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FORAMINIFERA IN THE PERMIAN ROCKS OF AUSTRALIA

BY

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FORAMINIFERA IN THE PERMIAN ROCKS OF AUSTRALIA.

1. INTRODUCTION.

Foraminifera were first recognized in the Permian sediments of Australia in 1882. Some systematic work on these micro-fossils was done up to 1905, but there was no further investigation until 1937, since when five papers on Permian foraminifera have been published. However, about ten years ago, systematic sampling of outcrops, cores and cuttings from bores was commenced with the object of determining whether micro-faunal zones could be established.

Since 1933 extensive collections of Permian rocks have been made in New South Wales and Western Australia, and smaller ones in Queensland, by geologists attached to private companies who were carrying out a search for oil in Australia. Subsidiary companies of Oil Search Limited drilled two deep bores in New South Wales and two in Queensland, which were partly or wholly in Permian sediments; and the Freney Kimberley Oil Company was drilling a deep bore in Western Australia, which is wholly in Permian beds and which, when operations were suspended in 1942 owing to the war, had reached a depth of 4,271 feet. Core samples and drill cuttings from these bores and the various outcrops have been examined by the writer and a micro-fauna identified. Surface samples from localities in New South Wales were also submitted by the Geology Department, University of Sydney, for micro-examination. There has been little investigation of the micro-fauna of Permian rocks in Tasmania, and the only foraminifera recorded are those described by Howchin in 1895 from the Piper River near Karoola and those listed by the writer in 1944 from sediments near Oonah. Recently foraminifera were discovered by the writer in sediments from Latrobe.

From the information presented in the following sections of this bulletin, it will be seen that, although a considerable amount of research is still necessary before a definite system of zoning, based on the micro-faunas, can be applied to the Permian rocks of Australia, such a system is possible. In the extensive collections of Permian rocks examined from the Hunter River District of New South Wales, assemblages of foraminifera rather than restricted species have proved useful for zonal purposes, and it will be shown that correlation of deposits in other States can be made by means of these assemblages.

A notable feature of the foraminiferal assemblage in the Permian rocks of Australia is the almost complete absence of the world-wide zonal forms, the Fusulinidae. The only record of their occurrence is the two poorly preserved specimens from the Upper Ferruginous Series in the West Kimberley Area, Western Australia, referred to the genera *Verbeekina* and *Neoschwagerina* by Chapman and Parr (1937). These important foraminifera are of considerable zonal significance in the Permian rocks of Sumatra, India, China and Japan.

2. HISTORICAL NOTES.

The first reference to the presence of Permian foraminifera in Australia was made by Professor Rupert Jones (1882) in his Catalogue of Fossil Foraminifera in the British Museum. The locality was

given as Piper River, Tasmania. Thomas Stephens (1889) published a note in the Royal Society of Tasmania on the discovery by R. Etheridge of Permo-Carboniferous foraminifera in a limestone from the "right bank of the Piper River, not very far from a place called Lilydale" (Howchin, 1894). Etheridge stated that this was the first record of the occurrence of foraminifera in the Permo-Carboniferous rocks of Australia and Tasmania. The Piper River material was further examined by Howchin (1894) when he recorded four species from thin sections of limestone.

Howchin (1895) described four new species of foraminifera from the "Carboniferous" beds, Irwin River area, Western Australia. This work, together with that by Chapman and Howchin in 1905 on the Permo-Carboniferous foraminifera of New South Wales, formed a basis for investigations on Permian foraminifera in Australia for many years. The nomenclature used by Chapman and Howchin in the latter paper (1905) was revised by those authors in collaboration with W. J. Parr in 1934 (Chapman, Howchin and Parr, 1934).

Etheridge, Jnr. (1907), listed Permian foraminifera from a bore at Port Keats, Northern Territory.

Chapman and Parr (1937) recorded the occurrence of two genera of Fusulinids in rocks from the West Kimberley area in Western Australia.

Two papers containing descriptions of new species appeared in 1940. One was by W. J. Parr and the writer (Crespin and Parr, 1940) on species of Permian foraminifera from New South Wales and the other by Parr (1940) on species from Western Australia.

The writer has recently published (Crespin, 1944) papers on Permian foraminifera from eastern Australia and from Oonah, Tasmania.

3. DISTRIBUTION OF FORAMINIFERA IN THE PERMIAN ROCKS OF AUSTRALIA.

The distribution tables given below for each State are based on the micropalaeontological examination by the writer in her capacity as Commonwealth Palaeontologist of samples supplied chiefly by various companies engaged in the search for oil in Australia. Other sources of material are also indicated. Assemblages of foraminiferal species have been recognized and these may prove useful for correlation purposes pending further investigation to see whether species with restricted ranges are present.

The relative abundance of a species in the samples examined is indicated by the letters "c", "f" and "r", referring respectively to common, few and rare.

A. QUEENSLAND.

Little micropalaeontological investigation has been undertaken on the Permian rocks of this State. The writer has examined fairly extensive collections of rocks from the Springsure area as well as

samples from two deep bores, namely, the Hutton Creek Bore, drilled to the depth of 4,688 feet and the Arcadia Bore, to 6,036 feet (Crespin, 1945). This material was submitted for examination by private companies engaged in the search for oil in Queensland. Following are the lists of localities from which foraminifera have been recorded:—

(i) Foraminiferal occurrences referred to the Middle Bowen Series.

1. Dry Creek, "Inglelara" property, Springsure.
2. Argus's selection, Springsure.
3. Watershed between Sandy and Dry Creek, south end of Serocold Structure.
4. Aldebaran, 4 miles north-east of Mount Catherine, 30 miles west of Rolleston.
5. Arcadia Bore, 85 miles north of Roma, from 1,800 feet depth down to 2,390 feet.
6. Hutton Creek Bore, 60 miles north of Roma, from 770 feet depth down to 790 feet.
7. Quarry beside Banana-Rannes-road, 9.6 miles from Banana.

(ii) Foraminiferal occurrences referred to the Lower Bowen Series.

8. Staircase Gully at base of Mount Sirius, 32 miles north-west of Rolleston.
9. Staircase Gully, just below Old Rolleston-road Crossing.
10. Staircase Gully.
11. Watershed between Little Gorge and Cabbage Tree Creeks.
12. Ironbark or Little Gorge Creek, Springsure-Rolleston-road.
13. Three miles from Cracow on road to Theodore.
14. Two and a half miles from Mantuan Downs Station, on Springsure-road.
15. Mantuan Downs.
16. North bank, Cattle Creek, 14 miles south-east of Springsure.
17. In Cattle Creek below Waterfall.
18. Mr. Reid's section through Mount Hope, 20 miles south of Springsure.

Table I. below summarizes the information available concerning the occurrence and distribution of foraminifera in the Middle Bowen and Lower Bowen Series of Queensland. Samples from all localities listed have been examined by the writer. For convenience, number designations are given to localities which are shown above. An attempt has been made to assign the localities to the various stages comprising the Middle Bowen and Lower Bowen Series. The result, it is understood, accords with the recent classification put forward by geologists attached to companies searching for oil in Queensland.

TABLE I.—DISTRIBUTION OF PERMIAN FORAMINIFERA IN QUEENSLAND.

Foraminifera.	Middle Bowen Series.							Lower Bowen Series.									
	Inglelara Stage.				Hor. Uncer.			Gypseous Stage.							Dilly Stage.		
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.
Ammodiscus milletianus Chapman	—	r	—	—	—	f	—	—	r	—	—	r	—	—	—	—	—	c
A. multicinctus Crespin & Parr	f	f	c	c	—	—	c	c	c	c	—	—	c	—	—	—	—	c
Hyperamminoides sp.	—	—	—	f	—	—	—	—	—	—	—	—	—	—	—	—	—	f
H. acicula Parr.	f	f	f	f	f	—	f	—	c	f	—	—	r	—	—	—	—	f
Calcitornella stephensi (Howchin)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	f	f	r
Reophax subasper Parr.	—	—	—	r	—	—	—	r	—	—	—	—	—	—	—	—	—	—
Ammobaculites woolnoughi Crespin & Parr.	—	r	—	r	r	—	—	—	—	—	—	—	—	—	—	r	r	—
Ammobaculites sp.	—	f	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Textularia sp.	—	—	—	f	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Digitina recurvata, Crespin & Parr.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	c	—	—
Digitina sp.	—	—	—	f	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Tetrataxis conica Ehr.	—	—	—	—	r	—	—	—	—	—	—	—	—	—	—	—	—	—
Glomospira, cf. *depressa* Waters	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r
Haplophragmoides sp. 3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—
Pelosina hemisphaerica Chapman & Howchin.	—	r	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Pelosina sp.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	c	—	—
Trepeilopsis cf. *grandis* Cushman & Waters	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	—
Nodosinella sp.	—	f	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Trochammina cf. *arenosa* Cushman & Waters	—	c	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	f
T. pulvillus Crespin & Parr.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r
Trochammina sp.	—	—	—	—	—	—	—	—	r	—	—	—	—	—	—	—	—	—
Nodosaria serocoldensis Crespin	—	—	—	—	—	—	—	r	—	—	—	r	—	—	—	c	—	r
N. springsurensis Crespin	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—
Dentalina grayi Crespin	—	r	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Frondicularia woodwardi Howchin	—	r	f	—	—	—	—	—	r	—	c	f	f	—	r	c	f	f
F. parri Crespin	—	—	r	—	—	—	—	—	—	—	r	—	—	—	—	r	r	—
Geinitzina triangularis Chapman & Howchin	—	—	—	—	—	—	—	—	—	—	—	f	f	f	r	r	r	r

Notes on the Assemblages.

On account of the small amount of material available for investigation from the Permian rocks of Queensland, remarks on the foraminiferal assemblages can only be regarded as tentative. It will be necessary for further collections of sediments to be made from both the Middle Bowen and Lower Bowen Series before definite zoning will be possible.

(i) *Middle Bowen Series.*

The assemblage found in samples from Localities 1 to 4, which are referred to the Inglelara Stage, contains *Ammodiscus multicinctus,*

Hyperamminoides acicula, Ammobaculites woolnoughi and *Frondicularia woodwardi.* It will be shown later that this assemblage is similar to that found in the Branxton stage of the Upper Marine Series of New South Wales, and it is probable that the sections in the Arcadia and Hutton Creek Bores can be correlated with this stage.

(ii) *Lower Bowen Series.*

Two assemblages are recognized in the Lower Bowen Series.

1. An assemblage consisting of *Ammondiscus multicinctus, Nodosaria serocoldensis, Frondicularia woodwardi* and *Geinitzina triangularis,* is present in samples from localities 8–15, which are referred to the Gypseous Stage of the Lower Bowen Series.

2. The second assemblage contains the important zonal foraminifer *Calcitornella stephensi,* together with *Trepeilopsis cf. grandis, Nodosaria serocoldensis, Frondicularia woodwardi* and *Geinitzina triangularis.* It is found in samples from localities 16, 17 and 18 which are referred to the Dilly stage. As pointed out later in this bulletin, the majority of these species may constitute a distinct assemblage in the Lower Bowen Series of Queensland, in the Lower Marine Series of New South Wales, in the Lower Latrobe Series of Tasmania, in the Callytharra limestone and Fossil Cliff beds of Western Australia and in the material from the Port Keats Bore, Northern Territory.

B. NEW SOUTH WALES.

Geologists from the Bureau of Mineral Resources, Canberra, the Mines Department, New South Wales, Oil Search Limited and the Commonwealth Oil Refineries Limited have made extensive collections of rocks in the Hunter River District in the hope that micro-faunal zones could be established. Material was also collected by Oil Search Limited from the section at Victoria Pass, Mitchell Highway, and rock samples from other Permian deposits in New South Wales were made available by the Geology Department, Sydney University.

Cores and cuttings from bores have also been investigated. Samples from the Kulnura Bore, which is situated 15 miles north-west of Gosford and which was drilled to a depth of 6,293 feet, were examined microscopically during the progress of drilling, and foraminifera were discovered at various depths (Raggatt and Crespin, 1940). Foraminifera were also present in the Balmain Bore, Sydney (Raggatt and Crespin, 1941) and in Bore J at Coorabin, 55 miles west of Albury (Crespin, 1943). The list of localities from which samples containing foraminifera have been examined is given below.

(i) Foraminiferal occurrences referred to the Upper Marine Series.

(*a*) *Hunter River District.*

Mulbring Stage—

1. West bank of railway cutting, west of Minimbah.
2. Minimbah, Cutting, east of station.
3. Minimbah-Belford Dome Section (part).
4. Long Point, left bank of Hunter River, near Singleton.
5. Padua Siding, Singleton-Muswellbrook Railway.
6. Mt. Thorley, Warkworth-road, west flank of Loder Dome.

7. John Brown's Reservoir Section, Mulbring-Buchanan-road, Richmond Vale by eastern Spillway.
8. Foster's Bridge Section, east of Mulberry Creek.
9. Pelaw-Richmond Main Railway line section, Portion 19, Ph. Stockington.
10. Saw Mill, Mulberry Creek, west of Mulbring.
11. Rix's Creek, above Muree.
12. Warkworth Stock route, Loder Dome.
13. McDougall's Hill, Singleton.
14. Box Tree Hill Cutting, north slope, Goorangoola-road, north of Singleton.

Muree Stage—

15. Minimbah-Belford Dome Section (part).

Branxton Stage —

16. Branxton Railway cutting, west of Branxton.
17. Pothanna Siding, west side of railway cutting.
18. Minimbah Section (part).
20. Cutting north side of road alongside railway, opposite bridge over railway, ¼ mile east of Muswellbrook Station.
21. Spoil from well on boundaries Portions 6, 7, and 13, Ph. Brougham, County Durham, west side of Ramrod Creek.
22. Shaft about 20 chains north-west of above locality.
23. Wollong (Chapman and Howchin, 1905).
24. Belford Dome, east flank.
25. Abbey Green, south of road in little creek off Loder's Creek.

(*b*) *Other occurrences referred to the Upper Marine Series.*

26. Foot of Victoria Pass, Mitchell Highway.
27. Kulnura Bore from 3,778 feet down to 4,490 feet.
28. Balmain Bore, Sydney from 4,750 feet down to 4,760 feet.

(*c*) *Horizon Uncertain.*

29. Bore J. Coorabin, at 334 feet.

(ii) Foraminiferal occurrences referred to the Lower Marine Series.

(*a*) *Hunter River District.*

Farley Stage—

30. Top of Farley beds, Farley-road, north-east of Railway Station.
31. Railway Cutting immediately west of Farley.
32. Leconfield section.
33. Bishop's Bridge, to Sawyer's Gully Section.
34. Rothbury to Black Creek Section.

Allandale Stage—

35. One and a half miles south-east of Jackson's Hill, Pokolbin.
36. Pokolbin (Chapman and Howchin).
37. Harper's Hill.
38. A little below Harper's Hill tuffs on road near a local road leading to "Oswald" property.
39. Greta-Harper's Hill Section.
40. Allandale Railway Cutting, east of Allandale.

TABLE II.—DISTRIBUTION OF PERMIAN FORAMINIFERA IN NEW SOUTH WALES.

Foraminifera.	Upper Marine Series.																													Lower Marine Series.													
	Mulbring Stage.														Muree Stage.	Branxton Stage.										Ref. U.M.			Hor. Un.	Farley Stage.					Allandale Stage.						Loch-invar.		Ref. L.M.
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.	26.	27.	28.	29.	30.	31.	32.	33.	34.	35.	36.	37.	38.	39.	40.	41.	42.	43.
Ammodiscus ovalis Chapm. ..	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	—	—	—	—	—	—	—
A. multicinctus Crespin & Parr. ..	c	c	c	f	c	—	c	c	f	r	c	r	f	r	f	—	f	—	—	—	—	—	—	c	—	c	r	—	—	—	c	—	—	—	—	—	—	—	f	r	—	f	r
A. milletianus Chapman	f	—	r	—	—	—	f	f	—	—	—	—	—	r	r	—	r	r	r	—	—	—	c	—	—	r	r	—	—	—	—	—	—	—	—	c	—	—	r	—	f	r	r
A. planoconvexus Chapm. Howchin & Parr.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	—	—	—	—	—	r
Hyperamminoides acicula Parr. ..	c	c	—	r	c	c	c	c	c	f	c	r	f	f	c	r	c	c	r	c	—	r	r	c	—	c	f	f	f	f	c	f	—	c	c	—	r	—	c	—	—	c	c
Hyperammina? rudis Parr. ..	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	—	—	—	—	r	—	—	—	r	—	—	—	r	—	—	—	—	—	—	—	—	—
Calcitornella stephensi (Howchin) ..	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	f	c	c	—	—	—	c	f	—	—
Tolypammina vagans (Brady) ..	r	—	—	—	—	—	r	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	—
T. undulata Parr.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	—	—	—	—	—	—	—	—	—	—
Trepeilopsis sp.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	—	—	—	—	—	r	—	—	—	—	—	—	—	—	—	—	—
Thurammina papillata Brady ..	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	—	—	—	—	—	—	—
Reophax subasper Parr.	r	r	—	—	—	—	—	r	—	—	—	—	—	—	—	—	—	r	r	—	—	—	—	—	—	—	—	—	—	—	r	—	—	—	—	—	—	—	r	—	—	—	—
Pelosina hemisphaerica Chapman & Howchin	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	—	—	—	—	—	—	—	—	—	—	—	r	—	—	—	—	—	—	—
Ruditaxis cf. *rhaetica* Chapman ..	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	—	—	—	—	—	—
Placopsilina tenuitesta Chapman & Howchin	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	—	—	—	—	—	—
Tetrataxis cf. *scutella* Cushman & Waters	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Crithionina teicherti Parr.	f	f	—	—	r	r	—	r	r	—	—	—	—	—	—	—	r	—	—	—	—	—	—	—	—	f	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Lituola sp.	r	r	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Lunucammina sp.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	—	—	—	—	—	—
Haplophragmoides sp.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	f	—	—	—	—	—	—	—	—
H. neocomianus Chapman	—	—	—	—	—	—	—	—	—	—	—	—	—	—	f	—	—	—	—	r	—	—	r	—	—	—	—	—	—	—	—	—	—	—	—	f	—	—	—	—	—	—	—
Ammobaculites sp.	—	—	—	—	—	—	—	r	—	—	—	—	—	—	r	—	—	—	r	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
A. woolnoughi Cresp. & Parr. ..	c	r	—	—	—	r	—	r	—	r	—	r	r	—	—	—	r	f	—	—	c	r	—	—	—	—	—	—	—	f	—	—	—	f	—	—	f	—	—	r	c	f	—
A. cf. *pseudospiralis* (Williamson) ..	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	—	—	—	—	—	—
Endothya macella Brady	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E. bowmani Phil.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Globivalvulina bulloides (Brady) ..	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Digitina recurvata Crespin & Parr. ..	c	r	—	f	—	—	f	c	r	—	—	—	r	—	—	—	f	—	—	c	c	—	c	—	f	f	—	—	—	—	c	—	—	—	—	—	f	—	c	f	f	—	c
cf. *D. recurvata* Crespin & Parr. ..	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	c	—	—	—	f	—	—	—	—	—	—	—	—
Textularia eximia Eichw.	f	r	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	c	—	—	—	f	r	—	—	—	—	—	—	—	—	—	—	—	—
Textularia sp.	—	—	—	—	—	—	—	—	—	—	—	—	r	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	f	—	—	—	—	—	—	—	—	—	—	—	f
Spiroplectammina sp. 1	f	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Spiroplectammina sp. 2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	c	—	—	r	—	—	—	—	r	—	c	—	—
Trochammina cf. *arenosa* Cushman ..	c	—	—	—	—	—	—	—	r	r	—	r	—	—	—	—	—	—	r	—	—	—	—	—	—	c	—	—	—	—	—	f	—	—	—	—	f	—	—	—	—	—	—
Trochammina sp.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	—	—	—	—	—	—	—	—	—	—	c	—	—	—	f	—	—	r	f	—	—	—	f
T. pulvillus Crespin & Parr. ..	—	—	—	—	—	—	r	r	'f	r	—	—	—	—	—	—	r	—	—	—	—	—	—	—	—	c	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Trochamminoides anceps (Brady) ..	r	—	—	—	f	r	—	—	r	r	r	—	—	—	—	—	r	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	f	—	—	—	—	—	—	r
Nodosaria serocoldensis Crespin ..	—	—	—	—	—	—	—	—	—	r	—	—	—	—	—	—	—	—	—	f	—	—	—	—	—	—	f	—	—	—	—	—	—	—	—	—	r	—	—	—	—	—	r
N. irwinensis Howchin	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	—	—	—	—	—	—
N. permiana (Spandel)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
N. ?antiqua Chap. & How. ..	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
N. pyramidis Chap. & How. ..	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	—	—	—	—	—	—	—	—	—	—	—	r	—	—	—	—	—	—	—
N. sp.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Dentalina bradyi Spandel	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Lingulina davidi Chap., Howchin & Parr.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Frondicularia parri Crespin ..	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	f	—	—	—	—	—	—	c	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
F. woodwardi Howchin	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	—	—	—	—	c	—	—	—	f	—	—	—	—	r	—	—	r	f	—	—	—	—	—	—	r
Frondicularia sp...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Geinitzina triangularis Chapman & Howchin	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	c	—	r	c	—	r	—	—	—	r	f	—	c	f	—	—	—	—	f	—	—

Lockinvar Stage—

41. Cranky Corner.
42. Paterson.

(*b*) *Other occurrence referred to the Lower Marine Series.*

43. Kulnura Bore, 4,667 feet down to 6,019 feet.

Table II. summarizes the information available concerning the occurrence and distribution of foraminifera in the Upper Marine Series and Lower Marine Series of New South Wales. The tabulation is based chiefly on the writer's examination of samples from the localities listed above but the work of Chapman and Howchin (1905) is also included. For convenience, numerical designations are given to the localities which are given above.

Notes on the Assemblages.

Three assemblages of foraminiferal species are recognized tentatively in the Permian rocks of New South Wales. One is characteristic of the Upper Marine Series; a second of the Victoria Pass section and the third of the Lower Marine Series.

(i) The most characteristic assemblage of foraminifera found in rocks referred to the Upper Marine Series, is present in the shales and sandstones of the Hunter River District. It contains *Hyperamminoides acicula, Ammodiscus multicinctus, Ammobaculites woolnoughi,* and *Trochammina pulvillus. H. acicula* and *A. multicinctus* are the commonest species, the former being sometimes the only foraminifer present in a sample. *H. acicula* is of little zonal value as it is well distributed in the Permian rocks of Australia.

An attempt can be made to zone the Upper Marine Series in New South Wales. *A. multicinctus* is abundant in the Mulbring Stage, the topmost zone of the Series. It is frequently associated with *Crithionina teicherti,* a species described by Parr (1941) from the Wandagee Beds in Western Australia, which are placed high in the Permian sequence in that State.

Not enough material has been examined from the Muree Stage to show any distinctive foraminifera.

Digitina recurvata is the most prominent species in the beds referred to the Branxton Stage. This form is especially prominent in the Muswellbrook deposits. Two other species, *Frondicularia woodwardi* and *Geinitzina triangularis,* typical of the Lower Marine assemblage occur in the Branxton Stage, being especially noticeable in the lower part of the section. Chapman and Howchin record both species from Wollong.

(ii) The second assemblage of foraminifera contains *Hyperamminoides acicula, Ammodiscus multicinctus* (these two species being less prominent than in assemblage 1), *Ammobaculites woolnoughi, Trochammina* cf. *arenosa, Textularia eximia* and *Digitina recurvata.* This assemblage is well developed in the sediments at the foot of the Victoria Pass section, Mitchell Highway. Some authorities refer this section to the Mulbring horizon but foraminiferal evidence suggests that it may belong to the Branxton. The two species, *Frondicularia woodwardi* and *Geinitzina triangularis* mentioned above are recorded from this locality. Neither of these species have been recorded from beds higher than the

Branxton in New South Wales and occur only at the base of the sections correlated with the Upper Marine Series in other parts of Australia. It is important to note also that this assemblage occurs in sediments typical of the Farley Stage, which is at the top of the Lower Marine Series.

(iii) A most distinctive assemblage of foraminifera occurs in the beds referred to the Allandale Stage of the Lower Marine Series. It was recorded first by Chapman and Howchin from a limestone at Pokolbin in the Hunter River District (1905). The assemblage is dominated by *Calcitornella stephensi,* the associated species being *Trepeilopsis* sp., *Nodosaria irwinensis, Frondicularia woodwardi* and *Geinitzina triangularis.* A similar assemblage is present in the Dilly Stage of the Lower Bowen Series of Queensland.

C. TASMANIA.

There has been little investigation of the Permian rocks of Tasmania for microfaunas, although the extent of the deposits is considerable. Howchin (1894) described foraminifera from the Piper River limestone near Karoola in the north-eastern part of the island, and the writer (1944) listed several species from rocks near Oonah, in the north-west. The rocks from Oonah were collected by Mr. P. B. Nye of the Bureau of Mineral Resources, who, more recently, obtained specimens of micaceous shale from the mouth of the Tasmanite shale adit at Latrobe, 40 miles east of Oonah, which contained a foraminiferal assemblage similar to that from Oonah.

(i) Foraminiferal occurrences correlated tentatively with the Upper Marine Series of New South Wales.

1. Oonah, 23 miles north of Waratah, on the main Somerset-Waratah road.
2. Mouth of the Tasmanite shale adit, Latrobe.

(ii) Foraminiferal occurrences correlated with the Lower Marine Series of New South Wales.

3. Piper River, near Karoola.

TABLE III.—DISTRIBUTION OF PERMIAN FORAMINIFERA IN TASMANIA.

Foraminifera.	1.	2.	3.
Ammodiscus multicinctus (Form A) Crespin & Parr	c	c	—
Ammodiscus multicinctus (Form B)	c	c	—
Hyperamminoides acicula Parr	f	—	—
Hyperamminoides sp. nov.	f	—	—
Hyperamminoides sp.	f	f	—
Crithionina teicherti Parr	f	—	—
Pelosina hemisphaerica Chapman & Howchin	c	—	—
Pelosina sp.	r	—	—
Reophax sp.	r	—	—
Lituola sp.	r	—	—
Ammobaculites woolnoughi Crespin & Parr	f	—	—
Ammobaculites sp.	r	f	—
cf. *Nodosinella*	f	—	—
Textularia sp.	r	—	—
Digitina recurvata Crespin & Parr	f	—	—
Calcitornella stephensi (Howchin)	—	—	c
Hemigordius schlumbergeri (Howchin)	—	—	r
Trochammina sp.	r	r	—
Nodosaria cf. *permiana* Spandel	—	—	r
Frondicularia sp.	r	—	—
Geinitzina triangularis Chapman & Howchin	—	—	r

NOTES ON THE ASSEMBLAGES.

Two assemblages of foraminiferal species are present in the Permian rocks of Tasmania so far examined. One is tentatively correlated with the Upper Marine Series of New South Wales and the other with the Lower Marine Series of that State.

(i) The assemblage in the sediments near Oonah and Latrobe is dominated by an extraordinary development of the species *Ammodiscus multicinctus*, both the microspheric and megalospheric generations being present in large numbers. The associated forms in the Oonah material, *Hyperamminoides acicula* (together with numerous tests of a new species of that genus), *Digitina recurvata* and *Crithionina teicherti*, suggest a correlation with the lower portion of the Upper Marine Series of New South Wales.

(ii) The second assemblage is dominated by the species *Calcitornella stephensi*, with associated species *Hemigordius schlumbergeri*, and *Geinitzina triangularis*. It is present in the Piper River limestone and is referred to the Lower Latrobe Series (Voisey, 1938). This assemblage has its equivalents in the Dilly Stage of the Lower Bowen Series of Queensland, Allandale Stage of the Lower Marine Series of New South Wales and the Callytharra limestone, Fossil Cliff beds and Nura Nura limestone of Western Australia and beds in the Port Keats Bore, Northern Territory.

D. WESTERN AUSTRALIA.

Extensive collections of Permian rocks have been made by geologists attached to Oil Search Limited, the Commonwealth Oil Refineries Limited, Freney Kimberley Oil Co., and Caltex (Aust.) Oil Development Co. during their geological reconnaissances in the search for oil in the North-West Basin and Kimberley areas of Western Australia. The bulk of this material has been examined by the writer. Cores from the Nerrima Bore, West Kimberley District have also been studied.

Localities from which foraminifera have been obtained, are listed below. They include those given by W. J. Parr in 1940.

(i) Foraminiferal occurrences correlated with the Upper Marine Series of New South Wales.

(a) Upper Ferruginous Stage, Kimberley Area.

1. Six miles north-west of the North-west Hill, Kimberley.
2. South-west corner of the north-east Structure at Bell's Ridge, Kimberley.

(b) Wandagee Beds, Minilya Area, North-West Basin.

3. Wandagee Station, ¼ mile upstream from Garden Outcamp, Minilya River.
4. Wandagee Station, ½ mile below Coolkilya Pool.
5. Minilya River, ¼ mile upstream from Wandagee Homestead.
6. (*a*) Nalbia Paddock about 110 chains due east of Trig. Station, Wandagee Hill.
   (*b*) Coolkilya Flat approximately 1 mile south of Homestead-Garden-road and 1 mile east of Shed-Outcamp telephone line.
7. (*a*) South of Minilya River.
   (*b*) Minilya-road, Coolkilya Flat, east limb of syncline north of Wandagee Hill.

(*c*) Burna Burna Paddock, Wandagee Station, on Wandagee-Mia Mia-road, about 3 miles in 231° 5′ from Burna Burna Hill.

8. (*a*) South side of Minilya River, near Coolkilya Pool, Wandagee Station.
   (*b*) East of Coolkilya Paddock, 865 links west of Teichert, Higgins and Utting's Station LII., traverse 20th May, 1939.
   (*c*) Extreme south-east corner of Coolkilya Paddock.
9. About 1 mile west of Cundlego Well, Minilya River.

(*c*) *Byro Beds, Gascoyne Area, North-West Basin.*

10. Gascoyne River at Jimba Jimba Homestead.
11. Gascoyne River, left bank, ¼ mile below hotel.
12. Gascoyne-Lyons motor road crossing.
13. Bank opposite hotel, Gascoyne Junction.
14. Left bank of creek flowing into Gascoyne River at Loc. 9 (C.O.R.)
15. Right bank, Gascoyne River, 2 miles below Bidgemai Homestead.
16. Excavation of well at Merlingleigh Station Woolshed.
17. Half mile west of junction of Vinabooka Creek and Gascoyne River.

(*d*) *Horizon uncertain.*

18. Mt. Pierre Well at 90 feet.

(ii) Foraminiferal occurrences correlated with the Lower Marine Series of New South Wales.

(*a*) *Nura Nura Limestone of the Kimberley Area.*

19. Low scarp north of hill "b", south of road, Grant Range.
20. Nerrima Bore, West Kimberley Area, from 38 feet down to 424 feet.
21. Layman's Bore, Quambin Station, West Kimberley.

(*b*) *Callytharra Limestone of the North-West Basin.*

22. Pell's Crossing, Gascoyne River.
23. Two miles north-east of Lyons River Homestead.
24. Twelve miles south of Lyons River Homestead.
25. Minginoo Homestead, Gascoyne.
26. Five miles north-east of Dairy Creek, Gascoyne.
27. Two miles west of Carey Downs turn off, main Byro-Glenburg-road, Gascoyne.
28. Bidgemai-Wyndham Gap.
29. Wyndham River, 1 mile below Gap.
30. Callytharra, Wooramel River.
31. Mouth of Salt Gully, Callytharra.
32. Section 4 to 8 miles north of K34 (Waterford Loc.), 8 miles south of Arthur River Station Outcamp.
33. Limestone in Creek on west side of Wooramel and close to Wooramel.

(*c*) *Irwin River Area.*

34. Fossil Cliff, Irwin River.

Table IV. summarizes the information available concerning the occurrence and distribution of foraminifera in the Permian deposits in Western Australia which are correlated with the Upper Marine and Lower Marine Series of New South Wales. For convenience, numerical designations are given to the localities listed above.

TABLE IV.—DISTRIBUTION OF PERMIAN FORAMINIFERA IN WESTERN AUSTRALIA.

Foraminifera.	Correlated with Upper Marine Series of New South Wales.																		Correlated with Lower Marine Series of New South Wales.												
	Up. Fer.		Wandagee Beds.							Byro Beds.								? Hor.	Nura Nura.			Callytharra Limestone.										Irwin R.
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.	26.	27.	28.	29.	30.	31.	32.	33.	34.
Ammodiscus milletianus Chapm.	—	—	—	—	r	—	—	—	—	—	—	r	—	—	r	—	—	r	—	—	—	—	—	—	—	—	—	f	—	—	—	—	—	r
A. multicinctus Crespin & Parr	—	—	—	—	—	—	—	—	—	—	f	r	r	f	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	—	—	—	—	—
A. nitidus Parr	—	—	c	—	r	—	c	c	—	—	r	—	—	r	r	—	—	r	—	r	r	—	—	—	—	—	—	—	—	r	r	—	—	—
A. wandageeensis Parr	—	—	—	—	—	c	c	c	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Hyperamminoides acicula Parr	—	—	c	c	c	—	c	c	r	f	r	—	—	f	c	—	f	—	r	c	r	—	—	—	—	—	r	c	r	—	r	r	r	—
H. coleyi Parr	—	—	—	—	—	—	c	c	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Hyperamminoides sp.	—	—	—	—	—	—	—	—	—	—	—	—	r	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Hyperammina ? rudis Parr	—	—	—	—	—	—	—	r	—	—	r	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	f	—	—	—
Calcitornella stephensi (How.)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	c	r	—	—	r	c	f	f	c	r	—	c	c	r	c	f
Glomospira adherens Parr	—	—	—	—	—	—	—	c	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Glomospira sp.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	—	—	—	—	—
Trepeilopsis cf. *grandis* Cushman & Waters	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	r	r	r	f	—	c	c	r	f	f
Apertinella cf. *grahamensis* (Harlton)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	—	—	—	—	—	—	—	—	r	r	—	—	—
Tolypammina undulata Parr	—	—	—	—	—	—	c	c	—	—	—	—	—	r	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	—	—	—	—
Psammosphaera pulsilla Parr	—	—	—	—	—	—	—	r	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Thurammina papillata Brady	—	—	r	—	f	—	r	r	—	—	—	—	—	r	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	—	—	—	—	—
Crithionina teicherti Parr	—	—	r	—	r	—	—	c	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	—	—	—	—	—
Hemigordius schlumbergeri (Howchin)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	—	—	—	r	r	—	f	r	r	r	c
Reophax subasper Parr	—	—	—	—	—	—	—	r	—	—	r	—	—	r	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
R. tricameratus Parr	—	—	—	—	—	—	—	r	—	—	—	—	—	r	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
cf. *Septammina* sp.	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Haplophragmium sp.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Haplophragmoides sp. 1	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	r	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Haplophragmoides sp. 2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	—	—	—	—	—
Ammobaculites sp.	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
A. woolnoughi Crespin & Parr	—	—	r	r	r	—	—	r	—	—	r	—	r	—	f	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Digitina recurvata Crespin & Parr	—	—	—	—	—	—	—	—	—	—	—	—	—	f	f	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Textularia eximia Eichw.	—	—	—	—	—	—	—	—	—	—	—	—	—	r	r	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Textularia sp.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Spiroplectammina sp.	—	—	r	—	—	—	—	—	—	—	r	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	—	—	—
Nodosinella sp.	—	—	—	—	—	—	—	—	—	—	r	—	—	—	—	r	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Tetrataxis conica Ehr.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	—	—	—	—	r	—	—	r	—	—	—
Bigenerina sp.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Endothyra cf. *media* Waters	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r
Trochammina subobtusa Parr	—	—	r	r	f	—	—	r	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	—
Verbeekina sp.	r	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Neoschwagerina sp.	—	r	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Nodosaria irwinensis Howchin	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	f	r	—	—	—	—	—	r	c	—	f	c	—	—	r
N. serocoldensis Crespin	—	—	—	—	r	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	—
N. sp.	—	—	—	—	r	—	—	—	—	—	—	—	—	—	—	—	—	—	—	f	—	—	—	—	—	—	—	—	—	f	c	—	—	r
Dentalina grayi Crespin	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	f	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Frondicularia parri Crespin	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	f	r	—	—	—	—	—	—	—	—	—	—	—	—	—
F. woodwardi Howchin	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	c	r	f	f	—	—	—	r	r	—	c	r	—	—	f
Geinitzina triangularis Chapman & Howchin	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	—	—	—	f	—

Notes on the Assemblages.

Four distinct assemblages of foraminiferal species are recognized in the Permian rocks of Western Australia. The first is present near the top of the sequence in the Upper Ferruginous Beds of the Kimberley area; the second in the Wandagee beds in the Minilya River area; the third in the Byro beds in the Gascoyne area and the fourth in the lower part of the sequence in the Kimberley, North-West Basin and Irwin River areas.

(i) The first assemblage contains the only record in Australia of the important zonal foraminifera of the Permian, the Fusulinids. The genera represented are *Neoschwagerina* and *Verbeekina* (Chapman and Parr, 1937). They occur in two localities in the Kimberley area, in the topmost bed of the Upper Ferruginous Series (Wade, 1938), which is considered to be the equivalent of the highest beds in the Upper Marine Series of New South Wales.

(ii) The second assemblage occurs in the Wandagee beds in the Minilya area of the North-West Basin. The foraminifera found in this area have been described by Parr (1941). The assemblage consists of *Ammodiscus wandageeensis, A. nitidus, Glomospira adhaerens, Tolypammina undulata, Hyperamminoides acicula, Hyperammina coleyi* and *Crithionina teicherti. H. acicula* is well represented in the Upper Marine and Lower Marine Series of New South Wales and in the Middle and Lower Bowen Series of Queensland, while *C. teicherti* is prominent in the Mulbring Stage of the Upper Marine Series of New South Wales.

(iii) The third assemblage appears in the Byro beds of the Gascoyne area, North-West Basin. Here, *Digitina recurvata, Ammobaculites woolnoughi* and *Ammodiscus multicinctus,* characteristic species of the Branxton Stage of the Upper Marine Series of New South Wales, are present.

(iv) The assemblage in the Callytharra limestone, North-West Basin, in the Fossil Cliff beds, Irwin River area, and in the Nura Nura limestone of the West Kimberley area, is dominated by the foraminifer *Calcitornella stephensi.* The associated forms are *Hemigordius schlumbergeri, Nodosaria irwinensis, N.serocoldensis, Frondicularia woodwardi,* and *Geinitzina triangularis.* This assemblage is similar to that found in the Lower Marine Series in New South Wales and Tasmania, and in the Lower Bowen Series of Queensland. Species restricted to this horizon in Western Australia are *Trepeilposis* cf. *grandis, Hemigordius schlumbergeri, Frondicularia woodwardi, Nodosaria irwinensis, Tetrataxis conica* and *Geinitzina triangularis.*

A study of the micro-faunal assemblages in the Permian deposits of Queensland, New South Wales, Tasmania and Western Australia suggests that the marine deposits met with between the depths of 39 feet and 785 feet in the Nerrima Bore, Kimberley area, can be correlated with the Nura Nura limestone of the West Kimberleys. The foraminifera found between the depths of 39 feet and 424 feet include *Calcitornella stephensi, Apertinella* cf. *grahamensis Tetrataxis conica, Nodosaria irwinensis, Frondicularia parri, F. woodwardi* and *Geinitzina triangularis.* Mega-fossils were recorded at 548 feet and 626 feet and there was no change in conditions of sedimentation until 810 feet.

E. NORTHERN TERRITORY.

Rocks of Permian age were described from the Port Keats bore by Etheridge, Jnr. (1907) who recorded and figured *Calcitornella stephensi* from samples obtained between the depths of 554 feet and 574 feet. The beds are correlated with beds containing *C.stephensi* in the Lower Bowen of Queensland, Lower Marine Series of New South Wales, and Tasmania, and with those in Western Australia which are considered as representing these Series in that State.

4. CONDITIONS DURING SEDIMENTATION OF THE PERMIAN ROCKS OF AUSTRALIA.

The foraminiferal assemblages indicated in Tables I. to IV. in section 3, point to differences in climatic and bathymetric conditions under which the Permian deposits of Australia were laid down.

1. The assemblage which is dominated by *Calcitornella stephensi* and which is characteristic of the Lower Marine Series and its correlates in all States, suggests the existence of shallow, warm conditions at the time of its deposition.

2. The foraminiferal assemblages in the Upper Marine Series contain many genera which are living in the seas at the present day and an ecological study of these forms gives a fairly reliable indication of climatic and bathymetric conditions during deposition of the beds comprising the Upper Marine Series. All forms suggest lower temperatures and slightly deeper water conditions than were experienced during the deposition of parts of the Lower Marine Series.

3. The presence of fusulinids in sediments high in the Permian sequence in Western Australia suggests the return in that State at least, of warmer and shallower water conditions towards the close of that period.

5. NOTES ON SOME OF THE FORAMINIFERAL SPECIES.

It is not intended in this Bulletin to describe any species of Permian foraminifera from Australian deposits, but short notes are given on the distinctive forms already known. The majority of the foraminifera belong to genera whose tests are arenaceous. Amongst these forms the commonest are *Ammodiscus, Hyperamminoides, Textularia, Digitina, Ammobaculites* and *Trochammina*. The most important hyaline genera are *Nodosaria, Frondicularia* and *Geinitzina*.

One of the most important species, which is widespread in distribution in the Permian rocks of Australia, but which, on present evidence, is restricted in vertical range, is *Calcitornella stephensi* (Plate 1, Figure 3). This calcareous and adherent species was described by Howchin in 1894 from a limestone from the Piper River, near Karoola, Tasmania. It appears to be restricted to deposits in various States which can be correlated with the Lower Marine Series of New South Wales. It is common at Pokolbin, New South Wales, and is found in sediments in the Springsure area in Queensland. It is abundant in the Callytharra limestone and Fossil Cliff beds, Western Australia and is present in samples from the Nerrima Bore, in the Kimberley area. It is recorded from the Port Keats Bore, Northern Territory.

Nodosaria irwinensis was described by Howchin (1895) from Fossil Cliff, Irwin River, Western Australia. It is also found in sediments

in the North-West Basin. It is not a common form and the only record in the eastern States is from the Lower Marine Series at Pokolbin, New South Wales.

Nodosaria serocoldensis (Plate 1, Figures 6 and 7) was recently described by the writer (1944) from the Lower Bowen Series in the Springsure area, Queensland. It is present in both the Upper Marine and Lower Marine Series of New South Wales and in beds that can be correlated with those two Series in Western Australia.

Geinitzina triangularis (Plate 1, Figures 14 and 15) was described by Chapman and Howchin (1905) from the Pokolbin limestone, New South Wales, and is usually found associated with *Calcitornella stephensi*. Although it is found in Western Australia and Queensland, as well as in New South Wales, it is a comparatively rare species. It occurs in the Lower Bowen Series in the Springsure area in Queensland, from localities in the Lower Marine Series in the Hunter River district in New South Wales, and from Fossil Cliff and from the Gascoyne area in Western Australia.

Frondicularia woodwardi (Plate 1, Figures 12 and 13) described by Howchin (1895) from Fossil Cliff, Irwin River, Western Australia, is widely distributed in the Permian rocks of Australia. In New South Wales its vertical range is restricted to the basal portion of the Upper Marine Series, and ranges down to the Allandale Stage of the Lower Marine Series. In the Springsure area, Queensland, there are two records of *F.woodwardi* in the Middle Bowen Series, while large tests, representing both the microspheric and the megalospheric generations are common in some of the deposits referred to the Lower Bowen Series. In Western Australia, it is restricted to the horizon represented by the Fossil Cliff beds and the Callytharra limestone.

Frondicularia parri (Plate 1, Figures 10 and 11) was recently described (1944) by the writer from the Kulnura Bore in New South Wales from the depth of 4,203 feet in sediments referable to the Upper Marine Series (Raggatt and Crespin, 1940). The only other occurrences of this species in New South Wales are also from the Kulnura Bore between the depths of 4,020 feet and 4,268 feet. *F.parri* is recorded from sediments in the Lower Bowen Series in Queensland. It is present in the Nerrima Bore, West Kimberley area, Western Australia between the depths of 39 feet and 272 feet, where it is associated with a foraminiferal assemblage similar to that of the Callytharra limestone.

Species with a more extensive vertical range are more numerous than those already noted and belong chiefly to arenaceous genera.

The most widely distributed foraminiferal species in the Permian rocks of Australia is *Hyperamminoides acicula* (Plate 1, Figure 1; Plate 2, Figures 19 and 20) described by Parr (1940) from the Wandagee beds near Coolkilya Pool, Wandagee Station, Western Australia. *H.acicula* is fairly common in those beds which can be correlated with the Upper Marine Series of New South Wales, but is rare in the lower horizon represented by the Callytharra limestone and the Fossil Cliff beds. This elongate, tapering foraminifer is very common in both the Upper Marine Series in the Hunter River district, New South Wales. It is also well represented in the Middle and Lower Bowen Series in the Springsure area in Queensland, and in the deposit referred to the Upper Marine Series in Tasmania. Parr records specimens of *H.acicula* up to 20 mm. in length, but the majority

of specimens are usually fragmentary. In some of the bore samples and in many of the rocks from the Hunter River district, this species is the only foraminifer present.

Ammodiscus multicinctus (Plate 1, Figure 2; Plate 2, Figure 18) described by Crespin and Parr (1940) from beds in the Upper Marine Series in the Hunter River district is a common species in that Series in New South Wales. It occurs less frequently in the Lower Marine Series. The species is found in both the Middle and Lower Bowen Series in the Springsure area, Queensland, large tests being present in the material from Mount Hope Section. In Tasmania, *A.multicinctus* is well developed in the beds at Oonah, referred tentatively to the Upper Marine Series. The tests are large and both microspheric and megalospheric generations are represented. The species is not common in Western Australia, where it is apparently replaced by another species *A.nitidus*.

Ammodiscus nitidus, described by Parr (1940) from the Wandagee beds in the Minilya area of the North-West Basin, Western Australia, is widely distributed in beds in that State correlated with the Upper Marine Series of New South Wales. It is known from a few localities in Western Australia correlated with the Lower Marine Series.

Crithionina teicherti was also described by Parr (1940) from the Wandagee beds, in Western Australia. It has been recognized in both the Upper Marine and Lower Marine Series of New South Wales, with its best development in the Mulbring Stage of the Upper Marine Series, which can be correlated in a general way with the type locality for the species in Western Australia. It has also been found in the Oonah beds, Tasmania.

Ammobaculites woolnoughi (Plate 1, Figure 6; Plate 2, Figures 16 and 17) is a widely distributed species described by Crespin and Parr (1940) from beds in the Upper Marine Series in the Hunter River district. The species is most abundant in that Series. In Queensland, it is present in both the Middle and Lower Bowen Series, but in Western Australia it is known only from the beds which can be correlated with the Upper Marine Series of New South Wales.

6. NOTES ON CORRELATION.

Basing his conclusions partly on evidence derived from the megafossils and partly on conditions of sedimentation, Teichert (1941) "proposed to correlate in a general way all Western Australian series up to and including the Fossil Cliff, Callytharra and Nura Nura Series with the Lower Marine Series of New South Wales . . . the Irwin River 'Upper Marine', the Upper Byro, Cundlego, Wandagee, Nooncanbah and Upper Ferruginous Series with the Upper Marine . . .". It is believed that this scheme of correlation finds general acceptance in Australian. The study of the micro-fossils from these deposits tends to support this correlation, which can be carried still further to include Queensland, Tasmania and Northern Territory. (A drafting error in Teichert's Correlation Table on page 399 may be noted. In this table it is not made clear that the Farley Stage is part of the Lower Marine Series).

In considering the distribution of foraminifera in the Permian rocks of Australia, the outstanding assemblage of wide-spread occurrence but of limited vertical range, is that dominated by

Calcitornella stephensi. It forms a basis for correlation of an horizon in the Lower Marine Series of New South Wales with stratigraphic equivalents throughout Australia.

The correlations are as follows:—

(1) The Allandale Stage of the Lower Marine Series of New South Wales in the Hunter River District.

(2) The Dilly Stage of the Lower Bowen Series of Queensland in the Springsure area.

(3) The Lower Latrobe Stage of the Lower Marine Series of Tasmania in the Piper River area.

(4) The Callytharra limestone, in the North-West Basin, the Fossil Cliff limestone in the Irwin River area, and the Nura Nura limestone in the Kimberley area of Western Australia.

(5) The Port Keats bore section, Northern Territory from 554 feet down to 574 feet.

In beds slightly higher in the stratigraphic sequence, but still correlated with the Lower Marine Series of New South Wales, the correlation cannot be recognized over such a large area. The equivalent of the Farley Stage in New South Wales is possibly the Gypseous Stage of the Lower Bowen Series of Queensland, but further investigations are necessary to confirm this view.

In the Upper Marine Series of New South Wales, two assemblages have been recognized and these permit correlation with deposits of similar age in other States.

(i) The assemblage characteristic of the Branxton Stage, the basal subdivision of the Upper Marine Series in New South Wales, contains *Hyperamminoides acicula, Ammodiscus multicinctus* (though not common), *Digitina recurvata* and *Frondicularia woodwardi*.

This assemblage suggests the following correlations:—

(1) The Inglelara Stage of the Middle Bowen Series of Queensland in the Springsure area.

(2) The Branxton Stage of the Upper Marine Series of New South Wales in the Hunter River District; the Victoria Pass section, Mitchell Highway and the Kulnura Bore section from 3,778 feet down to 4,490 feet.

(3) The Byro Beds of the Gascoyne area, North-West Basin, Western Australia.

(ii) The second assemblage in the Upper Marine Series of New South Wales contains *Hyperamminoides acicula, Ammodiscus multicinctus, Ammobaculites woolnoughi* and *Trochammina pulvillus*. It is characteristic of the Mulbring Stage, the topmost member of the Upper Marine Series.

This assemblage suggests the following correlations:—

(1) The Upper Marine Series of New South Wales in the Mulbring Stage in the Hunter River District.

(2) The Wandagee Beds in the Minilya area of the North-West Basin, Western Australia. At this locality, *A. multicinctus* is apparently replaced by another species *A. nitidus*.

On account of the paucity of material from beds referable to the Upper Marine Series in Tasmania no definite correlation is attempted with that Series in New South Wales.

The above considerations, based on the foraminifera, suggest that beds equivalent in age to the Lower Marine Series and Upper Marine

Series of New South Wales, occur also in Queensland, Tasmania and Western Australia, and that deposits referable to the Lower Marine Series are present in a bore in the Northern Territory.

7. STRATIGRAPHIC RANGE OF SPECIES.

Appended below is a table giving the range of all species which constitute the major assemblages. For convenience all beds considered to be equivalents of the Upper Marine Series in New South Wales are included under one heading and those as equivalents of the Lower Marine Series under another. The heavy line indicates the maximum development of the species, the lighter line indicating its continued range.

TABLE V.—STRATIGRAPHIC RANGE OF SPECIES.

Foraminifera.	Equivalents of Upper Marine Series of New South Wales.	Equivalents of Lower Marine Series of New South Wales.
Ammodiscus milletianus		
A. multicinctus		
A. ovalis		
A. nitidus		
A. planoconvexus		
A. wandageeensis		
Hyperamminoides acicula		
H.? rudis		
H. coleyi		
H. sp.		
Calcitornella stephensi		
Tolypammina vagans		
T. undulata		
Trepeilopsis cf. *grandis*		
T. sp.		
Apertinella cf. *grahamensis*		
Thurammina papillata		
Psammosphaera pulsilla		
Hemigordius schlumbergeri		
Reophax subasper		
R. tricamerata		
Pelosina hemisphaerica		
Pelosina sp.		
Ruditaxis cf. *rhaetica*		
Placopsilina tenuitesta		
Crithionina teicherti		
Haplophragmoides neocomianus		
Haplophragmoides sp. 1		
Haplophragmoides sp. 2		
Ammobaculites woolnoughi		
Ammobaculites sp.		
Digitina recurvata		
Textularia eximia		
Spiroplectammina sp. 2		
Trochammina subobtusa		
T. cf. *arenosa*		
T. pulvillus		
Verbeekina sp.		
Neoschwagerina sp.		
Nodosaria serocoldensis		
N. irwinensis		
N. permiana		
N. pyramidis		
Dentalina grayi		
Lingulina davidi		
Frondicularia parri		
F. woodwardi		
Geinitzina triangularis		

8. REFERENCES.

Chapman, F., and Howchin, W., 1905. A Monograph of the Foraminifera of the Permo-Carboniferous Limestones of New South Wales. *Mem. Geol. Surv. N.S.W. Pal.*, 14.

Chapman, F., Howchin, W., and Parr, W. J., 1934. A Revision of the Nomenclature of the Permian Foraminifera of New South Wales. *Proc. Roy. Soc. Vict.*, 47, (1), N.S., p. 175.

Chapman, F., and Parr, W. J., 1937. On the Discovery of Fusulinid Foraminifera in the Upper Palaeozoic of North-West Australia: with a Note on a New Bivalve. *Vic. Nat.*, 53, p. 175.

Crespin, I., 1943. Permian Foraminifera from a Bore at Coorabin, New South Wales. *Aust. Journ. Sci.*, 6, (2), p. 65.

Crespin, I., 1944. Some Permian Foraminifera from Eastern Australia. *Proc. Roy. Soc. Qld.*, 56, (3), p. 23.

Crespin, I., 1944. Permian Foraminifera from Oonah, Tasmania. *Aust. Journ. Sci.*, 8, (2), p. 59.

Crespin, I., 1945. The Hutton Creek Bore, Queensland. *Min. Res. Surv. Rept.*, No. 14.

Crespin, I., 1945. The Arcadia Bore, Queensland. *Ibid.*, No. 15.

Crespin, I., and Parr, W. J., 1940. Arenaceous Foraminifera from the Permian Rocks of New South Wales. *Journ. & Proc. Roy. Soc. N.S.W.*, 74, p. 300.

Etheridge, R., 1907. Fossils of the Port Keats Bore, Thirty Miles North of Fossil Head, Treachery Bay. *Suppl. Parl. Pap.* (S.A.), No. 55 of 1906.

Howchin, W., 1894. On the Occurrence of Foraminifera in the Permo-Carboniferous Rocks of Tasmania. *A.A.A.S. Adelaide Meeting* (1893), p. 334.

Howchin, W., 1895. Carboniferous Foraminifera of Western Australia with Descriptions of New Species. *Trans. Roy. Soc. S.Aust.*, 19, p. 194.

Jones, T. R., 1882. Catalogue of the Fossil Foraminifera in the British Museum (Natural History), London.

Parr, W. J., 1940. Foraminifera and a Tubiculous Worm from the Permian of the North-West Division of Western Australia. *Journ. Roy. Soc. W.Aust.*, 27, p. 97.

Raggatt, H. G., 1936. Geology of the North-West Basin, Western Australia, with Particular Reference to the Stratigraphy of the Permo-Carboniferous. *Journ. & Proc. Roy. Soc. N.S.W.*, 70, p. 100.

Raggatt, H. G., and Crespin, I., 1940. Possibility of Heavy-Mineral Correlation of Some Permian Sedimentary Rocks, New South Wales, by Dorothy Carroll. Discussion. *Bull. Amer. Assoc. Petr. Geol.*, 24, p. 1672.

Raggatt, H. G., and Crespin, I., 1941. Geological Notes on Natural Gas and Oil Corporations's Bore at Balmain, City of Sydney, New South Wales. *Aust. Journ. Sci.*, 4, (3), p. 102.

Raggatt, H. G., and Fletcher, H. O., 1937. A Contribution to the Permian-Upper Carboniferous Problems and an Analysis of the Fauna of the Upper Palaeozoic (Permian) of North-West Basin, Western Australia. *Rec. Aust. Mus.*, 22, (2), p. 150.

Stephen, T., 1889. Foraminifera in the Upper Palaeozoic Rocks. *Proc. Roy. Soc. Tas.*, p. 54.

Teichert, C., 1941. Upper Paleozoic of Western Australia: Correlation and Paleography. *Bull. Amer. Assoc. Petr. Geol.*, 25, (3), p. 371.

Voisey, A. H., 1938. The Upper Palaeozoic Rocks of Tasmania. *Proc. Linn. Soc. N.S.W.*, 63, (5-6), p. 309.

Wade, A., 1938. The Geological Succession in the West Kimberley District of Western Australia. *A.N.Z.A.A.S.* (*Auckland Meeting*, 1937), 23, p. 93.

9. EXPLANATION OF PLATES AND FIGURE.

PLATE 1.

AUSTRALIAN PERMIAN FORAMINIFERA.

Fig. 1.—*Hyperamminoides acicula* Parr. Dry Creek, "Inglelara" property, Springsure, Queensland. X30.

Fig. 2.—*Ammodiscus multicinctus* Crespin and Parr. Cattle Creek below Waterfall, near Springsure, Queensland. X40.

Fig. 3.—*Calcitornella stephensi* (Howchin). Pokolbin, Hunter River District, New South Wales. Showing surface that has been attached to rock. X30.

Fig. 4.—*Ammobaculites woolnoughi* Crespin and Parr. McDougall's Hill, Singleton, New South Wales. X30.

Fig. 5.—*Nodosaria springsurensis* Crespin. Cattle Creek below Waterfall, near Springsure, Queensland. X30.
Fig. 6.—*N. serocoldensis* Crespin. Cattle Creek below Waterfall, near Springsure, Queensland. X30.
Fig. 7.—*N. serocoldensis* Crespin. Same locality as Fig. 6. X30.
Fig. 8.—*Dentalina grayi* Crespin. Lower part of exposure on Argus's Selection, Springsure, Queensland. X40.
Fig. 9.—*Frondicularia parri* Crespin. Kulnura Bore, New South Wales, at 4,203 feet. X40.
Fig. 10.—*F. parri* Crespin. Same locality as Fig. 9. X40.
Fig. 11.—*F. parri* Crespin. Same locality. Showing irregular character of striae. X40.
Fig. 12.—*F. woodwardi* Howchin. Cattle Creek below Waterfall, near Springsure, Queensland. X30.
Fig. 13.—*F. woodwardi* Howchin. Mt. Hope, 20 miles south of Springsure, Queensland. X30.
Fig. 14.—*Geinitzina triangularis* Chapman and Howchin. Pokolbin, New South Wales. Microspheric form. X30.
Fig. 15.—*G. triangularis* Chapman & Howchin, Pokolbin. Megalospheric form. X30.

PLATE 2.

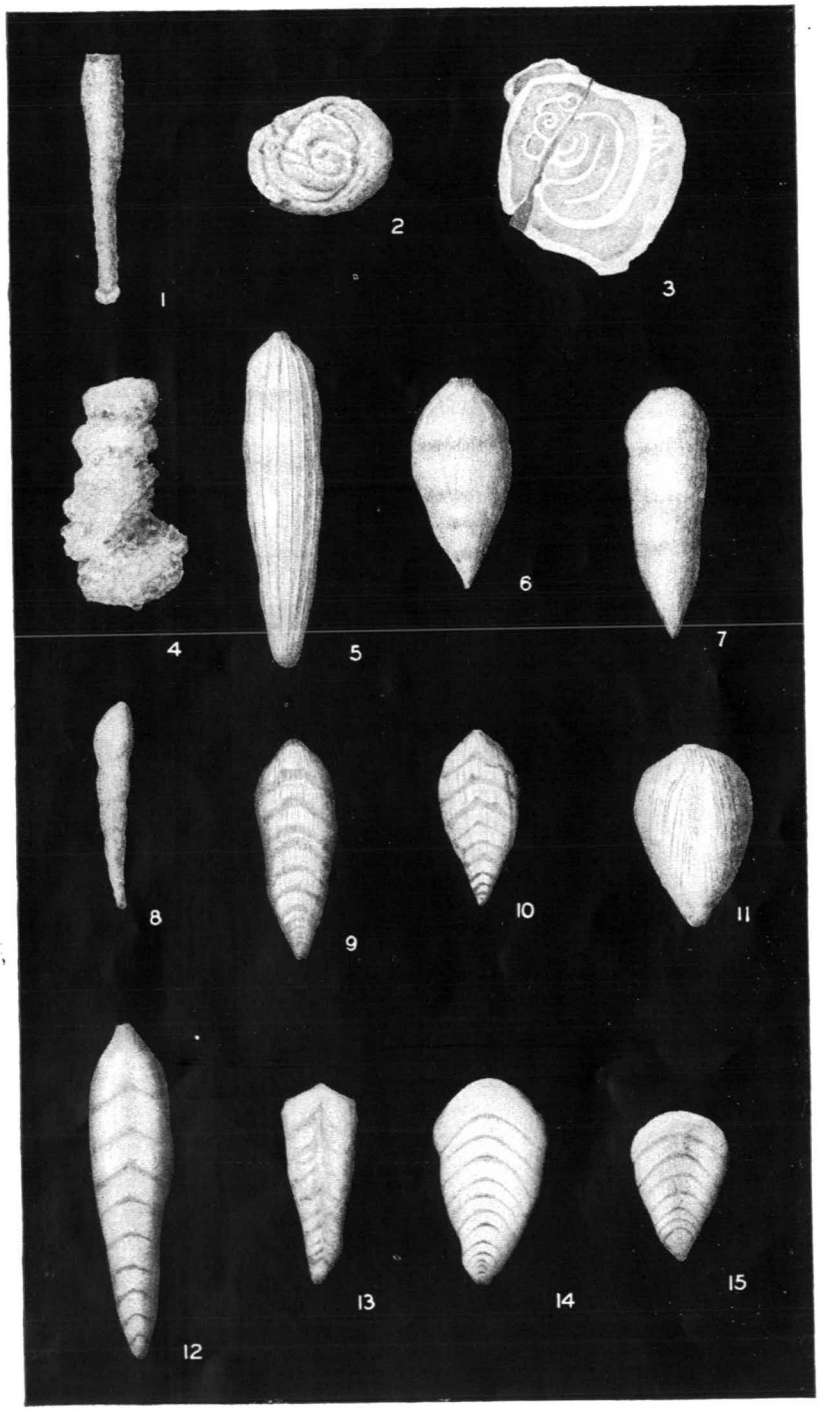
Australian Permian Foraminifera.

Fig. 16.—*Ammobaculites woolnoughi* Crespin and Parr. Farley Road, 300 yards north-east of Farley Station, New South Wales. X35.
Fig. 17.—*A. woolnoughi* Crespin and Parr. Same locality as Fig. 16. X35.
Fig. 18.—*Ammodiscus multicinctus* Crespin and Parr. Railway cutting immediately west of Farley Station, New South Wales. X28.
Fig. 19.—*Hyperamminoides acicula* Parr. West of Allandale Road turn-off from main Northern Road near road to Oswald property, Hunter River District, New South Wales. X10.
Fig. 20.—*H. acicula* Parr. Same locality as Fig. 19. X10.
Fig. 21.—*Trochammina pulvillus* Crespin and Parr. At foot of Victoria Pass, Mitchell Highway, New South Wales. Dorsal view. X70.
Fig. 22.—*T. pulvillus* Crespin and Parr. Ventral view of Fig. 21. X70.
Fig. 23.—*Digitina recurvata* Crespin and Parr. At foot of Victoria Pass, Mitchell Highway, New South Wales. X28.
Fig. 24.—*Textularia eximia* (Eichwald). Large railway cutting immediately west of Farley Station, Hunter River District, New South Wales. X28

Plate 1 is a reproduction of that prepared by Mr. F. Canavan and used by Crespin (1944). The plate is reproduced by permission of the Council of the Royal Society of Queensland. Plate 2 has been prepared from drawings by Miss J. Gilbert-Tomlinson of the Bureau of Mineral Resources.

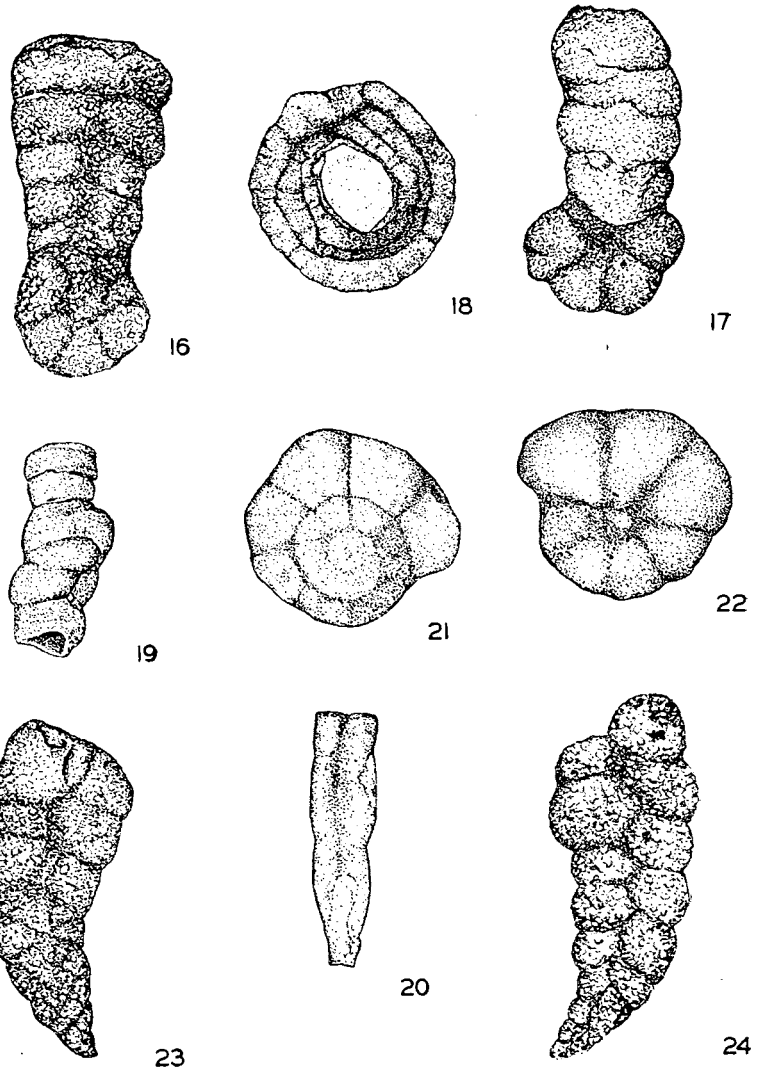
Figure 1.—Map showing Permian Foraminiferal Localities: It has been impossible to indicate on the accompanying map all localities from which Permian foraminifera have been recorded. Consequently it will be found that the numbers given will sometimes embrace districts, e.g., the Hunter River District, where localities are numerous.

PLATE 1.



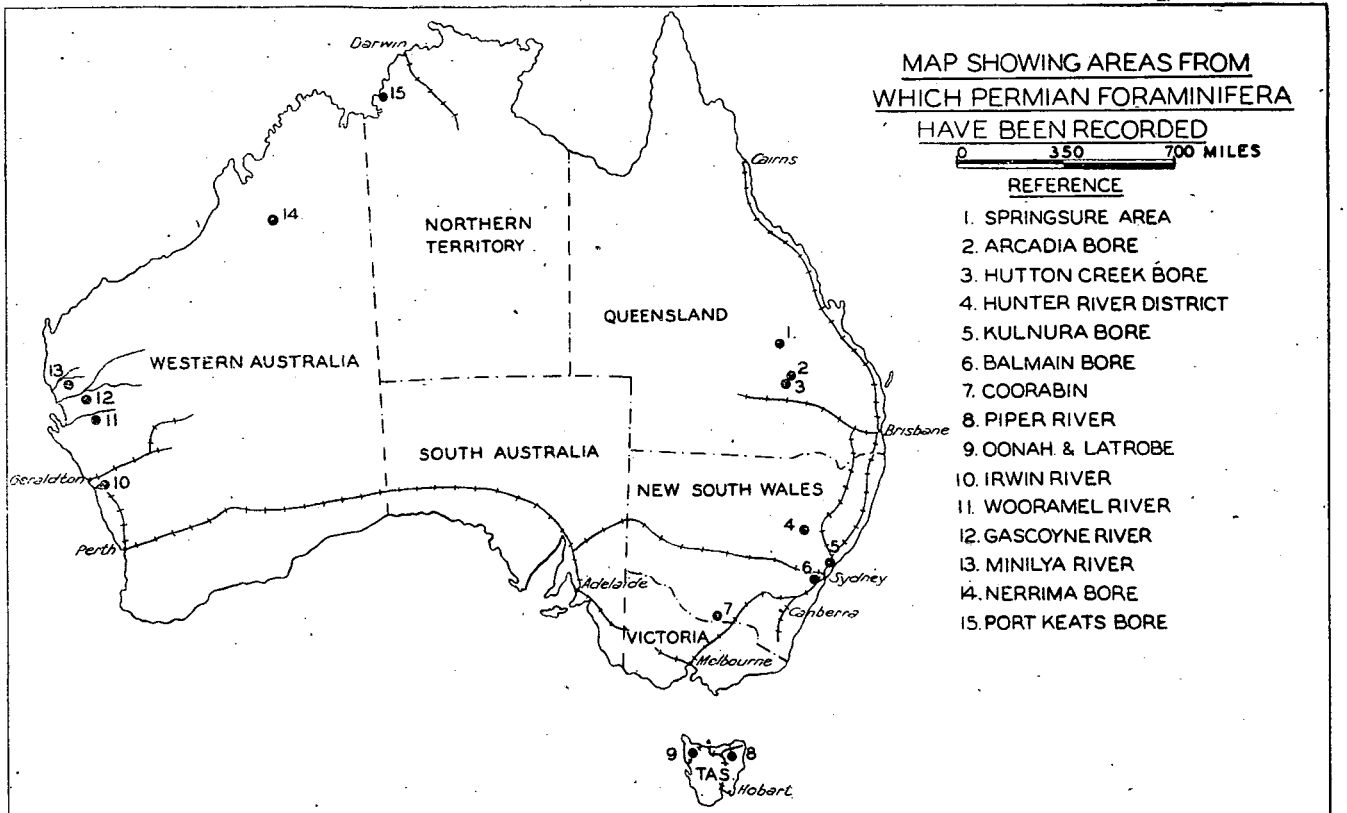
Australian Permian Foraminifera.

PLATE 2.



Australian Permian Foraminifera.

FIGURE 1.


MAP SHOWING AREAS FROM
WHICH PERMIAN FORAMINIFERA
HAVE BEEN RECORDED
0 350 700 MILES
REFERENCE
1. SPRINGSURE AREA
2. ARCADIA BORE
3. HUTTON CREEK BORE
4. HUNTER RIVER DISTRICT
5. KULNURA BORE
6. BALMAIN BORE
7. COORABIN
8. PIPER RIVER
9. OONAH & LATROBE
10. IRWIN RIVER
11. WOORAMEL RIVER
12. GASCOYNE RIVER
13. MINILYA RIVER
14. NERRIMA BORE
15. PORT KEATS BORE
Darwin
Cairns
NORTHERN TERRITORY
QUEENSLAND
WESTERN AUSTRALIA
SOUTH AUSTRALIA
NEW SOUTH WALES
VICTORIA
TAS.
Brisbane
Geraldton
Perth
Adelaide
Sydney
Canberra
Melbourne
Hobart