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TASMANIAN CYCADOPHYTA.

[Part 2.]

By

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(Read 11th December, 1933.)

In a former paper, read before the Royal Society on 12th May, 1930, I gave some illustrated notes respecting certain cycad stems recovered from the Miocene strata at Evandale. The status of these specimens was called in question by certain palæobotanists, both in and outside the Australian Commonwealth. By a fortunate discovery a small piece of a trunk was afterwards found that proved beyond all question that they had an organic origin, and were not, as objected, inorganic concretions. This discovery, however, did not extend the microscopical evidence to the concentric woody layers, but related to the inthrusts of periderm into the central cavity of the stem, a state of things already found to obtain in cycad trunks from Dakota, U.S.A. In September last a splendid section of a trunk was found in the railway ballast-pit, and through the kindness of Mr. G. Curtis, of the Railway Department, and the keen interest manifested in it by the actual finder—Mr. L. V. Mason—we were enabled to secure this unique specimen. Some 2 feet of the trunk, in three fragments, eventually came to hand, and in many places the structure of the woody rings can be readily studied. As the diameter of the bole is 6 inches by 5 inches, we are evidently in possession of the remains of a fully-grown tree. The finding of this stem sets at rest for ever all objections raised against the organic origin of the specimens, and at the same time supplies us with several connecting links that serve to complete our chain of evidence, as will now be shown.

As the 50 lb. weight of fragments obtained at Evandale suggested both *Cycadites* and *Bennettites*, they were exhibited in the Museum cases as being such—all that manifested concentric layers of wood being relegated to the former taxonomy, and those that showed the entire centre to be

altered parenchyma, without woody structure, to the latter. By far the best stems belonged to *Cycadites*, and in exhibition only one perfect illustration of *Bennettites* was shown (Q. V. M. Pal.-Bot. No. 33), but later on a stem was found at Mulgrave-crescent, Launceston, in which woody periderm ran into the central parenchyma in the form of a latticework. Until the recovery, from the Launceston Miocene strata, of this large woody cycad trunk this specimen (Q. V. M. Pal.-Bot. No. 77) was the only evidence available respecting the inthrusting of woody periderm into the central parenchyma. Now, however, the railway ballast-pit section (Q. V. M. Pal.-Bot. No. 66) shows this most perfectly in its lower parts, while the upper areas are completely hollow. Obviously, therefore, this is to be regarded as a growth note, in which the central parenchyma was reinforced at the base of the stem, but the process became unnecessary higher up.

A "developed" section of one of the original specimens that came to hand from Evandale (Q. V. M. Pal.-Bot. No. 31) shows the leaf traces leaving the stem to perfection. The outer surface is heavily scored with the leaf scars, and the fractured surface shows the course of no less than 12 most perfect bundles of leaf traces.

A specimen (Q. V. M. Pal.-Bot. No. 35) has yielded evidence of seeds *in situ* in the strobilus, but so far these are the only ones detected.

Among microscopical details obtained from the railway ballot-pit stem the following were noted:—

(1) Medullary rays.
(2) Bordered pits to tracheids.
(3) Raphides (cubical rather than needle-shaped).
(4) Good evidence as to the resin ducts.

As this is a mere recapitulation of Museum specimens, very little need be said as to the works of palæobotanical authors, except to again refer to Dr. Marie C. Stopes' (D.Sc., Ph.D.) fine work upon the cretaceous flora, in the British Museum Catalogue series, and the valuable books upon fossil botany by D. H. Scott.

A CORRELATION OF THE TASMANIAN PLEISTOCENE GLACIAL EPOCHS AND DEPOSITS.

By

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(Read 11th December, 1933.)

1. PRESENT PROGRESS OF INVESTIGATION.

During the past year Sir Edgeworth David did me the honour of asking me to contribute a section to his "Geology of Australia," dealing with the Pleistocene glaciation in Tasmania. In the course of this work I found it highly desirable to affix names to the three glacial phases, the existence of which is now fully established. In the space available in Sir Edgeworth's work, I could do no more than use these names. A purpose of this paper is to record my reasons for the choice.

The widespread range of Pleistocene glacial drifts in Tasmania was recognised by Charles Gould as early as 1860, and by 1885 R. M. Johnston had recorded their existence over the whole of the western highlands (Johnston, 1893). Until 1893 no suggestion had been made that there had been more than one glacial phase in Tasmania, but in the paper last referred to R. M. Johnston recorded difficulties in the interpretation of the field evidence, which have since been used to prove the existence of such separate phases (see *loc. cit.*, p. 100). In this branch of learning, however, I must award the palm for early accurate observation and clear geographical discernment to T. B. Moore. As early as 1895 this outstanding explorer advanced a theory that there had been two glacial epochs during the period under review, and advanced evidence which my later investigations confirm entirely (Moore (1895), p. 76; and see also R.S. of Tas., 1893 and 1894, *sub. nom.* T. B. Moore).

Unfortunately, T. B. Moore's theory was disregarded, and for 25 years various writers on this topic floundered in a maze of their own making. By disregarding the very clear evidence of separate and distinct glaciations, they endeavoured to reconstruct the traces of all into the framework of one ice invasion. The result was contradictions everywhere

and observers contented themselves with recording evidence—the reconstruction of ice movements being fraught with so many apparent difficulties. This fact must be borne in mind when studying the numerous reports of glacial phenomena published prior to 1920.

In 1921 Professor Griffiths Taylor drew attention to the clear evidence of a double glaciation in the National Park (Taylor, 1921), although he missed the true significance of the field evidence he recorded, as had I, in my description of the area published in the same volume. Some time prior to 1922 Dr. Loftus Hills had made certain observations in the vicinity of Strahan. These he showed to Sir Edgeworth David, who confirmed Dr. Hills' theory that here was distinct evidence of at least two glaciations (David, 1926). Dr. Hills made some mention of this to me at the time, but he did not publish or, as far as I know, elaborate his ideas then.*

In 1922 (December) I was descending the slopes of Mt. Anne, and, looking over the Huon valley—whether the evening light or the peculiar configuration of the Frankland Range emphasised the fact I know not—but I was struck with the absolute clearness, in the panorama there unfolded, of the evidence of two distinct and superimposed glaciations, the one responsible for the topography of the Huon Plains, the other disclosed in the tributary valleys leading down from the encircling ranges. The fact of a smaller series of valley glaciers, terminating in piedmont moraines, each resting on the older glaciated surface of the wide Huon valley, was too apparent to be missed. With this clear disclosure in the field, I found the key to the task of reconstructing the history of the Pleistocene glaciation in this island. I made reference to this idea in 1923, and definitely advanced the evidence on which I based the conclusion that Tasmania had experienced three Pleistocene glacial epochs (Lewis, 1923, p. 32). I then attempted to correlate the Tasmanian glaciations with those of the Northern Hemisphere, an attempt I have now abandoned. In the same year Sir Edgeworth David, after full consultation with all Tasmanian geologists, set his seal to the classification of the Pleistocene glaciations into three easily distinguishable phases (David, 1923).

After further study, the position was crystallised by the Report of the Glacial Sub-Committee of the A.A.A.S.,

* The distinctions noticed by Moore, Hills, and David were between the Malanna and the Yolande glaciations; those noticed by Taylor were between the Yolande and Margaret glaciations.

Adelaide meeting, 1924, in which I elaborated my previous ideas, and Sir Edgeworth David followed with modifications and confirmation of the general theory. (Lewis, 1926; David, 1926.) Since 1926 little further advance has been made, except in the direction of the collection of further evidence, all of which confirms the conclusions enunciated in the report referred to lastly above.

2. Nomenclature Assigned to the Subdivisions of the Pleistocene Glaciation.

For reasons to be set out hereafter, I have had to reject an absolute correlation between Tasmanian and European glacial epochs. The desirability of local names in cases in which absolute correlation is not absolutely certain is recognised. It is most difficult to fix upon any Tasmanian locality as absolutely typical of any of the glacial phases, as the features of all are so uniform throughout the country. After examining the claims of every recorded area to the title of type locality, I decided that the district in which clear examples of each phase could be found in the smallest compass was that described by Sir Edgeworth David. This area possesses the advantages for such purpose of accessibility and compactness, and has already been thoroughly mapped. Further, it has been described by the greatest authority on the subject, and Tasmania may well pay Sir Edgeworth David the compliment of choosing the area he has described as the type locality for its glacial geography.

For these reasons I selected the following names for the three identified glacial epochs:—

1. Malanna Glaciation: For the earliest, most extensive ice-cap stage of the Pleistocene period.
2. Yolande Glaciation: For the second, cirque cutting and most obvious stage.
3. Margaret Glaciation: For the most recent, or mountain-tarn, stage.

The applicability of this terminology will be appreciated on reference to Sir Edgeworth's description of the area. Nowhere else are the three phases to be seen in such clear juxtaposition within an area of the same size and accessibility.

3. The Late Tertiary and Pleistocene Succession in Tasmania.

The continual sub-aerial conditions, the confusing succession of land movements, and the absence of definite time marks render our period difficult to correlate with the accepted subdivisions of geological time. Indeed, as far as the geology of Tasmania goes, there is no justification for separating Pliocene, Pleistocene, and Recent periods.

At one end there comes the marine limestone of Table Cape and the Tamar basin, probably of Miocene age, with the freshwater leaf beds of the Launceston and Derwent basins, not far removed in point of age. Overlying these is the older olivine basalt, which may be of Miocene or Pliocene age. From the date of the latter rock, itself most uncertain, all is doubtful at present. The succession of the three glacial periods is clear as between themselves, but all search has failed to disclose a starting point for correlating them with the basalts and older tertiary formations, on the one hand, and the raised beach and river terrace deposits of Northern and Eastern Tasmania, which are usually referable to Recent age, on the other hand.

In point of fact, and it is one of my present purposes to stress, the glacial epochs cannot be segregated into a division by themselves and referred to " Pleistocene " age, and the raised beach and terrestrial deposits cannot be separated into another compartment and called " Recent," as has been done heretofore. The two series were probably deposited contemporaneously, but in different parts of the country.

As far as my observations have extended, no clearly defined Malanna glacial deposit or erosion feature stands in juxtaposition to defined tertiary strata or older basalt. We merely presume that the latter are older than any late Tertiary glaciation. This is supported by the balance of probabilities, but by nothing more. The relationship between the older and the newer basalts has not been worked out to such a degree that we can distinguish a given occurrence with certainty. It appears that a very considerable interval of time elapsed between the two eruptions, probably a greater interval than exists between the eruption of the newer basalt and the present day. I was struck by the fact that in the Coal River valley, immediately north of Richmond, newer basalts overlie clays and soils in no way distinguishable from those cultivated to-day in the immediate vicinity.

On the Central Plateau glacial features are superimposed on the newer basalts. But here we observe the faint feather-edge of the glaciation, and it is difficult to distinguish its period with certainty. There is no difficulty in saying that the Yolande glaciation was more recent by a considerable space of time than the eruption of the newer basalts. If my interpretation of the field evidence is correct, the Malanna glaciation is also superimposed over sheets of newer basalts in the vicinity of the Great Lake and elsewhere. But I have not yet established this fact to my complete satisfaction. Nevertheless, the balance of probabilities again points to the fact that the newer basalts preceded the Malanna ice-cap.

Of the boundary, in Tasmania, between the Pliocene and the Pleistocene, or the correlation of the Malanna glacial epoch to this point of time, we know nothing at present. The Wynyard stage, the older basalts, the river drifts and lacustrine deposits, and the newer basalts are distinct in themselves (see Nye and Lewis, 1928, for fuller descriptions), and no doubt exists as to the local succession. But they present a very broken and uncertain record of Tertiary times, and provide no connection with subsequent events.

In these circumstances we cannot date the Malanna ice age. We may accept the general correlation of the Tasmanian ice age with the Pleistocene period. It certainly is far later than the Miocene. Since that period the older basalts were erupted and eroded, great depths of terrestrial deposits accumulated and also eroded, and river systems were invaded by newer basalts at a considerably more recent date. From approximately the date of these flows until relatively modern times Tasmania has been subject, at least in higher altitudes, to more or less glacial conditions. But our real problem is: did our southern phases correspond with those of the Northern Hemisphere, or did they occur alternatively with the glacial and inter-glacial epochs in the Northern Hemisphere, or were they merely approximately contemporaneous without any real inter-connection? The solution of this problem would be Tasmania's greatest contribution to the knowledge of recent glacial phenomena. Unfortunately, an answer is not yet to hand.

It is clear that the Malanna glaciation was the most intense, and it is safe to state that it covered from a third to a half of Tasmania. The many apparent breaks and inconsistencies are due to post-Malanna erosion. It is also clear that the time-interval between the maximum phase of

the Malanna glaciation and that of the Yolande glaciation was far greater—I would say four times greater—than the time-interval between the Yolande glaciation and the present day. The remains of the Malanna glaciation have been largely eroded by the river systems; elsewhere the limits have been submerged under the sea, and the origins have been obliterated by the Yolande glaciation. It is therefore only in a few favoured localities that such evidence persists. It is no wonder that early observers connected these vestiges with the neighbouring Yolande valley glaciers rather than with the distant occurrences, now separated by miles of waterworn valley.

As to the duration of the Malanna glaciation, I can only say that from its extent and remains it appears to have been of far longer duration than the Yolande period. Then came the Malanna-Yolande inter-glacial. This also lasted for a very lengthy period. The Yolande glaciation occurred upon, virtually, our present day physiography; the Malanna glaciation left a physiography which differed so materially from that which we know that it is difficult to reconstruct it. Vast changes occurred during the Malanna-Yolande inter-glacial, and, moreover, obviously required a vast space of time to impart the results which are apparent. The date of the land movements that elevated most of our central plateaux is disputed. I incline to the idea that several sectional uplifts occurred, and that the first, involving the country from the west coast to a line from the Forth River to New River, occurred immediately prior to the Malanna glaciation, and the succeeding uplifts to the east occurred during the Malanna-Yolande inter-glacial. But I do not wish to press this view, as it is not accepted by the Geological Survey.

Nevertheless, this is certain: many rivers—the Pieman, King, Gordon, Huon, Derwent, Ouse, Lake, Mersey, and Forth, to name only the more important—cut gorges from 1000 to 2000 feet deep in the hardest of rocks during the Malanna-Yolande inter-glacial. This is the explanation of the fact that there are widespread Malanna morainal deposits at Strahan and south of Macquarie Harbour, but none in the lower King and Gordon Rivers, down which the ice would naturally flow; and similarly with other rivers. The erosion during the Yolande-Margaret inter-glacial has been inconsiderable, and, making all allowances for the increase in erosion in the lower reaches of rivers fed by Yolande

glaciers, it appears, from the extent of the Malanna-Yolande inter-glacial erosion, that the duration of this inter-glacial period, in itself far exceeded the time from the Yolande glaciation to the present day. Indeed, if the commencement of the Malanna glaciation were to be dated as a million years ago, I would estimate the length of the Malanna-Yolande inter-glacial as 600,000 years, and date the commencement of the Yolande glaciation not earlier than 100,000 years ago. This period would then have lasted for 50,000 years, with an inter-glacial period of about half as long, and the Margaret glaciation commencing about 20,000 years ago and lasting until within 5000 years or less of the present day. I place no reliance on these dates as such, but the relative time-interval represents my view of the proportion of the Pleistocene period occupied by each phase. The Yolande glaciation followed. This is unmistakable. It has been responsible for the moulding of the topography of the altitudes over 2000 feet—and this area is very considerable. It has also been responsible for the more obvious moraines and glacial deposits. It cannot be stated with absolute certainty that there was an absolute inter-glacial period between the Yolande and the Margaret glaciations, but all the evidence points to such occurrence. Certainly the Margaret glaciation was a definite and distinct feature, too universal, persistent, and protracted to be regarded as merely a phase of the recession of the Yolande glaciers. It probably represented a definite onset and waning of glacial conditions, but to a less degree of intensity, both as to level affected and time occupied, than the Yolande glaciation. This phase persisted until very recently. Indeed, it has not yet entirely departed, although permanent ice no longer exists.

Contemporaneously with the ice periods on the highlands and west coast, considerable river and estuarine deposits were accumulated in the lowlands and along the north and east coasts, and raised beaches of indefinite age appeared. Great differences in the flow of the principal rivers and consequent eroding power, due to marked changes of climate, are also apparent. All these are attributable to the same causes as produced the ice-flows further west. It is most apparent that our rivers and creeks have all shrunk in volume in the near past. This is natural considering that most were ice-fed during earlier periods. No attempt has yet been made to correlate the river terraces and raised beaches with the several glaciations, but this should not be impossible. I have to content myself here with stressing

that these deposits, which so largely cover the later basalts through Southern, Eastern, and Northern Tasmania, and fringe these coasts, are largely the results of the glaciation of the elevated country inland, and cannot be separated from the Pleistocene glacial periods. Similarly, it is impossible to differentiate downwards between Pleistocene and Recent strata. "Post-Margaret deposits" appears to be the more accurate term for those which can be differentiated as such.

4. Correlation With the Northern Hemisphere.

I have described three glacial periods as occurring in Tasmania. These three are distinct, and their occurrences are distinguishable. The general time-relationship, considering Tasmania alone, has been established. My investigations, however, do not preclude the occurrences of other glaciations. Three possibilities exist:—

(i) A pre-Malanna glaciation, the traces of which have been obliterated by erosion or by the more intense Malanna glaciation.

(ii) A phase between the Malanna and the Yolande, the evidence of which has been confused with one or other of the identified glaciations or obliterated by the Yolande glaciers.

(iii) A subdivision of the Malanna glaciation into more than one phase.

I am satisfied that the typical Yolande glaciation cannot be subdivided, and that none occurred between the typical Yolande and the Margaret or after the Margaret phases. As to the other possibilities mentioned above, all I can say is that no evidence exists. But in view of the present state of our knowledge, and the very fragmentary remains of the Malanna glaciation, this does not exclude such possibilities. The point is important. If we have had three glaciations, there would be a temptation to fit them in to the inter-glacial periods of the Northern Hemisphere. If we have had contemporaneous glaciations with the Northern Hemisphere, we must explain the absence of evidence of the missing one. If it is the earliest that is missing, as I strongly believe, and the Malanna glaciations can be correlated with the Mindel, it is possible that Tasmania escaped the Gunz glaciation owing to the fact that our mountains had not at that time been uplifted to the necessary height. To establish this fact would be to discover a date for the final elevation of our

horst plateaux. In any case, I feel that a close study of the earlier phases of the glacial period, and the relationship of river erosion and deposition thereto, will disclose that there also exists a powerful earth-movement factor. It is a purpose of this paper to point out that none of these factors can be understood separately.

In the present state of our knowledge it is impossible to correlate the Tasmanian glacial periods with those of the Northern Hemisphere. It is tempting to connect the Malanna glaciation with the Mindel, the Yolande with the Riss, and the Margaret with the Würm. In my opinion, however, such can be no more than a guess, and may lead to fatal error. For the present, we can only adhere to local terminology and correlation.

5. Future Investigations.

This field is really so lightly touched in essentials that any detailed investigation of the various problems mentioned above would be welcomed. It seems that the Yolande glaciation is our one definite time-mark, and that the work of correlation, both local and world-wide, must start from this base. Thence, the search for a Yolande moraine superimposed on a Malanna moraine must be prosecuted to success. A careful investigation of the edges of the Malanna deposits at Strahan may give a clue as to the succession downwards. It appears at present as if the river terraces or raised beaches of Pleistocene age are nowhere closely associated with glacial deposits, but an investigation of the shore-line between Recherche and Temma should throw sufficient light on this succession to establish a basis for inter-correlation. Failing any such discovery, a close study of the succession of river terraces and their erosion should provide a sequence which can be reasonably correlated with the glacial phases. I am satisfied that the data exist, but up to the present I have not been able to identify a reliable starting-point.

I conclude by expressing the hope that workers interested in Tasmanian glaciation will advance from a mere description of deposits and erosion forms to a logical correlation of the features observed, either to confirm or to contradict the conclusions summarised above.

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A CONTRIBUTION TO THE STUDY OF TASMANIAN COPEOGNATHA.

By

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Six Text Figures.

(Read 11th December, 1933.)

Probably few Tasmanian insects have been so generally neglected by students as those usually small but plentiful forms which comprise the order Copeognatha or Psocoptera. The Australian and New Zealand species have been studied by MacLachlan, Enderlein, and Tillyard, but the literature contains only isolated references to Tasmanian forms.

Among the species dealt with in the present paper are two archaic forms of more than ordinary interest. One of them closely resembles *Sphæropsocus künowi* Hagen, a fossil species found in Baltic amber, whilst the other is a member of the rare and primitive family, Lepidopsocidæ.

Suborder PARAPSOCIDA Tillyard, 1926.

Family LEPIDOPSOCIDÆ.

Genus *Tasmanopsocus* n.g.

Diagnosis.—Head very hairy. Thorax, abdomen, and legs clothed with both scales and hairs. Three ocelli present. Antennæ with 40 joints. Apical joint of maxillary palpi hatchet-shaped. Tibial segments of the legs armed with long powerful spines, as in the genus *Echinopsocus* Enderlein. Tarsi three-jointed. Forewings bluntly pointed and short, reaching only to the middle of the abdomen. The venation is not constant, but the arrangement of the veins as shown in Fig. 2 B holds good in most specimens of the genotype. Sc is not fused with R. The radial sector (Rs), which is unbranched, leaves R near the middle. M is fused with Cu_1 towards the base. Both M and Cu_1 are branched dichotomously. Cu_2 is absent. In the wings of some specimens 1A fades out towards the base. In other cases it is well developed and occasionally branched. As in the genus *Echmepteryx* Aaron, there is no distinct pterostigma. The