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Clarke, Coal, and Controversy

The Traumas of Reverend W.B. Clarke in his defence of Australian Geology during the Nineteenth Century

Michael Organ

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Introduction

Though readily given the title *Father of Australian geology*¹, the Reverend W.B. Clarke remains something of a mysterious figure to Australian geologists. When asked what his major achievements were, few would be able to offer an answer. Yet such disregard is commonly the fate of many pioneers in the field of science, for once a discovery is made, or theory proven, the profession moves on to new and more challenging fields, with scant regard for the foundations upon which current work is based.

Occasionally - as in the case of the recent Gupta affair, and Fred Hoyle's questioning of the authenticity of *Archaeopteryx* fossils - controversy causes scientists to look back and query the findings of previous or contemporary workers. However this is a relatively rare occurrence and the fraternity as such usually shy's away from open controversy. Bickering amongst its own ranks may become known to the public at large, and the credibility of the profession is then at issue, with the press prone to question the hard-won reputation of science and the results of scientific research.

William Branwhite Clarke (1798-1878) was a pioneer in the field of Australian science who, though he preferred to work singularly and pursue his priestly duties, was nevertheless occasionally embroiled in controversy with his fellow workers, including amongst them Sir Roderick Murchison, the famous pioneering British geologist, and Frederick McCoy, head of the Geological Survey of Victoria. He clashed with Murchison in regards to the discovery of gold in Australia, and with McCoy over the age and structure of the Australian coalfields.

Whilst the Reverend Clarke's religious teachings called for humility, his own ego and pride in scientific achievement brought him into the public arena on a number of occasions, as he defended the science and geology of the young Colony from the theorems and dogmatic pronouncements of fellow workers who were, more often than not, unfamiliar with the *in situ* realities.

The conflict between religion and science - especially the rapidly evolving geological sciences - was raging throughout Clarke's life and continues to rage, yet he never stood back from the issue. Clarke saw no real conflict between his belief and his science, yet he was often forced to defend science in public. As early as 1836 he had published a sermon entitled *Geology in reference to Natural Theology*, and was a defender of Charles Darwin's theory of evolution when it was made known in 1866. In 1849 Clarke had stated in a Sydney newspaper:

.....During many years I have directed my studies in physical matters to one end - the attempt to illustrate the natural phenomena mentioned in the Sacred narratives.²

W.B. Clarke was therefore forced to take on a multi-faceted role in the Colony, as a worker in, and spokesperson for, the physical sciences. His study of Australian geology was all encompassing - he valued highly field work and worked in the field right up until the year of his death. Though far from a brilliant palaeontologist, he was nevertheless well read in that field and was able to amass a significant collection of local fossils for study and identification by overseas workers.

Clarke played an important role in the delineation of the age and structure of the New South Wales coalfields during the nineteenth century. As a coal geologist he was recognised as the local authority until the Geological Survey of New South Wales was set up in the 1880s, and his study of the New South Wales goldfields in 1851-53 put the search for gold and future investigations on a scientific foundation. His many publications on the sedimentary formations of New South Wales - combining all the information gathered during his years of field work and fossil study - laid the foundations for the currently identified and dated units.

Clarke was the focus of geological studies in the Colony during the years 1839-78 and a veritable clearing house of ideas. Young scientists such as Richard Daintree, W.S. Jevons and C.T. Wilkinson would come to him for advice and to use his vast scientific library and collection. It is indeed unfortunate that his lifetime collection of fossils, field books, maps, sections, and personal library were all destroyed by fire in 1887 after being purchased by the New South Wales state government.

Clarke was also a prolific writer, and during his lifetime maintained a rich correspondence with geologists throughout the world, such as J.D. Dana, Sir Roderick Murchison, Adam Sedgwick, L.G. de Koninck and Ottokar Feismantel, right up until the time of his death in 1878. It is to be regretted that due to financial constraints he was never able to publish his findings as he would have liked. The quality of many of the works produced by the Geological Survey of New South

Wales during the period 1890-1920 was in part due to the foundation work of Clarke, and widely recognised as such.

Biographical Background

William Branwhite Clarke was born on 2 June 1798 at East Bergholt, Suffolk, England. He entered Jesus College, Cambridge, in 1817, eventually attaining a B.A. in 1821 and an M.A. in 1824. During this period he was a student of, and much influenced by, the noted geologist Professor Adam Sedgwick.

In 1823 Clarke was ordained a minister in the Church of England, and following the completion of his studies the following year took up religious and teaching duties, all the while continuing to pursue his interests in the arts and natural sciences.

Clarke married Maria Moreton (nee Stather) on 13 January 1832, and the couple were eventually to have two children - Mary and Mordaunt. In 1833 he was installed as first incumbent at Saint Mary Longfleet, Poole, Dorset, and the family were housed at the nearby residence known as Stanley Green. The Clarke's remained there until their departure for Australia six years later.

In January 1839 the Reverend Mr Clarke and his family emigrated to New South Wales, largely for health and financial reasons, though Clarke was also interested in the unexplored geology of the continent. He arrived in Sydney on 27 May 1839 and immediately took up duties as full-time minister. For a brief period during 1839-40 he was headmaster of King's School, Parramatta. Following a number of years as a roving parson responsible for the parishes of Castle Hill and Dural, he was made rector at St Thomas's Church, North Sydney, in 1846 and remained there until his retirement in 1871.

Early in 1842 Mrs Clarke and the two children left the Colony for England - Maria was homesick and the children needed an English education. They did not return until 1856, and throughout their period of absence William was forced to support his family with money sent from the Colony. This proved to be an almost unbearable strain on an always meagre income as a parish priest.

Following a hectic life as a full-time minister, part-time scientist, journalist, and parent, W.B. Clarke died on 16 June 1878, at his St Leonard's residence. He was in his eightieth year.

By the time W.B. Clarke and his family arrived in Sydney in May 1839, the Reverend was 41 years of age and had published over 80 papers in British and French journals on topics ranging from

natural history, meteorology, and theology, through to geology, including a major study of the geology of south east Dorsetshire during 1838-39.

Of his interests in coal geology, as early as 1821 he had visited the coal-fields of Staffordshire and Derbyshire, was made a fellow of the Geological Society of London in 1826, and during the 1820s and 1830s made a number of excursions throughout England and Europe to hone his skills as a field geologist.

By 1839 Clarke was therefore an extremely well-informed parson, and perhaps one of the most learned men to have migrated to New South Wales up to that point. It should be remembered that he was the first fully trained and experienced geologist to make his residence in the Colony and attempt a detailed, systematic study of the local geology. Over the forty years between 1839-78 he would work diligently and scientifically in mapping the Sydney Basin and surrounding sedimentary formations, plus determining the ages of the various units and coal seams. By the time of his death in 1878 he had laid the foundations for the stratigraphy which now exists. He forgot the plutonic and volcanic rocks or older Ordovician and Silurian sediments of New South Wales, publishing papers on all these topics.

Clarke prided himself in many 'firsts', and perhaps considered the subject of colonial geology as his own. He claimed the first discovery of Australian trilobites; the first scientific discovery of *in situ* specimens of gold, oil shale and diamonds; and the identification of Devonian sediments. He took objection to interlopers such as P.E. de Stzrelecki, J.B. Jukes, and even Sir Roderick Murchison who visited Australia briefly - if at all - and made pronouncements on its geological character, often upstaging topics which he had been working on systematically for a number of years.

Whilst Clarke was something of a loner, his career is nevertheless also marked by a series of important collaborations with recognised palaeontologists such as James Dwight Dana (1839-40), F. McCoy (1846-63), L.G. de Konick (1875-76) and Ottokar Feismantel (1877-78) resulting in the identification of a large collection of Mesozoic and Palaeozoic fossils of the Colony, and a determination of the age of the coal beds, for it was in this area that most controversy arose.

Clarke and Coal

The following account of Reverend W.B. Clarke's role in identifying the age and structure of the New South Wales coalfields is a summary of that given in Tom Vallance's 'The Fuss about Coal'³, to which the reader is referred.

Though Clarke was interested in all aspects of geological science, his work in New South Wales prior to the discovery of gold in 1851 naturally drew him to a study of the structure and age of the local coalfields - an area of future wealth for the struggling Colony, and one of complexity and continuing controversy.

With the advent of the gold discoveries he briefly turned his attention away from the coalfields - at the request of the local government - and produced a number of detailed reports on the New South Wales, southern Queensland, and Tasmanian goldfields between 1851-56. However his studies of the sedimentary formations of the Colony continued, as they had done since the time of his arrival in 1839.

Barely 6 months after arriving in the Colony, Clarke was involved in a geological excursion to the Illawarra district south of Sydney, accompanied by the American geologist James Dwight Dana. Dana was the first, and one of the most important, of Clarke's colonial collaborators. During their time together during 1839-40, Dana and Clarke developed the following stratigraphy for the Illawarra district, from Bulli to Kiama, and west to the escarpment:⁴

- Sydney Sandstone formation
- Coaly formation
- Wollongong Sandstone formation
- Basalt

More importantly, they came to the conclusion that the coal bearing sediments and the underlying marine beds were part of a thick conformable sequence, age as yet indeterminate, though Dana later suggested Carboniferous to Permian.

Other workers in the field, such as P.E. de Stzrelecki (1845) and Frederick McCoy (1847), would question this idea of a conformable sequence, based largely on discrepancies in the fossil record, and disregarding the field evidence.

Clarke's own views on the age of the coal beds varied, or rather developed, with time. In 1841 he wrote to his old mentor, Professor Sedgwick of Cambridge, stating that he believed the local coal to be 'oolitic' (Jurassic) - Mesozoic, in age. He reaffirmed this in an 1842 newspaper article reviewing Stzrelecki's paper on varieties of Australian coal.⁵

However following a sharp rebuttal of his views that same year by the local gentleman scientist W.S. Macleay - who questioned the validity of comparing and equating Australian fossils with those from Europe, and suggested a Triassic age for the Sydney Sandstone - Clarke reconsidered

the situation, and in August 1842 suggested that the coal beds were possibly older than Jurassic, perhaps Palaeozoic.

In an 1862 article Clarke was to proclaim of the Oolitic age of the New South Wales coal beds, 'To this I was all along opposed', for the moment forgetting his 1841-42 statements.

By November 1842 Clarke had spoken with visiting English geologist J.B. Jukes, who considered the New South Wales and Tasmanian coal beds to be as old as, or older than, the Carboniferous coal of England, and Clarke agreed with him.

During December 1845 Clarke visited Illawarra with Jukes, their field work resulting in the clarification of some of Clarke's views. The pair constructed a geological section from Campbelltown to Wollongong, and developed the following stratigraphy for that part of the Sydney Basin:

Upper Shales
Sydney Sandstone
Sandstone and Shales
Coal Measures
Lower Sandstone

Both agreed the sediments were part of a conformable sequence, and of Palaeozoic age.⁶

Clarke, in 1844, had sent a large collection of fossils to Professor Sedgwick in England for identification and age determination. Prior to obtaining the results of those investigations, which were carried out by his future nemesis Frederick McCoy and published in 1847, Clarke was forced to rely on the sparse palaeontological work of Stzrelecki and Morris, and his own views. Early in 1846 he agreed with Stzrelecki in so far as stating the:

.....Palaeozoic of New South Wales may be regarded as partly the equivalent of the Devonian and carboniferous system of other countries.⁷

In June 1847 he had further stated: 'Whatever conclusion we adopt, this is undoubted, that the Australian carboniferous deposits have nothing in common, save one or two rare species, with the Jurassic system, but have an antiquity in part greater than that of the European coal-fields.'⁸

Whilst agreeing with Jukes that 'it is impossible to class the Australian series exactly in a parallel with any of the European formation', he identified the sedimentary rocks of New South Wales as

representative '...of the Silurian and Devonian rocks [of Europe, including the carboniferous system of England, in one uninterrupted and conformable series of deposits.'

When Frederick McCoy's descriptions of Australian fossils collected by Clarke were published later that year⁹ the Reverend Clarke would have been surprised, to say the least, for the learned palaeontologist concluded that the New South Wales coal fossils were of Jurassic age, and the marine invertebrates from sediments below the coal beds were of 'Mountain Limestone' (Carboniferous) age, with an unconformity between.

McCoy had therefore disregarded the published and field evidence of Clarke and Jukes without so much as a mention of the discrepancy, and would continue to pursue this argument for the next twenty years, much to the detriment of Australian geology.

In 1848 Clarke discovered a fossil bed near Muree with both *Glossopteris* (McCoy's Jurassic plant) and marine invertebrate (McCoy's Carboniferous) fossils combined. This evidence confirmed the conformability of the coal sequences, but it was disregarded by Clarke and McCoy until 1861, and never wholeheartedly accepted by the later,¹⁰ who reaffirmed that, in regards to the New South Wales coal sequence:

....the whole is of one prolonged age, referable to the upper carboniferous, or partly the lower Permian era.¹¹

The argument rested there, at an impasse, until 1855 when McCoy arrived in Victoria as head of Geological Survey, with his firmly held views that the New South Wales coalfields were of Mesozoic age and unconformable. To enforce this belief, and reopen the controversy, in 1860 he identified a fossil fern *Taeniopteris* from the Cape Paterson coalfield of Victoria as Jurassic (Mesozoic) and then stated it was contemporaneous with *Glossopteris*, a fossil which proved so important in determining the age of the New South Wales coalfields.

McCoy also discovered *Cyclopteris angustifolia*, which he re-named *Gangamopteris*, and which was also found at Newcastle, therefore strengthening his argument that the New South Wales coal beds were Mesozoic.

Clarke was forced to reply to these 'accusations' by McCoy. Perhaps he saw it as a blatant impingement upon his territory, for his nemesis was now no longer upon foreign soil, but had planted roots in the Colony. The Clarke:McCoy war of words was another example of the omnipresent Sydney versus Melbourne controversy, played out over the years on a number of fronts.

Clarke, in a letter to the Victorian Governor¹², immediately questioned if McCoy's fossil was truly *Taeniopteris*, and then queried if it alone could be used to ascribe a Jurassic age to a unit. McCoy was upset by the questioning of his palaeontological expertise, and published a lengthy reply to Clarke's letter¹³ which he opened by haughtily pronouncing his '.....great dislike of controversy, and my belief that the time of a scientific man may be better employed in endeavouring to add new facts to the general store of human knowledge, than in defending himself or his views, when once put forward...'

McCoy then follows with a detailed 13 page rebuttal of Clarke's criticisms, in some parts calling Clarke a fabricator of stratigraphic information regarding the discovery of *Glossopteris* beds underneath those containing marine fossils at Stoney Creek near Maitland, saying that he 'had no evidence that the plant specimen had actually been *in situ* below the marine beds.'

McCoy's questioning of Clarke's field observations – especially from one who was so inexperienced in that aspect of geology – was rash, and must have raised the ire of the learned Reverend, who prided himself in his field expertise.

Clarke replied to McCoy's reply¹⁴ however McCoy wished to have the final word, and this was also published at the end of 1860.¹⁵

Clarke, ever the gentleman, continued to submit fossils to McCoy for identification, however in print he moved from the palaeontological arguments - where McCoy had the perceived edge to those based on field relationships and stratigraphy. He replied late in 1861 to McCoy's accusations with a detailed, unemotional article on his Stoney Creek find in the journal of the Royal Society of Victoria¹⁶, wherein he identified and described *Glossopteris* beds "underneath" marine (Carboniferous) beds at Maitland.

This evidence, despite pointing to the conformability of the coal sequences, did not move the one-eyed McCoy, who instead suggested that a fault had overturned the beds, placing the Carboniferous beds above the younger Jurassic sequences. When McCoy took the argument to the British "Magazine of Natural History in 1862 - to which journal Clarke had been a contributor since 1829 - and insultingly suggested that Clarke had misidentified Mesozoic fossils as Palaeozoic¹⁷ the Reverend saw this as the final straw. He immediately replied in a not so polite article¹⁸ dated 26 April 1862, where, in answering 'a kind of charge against my honesty ... alleged in [McCoy's] note', he emphasised that at Stoney Creek the Palaeozoic fossils are found over and below and around a set of coal-beds having the same general dip and disarrangements as the supposed older beds. At the end of the article he further stated, in summary:

.....I have never, in the recent controversy respecting the Coal-fields, done otherwise than request [McCoy's] determinations of fossils, thinking it due to him to lay all fresh information before him, and being willing to defer in palaeontological questions to his judgement. But I retain to myself the right of forming an opinion as to the structure of a country with which I am familiar, and which he has never seen.

In the long run Clarke was vindicated, however the whole period 1860-62 had been one of public controversy for the Reverend, both in Australia and overseas, and his reputation was tarnished. During 1861 he had been on public display before a committee of the New South Wales Legislative Assembly investigating 'the claims, if any, of the Reverend W.B. Clarke, for the services rendered by that Gentleman in developing the great mineral resources of this Colony', specifically with regards to his involvement in the discovery, and exploitation, of the Colony's goldfields'.

It seemed he was being attacked on all fronts at the time. However following these exchanges, Clarke settled back into his geological studies and spent the remaining years of his life refining his thoughts on the sedimentary formations of New South Wales, and continuing to supply fossils to overseas palaeontologists such as L.G. de Konick and O. Feismantel.

By 1866 Clarke had identified the following sequence in the Sydney Basin area:¹⁹

Wianamatta Beds
Hawkesbury Sandstone
Upper (Newcastle) Coal Measures
Upper Marine Series
Lower Coal Measures
Lower Marine Series

All were identified as Palaeozoic, and conformable, in defiance of McCoy and his supporters. In 1872 Richard Daintree convinced Clarke that the upper part of Sydney Basin was possibly early Mesozoic (Triassic), as suggested by W.S. McLeay in 1842. For the remainder of his life McCoy continued to call *Glossopteris* Mesozoic, though in Australia it was a Palaeozoic plant.

Just prior to his death in 1878, Clarke had seen through the publication of major palaeontological works on Australian fossils by L.G. de Konick.²⁰ De Konick worked on the fossils from 1864 to 1877, with Clarke sponsoring the project. An English translation was published in 1898.²¹

The real solution to the coal problem had come from O. Feismantel who admitted that *Glossopteris* could be Palaeozoic in Australia and Mesozoic in India. By 1880 it was commonly accepted that the New South Wales, Queensland, and Tasmanian coalfields were of late Palaeozoic to early Mesozoic age, whilst in Victoria they were Mesozoic. Robert Etheridge junior proposed the term 'Permo-Carboniferous' for the age of the Queensland coal beds and this replaced Clarke's scheme in 1887.

Further Controversy

The other major geological controversy of Clarke's life surrounded the role he played in the 'discovery' of gold in Australia. Parties such as Edward Hargraves, Paul Stzrelecki, Sir Roderick Murchison, William Tipple Smith, and Reverend Clarke, all claimed the honour, though Hargraves received the public accolades.

Clarke's claim brought him into conflict with Sir Roderick Murchison in England. It was Murchison who as early as 1844, following a comparison of the Great Dividing Range with the Ural Mountains, had suggested that gold may be found on its flanks, west of the Range. Though his theory was amiss, the locality was correct, and he therefore pursued his claim to the geological discovery of gold in Australia.

Clarke, as the resident geologist, claimed the first in situ discovery of gold in the Colony, and the conflict with Murchison continued right through to the 1860s. As always, a number of individuals had played a part in the discovery and exploitation of gold in the Colony, yet many vied for the honour - and financial rewards - associated with the title of 'discoverer'.

Throughout his life Clarke relied on both his own detailed field observations, and the findings of the overseas palaeontologist to whom he sent collections, to refine and correct his ideas on the age and structures of the local (New South Wales, Queensland, Tasmanian, and Victorian) sedimentary formations, especially the coal measures, which were so important in providing abundant fossils for any age determinations. Clarke's ideas were constantly changing, right up to 1878, when he published the fourth edition of his *Remarks on the Sedimentary Formations of New South Wales*.

Unlike McCoy, Clarke was flexible in his thoughts on the age of the local strata, and though as late as 1861 he was referring to New South Wales units in European terms such as 'Mountain Limestone', he eventually delineated the main structural units of the Sydney Basin, along with studies of the Devonian (e.g. Lambie Group) and Ordovician-Silurian rocks of the Colony.

Whilst he was always working behind the scenes on collecting fossils, mapping, drawing sections, writing to overseas and local correspondents, his public profile wavered, with periods of intense public scrutiny and others of enforced isolation. From the time of his arrival in 1839 he became a regular writer for local Sydney papers such as the *Sydney Morning Herald* and *The Australian*. Though such articles were usually published anonymously, the authorship was widely known amongst the small community of Sydney and his reputation spread as the ablest writer of scientific material for public digestion.

These articles brought his first major public controversy. In January 1847 he was criticised in *The Atlas* for anonymously publishing summary accounts of the travels of Australian explorers such as Leichhardt, Stokes and Eyre, in the *Sydney Morning Herald*. That paper defended his right to anonymity in its editorial of 21 January 1847 and Clarke retaliated with a scathing article entitled *The Intellectual Barrenness of New South Wales*²² in which he bemoaned the Colony's lack of patronage of literature and science in general, and absence of a national identity. He stated:

...an ignorant man can build a fine house, and an ignorant man can possess banknotes or bank-shares....and an ignorant man can do many other things besides, which add to the commercial importance of a community, as well as an instructed man, though the latter, had he the same means, which he often times has not, could do much better, because to the same means and to the same diligence, he could bring the power of knowledge; for the great Bacon tells us – “Knowledge is power!”

Such a cry is just as relevant today as it was in 1847. Clarke then compares New South Wales with America and surmises:

....The Americans have a right to their position as a nation. They exhibit their claims to it in the face of the whole civilized world. It is not their cities and their fleets, and their wars, and their revolution, and their great republican experiment, which renders them remarkable. It is their intellectual superiority. It is, that with all their search after dollars, and their ambitious pursuit after commercial enterprise, they have a feeling that if their country is to maintain its position amidst the contending rivalries of the older nations, it must not be simply by the strong arm, but by the refinement of the mind; by proving themselves worthy of the intellectual as well as the commercial conquests that await them.

His final plea was that:

...there is not one solitary channel in which the interesting facts of scientific enquiry, agricultural experiment, or mechanical ingenuity, can be handed down to our children, registered for reference, or conveyed to other nations as a proof and evidence that this great and ambitious colony has yet been emancipated from convict indifference, or the fumes of rum and tobacco.

This last paragraph explains much of the course followed by Clarke during his remaining years in the Colony. Many of his findings were published in overseas journals, and he constantly strove to maintain the link with the outside scientific community. He undoubtedly saw himself as a rose amongst thorns, working in isolation for the scientific advancement of the Colony. It was left to him to champion the cause of geological science in New South Wales. Such a course would naturally bring him into conflict with overseas commentators on colonial geology and workers such as Stzrelecki, Dana, and J.B. Jukes who published accounts of local geology based on relatively brief visits. Yet despite the setbacks, financial deprivations, ridicule, and widespread indifference, Clarke continued to pursue and promote Australian physical sciences through the mid to late nineteenth century. As an Anglican minister he easily wore the title 'Defender of the Faith', whether that faith was Anglicanism or Geology.

Endnotes

¹ Elena Grainger, *The Remarkable Reverend Clarke - The life and times of the father of Australian geology*, Oxford University Press, Melbourne, 1982, 292p.

² *Sydney Morning Herald*, 16 April 1849.

³ T. G. Vallance, 'The Fuss about Coal', in D.J. & S.G.M. Carr (editors), *Plants and Man in Australia*, Academic Press, Sydney, 1981, 136-176.

⁴ Manuscript map of the Illawarra district, c.1840, by J.D. Dana. Refer H.J. Viola & C. Margolis, *Magnificent Voyages*, Smithsonian Institute, Washington, 1985, 97.

⁵ *Sydney Morning Herald*, 27 June 1842.

⁶ J.B. Jukes, Notes on the Palaeozoic Formations of New South Wales and Van Dieman's Land, *Quarterly Journal of the Geological Society of London*, London, 1847, volume III, 240-249. This paper was partially based on discussions and excursions with W.B. Clarke.

⁷ *Sydney Morning Herald*, 3 April 1846.

⁸ W.B. Clarke, Genera and Distribution of Plants in the Carboniferous System of New South Wales. (16 June 1847), *Quarterly Journal of the Geological Society of London*, London, 1848, volume IV, p.63.

⁹ Frederick McCoy, The Fossil Botany and Zoology of the Rocks associated with the Coal of Australia, *Annals and Magazine of Natural History*, London, 1847, volume XX, Series 1, pp.145-157, 226-236, 298-319.

¹⁰ Refer T.G. Vallance, op cit., p.150. In 1849 J.D. Dana published his study of the geology of New South Wales and associated fossils as J.D. Dana, Geological Observations on New South Wales, in United States Exploring Expedition under the command of Charles Wilkes, U.S.N. Vol. X., Geology, C. Sherman, Philadelphia, 1849, 449-537; plus Appendix 1 - Description of Fossils, Fossils of New South Wales, 681-720 & plates 1-20.

¹¹ Op cit., p.495.

¹² W.B. Clarke, A Communication from the Reverend W.B. Clarke, of Sydney, to His Excellency Sir Henry Barkly, K.C.B., &c., &c., President of the Royal Society of Victoria, on Professor McCoy's "New Toeniopteris" from the Coal-bearing Rocks of the Cape Patterson District in particular, and on the Evidence bearing on the Question of the Age of Australian Coal-beds in general, *Transactions of the Royal Society of Victoria*, Melbourne, 1860, volume V, pp.89-95.

¹³ F. McCoy, A Commentary on "A Communication made by the Rev. W.B. Clarke to His Excellency Sir Henry Barkly, K.C.B., &c., &c., President of the Royal Society of Victoria, on Professor McCoy's new Toeniopteris, &c., &c., *Transactions of the Royal Society of Victoria*, Melbourne, 1860, volume V, pp.96-107.

¹⁴ W.B. Clarke, Remarks on Professor McCoy's Commentary on a new Toeniopteris, &c., *Transactions of the Royal Society of Victoria*, Melbourne, 1860, volume V, pp.209-214.

¹⁵ F. McCoy, Note on the Rev. Mr. Clarke's "Remarks," &c., *Transactions of the Royal Society of Victoria*, Melbourne, 1860, volume V, pp.215-217.

¹⁶ W.B. Clarke, On the Coal Seams at Stony Creek (junction of Singleton and Wollombi roads), West Maitland District, New South Wales, *Transactions of the Royal Society of Victoria*, Melbourne, 1865, volume VI, pp.27-31, plates 1,2. (Read 23 December 1861).

¹⁷ *Annals and Magazine of Natural History*, London, 1862, series 3, volume 9, p.143.

¹⁸ W.B. Clarke, On the Age of the New South Wales Coal-beds, *Annals and Magazine of Natural History*, London, 1862, volume X, pp.81-86.

¹⁹ W.B. Clarke, On the Occurrence and Geological Position of Oil-bearing Deposits in New South Wales, *Quarterly Journal of the Geological Society of London*, London, 1866, volume XXII, p.439-448; *Sydney Morning Herald*, 30 January 1867.

²⁰ L.G. de Konick, *Recherches sur les Fossiles Paleozoiques de la Nouvelle-Galle du Sud*, Memoires de la Societe Royale des Sciences de Leige, 2nd. series, volume II, Hayez, Bruxelles, 1876-77. This work contains descriptions of a fossil collection which W.B. Clarke had sent to England during the early 1860s.

²¹ Ottokar Feismantel, *Palaeozoische und Mesozoische Flora des Ostlichen Australiens*, Palaeontographica, Supp. Bd. III, Lieferung III, Heft 2, 3, 4, Theodor Fischer, Cassel, 1878 & 1879. This work by Feismantel, a member of the Geological Survey of India, was largely based on specimens of fossils and associated data which W.B. Clarke had sent to India in 1876. An English translation was published in Sydney in 1890.

²² *Sydney Morning Herald*, 12 March 1847.