THE PLEISTOCENE GLACIAL HISTORY OF TASMANIA

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Abstract. A. N. Lewis's scheme of Tasmania's Pleistocene glacial history in terms of three full glaciations —Malanna (ice cap), Yolande (valley glacier) and Margaret (cirque glacier)—is criticized on a number of specific and general grounds. The area reliably known to be glaciated is thought to be much smaller than Lewis claimed. Future work on Tasmanian glaciations should not be grafted on to Lewis's scheme and should aim especially to provide more reliable evidence for distinguishing and evaluating the glacial phases.

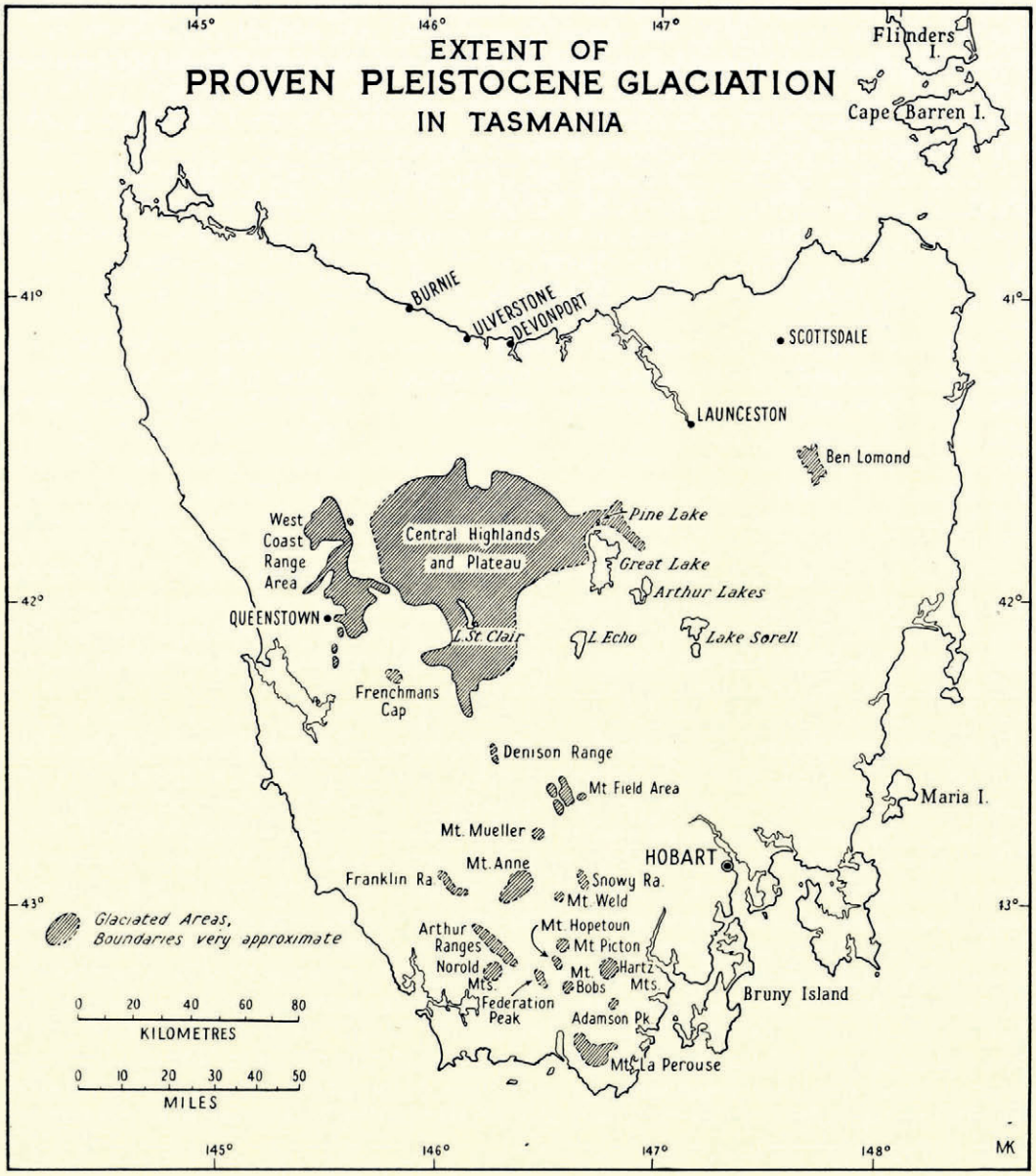
Zusammenfassung. Das System von A. N. Lewis Glazialgeschichte des Pleistozän von Tasmanien in Form von drei vollkommenen Vergletscherungen—Malanna (Eiskappe), Yolande (Talgletscher) und Margaret (Kargletscher)—wird an Hand einer Anzahl spezifischer und allgemeiner Gründe kritisch behandelt. Das zuverlässig bekannte Vergletscherungsareal wird für viel kleiner gehalten als von Lewis angegeben. Weitere Arbeiten über die Vergletscherungen von Tasmanien sollten nicht auf das System von Lewis aufgepfropft werden und sollten ganz besonders darauf hinarbeiten zuverlässigere Beweise zur Unterscheidung und Bestimmung der Glazialphasen zu beschaffen.

Recently in this *Journal* Dr. W. R. Browne [1] has succinctly presented afresh the picture of the glacial history of Tasmania, which over a long period A. N. Lewis built up in a series of pioneering papers, the product of strenuous spare-time field work in difficult country. It may seem invidious to criticize certain aspects of this work without at the same time being able to offer a well-validated framework in its place. However, whilst valuing Lewis's recognition and identification of glacial phenomena in various parts of Tasmania without the help of the air photographs, contoured maps and jeeps available now, we wonder, in the light of recent work (much of it not known to Dr. Browne when he wrote his paper), whether the scheme in which Lewis placed his observations is not now a hindrance to further progress.

That scheme consisted of three glaciations—Malanna, Yolande and Margaret—which were regarded as full glacial periods and constituted also a series of declining intensity of glacial activity, ice caps characterizing Malanna, valley glaciers Yolande and cirque glaciers Margaret. Lewis and Murray [2] suggested a fourth D'Entrecasteaux phase but afterwards Lewis [3] included this as a retreat phase in his Malanna glaciation. The Yolande was thought to consist of two distinct phases. Originally the three glaciations were correlated with the Mindel, Riss and Würm of Europe but later Lewis [4] abandoned his attempt at correlation though he was not consistent in this (*cf.* for instance Lewis [5]). Dr. Browne does not repeat the intercontinental correlation which rested on little evidence. However by employing the term Stage for the three glacial phases, he does imply, following Flint's usage, that they have the status of full glaciations.

Certain specific criticisms will now be directed against Lewis's scheme, followed by some more general argument.

(1) In the type area of Malanna, Banks and Ahmad have recently examined afresh the supposed tills and associated sediments—sand, clay and lignite—attributed to that glaciation. The details of the stratigraphy and the views of J. W. Gregory and T. W. E. David, both of whom considered tills present, will be discussed elsewhere. Here it must be briefly stated that Banks and Ahmad take the view that no evidence of glaciation is present, all the observed facts being explainable by repeated late Tertiary faulting and the development of fault scarp scree breccias, and fluviatile, lacustrine and paludal deposits in the lowland produced by the faulting. Dolerites are now known to occur near Firewood Siding



so there is no need to think that the dolerite boulders are glacial erratics from Mt. Sedgwick; the faults in the Permian beds at Firewood Siding are normal downthrows to the south-west, not thrusts from the east due to supposed ice pressure; the flattened faces of many dolerite and sandstone blocks are not glacial soles but simply the result of jointing; Owen Conglomerate boulders do not occur in the supposed till as might be expected if it is the product of ice from the east.

In addition glacial deposits near Strahan, which were regarded by Lewis [6] as due to the Pleistocene Malanna Glaciation, are considered by Banks and Ahmad to be Permian in age mainly because of the degree of lithification and the absence of Owen Conglomerate

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boulders. Moreover other beds at Strahan taken by David and Lewis to be glacio-fluvial outwash gravels, consist of gravels, sands, clays and lignites, with abundant evidence of stream, lake and swamp origin but yielding no evidence of glacial derivation (nor estuarine as Bradley [7] suggested). These beds were deposited in a Late Tertiary graben against the Permian glacial beds; they have since been tilted and cut into a series of terraces by marine erosion at different levels (J. L. Davies, personal communication).

In the whole of the Henty Peneplain west of the West Coast Range, which can be considered as the general type area of the Malanna Glaciation, Bradley [7] recorded glacial features only on the Henty River down to 86 m. above sea level about 24 km. inland and on the higher parts of the Yolande River further inland. Outside the limits shown on Bradley's map of the Yolande River sheet no signs of glaciation are known.

(2) Lewis [8] ascribed the varves at Gormanston near Queenstown to the Malanna Glaciation, the lake in which they were deposited being embanked by Malannan moraine. Recently a fossil wood specimen from these varves has been subjected to a carbon-14 assay which gave the date of 26,480±800 years (Gill [9]). Gill also quotes K. E. Caster's opinion based on considerable experience of the North American Pleistocene that there is nothing in the degree of preservation of the associated moraines to prevent their being of Wisconsin age. If Lewis's Malannan attribution is accepted, this evidence reduces the three phases to substages or stadia of a single glaciation. However the Linda Moraine at Gormanston responsible for the lake is as fresh in its topography as the moraines near Lake Margaret (called the Hamilton Moraine of Dunn and David but later apparently the Margaret Moraine of Lewis). So that if one adopts Lewis's scheme as a whole, it is better to attribute the Gormanston features to his Margaret Glaciation. In the one way or the other, Lewis's interpretation of this area needs drastic modification.

(3) Lewis and Murray [2] considered that good evidence of separate phases of glaciation occurred near the head of the D'Entrecasteaux River. Here they describe a "peculiar button-grass covered . . . spur", an older moraine, which had its northern end cut off by a glacier and had a later moraine deposited against it. The former moraine is the type feature of the D'Entrecasteaux phase mentioned above and the latter is said to be Yolande. However air photographs now make clear that this spur does not have the physiographic form of an end moraine but descends in a series of structural benches carved from the almost horizontal Permian rocks. The variety of rock types found in surface boulders is entirely represented in the bedrock succession in the ridges above and the surface material present is regarded as scree or periglacial solifluction material. The younger moraines are present. However the main line of evidence advanced by Lewis and Murray for superimposition of glacial phases here is considered invalid and capable of a very different interpretation. The flat-bottomed cross section of the valley lower down is a structural, not a glacial, effect and the morainal character of the deposit of quartz pebbles and basalt boulders at Leprena is not considered to be clearly established.

(4) The western part of the Central Plateau has recently been re-examined geomorphologically (Jennings and Ahmad [10]); in their view there is evidence here for only one glaciation. This was an ice cap glaciation with associated outlet glaciers. Some small cirques within the area are attributed to the advancing hemicycle of this glaciation. The high degree of preservation both of *roches moutonnées* and of moraines implies that the glaciation involved must be very young and is tentatively regarded as Würm. The region studied however includes areas ascribed by Lewis to each one of his three glaciations.

The ice cap glaciation cannot be attributed to Malanna because it is too fresh in its results; soils have not formed over much of its area of erosion. If it is ascribed to Margaret,

it is totally out of keeping with the slight intensity of glacierization which Lewis attaches to that last glaciation. If it is regarded as Yolande, there is less discrepancy on the side of degree of glacierization, but it has the corollary that Margaret becomes a substage of the Yolande Glaciation (*cf.* Flint [11, 12]).

(5) It is regrettable in view of the later wide use of the terms that Lewis was not more precise in defining the Yolande and Margaret phases in their type areas. Nowhere in his work is it clear just what features are to be regarded as Yolande phase in the Yolande River area nor what is Margaret in the area of Lake Margaret. To date no one has produced clear evidence of two epochs of glaciation in this area for, although Bradley [7] states that the lower Yolande moraine could have been formed by a small tongue of ice advancing *after* the formation of the bulk of the Margaret moraine, it is possible that all the features in the area are the result of the one glaciation as indeed Bradley suggests. In view of the lack of precision in the definition of the phases in the type area and the marked possibility of their being part of the one glaciation, it might perhaps be best at this stage to discard the names completely.

(6) Lewis gave little recognition to the action of periglacial processes in Tasmania. Davies [13] has shown that "Malannan moraine" on Mount Wellington (Lewis [14]) is in fact periglacial solifluction material and thinks it probable that similar confusion has taken place elsewhere.

The extent of the glaciation as mapped in Lewis [3] and reproduced in its essential features by Dr. Browne [1] is much greater than reliable evidence warrants. There is now, for example, no place known where ice reached the sea. The area between the mouth of the Pieman River and Macquarie Harbour shows no sign of glaciation closer than 26 km. from the coast. Port Davey as Dr. Browne noted is no longer regarded as a fjord but as a drowned river valley (Baker and Ahmad [15]) and there is no evidence for glaciation in southern Tasmania approaching more closely to the sea than 8 or 9 km. The area near the mouth of the Pieman River has recently been re-examined by Twidale [18] who finds no direct evidence of glaciation in the area. Jennings and Ahmad [10] indicate that the extent of ice in the Central Plateau is less than supposed by Lewis. No signs of glaciation have been found on Mt. Barrow and Mt. Victoria in the north-east. In general it seems that an ice sheet occurred only in the Central Plateau with cirque and valley glaciers elsewhere (see Fig. 1).

In one of his papers,[6] Lewis stated "Cirque erosion and not morainal deposits form the only sure guide to differentiate the various stages", and it is clear that this standpoint lies behind much of his interpretation. Most workers in the field of glacial geology and geomorphology would take the opposite point of view and it seems to the present writers that it was this standpoint which misled Lewis at various junctures. Thus the separation of a high cirque phase (later called Margaret) from a valley glacier phase (later called Yolande) which was itself divisible into two, goes back to his initial studies of the Mt. Field National Park.[16, 17] In the Broad River valley, the moraine-dammed Lake Webster is backed by a "cirque" which rises 90 m.; at that level there is Lake Seal, another moraine barrage lake, which heads in another "cirque" with a backwall 300 m. high. Above this backwall is the Tarn Shelf, a sort of elongated cirque, with several small lakes, rock-basined as well as moraine-dammed. The three "cirque" levels are related by Lewis to three levels of maximum frost action belonging to different glacial phases and the erosional work is regarded as having been performed successively. However, there seems to be no reason at all why the two lower "cirques" are not to be regarded as steps normal in a glaciated valley, pre-glacial steepenings in the valley gradient accentuated by the well-known peculiarities of glacial erosion. All the erosional features can surely be the product of a single glacial period

with a valley glacier occupying the whole valley; the various moraines may represent halts in the retreat of this one glacier.

The test of the comparison of deposition in the form of the volume of moraines with the amount of rock evacuated to form the cirques is not applied by Lewis. Thus the moraines on the Tarn Shelf seem much too meagre to balance the erosion at that level. It seems more in keeping with the facts to think of the Tarn Shelf as the work of a hanging glacier on a structural bench feeding a contemporary glacier below in the Lake Seal valley. The degree of glacial rounding of the lip below the Tarn Shelf is consistent with such an idea although no doubt windows in the ice exposed the rockwall to frost action for long periods.

Lewis failed to note the significance of the overriding by ice of the backwalls of cirques. Cirques are just as likely to be formed in the advancing hemicycle of a glacial period as in the retreating phase (*cf.* Charlesworth [9]). Thus there are a number of small cirque-like features on the western Central Plateau; yet almost without exception they were overridden by the ice cap and the lips of their backwalls are rounded by glacial abrasion (Jennings and Ahmad [10]).

Moreover the likelihood that regions peripheral to an ice cap will carry valley glaciers and cirque glaciers is strong and the work of outlet glaciers from an ice cap may be difficult to distinguish from that of valley glaciers. These are considerations which seem to allow of different interpretations for many of the glacial phenomena of which Lewis furnished pioneer descriptions. Thus it is clear that the ice cap of the western Central Plateau provided much of the ice which went to swell the might of the great piedmont glacier responsible for the 210 m. deep Lake St. Clair and the great festoons of fresh moraine ridges around the lake foot. Nor does there seem to be any evidence against the view that the glacial horn of Mt. Ida on the eastern shore of this lake is the product of this same ice cap phase. The neighbouring "cirques" which Lewis ascribes to the Margaret Glaciation show every sign of the deluge of ice from the plateau behind. Moreover the level of these "cirques" is over 300 m. below that of the opposing Margaret cirques high on the east face of Mt. Olympus and is therefore well below the altitude generally attributed to the Margaret Glaciation in this area.

Lewis's scheme of three glaciations each characterized by a type of glacier—ice cap, valley glacier, cirque glacier—is inherently unlikely over areas such as those involved in Tasmania, with their strong climatic gradients and wide variety of terrain ranging from highly dissected country to virtually untouched plateau. Such a simple scheme can no doubt fit the waning phase of a single glaciation in Tasmania or represent the full Pleistocene history of a single *massif* such as the Kosciusko region on the mainland. But for the whole glacial history of Tasmania a more complex picture is likelier, with combinations of all three types as the changing snow line brought varying extents of land in differing climatic and topographic contexts within its grip. This may be the major reason why Flint in his world survey of the Pleistocene [11, 12] has been disinclined to accept Lewis's views completely.

To construct a glacial history from the erosional results of ice work is difficult; the moraines which Lewis relegated to second place can tell us more from detailed analysis of their degrees of weathering and dissection, from examination of their erratic content and fabric revealing different movements and sources, from buried soils and weathered surfaces where tills are superimposed. Most of all should attention be given to the search for organic deposits interbedded with moraines or at least having significant distributions in relation to different moraines.* Palynological investigation and C-14 dating are the chief means whereby glacial advances and retreats can be reliably regarded as stadial phases or full

* Loftus Hills (in Lewis [14]) reported peat between two moraines on the Central Plateau at a site now beneath the waters of the Lake Augusta reservoir. It could imply anything from a retreat of a few hundred yards to a full interglacial.

glaciations. Meanwhile until such evidence is forthcoming, Lewis's chronology with doubts cast on its three type areas and a certain degree of improbability in its general nature, should not be regarded as a mould into which detailed studies of glaciation in different parts of Tasmania should be fitted.

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