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Correlation of the Tasmanian Pleistocene Raised Beaches and River Terraces in Unglaciated Areas

BY

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Two Plates and Three Text Figures

(Read 12th November, 1934)

This paper follows my attempted correlation of the Pleistocene glacial epochs (Lewis, 1934).

Further study of the raised beaches and river terraces in the Derwent, Coal, and Huon River valleys has made possible a tentative statement of the late Tertiary and Pleistocene succession in Southern Tasmania. The whole problem has by no means been solved, but sufficient data are forthcoming to warrant recording as a basis for future work. This is the phase of Tasmanian geology which has received the least attention in the past, and it was not until the effect of the waxing and waning of the four Pleistocene Ice Sheets on the level of the ocean was fully understood that the various apparently contradictory features of our coastal plains was decipherable.

The facts stated in this paper are entirely based on physiographic evidence. Certain palaeontological evidence is forthcoming from Northern Tasmania, and some information as to past happenings may be discoverable from a study of the petrological groupings of the pebbles in the various drifts, but no key in either direction has yet been found in Southern Tasmania. The association between the *Mirnyongs* (native kitchen middens) and the physiographic succession of river and marine terraces opens up an interesting field which has not yet been explored. This paper is intended to supply the geological background for further work by the anthropologist in this direction.

The remarkably accurate and detailed description of general post-Tertiary geology given by R. M. Johnston (1888) can hardly be amplified. W. H. Twelvetrees (1909) carried our knowledge very little further, and fully confirmed Johnston's general conclusions. Our present Government Geologist, Mr. P. B. Nye (1924) has given us the best general account of the geology of part of the area under discussion in this paper. He has divided the more recent sediments into Lower and Upper Tertiary, using the eruptive flows of olivine basalt as the dividing line. My observations confirm what Mr. Nye has written, except that it is quite possible that the whole of

the Tertiary deposits he describes are Upper Tertiary (Pliocene). The division, however, is clear. The basalt appears to be referable to the more recent or upper basalt flows, and the date may not be further back than the opening of the Pleistocene period. Deposition of river gravels appears to have preceded the basaltic eruptions and to have continued, almost uninterruptedly, after the volcanic phase. All this, however, is open to some doubt at present, and in the present paper I start with the physiography as it appears after the last orogenic movements and the probably accompanying volcanic phase had ceased.

Succession of Tertiary and Pleistocene Rocks in Southern Tasmania.

(*a*) Leaf beds at One Tree Point, Pipeclay Bluff, and Geilston Bay, with river drift conglomerates and sandstones undifferentiated *inter se*. (Lower Tertiary of Nye.)

(*b*)—(i) Nephelite-Basanite of One Tree Point.

(ii) An eroded, unidentified porphyry-like rock at One Mile Hill, east of Bellerive.

(iii) Olivine basalts that occur in isolated patches at intervals seldom exceeding a mile along the valleys.

The above appears to be the sequence of this series. Perhaps the two first named represent the lower basalts and the last the upper basalts; perhaps some of the river drifts accumulated between these eruptions; but no evidence is as yet forthcoming on these points. The conglomerates that fringe Mt. Nelson appear to be river deposits brought from a distance. At One Tree Point they are overlain by Nephelite-Basanite.

(*c*) Newer conglomerates of immediately pre-Malannan age overlying the basalts and covering the old floors of the valleys to a height of 50-100 feet above present sea-level. The best occurrence of these is at Millbrook Rise, New Norfolk.

(*d*) Malanna phase, represented by river erosion to a depth of 150 feet below present sea-level in entrenched meanders.

(*e*) Malanna-Yolande interglacial phase, represented by the silting up of the Malannan troughs in the main and tributary valleys to a height of 50 feet above present sea-level, with raised beaches, inland wave terraces, and sand dunes and secondary river terraces in places.

(*f*) Yolande phase, represented by river erosion to a depth of 60 feet below present sea-level and the erosion of the present river channels, again in entrenched meanders.

(*g*) Yolande-Margaret interglacial phase, represented by a third series of terraces, raised beaches, etc., 5-15 feet above present sea-level.

(*h*) Margaret phase, during which the existing river courses were eroded. Data as to the depth to which the main channels were cut in the Yolande-Margaret silts is not forthcoming, but many tributary valleys were deepened 10-25 feet in the most recent delta and terrace silts.

(*i*) Post Margaret phase, represented by a progressive rise in sea-level, resulting in the silting up again of estuaries and bays and the drowning of certain lower tributaries.

All search in this area fails to disclose evidence of the missing fourth glacial phase. I still regard it as possible that land movements during the early Pleistocene have obscured records of such a phase here as well as in the glaciated areas. Otherwise, Southern Tasmania appears to have been a stable area since Malannan times.

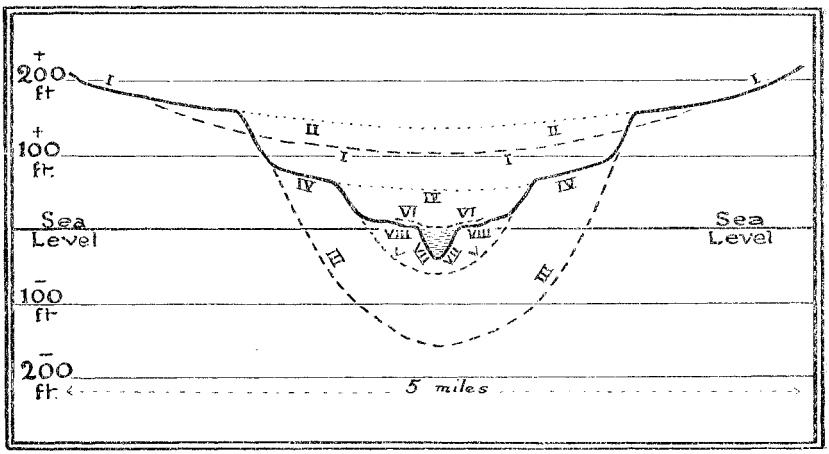

Fig. 1.—Generalized diagram, adapted from Derwent Valley features, illustrating comparative movements of strand-level with erosion and deposition features.

I—Late Tertiary valley.
II—Pre-Malannan silts.
III—Malannan trough.
IV—Malannan-Yolande silts.
V—Yolande trough.
VI—Yolande-Margaret silts.
VII—Margaret trough.
VIII—Post-Margaret silts.

The Derwent Valley

The pre-Malannan valley floor may be traced by remnants of consolidated clays, sands, and conglomerates standing at the fairly regular height of 50-100 feet above present sea-level. These are marked by the predominance of pebbles of quartzite and early Palaeozoic rocks, with an almost entire absence of dolerite pebbles. They are to be seen at Millbrook Rise, just below New Norfolk, and at several points on the northern bank of the river between the Rocks and Dromedary. They cap basalt flows between Bridgewater and Herds-

man's Cove, and are to be found about a mile east of Old Beach post-office. They occur at Claremont, Glenorchy, and Lindisfarne. The regularity, both petrographically and physiographically, of these remnants indicates that they were once part of a continuous plain. They could not have been deposited under existing conditions.

The river, evidently flowing in gentle curving meanders, cut into these deposits to a depth of about 200 feet, as is shown by borings at Risdon and Cornelian Point. (See Journals and Papers of Parliament, Vol. CXIX, No. 2, and Text figs. 3 and 4.) It would be impossible for this trough to have been eroded as it is to a depth of 150 feet below sea-level unless the strand line had dropped to this extent. The information supplied by these bores is conclusive. The general physiography of the valley indicates that the trough was eroded

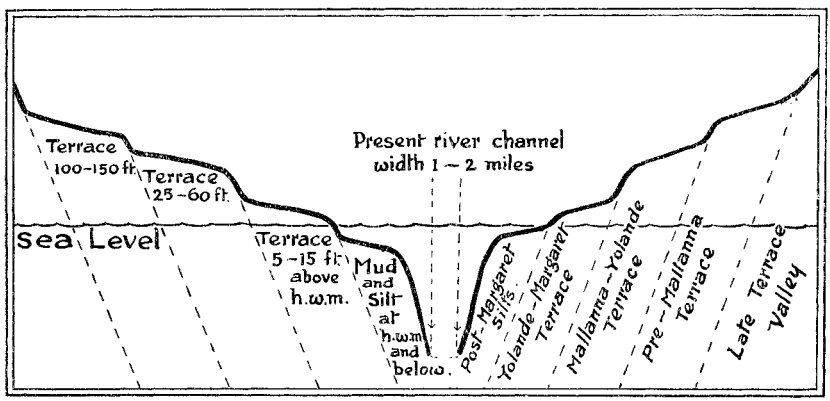

Fig. 2.—Diagram showing succession of terraces and periods of deposition.

subsequently to the deposits here termed pre-Malannan. It was probably at this period that the otherwise strange cliffs at the Rocks and Bedlam Walls were formed. The river clearly entrenched itself in pre-existing meanders in no clear relationship to the present minor details of the valley topography. Tributary valleys show a corresponding deepening—particularly the larger ones, such as the Lachlan and Jordan.

The subsequent rise of strand-level produced newer river conglomerates, which outcrop along the road from Granton to New Norfolk and elsewhere on both sides of the Derwent. Tributary valleys were drowned to a height of 30 feet or so, and deltas were formed in them. This newer conglomerate consists almost entirely of dolerite and Permo-Carboniferous mudstone pebbles. In some places it is clearly hill wash and the product of small hill streams, but is roughly stratified at a height well above where it could lodge under present conditions. In the majority of localities, however, the evidence

of well-worn pebbles and a considerable degree of stratification points to a deposition by the main river of materials brought from a considerable distance. These deposits have often been considerably eroded, and sometimes stand as the divide between more modern stream courses. The Malannan trough largely (perhaps entirely) silted up during this phase.

The next phase corresponds with the Yolande glaciation. The actual river valley during this phase is now submerged, and data are difficult to obtain, but the erosion of the deposits referable to the previous high-water phase was effected at this time, resulting in the many raised bluffs round which the road from Granton to New Norfolk winds. It also appears to me that the river channel was eroded to a depth of 30-60 feet below present sea-level. This formed virtually the present estuary, on the sides of which the subsequent terraces were deposited.

The Yolande-Margaret interglacial phase gave us the very distinct terraces standing now from high-water mark to 15 feet above high-water mark. The road from Granton to Sorell Creek winds along this terrace, and it is very noticeable under the Rocks where it is followed by the railway. It appears on both sides of Sorell Creek as a distinct separate terrace, and may be traced round the shore of most of the Derwent estuary, noticeably under Bedlam Walls, the cliffs at Lindisfarne, the Bluff at Bellerive, and the cliffs below the Shot Tower. Probably at this time the waters of the estuary extended to the obvious raised shore lines at the heads of several bays, notably at Kingston, where they extended inland to the present road bridge, and at Risdon Cove, where they extended to the old stone bridge or thereabouts.

The features imparted by the Margaret glacial phase of low water are also difficult to decipher except in tributary streams, but from Sorell Creek to the Iron Pot there is a definite old river channel meandering through the drowned estuary floor, a distinct river course to the vicinity of Hobart and then widening out. Its average depth below the general floor of the estuary is 20 feet. It is probably the result of erosion during this period. Throughout the area all streams have cut deep, straight-sided channels some 10 feet deep, or a little more in the newest terraces. This is such a uniform feature, particularly where the Yolande-Margaret terraces are well marked, that it must be due to more than local influences. The small entrenched meanders of such tributaries as the Lachlan, Sorell Creek, Risdon Creek, Kangaroo Rivulet, Rokeby Creek, and Brown's River, through their estuarine deltas of Yolande-Margaret interglacial age, provide the best examples, and the same feature may be seen in every creek and mountain stream through the area.

The last phase has been the steady drowning of the Derwent estuary and the mouths of its tributaries up to New Norfolk. This has resulted in a progressive silting in the course of the main river

above Bridgewater and in the bays below. This silting is quite distinguishable from the previously formed terraces, which it continues but at a slightly lower level.

Two further features deserve passing mention. Across the estuary at its mouth westward from the Iron Pot is a marked bar. This appears to me to be, most probably, the flooded and eroded continua-

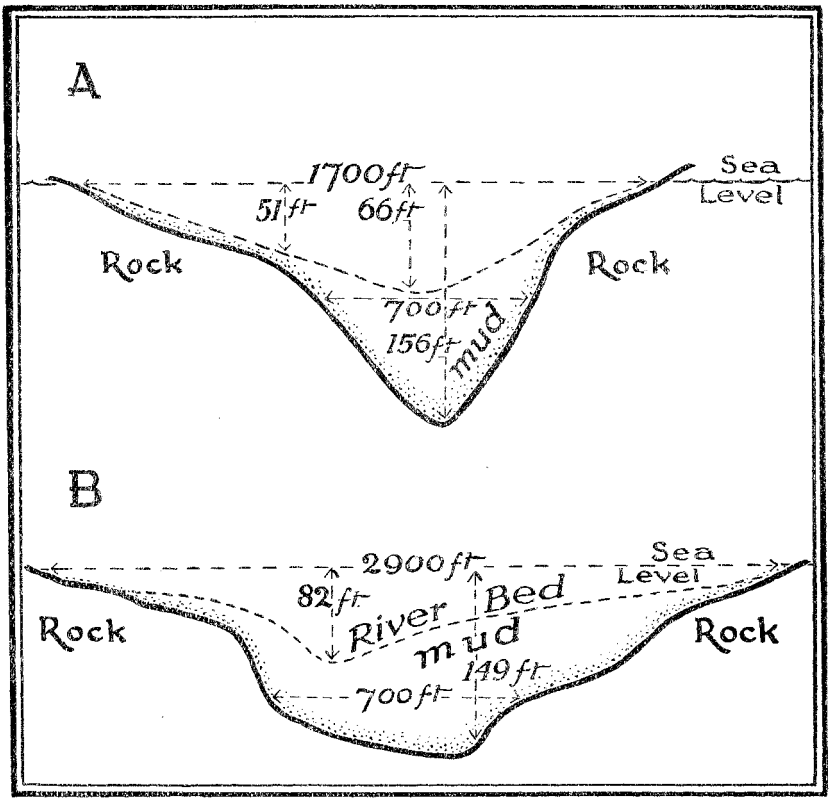

Fig. 3.—Sections through Derwent River (after diagrams in Journ. & Pap. Parlt. Tas. CXIX, No. 2).
A.—at Risdon. B.—at Cornelian Point.

tion of the line of sand dunes that may now be seen forming the connexion between the Sandford Peninsula and South Arm. It seems likely that during the maximum low-water phase of the Malanna period this was the real mouth of the river, and here sea-blown sand dunes accumulated as a bar. Perhaps the bar was complete with the waters of the Derwent passing down D'Entrecasteaux Channel. A

second bar extends from Long Point to the beaches at Bellerive. Long Point is the residual of a line of sand dunes that probably marked the mouth of the river during the Yolande period of low water.

The Coal River - Pittwater Valley

A similar series of features can be traced in this area. The older Tertiary deposits can be seen underlying basalt flows in the valley of the Coal just above Richmond. The pre-Malanna land surface stands at the height of the eroded basalt and over-lying gravels, about 50-100 feet above present sea-level. Subsequent events during the low-water periods are somewhat obscured by the fact that the Coal River does not appear to have eroded to the lowest sea-level, probably owing to its limited flow. During the Malanna phase the mouth of the river was probably in the vicinity of Lewisham, and the extensive sand-dune deposits of some antiquity that form the Milford Peninsula may be referable to this phase. The Coal River cut a considerable channel to an unknown depth south of Richmond, and it, with its tributaries, cut the channel through the present Pittwater. The effects of the second and third periods of high water are clearly decipherable in the double sets of terraces which occur throughout the river valley for several miles above and below Richmond. One, probably the Malanna-Yolande interglacial, was responsible for true raised beaches, which cover Milford, and may now be seen to a height of 20 feet or more on the road to the pine plantations and to a height of 10 feet surrounding Baralla Bay, and also for the line of old sand dunes that extend to the point terminated by Billy's Island, at the present mouth of the Coal River. Seven Mile Beach is a dune formation of new sand blown over older raised beach deposits at the mouth of the river as it stood during the lower water phases. Pittwater is the area of flooded river flats behind the line of dunes marking the true sea-board. The silting of the river mouths consequent on the latest rise in strand-level is most noticeable.

The Huon Valley

In this area older Tertiary deposits of white quartzite gravels and conglomerates are well developed, principally at Huonville and Castle Forbes Bay, where they occur several hundred feet above sea-level. At Ranelagh wharf they outcrop under newer basalt. This basalt appears to have been eroded no lower than 50 feet above present sea-level. The same sequence of newer terraces is discernible—particularly for several miles along the Cygnet-road near Woodstock. The first of the series formed the fertile flats now 5-15 feet above river-level and, probably, Egg Island. The third series can be seen again as more recent silts. As with the other valleys, the successive troughs are difficult to ascertain, but appear to follow a similar succession as those in the Derwent Valley.

The North Coast

R. M. Johnston (1888) has given us the best account of this area yet published. He notes (p. 326) raised beaches, subordinate valleys within the main ones, river terraces, hillocks of consolidated sand dunes, and the oscillation of the strand-level. He records raised beaches at 100 feet above sea-level on Chappell Island (Furneaux Group). The Helicidae Sandstone group, a marine deposit standing at 100 feet above present sea-level on nearly all the islands of Bass Strait, may be definitely correlated with the pre-Malannan deposits of Southern Tasmania. This appears to represent the period of high water that initiated the Pleistocene age. The clay pan deposits underlying the Mowbray and other swamps of the extreme north-west coast, and which are, in places at any rate, composed of compacted deposits of calcareous marine worm-tubes, are also referable to the same period. Similar rocks are common on the Victorian and South Australian coasts.

The succeeding Malanna glacial phase must have left exposed a land bridge between Tasmania and Victoria even if there has been no subsequent subsidence. Johnston notes, although he did not identify, the next or Malanna-Yolande interglacial raised beaches. He states that they are invariably 40-50 feet above the present sea-level, and sometimes extend for a mile inland. To the same phase is referable the marked shore platform that skirts the whole of the north-west coast almost without a break. The towns of Ulverstone, Penguin, and Burnie are built on this platform, and it may be seen very clearly when standing on any coastal eminence. This is merely a wave-cut platform in the localities where spurs jut northward, but in the lower localities, as at Ulverstone and at the mouths of the Forth and Emu, fine sections of stratified conglomerates and raised beaches are exposed.

The final high-water phase (Yolande-Margaret inter-glacial) gave a second terrace, now standing a few feet above high-water mark. This is most noticeable from the Don to some miles westward of the Forth, but it may also be seen in many places round the coast.

The river valleys display terrace features with a general similarity to those in Southern Tasmania. The only published description bearing on this topic is to be found in Sir Edgeworth David's inaugural R. M. Johnston Lecture (David, 1924). The observations therein reported correspond very closely with those I have recorded in this paper from the Derwent Valley. In the next section I mention grounds for supposing a negative movement of the Bassian isthmus since Yolande-Margaret times. This movement is not apparent on the immediate sea-board, although it is reflected in the river valleys.

The segregation of the Pleistocene deposits as stated above provides us with a key to the problem as to the date of the arrival of the Tasmanian aborigines in the island. At present I am not in a position to give a final answer to this problem, and the present paper is intended merely as a starting point for investigations in this direction. In the first place, I think it must be accepted that the race emigrated by a more or less dry-land Bassian bridge. They may have been a preserved residual of a race which had previously spread all over the continent, or they may have been driven across by the superior Australian races. Their condition as described by actual observers indicates that the race was decadent, and they may originally have been able to build better rafts that those seen by the early explorers. Even so, it is very difficult to imagine a primitive people setting out for a land which lay over the horizon, and of the existence of which they must have been entirely ignorant. If they came by boats at all, the strand-line must have been sufficiently lower than it is at present to have allowed them to see the next land ahead, and their boats must have sufficed to have carried a sufficient number of people to maintain the race. From every point of view, the emigration must have occurred when Bass Strait was very different from what it is to-day.

It is clear that the strand-line dropped some 150 feet (25 fathoms) during Malannan times, some 50-60 feet (10 fathoms) during Yolande times, and some 10-25 feet during Margaret times (2-4 fathoms). Reference to the diagrams given by Dr. Fitz Noetling (1911, Plate I) shows that if the Bassian segment has remained at the level at which we see it at the present time, a sufficient land bridge could have only existed during Malannan times, and the subsequent glacial phases would not have lowered the surface of the ocean sufficiently to affect the position materially.

The absence of traces of the fourth ice phase constitutes a difficulty here, but the Malannan phase, which is probably to be correlated with the Mindel of the northern hemisphere or the Ross-Mindel interglacial, cannot be later than the Mindel. The Tasmanian people were a Negrito stock. It seems to be out of the question to suppose that members of this race could have penetrated to Southern Australia in Mindel times. (See Griffith Taylor, 1921, Plate I.) Should this prove to have been the case, it would present a remarkable case of homotaxis, it would indicate the way in which the aborigines crossed to Tasmania, and it would prove that the Bassian isthmus has been stable since Malannan times.

It is necessary to search elsewhere for evidence. As far as I have been able to see, the earliest mirnyongs lie on the raised beaches of the Yolande-Margaret interglacial period. Those I tentatively correlate with the Ross-Worm interglacial stage. It appears to me to be clear from the erosion below present sea-level of many of the

coastal mirnyongs that some of these accumulated prior to the Margaret (Worm) glaciation. A very significant one may be seen on the New Norfolk road near the 13th milstone, and a repetition or continuation on the Bridgewater-Dromedary road a couple of miles from Bridgewater. These consist of shells of open-sea forms. Such molluscs could not exist in the estuary in its present form. They must have been gathered near where they are at present to be seen. They rest on the Yolande-Margaret terrace and are overlain by many feet of soil. It appears to me that the interglacial phases must have been accompanied by dry conditions, resulting in very little fresh water flowing into the estuary. The post-Margaret silts which now fringe the river could not then have existed. The water-level must have been somewhat higher, and the combination of all these factors resulted in a degree of salinity, even above Bridgewater, equal to that in the bays of the open coast. I consider these particular shell middens to have been eroded during the succeeding lower-water phase.

That would place this particular mirnyong in the Yolande-Margaret (Ross-Worm) interglacial phase, and this date corresponds with Griffith Taylor's for the emigration of the Tasmanians into Australia. It also corresponds with the age of the Talgai skull and the Doone flint (David, 1924). Estimates of time differ so greatly amongst various writers that it is difficult to give more than an approximation. Griffith Taylor would put the date, as far as our present knowledge goes, at which the aborigines accumulated the earliest mirnyongs that I have been able to identify at 200,000 years ago (Taylor, 1921). David makes this possibly 150,000 years, and Coleman would appear to date it as a somewhat more recent time in the neighbourhood of 100,000 years (Coleman, 1926). It does not appear to have been possibly later than the latter figure, extraordinary as this may seem.

To date, no shell mounds or flaked stones have been found earlier than the Yolande-Margaret interglacial terraces. The lowering of the sea-level during either the Yolande or the Margaret glacial phases could not have produced a land bridge to Victoria. That being so, the conclusion must be that there has been a negative eustatic movement of the Bassian isthmus since the aborigines emigrated to Tasmania. The evidence points to the fact that they migrated southward during a warm dry period. This indicates the possibility that the driving force may have been climatic, i.e., the southward movement of the central Australian desert belt, with the aborigines following the game which moved with the forest belts. It may have been a desert barrier which divided these people from the dingo-taming Australian races. All the evidence at present to hand therefore points to the separation of Tasmania, subsequent to the arrival of the aborigines, by earth movements across the Bassian land bridge which led to its eventual flooding. This trapped

the aborigines here during the Margaret ice age. It is probable that at the time of their advent the fauna was somewhat different and more plentiful, and the rigorous conditions of the last phase of the ice age resulted in a steady deterioration of the race.

The gelogical evidence all points to a recent slight sinking or sagging of the Bassian terrain. It is a recognised modern earthquake zone, from which minor tremors are frequently reported. Also, the very marked rejuvenation of the rivers emptying into the Strait points to a recent subsidence rather than a post-glacial flooding. The problem of the date of the advent of the aborigines into Tasmania is so intimately connected with the problem of the formation of Bass Strait that the two must be studied together.

Future Study

I have not been able to give close attention to more than a small fraction of river valleys and coastal estuaries which provide so rich a terrain for the study of these problems. We have a number of ardent anthropologists who devote much energy to the collection of worked stones from sand blows and middens. I hope I have opened up a new avenue for these workers, and I commend the devotion of some attention to the succession of Pleistocene terraces wherever they occur. A study of the relationship of these terraces to the mirnyongs, to ascertain the lowest gelogical horizon at which human life occurred, must prove more fruitful than the mere collection of specimens of culture, in themselves very uniform. Shell mounds are more likely to produce a key than isolated flints which may have become displaced, but all pebble drifts and terraces should be diligently searched for artifacts, as a vital clue may be found, as in the case of the Doone flint. The shell mounds themselves may be correlated to the phases of the Pleistocene period, and some change in culture may be traced when this correlation has been made. I have said sufficient to indicate a new field for anthropological study.

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EXPLANATION OF PLATES

PLATE VI—

Fig. 1.—Derwent Valley below Sorell Creek. Photo taken from site of pre-Malanna terrace. The second (Malanna-Yolande interglacial) series is visible as the cleared paddock beyond the tree and road in the foreground and by the point beyond the river on left of picture.

The third (Yolande-Margaret interglacial) series is visible as the river flats bordering the river. At this point the river is now affected by tidal influences. Post-Margaret silts line the river below H.W.M., and an old channel 30 feet deep winds through these.

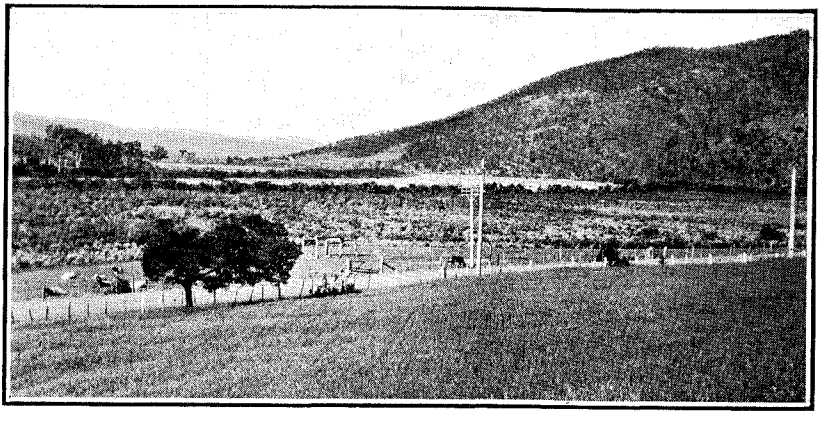
Fig. 2.—Terraces at Burnie, on the North Coast.

The hills in the background represent the old shore-line. The town of Wivenhoe is built on a second terrace, a section of which can be seen at the Emu Bridge in the right centre. A third terrace is visible to the seaward of this in the foreground and also at the termination of the point in the distance.

PLATE VII—Terraces in a tributary valley of the Derwent.

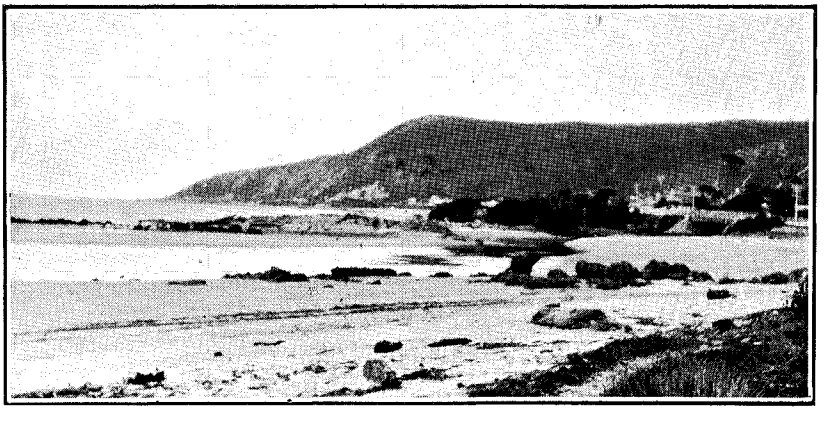
Fig. 1.—In the Lachlan Valley. The Millbrook Rise terrace can be seen under the farm buildings in the left middle distance. The next terrace formed by the silting up of the valley excavated in the Millbrook Rise terrace may be seen in the foreground. The present river has cut a channel in this, as seen in the foreground. The estuary of this channel ¾-mile below where photo taken has now been partly silted up.

Fig. 2.—Typical valley of tributary hill stream. The channel has been cut in the second (Malanna-Yolande) terrace, seen on the sides of the valley. The valley so excavated has been resilted up. In most cases this has again been dissected by recent streams.



[*A. N. Lewis Photo.*

Fig. 1.—Derwent Valley below Sorell Creek.



[*A. N. Lewis Photo.*

Fig. 2.—Terraces at Burnie, N.W. Coast, Tasmania.

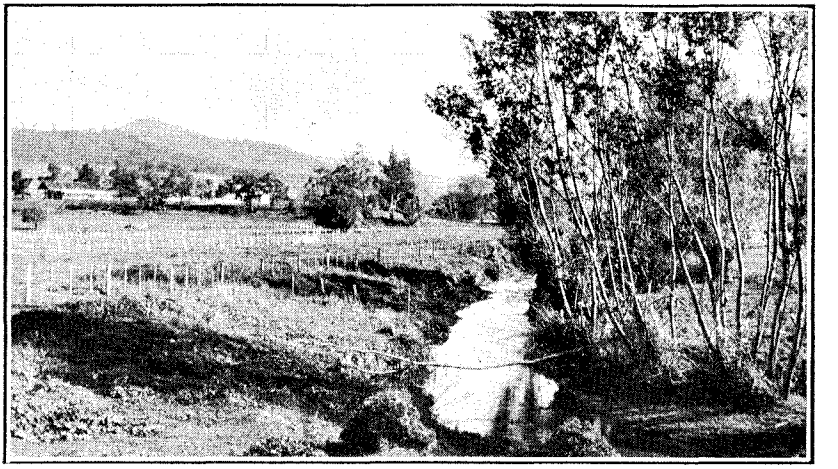


Fig. 1.—Lachlan Valley, New Norfolk. [*A. N. Lewis Photo*

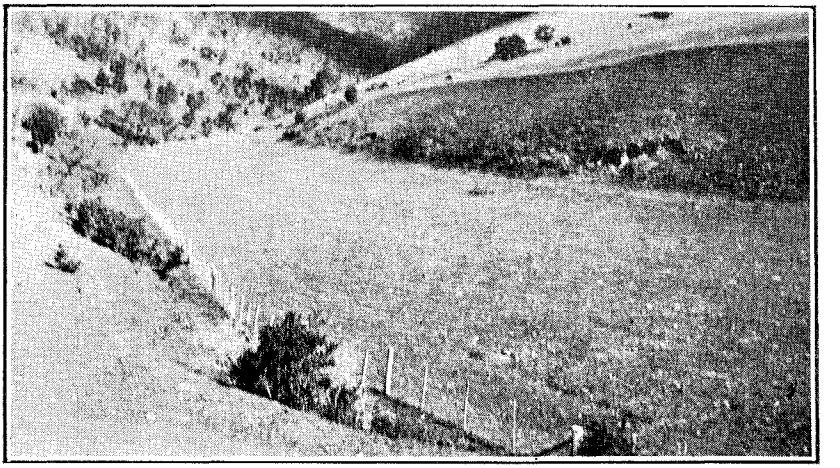


Fig. 2.—Silted Tributary Valley. [*A. N. Lewis Photo*