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THE HOLOCENE EUSTATIC SEA LEVEL PROBLEM

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The discussion and disagreeing opinion about the Holocene eustatic sea level changes have earlier circled around two questions, viz.:

1. Was the sea level ever above the present one or did it rise more or less steadily?
2. Was the sea level oscillation or does it form a smooth curve?

A third Holocene problem recently brought up to discussion (by Bloom at the INQUA VIII Congress in Paris 1969) is the cause of the 5-6 m eustatic rise after 4,500 (fig. 1, curves 1, 3, 4 and 5), when the continental Canadian ice was "completely" gone (according to Prest, 1969) but not according to Bryson et al., 1969) and the Scandinavian ice had been gone for 2,000 years. However, there are so many different factors affecting the ocean level that this hardly can be looked upon as a problem at our present stage of incomplete knowledge. Also, the minor changes after 3,900 BC, with only 3.5 m eustatic rise to the present, can easily be explained by changes in the main areas of present glaciation: the Canadian Arctic Islands, Alaska, Greenland and Antarctica. There is, for example, a very close similarity between the eustatic changes in my curve (fig. 1, curve 3), the climatic changes as recorded by the north Canadian vegetational changes (Nichols, 1967) and the changes of the glaciers on the Canadian Arctic Islands (Bryson et al., 1969; Andrews et al., 1970).

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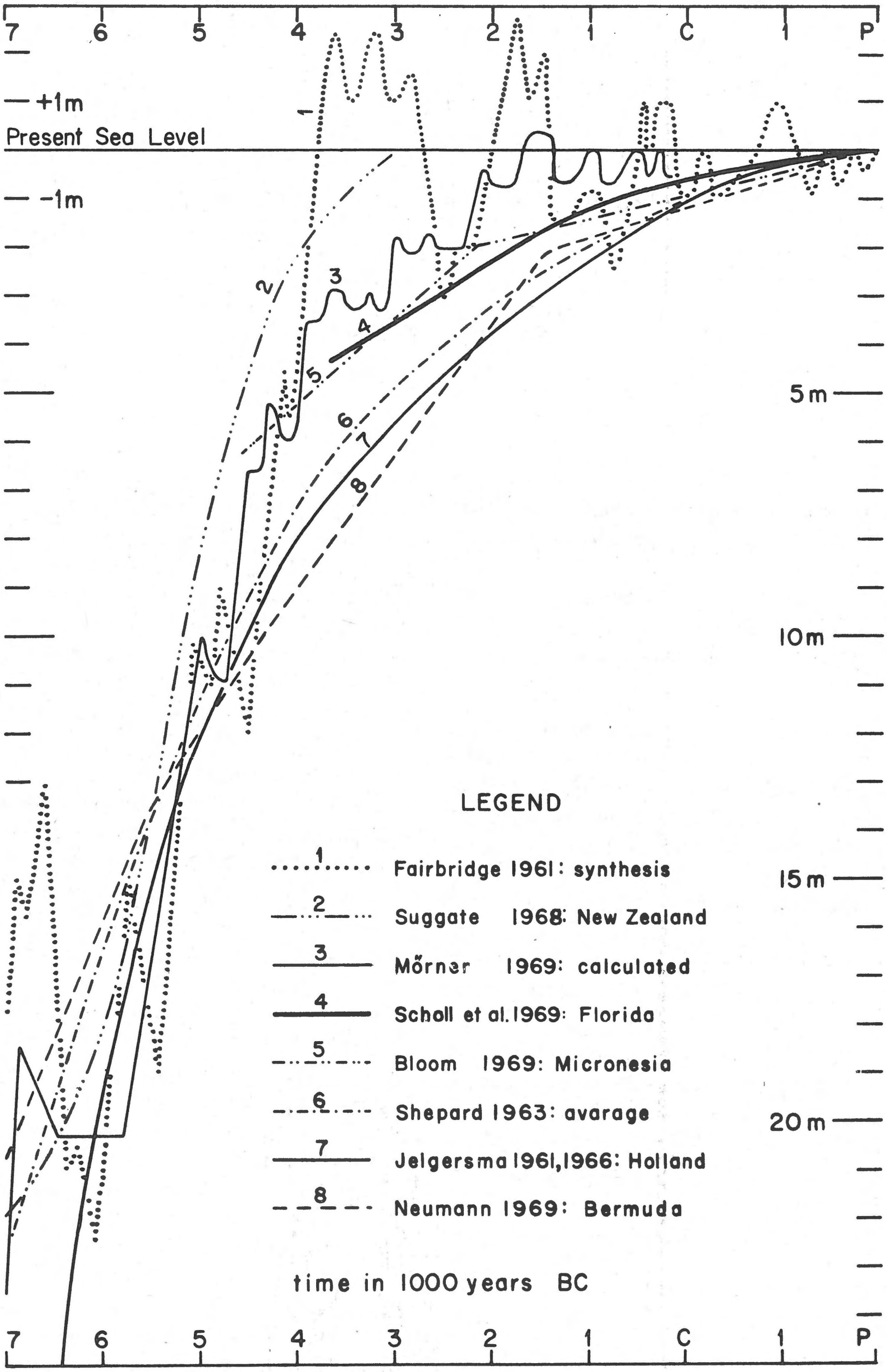
As the Holocene climate was oscillating and sea level oscillations are well recorded in all areas studied in sufficient details, I think a low-amplitude oscillating eustatic curve sooner or later will be generally accepted (cf. Mörner, 1970d).

High sea level stands about 5,000 BP and 3,500 BP have been recorded in several areas (e.g. Fairbridge, 1961; Schofield, 1960; Hopley, 1969), while other areas show the corresponding levels some meters below the present sea level (e.g. Shepard, 1963; Scholl et al., 1969; Bloom, 1969; Neumann, 1969). I have earlier discussed this problem (Mörner, 1969a, 1969b, 1969c, 1970a, 1970b, 1970c). The disagreement could – at a first glance – be explained as due to different isostatic changes (Mörner, 1970b; tables 2-3), where some areas (e.g. parts of Australia, New Zealand, South America and Africa) have gone up, while other areas (e.g. Florida, Bermuda and parts of Micronesia) have gone down. From Southern Scandinavia the isostatic and eustatic factors are separated, and a more true eustatic curve is believed to have been established (Mörner, 1969a).

However, the very problem is neither the oscillations nor the possible high stand. It is instead that the difference between the various curves does not grow bigger back in time (which would have been the case, if the cause would just have been different isostatic changes), but that all curves more or less converge at about 4,500-5,000 BC (fig. 1). This is the real problem. And what can the explanation be? There are two possibilities (excluding misinterpretation):

1. Either the ocean level was different and unequal



7
6
5
4
3
2
1
C
1
P
+1m
Present Sea Level
-1m
5m
10m
15m
20m
1
2
3
4
5
6
7
8
LEGEND
1 Fairbridge 1961: synthesis
2 Suggate 1968: New Zealand
3 Mőrner 1969: calculated
4 Scholl et al. 1969: Florida
5 Bloom 1969: Micronesia
6 Shepard 1963: avarage
7 Jelgersma 1961, 1966: Holland
8 Neumann 1969: Bermuda
time in 1000 years BC

Fig. 1

(for the interjacent period) to that of today and that of 4,500-5.000 BC. This could result from e.g. changes in the rate of rotation of the earth, changes in major currents, changes in the water density by changes in salinity and/or temperature (as suggested by S c h o f i e l d, 1967), changes in the tide, changes in major wind pattern and air pressure. However, this does not – at least alone – seem probable as areas from the same latitude or lying very close together differ very much.

2. Or there was a time of generally changed isostatic movements, giving the following sequence; stability – subsidence – upheaval – stability, or stability – upheaval – subsidence – stability. This seems – at present – also to be a little too complicated. If, however, a submerged coast is hydro-isostatically deformed with a compensational upheaval inside the axis of subsidence (M ö r n e r, 1970a, fig. 4; 1970c, fig. 3), reversed isostatic movements take place as the transgression goes on. This compensational upheaval may be recorded on the African West Coast by F a u r e's (1969) results, showing the 5,000 BP shore at + 2 m in the west and at + 4 m 80 km inland (southwards, it lies below the present sea level) – though an old, unequal, tectonic upheaval is more likely. The Bermuda curve (fig. 1, curve 8; N e u m a n n, 1969) suggests, in comparison with my curve (fig. 1), a reversed isostasy; from upheaval prior to 5,000 BC to subsidence after. Compared to the Dutch curve (fig. 1, curve 7) the Bermuda curve would show; upheaval – subsidence – upheaval. Several other curves suggest a similar reversed isostasy, caused by a compensational upheaval changed to hydro-isostatic subsidence; viz. Florida, Micronesia, Louisiana (M ö r n e r, 1970a; fig. 6).

This converging of the curves back in time is the very problem with the Holocene eustatic sea level, which I think we must consider in the future – discuss and gather information about – in order to be able fully to understand the isostatic and eustatic changes.

These differences seem only to apply for the last 7,000 years. For the older periods there is a striking general agreement between the various curves, though the details may differ very much (M ö r n e r, 1969a, fig. 160; 1970a, fig. 7).

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