JCR NECROLOGY

Joe Jennings

1916-1984

Geomorphologist Par Excellence

INTRODUCTION

Joseph Newell Jennings, affectionately known to all who knew him as Joe, died of a heart attack whilst skiing on 24 August 1984. His longtime colleague Oscar Spat noted at the time of Joe's death, that no manner of death could be more fitting for a man whose life for 30 years was devoted to the study and enjoyment of the Australian environment.

In this paper I wish to pay a personal tribute to Joe, not only as a scholar and gentleman who greatly influenced my own career, but also as a coastal scientist.

J.N. Jennings was born in Yorkshire and graduated from Cambridge University (St. Catherine's College) with first class honours in Geography in 1938. He started his graduate research in the Botany School at Cambridge, but the war interrupted his Ph.D program. In 1946 he joined the Geography Department at Leicester University proceeding to Australia in early 1953 to the position of Reader in Geomorphology in the newly established Research School of Pacific Studies, at the Australian National University, Canberra. His title was later changed to Professorial Fellow, and he became a foundation member of the Department of Biogeography and Geomorphology. This is a research department without undergraduated, but enjoying an enriching throughput of graduate scholars and post-doctoral fellows. He retired in 1977, "to make way for a younger man," but remained an active Visiting Fellow in the Department until his death.

Joe went up to Cambridge in 1935 with a dominant interest in human geography but, once there, he rapidly developed a life-long interest in physical geography. His great passion was geomorphology, firstly glacial geomorphology as a member of the Cambridge East Iceland Expedition of 1937.

> That expedition fermented my interest in glaciers and snow, attractively coupling with my love for mountaineering and rock climbing so that in 1938 I could not resist the invitation to go as glaciologist on the Imperial College of Science Expedition to Jan Mayen, a volcanic island nearer to Greenland than anywhere else but in fact isolated in the middle of the Norwegian Sea. (Jennings, 1978, p.9-10).

The adventurous spirit of Joe can be visualised from this quotation. No part of the world was too remote or uninteresting to warrent an analysis of its "natural" geography. In later years, he was to visit many parts of the globe, and in Australia, in particular, bring to that scientifically little known country tremendous skill, energy and comprehension of landform genesis.

Although his initial field research was in glacial geomorphology, and his Ph.D research involved coastal stratigraphy and pollen analysis (see below), his most abiding passion was the study of karst landscapes and caves.

> In the last decade, I have put greater effort into the study of limestone country, than into anything else. This interest goes back to my first year at high school when my class were taken into a cave with a 24 metre waterfall in it and to see it all one had to get quite close to it. (Jennings, 1978, p.17).

Alfred Steers at Cambridge thwarted Joe's desire to do as Ph.D on a Yorkshire karst area; he encouraged Joe to tackle the Norfolk Broads.

> (However) when I came to Australia I started caving with the Canberra Speleological

> Society purely for sport. Soon I was writing about karst out of my private trips. In 1959 I began including some work of this kind in my University research and now for some years, I have been trying to contract my efforts to that geomorphic domain alone (Jennings, 1978, p.17).

His success is embodied in his reference book on karst (JENNINGS, 1971) soon to be reprinted.

Although perhaps best known for his karst research, especially in North America, Joe's long-standing interest in glacial, periglacial, eolian, denudation and coastal geomorphology continued in Australia and has resulted in many significant publications (see JENNINGS, 1978, for a list of his works up to June, 1978). Other colleagues will be writing on his broader contribution. The invitation to write this paper provides me with an opportunity to concentrate on his coastal work, some of which has been published in relatively obscure journals (see bibliography of coastal works at the end of the paper).

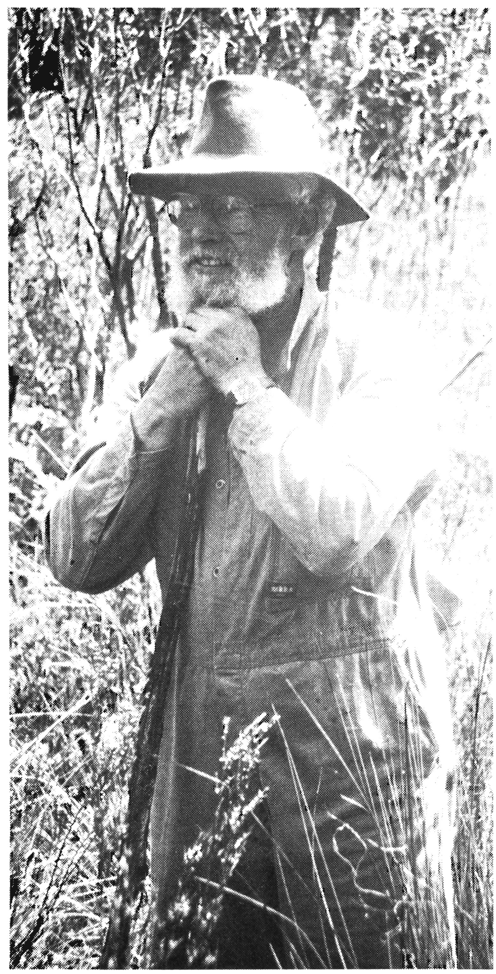
THE BROADS

When I first arrived in the USA in 1962, I was surprised to find that whenever Joe Jennings' name was mentioned, a smirk appeared on people's faces. Those who knew of his Norfolk research were aware of the title of his "Making of the Broads" monograph if not the content. Joe later commented:

> Professor George Dury was visiting the U.S. Geological Survey at the time of the publication of the new book and he told me that the title was a decided asset in a review seminar he gave there. The unfortunate thing was that I was not able to get to the U.S.A. for a long time after, too late to be received as a kind of 'scientist Don Juan' (Jennings, 1978, p.9).

In the year before World War II, Joe planned what he termed a "manifold attack on the problem of the Broads" involving drilling (mainly with a Hiller auger), pollen analysis, and a study of early cartography and historical literature. The Broads are shallow lakes in alluvial valleys along the East Anglican coast of Britain (Figure 1). He quickly showed that the lakes were surrounded by peat. Estuarine clays occurred on the seaward end of the valleys overlying the peat and in places overlain by it.

> So by the time I volunteered and took the King's shilling, I thought I had the essence of the origin of the Broads in that they were like drained lakes of the southern Fenland, *i.e.* peatland, whereas on the seaward side lay siltland built higher by tidal waters in Roman times (Jennings, 1978, p.4; see also Jennings, 1952, and Jennings and Lambert, 1951a).



J.N. Jennings at Fraser Island, Queensland, May 1984 (kindly supplied by Mrs. Betty Jennings).

What follows in the post-war period is a remarkable and intriguing story of multi-disciplinary research, involving new evidence based on more closely spaced drilling and ecological survey, on historical data and archeology, and on an ability on the part of all concerned, Joe in particular, to accept that early findings were wrong (JENNINGS, 1952; JENNINGS

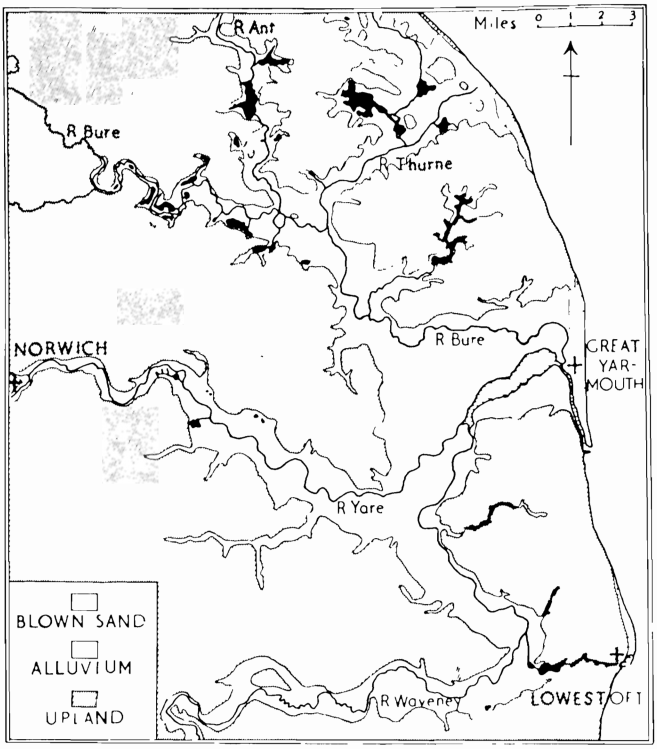


Figure 1. General map of the region of the Norfolk Broads, England, showing the location of the broads in black (From JENNINGS and LAMBERT, 1951a, Figure 1).

and LAMBERT, 1953). A new hypothesis had to be accepted (LAMBERT *et al.*, 1960).

> ... the Broads were made by men between the Viking invasions of the Tenth Century and the close of the Fourteenth Century, a thousand million cubic feet of peat being removed in the process (Jennings, 1978, p.7) ... So a problem in physical geography had transformed itself into largely one in human geography (p.8).

However, there was no doubting the role of marine transgression and regressions in the sedimentation of these low-gradient coastal valleys. A later Holocene transgression of Early Iron Age/Romano British times had deposited a "barrier of clay." Tongues of this clay blocked the mouths of small side valleys and formed estuarine levees in the main valleys adjacent to tidal channels. Thus in roman times a more open estuary existed behind Yarmouth. This was followed by the Saxon-Norman regression which encouraged peat growth and aided those involved in digging of peat in the valleys. The great flood of 1287 heralded a rise in water level in the valleys and helped put a stop to peat excavation.

> The pattern of clay and peat, which I first thought showed the lakes to be the result of natural depositional forces under control of river and tide, now was seen to have exerted a control on the distribution of a particular economic activity and through that only, on the resulting lake pattern (Jennings, 1978, p.8).

It was the Broads study which endeared Joe to R.J. Russell of Louisiana State University. Russell saw Jennings as a kindred spirit, one who appreciated the need to drill and study stratigraphy of alluvial and coastal sediments in order to unravel the historical geomorphology of a region.

COASTAL RESEARCH IN AUSTRALIA

One of Joe's dearest colleagues at Cambridge was the late Vaughan Lewis. In Britain, both Lewis and Steers had produced several papers demonstrating the role of wave action as the prime factor in constructional work on coasts (see LEWIS, 1931, 1938). Yet, ocean currents not waves were given pride of place by many Australians at the time of Joe's arrival.

> This difference probably arises from the lack of much attention to this field of study in Australia, rather than from any real divergence of enquiry (Jennings, 1955, p.36).

What Joe did was to explore, using maps, the application of Lewis's principle that there is a tendency for coastal constructional features to be fashioned to face the direction of approach of the dominant waves. Emphasis was placed on the role of storm waves which build beach ridges and play the "vital part" in the construction of spits, bay bars and offshore bars (*ibid*, p.37). Numerous examples were cited, including cuspate forelands on Bougainville Island, and "Zeta Curve" or asymmetrical bays common along the New South Wales coast. He criticized the circulating ocean current eddy hypothesis of Halligan stating:

> ... this view must be replaced by the interpretation of the Zeta curve as an extension of partial adjustment of the beach to the approach of the most frequent storm waves (Jennings, 1955, p.43).

To a large degree, this paper stimulated the work in the late 1950's by another British migrant coastal scientist, Jack Davies, who was based in Tasmania. Joe quickly appreciated that his emphasis placed on storm waves was perhaps too great when Davis published his seminal papers on the role of swell waves in transporting sand offshore, and in the moulding of the plan form of the beach to fit swell wave refraction patterns (DAVIES, 1957, 1960). Joe showed immense respect for Jack's ability to comprehend the difference between environmental conditions in the northern hemisphere compared to those of the southern, and in the ways those conditions manifested themselves in producing different morphological patterns on coasts (see DAVIES, 1972).

With one exception (JENNINGS and COVENTRY, 1973), Joe steered clear of wave processes and depositional landforms in subsequent years. Instead he first tackled problems of eolian sand transport, dune morphology, dune lake development and relative sea level change. The focus of his attention in the late 1950's was King Island, Bass Strait. In 1959 he published one of the most comprehensive regional coastal geomorphology studies ever produced in Australia (JENNINGS, 1959a). Just as the detailed studies by Fairbridge opened the way for an era of post-war geologic and geomorphic research in Western Australia (*e.g.* FAIRBRIDGE, 1948; LOGAN *et al.*, 1970), I consider that his King Island work highlighted past deficiencies in coastal research in eastern Australia, and showed what could be done by systematic field work. Modern geomorphology came of age in Australia with this study. There were also papers on coastal dunes and lakes published in *Geographical Journal* (JENNINGS, 1957a, b), a study of the submerged terrain of Bass Strait which was of value to later oil exploration (JENNINGS, 1959b), and a synthesis of sea-land change on King Island in a volume edited by Russell (JENNINGS, 1961).

All these studies show a meticulous attention to detail, and a concern to understand the sequential nature of landform evolution in the late Quaternary. Figure 2 is an example of one of his maps which clearly portrays the interrelation of eolian, marine and lacustrine landforms at Lavinia Point, King Island. Such maps and detailed levelled cross-sections are used in the JENNINGS (1959a) paper to document the coastal geomorphic history. His experience in the U.K. for multi-disciplinary assistance is demonstrated with several appendices by specialists on plant remains, mollusca and foraminifera. Of interest to me as a student at the time, this paper published his cautious conclusions about sea-level change given my reading of Zeuner and others.

> (There is) a provisional case for regarding the emergence of the Old and New Shorelines as eustatic ... any correlation of the King Island Old Shorelines is *uncertain* (Jennings, 1959a, p.30; my italics).

More recently, his findings of several levels at King Island have provided support for a regional neotectonic history for Bass Strait and Tasmania which is quite distinct from the mainland (see BOWDEN and COLHOUN, 1984).

His studies of coastal dunes, initiated on King Island, were later spread to other parts of Australia and southeast Asia. Three themes were developed: the alignment of parabolic dunes, the emplacement of cliff-top dunes, and the paucity of intertropical dunes. He applied Bagnold's method of determining the sand-shifting capacity of the wind (BAGNOLD,

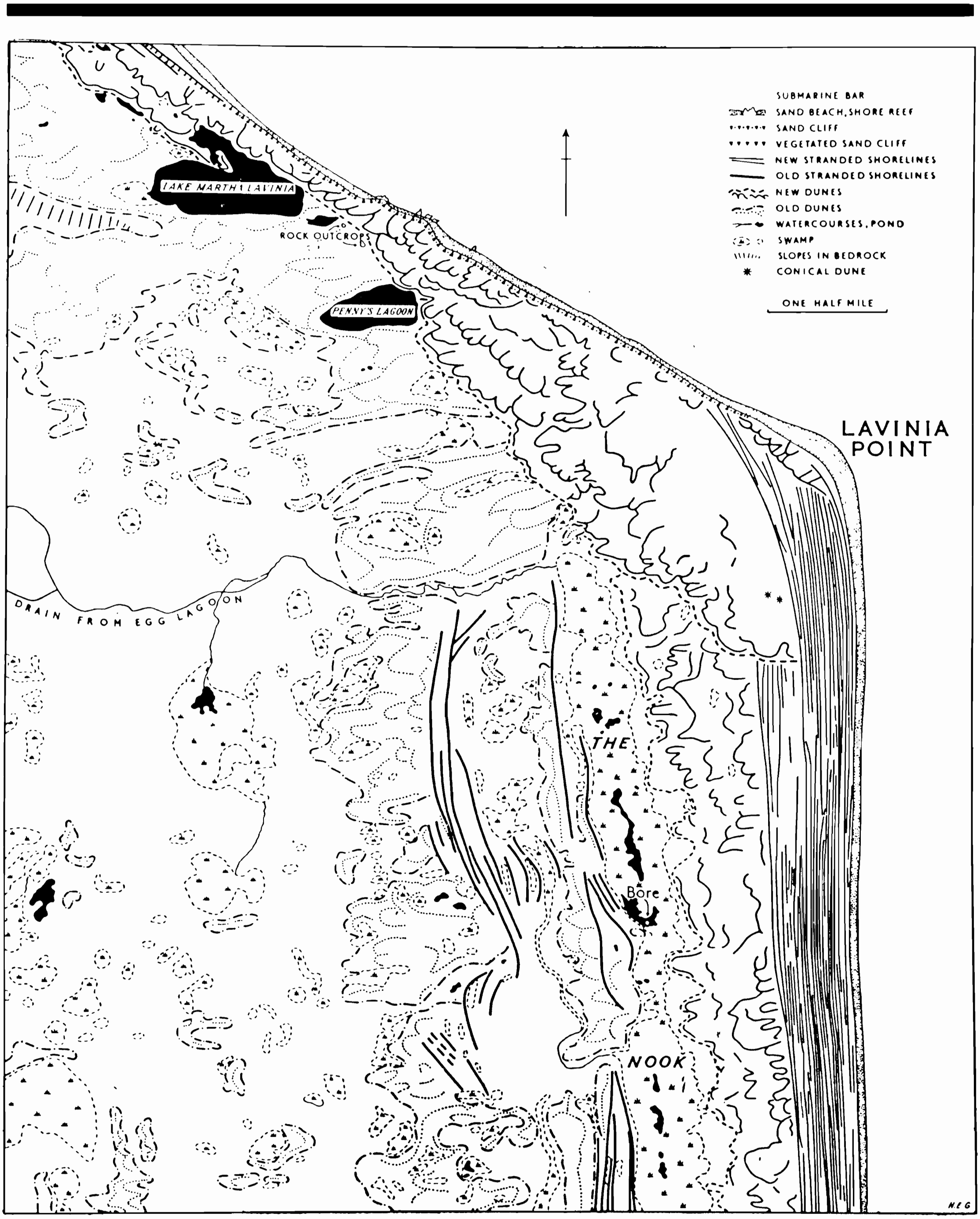


Figure 2. Coastal geomorphology of Lavinia Point, King Island, Tasmania, indicating complex Pleistocene (Old Dunes, Old Shorelines) and Holocene (New Dunes, New Shorelines) landforms (From JENNINGS, 1959a, Figure 6).

as modified by LANDSBERG (1956) to King Island dunes. However, Joe recognized that onshore winds must play a more vital role in coastal dune evolution than offshore ones because of the disposition of the sand source, the beach (JENNINGS, 1957a, p.474). Therefore he further modified the method to take into consideration only onshore winds in the formulation of wind resultants for different parts of King Island. He was able to show a more satisfactory correspondence with dune alignment than was the case if all directions were used.

Cliff-top dunes occur along many parts of the Australian coast. Their mode of emplacement has been a problem addressed by authors since the last century. In 1967, Joe wrote a paper which synthesized much of the literature and used his own observations from King Island and the Nullabor coast of the Great Australian Bight (JENNINGS, 1967a). Figure 3 shows how he conceptualized the various explanations of cliff-top dunes (*ibid*, Figure 1). He concludes:

> When modest negative shifts of sea level have exposed narrow coastal plains in front of these persistent cliff-lines, emplacement of dunes on the tops of emerged cliffs has occurred at localities favourable for this in terms of local aspect and sand-shifting wind directions. This may be the most frequent manner of formation of cliff-top dunes (*ibid*, p.49).

An I.G.U. conference in 1962 provided him with an excellent opportunity to visit the sand barriers or "permatang" of Malaysia. This visit raised the question of the virtual absence of dunes along humid tropical coasts (JENNINGS, 1964, 1965; see also BIRD, 1965). His initial paper was discussed by Bird, and this led to further enquiry by Jennings of climatological conditions along the Australian coast which are conducive to eolian sand transport. This work showed his flair for original thinking and the use of the literature to support his argument. But in conclusion he admitted:

> Thus the paucity of dunes in the humid tropics is complexly derived and calls for more investigation in the overall context of coastal morphogenic systems (Jennings, 1965, p.167).

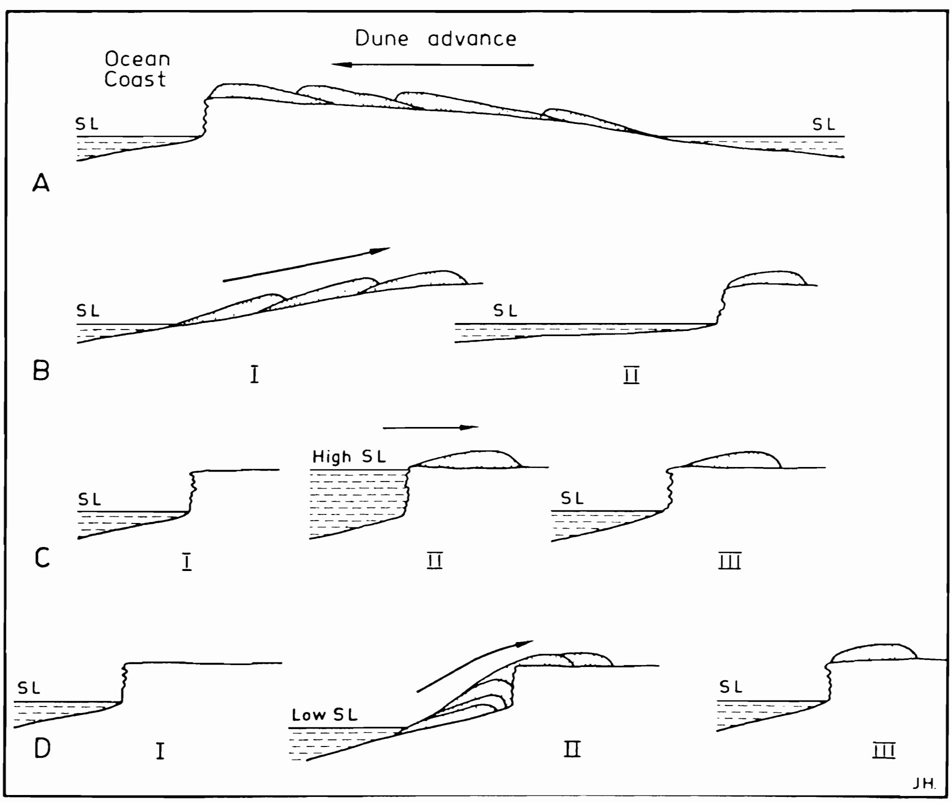


Figure 3. Schemmatic diagram illustrating different explanations of clilff-top dunes (from JENNINGS, 1967a, figure 1).

As with so much of his work, the ideas he floated set in train several other studies including those of DAVIES (1972) and PYE (1983).

Reference to Bird required me to mention another major synthesis contribution in coastal geomorphology of the 1960's. JENNINGS and BIRD (1967) combined to produce a regional account of estuarine environments, landforms and sediments. Their paper was presented at the Jekyl Island, Georgia, Estuarine Conference in 1964. Although descriptive in character, this paper provided one of the first attempts to show how estuaries differ around 30,000 km of coast. In retrospect this was an enormous task, but whenever I read their paper I am always impressed by the insights shown in their understanding of estuarine processes and geomorphic evolution. Again such a study has paved the way for more detailed estuarine research in southern (MARSDEN, 1979), eastern (ROY, 1984) and northern (WOODROFFE *et al.*, 1985) Australia.

Joe was able to relate some of his coastal studies to his karst work. An excellent example was his study of "syngenetic karst" in southwestern Australia (JENNINGS, 1968). Here he addressed problems of "modification morphology" (THOM, 1975) in eolianites. The Nullarbor Plain long fascinated Joe and his regional studies included an account of its coast (see JENNINGS, 1963, Figure 2); see also LOWRY and JENNINGS, 1974).

In the 1970's he finally published studies on estuarine geomorphology which commenced in 1958 in the Fitzroy estuary of Western Australia (Figure 4).

> I was fascinated by this estuary when I first saw it in 1958 because it was so different from the estuarine tracts of northwest Europe that I knew, despite the common dominating factors of interacting river and tidal forces. Yet climate dictates substantial contrasts. Tides are liable to build up sediment on the seaward side and along tidal channels to a higher level than towards the upland. In northwest Europe the hollow land between the uplands and the tidal buildup tends to be filling up with peat as the depressions are in fact created and there are natural freshwater lakes within these peatlands (despite that I had to write about the artificial origins of the Norfolk Broads earlier). In northwest Australia aridity makes the intertidal flats too dry and too saline for organic accumulation, though there are salt marsh communities and grassland communities over parts. Much remains a bare surface of clastic sediment, however. There are shallow lakes between the estuaring levees and the uplands around, most obvious in the dry season when tidal interchanges cease for periods of time and when they can temporarily become salinas. There is limited development of mangrove swamp, and an interesting sideline in that regard is that mangroves were more extensive and more luxuriant from 7-5000 years ago. I have interpreted this as relating to greater rainfall and freshwater flooding of the estuary than now (Jennings, 1978, p.14).

In a sense the Fitzroy work brought Joe full circle in his coastal research. He started in Norfolk with a detailed stratigraphic study, and he finished in Fitzroy estuary with a detailed morphostratigraphic study involving tedious drilling across bare tidal flats.

The geomorphic setting of the Fitzroy estuary leading into King Sound involves relict desert dunes which extend westward from inland across the "drowned valley" of the Fitzroy River. Swales and crests were transgressed by the Postglacial Marine Transgression. The resulting sedimentation pattern (Figure 4) is clearly shown in a block diagram published in *Catena* (JENNINGS, 1975, Figure 15). This is a masterly study of coastal landform evolution, thwarted only by his inability to extract dateable material from beneath a relict desert dune. He recognized the existence of vast mangrove swamps in the semi-arid region of northern Australia in the mid-Holocene; such swamps were quite general as shown by more recent work by Chappell, Woodroffe and Thom on the Ord, Daly and South Alligator rivers. Whether Joe was right in attributing them to increased rainfall is debatable.

Joe's interest in estuarine stratigraphy was only part of his contribution to unravelling changing environmental conditions in this region. He also investigated the role of mangroves in shoreline dynamics (JENNINGS and COVENTRY, 1973), and showed that the seaward mangrove swamps neither protect barrier embankments nor suffer seriously from waves rolling the embankments landward.

CONTRIBUTIONS TO PERSONAL DEVELOPMENT

An appreciation of Joe Jennings would be incomplete without some mention of how much he contributed to the academic development of students and colleagues. I was fortunate to have visited his

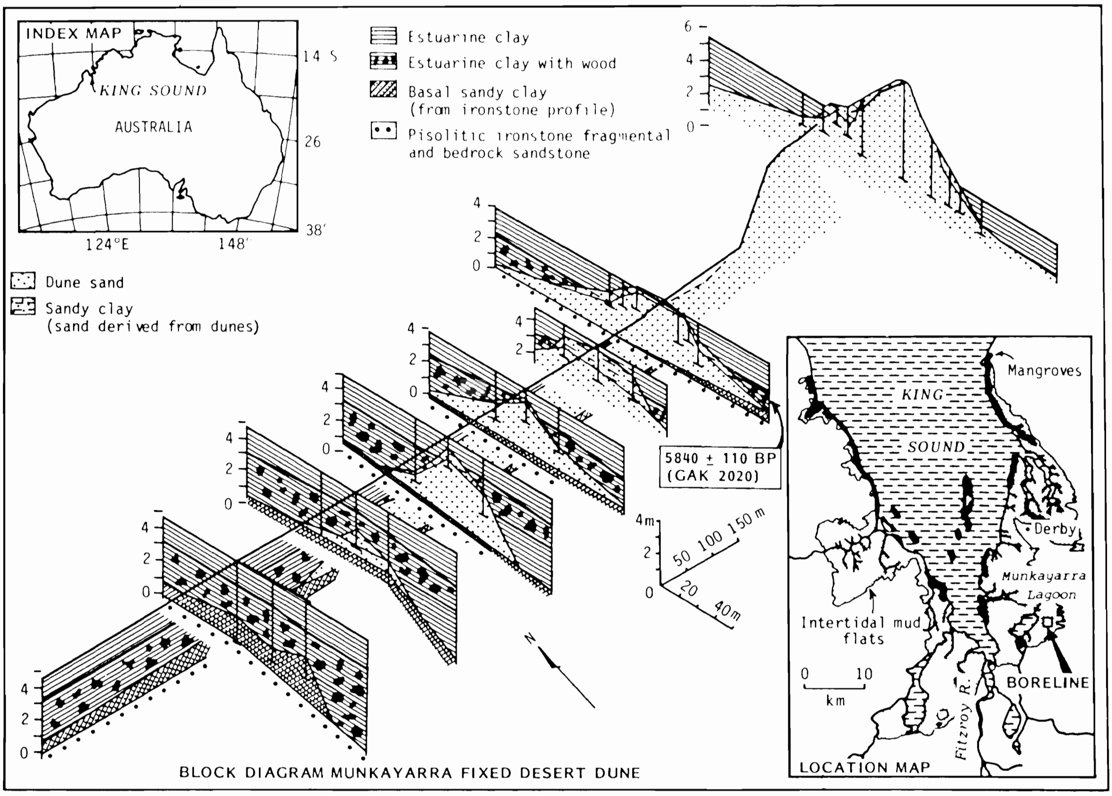


Figure 4. Block diagram of effects of estuarine transgressions on Fitzroy estuary, north-western Australia (from JENNINGS, 1975, Figure 15).

office and travelled with him in the field in both capacities.

Joe must have spent countless hours talking to us, reading our less than competent drafts, replying to letters, and writing letters of reference. How many academics and others owe their present position to the direct efforts of Joe? How many times has he been acknowledged for assisting us by helpful comments on our papers? How many students have been stimulated by his passionate and yet cogently argued lectures? How many colleagues have been excited by his wonderful insights into natural history as they tramped the dunes, plunged down caves, plodded across tidal flats, climbed mountains and hiked over glaciers with Joe? To many he was the epitomy of what the innovative Institute of Advanced studies at the Australian National University might stand for. The debt that we owe him cannot be communicated by words, but I'm sure there are many in Australia, New Zealand, Britain and elsewhere who know what I mean. As Donald Walker put it in an obituary:

> Although meticulous, critical and utterly objective in his science, Joe's major motivations were always emotional. He was immensely generous of his time and advice to all who seriously sought it because he could not bear to see anyone else in need of what he had to give.

SUMMARY OF CONTRIBUTIONS TO SCIENCE

Although I have dwelt mainly on the contributions of Joe Jennings to coastal research and to personal development, I cannot finish this paper without some reference to his broader contribution to science, especially in Australia.

(a) He pioneered systematic geomorphology in Australia, leading by his example of detailed fieldwork coupled with a grasp of the literature which few will ever surpass; he truly is the "father of geomorphology" in Australia.

(b) His infectious, outgoing personality exhibiting enormous patience and friendliness has stimulated students and colleagues to better research.

(c) Joe possessed that high degree of self-criticism and preparedness to accept when he is wrong (*e.g.* Broads and storm wave studies), a model not only for all who knew him, but also for all students who read his works; my own personal experience relates to our joint study of snow patch movement in the Snowy Mountains (COSTIN *et al.*, 1964). He was very sceptical of my findings, but after he independently examined the evidence, he concluded that snow movement can transport pebbles. In a letter to me dated 19 February 1963, he said:

> This last weekend I went up with a party to the Twynam cirque; we had good weather and a fine opportunity really to look at it. I hasten to recant, apologies for my former scepticism and say you are quite right in your interpretation of the abrasion marks and worn rocks. The snow must be moving en masse and moving rocks under considerable pressure.

He later followed up this work with considerable detailed measurement indicating less mass transport than was originally estimated.

(d) He was not one to be moved by fads in science although he readily appreciated the worth of new concepts and techniques. His review of "bandwagons" in geomorphology is a well-balanced account of developments in the science appealing to us to keep a broad perspective.

> So the developments I have briefly outlined can be viewed either as evolving from the Davisian triad of 'structure-process-stage' or as revolutions against it. There is surely only one conclusion to draw, we must weld together morphometry, process study and historical geomorphology and work truly in four dimensions. the Coastal Studies Institute of Louisiana State University is a good model here, no doubt helped by focussing on one geomorphic domain. Even then, because erosion destroys so much of the evidence, most of our answers may have no certainty about them, just varying degrees of probability (Jennings, 1973, p.129).

(e) Last but not least in my view, was his concern that man's geomorphological role in changing the face of the earth was such as to remove from existence all unmodified samples of morphogenetic systems. I can think of no better tribute to Joe than to finish with the following quote:

> To assess these biases it will be vital to retain unmodified samples of morphogenetic systems, whole drainage basins or sectors of coasts, for example, where the processes solely resulting from the relief, climate and vegetation can be carefully measured and analysed. Without such controls, we shall be able neither to understand the past properly nor guide the future intelligently; we shall have to go on, as we have largely done in the past, in 'ignorant disregard of the laws of nature' to use Marsh's phrase. Geomorphology therefore adds a further category of reasons to the long array assembled by conservationists why everywhere adequate samples of surviving ecosystems should be preserved in natural condition of as near as possible to 'wilderness' state. More than most other continents, Australia still has the opportunity to preserve samples of many of her ecosystems. Furthermore, without significant loss in terms of economic production, this country could allow samples of former ecosystems to revert to wilderness conditions in so far as the taxa still survive (Jennings, 1965, p.155).

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Corrigenda

Volume 1, No.2

"Barotropic M_2 tides and tidal currents in Long Island Sound: a numerical model," by A.M. Kenefick.

p. 118, 2nd Col., Para. 1. *For* U and V, *read* u and v.
Eq. (2.2). *For* fu *read* −fu.
2nd Col., Line 30 *For* 10^4 s^{-1} *read* 10^{-4} s^{-1}.
p. 119, Eq. (2.6), (2.7). *For* $-A_V$ *read* $+A_V$.
Eq. (2.6), (2.11). *For* −fU *read* +fU.
p. 120, Eq. (2.14). *For* $h_{i,j-1}$ *read* $h_{i,j+1}$.
p. 122, 2nd Col., Line 10. *For* 48% *read* 4%.