This is easily distinguished from *Z. barkleyi*, by the much thicker rachis, the broader oval form of the pinnules and their thicker substance. I have just received some specimens nearly like this plant in foliage, but having indications of the leaflets or leaves being in four instead of two rows, and having a branching stem, recalling *Lycopodites williamsoni* of the Scarborough Oolites, but with the leaves flat and elliptical, instead of thick carinate and falcate. I should propose the name *Bunyalites* for the fossil forms which approach *Araucarites* in many respects, and have branching stems, but with the leaves contracted at the base as in the *Podozamites*, and *Araucaria bidwilli* or Bunya-bunya. Along with these plants are also fruit cones resembling the Oolitic *Zamistrobus*, as far as their character can be seen.”

Podozamites longifolius. M'Coy (l. c., p. 35. pl. 8, fig. 3.) Fronds about ten lines wide, rachis about half a line thick; pinnæ slightly contracted and obliquely inserted at base, closely arranged in two rows, standing nearly at right angles to the rachis, except at the curved base; pinnæ linear narrow, elliptically pointed at apex about 5 lines long and half a line wide; midrib distinct with fine, parallel longitudinal striæ.

“At first sight this resembles *Z. taxinea* of the Yorkshire Oolites, but is smaller and even more like a yew from the distinctness of the midrib. It differs more essentially in the contracted base and oblique insertion of the leaflets. The strong midrib approximates the species to *Cycadites*, but it varies in some pinnæ and the contracted oblique base of the pinnæ prevents a reference to the genus. The plant is not so common as the other gymnosperms in the coal shale at Bellarine, where I have seen about half-a-dozen specimens.”

Podozamites lanceolatus, Lindley and Hutton (as *Zamia*), Foss. Flor., 111, 194, 1837. *Zamites lanceolatus*, Eichwald, Leth., Ross., II, p. 40, pl. 3, fig. 1, 1865-68; *Podozamites distans*, Schimper, Pal., veg., vol. 2, p. 159, Atlas, pl. 71, fig. 1. *P. lanceolatus* and varieties, Heer Flora Ostsibiriens, &c., p. 108, pl. 26, fig. 10, 1876; Feistmantel records Geol. Survey India 1 & 4, p. 131,

1876 ; Geyler, Jura Pflanzen aus Japan, 1877 ; Feistmantel Flora of the Jabulpûr group, Upper Gondwanas, Pal. India, vol. 2, p. 11 (91), pl. 3, fig. 7 to 14, pl. 4, fig. 1 to 10.

Leaves remote, deciduous, entire, narrowed at base, lanceolate acuminate at the apex, nerves many, forked just above the base then simple and converging to the apex. Dr. Feistmantel adds that this is "a very characteristic form widely spread in the Jurassic formation. It is known from Spitzbergen, England, S. Russia, East Siberia, Amûr, and Japan. In our own Jabulpûr group, it is pretty frequent." To these localities I am enabled to add Australia. I have found it very abundantly at Ipswich. In the work already quoted by Dr. Heer on the Jurassic Flora of Eastern Siberia, he distinguishes a number of varieties, some of which were formerly regarded as distinct species. Thus *P. distans* of Presl., a Rhætic fossil is connected with *P. lanceolatus*, as well as *P. eichwaldi* of Schimper. Dr. Feistmantel finds three varieties in India, namely, *P. lanceolatus genuinus*, in which the leaves are lanceolate with a pretty acuminate apex. South Rewah, Jabulpûr, and Sher River. *P. lan. var. spathulatus*, Feistm., pl. 4, fig. 11-12. Leaves shorter, oval lanceolate, base attenuate. "There are some leaves which I think however belong to the same species, distinguishing it as a variety only." South Rewah.

Both these varieties occur abundantly in the Ipswich basin, one specimen showing how the leaves were affixed to the parent stem, and though the fragment is imperfect it shows precisely the growth figured by Schimper. (Atlas, pl. 71, fig. 1.) There are other fragments of stems which also show the mode of attachment attributed to this species. I am aware of course of the risk of error in making the identification between the fossils of Ipswich and those of Europe, but the resemblance is so close that I do not think that there is any ground for hesitation.

In the Queensland specimens the veins are simple, straight, parallel, from 8 to 12 in a leaf. Length of leaves from 45 to 100 millim., breadth from 2 to 12 according as the leaf is ovate or lanceolate.

This plant may have been the same as *Zeugophyllites australis*, Morr. It must be remembered that the latter genus was established by Brongniart for a plant with leaflets such as these, but in pairs. In the plants found at Jerusalem, Tasmania, and classified by Morris as *Zeugophyllites* there was nothing to show that the leaflets were in pairs. The form of the leaf alone guided Prof Morris in his determination; and that form was so similar to the leaves described above that they may have been the same. For the present I must leave the matter as it stands. There is only one species of this plant, but I note, also, leaves of the same shape associated with them, but in which the coriaceous epidermis is almost smooth in consequence of the fine, close nerves. In these leaves there are sometimes faint traces of a midrib also; leaves larger and coarser than the foregoing, with which they are always associated. The nerves are only four or five, and the leaf has a rough appearance. Also a fossil which may be the same as *P. hacketi*, Feistm. (l.c., p. 92, pl. 7, fig. 4, 5, 4a, 4b, 5a,) in which the leaf is broader, springing from a thick rachis, veins numerous with an indistinct median nerve like a midrib. Dr. Feistmantel found it in connection with the rachis and compared it with Heer's *P. plicatus* from the Amur countries. The number and variety of the leaves at Ipswich makes that deposit peculiarly advantageous for their study. It is one of the many instances of the fact that we meet with a fossil in Australia, which is world-wide in its distribution.

PTILOPHYLLUM. Morris.

(As amended by Schimper.) *Paleozamia* (*Ptilophyllum*), Oldham and Morris. Leaves rather long, petiolate, petiole exactly terete, graceful, feather-like (whence the name), linear-lanceolate, gradually acuminate towards the summit, sometimes narrowed below. Leaflets of equal size, affixed to the rachis by the anterior side and somewhat imbricate there, flat, coriaceous, linear, apex obliquely acuminate above and slightly curved, the superior angle of the base rounded, sub-auriculate, free, the lower and fixed portion acute and slightly decurrent. Fructification strobiliform; seeds small, ovate, oblong. Stipe cylindrical, narrow.

This is the type of the Indian fossil plant, which has not been found in Europe, nor hitherto in Australia. It is distinguished by its long, straight, pinnate, feather like leaves, regularly acuminate above and below. The pinnules are very close and somewhat imbricate at the base, but the decurrent portion does not unite with the base of the leaflet beneath, but passes behind it. The nerves are somewhat numerous, well-defined, simple or bi-furcate and more or less divergent. The principal distinction is the manner in which the pinnules are affixed to the rachis. They were small and elegant plants which must have been abundant in the places where they grew, as numbers are always found entombed together. They seem to have no analogy with any living form. Two species are known, and both from India.

These plants were originally classed with *Palæozamia*. Endlicher, which included certain fossils referred by Brongniart to *Zamia*, and by Lindley and Hutton, to Ferns. Oldham in 1862, proposed to arrange the genus in three sections, viz.:—1. *Ptilophyllum*, with linear pinnae, approximate, *scarcely auriculate*, nerves parallel or slightly divergent. 2. *Otozamites*.—Pinnae lanceolate, *auriculate or semi-cordate at the base*, veins fine, numerous, divergent. 3. *Sphenozamites*.—Pinnae ovate, wedge-shaped or cuneiform, *not auriculate* at the base, veins numerous, diverging. The section *Ptilophyllum*, included five species from India, which are described in the 1st vol. of the Fossil Flora of the Gondwana system (pp. 27 to 31)* as *Palæozamia*.

When the revision of the Flora came out in 1880, Dr. Feistmantel in the same vol. at p. 116 (p. 64 of the Fasciculus) gave his reasons for including Oldham's section, *Ptilophyllum*, in a distinct genus of that name, which had been proposed by Morris in 1840.* He says (loc. cit.) "*Ptilophyllum*, is a peculiar Indian genus, which in the same form has not occurred elsewhere. The only analogy is the Liassic *Otozamites gracilis*, Kurr sp. The chief characteristics are in the insertion and the basal angle of the

* Memoirs of the Geol. Surv. of India. Palæontologica Indica, Ser. II. Calcutta. Govt. Printing Office, London, Trübner and Co., 1880. But Oldham's part appeared much earlier, in 1862.

leaflets. The leaflets are as M. Schimper has already pointed out, inserted only at the lower angle of their bases, where they are little decurrent, and are overlapped by the free and slightly auriculated angle of the next lower leaflet." This feature is only seen on the upper surface, while on the lower we see only the stalk.

In Dr. Oldham's first determination he included five species in his section. Three of these have since been included with *Otozamites* by Dr. O. Feistmantel. The other two are now described as *Ptilophyllum acutifolium*, Morr. and *P. cutchense*, Morr. The first is distinguished by its large size and acute leaflets; the second by the smaller size of the leaf and by the shorter and more obtuse leaflets. They occur in a compact limestone with Ferns, also in opaque white chalcedony, in which the fragments of fronds and leaf stalks form a breccia.

The species which I now describe partakes of an intermediate character. It has the acute leaflets of *P. acutifolium* and the small size of *P. cutchense*, and furthermore is distinguished from both by its few, simple parallel veins.

Ptilophyllum oligoneurum. n. s. Plate 7, figs. 2, 3, 4. Frond pinnate, long linear, gradually tapering to the apex. Pinnæ rather long, narrow, slightly oblique, alternate, separate, but very close, rounded and curved, somewhat falcate, ending in quite an acute apex at the upper edge; base rounder or auriculate above, obliquely inserted, leaving when detached a series of oblique alternate, elongate depressions on the rachis. Veins distinct from their origin and parallel to the apex, from 4 to 6 in number, all well marked and conspicuous. Length of longest pinnæ 12 to 15, breadth $1\frac{1}{2}$ to 2, mill.

Very common in the plant formation of Rosewood, near Rockampton, where it is associated with a *Sequoia* (?) to be hereafter described, a large *Equisetum*, some Ferns and *Vertebraria*. The stone crops out on the surface and is a kind of chert or travertin.

* Geol. Transactions, London, 2nd Ser. vol. for 1840, pl. 21, &c., and Annals of Nat. Hist. Ser. 1, vol. 7, p. 116.

The plant impressions often occur as in the Indian *Ptilophyllum* in a compact limestone, or an opaque chalcedony, in which the fragments of the fronds are imprinted and then have been broken. These have been subsequently stratified into lines of breccia between masses of more compact rock.

STANGERITES. Bornemann 1856.*

This genus was established by Bornemann for certain species of Cycads which had previously been regarded as Ferns of the genus *Teniopteris*, but which from their resemblance to the living Cycad *Stangeria* (from Port Natal), were called *Stangerites*. I mention this, because one species found by me at Rosewood, near Ipswich, was certainly Oldham v. Morris's *Stangerites ensis*, now however, regarded as a Fern of the genus *Angiopteridium*, already described in the foregoing pages.

OTOZAMITES. Fr. Braun.

(*Odontopteris*, Sternb. Göppert, Unger, in part. *Otopteris*, Lindley and Hutton, Schenk.)

Leaves moderately large, rarely very large, regularly pinnate, elongately linear, narrowed at each end, leaflets densely close or more or less remote, alternate or linear lanceolate, obovate rhomboid or sub-circular, base suddenly narrowed, obliquely inserted on the upper side of the sub-terete rachis, unequally auriculate, upper auricle smaller than the lower one, and adpressed to the rachis. Nerves radiating from the insertion of the leaflet; basilar arcuate, the others sub-arcuate, once or more dichotomous. Epidermis with elongate deeply sinuous cellules. This genus which is distinguished by its peculiar leaflets and thin mode of attachment to the rachis, has been by some, regarded as a Fern allied to *Lindsæa*, but the cycadaceous character is well established. *Otozamites* make their first appearance between the Trias and Lias. They abound most in the middle Oolite, and after that, diminish until in the upper Oolite, they are replaced by *Zamites* and *Sphenozamites*, No existing form closely resembles them.

* Ueber organische Reste der letzteren Kohlengruppe, Thüringen.

Otozamites mandeslohi Kurr, Beitrage Foss. Flora d. Juraform. Württemb., p. 10, tab. 1, fig. 3. (as *Zamites*). Leaves long linear, gradually narrowed towards the apex, 25 millim. wide. Leaflets densely crowded, oblique, alternating, inserted on the rachis with contiguous bases, ovate oblong, obtuse, base sub-cordate, 14 millim. long, 8 broad, nerves close, diverging.

On this species, Dr. Feistmantel says (op. cit. pl. xii., a fig. 6). "This is the first *Otozamites* identified from Australia. From upper mesozoic beds, Queensland, Talgai diggings. It appears to be very close to *O. mandeslohi*, a Liassic species, to which I refer it for the present." Also Toowoomba, common.

ZEUGOPHYLLITES. Brongniart.

Fronds (?) petiolate, pinnate, pinnæ opposite (?) oblong, nerves valid few, equal, becoming confluent at the base and apex.

This is the diagnosis which Brongniart originally gave of the genus from specimens which came from Ramiganj in India. Subsequently in 1844, in his "Tableau des genres de Végétaux fossiles, he says:—"Under this name (*Zeugophyllites*) I have described a pinnatifid form of *Monocotyledonous* leaf, resembling such Palm leaves as *Calamus*, *Desmoncus*, &c, whose leaflets have many principal nerves and are not bent into a keel on the median line. In the only species (then) known the leaves are opposed as in some species of *Calamus*."*

At first Dr. Feistmantel was inclined to think that this was a species of *Schizoneura*. This it will be remembered is an Indian equisetaceous plant, the sheaths of which are united and stem clasping. Subsequently they divide along sutural lines which look like nerves. But there is clearly no such division here, and neither Schimper, Morris, nor M'Coy, took that view. Still I cannot adopt the opinion that these leaves have anything to do with palms like *Calamus*. A comparison of the leaves will at once show the difference. Besides these plants have evidently grown in marshy places in company with the true *Equisetum*. Now though *Calamus* is found in moist jungle, it hardly seems to be of such a

*Ita Feistmantel op. cit. p. 95.

habit that it would probably give rise to coal. Then again, all the stems of such palms are extremely thick and woody, and we meet with no such remains. The same objections apply to *Zamia* and *Cycas*. They certainly do not grow in moist places in Australia, but on the contrary are found in the very driest and sandy soil. Undoubted Cycads are found in connection with coal in Europe and India, as the cones testify, but they are different from our existing forms.

To this genus was referred some specimens brought to Europe by Count Strzelecki. In the account given of the Fossil Flora of Australia, Prof. Morris says* *Zeugophyllites*, Brongniart, family uncertain. *Z. elongatus* (Pl. vi., fig. 5, 5a). Stem ? leaves petiolate, oblong elongate, entire truncate, and slightly thickened at the base; veins distinct, equal, parallel. The specimen figured, has been provisionally referred to *Zeugophyllites* Brongniart, as it agrees tolerably well with the characters assigned to the leaves of that genus. These leaves were probably sessile or even amplexicaul, as might be inferred from their slightly thickened base, and pinnately arranged at short distances along a common stem, after the manner of the foliation of *Schizoneura*, Schimper, *Convallarites*, Brongniart, to which genus our species offers some resemblance; the leaves however in *Schizoneura*, have fewer veins, and appear to have been somewhat carinated. Locality—Lower Jerusalem Basin, Van Diemen's Land.

Feistmantel quotes the genus from Newcastle beds as well. I have never seen it there, or at least the Newcastle specimens are not the same as those of Tasmania, which are very like those of the Ipswich (Q.L.) Mines, and probably as already stated, belonging to *Podozamites lanceolatus*, Lindley and Hutton.

FOSSIL PLANTS OF UNCERTAIN AFFINITIES.

NÆGGERATHIOPSIS. Feistmantel.

Leaves unknown, leaflets (pinnules) wedge-shaped from the base or elongate-spathulate, sub-rhomboid or obovate, margins

* See Physical Description of N. S. W. and Van Diemen's Land, by P. E. de Strzelecki, London, 1845, p. 250.

straight or incurved ; nerves close and numerous, somewhat thick at the base, and from thence forking twice or oftener, becoming slender and diverging into the leaf.

This is a genus erected by Dr. Feistmantel in 1878,* for certain leaves from the Talchir-Karharbari beds, which had been previously classed as *Nöggerathia*. To this latter genus had been referred similar fossil plants from the Newcastle beds by Dana, and also other leaves from the Jura rocks of the Altai mountains. A comparison since made, has shown that the whole of these leaves belong to closely allied plants, though Prof. Schmalhausen working independently, has called his genus *Rhoptozamites*. In Australia, they occur in paleozoic strata. In India, they are Liassic, and in the Altai, Oolitic. They differ in many ways from true *Nöggerathia*, a genus which includes a very miscellaneous assortment of plants. Some are probably Conifers and some Cycads, while Dr. Heer suggests that *Noeggerathiopsis* is a connecting link between the two. Dr. Feistmantel states (l.c. p. 156) that his father had made the discovery of a true Fern fructification of sporangia and spores in *Nöggerathia foliosa*, Sternberg, of the Bohemian coal measures, but this cannot be held to apply further than to that one species. The species are not to be confounded with either *Schizoneura* or *Zeugophyllites*, as the venation of the leaves clearly shows.

Noeggerathiopsis spathulata, Dana (l.c., p. 715, pl. 12, f. 9.) Leaves short, spathulate ; apex triangular and subacute, narrowed at the base, and thence gradually dilating, nerves very delicate and only partially distinct—four or five veins in the breadth of a line.

In the figure given of this fossil by Dana there is a cluster of leaves radiating from a common base, each nearly $2\frac{1}{2}$ inches long. "In this cluster," says Dana, "which is evidently a natural group, the leaves are of different sizes. The younger are quite narrow, oblanceolate ; length five times the greatest breadth, and have a tapering apex. The older are nearly an inch broader towards the apex, the base of the largest is but a little over $1\frac{1}{2}$ lines, and from this base they widen till within half an inch of

* Records Geol. Surv. India, vol. xi., p. 23.

the apex. The centre from which the leaves radiate has a shining coaly aspect, as if a soft bud or vegetable base of some thickness had been pressed down and carbonized. The same specimen contains a portion of another similar group.

Noeggerathiopsis media (Dana), loc. cit., pl. 12, fig. 10. Elongate lanceolate, tapering towards the base and broadest within an inch of the apex. Extremity subtriangular, and apex rounded. Veins a little divergent about fifteen to half an inch. One leaf five inches long, about an inch wide within an inch of apex, and a fourth of an inch at base; another shorter. Newcastle.

Noeggerathiopsis elongata.—This is a doubtful species which Dana identified with Morris *Zeugophyllites elongatus*, but says that it was found at Newcastle, which is clearly an error. He says that it may be identical with Goeppert's *N. distans*,* but that plant grew in clusters, and, moreover, had veins bifurcating in the middle, which does not occur in Morris' fossil.

Noeggerathiopsis prisca, Feistmantel (Pal. Flor. Oest. Aust., p. 158, pl. 16, fig. 3). Leaves unknown, leaflets (pinnules) medium-sized, sub-rhomboid, obovate, slightly inequilateral. Nerves close and fine, emerging radiately from a narrow base and forking twice or thrice.

Greta Creek, N.S.W., under the marine paleozoic fossiliferous strata.

CORDAITES. Unger.

Stem a simple woody cylinder without medullary rays, but composed of radiating scalariform vessels, encircling a large pith with transverse lamellar partitions. Bark marked with leaf-scars. Leaves simple, sessile, very long, flat, parallel-sided, with broad clasping base, easily disarticulated from the stem, no midrib, but fine parallel neuration.

These plants are variously placed by different authors. The leaves have certainly the aspect of endogenous plants, but the stem and woody tissue are cryptogamic. Schimper regards them as coniferous. They are characteristic of the Devonian and Carboniferous periods.

* Tchihatcheff's *L'Altai Oriental*, p. 385, pl. 28, fig. 8.

Cordaite australis M'Coy (Pal. Vict., Decade 4, p. 22. Plate, 36, figs. 6 and 7.) Leaves several inches long, thick, flattened, parallel sided, with unequal, longitudinal, simple parallel striæ; clasping base slightly widened and bent a little downwards. Leaves at one inch from the base, about four to five lines wide; base about two to three lines wider.

"The leaves of this species although narrow, are much thicker in the substance than in any of the other known species, and the parallel veins are more unequal and less distinct, the larger having fewer and sub-equal small ridges with much more numerous sub-equal fine striæ, thus approaching more to the foliage of *Dammara* and favoring M. Grand-Eury and Prof. Schimper's idea of coniferous affinities. Common in the Upper Devonian flags of Iguana Creek."

I believe I have identified the same species in the shales and slates of Gympie, Queensland (Lady Mary shaft), and also in the sandstone ranges at the Drummond Range (Bobuntungun in the sandstone, about one mile west of the railway station.)* In both it is not very abundant.

CLASS CONIFERÆ.

Trees or shrubs, mostly with resinous secretions, the leaves are stiff, sometimes linear or needle like, sometimes short and scale like, or more rarely broad, lobed, or divided. The flowers are unisexual, either in cylindrical or short catkins, with closely packed scales, or the females are solitary. There is no perianth. The stamens in the males are either inserted on the axis of the catkin under the scales, or the anther-cells are sessile, on the inside of the scales themselves, which then form part of the stamens. The ovules and seeds are naked, that is without ovary style or pericarp, although sometimes more or less enclosed in two bracts, or in a fleshy or hardened disk. The seeds are albuminous with one, or sometimes several embryos in the centre, each embryo having sometimes more than

* It is very common in the fragments of stone of which the embankment is made at the Medway bridge, with *Lepidodendron*.

two cotyledons. There are probably nearly two hundred species known, dispersed over a great part of the globe, several of them forming large forests in temperate climates, or more rarely within the tropics; while some of them extend almost to the utmost limits of woody vegetation in high latitudes, or at great elevations. They are distributed into about twenty-five genera, forming three tribes or sub-orders:—1. *Abietineæ*, with the fruits collected in cones and inverted ovules; of this the principal genera are *Pinus* (including *Abies*), *Araucaria*, *Cunninghamia*, *Sequoia*, &c. 2. *Cupressineæ*, with the fruits collected in cones and erect ovules; including *Juniperus*, *Callitris*, *Thuja*, *Cupressus*, *Taxodium*, *Cryptomeria*, &c. 3. *Taxineæ*, sometimes considered as a distinct family, with the fruits solitary or loosely spiked, including *Podocarpus*, *Dacrydium*, *Phyllocladus*, *Salisburia*, *Taxus*, &c.

The woody tissue of the trees of this family is seen to be marked with peculiar circular dots or punctuations, when examined under the microscope. The ovules at the base of each cone-scale are generally held to be naked, each ovule having a large opening at its apex, to which the pollen from the anthers is applied directly. But some say that the ovules are not naked, but are contained in a proper ovary, which is closely applied to the seed; that the outer membranous scales are modified leaves; and that the hard scales are altered bracts bearing the pistillate flowers.

Some botanists look upon Conifers as the highest type of true dicotyledons.

We have abundant evidence of the existence of Conifers in Australia, in almost all our plant beds except the very earliest coal formations. This is necessary to bear in mind, because Morris in Strzelecki's work already referred to, lays stress upon the absence of such woods from the N.S. Wales specimens. Wood, leaves and scales of Conifers, are mentioned by Dana. Many specimens of coniferous wood, are reported to occur in the lower coal measures, Greta Creek. Wood and leaves are found in the Jerusalem Coal Basin in Tasmania, and both are common as we have seen in the Ipswich coal beds and in the Tivoli Mines in Queensland.

Fragments of a kind of jet, in which however, the coniferous structure is very visible, are common also in the Desert Sandstone in Queensland. Finally, there are some fossil *Walchia*, which evidently bore a large share in forming the coal at Ballinore.

During the Triassic and Jurassic periods the exclusive reign of cryptogams had given place to an almost exclusive reign of Conifers. They formed the principal part of the vegetation in those times and gave it its particular aspect. *Lepidodendron* still lived but held a subordinate place, and at the same time Tree-ferns and Cycads in new forms of vegetation took their places amongst the Conifers. At the epoch of their first appearance these as far as fossil evidence will enable us to judge were represented by one type, and that was the araucarian type, at least that is the structure of the most ancient form of coniferous wood known. Several forms closely allied give us the gradual history of the differentiation of this proto-araucaria. Towards the middle of the Jurassic period, the Cypresses appear while successive forms of *Araucaria* have disappeared during the Permian, Liassic and Jurassic periods. From this epoch *Araucaria*, formerly so numerous commenced to decline in Europe and was represented only by the genus *Eutacta*, which appeared towards the close of the Jurassic age, and only grows now in some isolated localities of the southern hemisphere. With the close of the tertiary period the age *Araucaria* became extinct in Europe, and was replaced by the Abietinæ (Silver and Spruce Firs, Larches and Cedars), which has assumed the lead of the Cypresses. Nevertheless the Abietinæ though in the first rank of Conifers in the present day, is not nearly so numerous as it was during tertiary times.

The genus *Araucaria* (including under this name the genera *Colymbea* and *Eutacta*), has entirely quitted the northern hemisphere, where its first traces were seen in the Oolitic times. It is now confined to the south. One species inhabits the mountain ranges of Brazil; a second extends southward of Chili to Patagonia. There are only five other species known, and these are confined to Australia and a few Pacific Islands close to Australia. All the Araucariæ are distinguished by having the

scales of their cones one-seeded. In *Araucaria* proper, leaves are scale-formed, persistent, and widest at the base. The flowers are male and female on separate plants; the cones are mostly large globular, terminal, with scales partially or entirely deciduous, and the seeds more or less attached to them. *Colymbea*, a true *Araucaria*, with broad lanceolate leaves, and seed leaves germinating under ground. *Eutacta* (false *Araucaria*), with awl-shaped leaves and seed leaves germinating above ground. *Dammara*, with broad, flat, stalked leaves, opposite, alternate and leathery, cones axillary, scales persistent, seeds attached. See Schimper, *Paleontologie Vegetale*, vol. 2, p. 227, whose views I have summarized in the above remarks.

SUB-ORDER TAXODIACEÆ.

Leaves and scales of the strobilus or cone disposed spirally, rarely decussate. Leaves of very varied forms according to the genera either squamose, acicular or linear, falcate or narrow, spreading on every side or distinctly flattened. Bracts of the scales adnate more or less produced. Scales often ligneous, somewhat thick, not numerous. Ovules 2 to 9, inverse or erect.

In this sub-order is included one living Australian Conifer, *Arthrotaxis* which is indigenous to Tasmania, but according to this arrangement our common pine *Frenela* or *Callitris*, would be found amongst the CUPRESSACEÆ. Among the TAXODIACEÆ is included *Brachyphyllum* which is however doubtfully so placed as its true position and relations are matters of dispute.

BRACHYPHYLLUM. Brongniart.

Shrubs or trees. Branches irregularly pinnately ramulose. Leaves extremely short, arranged spirally, densely close, bases dilate, contiguous, probably fleshy when alive, pyramidal, curved above, or from the mutual pressure of the bases pentagonal and hexagonal, produced into short or very short papillæ, long persistent, and with age as the branches thickens, dilating and becoming scutelliform, subsequently when falling away leaving raised contiguous rhomboid scars marked in the middle with vascular cicatrices.

No genus of living Conifers corresponds with these fossil plants. The leaves are short and fleshy, straight or curved, contiguous at the base, but with age they resemble pentagonal or hexagonal cushions which clothe the branch like a cuirass. In this state they have been mistaken for the cones of Cycads or Conifers. The leaf scars resemble those of *Lepidodendron*. The fruits are unknown, and therefore the systematic position is uncertain. They are generally Oolitic fossils.

Brachyphyllum (?) *australe*. Feistmantel (l.c., p. 98, plate 7, figs. 3 to 6, and plate 17.) Branchlets elongate, slender, flexuous, much branched, leaves spirally disposed, squamiform, rhomboid-oblong, somewhat thick, apex acuminate, sub-keeled and a little flattened, amentum covered with sub-rhomboid, acute, acuminate scales, the apex somewhat flattened and spirally disposed.

The form and position of the leaves corresponds well with the typical species of *Brachyphyllum*. Several specimens of this fossil were found in the Eskbank and Lithgow collieries.

Brachyphyllum australe, var. or n.s., *crassum*, nobis, Plate 5. Brong. Prod., p. 19, *Mamillaria desnoyersii*, Ann. Sc. Nat. pl. 19, fig 9. Unger. Gen. et Spec., p. 308 (included amongst cycadaceæ). Branches and branchlets rigid, coarse and thick, leaves more or less irregular in shape, and mammillately shield-like, bases contiguous, 5 to 6 angled. Schimper separates this fossil from *B. mamillare*, Lind. and Hutton, which is much more slender and with more numerous branches. It is found abundantly in the Oolite of Oxford, Wiltshire, Yorkshire, and in several places in France. The above is Schimper's definition.

In the Geological Magazine for 1869 (vol. 6) there are figs. at Pl. ii., figs 12, 13, of branches of a coniferous plant, which Schimper identifies with this species. That which I distinguish as a variety of the same, may be thus described. Plant robust, thick, stem and branches, repeatedly dichotomous. Leaves thick and fleshy, densely crowded, homodromous, short, broad, obtuse, conspicuously keeled, erect, closely imbricate, but slightly spreading. Branches and branchlets very little narrower than the parent stem, and of equal width to the summit. All portions of the plant curved.

Three leaves visible in each spiral. About three rows in a centimeter. Length of leaves, from 2 to 3 mill.; breadth, from 5 to 6. Diam. of cauline stem at widest part, 10 mill.; of branchlets, 8 mill.; length of shortest, 18 mill.

Amongst the fragments imbedded around, there are some with rhomboidal depressions like lepidodendroid scars. These are stems from which the leaves have been shed. They are about 30 mill. long and 2 wide.

Ipswich coal, the only specimen I have seen.

TAXITES. Brongniart.

Leaves linear, narrow, or sub-falcate, obtuse, coriaceous, fleshy, with a median rib ending in a minute mucrone, flat, furnished with a half-twisted pedicel which is briefly decurrent.

This is a mesozoic genus of few known forms, about some of which Schimper says that he would not venture to offer an opinion. No doubt it includes different genera as those groups known only by the form of the leaf must necessarily do. They are known from Italy and Greenland, besides two species from the Upper Gondwana system (Jabulpur, Sripermatúr, and other places) on the Madras coast. The general habit and form of the leaves shows that we are dealing with plants closely allied to our living species of *Taxus* or Yew.

Taxites medius, n.s., Pl 9, fig. 3. Branchlets thin, leaflets spirally and bilaterally disposed, emerging at an acute angle, sub-alternate, sometimes slightly curved outwards, narrow linear, obtuse, rather long, and the decurrent pedicel thick, long, and broad (nearly as broad as the leaf at times). Midrib thick and conspicuous, surface shining and transversely wrinkled. Ipswich, Q. L., precise locality unknown.

This specimen is on a stone which has impressions of *Equisetum* stems and *Thinnfeldia odontopteroides*. The fossil is conspicuously shining, no doubt from its coriaceous surface, the wrinkling of the leaves is due to their fleshy nature. The number of detached leaflets scattered on the stone manifest their deciduous attachment. I name the specimen from its intermediate character between the

two Indian forms, *T. tenerrimus*, Feistm., which has very small horizontal leaflets, and *T. planus* which has also horizontal leaflets but much longer and broader.

SEQUOIITES. Carr.

Named from the close connection with *Sequoia*, Endlicher, a genus of splendid trees of gigantic height, separated from *Taxodium* on account of the non-deciduous leaves, and the seeds being from 3 to 5 in each scale. Leaves subulate, flat or scale-like in two rows. Flowers monœcious, male and female separate, but on the same plant, solitary and terminal in the living (*S. sempervirens* Endl., the Californian Redwood), but axillary in the fossil species. Anthers numerous, bilocular, connective peltoid. Female amentum terminal, densely covered with imbricate scales. Cones small, sub-globular, or obtusely oval and woody, the scales inserted almost horizontally, wedge-shaped and truncate. Seeds (in the fossil species) 5 to 7, affixed to the base of each scale, and winged nearly all round.

This genus is by most botanists made to include *Wellingtonia*, from which it can only be distinguished by the seeds being always as stated, and not four in number. The leaves are flat and yew-like, while in *Wellingtonia*, they have always a triangular section, and are closely imbricated. *Sequoia sempervirens* and *gigantea*, Lindley, are the only living species. The first is spread over all the mountains of the west side of North America and in the south of California. The other species is limited to a few places in California. Amongst the fossil species, *S. langsdorffii* cannot be distinguished from the living *S. sempervirens*. It occurs in the Miocene strata of Switzerland, Vienna, Berne, Italy, and Eastern Europe. It also occurs amid plant remains of similar age in Vancouver's Island, and on the edge of the Polar regions. *S. sternbergii* (tertiary) approaches *S. gigantea*, while *S. coultessiae* is a medium between the two. The earliest recorded appearance of the genus is in the Cretaceous period.

To this species I am inclined to refer a species which appears to be very common in the plant beds of Rosewood near Rockhampton

where it is associated with *Ptilophyllum oligoneurum*. It is of course only an approximate identification, as no cones, either male or female have been hitherto discovered. I think they should be abundant from the number of the leaves, but as yet the beds have been only explored by myself, and I merely collected stones from the surface. I give the plant therefore a name provisionally, not meaning to pronounce positively upon its characters, but only its resemblances. If the surmise—for I can call it little better than a surmise—be verified, it will be the first time that *Sequoiites* has been identified south of the equator. This however will not be so surprising since the genus *Phyllocladus* of Tasmania extends into Borneo and *Arthrotaxis* of the southern hemisphere can hardly be separated from the Chinese *Cunninghamia*. We have no Australian Conifer with leaves similar to *Sequoia* except *Podocarpus*, but though in some species of that genus the foliage is long, flat, and with a prominent midrib, there is a distinct petiole which in this fossil is wanting.

Sequoiites (?) *australis*, n. s. Leaves very close, two rowed (?) spread out, flat, alternate, straight, rarely falcate, smooth above, midrib prominent below, rounded at the apex, towards which there is only a very slight tapering, not contracted at the base but becoming a sheath, down the centre of which the midrib can be distinctly traced, from 20 to 25 millimetres long, and $1\frac{1}{2}$ wide, but much shorter and smaller near the extremities of the shoots, where they are somewhat imbricated all round the branch, and loosely spiral. The sheathing base of the leaves gives rise to a jointed appearance to the stem. Length of longest fragment 91 millim., on which there were about 50 leaves; width about 25 millim., at base tapering to 8 mill. Pl. 7, fig. 5.

ORD. ABIETACEÆ. Fam. WALCHIEÆ.

Schimper says that it was the system for a long time to place in genus *Araucarites* every impression of the branches of Conifers whose leaves showed some resemblance to the leaves of *Araucaria* of the group *Eutacta*. A better acquaintance with these plants, which arose from the discovery of inflorescence and fruits enabled paleontologists to show that most of the species had nothing in

common with *Araucaria* except the leaves and the structure of the wood. In other respects they were found to belong to many widely separated families. The genus *Araucarites* is now restricted by Schimper to two species. In referring as I do to the following species to the genus *Walchia*, I do so mainly because of the general similarity of the leaves, and the structure of the male amentum to which I shall presently refer. Otherwise the resemblance is to *Araucaria* as far as the leaves go.

WALCHIA. Sternberg.

Arborescent plants of the habit *Araucaria* of the sections *Eutacta** or *Dacrydium*, branches pinnate, ramulose, branchlets alternating and spreading. Leaves of two kinds, the shorter ovate or linear imbricate, the longer linear lanceolate and gathered into a tuft, incurved at the apex, or falcate and erect from the base, sub-decurrenly spreading, keeled on the back and finely striate. Cones terminal, oblong, cylindrical or elongate, scales ovate-acuminate or lanceolate, seed solitary in each scale, ovate, minutely apiculate. Male amentum (?) composite, anthers axillary, oval.

Schimper says of the genus that it partakes of the character of *Araucaria* and was for a long time regarded as a Lycopod in spite of its different mode of ramification. (*Lycopodites*, Brongniart and Unger.) With *Ullmannia* it is characteristic of Permian period. They are the most ancient Conifers of which the leaves and fruits are found, though coniferous wood occurs in the oldest paleozoic carboniferous formations. The two genera named disappear in Europe at the close of the Permian. *Voltzia*, *Albertia* and *Glyptolepis* take their place in the Trias.

Walchia milneana, n.s. Plate 2, fig. 3. Branches obtuse, leaves very closely imbricate, spirally disposed so as to leave three to four visible in each spiral ; falcate, acuminate, breadth at base, half the length, mucronate, in young branches, obtuse in the older ones, curving together in linear scale-like leaves at the top.

* In this section *Eutacta* the cones are small, terminal and globular ; unequal shaped and small. In *Dacrydium* the fruit is fleshy and erect, and the leaves acicular or scales and opposite. The *Araucarias* moreover differ from the pines and firs in having the sexes on separate trees.

By the side of one of the specimens, there is the end of a branchlet, which for a part of its course has crowded narrow leaves, much longer than the others. There is also a fragment whose leaves are broad and acuminate. Number of leaves visible in a branchlet, 25 mill., long, 16. Average length 5 mill., width 2 to $2\frac{1}{2}$ mill. The narrow long leaves referred to, are 10 mill. long by 1 mill. wide.

From Ballinore coal field, Talbragar near Dubbo, where it appears to be abundant.

With the branches and stems are associated certain remains, which I regard as the male amenta, of which a figure is given at Pl. 6, figs. 7, 8. They are distichous spikes, with closely set scale-like bracts in pairs, lying closely together and projecting in a long thin scale, like the glume of wheat, within this there is a scale with four distinct projections like a comb, within these may have been situate the anthers. In Goeppert's Foss. Flor., d. Perm. Form., pl. 49, fig. 13, there is a figure of what has been regarded as the male amentum of *Walchia piniformis*, Sternberg, in which these peculiar teeth on the scale are given on the summit of the figure.

CUNNINGHAMITES. Presl.

These Conifers are distinguished by their general resemblance to the genus *Cunninghamia*, R. Brown, a genus only known by one living species, which is the common native fir of China. It is thus described : Leaves lanceolate, quite entire, flat, sessile, spreading, rigid, pungent, bent downwards, one inch and a half long, and disposed all round the branches and stems except on the old lateral ones where they are arranged in two rows. Branches generally in whorls, lower ones horizontal, but those near the top ascending. Branchlets opposite in two rows and spreading. Male catkins, terminal in clusters, cylindrical and near an inch long. Cones globular, three or four together, but sometimes solitary, sessile, drooping, smooth, and about the size of a walnut. Scales ovate, tapering to a sharp point, leathery, sharply denticulated on the margins, thin and free at the points.

Three fossil species are known in Europe, all from Cretaceous rocks, and one from the Lower Jura or Upper Lias coal beds of India. It was named *C. inæquifolius*, Oldham and Morris, but Feistmantel thinking the name inappropriate changed it to *C. dubiosus*. The specimen is very imperfect. See Foss., Flor., Gondwana, vol. 1, p. 140, pl. 33, fig. 3, 4. Also Lindl. and Hutt., Foss., Fl., vol. II., pl. 127, where there is a figure of the living species with an axillary cone. Also Goeppert, Monogr., d. foss., Coniferen, pl. 47, fig. 5.

In the specimens found at Rosewood, Ipswich, there are two or three with male amenta in terminal clusters which are figured here rendering the identification of the genus much more certain. The leaves, however, are seldom entire, which gives the appearance of an obtuse or unequal foliage which is seen in the Indian fossil.

Cunninghammites australis, n. s. Plate 3, fig. 1, 2, 3, plate 4, fig. 1. Leaves long, linear, pointed, decurrent, entire. Male amenta in rather thick corrugated clusters at the ends of the branches. Generally two of the amenta are alone distinct in the fossil, but others can always be traced in the centre: they are *curved*.

Abundant in a pale, yellowish shale, at Rosewood, where no doubt a careful search would enable us to restore the plant completely.

PINE FRUITS.

Araucarites (?) *polycarpa*, n. s. I give this name to a fruit cone, of which a figure is given at Pl. 10, fig. 1. It was found in a conglomerate partly derived from the coal beds of the Burnett River, Q. L., but it may be of subsequent date or even Tertiary. It is an ironstone (limonite) concretion. The inside of the fruit has been dissolved, leaving a cast of the external portion beautifully preserved, except where it is covered by a black vitreous iron ore which fills the centre. The whole formed a brown water-worn stone, which being broken across in making the railway ballast discovered the fossil inside.

EXPLANATION OF PLATES.

NOTE.—The heliotypes though at first sight indistinct, will bear examination with a hand lens, when all the detail will be distinctly seen. Type specimens of all new species, except *Sph. bayleyana*, are in the Macleayan Museum.

PLATE I.

- Fig. 1. *Vertebraria towarrensis*.
 2. Ditto ditto.
 3. *Vertebraria equiseti*.
 4. *Vertebraria towarrensis*.

PLATE II.

- Fig. 1. *Equisetum latum*.
 2. *Sphenopteris flabellata*, var. *erecta*.
 3. *Walchia milneana*.

PLATE III.

- Fig. 1. *Cunninghamites australis*.
 2. Ditto terminal branch with cluster of male amenta.
 3. Portion of branch of same.
 4. *Sphenopteris crebra*.
 5. Male amentum of *Walchia milneana*.
 6. *Gleichenia lineata*.
 7. *Trichomanides spinifolius*.

PLATE IV.

- Fig. 1. *Cunninghamites australis*.
 2. *Sphenopteris bayleyana*,
 3. *Jeanpaulia bidens*.
 4. *Sphenopteris glossophylla*.

PLATE V.

Brachyphyllum crassum.

PLATE VI.

- Fig. 1. *Thinnfeldia media*, $\frac{1}{2}$ -nat. size.
2. *Merianopteris major*, $\frac{1}{2}$ -nat. size.
3. Ditto pinnule enlarged.
4. *Alethopteris currani*.
5. *Equisetum rotiferum*.
6. Ditto diaphragm.
7. *Walchia milneana*.
8. Ditto male amentum.
9. *Phyllothea concinna*, sheath leaves.

PLATE VII.

- Fig. 1. *Cunninghamites australis*, male amenta.
2. *Ptilophyllum oligoneurum*.
3. Ditto ditto.
4. Ditto single leaflet enlarged.
5. *Sequoiites australis*.

PLATE VIII.

- Fig. 1. *Thinnfeldia falcata*.
2. *Gleichenia lineata*.
3. *Podozamites distans*.
4. *Neuropteris (Aneimidium) australis*

PLATE IX.

- Fig. 1. *Alethopteris concinna*.
2. *Phyllothea carnosa*.
3. *Taxites medius*.
4. *Sagenopteris rhoifolia*.

PLATE X.

- Fig. 1. *Araucarites polycarpa*.
2. *Trichomanides laxum*.

PLATE XA.

Macroteniopteris wianamattæ.

Woods, Julian Tenison. 1883. "On the fossil flora of the coal deposits of Australia." *Proceedings of the Linnean Society of New South Wales* 8, 37–167.
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