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BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

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Correlation Chart for the Triassic System of Australia

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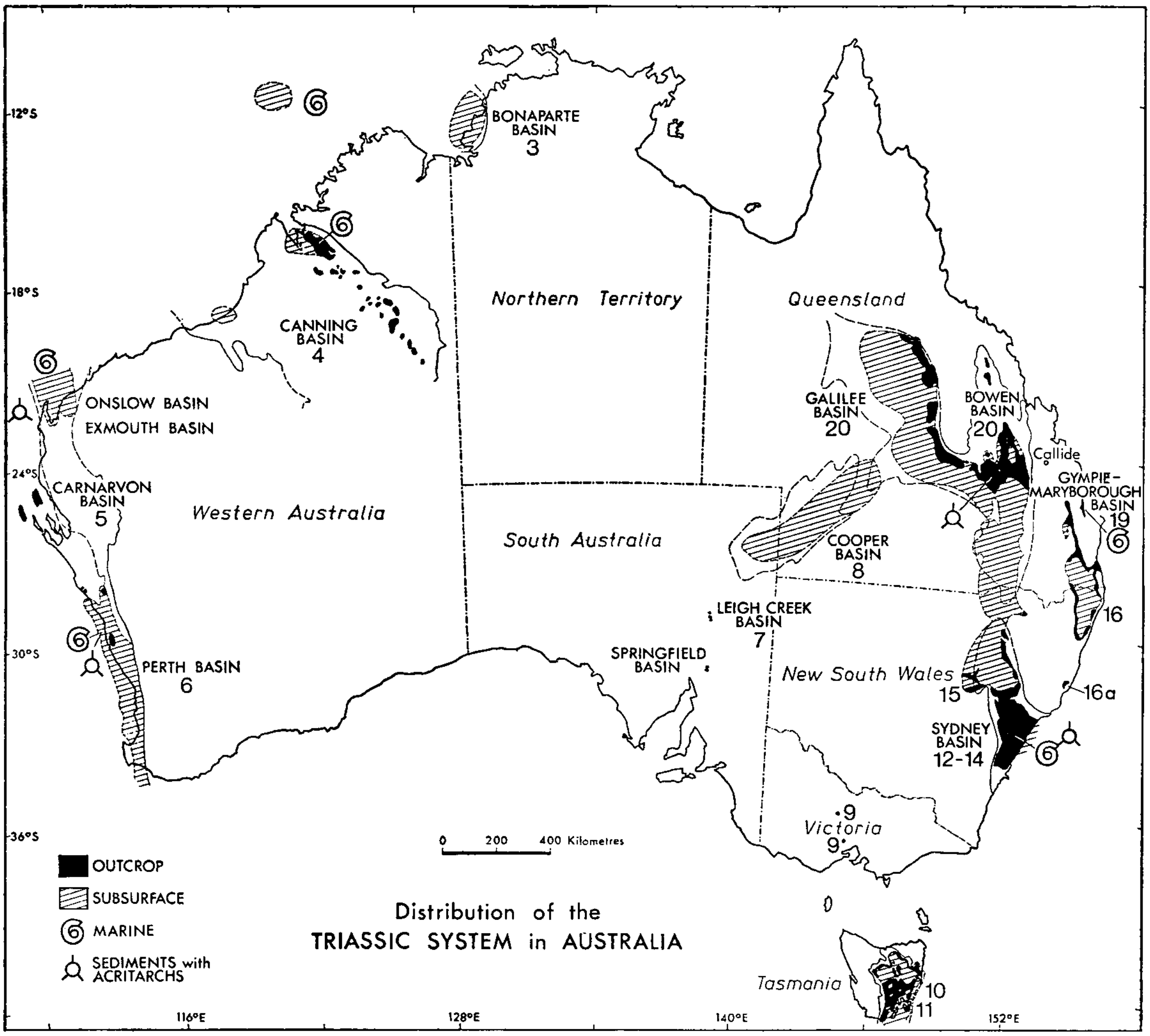
SUMMARY

A correlation chart for the Triassic System in Australia is presented. The base of the System in Australia is taken as the earliest occurrence of the *Lunatisporites pellucidus* Assemblage Zone in a section of the Rewan Formation in the Bowen Basin, Queensland, and the base of the Jurassic System as the occurrence of *Ceratosporites helidonensis* with *Classopollis* and *Retitriletes austroclavatitides* in the Upper Woogaroo Subgroup in a section near Ipswich in the Moreton Basin. Correlations within Australia are based predominantly on microfloral evidence with supporting evidence from fossil vertebrates and, to a minor degree, on macroflora. Correlation of Australian units with those in other continents depends on ammonites, bivalves, conodonts, vertebrates, and microflora in Lower Triassic units; and on vertebrates and microflora in higher units.

A cross-indexed bibliography on the Triassic System in Australia covering 21 years to the end of 1973 is also provided.



Distribution of the
TRIASSIC SYSTEM in AUSTRALIA

INTRODUCTION

The Triassic System in Australia consists predominantly of continental deposits up to about 2.5 km thick but with estuarine, deltaic, or shallow marine sediments within the present land areas only in the Fitzroy, Perth, and Maryborough Basins (see map). Marine sections have been reported offshore along the Northwest Shelf and in the Bonaparte Gulf Basin (Laws & Kraus, 1974). Sections in the Carnarvon (Thomas & Smith 1974), Perth, and Tasmania Basins span or almost span the Period, but sections in other basins represent only parts of the Period or are very discontinuous. Continuity of even the long sections is not yet demonstrated.

Correlations made prior to about the last decade depended heavily on the lithostratigraphical and biostratigraphical successions in the Sydney Basin. Discovery of marine Triassic rocks in the Perth and Gympie Basins and the extensive use of palynological evidence especially in the Bowen, Moreton, Sydney, and Perth Basins now provide much broader bases for correlation.

The microfloral succession known in Queensland is the most complete yet published but is thought to have gaps in it. An apparently continuous section in the Tasmania Basin has not yet been adequately sampled palynologically, and few details are yet published on the palynology of the apparently complete section in the Perth Basin. Species within the succession which are useful for intra- or intercontinental correlation are shown on the chart.

Correlations implied on the chart depend on published information as shown on the chart and in the reference list. The correlations are based predominantly on palynological evidence with support from macroflora, invertebrates—especially ammonoids—and vertebrates. Several people have been kind enough to criticise a preliminary chart and their help is acknowledged elsewhere. The author must, however, accept responsibility for the chart as presented. Correlations implied on the chart are similar to those implied by Anderson & Anderson (1970) probably because both sets are based on essentially the same data.

The evidence for the correlations adopted is shown in the form of italic numbers placed in the space provided for each formation, the numbers referring to the taxa listed below the chart, taxa whose range is shown in the column entitled 'Australian Biostratigraphy'. The ranges shown are based particularly on ranges known in the Bowen and Clarence-Moreton Basins.

The numbers in the top row of the chart refer to localities shown on the accompanying map, and in the bottom row to numbered references in the bibliography herewith. Wherever information is available, the thicknesses shown are known maxima in metres.

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LIMITS OF THE TRIASSIC SYSTEM AS USED IN AUSTRALIA

If time is defined as a dense set of events (Whitrow, 1961, pp. 161, 164), any duration (such as a geological Period) consists of all those events which include and occur after some initial instant (a set of events any two of which are simultaneous and such that there is no event not contained in the set which is simultaneous with them all), and before the instant which initiates the next duration. Thus the Triassic Period may be defined as a duration between and including some initial instant and some other instant which initiates the Jurassic Period. In the interests of clarity, reproducibility, usefulness, and stability the initial instant should have the following characteristics:

(a) be clearly definable (especially from the preceding instant),
(b) be readily recognisable,
(c) be amenable to far-reaching correlation, preferably by several methods.
(d) be one of a dense set of events recorded within the one geological section (i.e. preferably be within a section with 'continuous' deposition),
(e) be recorded by a rock at a particular level ('marker point') in a specified rock section ('stratotype'), the marker point and stratotype meeting the other conditions listed,
(f) be widely (preferably internationally) recognised as the initial instant.

These conditions are listed by or follow from condtions enumerated by Ager (1964) and George *et al.* (1967, 1969).

Most successions likely to include the base of the Triassic System fail on one or other of the conditions listed above, a situation which has resulted in difficulties and disagreements concerning the boundary. Only sections in the Armenia-Iran area, Kashmir and the Himalayas, and East Greenland seem to satisfy them. Sections at Kuh-e-Ali Bashi in northwestern Iran include limestone with *Paratirolites* and other limestones with ammonoids of Dorashamian Age (Rostovtsev & Azaryan, 1973), the former overlain by the Early Triassic Elikah Formation (Teichert *et al.*, 1973) correlated with the Kathwai Member on the Salt Range and containing *Claraia* and conodonts. Apart from other considerations placement of the base of the Triassic at the base of the Elikah Formation would not be particularly wise because of lack of ammonoids in that formation although presence of *Anchignathodus isarcicus* provides means of correlation with the Kathwai Member and the lower part of the Werfen Formation.

The section in the Kap Stosch area, East Greenland has been recently investigated by Teichert & Kummel (1973) who inferred a break 'equivalent to at least the Dzhulfian Stage'. In many places the 'base of the Triassic' is represented by a marked change in lithology. This section fails then on lack of continuity.

Lack of continuity as shown by Kummel & Teichert (1970) also precludes use of the setion in the Salt Range as a reference section.

There remain sections in Kashmir and the Himalayas. Of these, those in Kashmir are to be preferred as they are thicker and thus less likely to be condensed or have gaps in them. Attention must then be focussed on the Guryul Ravine section described recently by Nakazawa *et al.* (1970). Deposition appears to be continuous and fossils such as *Claraia* occur in beds below that in which *Otoceras* enters the section. Thus on present indications it appears best to define the beginning of the Triassic Period as the time of beginning of deposition of the lowest bed (Bed 52a) containing *Otoceras* in the Guryul Ravine near Srinagar, Kashmir. This may not be precisely contemporaneous with the beginning of deposition of the lowest bed containing *Otoceras* in the section at Lilang, Spiti, in the Himalayas, an horizon commonly used as the base of the Triassic Standard System (Tozer, 1971, 1972). At Lilang the *Otoceras woodwardi* Zone overlies beds with *Cyclolobus insignis* (Diener, 1912, p. 142) suggesting the presence of a break in continuity. Both sections suffer the disadvantage that no beds of Changhsingian (part of Dorashamian) Age have yet been discovered in them (Waterhouse, 1973, p. 310). Thus it seems that there is at present no known completely satisfactory section for the emplacement of the 'marker point' marking the base of the Triassic System. One solution might be to follow Waterhouse (1973) in making the base of the Smithian Stage the base of the Triassic System. This would have considerable practical advantage in that the 'point' could be placed within a continuous fossiliferous section in Smith Creek, Ellesmere Island. However, despite Waterhouse's arguments (1973), this would appear as a major departure from customary understanding and introduce, at least initially, great confusion. Use of the base of the *Otoceras* Zone in Kashmir (Bed 52a Guryul Ravine) or in Spiti, preferably the former, seems for the time being the best solution.

Emplacement of a 'marker point' in either of the Guryul Ravine or Lilang successions at the first appearance of *Otoceras* does not help particulary in determining the position of the base of the Triassic System in Australia. Ammonoids are known only in the Gympie-Maryborough and Perth Basins, those from the Perth Basin being the older. Evidence on the age of these has been re-assessed recently by McTavish & Dickins (1974) and Skwarko & Kummel (1974). The lowest 'Triassic' marine beds, Kockatea Shale, in the Beagle Ridge Bore contain *Claraia stachei* and another species of *Claraia* and are probably Early Griesbachian but, if the point is established at the base of bed 52a in the Guryul Gorge, could be very late Permian. At the same level as *Claraia* occur *Kraeuselisporites cuspidus, K. saeptatus, Lundbladispora playfordi, L. willmotti, L. brevicula, Lunatisporites pellucidus* and *L. obex*. The presence of *Claraia, Ophiceras* and *L. pellucidus* suggests correlation with the Kathwai Member in the Salt Range and in turn with part of the *Otoceras* Zone in the Himalayas. *L. pellucidus* enters the section in the Salt Range in the Kathwai Member (Balme, 1970). Higher beds with qualitatively essentially the same microflora are regarded by McTavish & Dickins (1974) as late Griesbachian to possibly early Spathian in age. The Kockatea Shale rests unconformably on the Permian Caryngina Formation, and the Beagle Ridge section is thus not suitable as one in which to designate the base of the Triassic System in Australia. More continuous deposition apparently occurred in the Tasmanian, Sydney, and Bowen Basins. Too little is known of the palynology of the Tasmanian Basin to permit establishment of a base within it. In the Sydney Basin the base of the *Lunatisporites pellucidus* Assemblage (i.e. the assemblage zone corresponding to that in the Beagle Ridge Bore) has been widely recognised (Helby, 1973, p. 147) but the detailed palynological biostratigraphy in relation to the lithostratigraphy has not been published so that a suitable horizon and locality for the Australian 'marker point' at the base of the Triassic System cannot be specified with confidence within the Sydney Basin. A position within the thicker part of the section, i.e. in the sections penetrated by the Balmain Shaft, the Cremorne No. 2 bore, or the Windeyer bore, would appear to be most appropriate.

The section about which most palynological information has been published is that in the Bowen Basin (de Jersey, 1970a) but *L. pellucidus* does not occur in the lowest Triassic unit, the Rewan Group, and most of the other components of the microflora in the Perth Basin enter well above the base of the formation (between 89.6 m and 69.9 m in D.R.D. 28), with a few even higher. The basal portion of the Rewan 'is tentatively regarded as Lower Triassic' (de Jersey, 1970a, p. 27) whereas higher portions are regarded as clearly Triassic. On the basis that the assemblage rather than a particular species thereof is used for correlation, the section beginning between 89.6 m and 69.9 m in D.R.D. 28 might be taken as a correlate of the lower part of the section in the Beagle Ridge Bore and the first convenient horizon below it taken as the base of the Triassic System. In fact, following Balme (1969b, p. 111), Helby (1969c, p. 405; 1973, p. 145) and Anderson & Anderson (1970, chart 6) and on the basis of the horizon of entry of *L. pellucidus* into the Salt Range section (Balme, 1970, p. 426), the base of this assemblage is probably the position most likely to correspond to the base of the Triassic System. One could thus establish an Australian 'marker point' between the two levels quoted in D.R.D. 28. For the sake of later clarity and precision the exact positioning of the spike would need closer palynological control than is now available, preferably within a continuously fossiliferous succession.

The base of the Jurassic Standard System may be taken as the base of the Blue Lias in the Watchet area, Somerset, United Kingdom (George *et al.* 1969, pp. 159-60). Lack of marine Jurassic beds of this age in Australia precludes direct correlation. In the correlation chart presented at the First Gondwana Symposium (Banks *et al.*, 1969) the entry of *Classopollis classoides* was taken as the base of the Jurassic System in Australia. Even at that time the use of this convention was of doubtful validity in view of the record of this species in the Rhaetian of Britain (Chaloner & Clarke, 1962). The situation is now complicated by the reassignment of specimens assigned to *C. classoides* to several other species and of the species previously called *Gliscopollis meyeriana* to *Classopollis* (de Jersey, 1973c). Several possibilities warrant examination.

The first of these possibilities is to place the boundary at the entry of *Classopollis simplex* in G.S.Q. Ipswich 4, sited near Lowood just north of Ipswich in the Moreton Basin (de Jersey, 1971a, pp. 2, 41-3; p. 24). This has the advantage that, of the local species of *Classopollis,* only *simplex* is restricted to the Jurassic System overseas (de Jersey, 1973c, p. 132). However, in the borehole cited the Helidon Sandstone rests with a paraconformity on the Raceview Formation and all the Upper Woogaroo Subgroup is thought to be missing. As it is desirable that the base of a System be within a conformable sequence this borehole does not provide a suitable type area for establishment of a 'marker point'.

Borehole G.S.Q Ipswich 1, drilled just south of Ipswich (de Jersey, 1971a, pp. 20, 40) has more potential from this point of view but palynological information is lacking on the upper part of the section. However, between 147.4 m (483 ft 7 in) and 117.15 m (384 ft 6 in) *Ceratosporites helidonensis* enters the section in small numbers and is associated with rare *Classopollis meyeriana.* Higher in the section (at 58.5 m) these species are more abundant and are associated with *Retitriletes austroclavatitides* in a microflora closely comparable to that in the basal part of the Helidon Sandstone in which *C. simplex* occurs (de Jersey, 1971a, p. 23). Thus on present evidence a convenient boundary might be taken as the entry of *Ceratosporites helidonensis* in the borehole G.S.Q. Ipswich 1, but a more compelling case could be advanced for a higher level, viz. between 117.15 and 58.5 m, on the basis of significant numbers of *C. helidonensis, Classopollis,* and *R. austroclavatitides.* De Jersey (1975, pp. 163, 170-71) also placed the boundary at about this position and from fig. 14.3 (p. 163) would appear to favour the higher of the two positions.

However, even this position might be too low. Thus Geiger & Hopping (1968, p. 7) noted that *C. meyeriana* first appears in Middle Keuper rocks and that while *C. torosus* occurs first in outcrop in basal Jurassic rocks, it occurs in cores in rocks just older than Rhaetic. Warrington (1974, p. 143) went further and reported both species in the Red (Keuper) Marls and that *Retitriletes austroclavatitides* (Cookson) occurs in the Upper Rhaetic beds in north Somerset. De Jersey (1971a, p. 9) noted that *R. austroclavatitides* has also been reported from the Middle Rhaetic in Germany. Morbey & Neves (1974, p. 162) took as the base of the Rhaetic in Austria the first appearance together of *Classopollis torosus* and *Granuloperculatipollis rudis*, in association with *Classopollis meyeriana* and *Ovalipollis ovalis*. Orbell (1973) examined the palynology of the British Rhaeto-Liassic and it is clear from his work that the use of *Classopollis torosus*, *C. meyeriana*, and *R. austroclavatitides* to mark the base of the Jurassic is invalid as their entry, mutual occurrence, and abundance antedate this boundary. He showed pictorially in Table 4 that the boundary lies within the *Heliosporites* Zone which, together with the underlying *Rhaetipollis* Zone, contains the above-mentioned spores. Even if the boundary was taken as suggested by Orbell (1973, p. 33) at the base of the *Heliosporites* Zone, the two Australian horizons are likely to antedate this, although the higher one may approximate to it. The base of the *Trisaccites variabilis* Zone (de Jersey, 1975) is clearly younger than the beginning of the Jurassic. One must, with de Jersey (1975. pp. 170-1), place the base of the Jurassic within the *Polycingulatisporites crenulatus* Zone and probably within the *Ceratosporites helidonensis* Subzone, but the exact position is not yet clear. The situation needs more clarification, perhaps by more intense palynological work on cores in the Ipswich area or by work on offshore Western Australian sections.

For the present the Triassic System in Australia may be taken approximately as the rocks deposited between the time of entry of the *Lunatisporites pellucidus* assemblage into the Rewan Group in D.R.D. 28 in the Bowen Basin and the time of formation of the rock containing significant numbers of *C. helidonensis*, *Classopollis*, and *R. austroclavatitides* at 58.5 m in borehole G.S.Q. Ipswich No. 1 in the Moreton Basin. An even higher horizon may well be more valid, but resolution of the question must await further work, possibly on Western Australian sections.

AUSTRALIAN MICROFLORAL ZONES

Balme (1964 pp. 65-8) recognised two microfloras in the Triassic System in Australia, an older *Taeniaesporites* Microflora, known with certainty only in Western Australia at the time, and a younger and more widespread *Pteruchipollenites* Microflora. Evans (1966) recognised eight sub-units which he assigned to three units, Tr 1, 2, and 3. The lowest subunit, one with abundant *Quadrisporites horridus*, is now generally regarded as Permian. Unit Tr 1b begins with the entry of *Lundbladispora*, and Unit Tr 2b with entry of *Aratrisporites*. In Unit Tr 3 *Falcisporites* spp. occur in great abundance. Within this unit Unit Tr 3b commences with the appearance of *Aratrisporites fischeri*, Unit Tr 3c contains neither *Aratrisporites* nor *Duplexisporites gyratus*, entry of the latter of which marks the base of Unit Tr 3d. Evans's system has had to be somewhat modified. Helby (1969c, pp. 404-5) recognised as Early Triassic a microflora with *Lunatisporites pellucidus*, several species of *Striomonosaccites* and several large species of *Protohaploxypinus*. This is followed by a microflora with *Densoisporites*, *Lundbladispora*, *Kraeuselisporites*, and *Lunatisporites*. Subsequently *Aratrisporites* enters the section. Later assemblages are dominated by *Alisporites* and *Osmundacidites* (Helby, 1969d, p. 417) with *Duplexisporites* entering the section within this assemblage but about half way through it. At an even higher level *Cadargasporites* enters (Helby, 1969d, p. 423). Anderson & Anderson (1970, Chart 6, following Helby) recognised a *'Lunatisporites' pellucidus* Zone, followed by the *Protohaploxypinus samoilovichii* Zone and then a *Falcisporites* Zone with four sub-zones, A, B, C, and D.

A recent work, that of Helby (1973), recognised four assemblage zones of Triassic age in New South Wales. In order from the base upwards these are the *Lunatisporites pellucidus*, *Protohaploxypinus samoilovichii*, *Aratrisporites tenuispinosus*, and *A. parvispinosus* Assemblage Zones. He also showed in tabular form the relation between earlier biostratigraphic schemes (his fig. 2).

Despite some lacunae, the sections in south eastern Queensland not only span more of the Triassic Period than others in Australia but more palynological work has been published on them (by de Jersey and his co-workers). Unfortunately no succinct statement on the complete microfossil succession is available, but a paper by de Jersey (1975) made formal definitions of some biostratigraphic units covering the upper parts of the Triassic System in Queensland. By considering papers by de Jersey and others published between 1964 and 1973, a biostatigraphic system based on first appearances, sharp increases in abundance, or microfloral assemblage can be deducted as follows:

Top

27. Entry of *Classopollis simplex* (in Helidon Sandstone).
26. Entry of *Ceratosporites helidonensis* in the Ripley Road Formation.

Rhaetian

25. Entry of *Foveosporites moretonensis* and *Polycingulatisportes mooniensis* (in the Raceview Formation).
24. Entry of *Classopollis* spp. incl. *meyeriana* and *Polycingulatisporites crenulatus* (in the Aberdare Conglomerate).

Norian to Karnian

23. Presence of *Osmundacidites parvus* (high in the Blackstone Formation).
22. Entry of *Semiretisporis antiquus* (low in the Blackstone Formation).
21. Presence of *Semiretisporis denmeadi* (Tivoli Formation to lower Blackstone Formation).
20. Entry of *Lycospora pallida* (Tivoli Formation).
19. Entry of *Aratrisporites flexibilis* (Tivoli Formation).
18. Entry of *Cycadopites tivoliensis* (Mount Crosby Formation).
17. Entry of *Craterisporites rotundus* (Mount Crosby Formation).

Ladinian

16. Presence of *Cadargasporites senectus* (Moolayember Formation).

Anisian

15. Presence of *Protohaploxypinus jacobii* (low in Moolayember Formation).
14. Entry of *Duplexisporites problematicus* (basal Moolayember Formation).
13. Entry of *Rugulatisporites trisinus* (Clematis Formation).

Scythian

12. Entry of *Triadispora crassa* (high in Rewan Formation).
11. Entry of *Aratrisporites tenuispinosus.*
10. Entry of *Tigrisporites playfordi.*
9. Entry of *Lophotriletes novicus.*
8. Increase in abundance of *Falcisporites* and *Aratrisporites* (in upper part of Rewan Formation).
7. Entry of *Aratrisporites rugulatus* and *Voltziaceaesporites heteromorpha.*
6. Entry of *Aratrisporites wollariensis* and *Kraeuselisporites cuspidus* (in middle part of the Rewan Formation).
5. Entry of *Lundbladispora willmotti* (in middle part of Rewan Formation).
4. Entry of *Densoisporites playfordi, Lunatisporites obex,* and *Kraeuselisporites saeptatus* (in lower part of the Rewan Formation).

Permian

3. Entry of *Guthoerlisporites cancellosus* (= *'Nuskiosporites' radiatus,* Balme & Helby 1973, p. 439).
2. Entry of *Cyathidites breviradiatus* and *Osmundacidites senectus.*
1. Entry of *Dictyophyllidites mortoni* and *Discisporites psilatus* (base of Rewan Formation).

Base of Rewan Group

0. Entry of *Lunatisporites novimundus* (Late Permian).

The Rewan also contains many species found in older rocks. The characteristically Triassic genus *Falcisporites* entered the record in the Permian System but did not become abundant until the later part of the Scythian.

Because of lack of microfloral assemblage overlap between the Moolayember Formation and Ipswich Coal Measures and between these Coal Measures and the Bundamba Group and because of ages of these units derived by correlation with overseas sections, de Jersey has in numerous publications shown gaps in the sequence between them.

De Jersey (1975, pp. 164-70) defined three zones and a subzone. The lowest of these, the *Duplexisporites problematicus* Zone, is based on a section of the Esk Formation and would cover Events 14 to 16 inclusive in the above list. Above this but not continuous with it is the *Craterisporites rotundus* Zone, corresponding to Events 17 to 23. Higher still and again not continuous is the *Polycingulatisporites crenulatus* Zone which extends from Event 24 well into the Liassic and which includes the *Ceratisporites helidonensis* Subzone beginning with Event 26 and also extending into the Liassic.

From range charts published by Balme (1970) and comments by Helby (1973), it is clear that the biostratigraphic scheme based on known Queensland ranges does not have general application. Thus *Osmundacidites senectus* (Event 2) occurs in the Permian Chhidru Formation in the Salt Range where *Nuskoisporites radiatus* (Event 3) enters even earlier (in the Amb Formation). The latter species also occurs in the Permian *P. reticulatus* Assemblage in New South Wales. *Densoisporites playfordi* (Event 4) enters the Salt Range section about half-way up the Chhidru Formation as also does *Kraeuselisporites cuspidus* (Event 6). *Aratrisporites* enters the Queensland section at Event 6 after which *Lophotriletes novicus* (Event 9) enters. The latter species occurs in the *Aratrisporites tenuispinosus* Assemblage in New South Wales but is known as early as the Amb Formation in the Salt Range. *Tigrisporites playfordi* (Event 10) occurs first in the *P. reticulatus* Assemblage of the Late Permian of New South Wales and ranges from the Chhidru Formation of the Salt Range into the Mesial Triassic. The palynomorphs noted from the *Aratrisporites parvispinosus* Assemblage in New South Wales enter the Queensland succession within the interval of Events 14 to 19 inclusive. *Lunatisporites pellucidus* used as name species for the earliest Triassic assemblage in New South Wales does not enter the Queensland succession until much later (in the Esk Formation (Events 14-16)). Brief mention has already been made of the occurrence of a few taxa in sections outside Australia, and ranges of some taxa are shown on the correlation chart. De Jersey (1970a, pp. 26-7) pointed out that although *Lunatisporites* (=*Striatisaccus*) *novimundus* enters sections in Central Europe at the base of the Triassic, it has also been recorded in Permian rocks in Great Britain and occurs in rocks as young as Keuper (de Jersey, 1970a, p. 16). In the Queensland section *O. senectus* does not range above about the middle of the Rewan Formation but has been recorded from the Late Triassic Leigh Creek Coal Measures (Playford & Dettman, 1965, p. 135). *Calamospora tener,* reported by de Jersey (1970a, p. 4, fig. 3) from within the Rewan Group, makes its first appearance in European sections at the base of the Muschelkalk (de Jersey & Hamilton, 1967, p. 24). The specimen figured by de Jersey (1970a) came from almost the top of the Rewan, above the entry of *Triadispora crassa* (event 12). *Grebespora concentrica* occurs elsewhere in Scythian and Anisian microfloras but not Permian ones (de Jersey, 1970a, p. 27). *Voltziaceaesporites heteromorpha* enters the European sections in the Middle Bunter (de Jersey, 1970a, p. 26; 1972a) and continues into the Keuper (Warrington, 1970, p. 196). *Lundbladispora brevicula* enters the Salt Range section at the base of the Mittiwali Member (Balme, 1970) which is Gyronitan (Kummel, 1966) (Late Griesbachian—Tozer, 1965). *Triadispora crassa,* noted by de Jersey (1970a, pp. 15, 26) as first occurring in the Upper Scythian and continuing to the Karnian, has been reported by Warrington (1970, p. 194) from the Röt, Upper Bunter, and Keuper. The type of *Accinctisporites ligatus* has recently (Scheuring, 1974, pp. 207-9) been shown to be identical with *Lunatisporites acutus.* It is known to range from the basal Muschelkalk to Upper Karnian and Upper Keuper (de Jersey & Hamilton, 1967, p. 14; Warrington, 1970, p. 192). *Triadispora falcata* is known in Europe from Röt to Keuper (Warrington, 1970, p. 194). *Protohaploxypinus jacobii* which occurs low in the Moolayember Formation is recorded elsewhere in rocks ranging from Permian to Anisian in age (de Jersey & Hamilton, 1967, p. 17; Geiger & Hopping, 1968). *Annulispora folliculosa* has been recorded from the Rhaetian of Svalbard (Smith, 1974, p. 177) and New Zealand (Dickson, 1972) and from the Liassic of Poland (de Jersey, 1970b, p. 9). *Stereisporites perforatus,* which enters the Queensland section in the Mount Crosby Formation, first appears in European sections in the Karnian (de Jersey, 1971b). *Baculatisporites comaumensis,* which enters the Queensland section a little higher than *S. perforatus,* enters the European section a little lower, in the upper Muschelkalk (de Jersey, 1970b, p. 7). *Apiculatisporis globosus,* which occurs in the higher parts of the Ipswich Coal Measures, also enters the European section in the Karnian. *Polycingulatisporis crenulatus* occurs first in Middle Rhaetic rocks in Germany and also occurs in Liassic rocks (de Jersey, 1970b, p. 10).

Although in a general way taxa enter the Queensland succession in the same order as their first appearances overseas, there are many anomalies in detail which may be due to ecological factors, different rates of migration, or inadequate sampling. The anomalies do, however, render the methods of correlation by first appearance or by overlap at least suspect forms which seem useful are shown on the chart, the range being based on correlations using microfossils.

In the Sydney Basin, *Schizoneura australis* occurs in the Munmorah Conglomerate and *Schizoneura gondwanensis* and *Dicroidium narrabeenense* in higher formations and then *Cylostrobus sydneyensis* in the Gosford Formation (Raggatt, p. 407 in McElroy, 1969). *Schizoneura* also occurs low in the Triassic System in southern Tasmania and *Cylostrobus* higher up, in the Knocklofty Formation which also contains a microflora with *Densoisporites playfordi* and *Lundbladispora brevicula. Lepidopteris madagascariensis* from the Narrabeen Group, the Hawkesbury Sandstone, the Esk Beds, and the Nymboida Coal Measures (Flint & Gould, 1975) suggests correlation with the Early Triassic Sakamena Group of Madagascar and the *Cynognathus* Zone of South Africa.

Flint & Gould (1975) listed other plants which occur in the Esk Beds but not in the Ipswich Coal Measures. These include and probably inapplicable. Correlation by similarity of microfloral assemblage would appear to be the only useful method.

Development of a generally applicable biostratigraphic scheme for the Triassic System in Australia will have to await publication of palynological work on rocks in the Sydney Basin, perhaps work on the Poatina Section in Tasmania, and more particulary work on the sections in the Carnarvon and perhaps offshore Bonaparte Gulf Basin.

ACRITARCHS

Acritarchs, commonly interpreted as indicating some marine influence in deposition, have been reported from the Rewan, Moolayember, and Esk Formations in Queensland (de Jersey, 1968, 1970a, 1972a; Evans, 1966), the Wianamatta Group and Tuggerah Formation in the Sydney Basin (Helby, 1969a; Mayne *et al.*, 1974, p. 207), the Kockatea Shale (Balme, 1963) and Woodada Formation (Balme, 1969a) in the Perth Basin, the Locker Shale in the Carnarvon Basin (Balme, 1969a), and the Blina Shale (Evans, 1966).

MACROFLORA

Although macroscopic plant remains are very common on some horizons in some places and have been known at least since 1845 (Strzelecki), their value for correlation still appears somewhat limited. Ranges of a few *Asterotheca hillae, Dictyophyllum davidi, Cladophlebis lobifolia, Lepidopteris madagascariensis, Dicroidium eskense, Anthryophyopsis grandis, Pterophyllum nathanii, Nilssonia* cf. *princeps, Pseudoctenis eathensis,* and *Taeniopteris crassinervis.* However *A. hillae* occurs in the Tingalpa Formation correlated by de Jersey & Hamilton (1965a) with the Ipswich Coal Measures on palynological grounds and in the 'Feldspathic Sandstone' at Mount Nicholas in Tasmania also correlated with the Ipswich Coal Measures.

The Ipswich Coal Measures contain a rich flora including *Neocalamites carrerei, Asterotheca fuchsii, Cladophlebis concinna, Dicroidium dentatum, Yabeiella brakebuschiana, Y. mareyesciaca, Pterophyllum multilineatum,* and *Linguifolium denmeadi* (Flint & Gould 1975). Similar floras occur in the Red Cliff Coal Measures in northern New South Wales (ibid.) and in the Late Triassic coal measures of Tasmania. Within the Tasmanian Basin Townrow (1966) has suggested that a zone with *Dicroidium odontopteroides* is followed by one with *D. obtusifolium.*

Calcareous algae have been reported from the Bald Hill Claystone and Wianamatta Group in the Sydney Basin.

INVERTEBRATES

Foraminifera have been reported from the Liverpool Subgroup of the Sydney Basin (Lovering, 1954a), perhaps more authentically from the Tuggerah Formation and Bald Hill Claystone (Mayne *et al.*, 1974), and from the Early Triassic rocks of Western Australia (McTavish, 1973), but are of no stratigraphic significance.

Mayne *et al.* (1974) recorded sponge spicules from the Tuggerah Formation. The 'Tarlton Formation' of the Huckitta area in the Northern Territory also contains sponge spicules but may not be Triassic.

A worm (*Spirorbis*) occurs in the Kockatea Shale (Dickins & McTavish, 1963) and a worm burrow (*Diplocraterion*) in the Blina Formation (Veevers & Wells, 1961, p. 110). These too lack stratigraphic significance but are palaeoecologically interesting.

Inarticulate brachiopods (*Lingula*) have long been known in the Blina Shale (see Veevers & Wells, 1961, p. 110) and also occur in other Early Triassic sediments in Western Australia with other undescribed brachiopods (McTavish, 1973, p. 279). Again these are of palaeoecological rather than stratigraphic interest.

Many years ago Etheridge described a gastropod *Tremonotus maideni* from the Hawkesbury Sandstone (see Mayne *et al.*, 1974). The bellerophontid gastropod *Stachella* was noted by Runnegar (1969) from near Woondum (Gympie-Maryborough Basin), associated with ammonites. Standard (1964, ref. quoted by Branagan, 1969) listed a gastropod from the Hawkesbury Sandstone (Sydney Basin), and McTavish (1973, p. 279) noted minute gastropods in the Lower Triassic of Western Australia.

Both marine and non-marine Pelecypoda have been described and the former have some stratigraphical significance. Marine pelecypods include *Bakevellia* sp., *Trigononucula* sp., *Claraia perthensis, C. stachei,* and *'Anodontophora'* cf. *griesbachi* from the Kockatea Shale (Perth Basin) for which they indicate an Early Triassic age (Dickins & McTavish, 1963; McTavish & Dickins, 1974). The significance of *Claraia stachei* has been noted earlier. *Pseudomonotis* sp. has been noted in the Blina Shale (Veevers & Wells, 1961, p. 110). The Brooweena Formation in the Gympie-Maryborough Basin contains *Nuculopsis* sp., *Nuculanella* sp., *Schizodus, Myalina* sp., *Neoschizodus teres, 'Ctenodonta' cordalbae,* and *Bakevellia capricorni,* a fauna suggesting a younger Triassic horizon than the bivalves in the Kockatea Shale but still an Early Triassic one. Fleming (1966b) considered that it was probably not older than Flemingitan (Late Dienerian).

Non-marine units contain pelecypods at Leigh Creek (*Unio eyrensis, Protovirgus jaenschi*), in the Springfield Basin (*Unio springfieldensis*), at Waterloo near Sydney (*Unionella wianamattensis*), in other parts of the Sydney Basin (*Unionella carnei, U. bowralensis, Protovirgus dunstani*), in the upper part of the Gosford Subgroup (Mayne *et al.*, 1974), at and near Ipswich in the Moreton Basin (*Unio eyrensis, Mesohydridella ipsviciensis*) (Ludbrook, 1961) and in the Tingalpa Formation near Slacks Creek (*?Unio eyrensis;* Gould, 1967).

Ammonites have been described from the Kockatea Shale (*Glyptophiceras* sp., *Ophiceras* (*Discophiceras*) cf. *subkyokticum, Subinyoites kashmiricus*) for which they suggest a Late Griesbachian to Smithian age (McTavish & Dickins, 1974). Runnegar (1969) has described other ammonites (*Latisageceras woondumense, Dieneroceras woondumense, Flemingites* sp., *Anaflemingites armstrongi, Paranorites queenslandicus, P. hillae, Pseudohedenstroemia* sp. and *Arctoceras?* sp.) from the Traveston Formation in the Gympie-Maryborough Basin and assigned a Late Dienerian or Early Smithian age to the horizon. Skwarko & Kummel (1974) have recorded further ammonites (*Proptychites* sp., *?Koninckites, ?Paranorites,* and *Gyronites*) from the Kockatea Shale in Dongara No. 4 borehole and suggest a Dienerian age for the occurrence. An outcrop of the Kockatea Shale near Mount Minchin has yielded *Arctoceras* spp., *Prionites* sp., *Hemiprionites* sp., and *Anasibirites kingianus* and was regarded by Skwarko & Kummel (1974, pp. 113, 117) as Smithian. Marine strata from a borehole in the Sahul Shelf were recognised as probably Early Anisian by these same authors (*op. cit.*, pp. 113, 115) on the basis of an ammonite, probably *Nicomedites.* This core also contained halobiid bivalve pieces.

Ostracodes have been found in the Wianamatta Group (Lovering, 1954a) and Bald Hill Claystone (Mayne *et al.*, 1974) in the Sydney Basin, and described from the Kockatea Shale (Jones, 1970).

Conchostracans have long been known from the Wianamatta Group (*Euestheria* cf. *coghlani, E. glenleensis, Palaeolimnadia wianamattensis*), from lower units in the Sydney Basin (*E. coghlani*), and from the Blackstone Formation in the Moreton Basin (*E. coghlani, E. ipsviciensis*). They occur in the Knocklofty and Brady Formations in Tasmania (Tasch, 1975). *Isaura* occurs as coquinas in the Blina Shale in the Canning Basin (Veevers & Wells, 1961, p. 110). Conchostracans have also been noted in the Kockatea Shale (Dickins & McTavish, 1963).

Of considerable biological interest are a small number of arthropods from the Triassic rocks of the Sydney Basin. These include a syncarid crustacean, *Anaspidites antiquus* (Chilton), an anostracan crustacean, *Synaustrus brookvalensis* Riek, and a xiphosuran, *Austrolimulus fletcheri* Riek from the Hawkesbury Sandstone at Brookvale and a phreatoicid crustacean, *Protoamphisopus wianamattensis* (Chilton) from the Ashfield Shale at Newtown.

Insects are abundant on several horizons, the main ones being the Hawkesbury Sandstone (Brookvale near Sydney), Ashfield Shale of the Wianamatta Group (St Peters near Sydney), the Mount Crosby Formation of the Kholo Subgroup and the Blackstone Formation near Ipswich in the Moreton Basin. Evans (1956a, b) and Riek (1954a, 1955a, b) have been the main recent students of this group but Fleming (1966a) has also made a contribution. Other localities with fewer insects are Balmain, near Sydney, in the lower part of the Narrabeen Group, and Fingal and New Town in the Tasmania Basin (Riek, 1962, 1967). Riek (1968) has also reported a beetle from the Hill River area in the Perth Basin and regarded it as Triassic. This group is no longer of any stratigraphic interest but is of considerable biological interest in revealing some facets of the evolution of the group.

The only records of echinoderms in Triassic rocks in Australia are of an ophiuroid from near Woondum in the Gympie-Maryborough Basin (Runnegar, 1969), crinoid fragments from the Early Triassic of Western Australia (McTavish, 1973, p. 279) and holothurian spicules in the Grose Subgroup in the Sydney Basin (Mayne *et al.*, 1974). Invertebrate tracks and other trace fossils have been recorded from the Kockatea Shale (Dickins & McTavish, 1963), from the Gosford Subgroup and from the Hawkesbury Sandstone *Brookvalichnus obliquus* (Webby, 1970).

VERTEBRATES

Vertebrates have long been known from Triassic rocks in the environs of Sydney and Hobart (Tasmania Basin) but have been recognised more recently in the Leigh Creek area of South Australia, in the Perth and Canning Basins, in other parts of the Tasmania Basin, and in the Clarence-Moreton and Bowen Basins in Queensland.

The oldest adequately dated vertebrate in the Triassic System in Australia is the rhytidosteid amphibian *Deltasaurus pustulatus* from the Early Scythian (probably Dienerian) Kockatea Shale in the Perth Basin (Cosgriff, 1965). The amphibian is within a sequence containing the *Lunatisporites pellucidus* microfloral assemblage, ammonites, and bivalves of Late Griesbachian and Dienerian age. Fish have been noted in the Kockatea Shale by Dickins and McTavish. A second species of *Deltasaurus, D. kimberleyensis,* occurs in the Blina Shale in the Canning Basin (Cosgriff, 1965) and in the Cluan Formation in Tasmania (Cosgriff, 1974). The Blina Shale also contains the brachyopid amphibian *Blinasaurus henwoodi,* and the trematosaurid *Erythrobatrachus noonkanbahensis,* as well as fish such as *Saurichthys* and dipnoans (Cosgriff, 1965, 1969; Cosgriff & Garbutt, 1972). On the basis of similarity of *Deltasaurus* to *Rhytidosteus* and *Peltostega,* of *Blinasaurus* to *Batrachosuchus, Boreosaurus,* and *Brachyops,* and of *Erythrobatrachus* to *Aphaneramma,* Cosgriff (*opera cit.*) has suggested correlation of the Blina and Kockatea with the *Cynognathus* Zone of South Africa, the Mangli Beds in India, and the Sticky Keep Formation of Spitzbergen, the age of the last being given by Tozer (1967, p. 20) as of the *Romunderi* Zone of the Smithian. On the evidence, therefore, the vertebrate-bearing part of the Blina Shale may be slightly younger than that of the Kockatea Shale.

Blinasaurus (as *B. townrowi*) has also been recorded in several localities in Tasmania (Cosgriff, 1974) associated with the dipnoan *Ceratodus, Cleithrolepis, Saurichthys, Deltasaurus kimberleyensis,* another rhytidosteid *Derwentia warreni,* a lydekkerinid *Chomatobatrachus halei,* and a proterosuchian reptile close to *Proterosuchus vanhoepeni.* The brachyopid and rhytidosteid amphibia suggest correlation with the Blina Shale and the overseas correlates noted above. Cosgriff (1974, p. 94) noted, however, that *Chomatobatrachus* shows similarities with the *Lydekkerina* and *Limnoketes* from the *Lystrosaurus* Zone, and the resemblance of the reptile to one also from the *Lystrosaurus* Zone has been noted above. The reptile also bears some resemblance, however, to *Euparkeria* from the *Cynognathus* Zone and on the combined evidence of the amphibians and the reptile Cosgriff (1974, p. 95) suggested an age for the Tasmanian vertebrate assemblage intermediate between that of the *Lystrosaurus* and that of the *Cynognathus* Zones. The vertebrates in the Tasmania Basin are associated with elements of the *Lunatisporites pellucidus* microfloral assemblage. On the evidence available the Tasmanian vertebrate faunas may be a little older than the Blina fauna.

The Rewan Formation contains dipnoan and actinopterygian fish, the brachyopid *Brachyops allos* Howie, the unusual amphibian *Rewana quadricuneata* Howie, and reptiles including probable eosuchians and thecodonts (Howie, 1972a, 1972b; Bartholomai & Howe, 1970). Romer (1971, p. 114) suggested that the reptile figured by Bartholomai & Howie was *Procolophon,* an element in the *Lystrosaurus* Zone of South Africa. The vertebrates may suggest correlation with the Mangli Beds of India.

The oldest vertebrates in the Triassic System in the Sydney Basin occur in the Gosford

Subgroup. This subgroup contains a rich fish fauna including a cestraciont shark, a dipnoan, and palaeoniscid, captopterid, perleidid, cleithrolepid, and saurichthyid forms (Hills, 1958). The unit also contains *Blinasaurus wilkinsoni* and the capitosaurid amphibian *Parotosaurus wadei,* the closest relative of which is *P. nasutus* from the Middle Buntsandstein. Cosgriff (1965, p. 89) correlated the vertebrate horizon of the Gosford Subgroup with the *Cynognathus* Zone, and (1974, p. 95) placed it a little younger that the Tasmanian vertebrate faunas. The Gosford Subgroup contains the plant *Lepidopteris madagascariensis* (Townrow, 1966) known also from the *Cynognathus* Zone in South Africa and the Sakamena Group of Madagascar. A little higher in the Sydney Basin, the Hawkesbury Sandstone contains a rich fish fauna—dipnoan, palaeoniscid, captopterid, perleidid, cleithrolepid, saurichthyid, pholidophorid, pholidopleurid, and promecosominid, as well as the capitosaur *Parotosaurus brookvalensis.* This formation contains *Lepidopteris strombergensis* as well as *L. madagascariensis* indicative of correlation with the Molteno Group of South Africa (Townrow, 1966).

The highest vertebrate fauna in the Sydney Basin is that in the Wianamatta Group (mainly in the Ashfield Shale). The fauna includes fish—a very late pleuracanth shark, a dipnoan, palaeoniscids, semionotids, a platysomid, a cleithrolepid, and a promecosominid (Hills 1958)—as well as a brachyopid *Notobrachyops picketti* (Cosgriff, 1973) and the large capitosaurid *Paracyclotosaurus davidi* (Watson, 1958). The latter was regarded by Watson as probably Early Keuper on its evolutionary position but the bulk of palynological evidence in New South Wales and Queensland does not support an allocation as late as this.

Later vertebrates include footprints, probably of a bipedal theropod, in the Blackstone Formation near Ipswich in the Moreton Basin (Staines & Woods, 1964), a stereosponyl footprint from the Tingalpa Formation at Albion near Brisbane (Hill *et al.*, 1965, p. 26), and a fish scale from Leigh Creek in South Australia (Hills, 1958). *Austropelor wadleyi,* a labyrinthodont amphibian from the Jurassic Marburg Sandstone near Brisbane, may be a reworked Triassic specimen (Colbert, 1967).

Present evidence is consistent with a vertebrate sequence starting with a barchyopid, rhytidosteid, lydekkerinid, proterosuchid assemblage, followed by a similar one lacking the last two groups but with a trematosaurid, then by a brachyopid-capitosaurid fauna with more abundant fish. This sequence cannot, however, be regarded as at all well established.

CONODONTS

Although conodonts had been noted earlier the first descriptions were published only late in 1973 (McTavish). Thirteen species were described and figured and indicate correlations of sections in the Perth and Carnarvon Basins with Dienerian, Smithian, and Spathian Stages.

RADIOMETRIC DATING

The beginning of the Triassic was placed by Smith (1964) at 225 million years ago on evidence from eastern Australia (Evernden & Richards, 1962; Cooper *et al.*, 1963). Later results favoured an age of about 235 m.y. based on a K-Ar age of biotite in a tuff in the Gyranda Formation (Webb & McDougall, 1967). This tuff is, however, well below the horizon in the Rewan Formation suggested as the local base of the Triassic System. If the local base is even only approximately contemporaneous with the base in Guryul Ravine, the age of 235 m.y. seems somewhat too high. On the other hand, Green & Webb (1974), using new constants for the calculation, suggested 240 million years (and recalculated Smith's figure to 230 m.y.).

Although many granitic bodies in eastern Queensland and northeastern New South Wales have been shown by radiometric dating in the last decade or so to be Triassic, few of them can be accurately placed stratigraphically and therefore they add nothing to stratigraphic understanding. Such granites will not be considered further. A few radiometrically dated rocks do, however, add stratigraphic information.

The oldest, and least informative, of these is the Crows Nest Granite, the biotite in which is dated at 237 (242 using new constants) m.y. by the $^{40}Ar/^{39}Ar$ method (Green & Webb, 1974). This granite is overlain unconformably by rocks of the Bundamba Group (Rhaetian), which must therefore be younger. A K-Ar dating on the Djuan Tonalite gave an age of 230 m.y. (Day *et al.*, 1974, p. 362) and it is overlain unconformably by the Tarong Beds correlated by de Jersey (1970c) with part of the Ipswich Coal Measures and thus probably Karnian. Hornblende in a dyke (one of the Brisbane Valley Porphyrites) gave an age by the K-Ar method of 218 or 219 m.y. (Webb & McDougall, 1967). These dykes intrude folded beds of the Esk Formation considered to be as young as Early Ladinian, and are overlain unconformably by the Early Jurassic Wivenhoe Sandstone. Rocks of the Somerset Dam Igneous Complex have been dated by Webb & McDougall (1967) by the K-Ar method using hornblende (213, 215 m.y.) and plagioclase (207, 208 m.y.). These rocks intrude the Neara Volcanics which underlie the Esk Formation and are probably Anisian. Cranfield & Schwarzbock (1974) noted that the Mount Byron Volcanics, which overlie the Esk Formation and other units of the Toogoolawah Group unconformably and are themselves intruded by dolerite and microgabbro, possibly related to the Somerset Dam Igneous Complex. These authors also noted the possibility that rhyolitic cobbles in the Kholo Subgroup may have been derived from the Mount Byron Volcanics. The Early Jurassic Wivenhoe Sandstone overlies the Somerset Dam Igneous Complex.

In the Nambour Basin, the North Arm Volcanics have recently (Green & Webb, 1974) yielded an age of 208 (213 using new constants) million years. They are overlain by the Landsborough Sandstone (Stevens, 1971) thought to be Jurassic.

In or close to the Gympie-Maryborough Basin a number of intrusive rocks have been dated radiometrically and show some relationship with Triassic (or Early Jurassic) rocks. They intrude the Brooweena Formation and in one case a younger Triassic unit. The Neurum Tonalite (K-Ar, biotite, 223 m.y. using old constants) intrudes the Early or early Middle Triassic Brooweena Formation and is overlain by the Landsborough Sandstone. Many of the granites in the basin have ages (K-Ar using old constants) averaging 218 m.y. and are unconformably overlain by the Myrtle Creek Sandstone correlated tentatively by Day *et al.* (1974, fig. 7, pp. 340, 349) with the Woogaroo Subgroup of the Bundamba Group. One of the granites intruding the Brooweena Formation has been dated (see Ellis, 1968, p. 24) at 218 m.y. and is overlain by the Aranbanga Beds (Ellis, 1968, p. 20). The Aranbanga Beds are themselves intruded by the Toonahra Granite dated at 210 m.y. (Whitaker *et al.,* 1974).

These relationships are shown in the appropriate columns.

P. O. Banks (1973), quoting Armstrong & Besancon (1970) and others, placed the end of the Triassic Period at 200-205 m.y. Green & Webb (1974) using new decay constants place the boundary at 205 m.y. None of the evidence for this age derives from Australia.

The Garrawilla Volcanics which occur along the eastern edge of the Great Artesian Basin in New South Wales have been dated as from 201 to 171 m.y. in age (Dulhunty, 1973a). They rest on the Saxa Member of the 'Talbragar' Formation correlated (Hind & Helby, 1969) with the Wianamatta Group considered by Helby (1973) as older than the Ipswich Coal Measures which are probably Karnian, and probably Late Anisian and Early Ladinian. The volcanics are overlain by the Purlawaugh Formation and are associated with the Ballimore Formation (Dulhunty, 1973, pp. 323-4). The Purlawaugh Formation contains Early and Middle Jurassic spores (Hind & Helby 1969, pp. 490-1) and the Butheroo Shale Member (base of the Purlawaugh Formation) which overlies the volcanics directly, a basal Jurassic microflora (Dulhunty, 1973b). If the end of the Jurassic Period was 200-205 m.y. ago as suggested by Banks (1973) these lavas may well be Early Jurassic rather than spanning the Triassic/Jurassic boundary as suggested by Dulhunty. Because of the potential value of this section in determining the age of the base of the Jurassic, it would probably repay much closer stratigraphic, palynological, and radiometric work.

NOTES ON THE COLUMNS

Column 1: Stages

Stage names are standard stage names. Subdivisions of the Scythian are those of Tozer (1965). Widespread use of subdivisions of the Scythian, the Mesial and Late Triassic within Australia is unjustified as yet because of difficulties of correlation with standard sections. They are included here to provide an approximate yardstick for the position of formations in columns 3 to 20. The evidence for such positioning is shown in column 2, by the fossils listed with each formation and in the fossil list at the foot of the chart. Heights assigned in this column to the major subdivisions of the Triassic System are roughly proportional to the thicknesses of the appropriate units in the Dolomite Alps and North Eastern Alps where the Triassic is essentially of the one rock type.

Column 2: Australian biostratigraphy

Ranges of microflora illustrated in this column are based on ranges established in Queensland sections and on ages assigned to formations within those sections, mainly by de Jersey. This is done because there is more published information on the palynology of these than on that of other sections. It is clear, however, that the succession is not complete, so the ranges must be regarded as somewhat tentative.

Macrofloral ranges are derived from correlations based on microflora. Invertebrate and conodont ranges are derived from marine sections in other parts of the world. Vertebrate ranges given are related to palynological ranges within Australia.

Column 3: Bonaparte Gulf Basin

Little has been published about the Triassic rocks of the Bonaparte Gulf Basin. A complete Triassic section is apparently present (Laws & Kraus, 1974, which see for earlier references) but little has been published on detailed litho- or biostratigraphy. Detailed study of marine Triassic sections in the Ashmore Block and mixed marine and non-marine sections in the Bonaparte Gulf Basin should provide good control biostratigraphy for use elsewhere in Australia and better correlations of Australian sections with those elsewhere.

Column 4: Canning Basin; Fitzroy Trough

Balme (1969a) correlated part of the Blina Shale with the Mianwali Formation in the Salt Range. He also dealt with the correlation of the Erskine Sandstone which contains *Dicroidium, Pleuromeia, Gleichenites, Aratrisporites,* and *Falcisporites. Aratrisporites* suggests a late Early Triassic or early Middle Triassic age.

The Culvida Sandstone contains *Dicroidium odontopteroides, D. feistmanteli, Equisetites woodsi, Linguifolium denmeadi, Ginkgoites antarctica, Danaeopsis hughesi, Xylopteris elongata* and *Lepidopteris stormbergensis,* a flora which led White (in Veevers & Wells, 1961, p. 295) to consider it equivalent to the Ipswich Coal Measures now considered to be probably Karnian. Such an age makes difficult the correlation of the overlying sandstone and shale unit containing *Isaura* with the Blina Shale as suggested by some authors.

The Cronin Sandstone (Veevers & Wells, 1961, pp. 128, 296) is doubtfully included as the macroflora indentified by White contains plants such as *Ptilophyllum pecten* not known elsewhere in Australia in the Triassic but known in the Jurassic either in Australia or overseas.

In the offshore section of this basin there are thick Middle to Late Triassic successions (Challinor, 1970).

Column 5: Carnarvon Basin

Thomas & Smith (1974) summarised the petroleum geology of the Carnarvon Basin and commented briefly on the Triassic sequence. Although the Triassic section is apparently not complete, it should provide valuable biostratigraphic data for improvement of correlations between Australian sections and those elsewhere. Some indication of this is given in McTavish's (1973) work on conodonts from the Locker Shale. The most detailed statements yet published on the Triassic rocks of this basin are those of Balme (1969a, 1969b).

Balme reported *Aratrisporites* from the Locker Formation suggesting thereby that part of it was Spathian or younger on the basis of the first appearance of *Aratrisporites* in the Narmia Member in the Salt Range and at comparable horizons elsewhere. He noted also that pelecypods listed in an unpublished report may show that part of the Locker Shale is Late Triassic.

The Mungaroo Beds contain *Aratrisporites* not known in eastern Australia in beds younger than the Ipswich Coal Measures, and two species which allow correlation with the Late Triassic (Isalo I) of Madagascar (Balme, 1969a).

Column 6: Perth Basin

Because of interdigitation of marine and non-marine fossils including microflora and vertebrates in the Kockatea Shale, the section in the Perth Basin is very important for correlations of Early Triassic rocks throughout Australia. In several places there are basal sandstone members of the Kockatea Shale (Hosemann, 1971) and these have been given different names in different places, e.g. Dongara Sandstone, Yardarino Sandstone.

The Woodada Formation contains a microflora including *Aratrisporites* indicating a late Early Triassic or younger age and some acritarchs (Balme, 1969a).

Aratrisporites and other plant microfossils in the Lesueur Sandstone suggest a Middle or Late Triassic age (Balme 1969a, p. 76).

Column 7: South Australia

Several basins of Triassic deposition are recognised, the most important being the Leigh Creek Basin and the Springfield Basin which contains more than 335 m of Triassic sediments. The Leigh Creek Coal Measures include Liassic units. Triassic sediments also occur in the Boolcunda Basin just south of the Springfield Basin, and about 60 m of Late Triassic sediments are known in the subsurface near Goyder Lagoon in far northeastern South Australia.

Column 8: Cooper Basin

Triassic rocks in the Cooper Basin are entirely subsurface and are apparently conformable with the Late Permian Gidgealpa Formation.

Column 9: Victoria

Triassic rocks occur in only two places in Victoria, at Bald Hill and at Yandoit Hill. The exact placement of these rocks within the Triassic is difficult but Douglas (1969, p. 279) noted some floral resemblance of the Yandoit Hill beds to the Ipswich Coal Measures and wrote of the difficulty of giving any age more precise than Mesozoic to the Bald Hill occurrence. Syenite of Late Triassic age is reported by Talent (1969) from east Gippsland.

Column 10: Tasmania Basin, Poatina section

The Poatina section, which rests gradationally on Permian rocks, is the most complete known in the basin but only reconnaissance biostratigraphy has been done. The Triassic rocks together with the Late Permian Jackey Shale constitute the upper freshwater division of the Parmeener Supergroup (M. R. Banks, 1973).

Column 11: Tasmania Basin, other sections

The exact stratigraphic relations between the formations shown in this column and in the Poatina section are unclear. Lithic arenites become noticeable components of the two sections at the base of the Tiers Formation and the New Town Coal Measures respectively. Drilling in the type section of the Cygnet Coal Measures has shown that the Barnetts Member of the Springs Sandstone is part of the Cygnet Coal Measures (Clarke & Banks, 1975). Coal is present in, and in many places has been mined from, the upper part of the succession. Many local names have been given but macro- and microfloral evidence indicates approximate contemporaneity. The type sections of the Springs Sandstone, the Knocklofty Formation, and the New Town Coal Measures are isolated by doleritic intrusions or faulting.

Columns 12-14: Sydney Basin

Stratigraphic nomenclature within the Triassic rocks of the Sydney Basin is very complex as also are the stratigraphic relations. No attempt is made on these columns to express all relations or show all named stratigraphic units. Relevant papers are noted below each column and in the Bibliography. Particular attention is drawn to a recent paper by Helby (1973).

Both Helby (1969c, 1973) and Grebe (1970) regarded the lower part of the Narrabeen Group and its correlates as Late Permian as did Balme (1969b).

Column 15: Great Artesian Basin

Triassic sediments occur only within the Coonamble Lobe of the Surat Basin in New South Wales. This lobe includes a small structural basin, the Oxley Basin. As in the Sydney Basin a multiplicity of stratigraphic names have been used (see Hind & Helby, 1969; Dulhunty, 1973), and no attempt is made to detail them here. In beds now correlated with the 'Talbragar' Formation, Hind & Helby (1969) and Helby (1973) noted microfossils of the *Aratrisporites parvispinosus* Assemblage Zone, characteristic of the Hawkesbury Sandstone and Wianamatta Group in the Sydney Basin .The use of the term 'Talbragar' in this context is subject to controversy (Ward, 1975).

Column 16: Clarence district of the Clarence-Moreton Basin

The Nymboida Coal Measures consists of four formations—Cloughers Creek Formation, Bardool Conglomerate, Copes Creek Tuff, and Basin Creek Formation, the last of which is the most significant in terms of coal. Other coal measures—Red Cliff Coal Measures and Evans Head Coal Measures—also occur along the east side of the basin. The Basin Creek Formation contains a macroflora indicating correlation with the Esk Beds, the Red Cliff Coal Measures a macroflora indicating correlation with the Ipswich Coal Measures (Flint & Gould, 1975). No palaeontological evidence is available on the age of the 'Bundamba Formation' of the Clarence part of the Basin.

Column 16a: Lorne Basin

The Camden Haven Group consists of the Camden Head Claystone at the base, the Laurieton Conglomerate, and the Grants Head Formation at the top. Correlations with the Sydney Basin are based on the occurrence of *Lunatisporites noviaulensis, Protohaploxypinus samoilovichii,* and *Aratrisporites coryliseminis* (Helby, 1973).

Column 17: Moreton district of the Clarence-Moreton Basin

Within the Ipswich Coal Measures the upper three formations are now grouped as the Brassal Subgroup, which, therefore, with the Kholo Subgroup constitutes the Coal Measures. Within the Bundamba Group the Triassic members shown have been joined as the Woogaroo Subgroup which with the Jurassic Marburg Formation constitutes the Group. These nomenclatural changes were introduced by Cranfield & Schwarzbock (1972). Elsewhere within the Clarence-Moreton Basin, Triassic rocks are also known near Mount Barney (Stephenson *in* Hill & Denmead, 1960) and around, north, and southeast of Brisbane.

In the Brisbane area the Brisbane Tuff, a prominent local rock and a unit which includes welded tuffs, is overlain disconformably by the Tingalpa Formation which is in turn overlain disconformably by the Moorooka Formation (Houston, 1965b). All three units contain a macroflora and were correlated by Houston with different units within the Ipswich Coal Measures. This correlation was confirmed by de Jersey & Hamilton (1965a) on palynological evidence.

A Triassic volcanic unit, the Chillingham Volcanics, occurs in the Mount Warning area on the New South Wales/Queensland border (Ewart *et al.*, 1971) and is considered equivalent to the Ipswich Coal Measures.

Column 18: Esk Trough

The Bryden, Neara, and Esk Formations have recently been grouped as the Toolgoolawah Group (Cranfield & Schwarzbock, 1972). Some other local names for Triassic formations and members are not shown on the chart. The most important of these, in the south and extreme southwest of the Trough, is the Wivenhoe Sandstone, which overlies the Esk Formation unconformably. It is correlated by Hill, Playford & Woods (1965) with the Tarong Beds which occur west of Nanango, which is itself somewhat west of the northern part of the Esk Trough and may not properly be included therein. De Jersey (1971a, p. 3) showed the equivalence of the Wivenhoe Sandstone with the Early Jurassic Helidon Sandstone.

The relation shown between the Triassic formations near Ipswich and those in the Esk Trough is based on palynological and macrofloral evidence and appears to conflict with photogeological correlations (Jorgenson & Barton, 1966).

Column 19: Gympie-Maryborough Basin

As noted earlier, the Maryborough Basin is important in that it contains Early Triassic marine fossils. Unfortunately no work has yet been published on the microfloral stratigraphy. The stratigraphic relation of the Kin Kin Phyllite is unclear, but it may include rocks of Triassic age (Runnegar & Ferguson, 1969). The age of the Myrtle Creek Sandstone is unclear; Ellis (1968, p. 29) regarded it tentatively as Jurassic and it also appeared on the Jurassic Correlation Chart (de Jersey & Williams *in* Banks *et al.*, 1967). Triassic volcanic rocks occur at Agnes Water, 80 km northwest of Bundaberg (Stevens, 1968).

Column 20: Bowen-Galilee Basin

Malone *et al.* (1969) combined the Rewan, Clematis, and Moolayember Formations to form the Mimosa Group. Subsequently Jensen (1975) elevated the Rewan and Clematis Formations to Group status on the basis of wide distribution of the units, formerly members, within those formations. The Rewan Group contains the Sagittarius Sandstone and the Arcadia Formation, the Clematis Group, the Glenidal Formation, and the Expedition Sandstone.

Several local and informal names have been applied to the Clematis Sandstone or part thereof. These include Wandoan and Showground, the former of which also includes equivalents of the Moolayember Formation (de Jersey & Hamilton, 1969).

The Dunda Beds, which rest on the Rewan along the northeastern edge of the Eromanga Basin, may be lateral equivalents of the Rewan Group in the Denison Trough of the Bowen Basin (Casey, 1970; Olgers, 1972). At or near the base of the Rewan Group occurs the Brumby Sandstone Member (Exon, 1968, p. 10).

The Carborough Sandstone of the northern end of the Bowen Basin (Allen *et al.* in Hill & Denmead, 1960, p. 282) is considered equivalent to the Clematis Sandstone (Hill, Playford & Wood, 1965; Olgers, 1972).

In the Charters Towers area the Warang Sandstone, an Early Triassic unit, crops out (Casey, 1969; Clarke & Paine 1970); it formed near the northeastern edge of the Galilee Basin. Olgers (1972, p. 59) showed the Warang Sandstone as correlative with the Dunda Beds and the Clematis Sandstone. The Collopy Formation of the Townsville area may also be Triassic on the basis of correlation with the Warang Sandstone (Wyatt *et al.*, 1970).

Other Queensland Triassic units

On the western side of the Yarrol Basin a small basin of Triassic deposition, the Abercorn Trough, occurs just south of Monto. Volcanic rocks and sediments, and the Cynthia Beds correlated with the Moolayember, Esk, and Clematis Formations, have been recognised (Day *et al.*, 1974). The authors also suggest likely correlation of some units with the Aranbanga Beds and the Muncon Volcanics.

The Callide Coal Measures from the northern end of the Yarrol Basin are considered as partly correlates of part of the Ipswich Coal Measures by Hill, Playford & Woods (1965) (see also Tweedale *in* Hill & Denmead, 1960, p. 280) and partly of the Jurassic Precipice Sandstone (Day *et al.*, 1974, p. 337).

In the Mossman area in far northern Queensland, the Pepper Pot Sandstone contains a macroflora of Triassic aspect (Amos & de Keyser, 1964) and the Featherbed Volcanics may also be Triassic but are regarded by de Keyser & Lucas (1968) as probably older.

Triassic rocks in Northern Territory

Sandstone and siltstone with some pebble, boulder, and cobble beds crop out in the area of the Tobermory and Hay River 1:250 000 Sheets near the Queensland border. They have been named the Tarlton Formation, and contain fossil plants determined by White in 1961 as being of Late Triassic age (Smith, 1963a, 1965).

Just to the west in the Huckitta Sheet area, conglomerate and silty sand crop out and are correlated with the Tarlton Formation (Smith, 1963b). They contain sponge spicules. The age of this unit must be regarded as doubtful.

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ADDENDUM (August 1978)

Since submission of this paper several important papers affecting the substance of the correlation chart have appeared. Brief comments on the significance of these papers follow.

LIMITS OF THE TRIASSIC SYSTEM

Nakazawa and his co-workers have presented (1975) a more detailed statement of the Permian and Triassic stratigraphy of Kashmir than was previously available.

They suggest use of the base of Bed 52 in the Guryul Ravine section as the base of the Triassic System there. This point falls within the Khunamul Formation. Below it *Claraia* occurs and in the basal beds of the Triassic so used occur some species of shelly fossils and conodonts which first occur in Permian rocks. The point chosen is the base of the *Otoceras-Glyptophiceras* Zone.

MICROFOSSIL ZONES

The succession in the Carnarvon Basin in Western Australia has proved amenable to subdivision into five microfloral zones (Dolby & Balme, 1976). At the base is the *Kraeuselisporites saeptatus* Assemblage Zone of Griesbachian to Early Smithian age and probably equivalent to the *Lunatisporites pellucidus* and *P. samoilovichii* Zones of the Sydney Basin. This is followed by the *Tigrisporites playfordii* Assemblage Zone, Early Smithian to Late Spathian or Early Anisian in age. The base of this zone probably corresponds with the base of the *Aratrisporites tenuispinosus* Zone of the Sydney Basin and an horizon high in the Rewan Group of the Bowen Basin on the basis of sudden increase in abundance of *Aratrisporites* and *Falcisporites* at those levels.

The top of the *T. playfordii* Assemblage Zone cannot be correlated with sections in eastern Australia nor can the succeeding zones, the *Staurosaccites quadrifidus* Assemblage Zone, the *Samaropollenites speciosus* Assembage Zone, and the *Minutosaccus crenulatus* Assemblage Zone. The lack of correlation is ascribed very reasonably to a development of provincialism during the Ladinian (or perhaps Late Anisian), a provincialism of latitudinal origin.

MACROFLORA

A system of macrofloral assemblage zones for eastern Australia has been proposed by Retallack (1977). Of Late Permian to Mid-Smithian age is the *'Thinnfeldia' callipteroides* Zone which corresponds to the *Protohaploxypinus reticulatus, Lunatisporites pellucidus* and *P. samoilovichii* microfloral Zones, then the *Dicroidium zuberi* Zone of Mid-Smithian to Mid-Anisian age, the *D. odontopteroides* Zone (Late Anisian to end of Ladinian) and the *Yabeiella* Zone of Late Triassic age. The *D. odontopteroides* Zone includes a lava at Nymboida in the southern part of the Clarence-Moreton Basin dated by K-Ar at 211 $\pm$ 5 million years.

RADIOMETRIC DATING

A date for part of the *D. odontopteroides* Zone has just been quoted. Further radiometric dates are available from Queensland Triassic rocks. The Kin Kin Phyllite (including the Traveston Formation) was deformed at the time of an intrusion dated as 235 m.y. (Murphy *et al.*, 1976). The Neara Volcanics have been dated in the Gympie area (Murphy *et al.*, 1976, p. 40) as 236 to 237 m.y. but the floras both macro and micro suggest an age younger than the ammonitic Kin Kin Phyllite. However, the Neara Volcanics were intruded by the Station Creek Adamellite about 231 m.y. ago (*ibid.*, p. 79). An anomaly is revealed when the Nymboida Coal Measures (211 $\pm$ 5 m.y.) is correlated with the Toogoolawah Group which includes the Neara Volcanics. The Mount Byron Volcanics, which overlie the Neara Volcanics with angular unconformity, are dated as 223 m.y. old (Murphy *et al.*, 1976). Correlation of the Mount Byron Volcanics with volcanics in the Ipswich Coal

Measures and the Brisbane Tuff has been made (Murphy *et al.*, 1976), but the North Arm Volcanics, also correlated with the Ipswich, give a radiometric date of 208 m.y. The age determinations on the Neara and Mount Byron Volcanics and on the Station Creek Adamellite may be too high, or some of the correlations or suggested structural relationships may be incorrect.

NOTES ON THE COLUMNS

Carnarvon Basin (5)

The Locker Shale is shown by Dolby & Balme (1976) as Dienerian to Late Spathian or perhaps as young as the Early Ladinian (fig. 4, p. 113), the Mungaroo Beds as Spathian to Late Triassic.

Great Artesian Basin (15)

The Gunnee Beds contain a macroflora indicating correlation with the Nymboida Coal Measures and the Esk and Neara Formations of the Esk Trough. The microflora is that of the *Aratrisporites parvispinosus* Zone. The overlying Gragin Conglomerate is thought to be no younger than Middle Triassic and not as young as the Ipswich Coal Measures (Bourke *et al.*, 1977).

Clarence District (16)

The Nymboida Coal Measures are placed too high in the chart as more recent work by Retallack (1977) and Retallack *et al.* (1977) shows a correlation with the Toogoolawah Group (i.e. Bryden Fm. to Esk Fm.) on the basis of macroflora. All contain the *D. odontopteroides* Assemblage Zone as also does the Wianamatta Group.

Moreton District (17)

The stratigraphy of this area has been described recently by Cranfield *et al.* (1976).

Gympie (19)

Murphy *et al.* (1976) have detailed the Triassic stratigraphy of part of this basin.

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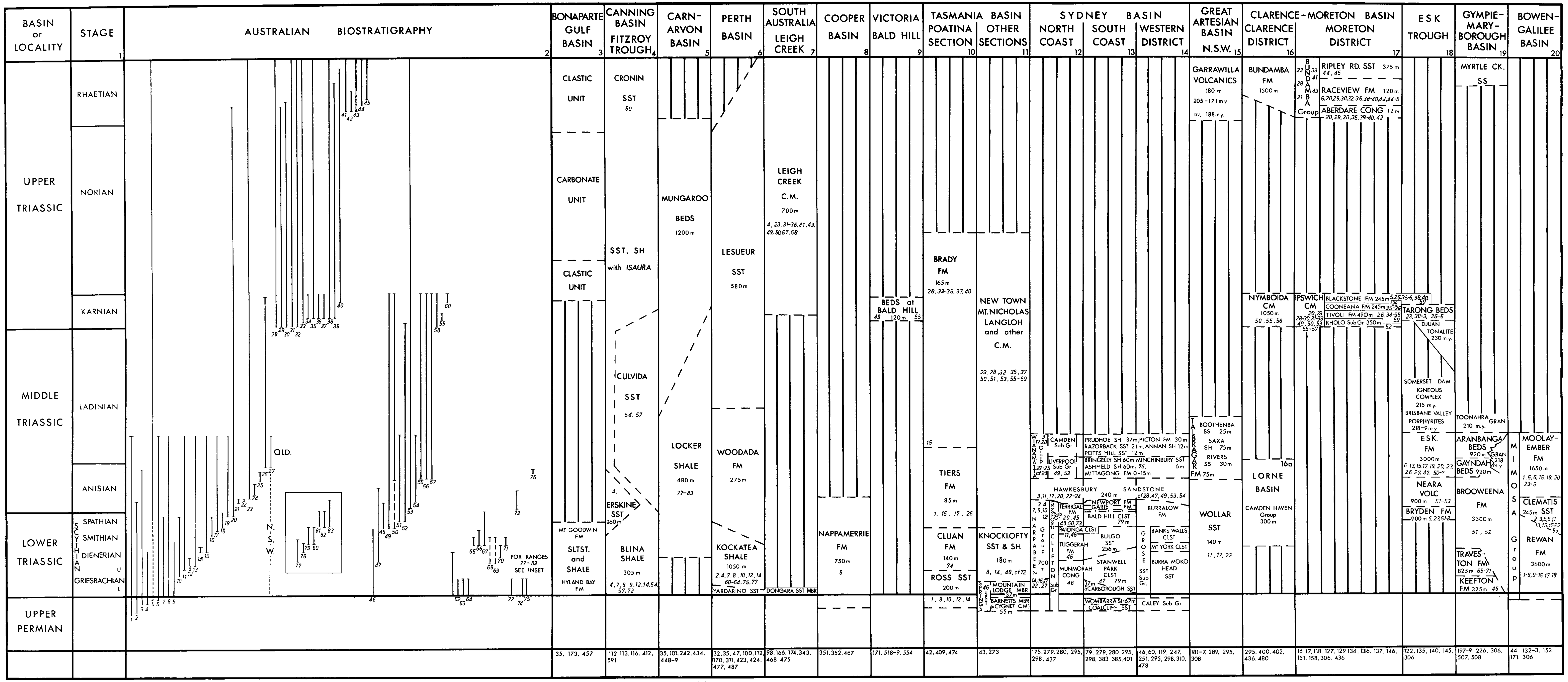
CORRELATION CHART FOR THE TRIASSIC SYSTEM IN AUSTRALIA



——— Boundaries known on the ground, conformity, correlation well known — — Boundaries known on the ground, conformity, but correlation indefinite —?— Formation boundaries poorly known and poorly correlated | | | | Gap in sequence C.M. = Coal measures CLST = Claystone CONG = Conglomerate SH = Shale SST = Sandstone FM = Formation MBR = Member Sub Gr = Sub Group GRAN = Granite

MICROFOSSILS

1 *PROTOHAPLOXYPINUS SAMOILOVICHII* (ZECH-BUNT)
2 *LUNATISPORITES NOVIMUNDUS* (PERMIAN-KEUPER)
3 *LIMATULASPORITES LIMATULUS*
4 *OSMUNDACIDITES SENECTUS* (M. CHHIDRU-TREDIN)
5 *CALAMOSPORA TENER* (BAS MUSCHEL-U TR.)
6 *GREBESPORA CONCENTRICA* (SCYTHIAN-ANISIAN)
7 *LUNATISPORITES OBEX*
8 *DENSOISPORITES PLAYFORDI* (M CHHIDRU-MIANWALI)
9 *PEROTRILETES SAEPTATUS*
10 *LUNDBLADISPORA WILLMOTTI*
11 *ARATRISPORITES WOLLARIENSIS*
12 *PEROTRILETES CUSPIDUS* (M CHHIDRU-MITTIWALI)
13 *VOLTZIACEAESPORITES HETEROMORPHA* (M.SCYTH-KEUP)
14 *LUNDBLADISPORA BREVICULA* (MITTIWALLI-LANDA)
15 *ARATRISPORITES STRIGOSUS*
16 *ARATRISPORITES GRANULATUS*
17 *ARATRISPORITES TENUISPINOSUS*
18 *TRIADISPORA CRASSA* (THROUGHOUT TRIASSIC)
19 *LUNATISPORITES ACUTUS* (BAS MUSCH.-U KARN)
20 *CLAVATISPORITES* cf. *HAMMENII*
21 *TRIADISPORA FALCATA* (M BUNTER-KEUPER)
22 *PEROTRILETES DIFFERENS*
23 *DUPLEXISPORITES PROBLEMATICUS* (M KEUP-CRET)
24 *PROTOHAPLOXYPINUS JACOBII* (PERM.-ANIS)
25 *CADARGASPORITES SENECTUS*
26 *ARATRISPORITES BANKSI*
27 *LUNATISPORITES PELLUCIDUS* (KATHWAI-MIANWALI)
28 *ANNULISPORA FOLLICULOSA* (RHAET-LIAS)
29 *PUSTULATISPORITES BLACKSTONENSIS*
30 *CRATERISPORITES ROTUNDUS*
31 *POLYCINGULATISPORITES DENSATUS*
32 *STEREISPORITES PERFORATUS* (KARN.-LIAS.)
33 *BACULATISPORITES COMAUMENSIS* (UPPER MUSCHELKALK-CRET)
34 *ACANTHOTRILETES BRADIENSIS*
35 *APICULATISPORIS GLOBOSUS* (KARN.-LIAS)
36 *ARATRISPORITES FLEXIBILIS*
37 *ARATRISPORITES PARVISPINOSUS*
38 *CADARGASPORITES BACULATUS*
39 *DUPLICISPORITES GRANULATUS*
40 *SEMIRETISPORIS ANTIQUUS*
41 *CLASSOPOLLIS MEYERIANA*
42 *PARTITISPORITES NOVIMUNDANUS*
43 *POLYCINGULATISPORITES CRENULATUS* (RHAETIAN)
44 *POLYCINGULATISPORITES MOONIENSIS*
45 *LYCOPODIUMSPORITES ROSEWOODENSIS*

MACROFLORA

46 *SCHIZONEURA AUSTRALIS* or spp. but not α
47 *LEPIDOPTERIS MADAGASCARENSIS* (SAKAMENA GP; EARLY TRIASSIC; and CYNOGNATHUS ZONE)
48 *CYLOSTROBUS SYDNEYENSIS*
49 *TAENIOPTERIS WIANAMATTAE*
50 *DORATOPHYLLUM TENISONWOODSI*
51 *ASTEROTHECA HILLAE*
52 *DICROIDIUM ESKENSE*
53 *CLADOPHLEBIS AUSTRALIS*
54 *LEPIDOPTERIS STORMBERGENSIS* (MOLTENO GP, MESIAL or LATE TRIASSIC)
55 *PHOENICOPSIS ELONGATUS*
56 *TAENIOPTERIS CARRUTHERSI*
57 *XYLOPTERIS ELONGATA*
58 *DICROIDIUM OBTUSIFOLIUM*
59 *LINGUIFOLIUM LILLEANUM*
60 *XYLOPTERIS TRIPINNATA*

INVERTEBRATES

61 *CLARAIA* sp. (SCYTHIAN)
62 *GLYPTOPHICERAS* sp (GRIESBACHIAN)
63 *OPHICERAS* (*DISCOPHICERAS*) cf. *SUBINYOTICUM* (GRIESBACHIAN)
64 *SUBINYOITES KASHMIRENSIS* (GRIESBACHIAN)
65 *ANAFLEMINGITES ARMSTRONGI* (GENUS LOWER SCYTHIAN)
66 *ARCTOCERAS* ? sp (GENUS UPPER SCYTHIAN)
67 *DIENEROCERAS WOONDUMENSE* (GENUS UPPER SCYTHIAN)
68 *FLEMINGITES* sp (GENUS SCYTHIAN
69 *LATISAGECERAS WOONDUMENSE* (GENUS SCYTHIAN)
70 *PARANORITES HILLAE* (GENUS LOWER SCYTHIAN)
71 *PSEUDOHEDENSTROEMIA* sp (GENUS LOWER SCYTHIAN)

VERTEBRATES

72 *BLINASAURUS HENWOODI*
73 *BLINASAURUS WILKINSONI*
74 *DELTASAURUS KIMBERLEYENSIS*
75 *DELTASAURUS PUSTULATUS*
76 *PARACYCLOTOSAURUS DAVIDI*

CONODONTS

77 *NEOSPATHODUS DIENERI* (DIENERIAN-MESIAL SMITHIAN)
78 *NEOSPATHODUS PAKISTANENSIS* (LATE DIENERIAN to EARLY SMITHIAN)
79 *NEOSPATHODUS CONSERVATIVUS* (SMITHIAN)
80 *NEOSPATHODUS WAAGENI* (SMITHIAN)
81 *NEOSPATHODUS HOMERI* (SPATHIAN)
82 *NEOGONDOLELLA JUBATA* (SPATHIAN)
83 *NEOSPATHODUS TIMORENSIS* (LATE SPATHIAN-EARLY ANISIAN)