Correlations of the Queensland Permo-Carboniferous Basin.

THE DILLY STAGE OF THE LOWER BOWEN.

By J. H. Reid.

(Read before the Royal Society of Queensland, 30th November, 1931).

There are many diverse aspects of the Permo-Carboniferous system in Eastern Australia on which there is no general agreement as yet. It is hoped that the present contribution of one who has been enabled to carry out considerable field research over the enormous Permo-Carboniferous basin of the Great Syncline of Queensland may at least tend to ameliorate that condition and help to advance knowledge a little further towards general elucidation of some of its major problems. While most of the field work has been of a reconnaissance type (with all its obvious limitations), several areas have been mapped in detail and from data supplied largely by the latter it seems possible to formulate queries and deductions regarding the vast areas which are yet imperfectly known and which may largely remain so for many years to come. This paper deals with the Dilly Stage of the Queensland Lower Bowen Series, and attempts to prescribe its distribution in Queensland, the variable physical character of its beds, as well as discuss its probable age. An appendix by Mr. F. W. Booker describes a hitherto undescribed species of Productus of cosmopolitan type which, as far as the stratigraphical zoning of the Springsure Dome in Central Queensland has proceeded, appears confined to the Dilly Stage. A large collection of this species has been made during the past year from the districts of Springsure and Saltbush Park (Nebo), and has formed the material described in the appendix. While mapping the Springsure Dome the writer observed, on one horizon, immense numbers of the pedicle valve of a productid that showed abnormal ear expansions that were mostly broken off. A chance recollection of a past reference that had stimulated some interest recalled Diener's figures of a form from the Anthracolithida fauna of Kashmir. By dint of careful searching a number of beautiful brachial valves were also discovered in the hard calcareous concretions enclosed in the soft shales in which the pedicle valves were mostly in a decrepit state with the brachials either obscured or missing. It is clear from the figures of Productus (Linoproductus) Springsurensis that odd specimens of it have been found previously in Queensland, but it is certainly the first occasion on which such a complete collection of both valves has been brought together and which has enabled an adequate description to be made available of this interesting form, interesting because it is evidently an additional link between the Tethyan and Pacific faunas.
CORRELATIONS OF THE PERMO-CARBONIFEROUS BASIN

The Type District: At Dilly, a few miles north of Springsure, the beds of this stage were first remarked, many years ago, apparently by Dr. Jack. Beyond a good individual outcrop of the Eurydesma-glacial horizon, the lack of exposures in the surrounding district did not permit of its stratigraphical position in the Lower Bowen being established. In 1929 a Queensland Geological Survey party, under the writer's direction, was enabled by broad mapping of an extensive region to place this horizon in the general sequence. This sequence has needed some modification since detailed work was carried out by the writer under other control in 1930, on portion of the Springsure Dome, about 40 miles southerly from Dilly.

The Dilly Stage, as defined by this latest work, is as follows:

**Dilly Stage Section, Springsure Dome.**

<table>
<thead>
<tr>
<th>Bed Description</th>
<th>Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serocold Sandstone (freshwater and marine)</td>
<td>950 ft.</td>
</tr>
<tr>
<td>Overlap *Upper shales (L. springsurensis zone)</td>
<td>100-140 ft.</td>
</tr>
<tr>
<td>Dilly *Shell beds (mainly Spirifer zone)</td>
<td>20-50 ft.</td>
</tr>
<tr>
<td>Stage *Fossiliferous ferruginous shales</td>
<td>30 ft.</td>
</tr>
<tr>
<td>(310 ft.+) *Sandstone group (with shales)</td>
<td>40-100 ft.</td>
</tr>
<tr>
<td>Eurydesma limestone (15 ft.) in shales</td>
<td>35 ft.</td>
</tr>
</tbody>
</table>

(The base of the Dilly Stage is unknown).

The beds marked * comprise the glacial horizons in the locality. The two small outcrops of the Eurydesma limestone, being the only exposures of this bed that occur on the crest of a local dome, do not contain the glacial erratics which are present in the equivalent bed at Dilly.

The stage appears to be totally marine and is very rich in the remains of varied marine organisms, as all divisions of it are more or less fossiliferous. The shale beds, mostly, are the common type of the yellow, blue and grey shales of the other marine stages of the Lower and Middle Bowen in the district and contain thin seams of gypsum, secondary lime and magnesian efflorescences.

The Eurydesma bed is a shelly limestone plus hard calcareous shale with a most prolific fossil fauna. A preliminary list of the fauna has been published by Dr. Whitehouse (1930, Little Gorge Creek B = Eurydesma limestone). The overlying sandstone group has revealed one fossiliferous sandstone. The ferruginous shales—brown, yellow and red—contain numerous casts of brachiopods, etc. The shell (Spirifer) beds are denoted by myriads of broken and comminuted remains of the original tests and contain bands or lenses of hard shelly limestone though the enclosing matrix is usually shale but varies to soft yellowish sandstone. Loose fragments of *Spirifer, Pterophyllum*, etc., litter the outcrops. The preliminary list of fossils from this bed and from the upper shales has been published by Whitehouse (1930, as Little Gorge Creek A). The upper shales are well exposed at the headwaters of a small watercourse—Cattle Creek. In its crumbling shale banks, 40 ft. high, enormous numbers of the newly-described *L. springsurensis* are entombed.
These beds are all exposed about the crest of a local dome and are entirely surrounded by the cliff-forming sandstones of the Serocold Stage, which, in several instances, overlap the upper shales between Cattle and Little Gorge Creeks. There are no contemporaneous volcanic rocks in the Dilly Stage, nor, as far as our knowledge goes, in the complete marine Permo-Carboniferous succession of the Springsure district.

The Dilly Stage appears to have a limited faunistic individuality, that is not partaken of by the other known marine stages in the district, and more definitely, because better known, by the younger marine stages. There are certain reservations that must be given due weight in making such a statement for the overlying stage of nearly 1,000 ft. consists of massive sandstones which are known to be definitely marine in its upper members while, just as definitely, some of them are of freshwater origin. As a whole the Serocold Stage does not generally contain a suitable facies for the preservation of the usual marine organisms. The Lower Bowen section below the Dilly Stage is not well known and it would be unsafe yet to dogmatise as to the downward range of some of the characteristic species of that stage, the base of which has not been definitely identified.

Amongst the large retinue of Permo-Carboniferous fossils the following are of more than ordinary interest from this stage:—


The collections made during 1930 have not yet been either formally listed or described. They include possibly a new species of "Derbyia."

With the reservations mentioned Productus (?) subquadratus, Linoproducctus springsurensis, and Eurydesma appear restricted to the Dilly Stage in the Springsure district sections.

The position of the main Eurydesma horizon is as listed earlier. Only one specimen of the genus has been collected in higher horizons, either in the upper shales or shell beds. In view of the detailed mapping performed its rarity above the main horizon is notable and the lower horizon may represent its acme. P. (?) subquadratus is present in the Eurydesma bed and has been found in the sandstone group above it (associated with "Derbyia."). L. springsurensis occurs sparingly in the Eurydesma beds and reaches its apparent acmeic stage of development in the upper shales. In this zone Strophalosia gerardi is numerically well represented, and little else has been found but a large Mœonia is represented in the collections by one specimen. The three supposedly restricted forms, in combination and particularly with the adjunction of Aviculopecten of the A. mitchelli type (restricted to the Lower Marine in N.S.W.), are considered to form a strong nucleus for instituting a limited zonal correlation in the Queensland Lower Bowen.
The marine division of the Lower Bowen lying above the Serocold Sandstones is, to a considerable extent, lithologically similar to the generality of beds in the Dilly Stage; likewise it forms a conspicuous horizon of glacial erratics of large size. Though extensively collected from, neither *L. springsurensis* nor *P. (?) subquadratus* has been found in it though their associate in the Dilly Stage, *L. cora* or *L. farleyensis*, is well represented. Its presence, as well as a rather general lithological similarity, would suggest that the former are possibly not absent through unsuitability of either environment or facies, and it would seem that they are, in ranging upwards, restricted at some horizon below the top of the Serocold Stage. On the present evidence *P. (?) subquadratus* may be restricted below the ferruginous shales. *L. springsurensis* since it is so predominant in the highest zone must evidently have a higher range of life than the top of the Dilly Stage. Neither of the Lower Bowen corals, *Monilopora* and *Trachypora*, has been found in the Billy Stage. They have, however, been recorded in association in the Coral Stage (with *Conularia*) at an interval of possibly 900 ft. below the Dilly Stage. They have also recently been found by the writer in the marine stage above the Serocold Stage, but *Trachypora* is exceedingly rare therein, while *Monilopora* is abundant.

**Correlations in the Great Syncline of Queensland.**

The zoning of the Billy Stage on the Springsure Borne enables, for the first time, a definite attempt to be made to correlate the eastern and western beds of the basin. In attempting to correlate Lower Bowen stages on the eastern side of the Great Syncline with the Dilly Stage, a remarkable feature is that those beds that seem faunally allied to it do not appear to have any undoubted glacial erratics so far as observed.

The detailed field study of certain limited portions of the Springsure Dome, in demonstrating overlaps, rapid sequences of alternating freshwater, marine and lagoonal deposits, in addition to faunal and stratigraphic overlaps in other districts, attests the markedly unstable conditions of the Lower and Middle Bowen periods of sedimentation. Physical configuration must have been variable to a degree that has left its impress in dissimilar composition of the vertical columns of the system in distinct areas. Through great differences are woven threads of similarity of type; thus, as an example, a minor type in the amorphous yellow and grey (Monilopora) limestones of one of the Lower Bowen stages on the Springsure Dome has its replica in specimens collected from the Dawson River region some 150 miles distant. But while apparently contemporaneous stages in distant districts may be very different lithologically, certain sedimentary types are universal throughout the main basin such as the common bluish, yellowish and grey micaceous shales which are of uniform type and appearance of almost any age of Lower and Upper Marine deposition.

It may perhaps be repeated here that the Great Syncline forms an elongated trough tapering at its northern extremity (lat. about 20° 30' S.) and passing southwards beneath the overriding and unconformable Mesozoics of the Great Artesian System (lat. about
25° 45'). It is margined by outcropping Lower Bowens (very largely of volcanic derivation) and marine strata of more than one series form, apparently, an almost continuous, if disconnected, marine zone around it. For 400 miles on an almost direct line between the parallels of latitude mentioned above, marine sediments mark the eastern side of the syncline along the inland or western foothills of the coastal ranges. In the latitude of Springsure, outcrops of corresponding stages on the eastern and western sides of the basin have an interval of as much as 120 miles covered by younger beds, apparently without intervening outcrop. The Lower Bowen sedimentation on the western (Springsure) margin was exempt from volcanic accumulations while on the whole of the eastern side contemporaneous volcanic action contributed quotas, in some cases predominantly, and then marine sedimentation could only occur during geologically brief interregna between the deposition of intermittently progressive volcanic deposits. Thus there is a great possibility, considering also the intercalated freshwater beds in the volcanic areas, that land surfaces more habitually existed then, in the area of the present coastal hinterland, than in the more westerly areas such as Springsure, where one may perhaps postulate an increase to maximum deposition of marine strata in the southern half of the syncline.

The apparent absence of glacial horizons in the Lower Bowen marine beds of the eastern margin, even in the stages in which contemporaneity with the Dilly Stage is most strongly implied by the the mutual association of apparently restricted life forms, may be due, in conjunction with the effects of crustal movements, to the great accumulations of volcanic ejecta that were massed on that margin at various periods. These may have represented obstructions interrupting marine transportation of ice floes, for it may be remarked that no terrestrial glacial deposits are known to exist in the Queensland Permo-Carboniferous. Apart from such arguments to account for the lack of glacial erratics, the vagarious distribution of glacial debris from floating and dispersing ice is illustrated locally in the Springsure district itself where in one case the Eurydesma bed is littered with small erratics and in two other exposures of it they are absent.

Considering the association of *L. springsurensis*, *P. (?) subquadratus*, *Ariculopecten mitchelli* and *Eurydesma* as strongly indicative of Dilly age, with the reservation that the evidence cannot yet be considered conclusive that they, individually or collectively, may not range below that stage, we may consider the occurrence of these forms in combination on the eastern side of the Great Syncline together with other species occurring in that stage or known to be co-zonal.

**Mt. Britton (Homevale Bed).** *P. (?) subquadratus, Linoproductus springsurensis, A. mitchelli (*) ; also Linoproductus farleyensis, A. tenuicollis (*). (Girtyites (?) recorded here but not in Dilly Stage, Springsure).**

*Restricted to Lower Marine in N.S.W.*
Correlations of the Permocarboniferous Basin

Saltbush Park, Nebo. In beds occurring six miles N.E. of Homestead and continuing north-westwards to at least 15 miles N. of Homestead.

P. (?) subquadratus, L. springsurensis, A. mitchelli; also Monilopora.

Yatton.—P. (?) subquadratus and Eurydesma cordatum in unidentified beds; L. springsurensis, Monilopora and Trachypora were found in a comparatively limited zone which is likely to embrace the former two.

Cracow.—P. (?) subquadratus, L. springsurensis, A. mitchelli, E. cordatum, E. sp. nov. (Dilly type), also Stenopora cf. ovata, L. farleyensis, P. brachythaerus.

The Cracow section of A. K. Denmead (1931) includes the Eurydesma, Monilopora and L. springsurensis zones in that ascending order in a section comprising shales, sandstones and limestones with andesites in intermediate flows. It is of particular interest in relation to Dilly because of the grouping of the three common forms of the Eurydesma bed there in the lowest specified Cracow horizon and an abundance of L. springsurensis in the highest specified zones in both areas.

It thus appears that there are palaeontological grounds for correlating portions of the marine sections in all four eastern localities, enumerated above, with the Dilly Stage. It is not improbable that the stage or portions of it may be represented almost continuously along the eastern margin from Cracow, where it passes under the Artesian System, proceeding northerly to the south-eastern portion of the Bowen River Coalfield.

The following localities have beds with limited claims to provisional equation with the stage:—

Hazlewood Creek and Blenheim (Bowen River System): the former has provided some of our most typical Queensland specimens of P. (?) subquadratus while L. springsurensis occurs at Blenheim.

Camboon Woolshed and Delusion Creek (Dawson River System): Shelly and also chaledonic limestone with Trachypora and very large crinoids, etc. It continues to Delusion Creek, where there is a remarkable crinoidal limestone interbedded with andesites. At Camboon Woolshed the limestone is probably the most conspicuous Trachypora horizon yet located in the Great Syncline. On the weight of evidence—intercalation with andesites and the presence of Trachypora which, like Monilopora, has never been found in the known post-Greta beds of the main basin—this horizon may be definitely placed in the Lower Bowen. Its extension to Delusion Creek takes it within twelve miles of representatives of the Dilly Stage at Cracow and the presence of limestone with Trachypora in the andesitic series of both localities, renders it not improbable that these two occurrences are exactly contemporaneous in age. In a northerly direction the writer has rapidly traversed the Camboon Lower Bowen
Series of volcanics, sandstones, conglomerates, etc., and has not been able to separate them, as a series, from the Lower Freshwater Series of the Lower Bowen of Dunstan (1901) at Banana and to the west thereof. It is therefore not beyond the bounds of possibility that beds of Dilly age are represented in the Banana Lower Freshwater. What age, then, are the marine zones of Dunstan’s still older Lower Marine Series? It is very possible that over such an extensive area the scattered fossil localities may represent different zones if not stages. Still lower, and conformably (?), according to Dunstan, are the metalliferous slates, etc., including limestones with *Ariculopecten* and a rugose coral, that he classified as Gympie. A striking feature of his Lower Marine fossil lists is the absence, from rather extensive collections, of such easily recognised forms as *Productus* (?) *subquadratus* and *Eurydesma*, forms which had a most extensive habitat and are found abundantly in a number of Lower Bowen localities of the main basin. It would certainly be premature to draw the conclusion that their absence might indicate a downward limit to the range of the two forms mentioned at an horizon above his Lower Marine Section, but it seems to make desirable a further palaeontological examination of any material collected from Dunstan’s Lower Marine and Gympie Series of the Dawson River.

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**Age of the Dilly Stage:** Any consideration of the age of this stage entrenches on the delicate and arbitrary question of the division line between Upper Carboniferous and Lower Permian formations, a question that has universally raised more academic discussion between palaeontologists than perhaps almost any other, and a convenient retreat from which was the coining and continued usage of the term Permo-Carboniferous.

It appears for the present that the determination of age will rest largely on the brachiopods and certain bryozoans and pelecypods owing to the absence so far of definite ammonites as horizon markers. Evidently the only possible specimen of the latter found in the entire Permo-Carboniferous basin Queensland is one collected by the writer in 1924 from the Mount Britton (Homevale) bed. This is a very incomplete impression of several whorls and was determined by Dr. Whitehouse (1925) as “impression of a cephalopod (?) resembling *Girtyites*."

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In the description of *Linoproduclus springsurensis*, Booker has stated that its nearest allies are *Productus waagenianus* (Girty) of the Guadalupian, *P. eucharis* (Girty) of the Phosphoria Formation of South-eastern Idaho and *P. aagardi* of the Spitzbergen Artinskian, all three of recognised Permian age. Girty (1908) provisionally classified the Guadalupian fauna as Lower Permian. Schuchert (1928) placed the upper (Capitan) division of the Guadalupian in the Upper Permian on the ground that the lower division (Delaware) had some ammonite relationships with other American Permian formations which were definitely tied to the Fusulina limestone of Sicily. *P. waagenianus* occurs on about a middle horizon of the Capitan. *P. eucharis* comes from the Lower Permian (Phosphoria). Girty (1927) stated it may be identical with *P. aagardi* (Toula). Our species may also have a close alliance with *P. aff. aagardi* of the Alaskan Lower Permian. Booker gives two other close relationships for the Dilly species, viz., Diener's form of *P. waagenianus* from the Zewan Permian beds and the Uralian form of *P. aagardi* from the Russian Upper Carboniferous. Thus through *L. springsurensis* the Dilly Stage would appear to have at least one definite affiliation with the Tethyan and American Permian. Such an affiliation is not weakened by Etheridge's record of *Strophalosia clarkei* from Dilly, a form which he went to the trouble of declaring (in 1892) had much relationship with *S. goldfussi* which is a conspicuous species of the Zechstein of the European Upper Permian. At Dilly the abundant development of *Strophalosia gerardi* and the presence in its lower beds of the Permian Upper Marine species *Stenopora crinita*, will make it additionally difficult to maintain an earlier age than Lower Permian for the Stage.

The Dilly Stage may have a time relationship with the *Eurydesma* and *Conularia* faunas of the Salt Range in the latter of which Schuchert states there are nine Australian species, one of those cited (*Chonetes cracowensis*) intriguing the interest since the Dilly fauna seems really established at Cracow, Queensland, where the type of this species comes from. As to the age of these Salt Range horizons Schuchert places them as Middle Permian. C. S. Fox (1928) as Lower Permian, while Dighton Thomas gives reasons for regarding them as of high Carboniferous age.

“"If the *Eurydesma* and *Conularia* faunas of the Salt Range are reliable guides they indicate an Upper Carboniferous age for the Lower Marine Series of the Hunter River of New South Wales," according to the last-quoted authority, an interpretation of age that has also secured the adhesion of A. C. Seward. To the contrary, there seems to be an ever-growing body of opinion in Australia that the base of the Permian must at least be placed very considerably down in that Series, and the Dilly Stage with several definite Permian affiliations seems certain to be correlated with a low stage in it and at present, most obviously, with the *Eurydesma*-glacial stage of Allendale. If the *Eurydesma* beds of India and Eastern Australia are approximately synchronous then a considerable body of Australian opinion would appear to closely conform to the Indian view expressed by Fox as to the position of the dividing line between Carboniferous and Permian in regard to that fauna.
It would be outside the ambit of this paper to refer to statements which have appeared in papers abroad, and which have subsequently been cited in Australian related literature that there are no ammonites in the Permo-Carboniferous of New South Wales were it not that any such occurrences should have a bearing on the age of the Bowen Series in Queensland. In a footnote by Whitehouse (1929 b) to fossil lists of the Bowen River Coalfield, he showed that a number of the reputed "Agathiceras micromphalus" from that field were referable to Bellerophon, but the statement allowed that the species from the Upper Marine Series of the Maitland district, referred by Etheridge (1896) to Goniatisites micromphalus Morr. sp., is a definite ammonoid.

It will now be difficult to maintain that the coral known as Monilopora nicholsoni from the Queensland basin is restricted to the Carboniferous owing to the recent discovery of a very large type of it in post-Dilly beds of the Springsure Dome and in the L. springsurensis zone of Saltbush Park.

The writer's view, based on his stratigraphic investigations in Queensland, and the faunal determinations available, that the Queensland Permo-Carboniferous fauna dates from the Upper Carboniferous would possibly not be affected by advocacy of a Lower Permian age for the Dilly Stage. If it is really equivalent to some portion of the Lower Freshwater of the Dawson River, as there are at present grounds for believing, there must be a very great thickness of strata below it, involved in Dunstan's Lower Marine and perhaps portion of his Gympie Series, which contains what is usually termed in Australia a Permo-Carboniferous faunal assemblage. The records of these beds, possibly very imperfectly collected from, do not contain Productus (?) subquadratus nor Eurydesma, two characteristic, if not restricted, forms of the Dilly Stage of the Lower Bowen.

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(1929) (b) Whitehouse, F. W.—See Geol. of Bowen River Coalfield, Q.G.S. Pub. 276, p. 80.


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