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Regressional episodes and diversity patterns of Australian Devonian tabulate corals

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Abstract – Biostratigraphic distribution of Australian Devonian tabulate corals appears to be influenced by episodes of transgression and regression both locally and world wide. Decreases in species diversity can be related to local regressive phases. Examination of contemporaneous sequences unaffected by regression is needed before a strong cause and effect relationship can be established.

OCCURRENCES OF TABULATES IN AUSTRALIA

The major occurrences of tabulate coral-bearing units in the Early and Middle Devonian of Australia (Figure 1) are confined to eastern Australia at least until the later part of the Givetian.

Few poorly documented tabulates occur in Frasnian sequences in Eastern Australia. Better documented, are the late Givetian and Frasnian tabulates in the Canning Basin of Western Australia. By the Famennian, cyanobacterial reefs replaced stromatoporoid-coral reefs; this is especially noticeable in the Canning Basin.

TRANSGRESSION CYCLES AND DIVERSITY

Talent (1989) and Talent *et al.* (1993) produced a transgression–regression curve for eastern Australia, portion of which is reproduced in Figure 2. Discussions herein regarding changes in tabulate diversity through the Early and Middle Devonian are made in relation to Talent's curve.

Earliest Lochkovian (*hesperius* Zone) tabulate faunas are low in diversity, with ten of the eleven species present being Silurian holdovers. This low diversity is possibly related to the Derringullen Creek/Bowning Regression associated with the Bowning Orogeny affecting southern New South Wales. With the onset of the Garra 1 and Garra 2 transgressive cycles (Figure 2 from Talent 1989 and Talent *et al.* 1993) preserved in the Garra Limestone near Wellington in central New South Wales and the Martins Well transgressive cycle in the Broken River area of north Queensland, conditions more favourable for limestone formation returned. This resulted in an increase in tabulate species diversity. Beginning with the Garra 1 Transgression spanning the *eurekaensis-delta* zones 53% of the tabulate species were new with 26% of existing species disappearing from the record. The Garra 2 and Martins Well transgressions during the *pesavis-sulcatus* interval saw tabulate numbers at their maximum of 55 species, 47% of which were new. Extinctions were low with only 5% of species making their last appearance. This high net increase reflects the widespread nature of these transgressive events in southeast Australia (Talent 1989).

Much of the contribution to this diversity comes from the favositids. The loss of nearly 53% of tabulate species at the close of the Pragian appears to be associated with a regressive interlude. This is, however, possibly accentuated by an artefact of the literature. Apart from early work by Jones (1937, 1941 and 1944) the only substantial published work on Early Devonian favositids is that of Philip (1960) which focuses on Pragian (latest *sulcatus* to *pireneae*) favositids from Victoria. The progressive increase in species diversity until well into the Emsian within most of the other tabulate families present supports the idea of a literature-based artefact.

Further support for this comes from the rugose corals which show increasing generic diversity from the Pragian to the Emsian (Zhen *et al.* 1997). This pattern is also consistent with a general increase in the proliferation of tabulate, stromatoporoid and rugosan buildups beginning in the Emsian and peaking in the Givetian and Frasnian (Talent 1988a).

The increase in diversity during the Emsian coincides with further widespread transgressive phases in eastern Australia. These include the Buchan Caves Limestone and basal Taravale transgressions in eastern Victoria and the Lockup Well Transgression in the Broken River area of north Queensland (Figure 2). The Buchan Caves Limestone Transgression beginning at the base of the Emsian saw a recovery in species numbers with 22% being new species. Similar increases occurred during the Basal Taravale Transgression across the latest *dehiscens* and *perbonus-gronbergi* intervals

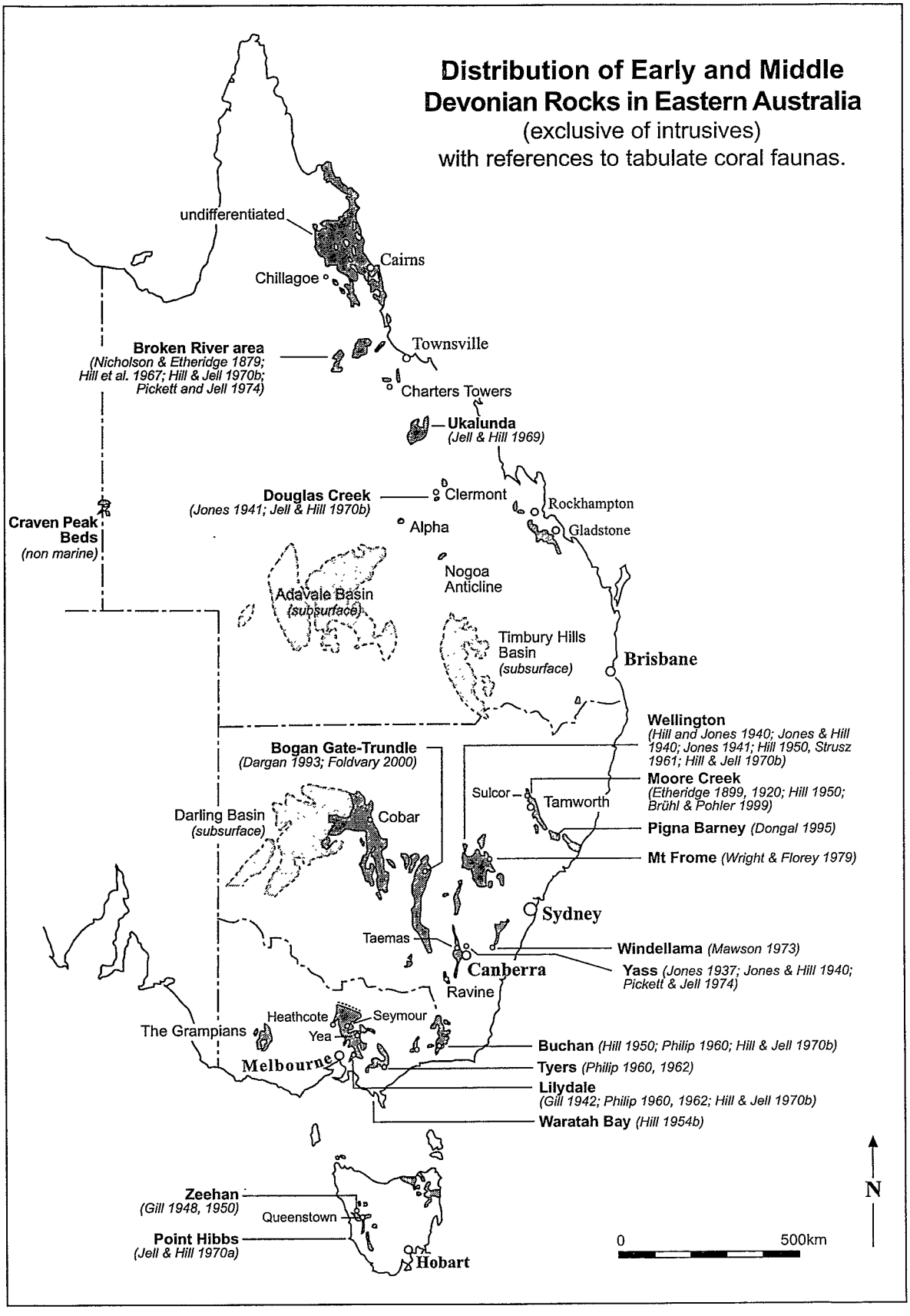

Figure 1 Distribution of Early and Middle Devonian rocks in eastern Australia (exclusive of intrusives) with references to tabulate coral faunas (after Mawson and Talent 2000).

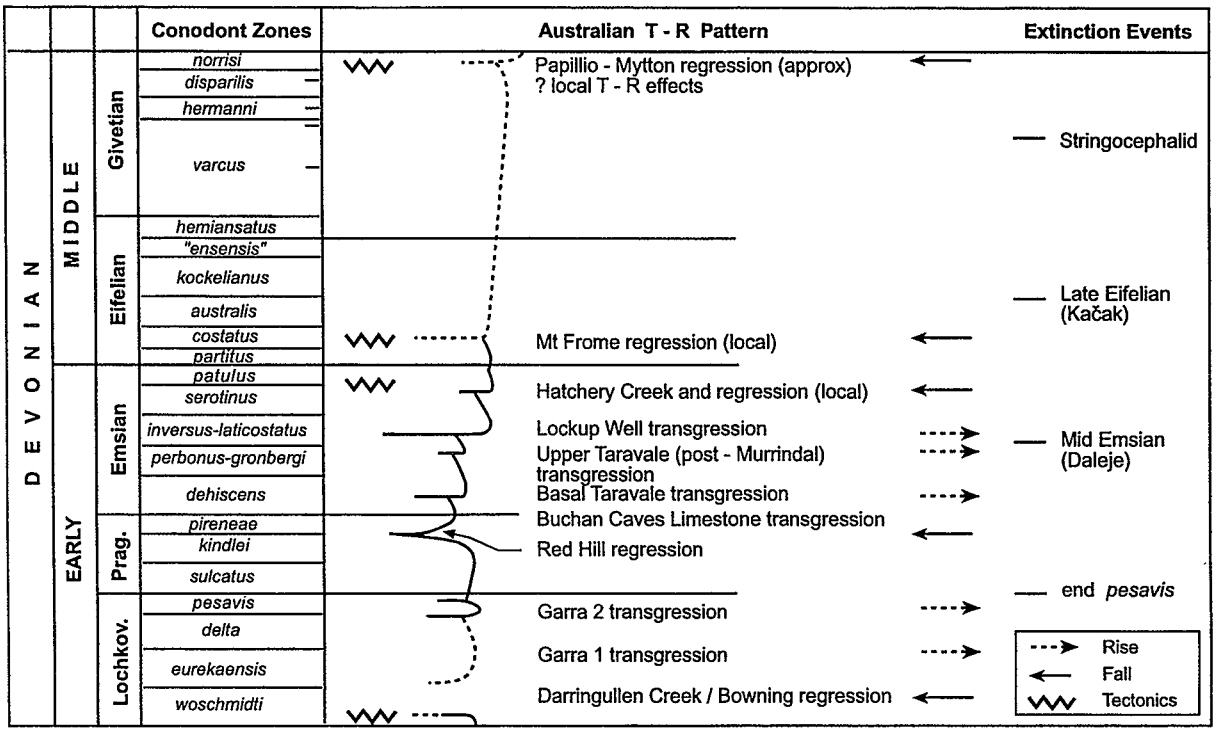

Figure 2 Transgression–regression pattern and major extinction events occurring in the Early and Middle Devonian in eastern Australia plotted against conodont zones for the interval (after Talent 1989 and Talent *et al.* 1993).

when 41% of the species present were new. In contrast the Upper Taravale Transgression which took place through the *perbonus-gronbergi* and *inversus-laticostatus* intervals was associated with the disappearance of 45% of tabulate species across the zonal boundary. This disappearance was due to the replacement of carbonate platform facies by muddy, pelagic facies. The Upper Taravale Transgression appears to be associated with the Daleje event and a global transgression which occurred at this time (Talent *et al.* 1993). A major transgression commenced in the *inversus-laticostatus* zone in the Broken River area of north Queensland. This is marked by a shales with minor carbonates in the Chinamans Creek Limestone at Lockup Well and Chinamans Creek. Less than 10% of tabulate species at this time were first appearances.

A local tectonically-based regression at the *serotinus/patulus* boundary, the Hatchery Creek Regression in the Yass area of southern New South Wales does not appear to have had any initial effect. The earliest Eifelian Mt Frome Regression, although related to local tectonics, coincides with substantial losses among the pachyporids and the disappearance of the roemeriids and michelinids from the Australian Devonian record. For example, the last of the Devonian michelinids, *Holacanthopora clarkei*, occurs in the *patulus* Zone below the regressive portion in the Mt. Frome sequence in central New South Wales (Wright and Florey 1979). Although 20% of species made their last appearance in the *patulus* Zone new species made up 23% of the tabulate species present. The onset of the Mt Frome Regression is marked by the disappearance of 32% of species across the *costatus/australis* interval.

Scattered species losses in most tabulate families across these intervals may be due to a more extensive regressive phase than indicated by these two local regressions. Talent (1988b) suggested that the Hatchery Creek Regression may have marked the beginning of a series of northward moving diachronous regressions. This could also offer an explanation for the scattered nature of the extinctions at this time. One way of testing this would be to examine faunas in the platform carbonates of the Broken River area of north Queensland. There is no evidence of a regressive event here and any extinctions would presumably be decoupled from regression based extinctions elsewhere.

Little change occurred in tabulate species diversity until the Givetian when 41% of species disappeared across the *hemiansatus/varcus* interval. This does not coincide with any known transgressive or regressive episode. Disappearance of 92% of species appears to coincide with the mid-*varcus Stringocephalus* (Taghanic) Event. This marks the disappearance of both *Favosites* and *Heliolites* along with species extinctions scattered among other tabulate families. The local tectonically related Papilio-Mytton Regression occurred at this time and is represented in the Broken River sequence of north

Queensland. This also corresponds with regressive intervals in the Southern West Siberian and Euramerican sea level curves (Talent and Yolkin 1987).

Although tabulates occur in Frasnian sequences in Eastern Australia they are poorly documented. One species of *Thamnopora* and one of *Alveolites* were described by Hill (1954a) from the Gneudna Formation in the Carnarvon Basin of Western Australia. These came from the upper, presumably Frasnian, portion of the formation. Although well documented, late Givetian and Frasnian tabulates in the Canning Basin of Western Australia (Hill and Jell 1970a) were not studied with a focus on biostratigraphy (Brownlaw and Jell 1997). Because of this their ranges, particularly their upper limits incorporate some degree of conjecture. Tabulates are a minor component of the stromatoporoid-dominated faunas in the Canning Basin. *Alveolites* diversified to share the niches formerly dominated by massive *Favosites* with stromatoporoids. Along with *Thamnopora* the alveolitids also included branching forms while auloporids had an encrusting role. Tabulate species diversity in this region is highest in the earliest Frasnian with 15 species present. However stratigraphic imprecision precludes a causal link with a global transgression at the base of the *asymmetricus* Zone.

The Famennian was marked in the Canning Basin by the replacement of stromatoporoid-coral reefs with cyanobacterial reefs. There is no sedimentological evidence in the Canning Basin for Kellwasser-type events at the Frasnian/Famennian boundary. There is however, evidence for several sea level changes in the boundary beds including one which possibly correlates with a latest Frasnian regression elsewhere in the world (Becker *et al.* 1991).

SOME BIOGEOGRAPHIC AFFINITIES

The diversity of favositid species in the Early Devonian suggests some degree of isolation of this region of Gondwana at least until the end of the Pragian. An increase in diversity in the Emsian corresponds with the appearance of a diverse favositid fauna in South China at this time (Oekentorp and Deng 1989). However, the only *Favosites* species they appear to have in common are the many varieties of *F. goldfussi* d'Orbigny.

The presence of *Holacanthopora* in the Emsian and the possible occurrence of *Petridictyum* in the Pragian of Australia suggests some North-West Gondwanan affinity as *Holacanthopora* occurs in the early Eifelian of Algeria while *Petridictyum* occurs in the Early and Middle Devonian of Europe and Morocco. The presence of *Yacutiopora*, which occurs in the Early Devonian of Algeria, Asia and Australia also supports this.

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