Evidence of high sea level during the mid-Holocene on the southwest coast of Sri Lanka

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A well-developed extensive buried coral reef at Akurala, north of Hikkaduwa, is deposited on a low plateau of decomposed crystalline rocks of Precambrian age. Radiocarbon age datings from three coral quarries in the area reveal that the branching and massive corals, in a position of growth, were gradually deposited between 6,110 ± 80 B.P. and 5,580 ± 80 B.P. in a bay or a lagoon as isolated patches, and their heights vary from 1.4 m to 3.9 m below mean sea level (MSL). Four radiocarbon age datings of emerged coral reef patches at Akurala and Akurala-Telwatte vary from 6,170 ± 70 B.P. to 5,350 ± 80 B.P. and at levels between 10 cm and 70 cm above MSL respectively. The present living corals in front of the southwest coast thrive from mean low water spring (MLWS) tidal level to 4 m in depth in lagoonal reef areas. From the level of present living coral it is inferred that sea level was above the present level about 50 cm at 6,110 ± 80 B.P. and 1 m or more at 5,560 ± 80 B.P. The in situ position and condition of the materials show that they were not accumulated by catastrophic events such as storm waves.

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The island of Sri Lanka, which is situated in the Australia–Indian Plate, is considered as stable (Katz 1978; Swan 1982). Sri Lanka has a coastline about 1,920 km in length (Madduma Bandara 1982). Evidence of recent oscillatory movements can be seen along the coast and lower parts of drainage basins (Coates 1935; Deraniyagala 1958). Deraniyagala (1958) regarded the buried coral deposits at Akurala to be of reefal origin, while Coates (1935) and Cooray (1967) stated that the accumulation of debris washed off the outlying reefs by the storm waves and was covered later by sand. Hubbs *et al.* (1962) dated Giant Clam (*Tridacna*) shell from an emerged beach (90 cm above low tide level) at Hikkaduwa about 6 km to the south of Akurala at 2,990 ± 200 B.P. Neef & Veeh (1981) dated one coral sample (*Porites* – about 4 m depth from surface), in position of growth, from an exposed coral quarry at Wenamulla (Akurala) at 6,600 ± 500 B.P.

There are no age dating facilities available in Sri Lanka and it is very difficult to consider Holocene sea level change using the very few published dates. The present study dealt with the preliminary dating of thirteen fossil corals from the above mentioned area (Fig. 1) in order to assess high sea levels during the Holocene Epoch.

Many parts of the coastal lowlands in Sri Lanka with elevation from sea level to 30 m, consist of sedimentary deposits of late Pleistocene and Holocene Epochs lying on a peneplain of crystalline rocks of Precambrian age or on Miocene limestone. Along the southwest coast the residual hills and ridges which are formed of weathered bedrock and capped by lateritic soils are located close to the sea. Littoral deposits widen in both directions to the north and east attaining their maximum width on the west coast near Chilaw and on the east coast near Kalkudah respectively (Coates 1935).

The tidal range on the Sri Lanka coasts is small, ranging from the mean low water spring (MLWS) at −37 cm to mean high water spring at +40 cm from the mean sea level (MSL) (data based on standard point of Colombo, datum level 38 cm below MSL). High waves (height 5 m or more) are seen along the southwest and south coasts and are related with the strong monsoon winds from May to September.

In the southwest coastal region there are living corals, emerged coral reef patches, well-developed buried coral deposits and beachrock shoals. The present living corals, in front of the southwest coast, thrive from MLWS tidal level to 4 m in depth

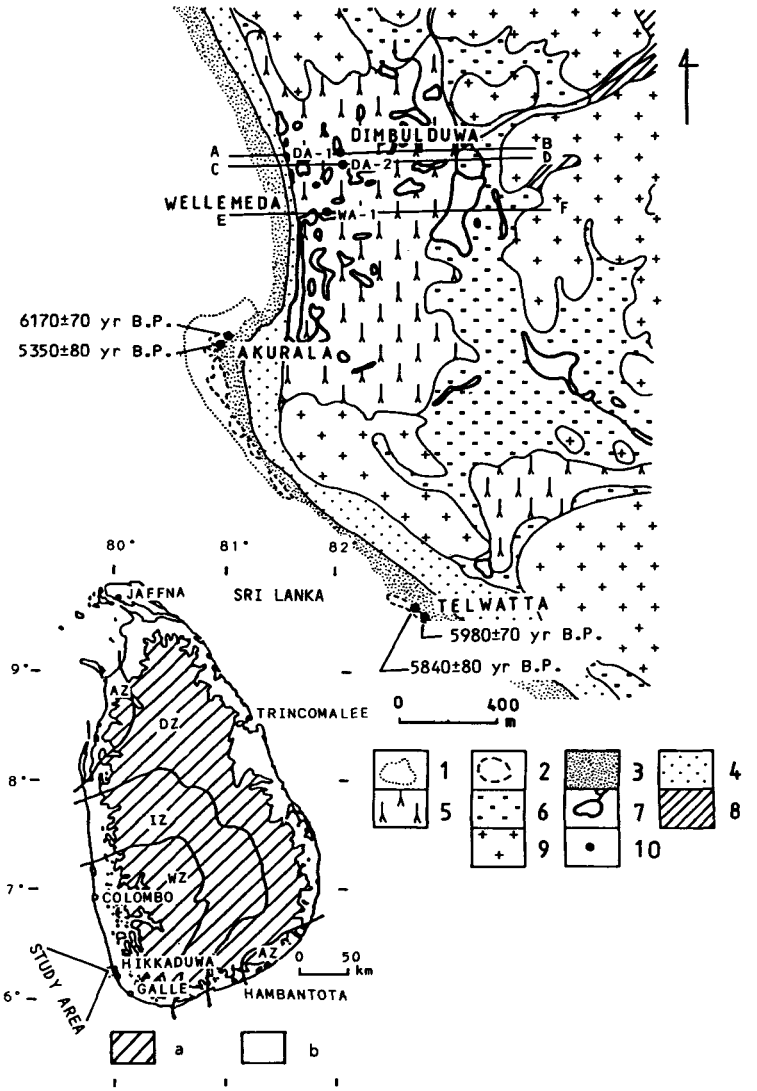

Fig. 1. Location and landforms map of the study area (cross-sections refer to *Fig. 2* and radiocarbon age datings refer to *Table 1*). (a) Highland, (b) lowland, (1) Intertidal coral reef patch, (2) emerged coral reef patch, (3) foreshore, (4) beach ridge, (5) mangrove swamp, (6) marsh, (7) water pool, lake and stream, (8) flood plain or valley plain, (9) residual hills and ridges, (10) sample location.

in lagoon reef areas and to 8 m in fringing reef areas (Mergner & Scheer 1974). An extensive buried coral deposit at Akurala extends for 250 m or more inland from the present shore (Fig. 1) and is deposited on a low plateau of decomposed crystalline rocks of Precambrian age. The bed is presently being quarried on a large scale for lime burning; mangroves and water pools now exist where the coral deposits have been quarried.

Materials and methods

The samples were collected for radiocarbon age determination during August, 1985 and November, 1986. Sample points were levelled based on the Colombo datum level. All corals were treated in 10% HCl, and pure $CaCO_3$ samples were dated by liquid scintillation counting of methanol using the laboratory procedure described by Fujiwara & Nakata (1984). Radiocarbon age measurements were carried out at the Department of Geography, Hiroshima University radiocarbon dating laboratory. The results are expressed in radiocarbon years relative to A.D. 1950 based on

the Libby half-life of 5,568 ± 30 years, using the new NSB oxalic acid standard (SRM 4900C) as 'modern' (Stuiver 1983).

Results

Dated sequences of coral quarry nos. DA-1, DA-2 and WA-3, and emerged coral reef patches at Akurala are shown in Figs. 1 and 2. The upper layers of these coral deposits are covered by calcareous sandy clay with coral debris (Fig. 2). Upright branching (*Acropora*) and massive corals (*Porites, Favites, Goneastrea*, etc.) of buried reef patches show that the accumulation of the materials was not caused by catastrophic events such as storm waves. The layers vary from 4 m to 5 m in thickness, and rest on a sand and mud layer. The mud is present as a matrix between the corallites. The samples of the lowest and uppermost parts of the deposits have been dated at 6,110 ± 80 B.P. and 5,590 ± 80 B.P., and their height varies between 1.4 m and 3.9 m below MSL (Fig. 2). The shells of the upper layers deposited with lagoonal or marshy deposits are 'recent'. These sequences reveal that the corals have thrived in a bay or a lagoon since mid-Holocene.

Emerged coral reef patches at Akurala and Akurala-Telawatte (Fig. 1) consist of various species of coral (Table 1). Four coral samples were collected at levels between 10 cm and 70 cm above MSL, and their ages vary from 6,170 ± 70 B.P. to 5,350 ± 80 B.P.

Discussion

The age sequence of buried coral deposits and emerged coral reef patches (Figs. 1 and 2) reveals that sea level was higher than at present during the mid-Holocene Period in the southwestern part of Sri Lanka. Following the postglacial transgression, the former drainage basins on the southwest coast were submerged and headland bay beaches were created. As a result of this transgression the coral thrived in former bays or lagoons where factors were well fitted to growth of coral, and gradually formed reefs in many places on the southwest coast since the mid-Holocene period.

Mergner & Scheer (1974) divided the lagoon reef in front of Hikkaduwa into four zones: shore, reef lagoon with inner reef patches, outer barrier and littoral flat (from inland to sea). The author assumes that the ground plan and the profile, with morphological, structural and physiographic zones

Table 1. Dated coral samples on the southwest coast of Sri Lanka.

No.	Locality	Elevation (m from present MSL)	Dated material	^{14}C age (years B.P.)	Laboratory no.
Dimbulduwa–Akurala					
(Coral quarry no. 1)					
1	6°12′10″N 80°03′57″	−1.40	*Acropora*	5,830 ± 90	HR 111
2	6°12′10″N 80°03′57″	−2.00	*Echinopora*	5,820 ± 90	HR 112
3	6°12′10″N 80°03′57″	−2.90	*Porites*	5,910 ± 80	HR 113
4	6°12′10″N 80°03′57″	−3.00	*Acropora*	6,000 ± 90	HR 114
(Coral quarry no. 2)					
5	to the southeast from quarry	−1.70	*Acropora*	5,590 ± 80	HR 236
6	to the southeast from quarry	−3.40	*Acropora*	5,840 ± 80	HR 237
Wellemeda–Akurala					
(Coral quarry no. 3)					
7	6°11′50″N 80°03′57″E	−0.30	*Thiaridea* (shell)	recent	HR 115a
8	6°11′50″N 80°03′57″E	−2.10	*Acropora*	5,800 ± 80	HR 115b
9	6°11′50″N 80°03′57″E	−3.90	*Acropora*	6,110 ± 80	HR 109
Akurala					
(Emerged coral)					
10	6°10′30″N 80°03′30″E	+0.50	*Acropora*	5,350 ± 80	HR 238
11	Near to No. 10	+0.10	*Platygyra*	6,170 ± 70	HR 239
Akurala–Telwatte					
(Emerged coral)					
12	6°10′10″N 80°03′50″E	+0.70	*Favites*	5,840 ± 00	HR 240
13	to the south of No. 12	+0.60	*Montipora*	5,980 ± 70	HR 241

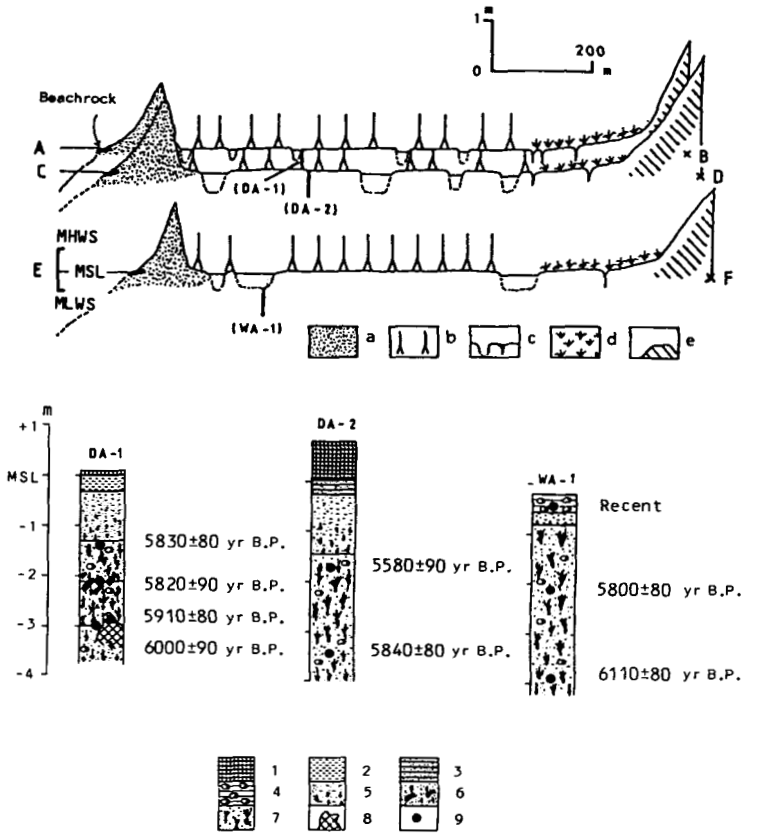

Fig. 2. Cross-sections, stratigraphic and radiocarbon datings of three coral quarries at Akurala. Age datings are referred to in *Table 1*. DA-1 = Coral quarry no. 1, Dimbulduwa–Akurala; DA-2 = Coral quarry no. 2, Dimbulduwa–Akurala; WA-1 = Coral quarry no. 3, Wellemeda–Akurala. (a) Beach ridge, (b) mangrove swamp, (c) water pool, lake and stream, (d) marsh, (e) residual hills and ridges. (1) Top soil, (2) brownish grey soil, (3) dark grey mud, (4) dark olive grey mud with shells, (5) calcareous sandy clay with coral fragments, (6) stratified coral (*Acropora* and *Echinopora*), (7) stratified coral (*Acropora*), (8) massive coral, (9) sample location.

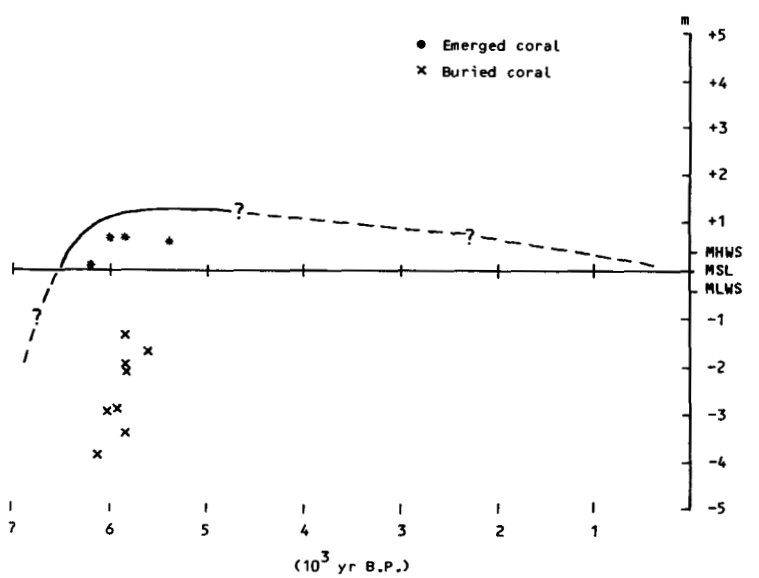

Fig. 3. Sea level change on the southwest coast in Holocene of Sri Lanka.

of isolated reef of the palaeo-bay, were very similar to present living lagoon reefs at Hikkaduwa. In comparing the lowest and uppermost levels of the eight dated samples of the exposed coral quarries with the present living reef lagoon zones, which occur from MLWS tidal level to 4 m in depth, it is estimated that the MSL was higher than at present by about 50 cm at 6,110 ± 80 B.P. and by 1 m or more at 5,560 ± 70 B.P., respectively. Furthermore, in comparing the present MLWS tidal level (the highest level of the present living corals) with ages and heights of the emerged coral reef patches it is assumed that at least between 6,170 ± 70 B.P. and 5,350 ± 80 B.P. sea level remained 1 m or more above present level (Fig. 3). Regarding the stratigraphic and deposition pattern in exposed quarries, the corals are upright and most appear in position of growth. The undisturbed condition of the materials emphasises that they were not accumulated by a catastrophic event such as storm waves.

Conclusions

Radiocarbon age datings of buried coral deposits at Akurala are between 6,110 ± 80 B.P. and 5,590 ± 80 B.P., and indicate that the corals thrived in a bay or a lagoon following the marine transgression in the mid-Holocene. Comparing the age sequences and the heights of the samples with present living corals which occur from MLWS to 4 m in depth at present living reef lagoon zones, the sea level remained 1 m or more above the present MSL at 5,590 ± 80 B.P. The stratigraphic sequences and deposition patterns of coral quarries show that upright corals are in a position of growth. The relatively good condition of the materials shows that they were not accumulated by catastrophic events such as wave actions. The results of emerged coral reef patches also confirm 1 m or more of emergence between 6,170 ± 70 B.P. and 5,350 ± 80 B.P. on the southwest coast of Sri Lanka.

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