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B. F. Leach & A. J. Anderson

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# The Transformation from an Estuarine to Lacustrine Environment in the Lower Wairarapa

B. F. Leach and A. J. Anderson
Department of Anthropology, University of Otago



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### *Abstract*

The lower Wairarapa valley, which is now a riverine-lacustrine complex, was a large estuary as late as 3500-4000 years B.P. Vegetation at that time was podocarp forest, as it was in the area at the time of European exploration. The most likely explanation of the change in environment is extensive late Holocene alluviation, although retreat from higher post-glacial sea levels, or local tectonic events, cannot be ruled out as contributing factors.

## Introduction

Although briefly discussed last century by Crawford (1879), the development of the lacustrine complex of the lower Wairarapa valley has subsequently received only spasmodic attention. Crawford considered that Lake Wairarapa had been formed by the scouring action of the prevailing northwest wind. Kite (1952) argued that the area was a shallow arm of Palliser Bay during the Flandrian transgression, which was later cut off from the sea by progradation of the eastern shore, warping, and tilting during the time of falling sea levels. Cotton (1958:197) suggested impounding by alluviation of the Ruamahanga River across the course of the Tauherenikau River, accompanied by or following warping.

Considerable public works have been undertaken over the last five years or so in the lower Wairarapa, to lessen the effects of Ruamahanga flooding; these have revealed details of the most recent sediments on the eastern shore of the lake which suggest that the question of its origin may be profitably re-opened.

During archaeological reconnaissance in the area in January 1969, we learnt from Mr R. Sutherland of Pukio, one of the dredge operators on the main Ruamahanga diversion, of his discovery in several locations of shell remains under lake and river sediments. These were initially investigated because is seemed possible that they might be prehistoric middens. It quickly became clear however, that the deposits in question were *in situ* estuarine shell beds, invariably associated with a bluish marine sand.

Two sites (Figure 1) were investigated in detail in order to examine the possibility that an estuarine environment prevailed in the area during some part of the period of prehistoric human habitation.

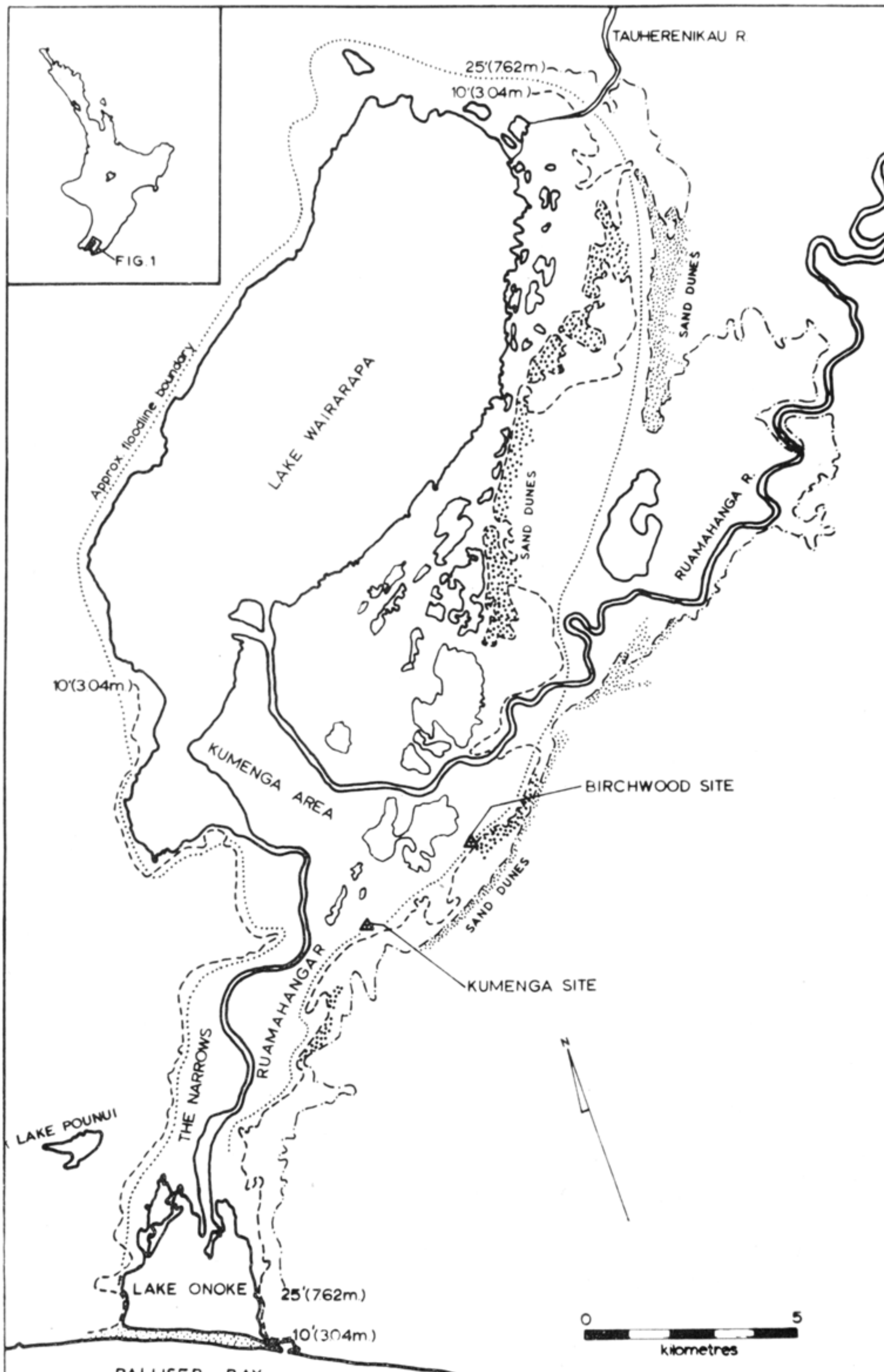


FIG. 1.—Lower Wairarapa Valley.

## STRATIGRAPHY

At each site the uniform stratigraphy was observable for approximately 20 m each side of the typical sections shown in Figure 2. The shell occurred in lenses of slightly variable dimensions, but always at precisely the same level. The two sections (Figure 2) have been drawn with reference to the M.S.L. and M.H.W.S. values for Wellington, which are virtually the same as at Cape Palliser. Both tidal levels are average values for a cycle of approximately 18.6 years (Marine Department, 1971). The height surveying was achieved by theodolite using the Jackson's Bridge benchmark (36.52 m), and the zero line (30.48 m) on the Kumenga Pumping Station gauge. These heights were supplied by Mr P. G. Mahony, Chief Engineer of the Wairarapa Catchment Board. The Board uses a datum of H.W.O.S.T. plus 30.48 m, but in Figure 2 and the following discussion, H.W.O.S.T. has been taken as equivalent to M.H.W.S., and the arbitrary 30.48 m has been subtracted from all calculations.



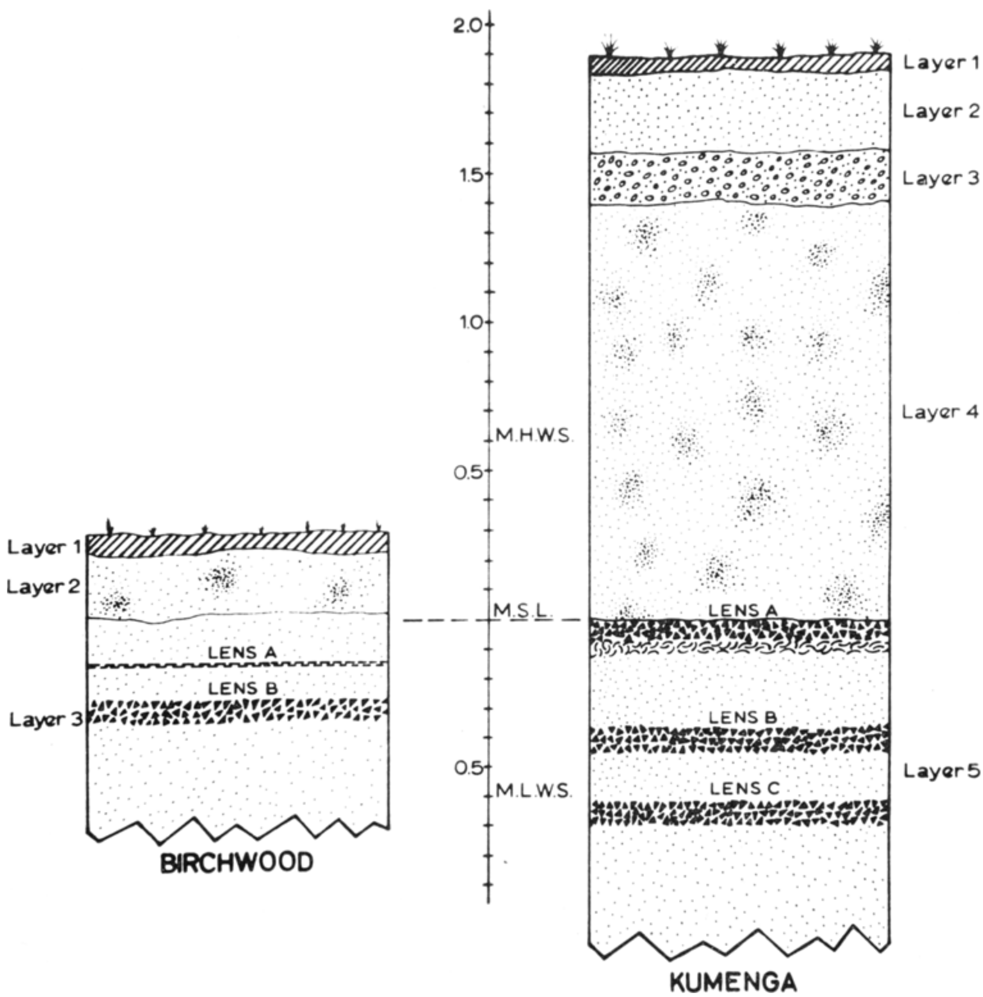


FIG. 2.—Lower Wairarapa Estuarine Shell Beds.

### *Kumenga Site*

This site (Figure 1) has a grid reference of N165/736181 and is close to a large drain in an area reclaimed from the Lake bed during the 1855 earthquake (see below). Little European land development has taken place until recently. Remains of prehistoric human habitation are scattered over consolidated sand dunes 1 km to the southeast of the site. The deposits in the site comprise five major stratigraphic layers (Figure 2):

*Layer 1*: Turf and brown soil (5 cm)
*Layer 2*: Dry grey silt (28 cm)
*Layer 3*: Dry grey silt with alluvial gravels (17 cm)
*Layer 4*: Damp grey silt with brown staining, and finely comminuted carbonaceous material (140 cm)
*Layer 5*: Wet blue-grey fine sands containing 5-10 cm thick lenses of bivalve and gastropod shell (110 cm excavated):
- *Lens A*: Fragmented shell grading into whole individuals; fragmented plant material throughout. At surface of *Layer 5*
- *Lens B*: Fragmented shell, 25 cm below *Lens A*
- *Lens C*: Fragmented shell, 15 cm below *Lens B*

*Birchwood Site*

This site (Figure 1) has a grid reference of N165/773191 and is near a smaller drain about 3 km northeast of the Kumenga site. The area provides few surface clues to the stratigraphy because of post-European land development. A late prehistoric pa site (N.Z. Archaeological Association Site No. N165/20) is situated on consolidated dunes a few hundred metres east of the Birchwood site. Nearby are relic stands of mixed podocarp-hardwood forest. The deposits in the site comprise three major stratigraphical layers (Figure 2):

*Layer 1*: Turf and brown soil (6 cm)
*Layer 2*: Damp grey silt with much brown staining (22 cm)
*Layer 3*: Wet blue-grey fine sands containing two lenses of organic material (85 cm excavated):
- *Lens A*: Silty sand with brown ligneous staining (1 cm thick), 15 cm below surface of *Layer 3*
- *Lens B*: Dense layer of shells (5-10 cm thick) in varying states of fragmentation, 11 cm below *Lens A*

## MOLLUSCAN FAUNA

There was very little difference among the shell lenses in species composition, except that gastropods were more common in the Birchwood site. The dominant species in all deposits was *Mactra ovata*. The species identified are as follows (systematic names are according to Powell 1961):

| | |
|---|---|
| *Amphidesma australe* | Very few specimens, mostly juvenile. Single valves only. |
| *Chione stutchburyi* | Only rare single valves. |
| *Mactra ovata* | Great quantities of both fragmented and paired valves. Numbers of prodissoconch valves were also found. |
| *Amphibola crenata* | Relatively rare, but full size range is represented. |
| *Potamopyrgus corolla* | Abundant in all contexts. |
| *Potamopyrgus antipodum* | Abundant in all contexts. |
| *Melanopsis* (*Zemalanopsis*) *trifasciata* | Quite common, but much fewer than *Potamopyrgus* sp. |
| *Modiolus fluviatilis* | Rare juvenile specimens. |

The faunal assemblage is typical of estuarine areas from about the mid-tide to low-water level. There appear to be several derived elements, which is usual in such localities, and these are represented by probably all but the *Mactra ovata, Potamopyrgus,* and *Melanopsis* species.

The latter two shellfish are commonly found in brackish areas, especially near stream mouths (Morton and Miller 1968:402) and, along with *Mactra ovata,* are usually associated with a silty substrate. In this case, however, the sediments are somewhat coarser than usual. In both *Lens A* at Kumenga, and *Lens B* at

Birchwood, the state of preservation of the shellfish was noticeably good. The periostracum of the *Potamopyrgus* and *Melanopsis* species was almost completely intact, and in the case of *Mactra ovata,* stains remained where the shrivelled organism had adhered during decomposition. In *Lens A* at Kumenga there were many " closed pairs " of *Mactra ovata.* The bivalves appeared to be in life position, suggesting a sudden death. Additional evidence of rapid mortality is suggested by the fact that the small gastropods had not filled with sediments in any of the lenses.

## RADIOCARBON DATING

Two samples of mixed molluscan species from the upper and lower fractions of *Lens A* at Kumenga were submitted for radiocarbon dating to the D.S.I.R., Wellington. The results are as follows:

| | | | |
|---|---|---|---|
| Kumenga Upper *Lens A* | (N165/736181) | NZ1634 | 3470 ± 50 yr B.P. |
| Kumenga Lower *Lens A* | (N165/736181) | NZ1635 | 4120 ± 50 yr B.P. |



## FLORAL COMPONENTS

Considerable quantities of plant material—leaves, seeds, wood fragments, and branchlets—were found amongst the shell in *Lens A* at Kumenga. The association of plant material with calcareous remains is somewhat surprising, because in general acid soils are required for such preservation and shells might be expected to reduce the acidity level. The pH of each layer was therefore measured, using the method outlined by Metson (1961:21). It was found that all the layers at Kumenga were remarkably acid, increasingly so with depth. *Lens A,* however, was slightly less acid, perhaps due to the neutralising effect of calcium carbonate. The pH levels are as follows:

*Layer 2*: 4.8 ± 0.2
*Layer 3*: 4.1 ± 0.2
*Layer 4*: 2.9 ± 0.2
*Layer 5*: 3.2 ± 0.2 (sample near *Lens A*)

The following species of plants were identified (systematic names are according to Allan 1961; and Moore and Edgar 1970):

*Seeds*: *Podocarpus ferrugineus*
*Podocarpus spicatus*
Cyperaceae sp.

*Wood*: *Podocarpus totara*
*Podocarpus ferrugineus*
*Podocarpus spicatus*
*Dacrydium (?) cupressinum*
*Podocarpus (?) hallii*
*Leptospermum* sp.

*Leaves*: *Nothofagus menziesii*
*Nothofagus solandri* var. *solandri*
*Podocarpus dacrydioides*

The assemblage is strongly indicative of a podocarp forest, although not necessarily in the immediate vicinity. Judging from the present habitat, the remains of *Nothofagus menziesii* and *Podocarpus hallii* were probably water-transported from higher altitudes in the Aorangi Mountains. *Nothofagus solandri* is found in localised dense stands a few kilometres to the east, especially in the Waihora catchment (Wardle 1967:28), and the remains in the site may again have been water-transported. The vegetation at Kumenga today is typical of low-lying swampy areas, and includes *Phormium tenax, Cordyline australis,* and Cyperaceae species; however, extensive podocarp forest was encountered along the eastern shores of Lake Wairarapa by the first European explorers (Fox 1843).

## DISCUSSION

It is clear that the lower Wairarapa has been a swampy lacustrine complex for only a relatively short period in its geological history, and that for an unknown time before 3500-4000 years B.P. a sandy estuarine environment pertained in the area. The presence of podocarp floral components in the estuarine sediments, and the relic podocarp stands in the area today, suggest that there has been considerable continuity in forest type during the last 4000 years.

The events which effected an environmental change some four millennia ago cannot be easily discerned in the evidence presented here. However, the postulation of a higher sea level in post-glacial times to account for similar circumstances in other areas of New Zealand, and evidence of recent and perhaps continuing tectonism in the Wairarapa region, suggests that these factors need to be considered in the present context.

### *Higher Post-Glacial Sea Levels*

Coastal features considered as evidence of a post-glacial sea level higher than that today have been described from a number of localities in New Zealand (Turner and Bartrum 1929; Brothers 1954; Stevens 1956; Schofield 1960; Te Punga 1962; Wellman 1962; Fleming 1965; Kear and Waterhouse 1971). On two major counts, however—the magnitude of the hypothesised rise above current levels, and the time of this event—the evidence is far from conclusive. Few areas in New Zealand have been tectonically stable for the last 7000 years, and features held as representing a higher post-glacial sea level are consequently between 0.61 and 5.18 m above the present level. A lack of accurate information regarding height differentials between postulated post-glacial maximum levels and precisely located modern tidal data, and insufficient attention to precisely where in the post-glacial maximum tidal range a particular level would lie, further complicate the issue. Thus, although there is a concentration of estimates suggesting a maximum level of 2.44–3.66 m above the present level, these lie outside the directly dated and precisely surveyed Miranda Traverse maximum level of +2.13 m (Schofield 1960).

Chronological evidence, with the exception of Schofield's, is also fragmentary and complicated by earth movements. Stevens (1956), for example, used C-14 dates obtained from fossil wood 5.18 m below the surface which he considered a post-glacial maximum level; and Kear and Waterhouse (1971) tentatively dated the Waihi Beach Surface by reference to Schofield's (1960) dates.

Outside New Zealand there is mounting evidence against the hypothesis of a higher post-glacial sea level. This is particularly suggested from the investigations on the tectonically stable "dipstick" islands of Micronesia (Shepard *et al.* 1967; time before 3500-4000 years B.P. a sandy estuarine environment pertained in the area. Curray *et al.* 1970; Newell and Bloom 1970; Bloom 1971), and also along the eastern seaboard of Australia (Thom *et al.* 1972). The hypothesis cannot be rejected however, as there is some recent evidence in its favour also (Schofield 1970; Gill and Hopley 1972), but until the issue is satisfactorily resolved, considerable caution is clearly required in ascribing suggestive coastal features to recent eustatic events.

At both Kumenga and the Birchwood sites the surface of the marine sand is at about present M.S.L., and the molluscan fauna contained in this sand consequently is situated from about the present half-tide mark down. Had there been a higher sea level about 4000 years B.P., and assuming no tectonic complications in the interval, it might be expected that the marine sand and shell would extend perhaps another 2–3 m higher up the section. Similarly, although the dune lines (Figure 1) probably mark stages in the recession of the estuarine level, this need not be taken as evidence of eustatism. The level of the base of the dunes, relative to sea level, is now obscured by fluviatile and lacustrine sediments deposited during seasonal flooding which has been characteristic of Lake Wairarapa since the formation of the Lake Onoke sand bar (Kite 1952). Until such stratigraphical evidence is obtained, the possibility that the dunes are related to changes in tidal range, as the estuary entrance became progressively restricted, for example, must remain.

*Recent Tectonism*

Late Holocene tectonic activity on the Wairarapa coast has recently been discussed by Wellman (1969; 1971a; 1971b) and Singh (1971). The uplifts which have been inferred at Cape Turakirae at least, appear to have been abrupt, and probably related to earthquake activity (Stevens 1969), although the chronology of these events has recently been questioned by Suggate and Lensen (1973). Between Cape Turakirae and the lower Wairarapa valley is a major faultline which was active during the 1855 A.D. earthquake. Only minor movements associated with this event appear to have occurred in the valley itself (see Iorns 1932; Lyell 1867; Ongley 1943; Taylor 1855:471–2; Vella 1963; Vennell 1891), and with the exception of the Kumenga area, these seem to have been largely confined to locations further north near Masterton.

A minor uplift may have been all that was required however, to effect the final transition from an estuarine to lacustrine environment, since the average level of Lake Wairarapa is only some 1.2–1.5 m above present M.S.L. (Gardiner 1944; Vella 1963). From the tortuous debate which occurred between 1853 and 1890 (MacKay 1891) concerning ownership of land holdings on the lake margins, it is clear that just such an event occurred, but on a small scale—the Kumenga area was raised from below the lake at the time of the 1855 earthquake. It is not possible to gauge the magnitude of this uplift, but as the lake is exceedingly shallow it could have been as little as 0.2–0.3 m.

The correspondence of the upper surface of the marine sand in the Kumenga and Birchwood sections again suggests that no significant nett uplift has occurred since 4000 years B.P., although the fact that both sections are close to the general area affected by the 1855 earthquake may indicate that the surface of the marine sand was slightly below M.S.L. before then.

## CONCLUSION

Two sites on the eastern shore of Lake Wairarapa support Kite's contention (1952) that the lower Wairarapa was an estuary until fairly recently. Radiocarbon dates for two samples from the Kumenga site indicate that estuarine conditions persisted until about 3500-4000 years B.P., after which extensive fluviatile and lacustrine sedimentation is apparent. The disposition of shell remains in *Lens A* of the marine sand layer at Kumenga, in attitudes indicating sudden death, suggests that the final events of the transition in environment were rapid. No significant changes in forest type however are indicated by comparison of plant remains in the Kumenga site with nineteenth-century flora.

Coincidence of the surface of the estuarine sediments in the Kumenga and Birchwood sites with present M.S.L. suggests that neither retreat from a higher post-glacial sea level, nor tectonic uplift, in the last 4000 years need be invoked to explain the environmental change in the Lake Wairarapa area.

Since extensive alluviation is indisputable in the area, the simplest explanation may be as follows: progradation, possibly following or accompanied by warping and tilting, progressively narrowed the seaward end of the Lake Wairarapa area. As this occurred, changes in tidal range caused the retreat of the estuary shore from the outer dune line to a lower high water mark, where a second line developed. Continuing progradation and development of bay bars in the Narrows area constricted the sea entrance until a sufficiently severe episode of freshwater flooding, sedimentation, and bar development, was able to effect the closure of the Narrows, and a consequent transformation from estuarine to lacustrine conditions. Subsequent sedimentation has raised the floor level and restricted the area of the lake, at the same time raising the level of the lake margins.

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B. F. LEACH
A. J. ANDERSON
Department of Anthropology
University of Otago
P.O. Box 56
Dunedin
New Zealand