https://doi.org/10.24199/j.mmv.1939.11.02 November 1939

Mem. Nat. Mus. Vict., XI, 1939.

GRAPTOLITES OF AUSTRALIA: BIBLIOGRAPHY AND HISTORY OF RESEARCH

By R. A. Keble, F.G.S.
(Palaeontologist, National Museum, Melbourne)
and
Professor W. N. Benson, B.A., D.Sc.
(University of Otago, Dunedin, New Zealand.)

The Australian graptolite fauna is probably the most complete in the world, certainly in regard to its Ordovician components, a fact clearly appreciated by McCoy. He had ready for the press descriptions and figures of most of the species afterwards described in James Hall's Monograph published in 1865, which may be regarded as the basis of systematic graptolite research, when he received from Hall a proof of his figures. McCoy immediately conceded him priority and adopted his specific names. Had Hall delayed sending his proof, McCoy would certainly have published his figures and descriptions and his name would have been just as prominent in the literature of graptolites as Hall's. Commenting on "Graptolites (Didymograpsus) fruticosus (Hall sp.)," McCoy says, "this is the first Victorian graptolite I ever saw, and, as it was then a new species, I had named it in my MSS. after Mr. J. A. Panton, who found it in the soft shales of Bendigo, of which goldfield he was then Warden, and in whose hospitable camp I was then able to recognize the true geological age of the gold-bearing slates of the colony for the first time. The same species was subsequently discovered by Professor Hall in Canada; and as he kindly sent me an early proof of his illustration before publication, I of course adopted his name as above" (Prod. Pal. Vict. I, p. 13, 1874. Melb.). Thus, that well-known species *Tetragraptus fruticosus* J. Hall escaped the specific name *pantoni* McCoy only by months.

The present generation of research workers can scarcely realize the difficulties that confronted the indefatigable pioneers in Australian graptolite research. True, the geologists of the Geological Survey of Victoria collected most of McCoy's specimens, but not all. We find McCoy himself at Bendigo and at other places. Australia was then largely an unsettled country with its ways of communication yet

unopened and the mode of travel either by foot or horse. Bendigo, to refer to it again, may now be reached in a few hours by train or car, but in McCoy's time the journey took three or four days of fatiguing travel. So, too, in T. S. Hall's day, when, although railways made access easier, the difficulties were still formidable. Workers like W. J. Harris and R. A. Keble who have carried on research both before and since the advent of the motor car, can appreciate the difficulties experienced by earlier workers and the enormous advantage modern workers have.

Much of this early work on Australian graptolites has been overlooked, possibly because the literature is difficult of access, and the laborious search for new facts by the pioneers forgotten, for there are few left to tell. It was known to Nicholson, Salter, Lapworth, and other overseas workers, and lest it goes into the limbo of forgotten things, we have taken some trouble to record it.

Abbreviations.

Ann. Mag. Nat. Hist.—The Annals and Magazine of Natural History. London.

Ann. Rep. Dep. Mines, N.S.W.—Annual Report of the Department of Mines of New South Wales. Sydney.

Arkiv f. Zool.—Arkiv för Zoologi utgivet av K. Svenska Vetenskapsakademien. Stockholm.

Aust. Ass. Adv. Sci.—Report of the —— Meeting of the Australasian Association for the Advancement of Science. (New title, Australian and New Zealand Association for the Advancement of Science.) Published in city where meeting is held.

Bul. Geol. Soc. Am.—Bulletin of the Geological Society of America. New York.

Bul. Geol. Surv. Vict.—Bulletin of the Geological Survey of Victoria. Melbourne.

Bul. N.Y. State Mus.—Bulletin of the New York State Museum. Albany.

Fed. Hbk. Brit. Ass. Adv. Sci.—Federal Handbook of the British Association for the Advancement of Science, Melbourne Meeting, 1914. Melbourne.

Geol. Mag.—The Geological Magazine, London.

Geol. Surv. Vict., Map, Q.S.—Geological Survey of Victoria, Geological Map, Quarter Sheet No.—. Melbourne.

Journ. Roy. Soc. N.S.W.—Journal of the Royal Society of New South Wales. Sydney.

Mem. Geol. Soc. Am.—Memoirs of the Geological Society of America. New York.

Mem. Geol. Surv. Vict.—Memoirs of the Geological Survey of Victoria. Melbourne.

Mem. Nat. Mus. Melb.—Memoir of the National Museum. Melbourne.

Mem. N.Y. State Mus.—Memoir of the New York State Museum. Albany.

Min. and Geol. Journ.—Mining and Geological Journal, Department of Mines. Melbourne.

Mon. Pal. Soc.—Monograph of the Palaeontographical Society. London.

Mon. Prog. Rep. Geol. Surv. Vict.—Monthly Progress Report of the Geological Survey of Victoria. Melbourne.
Norsk Geol. Tids.—Norsk Geologisk Tidskrift. Oslo.
Pap. Proc. Roy. Soc. Tas.—Papers and Proceedings of the Royal Society of Tasmania. Hobart.
Phil. Trans. Roy. Soc. London.—Philosophical Transactions of the Royal Society. London.
Proc. Linn. Soc. N.S.W.—Proceedings of the Linnean Society of New South Wales. Sydney.
Proc. Roy. Soc. Vict.—Proceedings of the Royal Society of Victoria. Melbourne.
Prod. Pal. Vict.—Prodromus of the Palaeontology of Victoria. Melbourne.
Prog. Rep. Geol. Surv. Vict.—Progress Report, Geological Survey of Victoria. Melbourne.
Q.J.G.S.—Quarterly Journal of the Geological Society. London.
Rec. Geol. Surv. N.S.W.—Records of the Geological Survey of New South Wales. Sydney.
Rec. Geol. Surv. Vict.—Records of the Geological Survey of Victoria. Melbourne.
Rep. Brit. Ass. Adv. Sci.—Report of the British Association for the Advancement of Science. London.
Summ. Prog. Geol. Surv. G. Brit.—Summary of Progress, Geological Survey of Great Britain. London.
Sver. Geol. Und. Arsbok.—Sveriges Geologiska Undersökning. Arsbok. Stockholm.
Trans. N.Z. Inst.—Transactions and Proceedings of the New Zealand Institute. Wellington.
Trans. Roy. Soc. N.Z.—Transactions and Proceedings of the Royal Society of New Zealand. Wellington.
Vict. Nat.—The Victorian Naturalist. Melbourne.

Bibliography.

1. 1856–1865 Aplin, C. D. H., Geol. Surv. Vict., Maps, Q.S. 1 NW., 2 NW., 2 SW., 6 NW., 6 SW., 7 SE., 10 NW., 10 NE.
2. 1856–1865 Aplin, C. D. H., and Taylor, N., ibid., 6 SE, 7 NE.
3. 1856–1868 Taylor, N., ibid., 5 NW., 5 SW., 13 NE., 51 SW.
4. 1858–1865 Aplin, C. D. H., and Ulrich, G. H. F., ibid., 13 SW., 14 SE., 15 NE.
5. 1858–1865 Daintree, R., ibid., 12 SE.
6. 1861 McCoy, F., On the Ancient and Recent Natural History of Victoria. Catalogue of the Victorian Exhibition, 1861, pp. 159-174. 8vo. Melbourne.
7. 1861 Daintree, R., and Wilkinson, C. S., Geol. Surv. Vict., Map, Q.S. 12 NE.
8. 1862 McCoy, F., Notes on the Ancient and Recent Natural History of Victoria, Ann. Mag. Nat. Hist., ix (3), pp. 137-140.
9. 1863 Salter, J. W., Note on the Skiddaw Slate Fossils, Q.J.G.S., xix, (I), pp. 135-140.
10. 1865 Wilkinson, C. S., and Murray, R. A. F., Geol. Surv. Vict., Map, Q.S. 19 SW.

11. 1867 McCoy, F., On the Recent Zoology and Palaeontology of Victoria, Ann. Mag. Nat. Hist., xx (3), pp. 199-201.
12. 1872 Nicholson, H. A., Migrations of the Graptolites, Q.J.G.S., xxviii, (III), pp. 217-232.
13. 1874 Etheridge Jun., R., Observations on a Few Graptolites from the Lower Silurian Rocks of Victoria, Australia. Ann. Mag. Nat. Hist., xiv (4), pp. 1-10, pl. iii.
14. 1874 McCoy, F., Prod. Pal. Vict., Dec. 1, pp. 5-20, pl. i, ii.
15. 1875 Hopkinson, J., and Lapworth, C., Description of Graptolites from the Arenig and Llandeilo Rocks of St. David's. Q.J.G.S., xxxi, pp. 631-672, particularly p. 637.
16. 1875 McCoy, F., Prod. Pal. Vict., Dec. II, pp. 29-37, pl. xx. Melbourne.
17. 1876 McCoy, F., On a New Victorian Graptolite. Ann. Mag. Nat. Hist., xviii, (4), pp. 128-130 fig.
18. 1877 McCoy, F., Prod. Pal. Vict., Dec. V, pp. 39-41, pl. l. Melbourne.
19. 1878 Etheridge Jun., R., A Catalogue of Australian Fossils, pp. 4-10. 8vo. Cambridge.
20. 1885 Herrmann, O., On the Distribution of the Graptolithidae in Time and Space. Geol. Mag. iii, (II), pp. 406-412.
21. 1886 Herrmann, O., On the Graptolite Family Dichograptidae, Lapw., ibid. iii (III), pp. 13-26, 9 fig.
22. 1887 Murray, R. A. F., Geology and Physical Geography, p. 42. 8vo. Melbourne.
23. 1892 Pritchard, G. B., On a New Species of Graptolithidae (*Temnograptus magnificus*). Proc. Roy. Soc. Vict., (n.s.), iv, (I), pp. 56-58, pl. vi.
24. 1892 Hall, T. S., On a New Species of Dictyonema, ibid., pp. 7, 8, pl. i, ii.
25. 1893 Hall, T. S., Note on the Distribution of the Graptolitidae in the Rocks of Castlemaine. Aust. Ass. Adv. Sci., v, pp. 374-5. Adelaide.
26. 1894 Hall, T. S., Some References to Literature Dealing with Graptolites, Vict. Nat., xi, pp. 78-79.
27. 1895 Pritchard, G. B., Notes on Some Lancefieldian Graptolites. Proc. Roy. Soc. Vict., (n.s.), vii, pp. 27-30.
28. 1895 Hall, T. S., The Geology of Castlemaine, with a Subdivision of Part of the Lower Silurian Rocks of Victoria, ibid., pp. 55-88, map.
29. 1896 Hall, T. S., Notes on *Didymograptus caduceus* Salter, with Remarks on its Synonymy, ibid., viii, pp. 69-73.
30. 1897 Hall, T. S., On the Occurrence of Graptolites in North-Eastern Victoria, ibid., ix, pp. 183-186.
31. 1897 Hall, T. S., Victorian Graptolites, Part I, ibid., x, (I), pp. 13-16.
32. 1897 Hall, T. S., Appendix to the Geology of Coimadai, Part II, by G. Officer and E. G. Hogg, ibid., x, (2), pp. 202-3.
33. 1897 Roemer, F., and Frech, F., Lethaea Geognostica, I, Lethaea Palaeozoica, (3), Graptolithiden, pp. 584-668. Stuttgart.
34. 1897 Dun, W. S., The Occurrence of Lower Silurian Graptolites in New South Wales, Rec. Geol. Surv. N.S.W., v, (3), pp. 124-127.
35. 1898 Dun, W. S., The Occurrence of Graptolites in the Peak Hill District, ibid., v, (4), p. 183.

36. 1898 Hall, T. S., An Examination of the Tasmanian Graptolite Record, Aust. Ass. Adv. Sci., vii, pp. 401-402. Sydney.
37. 1898 Hall, T. S., Report on Graptolites, Prog. Rep. Geol. Surv. Vict., ix, pp. 126-128.
38. 1899 Hall, T. S., Report on the Graptolites of the Dart River and Cravensville District, Mon. Prog. Rep. Geol. Surv. Vict., 6 and 7, pp. 13-14.
39. 1899 Hall, T. S., Victorian Graptolites: Part II, The Graptolites of the Lancefield Beds, Proc. Roy. Soc. Vict., (n.s.), xi. (2), pp. 164-178, pl. xvii-xix; reprinted in Mon. Prog. Rep. Geol. Surv. Vict., 6 and 7, pp. 13-14. Melb.
40. 1899 Hall, T. S., The Graptolite-bearing Rocks of Victoria, Australia, Geol. Mag., iv, (VI), pp. 439-451, pl. xxii, 3 fig.
41. 1900 Dun, W. S., Ann. Rep. for 1899, Dep. Mines, N.S.W., p. 207.
42. 1900 Hall, T. S., On a Collection of Graptolites from Mandurama, Rec. Geol. Surv. N.S.W., vii, pp. 16-17, pl. vi.
43. 1902 Hall, T. S., The Possibility of Detailed Correlation of Australian Formations with those of the Northern Hemisphere, Aust. Ass. Adv. Sci., ix, pp. 176-177. Hobart.
44. 1900 Ruedemann, R., Note on the Growth and Development of *Goniograptus thureaui* McCoy, Bull. N.Y. State Mus., 52, (6), 19 fig.
45. 1900 Hall, T. S., On the Occurrence of Monograptus in New South Wales, Proc. Linn. Soc. N.S.W., xxvii, pp. 654-655, fig.
46. 1900 Hall, T. S., Reports on Graptolites, Rec. Geol. Surv. Vict., i, (I), pp. 33-35, 2 fig.
47. 1900 Hall, T. S., The Graptolites of New South Wales, in the Collections of the Geological Survey, Rec. Geol. Surv. N.S.W., vii, pp. 49-59, pl. xii-xiv.
48. 1900 Hall, T. S., Evidence of Graptolites in Tasmania, Pap. Proc. Roy. Soc. Tas., 1902, pp. 16, 17.
49. 1903 Elles, G. L., and Wood, E. M. R., British Graptolites, Part III, Mon. Pal. Soc., lvii, pp. xliv, xlv.
50. 1904 Ruedemann, R., Graptolites of New York, Mem. N.Y. State Mus., 7, pp. 743-746.
51. 1904 Hall, T. S., Reports on Graptolites, Rec. Geol. Surv. Vict., i, (3), pp. 217-221, 2 fig. Melbourne.
52. 1905 Hall, T. S., Victorian Graptolites, Part III, from near Mount Wellington, Proc. Roy. Soc. Vict. (n.s.), xviii, (1), pp. 20-24, pl. vi.
53. 1906 Hall, T. S., Reports on Graptolites, Rec. Geol. Surv. Vict., i, (4), pp. 266-278, pl. xxxiv, fig.
54. 1906 Elles, G. L., and Wood, E. M. R., British Graptolites, Part V, Mon. Pal. Soc. lx, pp. lxxxiv, lxxxvii.
55. 1907 Elles, G. L., and Wood, E. M. R., British Graptolites, Part VI, ibid., pp. cxi, cxviii, cxix.
56. 1907 Hall, T. S., Reports on Graptolites, Rec. Geol. Surv. Vict., ii, (I), pp. 63-66.
57. 1907 Hall, T. S., Reports on Graptolites, ibid., ii, (2), pp. 137-143, pl. xv.
58. 1907 Skeats, E. W., Notes on the Geology of Moorooduc, in the Mornington Peninsula, Proc. Roy. Soc. Vict. (n.s.), xx, (2), pp. 89-103, map.

59. 1908 Hall, T. S., Reports on Graptolites, Rec. Geol. Surv. Vict., ii, (4), pp. 221-227.
60. 1908 Elles, G. L., and Wood, E. M. R., British Graptolites, Part VII, Mon. Pal. Soc., lxii, pp. cxxvii, cxxxi, cxli, cxlv, cxlvii.
61. 1908 Hart, T. S., The Graptolite Beds of Daylesford, Proc. Roy. Soc. Vict., (n.s.), xxi, pp. 270-284, pl. xii.
62. 1908 David, T. W. E., Geological Notes on Kosciusko, Proc. Linn. Soc. N.S.W., xxxiii, p. 659.
63. 1909 Hall, T. S., On a Collection of Graptolites from Tallong, New South Wales, Rec. Geol. Surv. N.S.W., viii, (4), pp. 339-341, pl. 55.
64. 1909 Hall, T. S., Recent Advances in our Knowledge of Victorian Graptolites, Aust. Ass. Adv. Sci., xii, pp. 318-320. Brisbane.
65. 1909 Woolnough, W. G., The Geology of Marulan and Tallong, N.S.W., Proc. Linn. Soc. N.S.W., xxxiv, pp. 782-808.
66. 1909 Laseron, C. F., Exhibit of Graptolites from near Cooma, New South Wales, ibid., p. 118.
67. 1910 Chapman, F., A Synopsis of the Silurian Fossils of South Yarra and the Yarra Improvement Works, Vict. Nat., xxvii, p. 65.
68. 1911 Ruedemann, R., Stratigraphic Significance of the Wide Distribution of the Graptolites, Bull. Geol. Soc. Am., 22, pp. 231-237.
69. 1912 Hall, T. S., The Ages of the Rocks at Marong and Dunolly, Rec. Geol. Surv. Vict., iii, (2), pp. 185-188.
70. 1912 Hall, T. S., Reports on Graptolites, ibid., pp. 188-211, pl. xxvi.
71. 1913 Chapman, F., Palaeontology of the Silurian of Victoria, Aust. Ass. Adv. Sci., xiv, pp. 207-236, Melbourne.
72. 1913 Howitt, A. M., Geol. Surv. Vict., Map, Q.S.42b, SW.
73. 1913 Ruedemann, R., Graptolitoidea: in Text-book of Palaeontology by K. A. Zittel, trans. by C. R. Eastman, p. 133. 8vo. London.
74. 1913 Junner, N. R., General and Mining Geology of the Diamond Creek Area, Proc. Roy. Soc. Vict., (n.s.), xxv, (2), pp. 323-353, pl. xxv, xxvi.
75. 1914 Browne, W. R., The Geology of the Cooma District, New South Wales, Journ. Roy. Soc. N.S.W., xlviii, pp. 172-222, 2 fig.
76. 1914 Hall, T. S., Victorian Graptolites, Part IV; Some New or Little-known Species, Proc. Roy. Soc. Vict. (n.s.), xxvii, (1), pp. 104-118, pl. xvii, xviii, 7 fig.
77. 1914 Hall, T. S., Reports on Graptolites, Rec. Geol. Surv. Vict., iii, (3), pp. 290-300.
78. 1914 Hall, T. S., Australian Graptolites, Fed. Hbk. Brit. Ass. Adv. Sci., pp. 290-291.
79. 1914 Chapman, F., Australasian Fossils, pp. 63, 123-130, 3 fig. 8vo. Melbourne.
80. 1915 Hall, T. S., Victorian Graptolites, Rep. Brit. Ass. Adv. Sci., p. 359.
81. 1916 Harris, W. J., The Palaeontological Sequence of the Lower Ordovician Rocks of the Castlemaine District, Part I, Proc. Roy. Soc. Vict., (n.s.), xlix, pp. 50-74, pl. i, map.

82. 1918 Chapman, F., On Some Hydroid Remains of Lower Palaeozoic Age from Monegeeta, near Lancefield, ibid., xxxi, (2), pp. 388-393, pl. xix, xx.

83. 1919 Teale, E. O., The Diabases and Associated Rocks of the Howqua River near Mansfield, with reference to the Heathcotian Problem in Victoria, ibid., xxxii, (1), pp. 33-66, pl. iv, 4 fig., map.

84. 1919 Teale, E. O., A Contribution to the Palaeozoic Geology of Victoria with Special Reference to the Districts of Mount Wellington and Nowa Nowa respectively, ibid., pp. 67-146, pl. vi-ix, 18 fig., map.

85. 1919 Chapman, F., and Skeats, E. W., On the Discovery of Fossil Hydroid Remains of the Older Calyptoblastea in the Palaeozoic of Victoria, Geol. Mag. vi, (VI), p. 550, pl. xv.

86. 1920 Hall, T. S., On a Further Collection of Graptolites from Tolwong (cf. 63, 159), Rec. Geol. Surv. N.S.W., ix, (2), pp. 63-66.

87. 1920 Keble, R. A., Some Subzonal Forms of the Lower Bendigo and Upper Lancefield Zones, Rec. Geol. Surv. Vict., iv, (2), pp. 195-202, pl. xxxiii, xxxiv, 4 fig.

88. 1920 James, A. V. G., The Physiography and Geology of the Bulla-Sydenham Area, Proc. Roy. Soc. Vict. (n.s.), xxxii, (2), pp. 323-349, pl. xxxii-xxxiv, 2 fig.

89. 1921 Harper, L. F., Note on the Occurrence of Graptolite-bearing Beds of Ordovician Age at Yalgogrin and Ariah Park, Rec. Geol. Surv. N.S.W., x, (1), pp. 78-81.

90. 1921 Harris, W. J., and Crawford, W., The Relationships of the Sedimentary Rocks of the Gisborne District, Victoria, Proc. Roy. Soc. Vict. (n.s.), xxxiii, pp. 39-78, 3 fig., map.

91. 1923 Hall, T. S., Report on Graptolites from Main Cut, Phosphate Hill, Mansfield, Bul. Geol. Surv. Vict., 46, p. 45.

92. 1923 Keble, R. A., Report on Graptolites Occurring with the Upper Cambrian Fauna at Loyola, Mansfield, ibid., p. 46.

93. 1923 Herman, H., Structure of the Bendigo Goldfield, ibid., 47, particularly pp. 10-11, maps, table.

94. 1923 Whitelaw, H. S., and Baragwanath, W., The Daylesford Goldfield, Bul. Geol. Surv. Vict., 42, pp. 1-64.

95. 1923 Summers, H. S., The Geology of Bacchus March and Coimadai District, Proc. Pan-Pacific Science Congress (Australia), ii, pp. 1632-1648, particularly p. 1638, list. 8vo. Melbourne.

96. 1923 Summers, H. S., The Geology of Mount Macedon and Woodend Area, ibid., pp. 1654-1663, particularly p. 1656, list.

97. 1923 Skeats, E. W., On the Cambrian (Heathcotian) and Lower Ordovician Rocks of the Lancefield and Romsey District, ibid., pp. 1664-1673, particularly pp. 1669, 1670, 1673, lists.

98. 1924 Harris, W. J., Victorian Graptolites, New Series, Part I, Proc. Roy. Soc. Vict., (n.s.), xxxvi, pp. 92-106, pl. vii, viii.

99. 1924 Chapman, F., On the Question of the Devonian Age of the Tanjilian Fauna and Flora of Victoria, Aust. Ass. Adv. Sci., xvii, p. 313-318. Adelaide.

100. 1925 Kenny, J. P. L., Bright, Wandiligong, and Freeburgh Goldfields. Bul. Geol. Surv. Vict., 44, p. 6.

101. 1925 Keble, R. A., Report on Graptolites, Rec. Geol. Surv. Vict., iv, (4), pp. 479-481, pl. vii, viii.

102. 1925 Keble, R. A., and Harris, W. J., Graptolites from Mt. Eastern (corr. Easton), ibid., iv (4), pp. 507-516, pl. 69, 71, 5 fig., map.

103. 1925 Bulman, O. M. B., British Dendroid Graptolites, Part I, Mon. Pal. Soc., lxxix, p. 7.

104. 1925 Baragwanath, W., The Aberfeldy District, Gippsland, Mem. Geol. Surv. Vict., 15, pp. 19-22, 11 fig., pl. i-xix.

105. 1926 Harris, W. J., Victorian Graptolites, New Series, Part II, Proc. Roy. Soc. Vict., (n.s.), xxxviii, pp. 55-61, pl. i, ii.

106. 1926 Bulman, O. M. B., British Dendroid Graptolites, Part II, Mon. Pal. Soc. lxxx, pp. vi, vii, x, xii, xv, xvi, xix, xx, xxiii, xxxi, 29-64, pl. iii-vi, fig. 19.

107. 1927 Jones, O. A., Silurian Graptolites from Studley Park, Melbourne, Geol. Mag., vii, (IV), pp. 101-105, pl. 5.

108. 1928 Keble, R. A., Tasmanian Graptolite Record, Pap. Proc. Roy. Soc. Tasmania, pp. 69-71.

109. 1928 Harris, W. J., and Keble, R. A., The Staurograptus Bed of Victoria, Proc. Roy. Soc. Vict., (n.s.), xl, (2), pp. 91-95, pl. ix.

110. 1928 Skeats, E. W., The Stratigraphical and Structural Relations of the Silurian Rocks of the Walhalla-Woods Point District, Victoria, in Relation to the "Tanjilian" Series, Aust. Ass. Adv. Sci., xix, pp. 219-230, 6 fig.

111. 1929 Keble, R. A., and Benson, W. N., Ordovician Graptolites of North-west Nelson, Trans. N.Z. Inst. xlix, pp. 840-863, pl. civ-cvii.

112. 1929 Bulman, O. M. B., The Genotypes of the Genera of Graptolites, Ann. Mag. Nat. Hist., 10 (4), pp. 169-185.

113. 1929 Skeats, E. W., The Devonian and Older Palaeozoic Rocks of the Tabberabbera District, North Gippsland, Victoria, Proc. Roy. Soc. Vict., (n.s.), xli, (2), pp. 97-120, pl. xv.

114. 1930 Harris, W. J., and Keble, R. A., A Collection of Graptolites from the Federal Territory, ibid., xlii, (I), pp. 27-29, fig.

115. 1930 Dun, W. S., Ann. Rept. Dep. Mines, N.S.W., p. 76.

116. 1931 Browne, W. R., Exhibit of a Graptolite from Cooma, Journ. Roy. Soc. N.S.W., lxi, Geol. Sec., p. xliv.

117. 1931 Bulman, O. M. B., South American Graptolites, Arkiv f. Zool., 22A, No. 3, pp. i-iii, pl. 1-12, 41 fig.

118. 1932 David, T. W. E., Explanatory Notes to Accompany a New Geological Map of the Commonwealth of Australia, pp. 38-48, tables, fig. 8vo. Sydney.

119. 1932 Elles, G. L., Correlation Table of Australian and extra-Australian Graptolite Zones, ibid., opp. p. 41.

120. 1932 Keble, R. A., Zones and Sub-zones of the Lower Ordovician, Victoria, ibid., pp. 41-43.

121. 1932 Harris, W. J., and Keble, R. A., Victorian Graptolite Zones with Correlations and Descriptions of Species, Proc. Roy. Soc. Vict., (n.s.), xliv, (1), pp. 25-48, pl. iii-vi, 5 fig.

122. 1932 Ripper, E. A., Distribution of the Zones of the Castlemaine and Darriwil Series near Ingliston, ibid., xliv, (2), pp. 200-211, pl. xx, fig.

123. 1932 Thomas, D. E., The Kerrie Series and Associated Rocks, ibid., pp. 257-288, pl. xxiii, 6 fig.

124. 1932 Bulman, O. M. B., British Dendroid Graptolites, Part III, Mon. Pal. Soc., lxxxvi, pp. xxxiv, lii, lvii, 65-92.

125. 1933 Elles, G. L., The Lower Ordovician Graptolite Faunas, with Special Reference to the Skiddaw Slates, Summ. Prog., Geol. Surv. G. Brit. for 1932, ii, pp. 94-111, particularly p. 108.
126. 1933 Thomas, D. E., and Keble, R. A., The Ordovician and Silurian Rocks of the Bulla-Sunbury Area and Discussion of the Sequence in the Melbourne Area, Proc. Roy. Soc. Vict., (n.s.), xlv, (2), pp. 33-84, 7 fig.
127. 1933 Harris, W. J., *Isograptus caduceus* and its Allies in Victoria, ibid., xlvi, (I), pp. 79-114, pl. vi, 8 fig.
128. 1933 Keble, R. A., Middle Silurian Land Plants, Vict. Nat., xlix, pp. 293-296. pl.
129. 1934 Harris, W. J., and Thomas, D. E., The Geological Structure of the Lower Ordovician Rocks of Eastern Talbot, Victoria, Proc. Roy. Soc. Vict., (n.s.), xlvi, pp. 153-178, 2 maps, sec.
130. 1934 Harris, W. J., The Eastern Boundary of the Bendigo Goldfield, ibid., pp. 200-206, 2 fig.
131. 1934 Keble, R. A., and Harris, W. J., Graptolites of Victoria: New Species and Additional Records, Mem. Nat. Mus., Melb., 8, pp. 166-183, pl. xx-xxii, 7 fig.
132. 1934 Sherrard, K., Exhibit of Graptolites from the Parish of Derrengullen, New South Wales, Journ. Roy. Soc. N.S.W., lxviii, (2), p. xlviii.
133. 1934 Ruedemann, R., Palaeozoic Plankton of North America, Mem. Geol. Soc. Am., 2, pp. 1-106, pl. 1-26, 6 fig.
134. 1935 Harris, W. J., and Thomas, D. E., Victorian Graptolites (New Series), Proc. Roy. Soc. Vict., (n.s.), xlvii, (2), pp. 288-313, 3 fig.
135. 1935 Thomas, D. E., Ordovician, in Outlines of the Physiography and Geology of Victoria, Aust. Ass. Adv. Sci., Handbook for Victoria, pp. 96-105. 8vo. Melbourne.
136. 1935 Chapman, F., and Thomas, D. E., Silurian, ibid., pp. 106-110.
137. 1935 Thomas, D. E., The Muckleford Fault in the Guildford-Strangways Area (near Castlemaine, Victoria), Proc. Roy. Soc. Vict., (n.s.), xlvii, (2), pp. 213-224, fig., map.
138. 1935 Harris, W. J., The Graptolite Succession of Bendigo East with Suggested Zoning, ibid., pp. 314-337, 3 fig.
139. 1935 Elles, G. L., in Lang, W. H., and Cookson, I. C., On a Flora including Vascular Land Plants, associated with *Monograptus,* in Rocks of Silurian Age, from Victoria, Australia, Phil. Trans. Roy. Soc. Lond., 224, pp. 421-449, particularly p. 422, pl. 29-32.
140. 1935 Cookson, I. C., On Plant Remains from the Silurian of Victoria, Australia, ibid., 225, pp. 127-148, particularly pp. 127-129, pl. 10-11.
141. 1935 Naylor, G. F. K., Note on the Geology of the Goulburn District with Special Reference to Palaeozoic Stratigraphy, Journ. Roy. Soc. N.S.W., lxix, (I), pp. 75-85, pl. iii, 3 fig.
142. 1935 Benson, W. N., and Keble, R. A., The Geology of the Regions adjacent to Preservation and Chalky Inlets, Fiordland, New Zealand, Part IV, Trans. Roy. Soc. N.Z., 65, pp. 244-294, 4 fig., pl. 30-33.
143. 1935 Naylor, G. F. K., The Palaeozoic Sediments near Bungonia: their Field Relations and Graptolite Fauna, Journ. Roy. Soc. N.S.W., lxix (II), pp. 123-134, 3 fig.
144. 1936 Keble, R. A., Graptolites of Victoria: A Lower Ordovician

Monograptus from Bendigo, Mem. Nat. Mus., Melb., x, pp. 119-120, pl. xvii.

145. 1936 Bulman, O. M. B., On the Graptolites Prepared by Holm, Part VII, Arkiv f. Zool., 28A, No. 17, pp. 1-107, pl. 1-4, 30 fig.

146. 1936 Bulman, O. M. B., The Structure of *Oncograptus* T. S. Hall, Geol. Mag., lxxiii, pp. 271-8, 5 fig.

147. 1936 Chapman, F., and Thomas, D. E., The Cambrian Hydroida of the Heathcote and Monegeeta Districts, Proc. Roy. Soc Vict., (n.s.), xlviii, (2), pp. 193-212, pl. xiv-xvii. Melbourne.

148. 1937 Ekström, Gunnar, Upper Didymograptus Shale in Scania, Sver. Geol. Und. Arsbok, 30, No. 10, pp. 1-53, pl. i-xii, 3 fig. Stockholm.

149. 1937 Monsen, Astrid, Die Graptolithenfauna im Unteren Didymograptusschiefer (Phyllograptusschiefer), Norwegens, Norsk Geol. Tids., xvi, pp. 57-266, 2 fig., pl. i-xx.

150. 1937 Sherrard, K., and Keble, R. A., The Occurrence of Graptolites near Yass, New South Wales, Proc. Linn. Soc. N.S.W., lxii, pp. 303-314, pl. xv, fig. 23, map, sec., table.

151. 1937 Ripper, E. A., A Note on the Occurrence of *Didymograptus protobifidus* Elles in the Lower Ordovician of Victoria, Proc. Roy. Soc. Vict., (n.s.), xlix, (2), pp. 153-164, 17 fig.

152. 1937 Naylor, G. F. K., A Preliminary Note on the Occurrence of Palaeozoic Strata near Taralga, New South Wales, Journ. Roy. Soc. N.S.W., lxxi, pp. 45-53.

153. 1937 Thomas, D. E., Some Notes on the Silurian Rocks of the Heathcote Area, Min. and Geol. Journ., i, (I), pp. 64-67, fig.

154. 1937 Harris, W. J., and Thomas, D. E., Victorian Graptolites (New Series), Part IV, ibid., pp. 69-79, pl. i, ii.

155. 1938 Harris, W. J., and Thomas, D. E., Victorian Graptolites, Part V, ibid., i, (2), pp. 70-81, pl. i-iv.

156. 1938 Harris, W. J., and Thomas, D. E., Notes on the Geology of the Howqua Valley, ibid., pp. 81-84, fig.

157. 1938 Harris, W. J., and Thomas, D. E., A Revised Classification and Correlation of the Ordovician Graptolite Beds of Victoria, ibid., i, (3), pp. 62-72, pl. 1-3, tables.

158. 1938 Bulman, O. M. B., Graptolithina, in Schindewolf Handbuch Palaeozoologie Leiferung 2 (Bd. 2 D). Berlin.

159. 1939 Naylor, G. F. K., Graptolites of the Goulburn District, New South Wales, Part I, Some Forms and Localities, Journ. Roy. Soc. N.S.W., lxxii, pp. 129-135.

Authors' Publication Number in Bibliography.

History of Research.

First Period: 1856-1892.

In the following pages, numbers enclosed in brackets refer to works listed in the Bibliography. Only those papers that have contributed in some way to our knowledge of Australian graptolites are reviewed in this History of Research.

1856-1865.—The first Australian graptolites were collected by C. D. H. Aplin, N. Taylor, G. F. H. Ulrich, R. Daintree, C. S. Wilkinson, and R. A. F. Murray, Field Geologists of the Geological Survey of Victoria. The identification of these, which appear on their Quarter Sheets (1, 2, 3, 4, 5, 7, and 10), were made by Frederick McCoy, who was appointed Palaeontologist to the Geological Survey in 1856.

1861.—In an essay "On the Ancient and Recent Natural History of Victoria," McCoy (6) summarized his identifications made for the field geologists. He recorded from Victoria *Diplograpsus pristis, D. mucronatus, D. rectangularis, D. ramosus, D. folium, D. bicornis, D. ovatus, Phyllo-*

graptus typus, Didymograpsus serratulus, D. caduceus, D. furcatus, Graptolites gracilis, G. logani, G. quadribrachiatus, G. octobrachiatus, G. ludensis, G. tenuis, G. latus and *G. sagittarius,* forms common to both Europe and America.

1862.—McCoy (8) published the foregoing list in the *Annals and Magazine of Natural History* in anticipation of the specimens being exhibited at the Intercolonial Exhibition to be held in London the following year.

1863.—Salter (9) referred to "a remarkable coincidence even to minutae" in the graptolites from Victoria displayed by McCoy at the Intercolonial Exhibition with those of the Skiddaw Slates, remarking that "they agreed genus for genus, and almost specifically, with the North-of-England forms." He inferred that "there is a peculiar zone or horizon of the Llandeilo rocks of which these genera of graptolites are characteristic." In his list of graptolites from the Skiddaw Slates, he referred to a form as "*Didymograptus* sp. like *G. pantoni* McCoy." He concluded by naming this form *D. v-fractus* and it is specifically distinct from *D. pantoni* (cf. 14).

1867.—McCoy (11) stated that "all the slates containing gold-bearing veins in Victoria were identical in age and character with those in North Wales in which the Romans worked the gold-mines of Gogofau." The majority of the graptolites found in Victoria are found in the Welsh Llandeilo Flags, the Cumberland and the Scotch Shales, and almost all those identified by J. Hall from Canada occur in Victoria. He added *Diplograpsus palmeus* (Barrande), *D. bryonoides* and *D. nitidus* to the list of Victorian forms and stated that "on the upper end of many specimens of *D. palmeus* there is a large, smooth, pear-shaped or heart-shaped appendage which he believed to be an ovarian vesicle."

1872.—Nicholson (12) referred to Australia "in which some of the peculiar genera of the Skiddaw and Quebec groups have been discovered. Here we are compelled to assume that we have a case of migration, though we have at present no data whereby to decide whether the course of migration was from Canada to Australia (as is most probable), or vice versa."

1874.—Etheridge (13) either figured or recorded eleven species from Victoria, nine of which McCoy had previously recorded and two that McCoy had exhibited at the Intercolonial Exhibition as *Didymograptus (?) fruticosus* J. Hall and *D. pantoni* (?) MSS. McCoy (14) described and figured ten species, viz.: *Phyllograptus folium* (His.) var. *typus*

(Hall), *Diplograpsus mucronatus* (J. Hall sp.), *D. pristis* (His. sp.), *D. rectangularis* (McCoy), *D. (Climacograptus) bicornis* (J. Hall), *Graptolites (Didymograptus) fruticosus* (J. Hall sp.), *G. (D.) bryonoides* (J. Hall sp.), *G. (D.) octobrachiatus* (J. Hall sp.), and *G. (D.) logani* (J. Hall) var. *australis* nov.

J. Hall described and figured *Tetragraptus fruticosus* in 1857. McCoy states (loc. cit.) that he had previously named it in manuscript *"pantoni,"* but as Hall had forwarded proofs of a manuscript in which the specific name *"fruticosus"* was used, he adopted it. Both Hall and McCoy describe and figure the three-branched and four-branched forms, but not the two-branched form. Etheridge (13) figures the two-branched under the name of *Didymograptus pantoni* (?) which, being both generically and taxonomically in order, must receive priority.

1875.—Hopkinson and Lapworth (15) drew attention to the fact that species characteristic of the Middle Arenig of St. David's, Wales, occur in Australia.

McCoy (16) figured and described seven species, viz.: *Graptolites (Didymograpsus) extensus* (J. Hall), *G. (D.) caduceus* (Salter), *Diplograpsus palmeus* (Barr. sp.), *Cladograpsus ramosus* (J. Hall sp.), *C. furcatus* (J. Hall sp.), *Graptolites (Didymograpsus) gracilis* (J. Hall), *Retiolites australis* sp. nov.

1876.—McCoy (17) described and figured *Didymograpsus thureaui.* He suggested the genus *"Goniograptus"* for such forms in which the "branches of the funicle (for which he introduced the name stolons) are angularly bent at the points of budding into celluliferous stems." He thus distinguished between monopodial and dichotomous branching.

1877.—McCoy (18) again described and figured *Graptolites (Didymograpsus) thureaui* (cf. 17), also *G. (D.) headi* (Hall).

1879.—Etheridge (19), in his catalogue of Australian fossils, included all the Victorian graptolites hitherto identified by McCoy except *Goniograptus thureaui* and systematized the somewhat confused taxonomy.

1885, 1886.—Herrmann (20, 21) commented on the cosmopolitan distribution of the graptolites, pointing out that they are found in three continents, viz. Europe, America, and Australia. He referred to the researches of McCoy and Etheridge as showing their affinities with the British Arenig and Llandeilo.

1887.—R. A. F. Murray (22) listed the identifications hitherto made by McCoy. He also recorded from Deddick* *Diplograpsus rectangularis* McCoy, and from Guttamurrh Creek, Snowy River, *Didymograpsus caduceus* and *Diplograpsus foliaccus* "in vertical slates capping the granite."

The First Period of Research might aptly be called McCoy's Period, for on his identifications was based all that was adduced in connection with Australian graptolites. The fauna was correlated with the European and American which, at that time, was still imperfectly known. No attempt was made to discover an Australian stratigraphical sequence.

Second Period: 1892-1932.

Early in the Second Period, T. S. Hall (25) suggested a basis for zoning the Australian fauna and subsequently developed it (28 and 64). W. J. Harris and R. A. Keble (81, 121) working on Hall's zones, defined them and showed that they were capable of much closer subdivision.

1892.—G. B. Pritchard (23) described and figured *Temnograptus magnificus* sp. nov. from Lancefield (cf. 39). T. S. Hall (24) described and figured *Dictyonema grande* sp. nov. (cf. 31).

1893.—T. S. Hall (25) suggested a basis for zoning the Victorian Lower Ordovician and named some of the zonal graptolites that could be used, among which were *Tetragraptus fruticosus, Didymograptus caduceus, D. bifidus, Phyllograptus typus* and *Loganograptus logani.*

1895.—G. B. Pritchard (27) added to his description (23) of *Temnograptus magnificus* and T. S. Hall's species *Dictyonema grande* (24). He compared Victorian forms of *Clonograptus flexilis* with J. Hall's original description. He also recorded *Tetragraptus quadribrachiatus* from Lancefield.

T. S. Hall (28) instituted a system of zoning for the Castlemaine area which was incidentally to become the basis for the Lower Ordovician of Victoria. The Castlemaine area is suited to such a purpose as the railway cuttings and water races are generally at right angles to the strike and sections are exposed over long distances. He referred to *Didymograptus caduceus* as *Tetragraptus caduceus,* an anomaly that he says (cf. 29) was forced on him by the confused synonymy of *Didymograptus caduceus.* He also listed the hitherto unrecorded *Thamnograptus* sp. and *Dichograptus kjerulfi.* He commented on the similarity of some forms of *Tetra-*

*If a locality is in any other State than Victoria, the particular State is always mentioned.

graptus fruticosus to *D. v-fractus* (9). All other species mentioned by T. S. Hall were previously recorded by McCoy.

After commenting on the associations at Bendigo, Daylesford, Lancefield, Gisborne, Darriwil and New Zealand, he proposed the following zoning, the beds being arranged in descending order:

1. Zone of *Loganograptus logani* occurring at Castlemaine and Darriwil.
2. Zone of *Tetragraptus caduceus* occurring at Castlemaine.
3. *Phyllograpto-caduceus* zone occurring at Castlemaine.
4. Burns' Reef Beds occurring at Castlemaine.
5. Wattle Gully Beds occurring at Castlemaine and (?) in New Zealand.
6. Zone of *Tetragraptus fruticosus* occurring at Chewton, Bendigo, Spring Plains, Tarilta, Upper Loddon, Daylesford, Gisborne and to the north-west of Lancefield.
7. The Lancefield shales.

Hall called No. 1 the Darriwil Zone. It rests immediately above 2, 3, 4, and 5, which together form the Castlemaine Zone; and this, in turn, rests on the Bendigo Zone, which Hall defined as the strata containing *Tetragraptus fruticosus*. All strata below the Bendigo Zone containing graptolites were called by Hall the Lancefield Zone. He was more or less hazy as to what constituted his Darriwil and Lancefield Zones.

1896.—T. S. Hall (29) commented on the synonymy of Salter's *Didymograptus caduceus*, described from a Canadian specimen, and regarded Salter's species as valid. He pointed out that Nicholson (after following J. Hall, who made Salter's *D. caduceus* synonymous with *Tetragraptus bigsbyii)* "found a species in the Skiddaw Slates which seemed to agree perfectly with Salter's Canadian species. This species he named *Didymograptus gibberulus*" stating that "Salter's original specimen," (although he had not seen it) "was beyond doubt an example of *Tetragraptus bryonoides* or *T. bigsbyi*, and that Salter had confused an English species with it." T. S. Hall pointed out the improbability of this and contended that "*D. gibberulus* must be relegated to synonymy, for it does not seem separable from *D. caduceus*."

1897.—T. S. Hall (30) recorded from Wombat Creek, North-eastern Victoria, *Climacograptus bicornis* and *Dicellograptus elegans;* from Tungamah, (?) *Dicellograptus sextans,* (?) *Dicranograptus ramosus* and *Diplograptus pristis;* from Walwa (Walwal) Creek, *Dicellograptus*

anceps, Diplograptus pristis, D. truncatus, Climacograptus bicornis; and from an area east of the Snowy River, *Diplograptus rectangularis, D. foliaceus* and *Didymograptus caduceus.*

T. S. Hall (31) recorded from a locality four miles from Matlock, Victoria, on the Wood's Point Road, forms comparable with *Dicellograptus morrisi* and *Diplograptus foliaceus.*

He pointed out that the specific name *"grande"* (24) in *Dictyonema grande* was preoccupied and he substituted *"macgillvrayi"* for it. He discussed the relative position of the graptolite bed at Lancefield in regard to other beds in Victoria.

He examined (32) a collection of graptolites from Coimadai. From Basin Creek he identified *Didymograptus bifidus, D. murchisoni, D. extensus, Tetragraptus quadribrachiatus, T. serra, Phyllograptus typus, P. angustifolius;* from Cockatoo Gully, *Didymograptus extensus, D. caduceus, Tetragraptus* cf. *quadribrachiatus, Phyllograptus* (?) *angustifolius;* from Back Creek, *Didymograptus caduceus;* from Deep Creek, Melton, *D. caduceus, Tetragraptus serra, Dichograptus* (?) sp. nov., *Phyllograptus typus* (?), *Diplograptus* sp. (very common).

W. S. Dun (34) recorded graptolites from the County of Wellesley, New South Wales. From the Parish of Lawson, he identified *Dicranograptus furcatus, Didymograptus* cf. *caduceus, Diplograptus* cf. *mucronatus, D.* cf. *rectangularis* and *Phyllograptus* (?); from the south-west corner of the Parish of Currawang, *Diplograptus* cf. *palmeus, Dicranograptus* sp., *Dicellograptus* sp.; from Stockyard Creek, Parish of Alexander, *Dicranograptus furcatus, Diplograptus* cf. *palmeus, D.* cf. (? *rectangularis* McCoy), *Dicellograptus* sp.; from 1½ miles south of Portion 2, Parish of Tingaringi, *Diplograptus* cf. *palmeus, Didymograptus* sp., *Dicranograptus furcatus, Dicellograptus* sp.

1898.—W. S. Dun (35) identified *Diplograptus, Climacograptus* and *Dicellograptus* from Myall Reef, near Tomingley, in the Peak Hill District, New South Wales.

T. S. Hall (36), after reviewing the evidence, thought that a graptolite, probably referable to *Diplograptus,* may have been found at Lisle, Tasmania.

1899.—T. S. Hall (37) compiled a list of identifications from various localities in Victoria. The localities are at Wombat Creek, Chewton, Cabanandra, Bulla, Sunbury, Deddick, Bendigo, Sandy's Creek, Ryan's Creek, Tarilta,

Newham, Parwan, Darriwil, Holden, Leigh River, Melbourne, Lancefield, Loddon River, Kangaroo Creek, Coolbarghurk, Spring Plains, Daylesford, Cockatoo Gully, Werribee Gorge, Watchbox Ranges, and Redesdale. Most of these localities are from the Quarter Sheets (*vide* 1, 2, 3, 4, 5, 7, 10).

He recorded from Alexandra, *Monograptus* cf. *galaensis;* from McLauchlan's Creek, south of the Victorian border, East Gippsland, (?) *Dicellograptus morrisi, D. anceps, Diplograptus truncatus,* (?) *Climacograptus caudatus;* and from Thoona, *Glossograptus, Diplograptus, Climacograptus* and cf. Dichograptidae. From the Moorabool River near Maude, he recorded *Tetragraptus* cf. *quadribrachiatus.*

He recorded (38) from Cravensville, *Climacograptus bicornis* et var. *tridendatus, Diplograptus foliaceus, Dicellograptus sextans, Glossograptus* sp.; from mid-way between Cravensville and Dart River, *Didymograptus* sp.; from Glendart, near Dart River, *Climacograptus* sp., *Glossograptus* sp., *Diplograptus* sp. He gives the age of the Cravensville beds as Upper Ordovician.

He adds that the *Glossograptus* obtained from Cravensville and Glendart is identical with that previously recorded from Sandy's Creek (37), and Tungamah (30).

A collection of graptolites from a small quarry a few hundred yards north of the disused Mt. William Railway Station near Lancefield disclosed a number of new species as well as already described forms on which he had based his Lancefield Zone. The new species described and figured (39) were *Bryograptus victoriae, B. clarki, Leptograptus antiquus, Didymograptus pritchardi, D. taylori, Tetragraptus decipiens, Dictyonema pulchellum,* and he recorded *Clonograptus flexilis, C. magnificus, C. rigidus, C. tenellus, Phyllograptus* sp. and *Dictyonema macgillvrayi.*

He reviewed (40) the earlier graptolite work done by McCoy and others. He pointed out that the work of these pioneers, as in England before Lapworth undertook his work of revision, is unreliable. He stressed the fact "that the minute differences on which it has been found advisable to separate the species in this difficult group were not then generally recognized, and we find many of our graptolites identified with forms from which we now regard them as even, it may be, generically distinct. In the case of those forms where the method of branching and the habit is a guide there was, of course, less liability to confusion, and here the specific identifications are of value, but it is extremely doubtful, on the other hand, whether any of the

Diplograptidae have been correctly determined and a great number of those forms referred to *Didymograptus* (*sensu stricto*) are probably incorrectly identified. One feature, however, must not be overlooked, and this is that the records have in many cases been made from exact localities; and this in the case of Sir F. McCoy's papers, owing to his official connection with the Survey, is of peculiar value, as the precise position from which the fossils came is recorded both by him and on the Geological maps, and we are thus frequently able to check the records in a very effective way."

Discussing the sequence, he commented on certain species that seem anomalous in other countries. The form he named *Leptograptus antiquus* (39, cf. 111), though not perhaps a typical member of the genus, is certainly not a *Didymograptus*. It has since been made synonymous with *Bryograptus* (111). *Didymograptus bifidus* (now *D. protobifidus* (151)) dies out long before *Phyllograptus typus* has disappeared and is survived by a *Clonograptus* and two or three species of *Dichograptus*. He emphasized the fact that in the Northern Hemisphere *Clonograptus flexilis* is associated with forms which characterize the next higher horizon in Victoria. The case of *C. rigidus* is also striking, for though in America it is, according to Amii, associated with *Loganograptus,* yet with us the latter genus does not appear till *Phyllograptus typus* and closely allied species have become extinct. In regard to this statement of Hall's it should be stated that *Loganograptus* has since been found at a much lower horizon (131).

Hall discussed the composite fauna of the Lower Ordovician in regard to the Lancefield, Bendigo, Castlemaine and Darriwil Series. Apart from the Castlemaine Series he does not mention limiting forms. He states that the Darriwil Fauna "differs from the typical Castlemaine fauna by the almost entire absence of *Didymograptus caduceus* and the appearance of *Lasiograptus* and *Glossograptus*. *Trigonograptus* and several species of *Didymograptus* and *Climacograptus* occur, while *Tetragraptus serra* and *Loganograptus* still persist. This series appears to mark the close of the Lower Ordovician as in the succeeding rocks Dicranograptidae put in their appearance." Thus he regarded the appearance of *Dicranograptus* as heralding the incoming of the Upper Ordovician.

He commented on Upper Ordovician species, pointing out that no stratigraphical work had yet been done.

In regard to the Silurian, he identified *Monograptus*

priodon from Macclesfield and *M.* cf. *dubius* from South Yarra; he also mentioned other occurrences. He thought the record of *Phyllograptus* (34) in New South Wales is doubtful.

He described and figured *Tetragraptus projectus* sp. nov. and *Trigonograptus wilkinsoni* sp. nov. He also commented on and figured *Didymograptus gracilis* Torn., *Leptograptus antiquus* T. S. Hall (now *Bryograptus antiquus), Dichograptus octonarius, Clonograptus tenellus* and *Bryograptus victoriae.*

1900.—W. S. Dun (41) recorded from the Coolgardie Gold Mine G.L. 14, Parish of Clarendon, County of Bathurst, New South Wales, at a depth of 150 feet, a number of specimens of *Diplograptus.*. He could not say whether they were Ordovician or Silurian.

T. S. Hall (42) described and figured a number of graptolites from Mandurama, New South Wales, including *Climacograptus affinis* sp. nov. and *Diplograptus manduramae* sp. nov. The graptolites were associated with radiolaria and *Agnostus.*

1902.—T. S. Hall (43) considered that the evidence of transgression in the case of graptolites is somewhat stronger (than in other groups), and is more clearly seen, as the collecting in part of our (Victorian) Lower Ordovician has been done zonally. "I have elsewhere (39) shown," he continues, "that on the same slabs of rock at Lancefield we find *Bryograptus* and *Clonograptus tenellus,* which in Europe are exclusively Cambrian, associated with *Didymograptus, Tetragraptus, Clonograptus flexilis, C. ridigus, Phyllograptus,* and two species of *Dictyonema* which are just as typically Lower Ordovician in Europe. In America *Clonograptus flexilis* is associated with such forms as occur at Bendigo, the next horizon above the Lancefield beds, which do not contain them, while *C. rigidus* is found with *Loganograptus logani.* Now, in Australia, the last named does not put in an appearance till the rich fauna of Bendigo and a great part of the Castlemaine series, which is younger than the Bendigo series, has disappeared entirely (cf. 131). Another example may be quoted. The group characterized by *Didymograptus bifidus* (cf. 151) 'the tuning-fork graptolites,' as they are sometimes called, is in Europe and America characteristic of the Upper Arenig, when the complexly branched forms, and the peculiar *Phyllograptus,* have died out. With us their horizon is lower and their range very short. *Phyllograptus, Clonograptus,* and *Dichograptus* long

survive them, while *Loganograptus logani* only puts in an appearance when they, in their turn, have almost passed away. Graptolites are not always easy of recognition, but these forms all belong to readily-recognizable groups; the specific determinations, it is possible, may be incorrect, but the generic cannot be confounded."

He recorded and figured (45) from Belle Vale, Yass, New South Wales, a *Monograptus* which he ascribed to the *M. dubius* group.

He described and figured (46) from Sandy's Creek, Mitchell River, *Didymograptus ovatus* sp. nov. and *Glossograptus hermani* sp. nov.

He tabulated the species already recorded from Upper Ordovician localities.

He recorded from Castlemaine, *Goniograptus macer, Didymograptus* aff. *nitidus* and *D. extensus.* From a locality 1½ miles south-west of Kelly's Hill, Matlock, he recorded *Dicellograptus morrisi, Diplograptus foliaceus* and other forms and assigns the beds to the Upper Ordovician.

He examined (47) the graptolites in the collection of the Geological Survey of New South Wales. From Stockyard Creek, he identified *Dicellograptus affinis, D.* cf. *divaricatus, Diplograptus carnei, D. foliaceus, Climacograptus bicornis, C. hastata, C. tubuliferus, Cryptograptus tricornis* (vide 63), and *Retiolites caudatus;* from Currawang, (?) *Dicellograptus affinis, Dicranograptus zic-zac* var. *minimus, Diplograptus foliaceus, Climacograptus bicornis* and *C. tubuliferus* (?); from Lawson, *Dicranograptus zic-zac* var. *minimus, Glossograptus* cf. *mucronatus* and *Clathrograptus* cf. *geinitzianus;* from Orange, *Diplograptus carnei;* from Tomingley, *Dicellograptus* cf. *divaricatus, Diplograptus carnei, D. foliaceus, D.* cf. *whitfieldi, Climacograptus tubuliferus, Callograptus* cf. *salteri, Dictyonema* sp. and *Dendrograptus* spp.

He described and figured *Dicellograptus affinis* sp. nov., *Diplograptus carnei* sp. nov., *Climacograptus hastata* sp. nov. and *Retiolites caudatus* sp. nov. "Certain species identified from Victorian rocks by the late Sir F. McCoy," he said, "namely, *Diplograptus mucronatus* J. Hall, *D. rectangularis* McCoy and *D. palmeus* Barr. are not those species, the two latter, indeed, not occurring in Ordovician rocks at all, but being characteristic of Silurian age."

He discussed (48) the evidence for the existence of graptolites at a locality near the Ring River, north-east of Dundas Railway, and from near Zeehan, both in Tasmania.

1904.—T. S. Hall (51) recorded from slate pebbles at San

Remo the genera *Diplograptus, Climacograptus, Dicellograptus, Dictyonema, Callograptus* and *Ptilograptus.* He figured *Callograptus* and *Ptilograptus.*

From Knowsley East he recorded a form resembling *Ptilograptus;* from near the "trap" area marked on Q.S. 15 NE., near Vaughan, *Didymograptus bifidus, D. extensus* (?), *Tetragraptus quadribrachiatus, T. serra, T. fruticosus* (3-branched variety), *Phyllograptus typus;* from Wood's Point District, *Dicellograptus affinis, Diplograptus foliaceus, D.* cf. *tamariscus, Climacograptus hastatus, C. tubuliferus, C.* cf. *innotatus;* from Bald Hill, Waratah North, *Diplograptus* sp.; and from boulders at Grice's Creek, Mornington, *Climacograptus* and *Diplograptus.*

From Balnarring, he recorded *Tetragraptus approximatus, T. quadribrachiatus, T. fruticosus* and *Didymograptus* cf. *pritchardi.* This is the first record of *Tetragraptus approximatus* in Australia. From Bulldog Creek, near Dromana, he recorded *T. approximatus, T. quadribrachiatus, T. fruticosus;* from the junction of Stander's Creek with the Goulburn River, near Wood's Point, he recorded a form belonging to *Dendrograptus* or *Dictyonema.*

1905.—T. S. Hall (52) recorded from near Mt. Wellington, *Diplograptus thielei* sp. nov., *Climacograptus wellingtonensis* sp. nov., *C. bicornis, Cryptograptus tricornis, Lasiograptus* sp., *Dicellograptus elegans, Dicranograptus nicholsoni,* and *D. hians* sp. nov. He described and figured *Diplograptus thielei, Climacograptus wellingtonensis* and *Dicranograptus hians.*

1906.—T. S. Hall (53) recorded from Turquoise Mine, Ryan's Creek, Myrhee, *Diplograptus* sp.; from Mt. Avis, Edi, *Diplograptus, Climacograptus, Glossograptus* and a doubtful *Didymograptus.* He regarded the beds as Upper Ordovician.

From Graptolite Gully, Jordan River, Aberfeldy District, on the track half-a-mile from the Thomson River junction, he recorded *Monograptus dubius* which he described and figured. From the northern slope of Mt. Easton he recorded *Dicellograptus affinis, D. elegans, Climacograptus tubuliferus, C. bicornis, Glossograptus fergusoni;* from Dingo Creek, *Dicellograptus affinis, D.* cf. *forchammeri* and *Diplograptus foliaceus;* a mile south from the Thomson-Jordan junction, *Monograptus* cf. *dubius;* from the Cornish Line of Reef, Daylesford, *Didymograptus bifidus, Tetragraptus quadribrachiatus, T. fruticosus, T. bryonoides* and *Phyllograptus typus;* from the Little Snake Reef, Trentham, *Tetragraptus quadribrachiatus;* from The Springs, Daylesford, *T.*

fruticosus, T. bryonoides, and *Phyllograptus typus;* from Bullarto, *Didymograptus caduceus;* from Bullarto railway-cutting, *Phyllograptus angustifolius;* from the spur between Boy's and Bell's Creek, on the track along the Thomson River, 4½ miles below the Jordan junction, *Monograptus* sp. and *Pristiograptus;* from the spur south-west of Blaze XIII, at Thomson River, 5½ miles from the Jordan junction, *Monograptus* sp.; from No. 10 spur on the Main Divide, between Spring Hill and Mt. Selma, *Diplograptus* sp.; from Black River, near junction of Ten Mile Creek, *Dicranograptus* sp., *Diplograptus* cf. *murchisoni;* from Bendigo, Concord Company's Lease, *Tetragraptus serra, T. fruticosus* (3 and 4-branched), *Phyllograptus typus,* from between Lansell's 180 Mine and Victoria Reef Mine, *Tetragraptus fruticosus* (3 and 4-branched), *T. pendens, Dichograptus octobrachiatus;* from Hustler's Line of Reef, *Tetragraptus fruticosus* (3 and 4-branched), *T. approximatus, T. quadribrachiatus, T. bryonoides, T. serra,* and *Dichograptus octobrachiatus;* from two miles north-west of Mt. Easton, *Leptograptus flaccidus, Dicellograptus complanatus* var. *ornatus, Diplograptus carnei, Climacograptus mensoris* sp. nov., and *Retiolites caudatus;* from three-quarters of a mile north-west of Mt. Easton, *Leptograptus flaccidus, Dicellograptus elegans, Dicranograptus ramosus* var. *semispinifer* nov., *D. hians, D. nicholsoni, Diplograptus ingens* sp. nov. *D. foliaceus, D.* cf. *aculeatus, D. quadrimucronatus, Cryptograptus tricornis, Climacograptus baragwanathi* sp. nov. and *C. bicornis.* He described and figured *Climacograptus mensoris, Leptograptus flaccidus, Dicellograptus elegans, Dicranograptus ramosus* var. *semispinifer, Diplograptus ingens, D. quadrimucronatus,* and *Climacograptus baragwanathi.* He figured *Dicellograptus complanatus* var. *ornatus, Diplograptus carnei* and *Retiolites* sp. He also commented on *Diplograptus foliaceus, D.* cf. *aculeatus, Cryptograptus tricornis* and *Climacograptus bicornis.*

1907.—T. S. Hall (56) recorded from the Painswick Railway Station ground, near Dunolly, (?) *Bryograptus* or *Dendrograptus,* (?) *Clonograptus* and (?) *Tetragraptus decipiens;* from Q.S. 22 NW., north-west of Mt. Easton, *Dicranograptus ramosus* var. *semispinifer, Diplograptus ingens*; from the railway quarry near the four and a half mile post, railway viaduct, Ingliston, *Tetragraptus serra, Phyllograptus* sp. and *Didymograptus caduceus;* from Ingliston, 42¾ miles, in railway cutting, *D. caduceus;* from a site 100 chains distant on a bearing E. 35° 53′ from the middle

of the Painswick Railway Station ground, near Dunolly, *Tetragraptus decipiens,* (?) *Clonograptus magnificus, C.* cf. *tenellus, C.* sp. and *Bryograptus* sp.; from Dunolly (No. 32 on Locality Map) *Tetragraptus decipiens, Clonograptus tenellus* and *C.* sp.; from a site 242 chains south from the SE. corner of Allotment A18, Parish of Moliagul, near Dunolly, *Tetragraptus decipiens, Didymograptus pritchardi, Clonograptus magnificus, C. tenellus* and *Dictyonema macgillvrayi;* from the Daylesford Mine Mullock Tip, *Tetragraptus fruticosus, T. bryonoides, T. serra, Didymograptus bifidus* and *Phyllograptus typus;* from the Daylesford Shaft, quarter-mile south of the New Cornish Company's Shaft, *Didymograptus* cf. *extensus* and *D. caduceus;* from Daylesford, north side of Jubilee Lake, quarter-mile east of railway station, *Didymograptus caduceus* and *Dichograptus octobrachiatus;* from near Dartsmouth, four chains from battery in gully, Green's Creek, *Diplograptus* cf. *foliaceus;* from Bald Hill quarry, Parish of Kangerong, east of Dromana, *Didymograptus* sp., *D.* cf. *extensus, Tetragraptus pendens, T.* cf. *quadribrachiatus,* and *Clonograptus* sp.; from south-east portion of Jamieson's Special Survey, Parish of Kangerong, *Tetragraptus approximatus, T. fruticosus* and *Clonograptus* sp.

He identified (57) from several specified localities in the Dunolly district, *Clonograptus tenellus, C. rigidus, C. magnificus, Tetragraptus decipiens, Didymograptus pritchardi;* from the Jordan River, *Diplograptus calcaratus, D. tardus* sp. nov., *Climacograptus bicornis* et var. *peltifer, Cryptograptus tricornis, Glossograptus* cf. *hermani, Dicellograptus elegans, D. sextans, Dicranograptus furcatus, D. ramosus* et var. *longicaulis, D. nicholsoni;* from the Little Jordan Creek, *Diplograptus tardus* and *Dicranograptus nicholsoni.*

From certain specified localities on the Thomson River, Q.S. 22 NW., he recorded *Monograptus* cf. *dubius, M. crenulatus,* and *M.* sp. (colonus group); from Kangerong, *Tetragraptus approximatus, T. fruticosus, T. quadribrachiatus, Clonograptus magnificus;* and from specified localities at Bendigo, *Tetragraptus quadribrachiatus, D. latus* sp. nov., *Tetragraptus fruticosus, T. serra, T. approximatus, Dichograptus octobrachiatus, Goniograptus thureaui, Clonograptus flexilis* and *Phyllograptus typus.* From Myrtleford he examined some fragmentary forms that he considered to be possibly a *Bryograptus* allied to *B. victoriae.*

He described and figured *Diplograptus tardus* and *Didymograptus latus.* He commented on and figured *Diplo-*

graptus calcaratus, Glossograptus cf. *hermani, Dicranograptus ramosus* var. *longicaulis, Dicellograptus sextans* and *Climacograptus bicornis* var. *peltifer.*

E. W. Skeats (58) found at Mooroodue at localities indicated on his map of the area, *Didymograptus caduceus, Tetragraptus serra (sensu stricto), Diplograptus* sp. *Trigonograptus* sp., *Lasiograptus* sp. and *Glossograptus* sp. T. S. Hall, who identified these graptolites, states that "the horizon is that of the Upper Castlemaine series, although the presence of *Glossograptus* is suggestive of the horizon of the Darriwil series. The species of *Diplograptus* is similar to the one which occurs as low down as the Victoria Gully beds at Castlemaine, but is indistinct."

1908.—T. S. Hall (59) reported *Dicellograptus* fragments from Myrtleford; from Kerrie, Riddell, *Climacograptus* sp.; from the Parish of Barp, *Dictyonema* and *Dendrograptus;* from the Parish of Painswick, *Clonograptus magnificus* (?), *C. flexilis, Tetragraptus decipiens, Dichograptus octobrachiatus, Dictyonema* spp. and *Phyllograptus typus* (?); from the railway cutting between Goldsbrough and Bealiba, *Clonograptus* cf. *rigidus;* from Allotment 14A, Parish of Tarnagulla, what appeared to be a Dicellograptid; from the Parish of Wareek, *Clonograptus gracilis, C. magnificus, C. rigidus, C. tenellus, Bryograptus* probably *victoriae, Tetragraptus decipiens* and *Leptograptus antiquus.* This collection is interesting as being the most westerly yet found in Australia. From Bendigo, he identified *Tetragraptus fruticosus, T. bryonoides, T. serra, T. pendens, Goniograptus thureaui, G. macer, Dichograptus octobrachiatus, Didymograptus extensus* and *Phyllograptus typus;* from Daylesford, *Tetragraptus fruticosus, T. pendens, T. quadribrachiatus, Didymograptus bifidus, D. caduceus, D. extensus, D. murchisoni, D. nitidus, Goniograptus macer,* and *Phyllograptus typus;* from Dolly's Creek, three miles north-east of Elaine, *Tetragraptus fruticosus, T. pendens, T. bryonoides, T. serra, T. quadribrachiatus, Didymograptus bifidus, D. nitidus, D. extensus* and *Phyllograptus typus;* from Marong, *Tetragraptus fruticosus, T. bryonoides, T. serra, Phyllograptus typus, Didymograptus nitidus, D. bifidus, Goniograptus macer.*

He corrects his identification of *Retiolites caudatus* from Mt. Easton (53) to *Lasiograptus margaritatus* Lapw.

T. S. Hart (61) collected graptolites at a number of localities at Daylesford. The greater part of the collecting was done between Sailor's Creek on the west, and the line of the Dry Diggings Road on the east, extending north and south over a distance of about six miles. He states that many of

the forms were examined and identified by T. S. Hall. Hart divided the area into three parts, a western area, west of the line of strike passing through the Ajax Mine, which belongs to the Bendigo Series; a central belt, with Bendigo beds on its west side and the Wattle Gully series farther east; and his eastern localities east of the Ballarat railway near Woodburn and eastwards from the Springs at Hepburn, all of which are referable to parts of the Castlemaine Series above the Wattle Gully beds.

From the western area he fixed a number of localities more or less precisely and refers to them by numerals from 1 to 13. From them he recorded *Tetragraptus fruticosus, T. bryonoides, T. pendens, T. quadribrachiatus, Didymograptus bifidus, D.* cf. *murchisoni, Goniograptus thureaui, G. macer* and *Phyllograptus typus.* In the central area, he numbered his localities 14 to 43. He recorded from them *Didymograptus bifidus, D. extensus, D.* cf. *nicholsoni, D. caduccus, Tetragraptus bryonoides, T. serra, T. quadribrachiatus, T. fruticosus, Clonograptus abnormis, C. flexilis* (?), *Phyllograptus typus* and *Dendrograptus* sp. (?). From the eastern localities numbered, 44 to 54, he recorded *Didymograptus caduceus* (large), *D. nitidus, Dichograptus octobrachiatus, Tetragraptus quadribrachiatus, Phyllograptus typus* and *P. angustifolius.*

In regard to these faunas he points out that there is—

1. A series of beds in which *Didymograptus caduccus* is abundant and sometimes large, associated with *Phyllograptus angustifolius* and *Didymograptus nitidus,* neither of which he found in other beds, and *Tetragraptus quadribrachiatus,* which also appears in other beds.
2. A series characterized by the extreme abundance of *Didymograptus bifidus.*
3. Beds with *Phyllograptus typus, Tetragraptus fruticosus,* and *T. bryonoides.*

In these beds *Didymograptus bifidus* is seldom present and never common. *Tetragraptus fruticosus* is never observed in beds in which *D. bifidus* is common.

4. At one locality with *Phyllograptus typus* and *Tetragraptus bryonoides, Clonograptus* was conspicuous, but neither *Tetragraptus fruticosus, Didymograptus bifidus* nor *D. caduccus* was noticed there.

This may be summarized as follows:

3rd, beds with abundant *Didymograptus caduceus,* newer than

2nd, beds with abundant *Didymograptus bifidus* and with *Phyllograptus typus,* newer than

1st beds with *Tetragraptus fruticosus* and *Phyllograptus typus,* the oldest beds observed.

This is in agreement with delimitations at Castlemaine, but Hart said that he had not collected in beds that can be decisively referred to that part of the series in which *Didymograptus caduceus* has begun to be common and *Phyllograptus typus* has not disappeared. On the other hand, there are apparently beds at Daylesford above the horizon at which *Tetragraptus fruticosus* ceases to be common but older than the beds with abundant *Didymograptus bifidus* which may be a local unimportant peculiarity. He tabulated the species records under the numbers of their localities and marked them on a transverse section.

T. W. E. David (62) recorded *Leptograptus* from a locality about two miles westerly from Berriedale, on the Kosciusko Plateau, New South Wales.

1909.—T. S. Hall (63) recorded from Tallong, New South Wales, *Dicellograptus elegans, Dicranograptus nicholsoni, D. hians* var. *apertus, D.* cf. *cyathiformis, Diplograptus, D. foliaceus, Climacograptus bicornis, Cryptograptus tricornis,* and *Glossograptus quadrimucronatus.*

He summarized (64) our knowledge of Victorian graptolites. He stated that *Tetragraptus approximatus* was an important zone fossil, being associated with both the lower part of the Bendigonian and the upper part of the Lancefieldian.

He examined a graptolite from Ballarat and considered it to be a Dichograptid, but otherwise indeterminate.

W. G. Woolnough (65) stated that an abundant and well preserved graptolite-fauna is present in the slates at Marulan and Tallong, New South Wales.

C. F. Laseron (66) exhibited *Diplograptus, Climacograptus* and *Dicellograptus* from a band of black slate in a creek crossing the Adaminaby Road, 11 miles from Cooma, New South Wales. He regarded the strata as a continuation of that of the Berriedale area.

1910.—F. Chapman (67) commented on graptolites from the Yarra Improvement Works, excavations made along the south side of the River Yarra, between Brander's Ferry and the South Yarra Railway Bridge. He stated that they "may be provisionally referred to as two types, which bear certain resemblances in the shape and width of the thecae to *Monograptus concinnus* Lapw. and *M. cyphus* Lapw.

1911.—R. Ruedemann (68) discussed the stratigraphic significance of the wide distribution of the graptolites and stated that "the closer investigation of the graptolites in Europe, America and in Australia has brought out the fact of the presence in all three continents of the common or guide graptolites, of the Ordovicic at least, and of the general agreement of the sequence of zones. The distribution of an important fraction (roughly, at least one-third) is world-wide."

He cited the late appearance of *Loganograptus* in Australia (cf. 40, 131), and the Deep Kill beds of New York as evidence that "if new forms originated in one oceanic basin they so rapidly spread into the others that deposition of rock did not take place sufficiently quick to record this migration in the rock."

He then discussed the American graptolite zones in regard to their connections with the Atlantic and Pacific basins. "The principal Atlantic graptolites," he says, "are fully at home in the Pacific. We find, for instance, one horizon in Victoria, Australia, characterized by *Didymograptus bifidus* (cf. 151), *D. extensus* (?), *Tetragraptus quadribrachiatus, T. serra, T. fruticosus, Dichograptus, Phyllograptus typus* and *P.* sp. and the fact that the differences in the time of appearance of some important forms between Australia and Europe (as the later appearance of *Loganograptus logani* and the earlier appearance of *Didymograptus bifidus* in Australia) are exactly duplicated in our Deep Kill Zones, and the appearance of *Goniograptus thureaui* in both Australia and the Levis Channel are strong arguments not only in favour of some connection of the Levis basin with the Pacific Ocean, but even of the arrival of some of the forms of this far distant basin by a current from the west."

1912.—T. S. Hall (69), from the evidence then before him, fixes the age of the rocks at Marong as Bendigonian, the presence of *Didymograptus nitidus* indicating that they are not the lowest and the absence of "tuning-fork" graptolites, negative evidence of no great value, that the uppermost Bendigonian is not represented. Regarding the age of the rocks about Dunolly, he prefaces his remarks with a discussion of the characteristic fossils of the Bendigonian, viz.: *Tetragraptus fruticosus, T. pendens* and *Goniograptus thureaui. Tetragraptus approximatus* is characteristic of the lowest part of the Bendigo Series and passes into older rocks below "while *T. serra, T. bryonoides* and *Phyllograptus typus* range throughout, but also pass up into the higher series

of beds. Below the Bendigo series is found a series of rocks which are best studied at Lancefield, and are hence called Lancefieldian."

The district to which his subsequent remarks apply extends westwards of Bendigo nearly to Bealiba, a distance of nearly 40 miles, and from near Maryborough northwards to Inglewood, a distance of about 25 miles. He considered the material from 40 localities, much of it "in an extremely poor state of preservation, so that in a large number of cases it was not possible to determine the fossils; still, from most localities, a sufficient number of identifications were made to fix the age of the beds approximately."

From a couple of miles east of Bealiba to Laanecoorie the rocks appear to be entirely of Lancefieldian age and this has been proved north and south along their strike for 15 miles. About 15 miles north of the east and west Bendigo-Bealiba line is found at Inglewood, slightly to the east of the Laanecoorie strike *Tetragraptus decipiens* and *Clonograptus* sp., suggesting Lancefieldian and *Tetragraptus approximatus* hitherto only found in association with *T. fruticosus* at Bendigo and Dromana. "Its presence, then, may be taken to indicate on the one hand the top of the Lancefield, and, on the other, the base of the Bendigo series, and the two series pass into one another without a break." He details the serial occurrences east and west of the Inglewood strike and the Bealiba-Laanecoorie belt and also those at Marong.

He concluded that "the age of the rocks about Dunolly, in the middle of the Bealiba-Laanecoorie belt, is Lancefieldian, then on the Inglewood-Campbelltown-Smeaton strike we reach the higher Bendigonian series. The eastward continuation of this, between Llanelly and Marong, is basalt masked, but Bendigonian is again met with at Marong, and possibly still farther to the eastward."

He reported (70) on graptolites from Sebastian, which he placed in the Castlemaine Series (they are now known to belong to the Darriwil Series) and from several localities at Bendigo, Chewton, Dunolly, Bromley, Barp, Waanyarra, Goldsborough, Bet Bet, Tarnagulla, Elaine, Inglewood, Wedderburn (?), Moolort, Deep Creek (Parish of Bullarook), Eganstown, Wombat, Rocky Lead, and localities in the Parishes of Dean, Bullarook, Creswick, Smeaton, Clarendon, Painswick, Ballarat district, Woodend, Mansfield, Kevington district, Myrtleford district, Nowa Nowa, Mt. Wellington district, and Accommodation Creek.

He described and figured *Trichograptus fergusoni* sp. nov.,

Dichograptus octobrachiatus, Clonograptus abnormis and *C.* sp.

1913.—In 1903 J. W. Gregory[1] divided the Silurian of Victoria into two series, viz.: the Melbournian and the Yeringian, and Chapman (71) added the Tanjilian. From the Melbournian Chapman (71) recorded *Dendrograptus* sp., *Monograptus* cf. *concinnus, M.* cf. *cyphus, M.* cf. *dubius, M. priodon;* from the Yeringian, *Cyrtograptus* sp., *Monograptus priodon, M. riccartonensis,* and *Retiolites australis;* and from the Tanjilian (?) *Cyrtograptus* sp., *Monograptus* cf. *crenulatus* and *M. dubius.* N. R. Junner (74) found *Climacograptus* and *Diplograptus* in black, pyritic slates at the Diamond Creek Mine.

1914.—W. R. Browne (75) gave a list (supplied to him by C. F. Laseron) of graptolites found by the latter in Wambrook Creek, near Cooma, New South Wales. The list is more detailed than that previously given (66) and comprises *Diplograptus foliaceus* (very abundant), *Climacograptus bicornis, C. hastata* (very abundant), *Dicellograptus elegans, D. caduceus, D. affinis* and (?) *Pleurograptus.* He stated that *Tetragraptus, Didymograptus* and *Diplograptus* occur in slates at Geygedzerick Hill, 2¼ miles north-east of Berriedale, indicating the existence of the higher series of the Lower Ordovician in New South Wales. He also mentioned that C. F. Laseron had found in the neighbourhood of Cobargo, about 44 miles a little south of east of Cooma, *Diplograptus foliaceus, Climacograptus, Dicellograptus* (?) *gracilis* and *D. affinis.*

T. S. Hall (76) described and figured *Didymograptus extensus, D. perditus* sp. nov., *D. gracilis, D. aureus* sp. nov., *D. latens* sp. nov., *D. procumbens* sp. nov., *D. adamantinus* sp. nov., *D. mundus* sp. nov., *D. dilatans* sp. nov., *D. bifidus, D. caduceus* var. *manubriatus* nov., *Oncograptus* gen. nov., *O. upsilon* sp. nov., *Goniograptus macer, G. speciosus* sp. nov., *G. crinitus* sp. nov., *G. laxus* sp. nov., *Tetragraptus harti* sp. nov., *T. whitelawi* sp. nov., *Monograptus aplini* sp. nov., *M. turriculatus, M. priodon, Triaenograptus neglectus* gen. et sp. nov.

He reported (77) on graptolites from 11 localities in the Steiglitz District and 40 localities in the Bendigo District.

Chapman (79) gave the stratigraphic subdivisions of the Lower Ordovician of Victoria, based on T. S. Hall's researches on graptolites (28). He also summarized the

1. 1903 Gregory, J. W., The Heathcotian—A Pre-Ordovician Series—and its Distribution in Victoria, Proc. Roy. Soc. Vict. (n.s.) xv, (II), pp. 148-175. Melbourne.

Lower Ordovician of New Zealand, the Upper Ordovician of Victoria and New South Wales, and the Silurian of Victoria. He states that graptolites have been recorded from Tasmania, but that the horizon and the locality is uncertain.

He figures many of the better-known graptolites from the Ordovician and Silurian.

1915.—T. S. Hall (80) stated that the graptolite-bearing rocks of Victoria occupy about 20,000 square miles. The Upper Ordovician strata range north from eastern Victoria 300 miles into New South Wales. He expressed the opinion that the Victorian, not the British, sequence will be found in New Zealand. "Broadly," he continued, "the sequence of Australian graptolites agrees with the European, but in details is closer to that of New York, as Ruedemann has pointed out. The important differences in the range of *Didymograptus bifidus, D. caduceus, D. nicholsoni, Loganograptus, Clonograptus rigidus* and some other genera and species negative the idea that graptolite zones are world-wide, and as no one believes that all the genera and species originated in one locality and radiated thence, this is what we should expect."

1916.—W. J. Harris (81) worked on an area in the Castlemaine District somewhat more extensive than that previously worked by T. S. Hall (28). He examined all but three or four of the outcrops visited by Hall and paid tribute to the accuracy of the latter's observations. He revised Hall's subdivisions of the Castlemaine and defined the Darriwil. The subdivisions proposed by Harris were as follows:

Series and Division	*Locality of Typical Development*	*Zone Fossils*	*Other Characteristic Fossils*
Darriwil (W. J. Harris and T. S. Hall)			
Upper	Guildford-Strangways Road	*Glossograptus* sp. indet. *Trigonograptus* *Lasiograptus* (absence of *C. morsus*)	*Diplograptus* cf. *angustifolius.* *D. gnomonicus* sp. nov. *Didymograptus caduceus.* *D. v-deflexus* sp. nov.
Middle	Guildford-Strangways Railway	*C. morsus* *Trigonograptus* (absence of *Oncograptus*)	*Diplograptus gnomonicus* sp. nov. *Didymograptus caduceus* *D. v-deflexus* sp. nov. *Phyllograptus* sp.

Series and Division	*Locality of Typical Development*	*Zone Fossils*	*Other Characteristic Fossils*
	Chinamen's Creek	*C. morsus* ` *Oncograptus* *Trigonograptus*	*Diplograptus gnomonicus* *Didymograptus caduceus* *D. v-deflexus* sp. nov. *Phyllograptus* sp.
Lower	Woodbrook Road	*Oncograptus upsilon* *Trigonograptus* (absence of *C. morsus*)	*Didymograptus caduceus* *D. v-deflexus* *Phyllograptus* sp. *Didymograptus caduceus* var. *manubriatus*
Castlemaine Upper	McKenzie's Hill	*Didymograptus caduceus* (max. dev.) *Loganograptus logani*	*Didymograptus* spp. *Diplograptus* spp.
	Victoria Gully	*Didymograptus caduceus* (absence of *Phyllograptus typus*)	*Dichograptus* cf. *octonarius* *Diplograptus* spp.
Middle	Victoria Gully East	*Didymograptus caduceus* (small) *Phyllograptus typus*	*Dichograptus* cf. *octonarius* *Clonograptus* sp.
	Burns Reef	*P. typus* (absence of *D. bifidus*)	*Clonograptus* sp.
Lower	Wattle Gully	*D. bifidus* (absence of *Tetragraptus fruticosus*)	*Phyllograptus typus* *P.* cf. *angustifolius* *Dichograptus octobrachiatus* *Clonograptus* spp. *Goniograptus crinitus* *Tetragraptus pendens* *T. similis*
Bendigo Upper	Daphne Reef	*Tetragraptus fruticosus* (3-branched)	As in Wattle Gully Beds and *Goniograptus macer* *G. thureaui*
Middle	South Fryerstown Race	*Tetragraptus fruticosus* (4-branched)	*Goniograptus macer* *Tetragraptus pendens* *T. similis* *Phyllograptus* cf. *typus* *Didymograptus latus*

He recorded beds of the Darriwil Series "as previously constituted", for the first time from the Castlemaine District. He extended the meaning of the term Darriwil to include not only the beds hitherto placed in it by T. S. Hall, but beds in the district between them and the Upper Castlemaine (Logano-caduceus) zone all of which he had found in the Darriwil district. He retained the Castlemaine Series as fixed by T. S. Hall although to him the two zones of the Middle Castlemanian are not always distinguishable. He divided the Bendigo beds at Castlemaine into two, one characterized by the three branched *Tetragraptus fruticosus* and the other by the four-branched. He stated that *T. fruticosus* (three-branched) and *Didymograptus bifidus* are found associated at Tarilta and other places. He defined his new conception of the Darriwil, the nature of its facies, its stratigraphical position, particularly in regard to the evidence afforded by the development of *Didymograptus caduceus* in both the Darriwil and Castlemaine Series, transitional beds and subdivisions.

He published a zone map and sections, also figures of *Cardiograptus morsus* gen. et sp. nov., *Diplograptus gnomonicus* sp. nov. and *Oncograptus biangulatus* sp. nov.

1918.—F. Chapman (82) described some hydroid remains belonging to the Calyptoblastea from black slate or shale, two miles east-north-east of North Monegeeta, south of Romsey. He inferred from the presence of *Acrotreta antipodium* that the beds were probably of similar age to the Lancefieldian of the Mt. William and Lancefield districts.

1919.—E. O. Teale (83) found in the Howqua River area graptolites on either side of the main diabase area there. On the western side, only Upper Ordovician *(vide* 156 *post)* and, possibly, Silurian graptolites occur. He searched assiduously where the *Monograptus* identified by T. S. Hall was stated to have been found, but did not find a single specimen of that genus, though hundreds of forms of less restricted range, chiefly *Climacograptus* and *Diplograptus* and probably *Glossograptus* were obtained.

On the eastern side, in thin black slates, he obtained *Tetragraptus* and *Didymograptus,* indicating a Lower Ovdovician horizon. Some distance upstream from the last locality, a few chains west of Eight-mile Creek, he found indistinct graptolites, suggesting *Diplograptus* and *Climacograptus.*

The same author gave (84) a useful synoptic table of Upper Ordovician assemblages recorded from Victoria. He added to the list from Mt. Wellington (52) *Diplograptus foliaceus,*

D. quadrimucronatus, D. calcaratus, Leptograptus flaccidus, Climacograptus bicornis var. *tridentatus, C. tubuliferus, Dicellograptus morrisi, D. gurleyi, Cryptograptus tricornis, Nemagraptus gracilis* and *Lasiograptus margaritatus.*

F. Chapman and E. W. Skeats (85) published what is largely a duplication of Chapman's paper (82) on the hydroids from North Monegeeta. They state that somewhat similar branching forms occur with *Dinesus ida* and other trilobite remains probably of Cambrian age near Heathcote, 30 miles to the north.

1920.—T. S. Hall (86) added to his list (63) of the Upper Ordovician forms from Tolwong *(vide* 159 *post),* New South Wales, *Leptograptus flaccidus, Dicellograptus complanatus* et var. *ornatus, D. morrisi, D.* cf. *caduceus, Dicranograptus ramosus* var. *semispinifer, D. hians, Climacograptus caudatus* var. *wellingtonensis, C.* cf. *tubuliferus, Diplograptus theilei, D. linearis, Glossograptus* sp., *Lasiograptus (Neurograptus)* cf. *fibratus,* (?) *Retiograptus geinitzianus* and Retiolitidae fragt. He added notes on *Diplograptus (M.) linearis, Climacograptus tubuliferus* and *C. caudatus* var. *wellingtonensis.*

R. A. Keble (87) described and figured *Tetragraptus approximatus* Nich., *T. acclinans* sp. nov. and *T. decipiens* T. S. Hall.

A. V. James (88) gives Upper Ordovician and Silurian graptolite localities on his map of the Bulla-Sydenham area in addition to those indicated on Quarter Sheets 1 NW., 7 SE.

No specific determinations of the graptolites he obtained from them are given.

1921.—L. F. Harper (89) recorded from Yalgogrin, New South Wales, *Climacograptus hastatus, Dicellograptus* cf. *affinis* and fragmentary forms comparable with *D. caduceus.*

W. J. Harris and W. Crawford (90) published lists of graptolites obtained from numerous specified localities in the Gisborne District. They represent collections from the Bendigo, Castlemaine and Darriwil Series and the Upper Ordovician. *Dicellograptus smithi* was recorded for the first time in Victoria.

A tentative recognition of three Upper Ordovician graptolite zones was proposed:

1. *Diplograptus-Didymograptus* Zone (lowest).
2. *Dicellograptus* Zone.
3. *Dicranograptus* Zone.

They stated that the Riddell Grits overlie the *Dicranograptus* shales (Upper Ordovician) and they underlie the

Kerrie Conglomerate. They suggested that the age of the Kerrie Conglomerate is basal Silurian.

1923.—T. S. Hall (91) recorded from Phosphate Hill, Mansfield, *Tetragraptus decipiens* and *T. approximatus*.

R. A. Keble (92) recorded the same species from Phosphate Hill, Mansfield, and placed them in the Upper Cambrian in conformity with American stratigraphy.

H. Herman (93) published zone maps and sections of the Bendigo Goldfield based on a subdivision of the Bendigo Series published therewith.

H. S. Summers (95) listed the graptolites from the Bacchus Marsh and Coimadai District and he (96) reviewed the evidence for the age of the Kerrie Conglomerate and gave lists of graptolites from Allot. 20, Parish of Newham; Allot. 5, Parish of Macedon; and Allot. 48A, 109 and 114, Parish of Kerrie.

E. W. Skeats (97) gave faunal lists in the Lancefield and Romsey districts. Most of the species had already been recorded (23, 24, 27, and 39). From the Bendigo Series, however, on the northern boundary of Allot. 49, Parish of Goldie, he recorded *Tetragraptus fruticosus* (3 and 4 branched), *Goniograptus macer* and *Phyllograptus*. In the railway cutting two miles east of Kilmore Gap he recorded Silurian species and he stated that *Monograptus* had been found two miles south-east of the cutting.

1924.—W. J. Harris (98) described and figured *Didymograptus v-deflexus* sp. nov., *Lasiograptus* (*Thysanograptus*) *etheridgei* sp. nov., *Retiograptus speciosus* sp. nov., *Climacograptus riddellensis* sp. nov., *Glossograptus hincksi, Didymograptus (Isograptus) caduceus*. He described and commented on *Cardiograptus* gen. and *C. morsus* sp., *Oncograptus biangulatus, Diplograptus gnomonicus, Trigonograptus ensiformis* and *Thamnograptus capillaris*.

Diplograpsus mucronatus (13) was relegated to the synonymy of *Lasiograptus* (*T.*) *etheridgei, Diplograptus rectangularis* (14) to *Climacograptus riddellensis* and *Diplograpsus mucronatus* (14) to *Glossograptus hincksii*.

F. Chapman (99) gave a systematic list of Tanjilian fossils in which he includes *Cryptograptus* sp., *Monograptus* cf. *crenulatus, M.* (?) *dubius* ("in Jordan River series") and *M.* cf. *jaekeli*. In regard to this list he adds the following note: "doubtfully included here. Occurring in the typical Walhalla Series, and high in that series, plant remains occur." (*Cryptograptus* is probably written in error for *Cyrtograptus*.)

In some critical remarks on the flora and fauna, he states: "Graptoloidea have been reported on by the late Dr. T. S. Hall. Some of the forms are rather high in the series, as compared elsewhere, and on account of their indifferent preservation, may require revision. Besides the first three on the list, determined by Dr. Hall, I have found the predominant graptolite supposed to belong to the Walhalla plant-bearing beds, to be a form related to *Monograptus* cf. *jaekeli* Perner, of the *M. priodon* type. Dr. T. S. Hall's plesiotypes of *M. dubius,* which have been examined by Mr. W. J. Harris and myself, belong to a form of the *M. priodon* type."

1925.—R. A. Keble (101) recorded from Allot. 28, Parish of Langwarrin *Climaçograptus* sp., probably of Upper Ordovician age; from the Howe's Creek Phosphate Mine, in a trench on Allot. 113A, Parish of Loyola, *Monograptus leptotheca, M. mcCoyi, M.* cf. *cutellus, M.* cf. *proteus, M.* spp. nov., *Climacograptus* sp., *Diplograptus* sp., and *Retiograptus* sp. He regarded the age as equivalent to the Llandovery of Britain.

From a locality north of Greendale he recorded *Didymograptus aureus, Tetragraptus fruticosus* (4 and 3 branched), *T. bryonoides, T.* cf. *quadribrachiatus, T.* cf. *acclinans, Dichograptus octobrachiatus,* and *Goniograptus laxus.*

From the Lerderderg River, between the river and the headwaters of Rum Creek, Parish of Blackwood, he recorded *Didymograptus aureus, D. latens, D. extensus, Tetragraptus fruticosus* (4 branched), *T. pendens, T. decipiens, T. harti, T. serra* and *Phyllograptus angustifolius.*

R. A. Keble and W. J. Harris (102) recorded a number of species from Mt. Easton (incorrectly referred to as Eastern). *Diplograptus calcaratus* var. *vulgatus* and *Leptograptus capillaris* were recorded for the first time in Victoria. They described and figured *Climacograptus missilis* sp. nov., *C. exiguus* sp. nov., *Leptograptus flaccidus* var. *subjectus* nov., *L. eastonensis* sp. nov. and *Dicellograptus gravis* sp. nov. They show in a table the relative position of the Mt. Easton beds in relation to the British Zones.

W. Baragwanath (104) adopted the following provisional classification of the Silurian in the Aberfeldy District:

Upper Silurian

Walhalla Series.
Jordan River (and Donnelly's Creek) beds.

Lower Silurian

Mt. Useful beds.

He collected graptolites from a number of places in the area which were submitted to T. S. Hall for identification.

He obtained *Monograptus* in black slates in the valley of the Thomson for half a mile above the Jordan-Thomson River junction. Regarding these graptolites he quotes T. S. Hall, who states that "*Monograptus* seems to be the only genus represented, and, as far as the material allows of careful examination, only one species is present. With some hesitation, owing to the imperfection of the material, I identify this as *M. dubius* Suess. . ." From a spur one mile south of the Thomson-Jordan junction, Hall identified *M.* cf. *dubius* and *M.* sp. Commenting on the forms from a spur between Little Boy's and Bell's Clear Creek, he remarked on their poor preservation and that they appeared to belong to the sub-genus *Pristiograptus.* Certain specimens had thecae of the "*priodon*" type. The forms from a spur a mile south of the last locality were likewise inconclusive.

From a locality near the last one, two specimens (Nos. 547 and 548) submitted to him provoked considerable comment. "No. 547," Hall says, "is a *Monograptus,* and is therefore a Silurian form, whereas No. 548 is a *Didymograptus,* having the aspect of *D. caduceus.* The cast of the sicula can be clearly seen, and the reverted apertural denticles of the thecae are visible. Of the generic position of the fossil there can be no question. The matrix, an indurated micaceous mudstone, appears the same as that of many of the other specimens from the same spur, but I feel convinced that the presence of the Lower Ordovician type in association with Monograptidae is an error due to human agency. With the exception of this fossil, the whole of the rest of the fossils (Nos. 522-538 and 547) are of Silurian age."

To this he added a footnote. "In face of Mr. Baragwanath's personal assurance that there was no confusion of localities in these two specimens, but that both came from the same block of stone, I have requested permission to re-examine them. I see no reason to alter my opinion as to their generic position. I have, moreover, explained the case to Mr. F. Chapman, A.L.S., and he has examined the supposed *Didymograptus.* He allows me to say that he agrees with my identification. Further specimens are urgently required from this locality as the inferences to be drawn are too important to rest on a couple of very indistinct fossils."

In view of the above, a further search was made in the same place and from the resulting specimens, T. S. Hall identified *Monograptus* cf. *dubius* Suess, *M.* cf. *crenulatus* Torn. (genus

Monoclimacis Frech), *M.* sp. (*colonus* group), *M.* sp. and (?) *Monograptus* or *Cyrtograptus.*

From the Thomson River valley at a blazed tree, 23 chains south of the southern boundary of the map, Hall identified *M.* cf. *dubius,* and *M.* sp.

The graptolites from the Upper Ordovician have been reviewed (53, 56, 102).

1926.—W. J. Harris (105) described and figured *Didymograptus nodosus* sp. nov., *Cardiograptus crawfordi* sp. nov., *Cryptograptus tricornis,* Atopograptidae fam. nov., *Atopograptus* gen. nov., *A. woodwardi* sp. nov. He commented on an assemblage from a locality north of Gisborne and one at Bendigo East, both high in the Lower Ordovician and possibly the highest yet recorded.

1927.—O. A. Jones (107) recognized the presence of *Monograptus chimaera, M. colonus, M. romeri* and *M. varians* at Studley Park, Melbourne. He showed that they indicated an horizon equivalent to that of the *M. nilssoni* Zone of the Lower Ludlow and were younger than the graptolites recorded from South Yarra, Macclesfield and Keilor.

1928.—R. A. Keble (108) examined two of the slabs from the Ring River, Tasmania, previously examined by T. S. Hall (48) and recorded a Dichograptid fragment, (?) *Tetragraptus* sp., (?) *Leptograptus* sp., (?) *Syndyograptus* sp.

W. J. Harris and R. A. Keble (109) described and figured *Staurograptus diffissus* sp. nov., *Dictyonema campanulatum* sp. nov., and *D. scitulum* sp. nov., from a band of blue slate at Lancefield. They regarded the bed as the oldest graptolite-bearing bed yet found in Australia and later (121) placed it at the base of the Ordovician.

E. W. Skeats (110) reviewed the field evidence regarding the occurrence of Silurian and Ordovician rocks in the Walhalla-Woods Point District where Etheridge[1] had noted traces of primitive plants in marine shales. As a result of the detailed study of the district by Herman,[2] Whitelaw,[3] Junner,[4] and Baragwanath,[5] the Silurian formations had been divided into the Lower (Mt. Useful), Middle (Jordan

1. Etheridge, R., Determinations of Palaeozoic and Mesozoic Fossils, Rec. Geol. Surv. Vict. 1 (1), p. 10. 1902.
2. Herman, H., Rep. on the Walhalla Goldfield. Special Rep. Dep. of Mines, Victoria. 1901.
3. Whitelaw, O. A. L., The Wood's Point Goldfield, Mem. 3, Geol. Surv. Vict. 1905, and The Topography, Geology and Mines of the Wood's Point District, ibid., 13. 1905.
4. Junner, N. R., The Geology of the Ore Deposits of the Walhalla-Woods Point Auriferous Belt, Proc. Aust. Inst. Min. & Met. (n.s.) 39. 1909.
5. Baragwanath, W., The Aberfeldy District, Gippsland, Mem. 15, Geol. Surv. Vict. 1925.

River) and Upper (Walhalla) divisions. The Jordan River beds had been held by Junner[6] to contain *Monograptus* in the lower portion of the Penenka shales with plant remains in the upper portion, while others were of the view that the plants were contained within graptolite bearing beds. Chapman[7] expressed doubts concerning this and believed that the plant-bearing Penenka shales were actually of Lower Devonian age, and rested on the Walhalla beds, in the lower portion of which was a Yeringian or Upper Silurian fauna. Skeats, however, confirmed the inferior position of the plant-bearing beds in regard to the Walhalla series, and confirmed the reported association of plants and graptolites in the Jordan River shales. An illustration of this was afforded by Keble (128) who identified a graptolite that occurred on the same slab as plants as *Monograptus riccartonensis* and relegated the series to the Zone of *M. riccartonensis* of the lower Middle Silurian of Britain. Subsequently a more extensive series of forms were studied by Elles (139) who referred them to the *M. nilssoni* Zone of the European early Upper Middle Silurian. The associated Psilophytales were described by Lang and Cookson (139).

1929.—R. A. Keble and W. N. Benson (111) published a correlation table showing that the graptolite succession in North-west Nelson, New Zealand, agreed with that in Australia. They described and figured a number of new species, some of which have since been found in Australia.

O. M. B. Bulman (112) published a useful paper dealing with the genotypes of graptolite genera. His comments in regard to Australian genera are as follows:

"*Atopograptus,* Harris, 1926, p. 59, genotype *A. woodwardi.*". (*vide* 105.)

"*Cardiograptus,* Harris & K., 1916, genotype *C. morsus* Harris & K. Possibly referable to *Phyllograptus* Hall." (*vide* 81.)

"*Goniograptus,* McCoy, 1876, genotype, *Didymograptus thureaui* McCoy." (*vide* 17.)

"*Oncograptus,* T. S. Hall, 1914, genotype, *O. upsilon,* T. S. Hall. Possibly best regarded as a subgenus of *Didymograptus,* McCoy." (*vide* 76.)

"*Triaenograptus,* T. S. Hall, 1914, genotype *T. neglectus,* T. S. Hall." (*vide* 76.)

E. W. Skeats (113) recorded graptolites from Tabberabbera at localities indicated on his map of the area.

1930.—W. J. Harris and R. A. Keble (114) identified from

6. Junner, N. R., *supra cit.*

7. Chapman, F., On the Question of the Devonian Age of the Tanjilian Fauna, Rep. Aust. Ass. Adv. Sci., xvii. 1926.

the Federal Territory, *Dicellograptus* cf. *gravis, D.* cf. *gurleyi, Dicranograptus furcatus* cf. var. *minima, Diplograptus calcaratus* var. *vulgata, D. ingens* and *Climacograptus tubuliferus.*

W. S. Dun (115) stated that certain areas at Narrandera, New South Wales, regarded as Devonian, were Ordovician, containing *Diplograptus.* He thought that most of the Palaeozoics between Narrandera and Albury were of Ordovician age.

1931.—W. R. Browne (116) recorded *Diplograptus (? Climacograptus) bicornis* from a locality south of Cooma, New South Wales.

O. M. B. Bulman (117) described and figured a number of species from South America. Commenting on the multiramous Dichograptids and the Phyllograptids having such a a high stratigraphical position in South America, he pointed out that the discrepancy is less when comparison is made with the Lower Ordovician faunas of eastern North America and Australia than with those of Europe. In regard to T. S. Hall's remark (40) that secondary branches of *Goniograptus macer* give off tertiaries on alternate sides, he said that an alternative is that *G. macer* is only an abnormal and incomplete example of what he terms *Loganograptus logani* var. *kjerulfi.*

He described *Dichograptus octobrachiatus* var. that resembles the form described by McCoy in 1874 (14). He also described and figured under *Didymograptus (Isograptus) caduceus* Salter, emend. var., a form comparable with the large V-shaped *D. caduceus* recorded by Harris (81).

1932.—G. L. Elles (119) published, with T. W. Edgeworth David's explanatory notes to accompany a new geological map of the Commonwealth of Australia, a correlation table of Australian with extra-Australian graptolite zones. She correlated the Australian Zones with what she considered their British, and American serial and zonal equivalents. She gave what she considered the Australian equivalents of many British species. T. W. Edgeworth David stated that G. L. Elles believed that the sequence of graptolite zones in Australia was practically the same as that in Europe.

R. A. Keble (120) published, with T. W. Edgeworth David's notes, a synoptic table of the Victorian Lower Ordovician graptolite zones and a table in which the Darriwil, Castlemaine, Bendigo and Lancefield Zones were elevated to series each of which was subdivided into five zones. Typical zone localities, restricted and common zone fossils are given. T. W. E. David said that Keble considered "that the grapto-

lite succession of Australia differs from that of Europe, and more closely resembles that of America, where, in the opinion of Ruedemann, the succession differs from that of Europe. T. W. E. David (118) deals with the Upper Ordovician rocks at Omeo and Mitta Mitta in Victoria which he states pass into New South Wales where, he says, they "lie in several parallel belts, of which the most easterly nearly follows the coast line to Batman's Bay, and thence perhaps trends inland to Tallong, near Marulan. The rich gold-bearing saddle-reefs of Hargreaves traverse Upper Ordovician rocks. The most westerly belt as yet proved strikes from the Forbes-Parkes area to Tomingley and Myall Reefs, also a gold-bearing zone."

He defines the limits of the Ordovician sea and the direction of the old shore-line. "East of this shore-line," he says, "there is a great development of Ordovician rock of a pelagic graptolite type belonging to this sea. These extend southward into Tasmania and northward into New South Wales right up to the Queensland border. This sea, probably continuous with the Larapintine Sea, spread over much of eastern Queensland as well, but so far no fossils have been found belonging to the eastern extension of the sea, except in the south-east extremity of the State, near Point Danger. There a *Diplograptus* has been identified in the local Brisbane schists, which there belong to either the top of the Ordovician (?) Bunya Series or to the base of the Silurian (?) Neranleigh Series. A long intermittent belt of Upper Ordovician rocks, characterized by veins of turquoise and other hydrous phosphates, extends from the Ovens River, Victoria, through Bodalla and Murwillumbah in New South Wales, the Neranleigh and Bunya Series of Brisbane, and the cherts of Gladstone and Yeppoon, to Innisfail, south of Cairns, Queensland. The uniform character of this phosphate zone suggests a more or less continuous development of Upper Ordovician rocks, along the eastern sea-board of Australia, for the distance of about 1,700 miles."

In regard to the Silurian, he gives a tentative correlation of the Silurian rocks of the Commonwealth. The graptolite assemblages of Victoria are, for the "Studley Park Bed," *Monograptus nilssoni* and *M. colonus;* the "Jordan Series," *M. priodon, M. dubius, Retiolites australis;* the "Keilor Beds"(upper part), *Monograptus riccartonensis;* the "Keilor Beds" (lower part), *M. turriculatus, M. exiguus, M. aplini;* the "Mount Useful Series" of the Walhalla Geosyncline, *M. convolutus.* He records Monograptids in the Hume Beds of

New South Wales and *Diplograptus* sp. in the Neranleigh Series of the Brisbane Series, an occurrence that he assigns to an horizon about the Valentian of Britain.

Third Period: 1932 to Present.

This may be termed the period of systematization. In 1932 the graptolite fauna was well enough known to subdivide the Lower Ordovician strata into series and zones, but the problem confronting systematists was where to fix their limits. It was known that the zones as constituted by T. S. Hall had not been based on the best principles of zoning, but it was difficult to adjust them without causing confusion. In 1932 W. J. Harris and R. A. Keble (121) systematized the subdivision of the Lower Ordovician largely on the basis laid down by T. S. Hall. They elevated his zones to series and subdivided each of these series into five zones.

W. J. Harris (138) suggested a further subdivision of the Darriwil, and he and D. E. Thomas (157) revised the subdivisions of all previous workers and added new series.

1932.—The systematization of the Victorian Lower Ordovician succession by W. J. Harris and R. A. Keble (121) is as follows:

DARRIWIL SERIES.

Zone	*Typical Locality*	*Zonal Species*	*Associated Forms*
D1	Bendigo East	Didymograptus nodosus Atopograptus woodwardi Brachiograptus etaformis	Cardiograptus crawfordi Climacograptus Didymograptus caduceus (rare) Phyllograptus nobilis Lasiograptus Glossograptus Diplograptus Cryptograptus tricornis Trigonograptus ensiformis Tetragraptus quadribrachiatus
D2	Loc. 7SZ Geol. Surv. Vic. Sutherland's Creek Steiglitz	Diplograptus austrodentatus	D. caduceus Trigonograptus Glossograptus C. tricornis Tetragraptus
D3	Castlemaine-Maryborough Railway W. of Strangways	Cardiograptus morsus	D. caduceus D. v-deflexus Tetragraptus Phyllograptus Diplograptus gnomonicus Trigonograptus

Zone	*Typical Locality*	*Zonal Species*	*Associated Forms*
D4	Chinamen's Creek, Muckleford	Cardiograptus morsus Oncograptus	D. caduceus D. v-deflexus Trigonograptus Phyllograptus Tetragraptus Strophograptus trichomanes D. gnomonicus
D5	Castlemaine-Walmer Rd. E. of borough Boundary, Castlemaine	Oncograptus upsilon	Much as in D4 D. forcipiformis Goniograptus speciosus
		CASTLEMAINE SERIES.	
C1	McKenzie's Hill, Castlemaine, water race in paddock N. of Castlemaine-Maldon Rd.	D. caduceus (maximum development)	Loganograptus logani Diplograptus sp. Didymograptus uniformis Tetragraptus quadribrachiatus
C2	Victoria Gully, Castlemaine	D. caduceus (sub-maximal development)	Diplograptus sp. Didymograptus spp. Dendroid forms Dichograptus cf. octonarius
C3	Victoria Gully, east of the Type locality of C2	D. caduceus (small forms) Phyllograptus cf. typus	Comparatively few
C4	Burns Reef, Chewton	P. cf. typus D. caduceus (small and rare)	Comparatively rare
C5	Wattle Gully, Chewton	D. bifidus	D. caduceus (small) Clonograptus spp. D. octobrachiatus Phyllograptus Goniograptus laxus G. crinitus Tetragraptus similis T. pendens
		BENDIGO SERIES.	
B1	Paddy's Gully, Bendigo	Tetragraptus fruticosus 3-br. D. bifidus	D. octobrachiatus Phyllograptus cf. typus Clonograptus abnormis Tetragraptus similis T. quadribrachiatus G. laxus
B2	Napoleon Syncline, Bendigo	T. fruticosus 3-br.	Much as in B1 Didymograptus similis Goniograptus thureaui D. extensus

Zone	*Typical Locality*	*Zonal Species*	*Associated Forms*
B3	Red, White and Blue Reef, Bendigo	T. fruticosus 3-br. and 4-br.	Didymograptus dilatans D. extensus Goniograptus thureaui T. pendens
B4	Garden Gully, Bendigo	T. fruticosus 4-br.	T. similis T. serra Clonograptus spp.
B5	Hustler's Hill, Bendigo	T. fruticosus 4-br. T. approximatus	D. aureus T. decipiens T. quadribrachiatus T. acclinans Loganograptus logani Clonograptus tenellus
	LANCEFIELD SERIES.		
L1	Bull Dog Creek, Mornington Peninsula	T. approximatus	T. decipiens T. quadribrachiatus T. acclinans C. tenellus
L2	Lancefield, near Deep Creek	Bryograptus victoriae T. decipiens	Clonograptus tenellus
L3	Lancefield Quarry, N.E. of Old Mt. William Railway Station	Dictyonema macgillivrayi B. victoriae	T. decipiens Clonograptus spp. Didymograptus pritchardi D. taylori
L4	North east of Romsey	Dictyonema campanulatum D. scitulum Staurograptus diffissus	No associates have been found
L5	Not yet recognized in Victoria	(Dictyonema)	

Commenting on the limitation of the Bendigo Series by the advent and extinction of *Tetragraptus fruticosus,* they say that "before dealing with each series and its zones in detail attention may well be called to a point which is of importance in all attempts at zoning, and which has been well expressed by Dr. Elles.[1] That experienced graptolithologist, from her extended study of British graptolite zones, writes: 'some commingling at the boundaries of the zones must naturally

1. Elles, G. L., The Characteristic Assemblages of the Graptolite Zones of the British Isles, Geol. Mag. lxii, pp. 337-347. 1925.

be expected, especially when dealing with the succession of purely shaly deposits, but as a rule even then the coming in of new forms in abundance should be taken as an index of the passage to a higher horizon. This fact is one upon which great emphasis should be laid; it is upon this, the coming in of new forms, usually indicative of a more advanced stage in evolution, that the basis of modern zonal stratigraphy is laid; the persistence of old forms tends to vary greatly in different localities. There does not appear to be any justification for action which results from focusing too much attention upon the index fossil rather than upon the assemblage, which is the determining factor'."

A short history of graptolite research was published and a correlation of the Victorian zones with those in the Northern Hemisphere.

They described and figured *Diplograptus (Glyptograptus) austrodentatus* sp. nov., *Phyllograptus nobilis* sp. nov., *Didymograptus forcipiformis, D. dependulus* sp. nov., *Brachiograptus etaformis* gen. et sp. nov., and *Goniograptus palmatus* sp. nov.

E. A. Ripper (122) indicated the distribution of the zones of the Castlemaine and Darriwil Series at Ingliston, near Bacchus Marsh. She found in the Darriwil Series Zone D2 characterized by the zone fossil *Diplograptus austrodentatus, Glossograptus* sp. and absence of *Cardiograptus morsus;* D3, characterized by *C. morsus* and the absence of *Oncograptus;* D4, with *Cardiograptus morsus* and *Oncograptus* sp.; D5-4, with *Oncograptus biangulatus* and *O. upsilon* and D5 with *O. upsilon* and the absence of *Cardiograptus.* In the Castlemaine Series she found Zone C1 with *Didymograptus caduceus* (maximum development) and *Oncograptus* absent.

She published detailed maps and sections.

D. E. Thomas (123) gave lists of graptolites from Lower and Upper Ordovician localities in the area to the north and north-west of Riddell and including parts of the Parishes of Kerrie, Monegeeta and Rochford. The localities are indicated by symbols on the map published with the paper. He records for the first time in Australia *Diplograptus (Amplexograptus)* cf. *arctus, D.* cf. *pageanus, Climacograptus minimus, C. putillus* cf. mut. *eximius* and *Dicellograptus forchammeri* var. *flexuosus.*

1933.—D. E. Thomas and R. A. Keble (126) published a comprehensive paper on the Bulla-Sunbury area and discussed the Silurian sequence in the Melbourne area. They outlined the history of ideas concerning the Silurian and

Ordovician systems and incidentally explained McCoy's conception which guided his investigations on Victorian Palaeozoic fossils when he was appointed Palaeontologist to the Geological Survey of Victoria in 1856 and during the next three decades. They also gave a number of sections and lists of fossils from localities indicated by numbers on the plans published with the paper, and also from localities on the Quarter Sheets. They suggest a revised serial subdivision of the Upper Ordovician, viz., (1) the Gisbornian Series (the oldest), (2) the Eastonian Series, and (3) the Bolindian Series. Lists of typical fossils from each of these series were supplied, together with a table of ranges of both Upper Ordovician and Silurian species. They compared the Victorian species with the British and showed their points of agreement as well as their differences.

They discussed the Ordovician-Silurian boundary west of Melbourne and in other parts of Victoria, particularly in regard to the anomalies that have arisen in previous work. The stratigraphy of the Silurian in and near Melbourne as hitherto worked out is discussed at length. The basis of palaeontological subdivision, particularly that of J. W. Gregory when he divided the Silurian into two series, viz., the Melbournian (the lowest) and the Yeringian, is reviewed. They showed that the evidence conflicts with that of the palaeontology and stratigraphy of the Melbourne area—the type locality of the Melbournian, which is high in the Silurian and the equivalent of the British Ludlow, and the area to the west. They proposed a revised subdivision in which they erected a new series, viz., the Keilorian, and substituted the term Yarravian for Gregory's Melbournian. They considered the sequence to be—

3. Yarravian.
2. Yeringian.
1. Keilorian (oldest).

The name Yarravian is suggested in place of Melbournian owing to the confusion that must inevitably arise from the previous assumption that the Melbournian represents the lowest subdivision of the Silurian. The Yeringian is taken as the equivalent of the Wenlock on the authority of McCoy and Chapman. The Keilorian is characterized by the first appearance of the Monograptidae and comprises all those beds preceding the incoming of *M. riccartonensis,* which marks the beginning of the overlying series. On its characteristic graptolites the Yarravian (= Melbournian)

may be correlated with the Llandoverian (Valentian) of Britain.

The following species were recorded, many for the first time:

L., Lower Ordovician; G., Gisbornian; E., Eastonian; B., Bolindian; K., Keilorian; Yer., Yeringian; Y., Yarravian.

Didymograptus caduceus, L. G.
var. ovatus, G.
Tetragraptus quadribrachiatus, L.
tabidus, L. G.
clarkfieldi, G.
Cryptograptus tricornis, L. G. E.
Glossograptus hincksii, L. G.
acanthus, L. G.
hermani, L. G.
pilosus, L. G.
Lasiograptus sp., L. G.
Climacograptus riddellensis, L. G.
antiquus, G.
var. bursifer, G.
lineatus, G.
simulans, G.
bicornis, G. E.
var. peltifer, G.
brevis, G.
scalaris (? var.), B., K.
var. miserabilis, B.
normalis, B.
minimus, E.
cf. exiguus, E.
tubuliferus, E.
putillus var. eximius, E.
stylodeus, B.
supernus, B.
missilis, E., B.
uncinatus, B.
caudatus, E. B.
Diplograptus (Orthograptus) cf. bellulus, E.
calcaratus, E. B.
var. acutus, E. B.
basilicus, E. B.
priscus, G. E. B.
vulgatus, G. E.
insectiformis var. vagus, B.
cf. pageanus, E.
quadrimucronatus, E. B.
var. spinigerus, B.
truncatus, E. B.
var. abbreviatus.
intermedius, E. B.
pauperatus, E.
socialis, E. B. K.
D. (Glyptograptus) sinuatus, B.
tamariscus, B. K.
teretiusculus, L. G.
var. siccatus, G.
euglyphus, L. G.
D. (Mesograptus) foliaceus, G?
magnus, K.
modestus, K.
multidens var. nov., G.
ingens, G. E. B.
D. (Amplexograptus) coelatus, L. G.
perexcavatus, G. E. B.
Retiograptus pulcherrimus, B.
speciosus, G.
latus?, G.
Dicranograptus zic-zac?, G. E.
furcatus var. minimus, G. E. B.
nicholsoni, G. E.
ramosus, G. E.
var. longicaulis, E. B.
spinifer, G. E.
brevicaulis, G.
hians, E.
var. apertus, E.
Dicellograptus sextans, G.
caduceus, B.
complanatus, B.
var. ornatus, E. B.
divaricatus, G. E.
elegans, E. B.
var. rigens, E. B.
forchammeri, E. B.
intortus, G.
moffatensis, E.
pumilus, B.
gravis, E. B.
affinis, B.
didymus, B.
latusculus, B.
Leptograptus flaccidus, E. B.
var. subjectus, E. B.
eastonensis, E. B.
capillaris, E. B.
Nemagraptus gracilis, G.
Pleurograptus linearis var. dispansa, B.
Monograptus bohemicus, Y.

aplini, K.
chimaera, Y.
colonus, Y.
var. compactus, Y.
comis, Y.
concinnus, K.
dubius, Yer. Y.
exiguus, K.
fimbriatus, K.
galaensis, K., Yer.
griestonensis, Yer.?
gregarius, K.
jaculum, K.
marri, K. Yer.
melbournensis, Y.
nilssoni, Y.
pandus, K.
priodon, K. Yer.
romeri, Y.
sedgwicki, K.
spiralis var. permensis, K.
turriculatus, K.
varians, Y.
var. pumilus, Y.
vulgaris var. curtus, Y.
Retiolites (Cladograptus) geinitzianus, K.
Stomatograptus australis, K.

Numerous plans and sections are published with the paper.

W. J. Harris (127) erected the new family Isograptidae and subdivided it into the genera *Isograptus* (Moberg), *Oncograptus* (T. S. Hall), *Cardiograptus* (Harris & K.), *Skiagraptus* gen. nov., and *Meandrograptus* (Moberg). He fixed as the genotype of *Isograptus, D. caduceus* (Salter), thus conceding priority to Salter's specific name. He pointed out that *I. caduceus* and its allies are "the most easily followed of graptolite phylogenetic series and they are the most reminiscent of the best-known palaeontological phylogenies."

In the genus *Isograptus* he places *I. forcipiformis, I. hastatus* sp. nov., *I. manubriatus* (T. S. Hall partim), *I. dumosus* sp. nov., and *I. ovatus* (T. S. Hall). The genotype of *Oncograptus* is *O. upsilon,* and in this genus he placed *O. biangulatus.* The genotype of *Cardiograptus* is *C. morsus,* and in the genus he placed *C. crawfordi.* The genotype of *Skiagraptus* is *D. gnomonicus.* The genotype of *Meandrograptus* is *M. schmalenseei* Moberg, and in this genus he placed the Victorian species *M. aggestus* and *M. tau* spp. nov. He stated "that unity is given to the whole by progressive development along several lines" which he specifies with examples, as follows:

1. The rhabdosome becomes increasingly scandent.
2. Progression and then regression in the form of the thecal aperture.
3. Concrescence, the more important.

He commented on the ancestry of *Isograptus caduceus.* He published a table showing the stages in the hypothetical development of that genotype and allied forms.

Stage 1 shows a progressive increase in the size of the rhabdosome, accompanied by more open spacing of the thecae, angle of divergence, downward direction of apertural

mucros, and the completeness of the thecal overlap. Stage 2 is characterized by deployment into allied genera. *Oncograptus upsilon* and *Cardiograptus morsus* are the only forms that do not seem distinctly paracmic and even these are very variable. The stage is marked by tendency towards reduction in size with closer thecae, still increasing angle of divergence leading to biserial forms, variation in mucros, reduction of thecal overlap in manubriate forms, grouping of thecal origins in sicular region as distinct from concrescence, but shown with concrescence in forms like *Oncograptus* and *Cardiograptus*. Stage 3 is marked by extinction of the group except for rare examples. The evidence is insufficient to place *Maeandrograptus aggestus* and *M. tau*. The catagenetic varieties of *I. caduceus* except *I. caduceus* var. *divergens* are not shown in the table. They are commonest in Zones C1 and D5, and show great variability, making grouping difficult. Practically all agree in distally-narrowing stipes.

He then dealt with *Isograptus caduceus* and its varieties, also with their stratigraphical horizons, with other varietal forms, manubriate species, *Isograptus forcipiformis* and *Skiagraptus gnomonicus, Oncograptus* and *Cardiograptus* and their development, *Macandrograptus* spp. and other species. He concluded with remarks on the correlation and zonal range of the Isograptidae.

He defined the new family Isograptidae and gave an amended diagnosis of the genus *Isograptus*. He described and figured *I. manubriatus, I. hastatus* sp. nov., *I. ovatus*. He commented on the genus *Macandrograptus* and described and figured *M. tau* sp. nov. and *M. aggestus* sp. nov. He described *Skiagraptus* gen. nov. and described and figured *S. gnomonicus*. In conclusion he described and figured *Didymograptus eocaduceus* sp. nov. and *D. hemicyclus* sp. nov.

He supplied a page of text figures and a plate.

R. A. Keble (128) described the occurrence of graptolites and vascular plants on a single slab of shale from the Yarra Track, west of Matlock. He identified the graptolite as *Monograptus riccartonensis* (cf. 139) and the plant as belonging to the genus *Psilophyton*. The occurrence of *Monograptus* with vascular plants definitely fixes their age as Silurian and establishes them as the oldest vascular plants yet recorded.

1934.—W. J. Harris and D. E. Thomas (129) contributed a paper on the geological structure of the Lower Ordovician rocks of (the County of) Eastern Talbot.

The distribution of the graptolite series and their relation to the axial lines were discussed. A section showing the graptolite zones was given. The relation of the auriferous zones to structure was considered and the authors came to the following conclusions regarding auriferous quartz reefs in the various zones:

1. The Darriwil beds have so far been uniformly barren.
2. The upper beds of the Castlemanian have contained productive fault reefs. Occasional saddle-reefs are known, but productive spurry reefs are more characteristic.
3. The Bendigo horizon contains numerous productive saddle reefs in addition to productive spurry reefs.
4. Auriferous saddle reefs occur in beds of the Lancefield horizon, but "indicator" gold is more characteristic.

The principal graptolite localities were listed.

W. J. Harris (130) stated that to the east of the central or gold-fields area of Bendigo Ordovician strata higher in the series than those of the central area have long been known. He discussed a number of traverses across the boundary between these higher and lower beds and shows that if the localities are plotted "it is seen that the dividing line between the high Darriwilian beds to the east and the Lancefieldian beds to the west (probably Bendigonian in the southwest) is an almost straight line bearing about N. 15° W. and traceable about 14 miles or more. . . . The only practicable explanation of this seems to be faulting" for which he suggests the name Whitelaw Fault. He estimated that "the thickness of missing beds would be about 12,000 feet measured vertically or perhaps 5,000 feet measured at right angles to the dip."

R. A. Keble and W. J. Harris (131) figured and described *Didymograptus acriculus* sp. nov., *D. mendicus* sp. nov., *Tetragraptus chapmani* sp. nov., *T. decipiens* var. *bipatens* nov., *Pterograptus lyricus* sp. nov., *Climacograptus uncinatus* sp. nov., *C. subminimus* sp. nov., *Diplograptus* (*Glyptograptus*) *euglyphus* Lapw., D. (G.) *euglyphus* var. *sepositus* nov., *D. (Amplexograptus) perexcavatus* Lapw., *Trigonograptus* sp., *Glossograptus pilosus* sp. nov., *Cryptograptus circinus* sp. nov., *Retiograptus pulcherrimus* sp. nov., *Monograptus aplini* T. S. Hall emend. Keble & H., *M. spiralis* (Geinitz) var. *permensis* nov., *M.* cf. *scanius* Tullb., *M. pandus,* and *Stomatograptus australis* (McCoy).

K. Sherrard (132) exhibited at the Royal Society, Sydney, New South Wales, *Monograptus colonus* var. *compactus* and

M. cf. *nilssoni* from the Parish of Derrengullen, Yass District, New South Wales.

R. Ruedemann (133) stated that Australia, New Zealand and China have furnished graptolite faunas that are closely related to those of North America. In dealing with Palaeozoic seas and palaeo-geographic problems, he stated that "conclusions, at present only preliminary and based upon uncompleted survey of the graptolite faunas of North America, confirm the presence of a Pacific Ocean as an independent centre of evolution. This is evidenced by the presence of such genera as *Cardiograptus* and *Oncograptus* and various species that occur in the Pacific (Australia, British Columbia, Idaho and Texas) but not in the Atlantic province. The presence of these genera and species in the Cordilleran geosyncline leaves no doubt of its connection with the Pacific Ocean, at least periodically."

1935.—W. J. Harris and D. E. Thomas (134) described and figured a number of species, viz., *Pterograptus incertus* sp. nov., *Trichograptus immotus* sp. nov., *Tetragraptus defensus* sp. nov., *Didymograptus cognatus* sp. nov., *D. distinctus* sp. nov., *D. cuspidatus, D. compressus* sp. nov., *D. dubitatus* sp. nov., *D. nodosus, Diplograptus* (*Glyptograptus*) *austrodentatus, D.* (*G.*) *intersitus* sp. nov., *D.* (*G.*) cf. *euglyphus,* (?) *Mesograptus decoratus* sp. nov., *Amplexograptus modicellus* sp. nov., *A. confertus, A. differtus* sp. nov., *Glossograptus acanthus,* (?) *G. crudus* sp. nov., (?) *G. crudus* var. *gisbornensis* nov., *Cryptograptus schaferi, Lasiograptus* (*Hallograptus*) *proteus* sp. nov., *Lasiograptus* (*Thysanograptus*) *etheridgei, Cardiograptus crawfordi.*

D. E. Thomas (135) stated that the lithology of the Victorian Ordovician is consistent throughout, sandstones, shales, grits and mudstones alternating.

He gave a table showing the graptolite subdivisions of the Ordovician System of Victoria suggested by Harris and Keble and by Thomas and Keble, and supplemented it with a more detailed account of each zone and its graptolite assemblages. He gave the distribution and structure of the Lower and Upper Ordovician rocks and referred to the period of faulting and folding.

F. Chapman and D. E. Thomas (136) dealt with the distribution of the Silurian system, its lithographical types, relation to older and younger rocks, sequence, occurrence in the Walhalla, Heathcote, and Melbourne districts and its contained fossils both graptolites and others. They retained the name Melbournian on account of its priority over Yarra-

vian and considered the sequence to be Keilorian, Melbournian, and Yeringian, the Keilorian being the oldest. They correlated the Keilorian with the Lower Silurian or Llandovery Series of Britain; over these beds, at Keilor, come beds with *Monograptus riccartonensis,* indicating Middle Silurian or Wenlock age. They correlated the Melbournian with the Lower Ludlow Series of the Upper Silurian of Britain, and the Yeringian with the Upper Ludlow.

They discussed the lithological characters and fossil contents of the Keilorian, Melbournian and Yeringian in the Melbourne-Lilydale-Upper Yarra district as well as in other parts of Victoria.

W. J. Harris (138) in an important contribution discussed an area including the Parishes of Wellsford, Strathfieldsaye and Sedgwick with adjacent portions of other parishes, particularly in regard to the Darriwilian. He gave the general distribution of the graptolite series and an outline of the zoning of the Darriwilian as high as the D2 Zone. He contended that the incoming of the Diplograptidae in force in the D2 Zone marks a very important stage in the graptolite succession and discussed the relationship of the D2 beds to the lower zones. He described five sections from east to west across the area, and showed that there is a normally descending series of beds to the Whitelaw Fault, and that above the D2 horizon two zones may be distinguished with possible passage beds, (a) a zone characterized by *Diplograptus* (*Glyptograptus*) *intersitus* and *Didymograptus compressus,* and (b) a higher zone characterized by *Diplograptus* (*Mesograptus*) *decoratus* and *Didymograptus nodosus.* These zones may be recognized throughout the area. He maintained that field and biological evidence fixes the position of the zones already mentioned and that elsewhere in Victoria a higher zone in the Lower Ordovician can be recognized, while the basal graptolite bed of the Upper Ordovician (as at Ba 67 Quarter Sheet 6 SE.) should also be included in a *Diplograptus* series. In regard to the zoning of the Darriwilian and Castlemanian in Victoria, he stated that the grouping of zones from D2 to basal Upper Ordovician inclusive, as a *Diplograptus* series, leads to an attempt to treat lower beds in the same way. He states that the breaks between the typical series are largely artificial and suggests that the zones below the *Diplograptus* series, i.e., from D3 downwards to C4 (inclusive) may be regarded as an *Isograptus* series. Immediately below this series are passage beds characterized by *Didymograptus protobifidus* Elles, while

below these again the Bendigo Zones form a *Tetragraptus fruticosus* series.

DIPLOGRAPTUS SERIES

(In the following table, c = common, r = rare, v = very)

Zone of *Diplograptus* (*Glyptograptus*) *teretiusculus* (highest).

Typical locality: Ba 67 at junction of Riddell's and Jackson's Creeks (Q.S. 6 SE.).

Characteristic assemblage:

Diplograptus teretiusculus His. (v.c.).
euglyphus Lapw. (c.).
Climacograptus riddellensis Harris (c.).
Cryptograptus tricornis Carr. (c.).
Glossograptus hincksii Hopk. (c.).
Retiograptus speciosus Harris (c.).
Isograptus caduceus var. tenuis Harris var. (v.r.).
Didymograptus (horizontal spp.) (c.).
Pterograptus lyricus Keble & H.

Zone of *Diplograptus* (*Glyptograptus*) *euglyphus*.

Typical localities: Turner's Quarry; Eight-Mile, Howqua River.

As above, except that *Diplograptus teretiusculus* has not been recognized with certainty, *Tetragraptus* is more common, and *Retiograptus speciosus* not yet recorded. *Isograptus ovatus* occurs at both typical localities, though elsewhere it seems to be an Upper Ordovician form.

Zone of *Diplograptus* (*?Mesograptus*) *decoratus* (*D.* aff. *coelatus*).

Typical localities: Loc. 164 Strathfieldsaye; loc. 300, Sedgwick; Allot. 8, Sec. XXIX Huntly.

Diplograptus (?Mesograptus) decoratus Harris & T. (v.c.).
D. (Amplexograptus) confertus Lapw. (c.).
differtus Harris & T. (c.).
modicellus Harris & T. (c. locally).
Cryptograptus schaferi Lapw.
Lasiograptus proteus Harris & T.
Isograptus forcipiformis (Rued.).
Cardiograptus crawfordi Harris.
Brachiograptus etaformis Harris & K.
Trigonograptus ensiformis J. Hall.
Didymograptus nodosus Harris (v.c.).
dubitatus Harris & T.
cognatus Harris & T.
cuspidatus Rued.
acriculus Keble & H.
Atopograptus woodwardi Harris.
Phyllograptus nobilis Harris & K. (v.c.).
Tetragraptus spp.

In what are probably the lower beds of this zone, *D. decoratus, D. nodosus* and *Lasiograptus etheridgei* are the commonest species as, e.g., at loc. 176 and north-west of Turner's Quarry. A similar assemblage, with *Didymograptus nodosus,* very rare, is found at Woodend (Allot. 95, 99) and at Newham (Sec. 20).

Zone of *Diplograptus (Glyptograptus) intersitus.*
Typical localities: Loc. 196, 210 Strathfieldsaye; 298 Sedgwick.
Diplograptus (Glyptograptus) intersitus Harris & T. (v.c.).
Lasiograptus etheridgei Harris (v.c.).
Isograptus forcipiformis (Rued.).
caduceus var.
Cardiograptus crawfordi Harris (c.).
Cryptograptus schaferi Lapw.
Glossograptus acanthus Elles & W.
Trigonograptus ensiformis J. Hall.
Didymograptus compressus Harris & T. (c.).
spp.
Tetragraptus spp.
Pterograptus incertus Harris & T. (c.).
Phyllograptus sp.
Loganograptus cf. logani J. Hall (v.r.).
Zone of *Diplograptus austrodentatus* (D2).
Typical localities: Loc. 310 Sedgwick; Guildford-Strangways Road; Brisbane Ranges.
Characteristic assemblage.

ISOGRAPTUS SERIES

Zone of Cardiograptus morsus (D3).
„ „ Cardiograptus and Oncograptus (D4).
„ „ Oncograptus (D5).
„ „ Isograptus caduceus var. maxima et var. maximo-divergens (C1).
„ „ I. caduceus var. victoriae (C2).
„ „ var. lunata (C3, C4).

DIDYMOGRAPTUS PROTOBIFIDUS PASSAGE BEDS

Zone of Didymograptus protobifidus and Isograptus caduceus var. primula et lunata (C5).
„ „ Didymograptus protobifidus and Tetragraptus fruticosus (B1).

TETRAGRAPTUS FRUTICOSUS SERIES
(Bendigonian Zones)

He correlated the *Diplograptus* series with the Llanvirnian of Britain and suggested that the correlation of beds immediately below these will probably be facilitated by a study of the Victorian extensiform *Didymograpti.*

He published a map with notes, a section, an index to graptolite localities and a list of references.

W. H. Lang and I. C. Cookson (139) contributed a paper on the flora, including vascular land-plants, associated with *Monograptus,* in rocks of Silurian age. They submitted the associated graptolites to G. L. Elles, who identified *M. uncinatus* var. *orbatus* from the Yarra Track beds and *M. chimaera, M. uncinatus* var. *orbatus* et var. *micropoma* from the Alexandra beds; she regarded the assemblage typical of a Lower Ludlow horizon (110 and 128).

G. F. K. Naylor (141) indicated on a map of the Goulburn District, New South Wales, Upper Ordovician localities yielding *Climacograptus, Diplograptus, Dicranograptus* and *Dicellograptus.* From a locality on the Bungonia-Goulburn Road, about three miles west of Bungonia, he recorded Lower Silurian forms comparable with *Monograptus barrandei* and *M. exiguus.* He also recorded from a locality on the main Sydney Road near the Towrang turn-off *Monograptus* of an Upper Silurian type. D. E. Thomas (*ibid.* p. 80) suggested that it was *M. bohemicus* and probably contemporaneous with the zone of *M. nilssoni.* Naylor himself tentatively determined another form as *M. nilssoni.*

W. N. Benson and R. A. Keble (142) wrote on the geology of the regions adjacent to Preservation and Chalky Inlets, Fiordland, New Zealand, and correlated the New Zealand assemblages with those of Victoria. They described and figured a number of species, some of which were new and should occur in Victoria. In particular, they referred *Leptograptus antiquus* T. S. Hall to the genus *Bryograptus.*

1936.—G. F. K. Naylor (143) recorded from a locality between the third and fourth mile-posts on the Bungonia-Goulburn Road (presumably the locality mentioned in 141) *Monograptus exiguus* and *M. barrandei* and in addition *M. undulatus, M.* cf. *decipiens, M.* cf. *tortilis.* He recorded from the Upper Ordovician *Diplograptus quadrimucronatus* and *D. calcaratus* var. *tenuicornis.*

He described and figured from more or less specified localities *Monograptus bohemicus, M. exiguus, M.* cf. *decipiens, M. undulatus, M.* cf. *tortilis, Diplograptus* (*Orthograptus*) *quadrimucronatus* and *D.* (*O.*) *calcaratus* var. *tenuicornis.* He described *M. barrandei.*

R. A. Keble (144) recorded and figured from the Bendigo Series a form in which the flat spiral polypary and thecae growing upwards in a single linear series seemed to him to leave no other alternative than to place it among the Monograptidae.

O. M. B. Bulman (145) made serial sections and dissections of the graptolites of the Holm Collection from which he made wax models and traced their history and evolution by a close study of the initial part of the rhabdosome. This important work threw considerable light on such peculiarly Australian genera as *Brachiograptus* Harris & K., *Cardiograptus* Harris & K., *Goniograptus* McCoy, *Oncograptus* T. S. Hall and many cosmopolitan genera.

He also investigated (146) by serial sectioning and grind-

ing two specimens of *Oncograptus* from the El Paso Limestone (Canadian) of Marathon, Texas, United States, preserved in semi-relief in impure limestone. He showed "that *Oncograptus* can have no close relation to *Isograptus* but is derived from a Tetragraptid in which the mode of development had not progressed to the minutus stage of the Dichograptid type, where th.2^1 is produced from th.1^1, opposite and approximately at the same level as th.1^2. It hardly seems probable that a proximal end with the structure of *Oncograptus* could progress further towards the Diplograptid type of development and hence that *Cardiograptus* (assuming this to be its completely biserial descendant) could be an ancestor of any 'normal' Diplograptids."

F. Chapman and D. E. Thomas (147) recorded Cambrian Hydroida from Heathcote and Monegeeta Districts. New genera, species and varieties described and figured are *Archaeocryptolaria recta* Chapm. var. *flexilis* nov., *Archaeolafoea serialis* sp. nov., *A. fruticosa* sp. nov., *Protohalecium* gen. nov., *P. hallianum* sp. nov., *Sphenoecium* gen. nov., *S. discoidalis* sp. nov., *Cactograptus flexispinosus* sp. nov., *C. plumigerus* sp. nov., *Acanthograptus candelabrum* sp. nov.

1937.—P. Ekström (148) described and figured *Phyllograptus nobilis* Harris & K. and used it as a subzonal fossil in Norway.

A. Monsen (149) described and figured many Australian forms that had been found in the Norwegian graptolite shales such as *Dictyonema macgillvrayi, Didymograptus* cf. *aureus, D.* cf. *perditus, Tetragraptus* cf. *harti, T. decipiens* and *Goniograptus* aff. *palmatus.* Monsen compares the Australian succession as given by Harris and Keble (121) with the Norwegian succession and adds a synoptic table correlating the Norwegian with the Swedish, English, North American, Australian and Bohemian zones.

K. Sherrard and R. A. Keble (150) recorded graptolites from specified Upper Ordovician localities in the Parishes of Morumbateman, Mundoonen and Manton, near Yass, New South Wales. They gave a correlation table of the Yass occurrences with other places in New South Wales. From the Silurian beds near Yass, they recorded *Monograptus flemingi, M.* cf. *tumescens, M.* cf. *nilssoni, M.* cf. *vomerinus* and *Dictyonema* sp. They stated that "the graptolite bed overlies the Limestone Creek beds and incidentally the Barrandella shales . . . the succession seems to be quite conformable and undisturbed . . . Hence the age of the Limestone Creek beds and the Barrandella shales, if Shearsby

and Sherrard are right in stating that they are the same bed, may be fixed by the graptolite bed, that is, they are Silurian, probably high Wenlockian." Descriptions and figures were given of both Upper Ordovician and Silurian forms, including *Retiograptus yassensis,* a new species.

E. A. Ripper (151) published a paper on *Didymograptus protobifidus.* After reviewing the Victorian pendent *Didymograpti,* she gave a description of *D. protobifidus* Elles. She stated that T. S. Hall "referred under the name of *D. bifidus* (J. Hall) to some forms which undoubtedly belong to this more primitive species." Transients are to be found in the Upper Bendigonian and Lower Castlemanian assemblages and a number of localities where they occur are specified.

She gave a comparative table of the specific characters and details of the evolutional changes of *D. bifidus* and *D. protobifidus,* also remarks on assemblages and correlations.

"After a careful comparison of Victorian and British specimens," she concluded, "the tuning-fork graptolite occurring most abundantly in the uppermost Bendigonian and Lower Castlemanian (B1 and C5) zones in Victoria is identified with *Didymograptus protobifidus* Elles."

She supplied a table showing the proposed correlation of the Victorian and British Lower Ordovician graptolite succession.

G. F. K. Naylor (152) in a preliminary note on the occurrence of Palaeozoic strata near Taralga, New South Wales, gave a map and sections of the district. In the basal sediments he found "generically recognizable specimens of *Diplograptus, Climacograptus, Dicellograptus* and *Dicranograptus* pointing unquestionably to the Upper Ordovician age of the beds."

Silurian beds occur in rather restricted lenticular bands folded in among the Ordovician strata. The two most prominent forms of graptolites occurring in them are *Monograptus bohemicus* and *M. chimaera.*

D. E. Thomas (153) published notes on the Silurian rocks of the Heathcote area. He gave a classification to which he attached local names. In his Dargile Beds the lower beds are unfossiliferous and are separated by some sandstone from the Graptolite Beds which also contain numerous shelly fossils. He divided the Graptolite Beds into:

(a) The lowest beds with *Monograptus uncinatus,* var., *M. colonus* var. *compactus* and fossils other than graptolites.
(b) These are succeeded by sandstones and mudstones and the former have

yielded corals and a starfish bed. With this a graptolite cf. *M. nilssoni* was found.

(c) The upper beds yielded abundant graptolites, *M. colonus* var. *compactus, M. uncinatus* var., *M. bohemicus* and *M. varians* and fossils other than graptolites.

W. J. Harris and D. E. Thomas (154) published descriptions and figures of the following species:

(a) From the Heathcote district—
Monograptus bohemicus, M. colonus var. *compactus, M. varians, M. uncinatus* var. *orbatus, M. uncinatus* var. *micropoma, M.* sp. aff. *nilssoni* and *M.* cf. *comis.*

(b) From the Kilmore district—
Diplograptus sinuatus, Climacograptus hughesi, Monograptus runcinatus, M. (?) *nudus, M. priodon, M. exiguus* (syn. *M. aplini* T. S. Hall), *M. spiralis* var. *permensis, M. dubius.*

(c) From the Yarra Track—
M. uncinatus var. *orbatus, M. uncinatus* var. *micropoma, M. vomerinus* and *M. vomerinus* var. *crenulatus.*

(d) From the Melbourne district—
M. crinitus, M. dubius.

1938.—W. J. Harris and D. E. Thomas (155) dealt with the basal Bendigo (B5) assemblage from Allot. 16A, Parish of Campbelltown. They stress some of the features shown by the assemblage:

"(i) Instability of branching, so that Dichograptid or Loganograptid forms with from six to sixteen branches occur, together with five or six branched forms otherwise indistinguishable from *Tetragraptus fruticosus* (*vide Bryograptus crassus infra*). Three branched forms which are apparently three-branched representatives of horizontal *Tetragrapti* are also found."

"(ii) A great variety of extensiform *Didymograpti* including a series with 'closed' apertural regions (*D. hirundo* type) without any evidence of ancestral history as they are quite distinct from the rare *Didymograpti* recorded from the next lower zone (L1).

"(iii) Abnormal *Clonograpti* of great size with distinctive thecae of the *Tetragraptus chapmani* type."

"The higher beds (B4) are also extremely interesting as from them we are able to record for the first time from Australia the genera *Trochograptus* and *Schizograptus*, both with abnormal features, while the three-branched forms referred to above are not uncommon. This list by no means

exhausts the interesting features presented by the present collections."

"Apart from the forms which may be called abnormal the most interesting feature of the B5 assemblage from Allot. 16A is the notable 'burst' of extensiform *Didymograpti* and, contrary to the conclusions drawn by Elles[1] from English collections, the commonest forms on this, the lowest Victorian horizon on which *Didymograpti* are common, are those with 'closed' proximal regions. In Victoria the only *Didymograpti* of the Upper Lancefieldian are the distinctive *D. taylori* and *D. pritchardi*. The horizontal forms which come in so suddenly in B5 persist to higher horizons, but the *D. hirundo* type does not range above B4 where it reaches its climax in *D. latus* var. *aequalis* nov."

"The B5 horizon corresponds with that of the reclined *Tetragrapti* of the zone of *D. extensus* as defined by Elles and this agrees with her earlier correlation. The same horizon has been noted in New Zealand but there, as at most localities in Victoria, the number of species seems limited and there is no indication of the 'burst' of horizontal Didymograpti. The lower Bendigonian 'burst' of new forms is preceded by the 'burst' of *Bryograpti* and *Clonograpti* in the Middle Lancefieldian (L3) described by T. S. Hall. In the L1 beds the incoming of the horizontal *Tetragrapti* such as *Tetragraptus approximatus* and *T. acclinans* does not alter the general aspect of the assemblage, but the entry of the dependent *Tetragrapti* such as *T. fruticosus* and the extensiform *Didymograpti* in B5 introduces important new elements. A comparison of the Lower Bendigonian with those assemblages from other countries which may be correlated best with that stage shows that local differences are probably more important than some European graptolithologists have been prepared to admit, and that schemes of development based on the appearances of forms in any one region may not stand the test of observation when applied to more distant fields."

Commenting on branching as a generic character of the Dichograptids, they stated that "the presence of so many Dichograptid forms with apparently transitional numbers of branches brings forcibly to notice the artificial distinctions such as divide *Loganograptus* and *Dichograptus, Trochograptus* and *Schizograptus* and even *Tetragraptus* (where three-branched forms have been included in a genus which by its name was meant for four-branched forms). . . . The

1. Elles, G. L. Summary of Progress, Geol. Surv. G. Brit. for 1932, II, 1932.

problem of the development of branching forms such as *Loganograptus* and *Dichograptus* is complicated in Victoria by the simultaneous appearance of so many variants in the one bed without any indication of them in lower zones. It is therefore impracticable as far as Victorian graptolites are concerned to account for the production of *Dichograptus* by the reduction of stipes of *Loganograptus* unless it is presumed that reduction commenced as soon as *Loganograptus* appeared. The two forms appear together in B5, *Dichograptus* then persists, though not as a common form, as high as the Middle Darriwil, while *Loganograptus* is hardly known to occur again (one or two specimens have been recorded) until the Upper Castlemaine zones are reached, in spite of the large collections that have been made from intervening horizons. We have already referred to five- and six-branched dependent forms, which in number of branches, resemble *Tetragraptus fruticosus,* the normal four-branched form of which also occur in the same bed. These forms, abnormal in nothing except in number of branches, we must by current usage separate as *Bryograpti* (*vide B. crassus infra*). Another example of reduced branching is shown by forms from the B5 and B4 horizons which have only three branches and have therefore a superficial resemblance to *Triograptus* Monsen. It seems clear, however, that the three-branched habit is not due to the typical *Triograptus* form of development but rather to the failure of a fourth branch to arise in a horizontal Tetragraptus such as *T. harti*; that is these forms represent the three-branched phase of a horizontal *Tetragraptus* in the same way as the three-branched *T. fruticosus* does of a dependent *Tetragraptus.* An alternative would be to derive them from *Trichograptus* by suppression of branches but the *Tetragraptus* explanation seems simpler.'' Specimens were figured in the present paper but the authors postponed fuller discussion.

The forms figured and described are: *Trochograptus australis,* sp. nov., *T. indignus* sp. nov., *T.* cf. *diffusus, Schizograptus incompositus* sp. nov., *S. spectabilis* sp. nov., *Sigmagraptus yandoitensis* sp. nov., *Trichograptus fergusoni, Bryograptus crassus* sp. nov., *Clonograptus rarus* sp. nov., *C. smithi* sp. nov., *C. ramulosus* sp. nov., *C. tenellus* var. *problematica* nov., *Dichograptus sedecimus* sp. nov., *Tetragraptus pendens, T. harti, T. triograptoides* sp. nov., *T. volitans* sp. nov., *T. approximatus, Didymograptus latus, D. latus* var. *aequalis* nov., *D. abnormis, D. hemicyclus, D. similis, D.* cf. *suecicus, D. vicinus* sp. nov. and *D. aspersus* sp. nov.

The same authors contributed (156) some notes on the geology of the Howqua valley. They published a map and a section from west to east. They identify specimens in collections made at certain specified Upper Ordovician (Gisbornian) and Lower Ordovician (Darriwilian, Bendigonian and Lancefieldian) localities. They discuss T. S. Hall's identification of *Monograptus*.

W. J. Harris and D. E. Thomas (157) summarize critically the older classifications, and propose a modification of that latest in use, in which more time-significance is attached to the entry in abundance or "bursts" of new groups of forms into the faunal sequence, and the enumeration of successive zones in the reverse order of their deposition, which crept into the older scheme, is avoided. Certain of the major series are redefined, new serial names are introduced, and a Middle Ordovician division is for the first time brought definitely into the classification. The following is a brief statement of the scheme, and the correlation of the new zones with the older, the zone numbers for which are given in inverted commas.

LOWER ORDOVICIAN

(As now restricted)

Lancefield Series or Lancefieldian

La1 Zone of *Staurograptus* and *Dictyonema*. ("L4".)

La2 Zone of *Bryograptus*.

La2a: Burst of *Bryograptus, Tetragraptus*, primitive *Didymograpti*, and large *Dictyonemas*. ("L3".)

La2b: No large *Dictyonemas* ("L2").

La3 Zone of *Tetragraptus approximatus* ("L1").

Bendigo Series or Bendigonian (as now restricted)

Be1 Zone of *Tetragraptus fruticosus*, four-branched. Entry of the zone fossil; survival of *T. approximatus* ("B5"). This is one of the most important bursts of Victorian graptolites.

Be2 Zone of *T. fruticosus*, four-branched. Absence of *T. approximatus* ("B4").

Be3 Zone of *T. fruticosus*, three-branched. Entry of *T. fruticosus*, three-branched, in force; survival of *T. fruticosus*, four-branched ("B3").

Be4 Zone of *T. fruticosus*, three-branched. Absence of *T. fruticosus*, four-branched ("B2").

Chewton Series or Chewtonian (a Series newly instituted)

Ch1 Zone of *Didymograptus protobifidus*. Entry of *D. protobifidus*. Survival of *T. fruticosus*, three-branched ("B1").

Ch2 Zone of *D. protobifidus*. Absence of *T. fruticosus*. ("C5").

Ch3 Zone of *Didymograptus balticus*. At present imperfectly known. Characterized by *Didymograpti* and *Phyllograpti*, and containing small forms of *I. caduceus* var. *lunata*. ("C4").

Castlemaine Series or Castlemanian (as now restricted)

Ca1 Zone of *Isograptus caduceus* var. *lunata.* Entry of *I. caduceus* var. *lunata* in force. ("C3").
Ca3 Zone of *Isograptus caduceus* var. *victoriae.* ("C2").
Ca3 Zone of *Isograptus caduceus* var. *maximus* and var. *maximo-divergens.* ("C1").

Yapeen Series or Yapeenian

(Formal acceptance of name previously suggested to include the lower portion of the Darriwilian)

Ya1 Zone of *Oncograptus.* ("D5").
Ya2 Zone of *Cardiograptus.* ("D4 and D3").

Middle Ordovician

(Term established, with usage rather different from that in Great Britain, to include the upper portion of the Darriwilian and one higher zone)

M.O.1 Zone of *Diplograptus* (*Glyptograptus*) *austrodentatus.* Entry of the *Diplograpti* in force. ("D2").
M.O.2 Zone of *D.* (*G.*) *intersitus* ("D1a")
M.O.3 Zone of *D.* (*G.*) *decoratus.* ("D1b").
M.O.4 Zone of *D.* (*G.*) *teretiusculus* (formerly considered basal Gisbornian). *Glossograptus hincksii* abundant, entry of *Climacograpti.*

Upper Ordovician

Regarding the Upper Ordovician, Harris and Thomas, commenting on the divisions of Thomas and Keble (126) into

3. Bolindian.
2. Eastonian.
1. Gisbornian.

state that:

1. Apart from the zone of *Glyptograptus teretiusculus,* which has been included in the Middle Ordovician, the zone of *Nemagraptus* and zone of *Climacograptus peltifer* represent the *Gisbornian.*
2. The lowest beds of the Eastonian were not ascribed to any definite zone, but the upper part was correlated with the zone of *Dicranograptus clingani.*
3. The Bolindian was stated to contain three characteristic assemblages—
   (a) At the base *Diplograptus quadrimucronatus, Dicellograptus elegans,* and *Climacograptus tubuliferus.*
   (b) *Pleurograptus* sp. characterizes the middle portion.
   (c) Still higher assemblages are characterized by *Retiograptus pulcherrimus,* while *Diplograptus sinuatus* and *D. tamariscus* are also present.

As a result of work in the Romsey and Emu Creek areas, Thomas subdivided the Upper Ordovician as follows:

Zone of *Dicellograptus* cf. *complanatus*
Zone of *Pleurograptus* } Bolindian

Zone of *Dicranograptus hians* Zone of *Climacograptus wilsoni* (according to Elles (119), 1932, this is *C. baragwanathi*, T. S. Hall)	Eastonian
Zone of *Climacograptus peltifer* Zone of *Nemagraptus gracilis*	Gisbornian

Work by D. E. Thomas in the Romsey area on the zoning of the Upper Ordovician corroborates this classification to a certain extent; but faulting in the sections, their limited extent, the absence of certain zones, and the difficulty of obtaining well preserved specimens make a comprehensive account of the zones rather difficult. The remarkable similarity of the zones in the Upper Ordovician of Australia to those of Great Britain is striking, and with further work it may even be possible to adopt the English classification. The zone of *Dicellograptus* cf. *companatus* appears to include the fauna of the zone of *Dicellograptus anceps* of the European classification. Elles[1] points out that the "zone of *Dicellograptus companatus* is conditional," and that "in Scandinavia a small form of *D. anceps* occurs with this fauna; so that in all probability it lies below the zone of *D. anceps.*" Harris and Thomas consider that until further detailed work is done, Thomas's subdivision of 1935 (135) should be adopted.

The characteristic assemblages are as follows:

Gisbornian.

The zone of *Nemagraptus* is easily identified by the incoming of *Nemagraptus, Dicellograptus sextans, D. divaricatus, Dicranograptus nicholsoni, D. zic-zac, Climacograptus bicornis, Hallograptus mucronatus,* and the various *Leptograpti.* The association is very similar in the next zone, but in it *Climacograptus peltifer* and *Mesograptus multidens* are very characteristic.

Eastonian.

The base of the Eastonian is characterized by abundant *Orthograpti.* In the zone of *Dicranograptus hians,* the zone fossil is abundant and *Climacograptus tubuliferus* is characteristic. *Dicranograptus clingani* occurs, but not in abundance. According to Elles, *Climacograptus baragwanathi* is synonymous with *C. wilsoni.*

Bolindian.

Pleurograptus is a rare form. *Orthograptus quadrimucronatus,* however, is very characteristic. The beds containing

1. Elles, G. L., Geol. Mag., lxxiv, 1937, p. 487.

this form are now included by Harris and Thomas in the Bolindian. Thomas and Keble (126) stated that this form occurred at the top of the Eastonian as well as at the base of the Bolindian. Harris and Thomas consider that the association of forms allies these beds more to the Eastonian than to the upper part of the Bolindian. Lithological changes appear in the Bolindian, so that in all probability it may be necessary to transfer this zone to the Eastonian, thus increasing the similarity with the British succession.

The higher beds of the Bolindian are included in the zone of *Dicellograptus* cf. *eomplanatus*. Three assemblages deserve mention in this zone:

(a) beds with the form identified as *D.* cf. *complanatus;*
(b) beds with *Retiograptus pulcherrimus, Leptograptus eastonensis* and *Climaeograptus uncinatus;*
(c) beds with *Glyptograptus tamariscus.*

The exact relationship is imperfectly known, but no *Dierano-graptus* has yet been found in these beds.

Harris and Thomas add a correlation of Victorian Ordovician zones with those of Great Britain, North America, Sweden, Norway, Bohemia, China and South America. They also include three plates of line drawings of the more important graptolites.

O. M. B. Bulman (158) comments on several graptolite genera that are found in Australia. *Goniograptus* with its four main zig-zag stipes (second order of dichotomy) from the angles of which undivided lateral branches are given off alternatively on both sides (the lateral branching being very regular both as regards interval and angle) might equally be considered as resulting from a regularly alternating dichotomous type of division. *Brachiograptus* has four main stipes, which form with the "funicle" the letter H, from the outer sides of which undivided lateral branches are produced. He comments on *Atopograptus* under the heading of *Didymograptus. Oneograptus* he considers is apparently derived from *Tetragraptus* by stipe reduction, but retains the two branches incorporated in the proximal end. *Cardiograptus,* in which the distal stipes have failed to develop, resembles *Oneograptus.*

He doubts the occurrence of *Diplograptus (sensu stricto,* i.e., *Mesograptus)* and *Amplexograptus* in Australia. He queries *Trigonograptus* as a member of the Diplograptidae. *Skiagraptus* is also queried as a member of the Diplograptidae, and he briefly defines it as having "biserial proximal

thecae pendent in position, later thecae becoming more horizontal." He relegates *Thysanograptus* to the synonymy of *Lasiograptus (senu stricto).*

Triaenograptus he places under ? Graptoloidea ineertae sedis describing it as having a "rhabdosome circular with radiating branches, from which paired lateral branches are repeatedly produced forming trident-like structures, adjacent lateral branches may unite to a single branch, from which paired laterals may again later be developed."

In regard to hydroids he includes under the Order Dendroidea, Family Dendrograptidae, Family Callograptidae, Family Acanthograptidae fam. nov. for the genera *Acanthograptus* and *Thallograptus,* and the Family Ptilograptidae of which the only genus is *Ptilograptus.* As a separate grouping he gives genera of uncertain systematic relationships, described as primitive graptoloids or dendroids, but having probably hydroid affinities; such are *Mastiograptus* and *Chaunograptus.* A genus which has been referred to the Dendroidea but with uncertain relationships is *Cactograptus.*

G. F. K. Naylor (159) has extended his study of graptolites in New South Wales by recording the presence of twenty-four Upper Ordovician species and varieties distributed through twenty-six localities and ten Silurian species and varieties in four other localities, the position of which are stated in terms of a grid-map covering 2,000 square miles of the Goulburn District, lying chiefly within the County of Argyle. He reaffirms his determinations of the occurrence of *Monograptus barrandei, M.* cf. *decipiens, M.* cf. *tortilis* and *M. undulatus,* on which some doubt had been expressed by Thomas (141). He also suggests that the locality Tallong named in the title of T. S. Hall's paper (63) was a misprint for Tolwong, the name appearing in the title of the second paper (86) on fossils from the same district.

Subdivisions Proposed by Various Authors.

Silurian.

Gregory, 1903 *vide* p. 39	*Chapman, 1913* (71)	*Chapman & Thomas, 1935* (136)	*Thomas & Keble, 1933* (126)
Yeringian Melbournian	Tanjilian Yeringian Melbournian	Yeringian Melbournian Keilorian	Yarravian = Melbournian Yeringian Keilorian

Ordovician.

Thomas & Keble, 1933 (126)	*Hall, 1895 (28) Harris & Keble, 1932 (121)*	*Harris & Thomas, 1938 (157)*	
Bolindian Eastonian Gisbornian		Bolindian Eastonian Gisbornian	Upper Ordovician
	Darriwilian		Middle Ordovician
		Yapeenian	Lower Ordovician
	Castlemanian	Castlemanian	
		Chewtonian	
	Bendigonian	Bendigonian	
	Lancefieldian	Lancefieldian	

Species and Synonyms of Graptolites.

Abbreviations.

aff.	related to	Keble & B. .	Keble & Benson
auct. non. . .	not author	Keble & H. .	Keble & Harris
Barr.	Barrande	Lapw. . . .	Lapworth
Brongn. . . .	Brongniart	Linn.	Linnarson
Carr.	Carruthers	Murch. . . .	Murchison
cf.	compare	Nich.	Nicholson
Chapman & T.	Chapman & Thomas	nom. nud. . .	nomen nudum
desc.	description	Rued.	Ruedemann
Elles & W. .	Elles & Wood	syn.	synonym
emend.	emendation	Thomas & K.	Thomas & Keble
Eth.	R. Etheridge Jun.	Torn.	Tornquist
fig.	figure	Tull.	Tullberg
Harris & K. .	Harris & Keble	var.	variety
Harris & T. .	Harris & Thomas	var. nov. . .	new variety
His.	Hisinger	vide	see
Hopk. . . .	Hopkinson		

Species and Synonyms	*Reference in Bibliography*
Atopograptus woodwardi Harris . . .	105 (desc.), 112, 131, 134, 135, 138, 157, 158
Brachiograptus etaformis Harris & K.	121 (desc.), 135, 138, 157
Bryograptus antiquus T. S. Hall, cf. Leptograptus antiquus	39 (desc.), 40, 59, 69, 70, 87, 97, 111, 134, 135, 142, 156, 157
clarki T. S. Hall	39 (desc.), 40, 87, 97, 134, 135, 157
crassus Harris & T.	155 (desc.), 157
hunnebergensis Moberg	157
simplex Torn.	157
victoriae T. S. Hall	39 (desc.), 40, 59, 69, 70, 87, 97, 120, 121, 134, 135, 156, 157

Hydroida.

Some hydroid genera of uncertain systematic relationship, such as *Mastigograptus* and *Chaunograptus,* have been regarded as primitive graptoloids or dendroids. Bulman (158) points out that "some of the Acanthograptoids and in particular the geologically early *A. priscus* recall in size and general appearance the Cambrian hydroids *Archaeolafoea* and *Archaeocryptolaria* of Chapman and Thomas (147), but in these there is at present no indication of polymorphism (such, indeed, would be of very different character if their relation to the Perisiphonidae is correctly assumed) and the resemblance is probably superficial only."

Chapman and Thomas (147), extending earlier studies (82) record from Cambrian shales and mudstones in Central Victoria the following hydroid forms which are referred by them to the calyptoblast families of Campanulariidae and Idiidae, though certain of the genera concerned have been classed by Ruedemann under the Dendroidea, in which *Ptilograptus* and *Thallograptus,* cited among the graptolites, have been retained there.

Locality Index.

This index gives the locality or district mentioned by the author of the paper, the number of which in the Bibliography, appears opposite that locality. In most papers more precise details are given.

Localities outside Victoria are indicated by the initial letters of the State in which they are.

The following abbreviations are used:

Co. . . . County	R. . . . River
Ck. . . . Creek	Rd. . . . Road
Mt. . . . Mount	Rf. . . . Reef.
N.S.W. . . . New South Wales	Rly. . . . Railway
Par. . . . Parish	T. . . . Tasmania
Q. . . . Queensland	

Symbols after some localities (thus, Ba 78) are those used on the Geological Quarter Sheets of the area to fix fossil localities; e.g., Ba 78 refers to a locality in Barker Street, Castlemaine, so shown on Quarter Sheet of the Castlemaine area.