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Chronology of Inland Shell Deposits on the Southern Coast of Sri Lanka

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Extensive patches of fossil shell deposits are found in many places along the rims of emerged coastal embayments and lagoon floors on the southern coast of Sri Lanka. Compositional and depositional sequences of fossil shells (Veneridae, Cerithidae, and Nassaridae) reveal that the bulk of the valves has been accumulated by three processes: (a) the shells have been piled up on the rims of emerged coastal embayments mainly by wave action; (b) following coastal progradation since the late Subboreal the shells possibly gathered on lagoon floors; and (c) the valves on the coastal hilly areas and dune areas were discarded by early human inhabitants in the course of their daily activities. Radiocarbon dates of fossil corals along the southwest and south coasts support this interpretation and indicate that mean sea level was at least 1 m higher than present in the middle Holocene. The fossil species may have lived in an intertidal zone of embayments and lagoons that extended 3 km or more inland form the present shore in the middle Holocene.

INTRODUCTION

Fossil shell deposits are well-known indicators of former sea levels and paleoecology (Craig and Psuty, 1971; Petersen, 1986). Patches of fossil marine shells, all belonging to existing species common in clayey and sandy deposits, are found in many places along the rims of emerged coastal embayments and lagoon floors on the southern coast of Sri Lanka (Fig. 1). These shell deposits now occur 3 km or more inland and are presently quarried for chemicals, lime burning, and chicken grit.

Several studies have been conducted emphasizing the distribution, composition, and taxonomy of fossil shell deposits and existing lagoonal shells along the coastal lowlands of Sri Lanka. Coates (1935) reported that the fossil shell deposits on the south and southeast coasts, belonging to existing species, are from 3.5 to 6.5 m above present mean sea level (MSL), and that the paleoclimate of the region had been different from that of the present. Buried shell layers from the west coast also reveal such climatic change (Wadia, 1941; Dissanayake, 1984). Deraniyagala (1958) found some inland molluscan deposits at Attudawa near Matara on the southern coast, about 3 km inland from the present shore and about 2.5 m below present MSL. On the basis of the residual pattern of emerged beach ridges in the Ruhunu National Park (southern quadrant) of Sri Lanka, Katz and Comaner (1975) assumed this area was submerged previously. It is very difficult to assess paleoenvironmental changes on the coastal lowlands of Sri Lanka using the few published dates (Hubbs *et al.*, 1962; Neef

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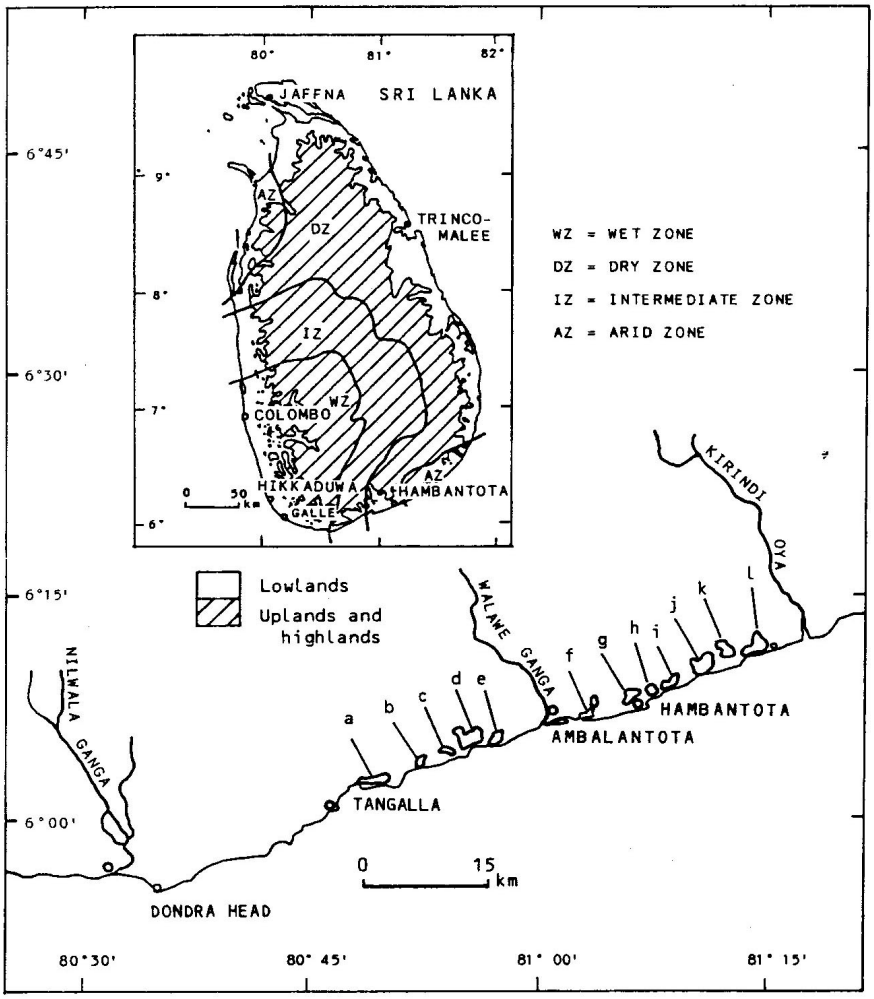

FIG. 1. Map showing location of the study area. (a) Rekawa Kalapuwa (lagoon); (b) Kahanda Kalapuwa; (c) Kunukalli Lewaya (salt pan); (d) Kalametiya Kalapuwa; (e) Lunama Kalapuwa; (f) Mahasittarakala Lewaya; (g) Karagan Lewaya; (h) Maha Lewaya; (i) Koholankala Lewaya; (j) Malala Lewaya; (k) Embilikala Lewaya; (l) Bundala Lewaya.

and Veeh, 1981). The present study showed the distribution of inland fossil deposits and identified a coastal progradation since late Holocene (late Subborial) time based on ^{14}C dates from the southern coast of Sri Lanka.

METHODS

Landform maps of the study area were compiled by aerial photo interpretation (1:20,000 photographs (1983) and mosaics (1956), Survey Department of Sri Lanka) and by field observations. Shell samples were collected for ^{14}C dating during August, 1985, November, 1986 and January, 1987. Ages were obtained by liquid scintillation counting of methanol at the Department of Geography, Hiroshima University radiocarbon dating laboratory using the laboratory procedure described by Fujiwara and Nakata (1984).

STUDY AREA

The island of Sri Lanka, which is situated on the Australia–India Plate, is considered relatively stable (Katz, 1978; Swan, 1982). The former coasts were subjected to drowning during the postglacial transgression (Katupotha, 1988a; Katupotha and Fujiwara 1988). Evidence of recent oscillatory

movements of sea levels can be seen along the coasts and in the lower drainage basins (Coates, 1935; Deraniyagala, 1958). The coastal lowlands consist of barrier beaches, barrier islands, sand dunes, buried and emerged coral reef patches, shell deposits, lagoons and lakes, marshes, mangrove swamps, and beachrock shoals which formed during the late Pleistocene and the Holocene (Katupotha, 1988a). Radiocarbon dates of buried and emerged coral reef patches on the southwestern coast and on the southern coast (west of Dondra Head) indicate that sea level was 1 m or more above present MSL in the middle Holocene (Katupotha, 1988b, c). Along the southern coast, lagoons are irregular basins bounded on the land side by low bluffs of decomposed gneissic rocks. On the sea side the wide beaches are capped by blown sand (Coates, 1935). According to Katz and Comaner (1975), the coastline exhibits a somewhat "scalloped" pattern with headlands alternating with continuous sand beaches in curved embayments. Dunes are usually aligned in a northeast–southwest direction, according to the prevailing winds during the northeast monsoon. The heights of the dunes are variable, and several are covered by scrub lands. Dunes bordering the beach are high with steep sides and are covered by halophytes. Lagoons are the prominent feature in the area. Several are lewayas (salt pans); others are marshy wastelands which were former lagoons. Some have been modified into water storage tanks for paddy cultivation. The estuaries of the present lagoons have been blocked by beach deposits during the dry season.

Throughout the area rainfall is quite variable from year to year (Wickramatilaka, 1956; Sirinanda, 1983), and annual rainfall (<1250 mm) sharply decreases east of Dondra Head. There are no significant seasonal floods in this area. Sri Lanka is fortunately located outside of major cyclone belt (Gerritsen, 1974). However, the risk of cyclones is not entirely to be discounted, and at certain times they hit the east coast, moving from east to northwest across the island. Mostly northern and eastern coastal areas are damaged by violent winds, storm waves, and floods. Along the southern coast near Tangalla, the south–southeast swell is the dominant wave condition and shows the typical characteristics of a long ocean swell with periods of 15 sec and possibly higher. The tidal range on the Sri Lanka coast is small, ranging from mean low water spring at −35 cm, to mean high water spring at +40 cm in relation to the MSL (data based on the Colombo datum, 38 cm below MSL. Tide Tables, vol 2, Pacific and Indian Oceans, 1987). Because of the dry climatic conditions and the low discharge of intermittent streams feeding the present lagoons, brackish conditions alternate with high salinity ones. Such physical conditions have been favorable for the growth of molluscan faunas to the east of Dondra Head (Coates, 1935; Katupotha and Fujiwara, 1988).

RESULTS

The fossil shells studied belong to two classes, pelecypoda and gastropoda. Most of the shells are white or pale in color. The bivalves belong to the Veneridae family, while univalves belong to the Cerithidae and Nassiridae families. Genus *Anadara* is a squarish shell about 7 cm long, inflated, and solid with simple radial ribs. Genus *Meretrix* is a heavy, smooth, trigonal shell about 6 cm long, while the gastropoda are 2 cm long. The Veneridae are common in the Kalametiya and Lunama areas, and the shell deposits are found as patches. Present living species, mainly *Meretrix*, can be found in the Rakawa Kalapuwa (lagoon) where *Anadara* and gastropoda are rare. A few isolated patches of shell deposits have been distributed along the rims of Mahasittarakala, Karagan, and Koholonkala Lewayas.

Six ^{14}C dates of the shell samples collected from dry lagoon floors and shrub areas of Kalametiya Kalapuwa and Udamalala area (Figs. 2 and 3) are listed in Table 1. The dates of four samples range from

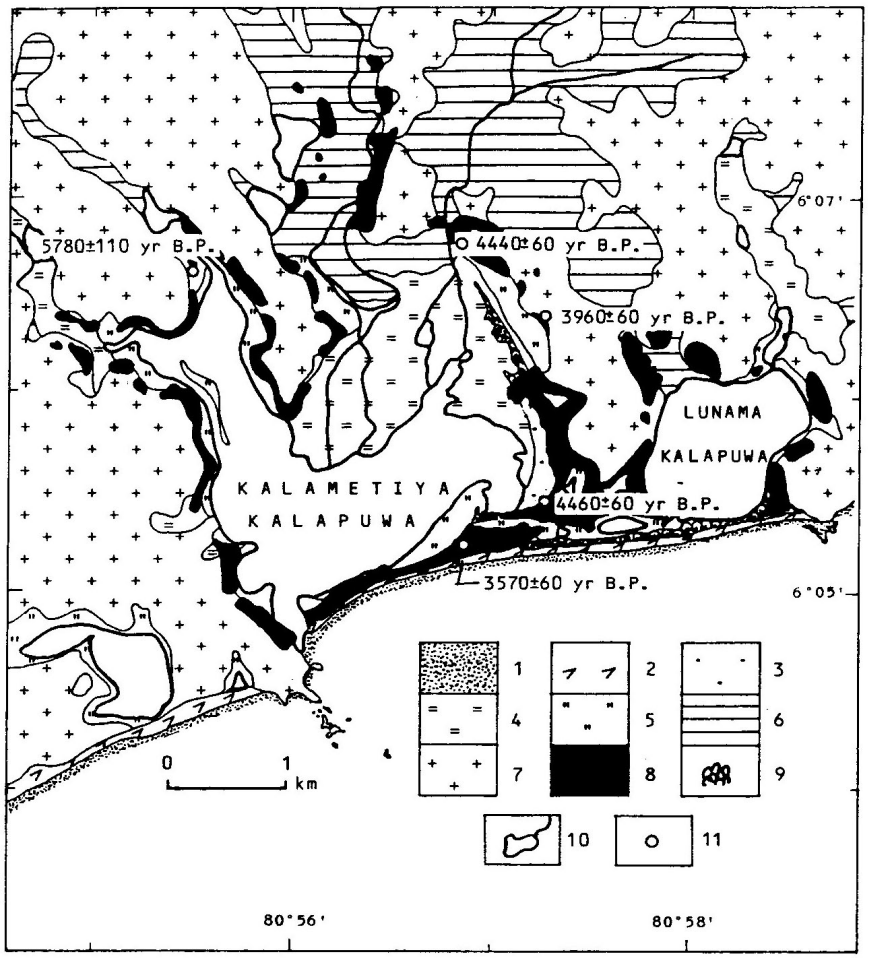

FIG. 2. Map showing landforms of Kalametiya area. ^{14}C dates of shell deposits are referred to in Table 1. (1) Foreshore; (2) sand dune; (3) beachridge; (4) marsh; (5) wasteland; (6) flood or valley plain; (7) residual hill and ridge; (8) emerged shell deposits; (9) mangrove swamp (10) water hole, lake, and stream; (11) sample location.

3570 ± 60 to 4460 ± 60 yr B.P., and altitudes ranged from 0.8 to 2.2 m (Table 1).

DISCUSSION

The emerged coastal embayments and lagoon floors on the southern coast encompass marshy lands, wastelands, and scrub lands. Most of the fossil deposits on the dry Kalametiya and Lunama lagoon floors are covered by a thin soil less than 1 m thick. The thickness of shell layers is locally variable, usually up to 1 m. The shell layers at Kiripattiya, northeast of Malala Lewaya, however, reach thicknesses of 3 m or more. Living species exist in the Rakawa Lagoon, but no emerged fossil shell deposits are found in its surroundings. Isolated shell deposits are seen around the Mahasittarakala, Karagan, and Koholankala Lewayas, although no living species are found there. The water of these lewayas is more saline than that of the Rakawa Lagoon. Annual precipitation also is quite different in the two areas (Wickramatilaka, 1956). On the other hand, in the area of Walawe Ganga (river) flood plain, between Lunama Kalapuwa and the Mahasittarakala salt pan, no fossil shell deposits are found. It is assumed that the water of the Walawe Ganga estuary was only very slightly brackish during the Holocene submergence, and that environ-

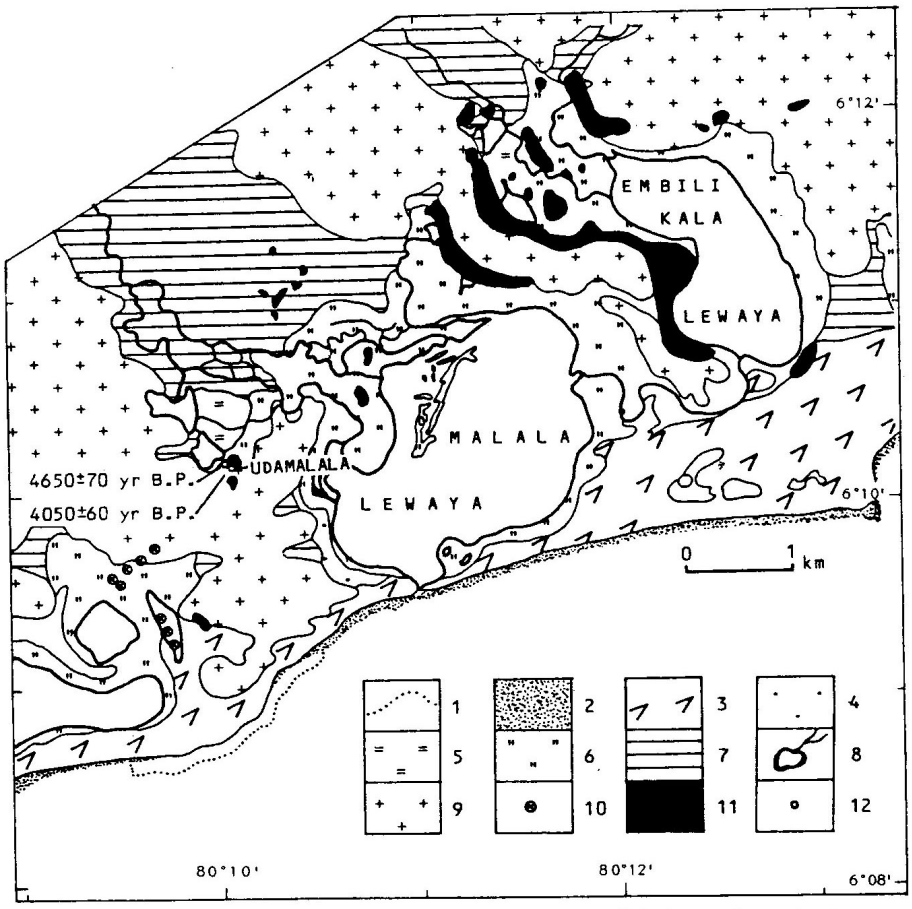

FIG. 3. Map showing the landforms of the Malala Lewaya area. ^{14}C dates of samples from two shell deposits are referred to in Table 1. (1) Intertidal reef patch; (2) foreshore; (3) sand dune; (4) beachridge; (5) marsh; (6) wasteland; (7) flood or valley plain; (8) water hole, lake, and stream; (9) residual hill and ridge; (10) small patches of emerged shell deposits; (11) extensive shell deposits; (12) sample location.

mental conditions did not allow marine mollusks to live in such areas.

The altitude and the matrix of the fossil shell deposits of the study area show morphological differences. The shells of four samples collected from the eastern part of the Kalametiya Kalapuwa belong to the Veneridae, Cerithidae, and Nassaridae families. Veneridae is the dominant shell in the area. The shells of sample HR-265 were found in a matrix of calcareous clay and black mud and dated at 3570 ± 60 yr B.P. The shells at Hatagala (HR-264) are almost similar to those of HR-265 and were enclosed in a black to bluish-black mud and clay. This sample was dated 4440 ± 60 yr B.P. It is inferred that those shells have been possibly piled up by wave action. Another sample (HR-267, 3960 ± 60 yr B.P.) was loosely held in a matrix of fine to coarse beach sand and contained various shell species of the Veneridae, Cerithidae, and Nassaridae families. The character and the composition of the shells and the other materials of this sample show that the shells at the rims of emerged coastal embayments have been piled up mainly by wave action. Shells of HR-266 (4460 ± 60 yr B.P.) were embedded in brownish-black silt; these shells perhaps accumulated on lagoon floors following the coastal progradation since late Subboreal. ^{14}C dates of buried coral deposits and emerged coral reef patches along the southwest and south

TABLE 1. DATED SHELL SAMPLES ON THE SOUTHERN COAST OF SRI LANKA

No.	Locality	Altitude (m)[a]	Dated material	Age (yr B.P.; half-life = 5568 ± 30)	Laboratory no.
		South coast			
1	Hungama (Shell deposit) 6°06′30″N, 80°55′30E	+1.3	Veneridae	5780 ± 110	HR 124[b]
2	Hatagala-Hungaga (Shell deposit) 6°06′35″N, 80°56′45″E	+0.8	Veneridae[c]	4440 ± 60	HR-264
3	Kalametiya (Shell deposit) 6°05′08″N, 80°56′45″E	+1.1	Veneridae[c]	3570 ± 60	HR 265
4	Kalametiya (Shell deposite) 6°05′15″N, 80°57′08″E	+2.2	Veneridae[d]	4460 ± 60	HR 266
5	Kalametiya (Shell deposit) 6°06′10″N, 80°57′15″E	+2.0	Veneridae[e]	3960 ± 60	HR 267
6	Karagan Lewaya (Shell midden) 6°07′20″N, 80°05′10″E	2.3	Veneridae	3050 ± 100	HR 123[b]
7	Udamalala (Shell midden) 6°10′15″N, 88°10′15″E	ca. +6.5	Veneridae	4050 ± 60	HR 122
8	To the north No. 7	ca. +5.0	Veneridae	4650 ± 70	HR 268

[a] From present MSL.
[b] Katupotha and Fujiwara, 1988.
[c] Possibly piled up by wave action (?)
[d] *In situ* deposit (?)
[e] Piled up by wave action.

coasts indicate that relative sea level has been 1 m or more higher than at present in the middle Holocene and the late Holocene (Katupotha, 1988b, c; Katupotha and Fujiwara, 1988). Katupotha and Fujiwara (1988) dated one shell sample collected from north of Kalametiya Kalapuwa which coincides with the first age group on the southwest and south coast and indicates that a brackish environment extended perhaps 3 km from the present shore.

The altitude, composition, and depositional sequences of shell deposits at Karagan Lewaya and Udamalala areas appear to differ from those other shell deposits in the study area. The shells of two samples (HR-122 and HR-123) are held together with reddish-yellow sand and pale yellow sand and covered by regosols. Another sample (HR-268) was found within a regosol and shells were weathered dark brown to reddish-brown. The base of the shell deposits consists mainly of weathered bedrock. On the basis of these criteria, these deposits are assumed to belong to shell middens.

CONCLUSIONS

Radiocarbon dates of fossil shell deposits at the rims of emerged coastal embayments and lagoon floors have ages between 4650 ± 60 and 3570 ± 60 yr B.P. It is inferred that the marine shells have accumulated by three processes: (a) The extensive shell deposits of emerged coastal embayments were mainly accumulated by wave action. (b) Following the coastal progradation, since the late Subboreal, the shells possibly

gathered in lagoon floors. (c) On the basis of the stratigraphic sequences of several deposits, it is assumed that early human inhabitants dwelled along the hilly coastal and dune areas and left shell middens close to where they lived. The fossil shells perhaps lived in an intertidal zone of embayments and lagoons that extended 3 km or more inland from the present shore in the middle Holocene and accumulated over a vast area along the southern coast.

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