The biostratigraphic significance of new dinoflagellate cysts from the Mid-Late Jurassic of the Northwest Shelf.

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SUMMARY

Palynostratigraphy is one of the primary methods employed to date and correlate strata on the Northwest Shelf. In this setting dinocysts provide the highest resolution for the Mesozoic, particularly for the Middle–Upper Jurassic interval. This period is characterized by a global-scale dinoflagellate radiation, which is reflected, in the Bathonian–Kimmeridigian strata of the Northwest Shelf by the highly diverse *W. indotata*–*D. swanense* assemblages

Transmitted light and scanning electron microscopy were used to document the palynological assemblages of 235 palynological strew slides prepared from conventional and sidewall cores from wells in the Bonaparte and Northern Carnarvon. Previously undescribed species of dinocyst were identified, and their geographic and stratigraphic ranges were documented. The data from all wells was then integrated to i) characterize the morphological variations of species across different basins, ii) identify common biostratigraphic events and iii) produce an updated regional biostratigraphic scheme.

Eleven new species of dinocyst and one species of acritarch with stratigraphic values have been formally described as a result of this work. An additional fourteen species, and two dinocyst genera were identified, of which four have been identified as potential biostratigraphic markers.

Most of the new species present a consistent stratigraphic distribution in both the Bonaparte and the Northern Carnarvon basins. These new markers increase the resolution of the regional biostratigraphic scheme.

The events observed in the Bonaparte Basin, increase the accuracy of well to well correlations and further characterise the evolution of the local area during the Bathonian–Kimmeridgian interval. Further investigation is likely to yield additional, significant biostratigraphic events.

Key words: Biostratigraphy, Dinoflagellate, Jurassic, Bonaparte Basin, Northern Carnarvon Basin.

INTRODUCTION

Palynology is one of the primary tools for Mesozoic biostratigraphy on the North West Shelf (NWS) of Australia. For the Middle–Late Jurassic interval, the dinocysts provide the highest biostratigraphic resolution. This is due to the prevalence of marine conditions throughout the Mesozoic of the NWS, and the related diversification and radiation experienced by the group during the course of this interval (MacRae et al., 1996; Fensome et al., 1996; Wiggan et al., 2017).

In spite of numerous investigations on Middle–Late Jurassic dinocysts from the Northwest Shelf (Riding & Helby 2001a–f; Mantle 2005, 2009a, b; Mantle & Riding 2012) the diversity of the assemblages has remained underrepresented. The extended area of the NWS (Figure 1) and its wide array of deposition settings has produced varying degrees intra- and interspecific variations in dinocyst morphology and stratigraphic range. These are documented and used by this study to improve both local (field–basin scale) and regional (NWS-scale) existing zonation. This progress is only possible through detailed and accurate morphological characterization of the fossil material, and the compilation of a standardized, robust (peer-reviewed) taxonomy. (which have been used in this study

METHOD AND RESULTS

Transmitted light microscopy (TLM) was used to conduct high resolution (250+) counts of palynomorph assemblages of 187 legacy and 48 newly prepared strew slides prepared from core and side-wall core samples from Alaria-1, Laminaria-2, from the Laminaria High and Elm-1, Taltarni-1, from the Vulcan Sub-basin. Taxonomic and biostratigraphic data from ten new preparations from Pyxis-1, Dampier Sub-basin, and 155 new samples (samples prepared in the last ten years) from Jansz-1, 2 & 3, and Io-1, Exmouth Plateau, Northern Carnarvon Basin (Sinclair 2012) were integrated into this study. The palynological successions from the Bonaparte Basin range cover the Bathonian–Kimmeridigian (*W. indotata*–*D. swanense* zones) interval, while those from the Northern Carnarvon Basin are limited to the Oxfordian (*W. spectabilis* Zone) (Table 1).

The wells Alaria-1 and Laminaria-2 were the primary focus of this study and were selected based on the availability of conventional core, and Elm-1 and Taltarni-1 were chosen for the large number of legacy side-wall core samples, and to provide a means of comparison of intra-basinal events to determine the regionality of key events. The data incorporated from the Northern Carnarvon Basin enabled the identification of regional events bioevents identified in this study. The Jansz-Io data set is limited to the Oxfordian and has restricted the inter-basin comparison to this interval.

New preparations from the Bonaparte Basin and Jansz-Io wells were processed using standard hydrofluoric acid maceration techniques at the University of Western Australia Palynology Laboratory and the Geoscience Australia Palaeontology and Sedimentology Laboratory, respectively. Pyxis-1 samples were prepared using a similar methodology by MGPalaeo Pty. Ltd. Information about the preparation of legacy slides processed some 25+ years ago by a commercial laboratory (Laola Pty. Ltd. Perth) could not be obtained.

High resolution counts were used to review the ranges of existing dinocyst species and establish baseline ranges for those newly identified taxa. Eleven new species of dinocyst and one new species of acritarch with biostratigraphic value were formally described. These new species represent a mix of previously known informal dinocysts, and newly identified species. Range data for these eleven new species was generated from biostratigraphy counts and calibrated using an existing unpublished zonation (MGPalaeo 2014). A comparison of ranges from the Bonaparte and Northern Carnarvon basins demonstrates a high degree of consistency for the majority of the newly described species (Figure 3). An updated detailed subzonal breakdown for the stratigraphic interval of the Bonaparte Basin will be forthcoming as a direct result of this work. Previously completed and subsequent biostratigraphic reports are available online through the WAPIMS or NOPIMS databases.

This work identifies a further fourteen species and two new genera of dinocyst with ample fossil material to allow detailed characterization and formalization, and a possible eight new species which currently lack sufficient material to establish a formal description. Of these additional species at least four show a distribution with stratigraphic value.

CONCLUSIONS

The formal description of eleven species of dinocyst, and one acritarch provides additional events to increase the resolution of the Middle–Late Jurassic biostratigraphic zonation. This study also indicates that numerous species of dinocysts W. indotata–D. swanense interval remain to be described.

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REFERENCES

Fensome, R. A., MacRae, R. A., Moldowan, J. M., Tayor, J. R. & Williams G. L., 1996, The Early Mesozoic radiation of Dinoflagellates. Paleobiology, 22(3), 329–338.

MacRae, R, A., Fensome, R. A. & Williams, G. L., 1996, Fossil dinoflagellate diversity, originations, and extinctions and their significance. Canadian Journal of Botany, 74(11), 1687–1694.

Mantle, D. J., 2005, New dinoflagellate cyst species from the upper Callovian-lower Oxfordian Rigaudella aemula Zone, Timor Sea, northwestern Australia. Review of Palaeobotany and Palynology 135, 245–264

Mantle, D. J., 2009a, Palynology sequence stratigraphy, and palaeoenvironments of the Middle to Upper Jurassic strata, Bayu-Undan Field, Timor Sea region. Part one. Palaeontographica Abteilung B, 280, 1–86.

Mantle, D. J., 2009b, Palynology sequence stratigraphy, and palaeoenvironments of the Middle to Upper Jurassic strata, Bayu-Undan Field, Timor Sea region. Part two. Palaeontographica Abteilung B, 280, 87–212.

Mantle, D. J. & Riding, J. B., 2012, Palynology of the Middle Jurassic (Bajocian-Bathonian) Wanaea verrucosa dinoflagellate cyst zone of the North West Shelf of Australia. Review of Palaeobotany and Palynology, 180, 41–78.

Partridge A.D., 2006, Jurassic—Early Cretaceous dinocyst zonations NWS Australia: 1st update of HMP 2004. In *Australian Mesozoic and Cenozoic Palynology Zonations – updated to the 2004 Geologic Time Scale,* ed. E. Monteil, Geoscience Australia Record 2006, 23.

Riding, J.B. & Helby, R., 2001a, A selective reappraisal of Wanaea Cookson & Eisenack 1958 (Dinophyceae). In *Studies in Australian Mesozoic palynology II: Memoir of the Association of Australian Palaeontologist no. 24*, ed. J. R. Laurie and C. B. Foster, 33–55. Association of Australian Palaeontologists, Canberra.

Riding, J.B. & Helby, R., 2001b, Phallocysta granosa sp. nov., a Mid Jurassic (Bathonian) dinoflagellate cyst from the Timor Sea, Australia. In *Studies in Australian Mesozoic palynology II: Memoir of the Association of Australian Palaeontologist no. 24*, ed. J. R. Laurie and C. B. Foster, 59–63. Association of Australian Palaeontologists, Canberra.

Riding, J.B. & Helby, R., 2001c, Microplankton from the Mid Jurassic (late Callovian) Rigaudella aemula Zone in the Timor Sea, north-western Australia. In *Studies in Australian Mesozoic palynology II: Memoir of the Association of Australian Palaeontologist no. 24*, ed. J. R. Laurie and C. B. Foster, 65–109. Association of Australian Palaeontologists, Canberra.

Riding, J.B. & Helby, R., 2001d, Dinoflagellate cysts from the Late Jurassic (Oxfordian) Wanaea spectabilis Zone in the Timor Sea region. In *Studies in Australian Mesozoic palynology II: Memoir of the Association of Australian Palaeontologist no. 24*, ed. J. R. Laurie and C. B. Foster, 111–139. Association of Australian Palaeontologists, Canberra.

Riding, J.B. & Helby, R., 2001e, Dinoflagellate cysts from the Late Jurassic (Kimmeridgian) Dingodinium swanense Zone in the North-West Shelf and Timor Sea, Australia. In *Studies in Australian Mesozoic palynology II: Memoir of the Association of Australian Palaeontologist no. 24*, ed. J. R. Laurie and C. B. Foster, 141–176 . Association of Australian Palaeontologists, Canberra.

Riding, J.B. & Helby, R., 2001f, Marine microplankton from the Late Jurassic (Tithonian) of the north-west Australian region. In *Studies in Australian Mesozoic palynology II: Memoir of the Association of Australian Palaeontologist no. 24*, ed. J. R. Laurie and C. B. Foster, 177–220. Association of Australian Palaeontologists, Canberra.

Sinclair, N. G. 2012, Upper Jurassic (Oxfordian) dinoflagellate cyst taxonomy, palynostratigraphy and biosequence stratigraphy of the Jansz-Io gas fields, North West Shelf, Australia. PhD thesis, Australian National University, Canberra.

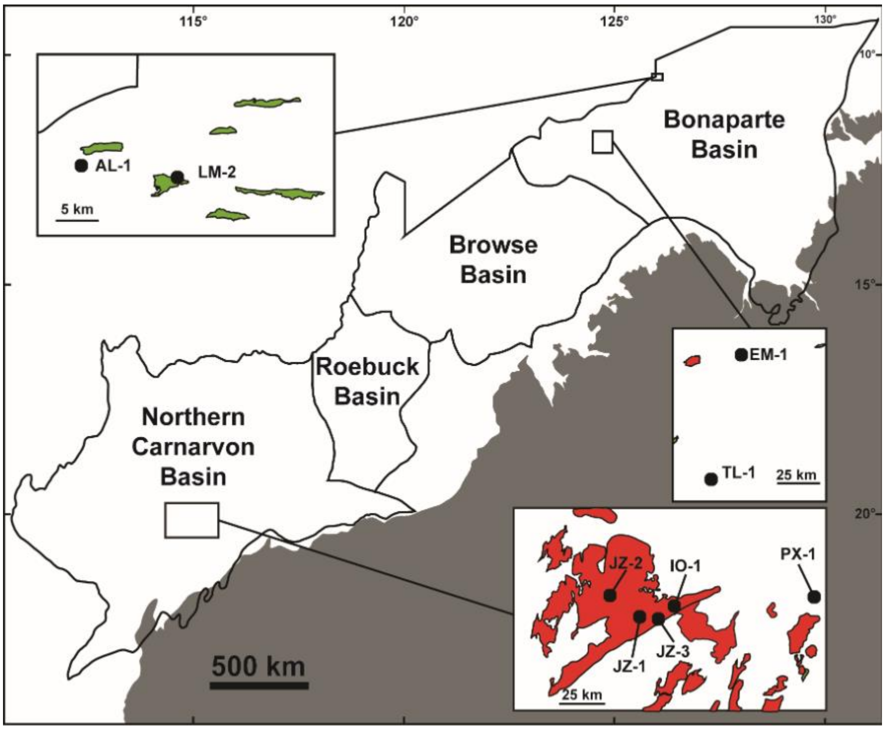

Figure 1. Map of the West Australian Basin. Insets show the location of the wells used in this study; Alaria-1 (AL-1), Laminaria-2 (LM-2), Elm-1 (EM-1), Taltarni-1 (TL-1), Jansz-1 (JZ-1), Jansz-2 (JZ-2), Jansz-3 (JZ-3), Io-1 and Pyxis-1 (PX-1).

Wells	*Studied interval (m)*		Zones	*No. of samples*	
	Top	Base		Leg.	New
Alaria-1	3310.00	3319.00	*D. swanense*	7	3
	3321.95	3419.51	*W. spectabilis*	34	25
	3421.01	3454.40	*C. ancorum*	15	3
	3455.89	3460.09	*V. tabulata*	5	0
Laminaria-2	3159.80	3200.90	*W. spectabilis*	9	0
	3202.30	3214.75	*C. ancorum*	3	2
	3215.62	3238.90	*V. tabulata*	5	5
	3239.60	3310.65	*T. balmei*	26	8
	3310.80	3496.00	*W. indotata*	16	2
Elm-1	2663.00	2702.00	*D. swanense*	3	0
	2715.00	2968.00	*W. spectabilis –C. ancorum*?	21	0
Taltarni-1	2328.00	2341.00	*D. swanense*	2	0
	2370.00	3212.00	*W. spectabilis*	41	0
Jansz-1	2875.00	2982.00	*W. spectabilis*	0	18
Jansz-2	2901.30	2917.00	*W. spectabilis*	0	17
	2918.00	2922.31	*W. spectabilis–?C. ancorum*	0	6
Jansz-3	2089.00	2865.00	*W. spectabilis*	0	57
	2866.00	2867.00	*W. spectabilis–?C. ancorum*	0	2
Io-1	2841.00	2895.90	*W. spectabilis*	0	55
Pyxis-1	3056.20	3079.00	*W. spectabilis*	0	10

Table 1. Studied wells, intervals and sample relation with existing Dinocyst Zone (Partridge 2006). Leg. –legacy slides.

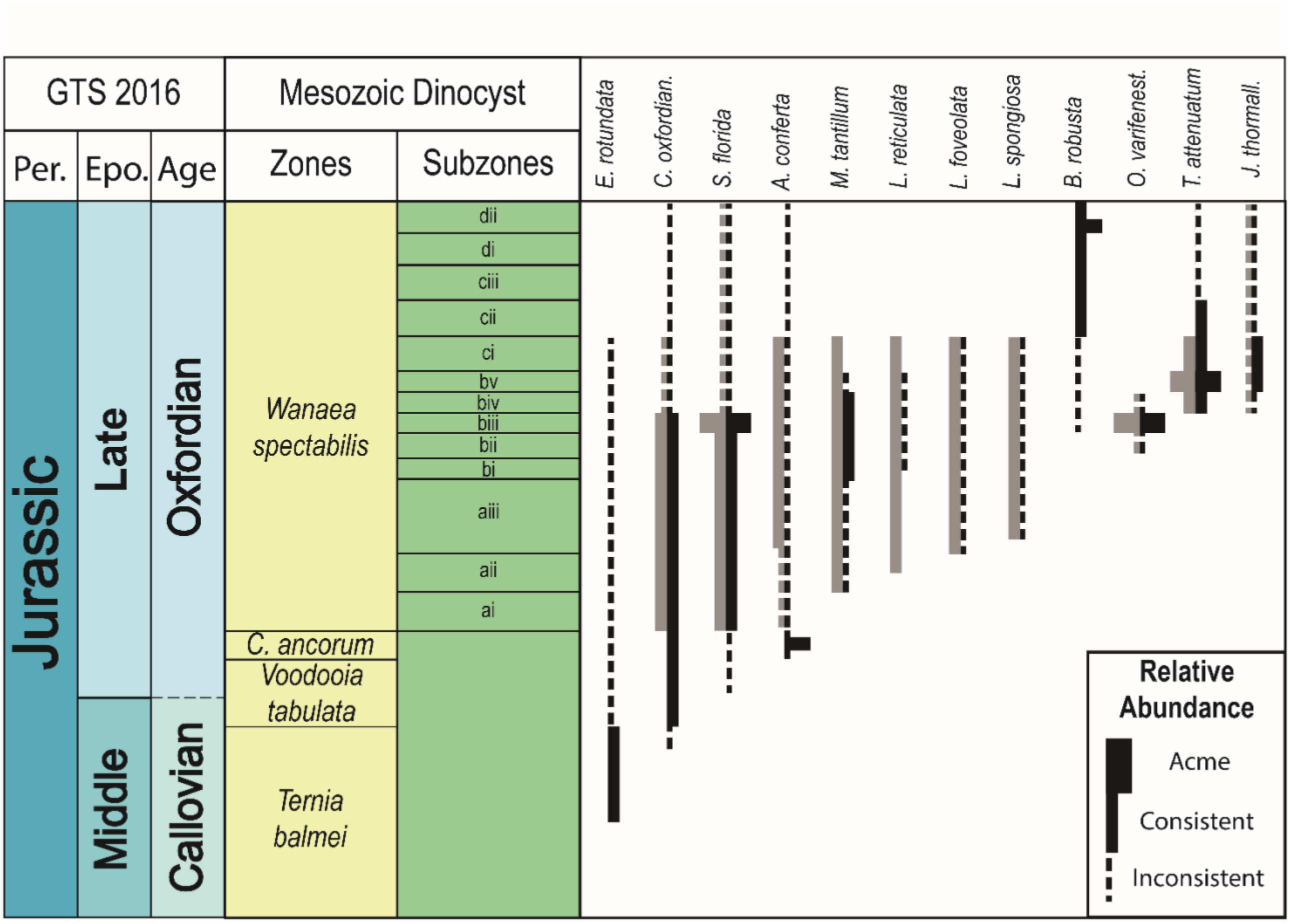

Figure 2. Range chart illustrating the range of newly described species herein discussed. Grey lines indicate ranges documented from the Jansz-Io field (Northern Carnarvon Basin), and black lines indicate those observed from the Laminaria High and Vulcan Sub-basin (Bonaparte Basin). Ranges for the Jansz-Io field are limited to the lower *W. spectabilis* zone, as this was the scope of the research project. Mesozoic Dinocyst Zones follow Partridge (2006), and subzones follow MGP 2014 (unpublished zonation). Full species names (left to right) *Evansia? rotundata, Cleistosphaeridium oxfordianum, Sepispinula florida, Ambonosphaera conferta, Microdinium? tantillum, Lanterna reticulata, Lanterna foveolata, Lanterna spongiosa, Batiacasphaerda robusta, Oligosphaeridium varifenestrata, Triovallium attenuatum* (acritarch), *Jansonia thormalleus.*