LOST CONTINENT OF PACIFICA

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> The whole Extent of this Prince's Dominions reacheth about six thousand Miles in length, and from three to five in Breadth. From whence I cannot but conclude that our Geographers of Europe are in great Error, by supposing nothing but Sea between Japan and California...'
> [Jonathan Swift, Gulliver's Travels, Part II Chapter 4].

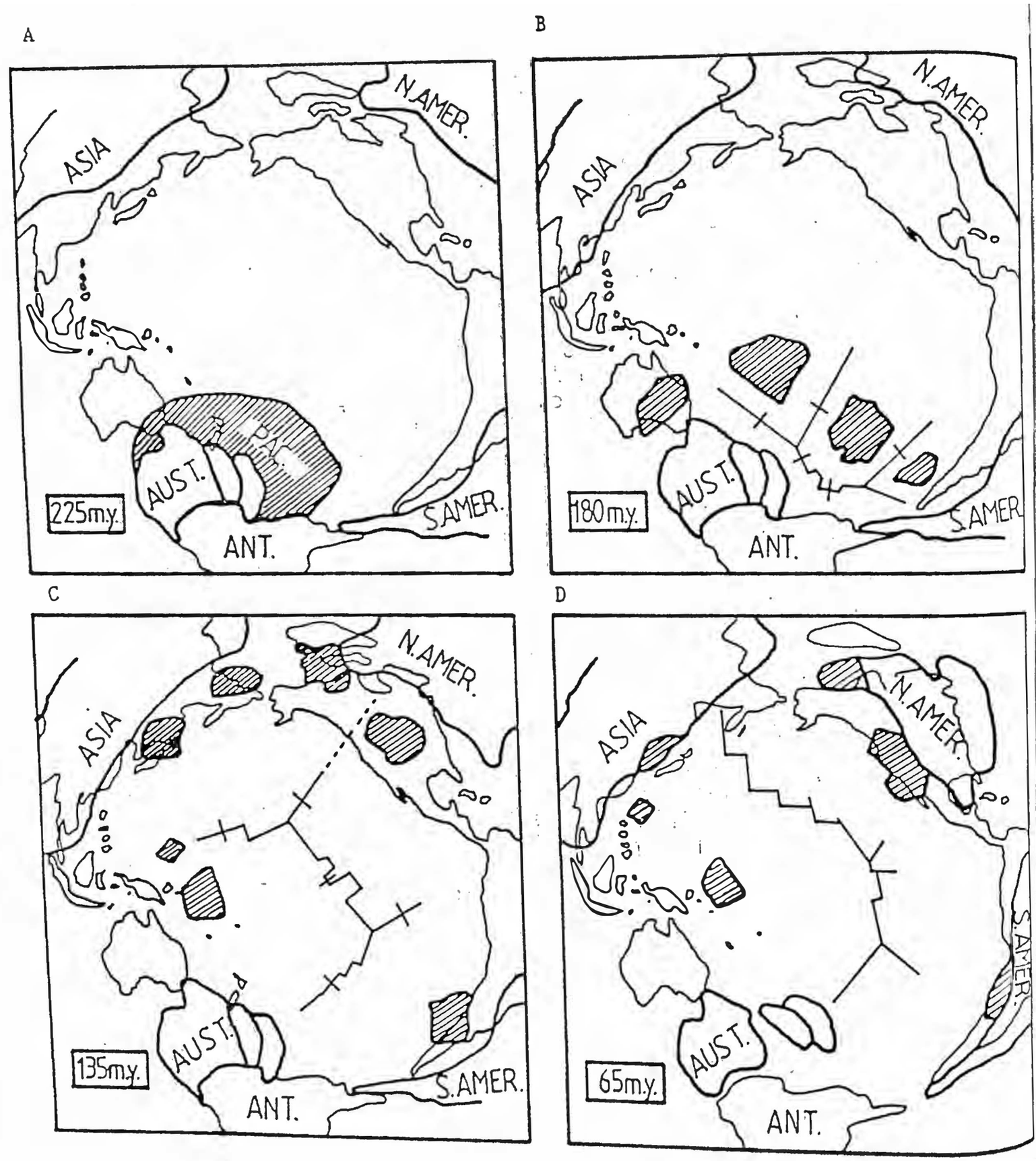
The theory of continental drift was first put forward by Wegener in 1915, from a growing body of speculation in the century previous. It claimed that continents moved relative to each other to cause mountain building, and originally were all grouped as one supercontinent, given the name Pangea. The theory sustained heated debate until a satisfactory driving mechanism emerged in the 1960's, with concepts of sea floor spreading by convection currents in the earth's mantle proposed by Dietz (1961) and forming the basis of a new theory of plate tectonics (Le Pichon,1968).

The implications of continental drift on past and present distributions of plants and animals is a core concern in classical biogeography (Vuilleumier,1978). If newly formed plates move apart, taxa with formerly continuous distributions become disrupted. If these separated populations are rafted across many degrees of latitude, they move into new climatic belts that provide new opportunities for some, but may result in extinction of others. Or if a continental fragment remains in an equable environment, then this will favour the persistence of relict species (Axelrod,1975). Hence pieces of the former continent will later feature different species with the same evolutionary ancestor, or this ancestor may have persisted in one.

From such analyses of species assemblages on different continents, much of the speculation that promoted Wegener's paradigm came from botanists and zoologists not geologists. For example, Hooker (1860) from consideration of the interrelationships of the floras of Australia, New Zealand and South America postulated migration via former land connections and Antarctica. Wegener dismissed his early ideas of continental drift, until quite by chance he came upon a compendium of references describing the faunal similarities of Palaeozoic strata in Africa and Brazil. From this support of the long noticed jigsaw fit of these continents across the Atlantic he sought out confirmatory data, and presented his hypothesis within four months (Marvin, 1973:66).

FIGURE 1

Schematic model of the breakup of Pacifica and the resulting collision events. Possible ages of the reconstruction stages: (a) 225 Ma; (b) 180 Ma; (c) 135 Ma; (d) 65 Ma. Fine lines mark the present-day continental outline. Heavy lines mark the location of the various continental areas through the geological evolution



Source : A. Nur and Z. Ben-Avraham.

There was a similar palaeobiogeographical basis for the more recent contention of the former existence of a Pacific continent, called Pacifica. Skottsberg (1920) suggested from the high endemism or unique species on Pacific islands that it is wrong to regard these as newly formed biological dependencies of nearby continents, rather they indicate an ancient existence. The Kew botanist R. Melville from years of study of angiosperm evolution and distribution in Australia, New Zealand and the Pacific islands concluded in 1966 that present distributions could only be accounted for by a now disappeared continent in that region (Melville,1966,1981). The initial proposal used meagre geological and geophysical data then available, but promoted research such that the concept now stands on its own in those disciplines (Nur and Ben-Avraham,1977,1978,1981;Ben-Avraham,1981).

The geological evidence for a Pacifica continent is based on two phenomena, the presence of allochthonous or geologically exotic continental fragments throughout the entire Pacific continental rim, and submerged thick-crusted platforms in the Western Pacific Ocean (Nur and Ben-Avraham,1978). Figure 1 shows a reconstruction of the position and movement of this continent over time. As part of Pangea 250 m years before present (Fig.1a) it was east of Australia and north of Antarctica, in the position of the present S.W.Pacific. The continent remained intact before early Mesozoic time (See Figure 2), and then became broken up in a manner similar to the present disintegration of Africa. Tectonically spreading centres are known to initiate under continental masses, i.e. the Red Sea Rift, with thermal blanketing and high radioactive heat generation beneath the continent causing upwelling of partial melt and spreading (Schuiling,1973). Pacifica split into four fragments (Fig 1b) which slowly drifted across the Pacific between the Triassic and the Cretaceous, at rates of around 10 cm/year similar to those measured today.

These fragments on meeting continents of the Pacific rim, collided and were subducted to cause the circum Pacific cordillera (Figure 1c)(Nur and Ben-Avraham,1977). In the proto Japan and South America areas a Pacifica fragment has totally coalesced, but in Western North America the bulk of the continental mass is approaching and collisions are taking place (Nur and Ben-Avraham,1978). Allochthonous terraines along this coastline were analysed by Batten and Schweickert (1981) in discussion of the Pacifica proposal, such as the tropically derived limestones now lodged in the coastal cordillera of British

Columbia. They concluded that evidence suggests that island arcs and other small land masses may have docked repeatedly against the North American cordillera, but where these terraines originated cannot be told with certainty.

Western fragments of the former Pacifica continent are proposed to have remained in the S.W.Pacific, largely submerging to form the platforms and blocks of that area, now rising some 2-3 km above the ocean floor, or emerging to form the larger islands of the region (Nur and Ben-Avraham,1981). These are renowned for their ancient and endemic floras: Fiji (Miller,1988) and New Caledonia and New Zealand (Stevens,1977).

But the greatest biogeographic significance of the Pacifica proposal is not these ancient relicts, but the migration route across the Pacific that it offers. Similar floras and faunas on both sides of the Pacific have aroused a number of explanatory theories, of landbridges (Van Steenis,1962), birds and ocean currents (Guppy,1906) and early men in boats (Heyerdahl,1952). Concentrating on the evolution and distribution of plants, angiosperms evolved in the Jurassic (Figure 2) in the southern part of Pangea that was centred on the tropics (Axelrod,1970). They became dominant in the plant kingdom some 50 to 80 million years after their first appearance, in the Cretaceous. Thus Pacifica would have been adjacent to the origin of the angiosperms in S.E.Asia, and carried on its drifting fragments some of these to the western shores of the New World (Melville,1966,1981; Nur and Ben-Avraham,1981).

A test case for such phytogeographical theories is the southern beech, Nothofagus, because the seeds are rapidly killed by sea water and so point directly at land connections (Van Steenis,1971; Melville,1982). Species of this genus occur as dominant forests in Tasmania, New Guinea, New Caledonia, New Zealand and the Fuegia/Patagonia area of South America. The distinctive pollen first appears in upper Cretaceous deposits, found in Australia, New Zealand and South America, so suggestive of a land connection when the genus evolved (Van Steenis,1971).

But, as pointed out by Seberg (1988), the existence of such a trans-Pacific connection is a geological and not a biological question. Admittedly geological explanations do have implications for biology, but they cannot be based on biology, if circularity is to be avoided (Mayr,1952). The Pacifica proposal has most concrete evidence in its support from the plant and animal distributions that it explains, as

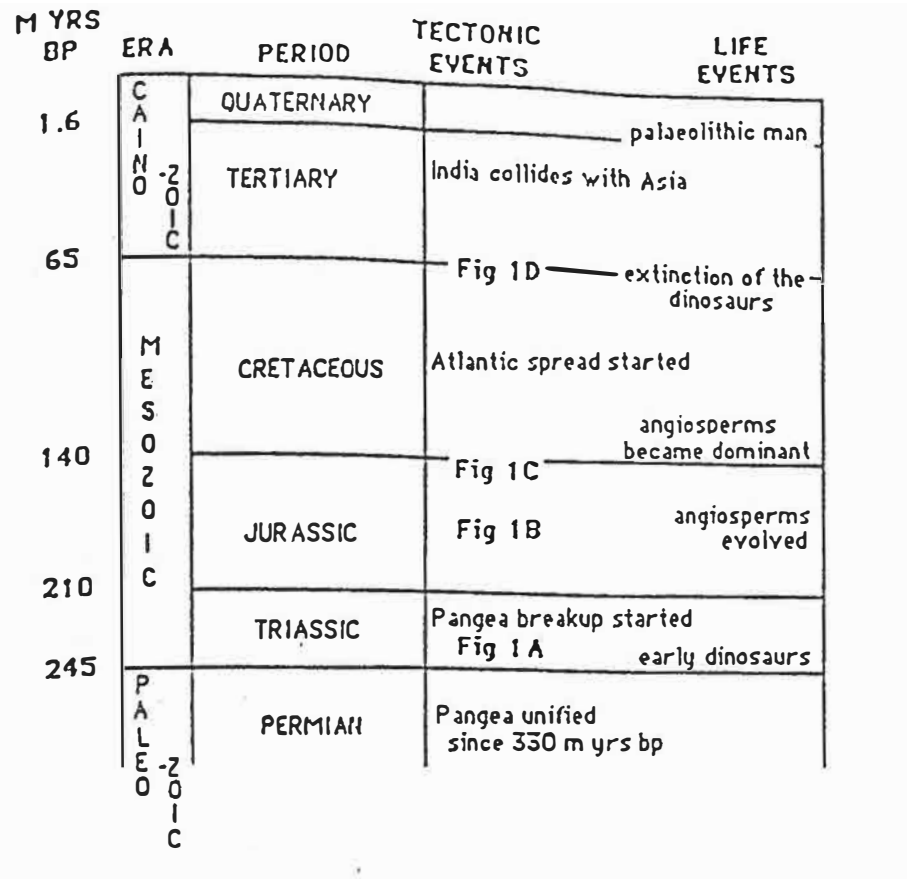


Figure 2: Chronology of events shown in Figure 1 put into context on a geological timescale.

the straight geological evidence is unavoidably concealed and confused by the time lapsed since, so can too readily be dismissed as circumstantial. Earth scientists should beware of being spoiled by the detailed hard-nosed facts now available for the last ten thousand years: lack of certain proof is no reason for dismissal of reconstructions of what was happening a hundred million years ago, especially when lack of support is founded on incredulity.

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