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Australian Stratigraphy and Palaeontology: the nineteenth century French contribution

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Abstract – D'Orbigny and numerous French-speaking geologists studied Australian fossils and contributed to the growth of Australian Stratigraphy. Significant collections were made to 1850 by French expeditions to the Pacific. Experience in France enhanced the Australian geological work of foreigners including P.E. Strzelecki and Ludwig Leichhardt. From 1840, contacts were maintained between Rev. W.B. Clarke and French-speaking palaeontologists, including P.E. de Verneuil and particularly L.E. De Koninck (Belgian), culminating in his classic *Recherches* (1876–1877). Australian Stratigraphy established its essential difference from European with the confirmation of a Late Palaeozoic glaciation in the late 1880s and the development of the Gondwanaland concept. ***To cite this article: D. Branagan, C. R. Palevol 1 (2002) 657–662.*** © 2002 Académie des sciences / Éditions scientifiques et médicales Elsevier SAS

d'Orbigny / French Pacific expeditions / Australian-French collaboration / Late Palaeozoic glaciation

Résumé – Stratigraphie et paléontologie australienne : la contribution française au dix-neuvième siècle. D'Orbigny et nombre de géologues français ont étudié les fossiles australiens et contribué à la stratigraphie australienne. Des collections significatives ont été réunies jusqu'en 1850 par des expéditions françaises dans le Pacifique. Les travaux sur la géologie australienne d'étrangers, comme P.E. Strzelecki et Ludwig Leichhardt, ont été mis en valeur en France. À partir de 1840, des contacts furent maintenus entre le Rév. W.B. Clarke et des paléontologistes français, parmi lesquels P.E. Verneuil et, tout particulièrement, L.E. De Koninck, avec son ouvrage *Recherches* (1876–1877). La stratigraphie australienne s'est essentiellement différenciée de la stratigraphie européenne par la confirmation, à la fin des années 1880, d'une glaciation au Paléozoïque supérieur et le développement du concept de Gondwanaland. ***Pour citer cet article : D. Branagan, C. R. Palevol 1 (2002) 657–662.*** © 2002 Académie des sciences / Éditions scientifiques et médicales Elsevier SAS

d'Orbigny / expéditions françaises dans le Pacifique / collaboration franco-australienne / glaciation du Paléozoïque supérieur

Version abrégée

Alcide d'Orbigny a apporté une contribution unique, mais d'importance, à la paléontologie australienne. Il décrivit les fossiles paléozoïques récoltés lors du « Voyage au pôle Sud » de Dumont d'Urville et collabora avec Jules J.F. Grange à la rédaction du rapport géologique [19] de l'expédition. D'Orbigny fut le premier d'une longue lignée de géologues francophones à avoir étudié les fossiles australiens et contribué à l'essor de la stratigraphie australienne. De nombreuses expéditions françaises (par exemple, celles de La Pérouse, d'Entrecasteaux, Baudin) visitèrent le Pacifique avant 1850 ; ces expéditions étaient équipées « pour faire de la science », ayant à leur bord nombre de savants, qui firent des observations variées et d'importantes collectes. Les rapports de Labillardière, Péron, von Buch, Quoy [7, 23, 28, 29] sont caractéristiques à cet égard. Bien qu'ils ne soient jamais allés en Australie, Lamarck et Cuvier se sont tous deux intéressés aux nouveautés de la géologie australienne et ont commenté des découvertes variées. *Glossopteris browniana*, dont il est prouvé qu'il s'agit de l'un des fossiles clés dans l'étude du Gondwana, a été déterminé et décrit dans les années 1820 par Adolphe Brongniart.

Deux étrangers ayant bénéficié de l'« éducation » française dans les années 1830 sont P.E. Strzelecki et L. Leichhardt, qui ont tous deux apporté des contributions significatives à la

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stratigraphie/paléontologie australienne. Des contacts entre le révérend W.B. Clarke en Australie et différents géologues français ont été entretenus pendant quarante ans. Pendant que P.E. Verneuil réalisait un important travail, la contribution la plus significative était apportée par le Belge L.E. De Koninck [22] par ses descriptions des faunes paléozoïques australiennes. La publication de la traduction de son travail en anglais [16] garantissait sa valeur dans la durée, au moment où la géologie australienne établissait fermement son indépendance, en affirmant des différences significatives d'avec la géologie européenne (ainsi, une glaciation très étendue au Paléozoïque supérieur).

1. Introduction

Alcide d'Orbigny made a single, but useful, contribution to Australian Palaeontology. He described and figured Australian Palaeozoic fossils collected on Dumont d'Urville's *Voyage au pôle Sud* (1837–1840) and assisted Jules J.F. Grange in the geological report of the expedition [19]. Grange, not a member of the expedition, was drafted to write the Geology thanks to the unpopularity of Élie Le Guillou, who had carried out geological work on the expedition, but ran foul of Dumont d'Urville [9]. D'Orbigny's descriptions suggested age determinations from Upper Silurian [present Silurian], through Devonian to Carboniferous. They were later included in the extensive summary publication of Australian Palaeozoic marine fossils by De Koninck [22], perhaps the most influential Australian Palaeontology publication well into the twentieth century, thanks partly to the English translation [16].

Contributions by French, or French-speaking geologists to Australian geology from the late 18th century to 1880 can be found listed in [17, 32].

The names of Lamarck and Cuvier are amongst distinguished French scientists commemorated along the coast of Australia, an acknowledgement of the French contribution to the study of Australia [35]. While these 'great men' commented on Australian matters, they were dependent on the observations and material collected by others. The next section mentions the observers and discusses some of the significant geological work carried out on some French expeditions. The later sections deal with French influences that were significant for some foreigners who were later in Australia, the interplay from the 1840s between long-term Australian residents and French researchers, and ends with brief comments on the development of an 'Australian' Stratigraphy.

2. Some earliest French observations and coal measures

From a stratigraphic viewpoint the significant discovery of the Bruni D'Entrecasteaux expedition (1791–1793), was that of coal-bearing strata at South-East Cape, Tasmania, (Fig. 1) by Jacques J.H. de Labillardière [23]. He called it *Steinkohlengebirge*, the term used by Werner for coal measures lying just above his Transition series. From this time the stratigraphic position of the coal measures of Australia (also discovered at Newcastle, 120 km north of Sydney two years earlier) [5], was regarded by many as the benchmark from which Australian Stratigraphy could be readily expanded through recognition of both younger and older strata. For Europeans the coal measures meant Carboniferous in the emerging stratigraphic succession being worked out in Europe. However, the stratigraphic age of the Australian coal measures provided long-lasting controversy, thanks to the presence of coal of more than one geological period, confusion about fossils, field relationships, and sheer pig-headedness of many of the geologists involved [34]. The coal at South East Cape was Triassic, not Permian as the main coals of New South Wales (and Queensland) eventually proved to be, while Permian coal occurs elsewhere in Tasmania, and Victorian black coals proved to be Jurassic, and enormous deposits of Tertiary brown coals also occur there. By the end of the 19th century, the only coal apparently lacking in Australia was Carboniferous. Thus during the 19th century, geologists in Australia struggled to solve the problem: were the rock successions of Australia equivalent to those in Europe?

3. French expeditions

Four geological aspects of the Baudin Expedition (1800–1804) were (1) aeolian calcareous coastal sandstones, (2) Maria Island, Tasmania, (3) the geology of the Sydney region, and (4) the expedition's rock collection. Lamarck and Cuvier were both interested in evidence of sea level change, or more particularly possible uplift of the coastal limestones (calcareous aeolian sandstones) of the south and southwest coasts. Péron and Flinders [18, 28] both thought the limestone was still forming at present sea-level. Péron was also concerned about the relation of the calcareous sandstones to the adjacent blown sands, and argued that the coastal limestone must be of recent origin because the fauna resembled the present sea fauna. He invoked a

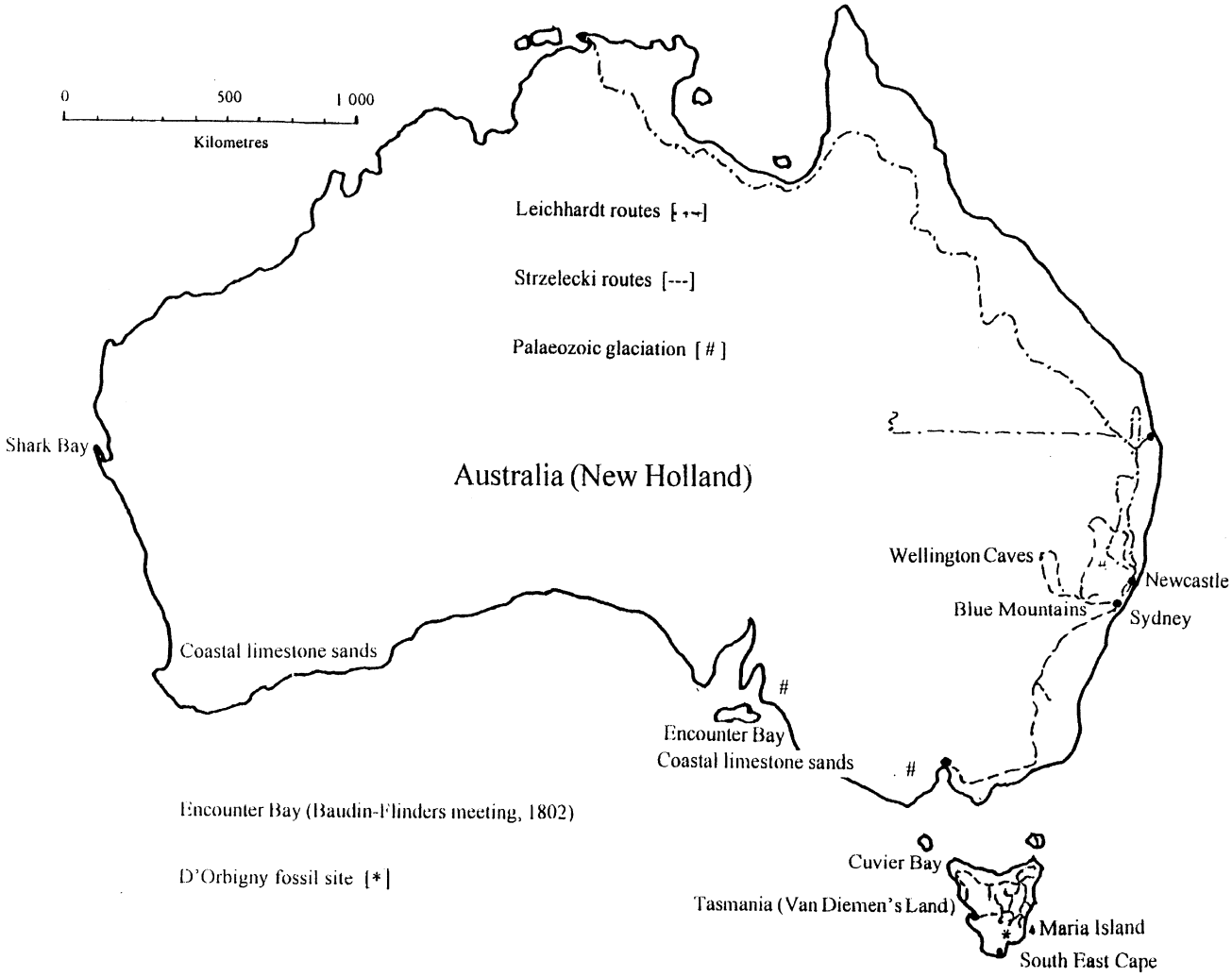

Fig. 1. Map of Australia, showing locations of French geological activities and related matters from the 1790s to 1850.
Carte d'Australie, montrant la localisation des activités géologiques françaises et des travaux associés entre les années 1790 et 1850.
Fig. 1. Carte d'Australie, montrant la localisation des activités géologiques françaises et des travaux associés entre les années 1790 et 1850.

catastrophic event for the uplift. Cuvier was happy to take up the catastrophic idea, but not the resemblance of the present fauna to the previous, which he felt should not be too closely related to the living forms [12]. Lamarck but did not postulate violent action for the uplift, [24] and accepted the evidence of "living fossils" such as Trigonia shells collected by Péron, which Lamarck described.

Péron thought that Maria Island, off the coast of Tasmania, mainly consisted of granitic material. True granite (Péron's "superb" variety) is present, while much of the higher portions of the island consists of Mesozoic dolerite (Péron's "green granite"). He also identified "primitive" and "secondary" sandstone. Péron wrote confidently: "I have overlooked nothing in order to give my observations that generality and correctness, which, until now, I have so rarely yet been able to give to anything that I have done." However, he was ambivalent, writing: "Everything here bears the mark of the world's great upheavals, everything here attests to its great antiquity; everything recalls the painful struggle that it had to carry on against the fury of the waves." He continued: "[There are]...horizontal layers ...[;] they were formerly submerged beneath the waves and have only been exposed as a consequence of that gradual and continued recession of the seas, the obvious signs of which we have found everywhere." [2, 28].

The Sydney Region

C. Bailly and L. Depuch were the first geologically trained visitors to Sydney (1802). The mineralogists were effectively confined to the coastal plain, stretching 50 km west from Port Jackson. They recognised the

two major units: quartzose sandstones (Hawkesbury Sandstone) of the coast and Sydney Harbour overlain by shales (Wianamatta Group), both of Triassic age, the latter containing fossil ferns. They used deductive powers to suggest aspects of the then inaccessible country to the west. In gravel banks in the Nepean River, at the foot of the Blue Mountains, they noted abundant pebbles of "granites, porphyries, gneisses or mica schists" and went on: "The various primitive substances... are found only in the bed of the river (and) one must conclude [....] that the mountains whence it takes its rise are themselves of a primitive nature" [28].

The 796 rocks and minerals collection remained unexamined until 1810, when Leopold von Buch studied them [7]. He hinted that rocks lithologically similar to those found in Europe might not necessarily be of the same age as their European counterparts.

L.D. de Freycinet led the next French Pacific expedition (1817–1820). He "firmly resisted all attempts by the professors at the Museum to burden him with too many naturalists. After a frightful row with Cuvier he succeeded in gaining approval for his own choice; the natural history to be entrusted to two surgeons and one pharmacist", all navy men [20]. One of these was J.R.C. Quoy, who added greatly to the information about the stratigraphy of Sydney and the mountains to the west.

Quoy also described the rocks north of Sydney to Newcastle where coal was being produced. He discussed the character of the coal, "*sans aucun doute d'origine originale*". Quoy noted the close association with the coal seams of "*poudingues d'une grande dureté*", an unusual occurrence in coal measure sequences. The fossil plants in the associated shaly beds were equally worthy of attention. Quoy's description is certainly the best summary of the geology of the Sydney region for that period [29].

Duperrey's expedition (1822–1825), with R.P. Lesson as scientist and artist, gathered 900 rock specimens. Lesson and the then Lt. Dumont d'Urville travelled together west over the Blue Mountains to Bathurst. Lesson felt that the deep valleys below the vertical cliff lines must have required "very great movement to rend so perceptibly this section of the Blue Mountains". Lesson saw the stratigraphic succession as: (1) Granites, quartziferous syenites and pegmatites at the base, outcropping west of the mountains, followed by (2) stratified lignites, with uppermost (3) ferruginous sandstones of the Blue Mountains, suggested as Tertiary. In this last matter, Lesson was misled by the plant fossils in the Triassic sandstones, believing them to show close affinities to the living Eucalyptus flora [25].

4. Fossil plants

Clarification about Australian fossil plants began with Adolphe Brongniart [6] in the 1820s when specimens collected by Robert Brown in 1804 at Newcastle, finally reached him. He called the species *Glossopteris browniana*. This became, in time, an important key in the history of Gondwanaland. But unravelling the stratigraphic and palaeobotanical story was "a long record of controversy, one far from restricted to Australia and one in which many distinguished geologists and palaeobotanists came to be involved. It is a record that revealed the limitations of European experience as the guide to world Stratigraphy and brought to light seeming conflicts between the witness of fossil animals and plants in the contexts of stratigraphic correlation" [7, 33].

5. Foreigners from France to Australia

Two foreigners, Paul Strzelecki, from Poland, Ludwig Leichhardt, from Germany, contributed to Australian Geology, thanks largely to French influences. Strzelecki was in France 1829–1831. He was the first to try to establish broad stratigraphic relations by reconnaissance mapping over a large region of southeastern Australia, initially basing his mapping on the ideas of Léonce Élie de Beaumont, François Beudant and Stanislaw Staszic. Strzelecki modified his work when he returned to England and his fossils were examined by William Lonsdale and John Morris, and Strzelecki adopted some of the newly-emerging stratigraphic concepts then developing in England [3, 5, 31]. Grange took up many points from Strzelecki and reproduced without acknowledgement two of Strzelecki's published cross-sections. Grange described Australian regions previously almost ignored in French writing.

Ludwig Leichhardt, based in France for three years from June 1838, attended many courses, particularly Geology, Botany, and Zoology, at the 'Jardin des Plantes' and elsewhere, explored the geology of the Paris Basin, and travelled through France and Italy. Adolphe Brongniart commissioned him to collect fossil plants from the Newcastle coal measures, as well as specimens of present-day timbers. Leichhardt studied the Triassic and Permian rocks of the Sydney Basin, and recognised the coal measure successions in Queensland. His fate on a journey attempting to cross Australia from east to west in 1848 remains a mystery [1, 4, 5].

6. French contributions in Palaeontology and links with Rev. W.B. Clarke

With the arrival of the long-term resident, the Anglican clergyman Rev. W.B. Clarke, (a student of Sedgwick at Cambridge) in 1839, some systematisation of Australian Stratigraphy began. While Clarke's major interest centred on the Late Palaeozoic and Mesozoic rocks of New South Wales he did some important work in the older, gold-bearing rocks, and also the Tertiary and Quaternary. Over some 40 years, Clarke carried out a wide range of field work. In a sense he remained rooted in European Geology, attempting always to fit his field results to European concepts. His publications show many contacts with French palaeontologists, particularly P. E. de Verneuil, and later the Belgian L.G. De Koninck.

The gold discoveries in the 1850s saw the establishment of official geological surveys in the Australian colonies and led to detailed study of the old gold-bearing rocks [5]. The Irish palaeontologist, Frederick McCoy, another protégé of Sedgwick, also moved to Australia [5]. At that time, the only trained palaeontologist in Australia, McCoy, like Clarke, clung to his European concepts. However, the two migrants held very different ideas about geological evidence, Clarke relying strongly on field relationships, McCoy on laboratory fossil examination. The stubborness of both Clarke and McCoy ensured a controversy that held back Australian Stratigraphy for many years [34]. In 1839, J.D. Dana suspected that the coal sequences in the Sydney Basin were Permian, not Carboniferous, and he reiterated this in his published work ten years later [13]. Dana's published suggestion of the Permian age was anticipated by a 'throwaway' line by De Koninck in 1846, when writing about fossils from Spitzbergen! [21]

During the 1840s, various European palaeontologists, e.g. W. Lonsdale, Jules d'Archiac, J.W. Salter, [17] tried to solve the Australian stratigraphical puzzles. Verneuil [36] recorded fossils from eastern Australia, belonging to "two great stages below the *anthraxifère* period, that of *pourprés* sandstone and that of *calcaires anthraxifères*". John Morris examined some of the fossils collected by Strzelecki [31], and concluded that: "The Palaeozoic series of Australia and Tasmania may be regarded as partly the equivalent of the Devonian and Carboniferous systems of other countries", while d'Archiac [14] wrote: "*Le développement des séries siluriennes et carbonifères dans l'Australie doit y faire soupçonner entre elles un représentant de celle qui vient de nous occuper, mais il ne semble pas qu'elle y ait encore été bien caractérisée par ses fossiles.*"

There was much to-ing and fro-ing about Australian Palaeozoic fossils, with suggestions that some fossils could be anything from Silurian to Carboniferous in age, and that the assemblages of these ages were almost indistinguishable. This was partly due to the lack of detailed stratigraphic mapping, caused by the few geological workers, the vast distances and the lack of good topographic maps. In view of the uncertainty, Clarke sent some 1000 Palaeozoic fossils to De Koninck in the late 1850s. He published his study of this collection in 1876–1877 shortly before Clarke's death [22]. Its subsequent publication in English [16] ensured its continuing value at a time when Australian Geology firmly established its independence with the affirmation of significant differences from European Geology.

Clarke summarised the geology of New South Wales in a Catalogue prepared for the Paris Universal Exhibition in 1867 [10]. His final summary was dedicated to the 'Congress of Geologists' – the first International Geological Congress of 1878 – meeting in Paris. Clarke drew upon a considerable number of French references, in summarising his life's work in Australia [11].

7. Vertebrate Palaeontology and the Diluvium

Finds of fossil bones in red earth deposits at Wellington Caves, New South Wales [5], stirred European interest in Australian Vertebrate Palaeontology. Through Buckland and William Pentland, French palaeontologists were informed of these finds [8, 26, 27]. The relations between the fossil vertebrate faunas and the diluvium concept attracted the attention of many French scientists [17].

8. A defining point

From the 1880s on there are many reviews of Australian Geology recorded in French geological literature, notably in *L'Annuaire géologique universel* [30]. This publication made better known in France the relationships between Australian and Indian Geology in particular, including the Late Palaeozoic glaciation and the Permian coal measures. A defining point in the story of a distinct Australian Stratigraphy was the establishment of this Late Palaeozoic glaciation as a major event. Its acceptance by the international geological community was largely the work of T.W. Edgeworth David [5, 15].

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