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FORAMINIFERA IN AUSTRALIAN PERMIAN STRATIGRAPHY

by

Irene Crespin

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SUMMARY

During the last few years Permian stratigraphy in Australia has received considerable attention from geologists engaged in the search for oil and coal. Many lithological units have been recognised, the majority of them containing characteristic foraminiferal assemblages.

Investigations in Western Australia have proved the record of Fusulinids (Chapman and Parr, 1937) in the deposits of the Fitzroy Basin to be incorrect. The beds are Triassic, not Permian, in age and the "Fusulinids" probably fish remains.

Publications on Australian Permian foraminifera are few; the most recent contribution is by Crespin and Belford (1957) in which two new genera of the family Ophthalmidiidae, Streblospira and Flectospira, have been described from Western Australia.

With the detailed geological work, changes in stratigraphical nomenclature in Australian Permian deposits have been necessary. Old names such as "Lower Marine Series" and "Upper Marine Series" of New South Wales stratigraphy have been superseded by rock-unit names in conformity with the Australian Code of Stratigraphic Nomenclature.

Extensive deposits of Permian marine rocks are known from all parts of Australia except Victoria and South Australia. Recently Permian foraminifera were found in a bore on Yorke Peninsula, South Australia (Ludbrook, 1957), but so far none have been discovered in Victoria. The present paper gives a summary of Permian stratigraphy in Queensland, New South Wales, Tasmania and Western Australia. The formations are listed in stratigraphical sequence and characteristic foraminifera are noted from those formations in which they have been recorded. New genera and species are listed as manuscript names; these will be described shortly in a Bureau Bulletin by the writer. Comments are given on genera and species found. The assemblages in subsurface deposits are characterised by numerous tests of the family Lagenidae, including Nodosaria, Dentalina, Frondicularia, Lingulina, Geinitzina and Lenticulina (Astacolus). Arenaceous species dominate all outcrop deposits, except those in the Mantuan Productus Bed, Springsure area, Queensland and in the Fossil Cliff Formation, Irwin Basin, and Callytharra Formation, Carnarvon Basin, Western Australia. Calcareous imperforate forms are common in the last two formations. Some species from the Pennsylvanian and Permian deposits of United States and from the upper Carboniferous and Permian of Europe have been determined. Eight foraminiferal assemblages have been recognised in the Australian Permian deposits; these should be useful in stratigraphical work.

Australian stratigraphers and palaeontologists are not agreed on the basis for the division of the Permian System into lower, middle and upper Permian and whether the Sakmarian Stage of Europe should be included in the lower Permian or in the upper Carboniferous. With the absence of Fusulinids in Australia, little evidence is given by the foraminifera for correlation with European Stages. However, the larger fossils have yielded certain reliable data.

INTRODUCTION

During the last few years Permian stratigraphy throughout Australia has received considerable attention from geologists engaged primarily in the search for oil and coal. These detailed investigations have been undertaken by geologists of the Commonwealth Bureau of Mineral Resources,

Geology and Geophysics, State Geological Surveys and of private companies engaged in the search for oil and by the Geology Departments of the Universities. Many lithological units have been recognised in the Permian rocks and micropalaeontological examination of beds comprising these units has revealed the presence of characteristic foraminiferal assemblages in many of them.

Investigations in Western Australia have shown that the beds in the Fitzroy Basin from which Chapman and Parr (1937) described "Fusulinids", are not Permian in age but are Triassic and that the "Fusulinids have yet to be found in the Permian of Australia.

Publications on Australian Permian foraminifera are few. These are listed under the heading of References. The most recent contribution is by D.J. Belford and the writer (Crespin and Belford, 1957) in which two new genera of the family Ophthalmidiidae were described. The present paper gives a summary of a comprehensive work by the writer which will appear at a later date as a Bulletin of the Bureau. In that work, five new genera and fifty-three new species have been discussed. Because many of these new forms are of zonal importance, they are referred to as manuscript names.

No Permian rocks from New Guinea have been studied for foraminifera for inclusion in this paper. Foraminifera have been recorded from a limestone near Kuta, Western Highlands (Glaessner et al, 1950; Rickwood, 1955).

SUMMARY OF PERMIAN STRATIGRAPHY IN AUSTRALIA WITH CHARACTERISTIC FORAMINIFERA IN LITHOLOGICAL UNITS

Extensive deposits of Permian marine rocks are known from all Australian States except Victoria and South Australia. (See map). Recently, Permian foraminifera have been found in a bore on Yorke Peninsula, South Australia (Ludbrook, 1957), but so far they have not been discovered in Victoria. With the detailed work on these sediments, changes in stratigraphic nomenclature have been necessary (Raggatt et al 1950).

In the short summary of Permian stratigraphy each State is dealt with individually and the characteristic foraminifera in the beds of the different formational units are listed.

Queensland

Permian deposits are widely distributed in eastern Queensland. The only deposits studied for foraminifera were those in the Springsure Shield which is on the eastern margin of the Great Artesian Basin (Hill, 1955) and from the coalfield area near Collinsville in the north-eastern part of the Bowen Basin. Beds of the Cattle Creek Formation and the Mantuan Productus Bed of the Springsure area have yielded excellent assemblages of calcareous species. Small assemblages have been found in bores drilled for oil, such as the Arcadia and Morella Bores. The only published work on the Permian foraminifera of Queensland is by Crespin (1945, 1947).

The stratigraphical sequence in the Springsure area (Hill, 1955, 1957) is shown in Table I. The Dilly Beds outcrop only in the core of the Springsure anticline, about 2000 feet of sediments being exposed. The Cattle Creek Formation is about 500 feet thick at the type locality. Webb

(1956) suggests, from evidence outside the Springsure area, that the Dilly Beds may form the lower part of the Cattle Creek Formation. The Ingelara Formation ranges from 90 feet to about 500 feet in thickness. The Mantuan Productus Bed contains richly fossiliferous limestone and marl (Hill, 1957).

Lithological units in the Springsure area:-

Bandanna Formation
Mantuan Productus Beds
Catherine Sandstone
Ingelara Formation
Aldebaran Sandstone
Cattle Creek Formation
Staircase Sandstone
Dilly Beds

Foraminifera have been found in the following formations:-

1. Mantuan Productus Bed - Frondicularia aulax MS., F.sutilis MS., Geinitzina striatosulcata MS., G.triangularis Chapman and Howchin, Lenticulina (Astacolus) initialis MS.

2. Ingelara Formation - Ammodiscus erugatus MS., A.multicinctus Crespin and Parr, Dentalina grayi Crespin, Frondicularia woodwardi Howchin, Geinitzina striatosulcata MS, Reophax minutissima Plummer.

3. Cattle Creek Formation - Ammobaculites woolnoughi Crespin and Parr, Ammodiscus multicinctus Crespin and Parr, Calcitornella stephensi Howchin, Frondicularia aulax MS., F.hillae MS., F.sutilis MS., F.woodwardi Howchin, Geinitzina triangularis Chapman and Howchin, Nodosaria serocoldensis Crespin, N.springsurensis Crespin, Sacculinella australae MS.

4. Dilly Beds - Calcitornella stephensi (Howchin), Frondicularia woodwardi Howchin, Geinitzina triangularis Chapman and Howchin.

New South Wales

Permian rocks in New South Wales outcrop mainly within a radius of 200 miles north, south and west of Sydney. The stratigraphy of all areas has been closely studied because of the extensive coal deposits that are present throughout the sequence. Stratigraphical nomenclature has been revised by Hanlon and Booker (Hill, 1955) and by Hanlon, Joplin and Noakes (1953).

Old names such as "Lower Marine Series" and "Upper Marine Series" of New South Wales stratigraphy, used by the writer in 1947 for broad correlation of the Australian foraminiferal assemblages, are now ~~obsolete~~ largely superseded. The names replacing these older terms in the major areas of Permian outcrop in the Sydney Basin are shown in the following table:

Old Nomenclature	New Nomenclature		
	Northern Coalfield	Southern Coalfield	Western Coalfield
Upper Coal Measures	Newcastle Coal Measures Tomago Coal Measures	Illawarra Coal Measures	Lithgow Coal Measures
Upper Marine Series	Maitland Group	Gerrigong Volcanics Shoalhaven Group	Capertee Group
Greta Coal Measures	Greta Coal Measures	-	-
Lower Marine Series	Dalwood Group	-	-

Extensive marine deposits are associated with the northern coalfields in the central Hunter River Valley; smaller ones occur in the southern coalfields south of Sydney towards Nowra and Jervis Bay and in the western area around Lithgow and along the Victoria Pass section of the Mitchell Highway. Subsurface deposits occur over a wide area in the Hunter River district (Reynolds, 1956) and in the Sydney Basin (Raggatt and Crespin, 1940, 1941) where they are at considerable depth. Small subsurface deposits are known in the southern part of the Riverina at Coorabin (Crespin, 1943; Sturmfels, 1950).

Chapman and Howchin (1905) published the first work on Permian foraminifera in New South Wales; Crespin and Parr described arenaceous species in 1941 and Crespin published contributions in 1943, 1945 and 1947.

The stratigraphical sequence in the Hunter River area, which has been studied in some detail, is shown below. Arenaceous foraminifera dominate the assemblage in the surface deposits of the Mulbring and Branxton Subgroups of the Maitland Group; calcareous species are common in the Dalwood Group and in subsurface material of the two Subgroups (Hill, 1955).

The sequence is as follows:-

Newcastle Coal Measures
Tomago Coal Measures
Maitland Group { Mulbring Subgroup / Branxton Subgroup
Dalwood Group

The following foraminifera are characteristic of the formations. "x" indicates species that have been found only in subsurface deposits.

1. Maitland Group.

(a) Mulbring Subgroup - Ammodiscus multicinctus Crespin and Parr, Ammobaculites woolnoughi Crespin and Parr, Dentalina grayi Crespin [x], Digitina recurvata Crespin and Parr, Frondicularia aulax MS [x], F.parri Crespin [x], F.woodwardi Howchin [x], Hyperammina expansa (Plummer) [x], H.hebdenensis MS, Lingulina antiqua Chapman and Howchin [x], Nodosaria raggatti MS [x], Pelosina hemisphaerica Chapman and Howchin [x], Reophax subasper Parr [x],

R.tricameratus Parr [X], Textularia bookeri MS.[X], Thuramminoides sphaeroidalis Plummer, T.teicherti (Parr) [X], Tolypammina undulata Parr, Trochammina pulvilla Crespin and Parr.

(b). Branxton Subgroup - Ammodiscus multicinctus Crespin and Parr, Ammobaculites woolnoughi Crespin and Parr, Digitina recurvata Crespin and Parr, Dentalina grayi Crespin [X], Frondicularia parri Crespin, F.woodwardi Howchin, Geinitzina triangularis Chapman and Howchin, Hyperammina hebdenensis MS., Lingulina antiqua Chapman and Howchin, Nodosaria raggatti MS., N.serocoldensis Crespin, Thuramminoides teicherti (Parr), Trochammina pulvilla Crespin and Parr.

2. Dalwood Group.

Ammobaculites woolnoughi Crespin and Parr, Calcitornella stephensi (Howchin), Digitina recurvata Crespin and Parr, Earlandia prolixa MS., Frondicularia woodwardi Howchin, Hemigordius schlumbergi (Howchin), Hyperammina fletcheri MS., Nodosaria tereta MS., Streblospira australa Crespin and Belford, Textularia bookeri MS., Trepeilopsis australiensis MS.

Tasmania

Permian rocks occur from Wynyard in the north-west to the south-eastern limits of the State, from Point Hibbs and the Henty River on the west coast to Coles Bay and Maria Island in the east and from the north coast to the south coast. The deposits are thickest in the south-east but even there, they reach only about 2,300 feet.

Three sections in different regions of the State have been recently studied by geologists:-

(a) Deloraine-Cressy section of the north-western and western parts by Wells (1957) and McKellar (1957);

(b) the Hobart-Woody Island section in the south-eastern and southern part by Banks and Hale (1957) and

(c) the Elephant Pass-St. Mary's section in the north-eastern part by K.G.Brill (unpublished).

Foraminifera have been studied only from isolated samples from the different sections. However, evidence based on the occurrence of Calcitornella stephensi (Howchin), supports the correlation of the Brumby Formation of the Golden Valley Group of the Deloraine-Cressy section and the Darlington Limestone of the Hobart-Woody Island section. Foraminifera have been examined from the Gray Limestone of the Elephant Pass section and the Berriedale Limestone of the Hobart-Woody Island section, which are stratigraphically higher than the Darlington Limestone, but more material is necessary to confirm the correlation of these two formations on the basis of the foraminifera. Crespin (1944) recorded foraminifera from a section near Oonah in the north-western region which probably come within the Golden Valley Group of the Deloraine-Cressy section.

South Australia

Permian foraminifera were recently discovered in a bore at Minalton, Yorke Peninsula (Ludbrook , 1957), giving the first evidence of the occurrence of marine Permian rocks in South Australia. The foraminifera-bearing beds underlie 500 feet

of fluvio-glacial sands and glacial boulder clay.

Western Australia

Considerable detailed stratigraphical work has been undertaken in Western Australia, especially since 1949, and at least five distinct sedimentary basins, all containing extensive Permian deposits, have been recognised. They are:-

1. Collie Basin
2. Irwin Basin
3. Carnarvon Basin
4. Canning and Fitzroy Basins
5. Bonaparte Basin

Permian foraminifera were first described from Western Australia by Howchin (1895) from Fossil Cliff, Irwin River. Parr (1942) described several new forms from the Wandagee area, Carnarvon Basin. No other species were described until recently when Crespin and Belford (1957) recorded two new genera and four new species from subsurface deposits in the Carnarvon, Fitzroy and Canning Basins. No foraminifera have been found in any beds in the Collie Basin. The record by Chapman (1907) of a small stunted foraminiferal fauna at Collie is not regarded as authentic either by the late W.J.Parr or the writer.

Irwin Basin.

Permian sediments in the Irwin Basin, about 250 miles north of Perth, crop out over an area of approximately 200 square miles between 28°30' and 29°30' S. latitude (Teichert and Glenister, 1952). Although seven formations have been mapped in the Basin, foraminifera have so far been recorded from only the lower ones in the sequence. The stratigraphical sequence is as follows:-

Wagina Sandstone
Carynginia Shale
Irwin River Coal Measures
High Cliff Formation
Fossil Cliff Formation
Holmwood Shale
Nangetty Glacials

The characteristic foraminifera of the formations are given below:-

1. Fossil Cliff Formation - Ammodiscus nitidus Parr, Calcitornella stephensi (Howchin), Frondicularia woodwardi Howchin, Geinitzina triangularis Chapman and Howchin, Hemigordius schlumbergi (Howchin), Nodosaria irwinensis Howchin, N.tereta MS., Hyperammina callytharraensis MS., Trepeilopsis australiensis MS.

2. Nangetty Glacials - Hemigordius schlumbergi (Howchin), Hyperammina elegantissima Plummer.

Carnarvon Basin.

The Carnarvon Basin is situated along the western margin of the Precambrian Shield between 21°30' and 27°45' South latitude. It covers an area of about 40,000 square miles and is up to 200 miles wide (Condon, 1954, Teichert, 1952). Extensive deposits of marine Permian are exposed in the central and southern part of the basin and more than 3,000 feet of sediments have been proved by boring.

The stratigraphical sequence of formations in

the central portion of the Basin is as follows:-

Coolkilya Greywacke
Baker Formation
Norton Greywacke
Wandagee Formation
Quinnanie Shale
Cundlego Formation
Bulgadoo Shale
Mallens Greywacke
Coyrie Formation
Callytharra Formation

The foraminiferal assemblages in the formations are given below. Except in the Callytharra Formation, arenaceous species are predominant in outcrop material. Because of the interesting assemblage found in subsurface beds, the species will be listed separately.

1. Baker Formation - Ammodiscus nitidus Parr, A.wandageeensis Parr, Hyperammina acicula (Parr), H.coleyi Parr, H.expansa (Plummer), Reophax subasper Parr, Thurammina phialaeformis MS., Thuramminoides sphaeroidalis Plummer, Trochammina subobtusa Parr.

2. Wandagee Formation - Ammodiscus nitidus Parr, Hyperammina acicula (Parr), H.coleyi Parr, Hyperamminita rudis (Parr), Reophax subasper Parr, Thuramminia phialaeformis MS., Thuramminoides sphaeroidalis Plummer, T.teicherti (Parr), Tolypammina undulata Parr.

3. Quinnanie Shale - Ammobaculites woolnoughi Crespin and Parr, Ammodiscus nitidus Parr, A. wandageeensis Parr, Glomospira adhaerens Parr, Hyperammina acicula (Parr), H.coleyi Parr, Psammosphaera pusilla Parr, Reophax subasper Parr, R.tricameratus Parr, Thurammina phialaeformis MS., Thuramminoides teicherti (Parr), Tolypammina undulata Parr, Trochammina subobtusa Parr.

4. Cundlego Formation - Ammobaculites woolnoughi Crespin and Parr, Ammodiscus nitidus Parr, A.wandageeensis Parr, Cornuspira condoni MS., Glomospirella nyei MS., Hyperammina acicula (Parr), H.expansa (Plummer), Nodosaria raggatti MS., Spiroplectammina carnarvonensis MS., Streblospira meandrina Crespin and Belford, Trochammina subobtusa Parr.

5. Bulgadoo Shale - Ammobaculites woolnoughi Crespin and Parr, Ammodiscus nitidus Parr, A.wandageeensis Parr, Hyperammina acicula (Parr), H.expansa (Plummer), H.elegans (Cushman and Waters), Nodosaria raggatti MS, Pelosina hemispherica Chapman and Howchin, Reophax ellipsiformis MS., Thurammina phialaeformis MS., Trochammina subobtusa Parr, Thuramminoides sphaeroidalis Plummer.

6. Mallens Greywacke - Ammoduscus nitidus Parr, Hyperammina acicula (Parr).

7. Coyrie Formation - Ammodiscus nitidus Parr, Digitina recurvata Crespin and Parr, Reophax asper Cushman and Waters, R.ellipsiformis MS., Sacculinella australae MS., Spiroplectammina carnarvonensis MS., Textularia improcera MS., Thuramminoides sphaeroidalis Plummer.

8. Callytharra Formation - Ammobaculites eccentrica MS., Ammodiscus nitidus Parr, Calcitornella stephensi (Howchin), Earlandia prolixa MS., Frondicularia woodwardi Howchin, Geinitzina triangularis Chapman and Howchin, Giraliarella

angulata MS., Hemigordius schlumbergi Howchin, Hyperammina callytharraensis MS., H.hadzeli MS., Nodosaria tereta MS., N.irwinensis Howchin, Placopsilina wooramelensis MS., Strebospira australae Crespin and Belford, Tetrataxis conica Ehrenberg, Trepeilopsis australiensis MS.

Two distinct assemblages, both dominated by calcareous species, were found in the only bore in the Carnarvon Basin to penetrate the Permian sediments. The assemblage in the upper part of the sequence is considered to be the equivalent of the Cundlego Formation-Bulgadoo Shale and that in the lower part to the Callytharra Formation. The characteristic species of the two assemblages are as follows:-

Cundlego Formation-Bulgadoo Shale: Ammodiscus nitidus Parr, Cornuspira condoni MS., Flectospira prima Crespin and Belford, Frondicularia woodwardi Howchin, Hyperammina elegans (Cushman and Waters), H.expansa (Plummer), Nodosaria conico-densestriata Paazlow, N.crassula MS., N.decoris MS., N.raggatti MS., N.serocoldensis Crespin, N.springsurensis Crespin, N.striatella Paazlow, Reophax ellipsiformis MS., Thuramminoides phialaeoformis MS.

Callytharra Formation: Calcitornella stephensi (Howchin), Earlandia prolixa MS, Geinitzina striatosulcata MS, G.triangularis Chapman and Howchin, Giraliarella angulata MS, Hyperammina elegantissima Plummer, Spirillina tuberculo-dentata Streblospira australae Crespin and Belford, Tetrataxis conica Ehrenberg.

Canning and Fitzroy Basins.

The Canning Basin (Traves et al, 1957) is the sedimentary Basin between the Kimberley and Pilbara areas of Precambrian rocks; it extends north-westward to the present continental shelf and is bounded on the east by Precambrian rocks near the Northern Territory-Western Australian border. The Fitzroy Basin is regarded as one of the individual downwarps in the floor of the Canning Basin.

Permian rocks are widely distributed in both surface and subsurface sections in the Canning Basin, particularly in the northern part (the Fitzroy Basin) (Guppy et al, 1952, 1957). Sand and Mesozoic sediments cover the central portion of the Basin.

The lithological units of the Canning and Fitzroy Basins are as follows:-

Liveringa Formation
Noonkanbah Formation
Poole Sandstone
Nura Nura Member
Grant Formation

Foraminifera occur in surface deposits of the Nura Nura Member of the Poole Sandstone, the Noonkanbah Formation and the lower part of the Liveringa Formation, but they are most common in subsurface sections of the Noonkanbah Formation. Recently they have been found in subsurface beds referable to the Grant Formation.

The following foraminifera are characteristic of the formations. "x" indicates species that have been found only in subsurface deposits:-

1. Liveringa Formation (lower part) - Ammodiscus erugatus MS^{x}, Hyperammina fusta MS, Nodosaria serocoldensis Crespin^{x},

Reophax subasper Parr[X].

2. Noonkanbah Formation - Ammodiscus erugatus MS., Ammodiscus nitidus Parr, Calcitornella heathi Cushman and Waters[X], Calcivertella palata MS.[X], Cornuspira condoni MS[X], Dentalina grayi Crespin[X], D.habra MS[X], Digitina recurvata Crespin and Parr, Flectospira prima Crespin and Belford[X], Frondicularia impolita MS[X], F.parri Crespin[X], F.semicostulata MS[X], F.woodwardi Howchin[X], Geinitzina caseyi MS[X], G.striatosulcata MS[X], G.triangularis Chapman and Howchin[X], Glomospirella nyesi MS[X], Hemigordius noonkanbahensis MS[X], Hyperammina acicula Parr, H.coleyi Parr, H.elegans (Cushman and Waters), H.expansa (Plummer), Nodosaria fisheri MS[X], N.raggatti MS[X], N.serocoldensis Crespin, N.spiculata MS[X], Plummerinella kimberleyensis MS[X], Pelosina hemisphaerica Chapman and Howchin, Psammosphaera pusilla Parr[X], Pseudohyperammina radiostoma MS[X], Reophax ellipsiformis MS., R.tricameratus Parr, R.subasper Parr, Sacculinella australae MS[X], Streblospira kimberleyensis Crespin, S.meandrina Crespin and Belford[X], Thurammina phialaeformis MS., Thuramminoides sphaeroidalis Plummer, T.teicherti (Parr), Trochammina subobtusa Parr.

3. Poole Sandstone, Nura Nura Member - Ammodiscus nitidus Parr[X], Calcitornella stephensi Howchin, Geinitzina triangularis Chapman and Howchin[X], Nodosaria tereta MS[X], Tetrataxis sp.[X], Hemigordius schlumbergi (Howchin).

4. Grant Formation - Hyperammina expansa (Plummer)[X], Nodosaria tereta MS[X], Reophax fittsi (Warthin)[X], Thuramminoides sphaeroidalis Plummer.

Bonaparte Basin.

Except for small mesa-cappings of Lower Cretaceous sediments and areas of alluvium, Permian rocks occur the entire coastal strip about 35 miles wide, extending from the Fitzmaurice River in the south to the Daly River in the north (Noakes, Opik and Crespin, 1952; Traves, 1955). The lithological units represented in the Basin are:-

Weaber Group
Port Keats Group

Foraminifera have been found only in a bore at Port Keats (Etheridge, 1907) in beds referable to the Port Keats Group. The species are: Ammodiscus nitidus Parr, Calcitornella stephensi (Howchin), Hyperammina acicula Parr.

COMMENTS ON GENERA AND SPECIES OF PERMIAN IN AUSTRALIA

During a recent investigation of Permian foraminifera of Australia by the writer, both surface and subsurface deposits have been studied. Several observations are worthy of note.

1. Up to the present no fusulinid foraminifera have been found in the Permian rocks of Australia, although they occur in some abundance in the island of Timor to the north-west of Australia.

2. There is a most remarkable development of certain genera of the family Lagenidae in both eastern and Western Australian deposits. The majority of these forms have been found in subsurface beds. The genera include Nodosaria, Dentalina, Frondicularia, Lingulina, Geinitzina and Lenticulina (Astacolus). Geinitzina

does not range higher than the Permian. Many of the species of Nodosaria, Dentalina and Frondicularia are strikingly ornamented. The subgenus Astacolus has not been previously recorded from beds older than Jurassic.

3. Calcareous imperforate genera include Calcitornella, Plummerinella, Orthovertella, Trepeilopsis, Hemigordius, Cornuspira and Earlandia. All these genera except Cornuspira are restricted to the Upper Palaeozoic.

4. Arenaceous foraminifera are characteristic of all Permian assemblages in Australia, especially in beds above those in the lower part of the Lower Permian sequence. The genera include Ammodiscus, Ammobaculites, Digitina, Hyperammina, Reophax, Spiroplectammina, Textularia, Thurammina and Thuramminoides. A few broken tests of Hyperammina are often the only foraminiferal form found in many deposits, whilst in certain beds in the Wandagee area, Carnarvon Basin, Western Australia and in the Hunter River area of New South Wales, tests of this genus occur in great abundance.

5. Several new genera have been discovered by the writer in the Permian deposits of Western Australia. Two of these Flectospira and Streblospira, which belong to the family Ophthalmidiidae, were recently described by Crespin and Belford (1957).

6. Some forms of arenaceous and calcareous imperforate foraminifera are referable to species described from the Permian and Pennsylvanian of North America, especially from Texas. These forms include Hyperammina elegantissima Plummer, H.elegans (Cushman and Waters), H.expansa (Plummer), Reophax fittsi (Warthin), Reophax asper Cushman, Calcitornella elongata Cushman and C.heathi Cushman and Waters.

FORAMINIFERAL ASSEMBLAGES IN THE PERMIAN ROCKS OF AUSTRALIA

Eight distinctive foraminiferal assemblages are recognisable in the Permian deposits of Australia, and it is quite possible that some of these assemblages may permit of long distance correlation within Australia.

1. A characteristic assemblage of species is found in the beds of the Callytharra Formation of the Carnarvon Basin, Western Australia, that is in the lower part of the Permian sequence. It is found in stratigraphically equivalent deposits both in eastern and Western Australia. It is of widespread distribution but of limited stratigraphic range and includes such species as Calcitornella stephensi, Frondicularia woodwardi, Earlandia prolixa, Geinitzina triangularis, Hemigordius schlumbergi, Nodosaria tereta MS., N.irwinensis, Streblospira australae, Tetrataxis concia, Trepeilopsis australiensis MS.

2. An assemblage of calcareous and calcareous imperforate species, chiefly new, and of arenaceous species including new genera is present in subsurface deposits of the Noonkanbah Formation of the Canning and Fitzroy Basins, Western Australia. The new genus and species recently described by Crespin and Belford (1957), Streblospira kimberleyensis, is so far restricted to the Noonkanbah Formation but the species S.meandrina Crespin and Belford, although characteristic of the Noonkanbah Formation, is found in surface deposits of the different formations of the Byro Group of the Carnarvon Basin and with other new species in the assemblage also found in the Carnarvon Basin, gives some evidence for the correlation of the Noonkanbah Formation with part of the

Byro Group of the Carnarvon Basin.

3. A persistent assemblage of arenaceous species occurs throughout the beds of the Byro Group, Carnarvon Basin, and Noonkanbah Formation of the Fitzroy and Canning Basins. The abundance of tests of individual species varies in beds of the different formations.

4. Arenaceous species are again predominant in the surface deposits of the Mulbring and Branxton Subgroups of the Maitland Group, Hunter River area, New South Wales. The abundance of individual species again varies from locality to locality.

5. Calcareous species are characteristic of the subsurface deposits of the Maitland Group, Hunter River area, New South Wales and include described species such as Dentalina grayi, Frondicularia parri, F.woodwardi, Lingulina antiqua and Nodosaria serocoldensis. The common occurrence of F.woodwardi together with F.parri suggests correlation with the Byro Group of the Carnarvon Basin and Noonkanbah Formation of the Canning and Fitzroy Basins, Western Australia.

6. A small assemblage dominated by Frondicularia parri Crespin is present in subsurface sections in the Sydney area, New South Wales.

7. A distinctive assemblage of calcareous species is present in the limestone of the Mantuan Productus Bed, Reid's Dome, near Springsure, Queensland. The species include Frondicularia aulax MS., F.woodwardi, Geinitzina caseyi MS., G.triangularis, Lenticulina (Astacolus) initialis MS., and Nodosaria serocoldensis It is suggested that the Mantuan Productus Bed may be correlated with the Noonkanbah Formation of Western Australia and the Maitland Group of New South Wales.

8. A unique assemblage of arenaceous species is found in a deposit near Oonah, north-west Tasmania. It contains new genera and species as well as described forms all of which are unusually large. The bed in which this assemblage occurs, is in the lowest part of the Permian sequence in Tasmania.

CORRELATION OF THE PERMIAN DEPOSITS OF AUSTRALIA WITH THOSE OUTSIDE THE CONTINENT

Australian stratigraphers and palaeontologists do not agree on the basis for the division of the Permian System into Lower, Middle and Upper Permian and whether the Salmarian Stage of Europe should be included in the Lower Permian or in the Upper Carboniferous. Little evidence can be based on the foraminifera because of the absence of Fusulinids. However, evidence from larger fossils is more reliable. Hill (1957) comments that much depends on future international agreement as to where the Carboniferous-Permian boundary should be drawn and also on future palaeontological work to correlate Australian stages with those of the "elected standard". David and Browne (1951, Table XVIII) give a tentative correlation of all Australian Permian deposits with European Stages, the Sakmarian, Artinskian and Kungurian-Tartarian. Subsequent correlations are given by the following authorities: Queensland, Hill (1955, 1957); New South Wales, Teichert and Fletcher (1943), Teichert (1953); Western Australia, Teichert (1941, 1952), Teichert and Glenister,(1952), Condon (1954), Hill (1955), Thomas and Dickins (1954); Tasmania, Banks (1952, 1956).

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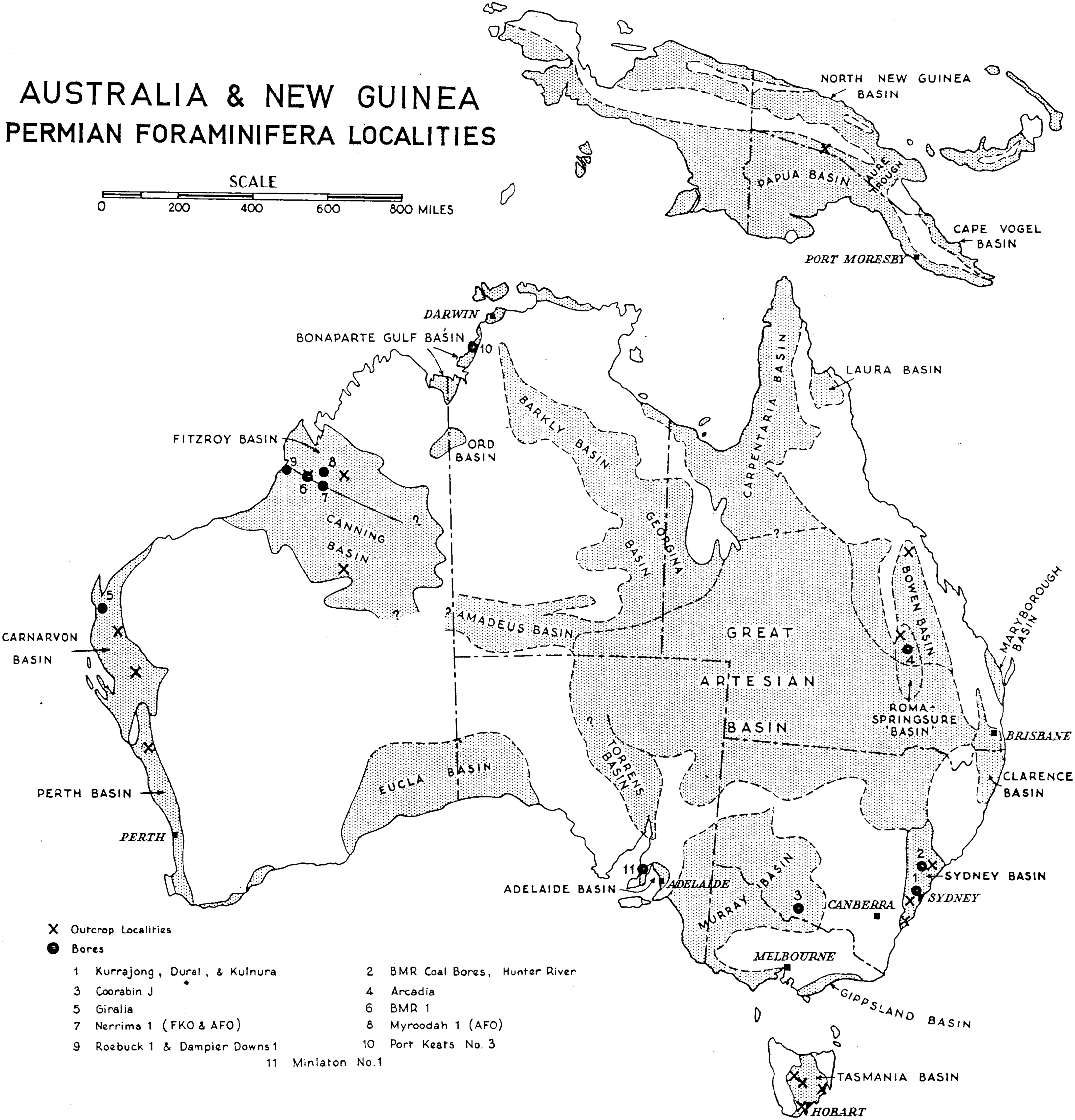
AUSTRALIA & NEW GUINEA
PERMIAN FORAMINIFERA LOCALITIES



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