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Testing the applicability of commonly accepted attributes of kitchen middens to distinguish the coastal shell middens in Sri Lanka

Thilanka Siriwardana*
Department of Archaeology and Heritage Management,
Faculty of Social Sciences and Humanities, Rajarata University of Sri Lanka
PhD candidate, Institute of Archaeology, University of Groningen, the Netherlands
*Correspondence: *thilanka.siriwardana@gmail.com*

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ශ්‍රී ලංකාවේ සිප්පි තැන්පතු අධ්‍යයනය දශක කිහිපයක් පුරා භූගෝල විද්‍යාඥයන් සහ පුරාවිද්‍යාඥයන් රැසකගේ දායකත්වයෙන් සිදුවී ඇත. මධ්‍ය හා පශ්චාත් හොලෝසීන මුහුදු මට්ටම් උස් පහත්වීම සමඟ දිවයිනේ දකුණු වෙරළ තීරය ආශ්‍රිතව තැන්පත් වී ඇති සිප්පි තැන්පතුව හෙවත් හුංගම තැන්පතුව ආශ්‍රිතව සමකාලීන පාරිසරික මෙන් ම මානව සංස්කෘතිය සම්බන්ධව සාධක රැසක් මෙම අධ්‍යයන ඔස්සේ අනාවරණය කරන ලදී. නමුත්, බොහෝ විට සංස්කෘතිකමය දෘෂ්ටිකෝණයකින් මෙම තැන්පතු අධ්‍යයනය කරන විට එහි පුරාකෘති වෙත වැඩි අවධානයක් ද සිප්පි තැන්පතුව වෙත සරල අවධානයක් ද යොමුකරන ලද බවක් පෙනී යයි. එහිදී ගැටළු උද්ගතවනුයේ ස්වභාවිකව නිර්මාණය වන වෙරළාශ්‍රිත සිප්පි තැන්පතු සහ මානව මැදිහත්වීමක් සහිත සිප්පි කසළ තැන්පතු අතර වෙනස පැහැදිලිව වෙන්කොට හැදෑරීමකට ලක් නොකිරීමයි. මෙම පර්යේෂණයේදී හුංගම තැන්පතුවේ කළමැටිය ආශ්‍රිතව පවතින එක් සිප්පි කසල තැන්පතුවක ස්ථාරානුගත සන්දර්භයන් 1954 දී එඩ්මන්ඩ් ජිල් විසින් ඕස්ට්‍රේලියානු ඇබොරිජිනල් සිප්පි කසළ තැන්පතු ස්වභාවික තැන්පතුවලින් වෙන්කොට හඳුනාගැනීමෙන් ඉදිරිපත් කරන ලද නිර්ණායක 09 අනුසාරයෙන් විග්‍රහ කිරීමටත් එයින් දිවයිනේ සෙසු සිප්පි කසළ තැන්පතු විශ්ලේෂණය සඳහා ක්‍රමවේදමය ප්‍රවේෂයක් ලබා ගැනීමටත් අපේක්ෂිතය. එවැනි ප්‍රවේෂයක් ලබාගැනීමට තැන්පතුවක අන්තර්ගතය ඉතා සූක්ෂ්ම ලෙස වාර්තාකරණය හා දත්ත ලබාගැනීමට ලක් කළ යුතු වන අතර මධ්‍යශිලා යුගයේ දඩකරු අන්නගවේෂීන්ගේ සසම්භාවි විලෝපික චර්යා, කණ්ඩයමක ශ්‍රම විභජනය වැනි සංස්කෘතිකමය ගැටළු මෙන් ම ආංශුක කලාපීය දේශගුණික වෙනස්වීම්, විශේෂයන්ගේ පරිසරානුගත රූපාකාර වෙනස්වීම් වැනි පුරා පාරිසරක ගැටළු පවා සලකාබැලීමට මෙම සිප්පි කසල තැන්පතු වැදගත් වේ.

මුඛ්‍යපද : පුරාමෘද්වංශවිද්‍යාව, ප්‍රාග් ඉතිහාසය, වෙරළබඩ තැන්පතු, කසළ තැන්පතු, වර්ගීකරණය

1. Introduction

In the coastal archaeology, there is a substantial list of criteria which are conventionally using to distinguish the nature and formation of cultural and natural shell compositions (Carter et al., 1999, 91). Among these, Edmund D Gill's (1954, 249) *'distinguishing marks of kitchen middens*" is one of the earliest introduced criteria. He listed nine attributes of Aboriginal shell middens in Australia which were often confused with marine shell beds. Gill's approach was widely discussed and tested by many other researchers since then (Bindon et al., 1978, Anderson, 1981, Cann et al., 1991, Attenbrow, 1992, Stein, 1992, Rowland, 1994, Carter et al., 1999, Ulm et al., 1999, Faulkner and Clarke, 2004, Gassiot et al., 2008, Bernaldez et al., 2008, Alexander, 2009, Bartosiewicz et al., 2010, Sullivan et al., 2011 and others referred in the text). The present study will examine the applicability of Gill's nine attributes of kitchen middens to the coastal shell middens in Sri Lanka.

In some cases, it is hard to distinguish a natural shell bed from a shell midden if both formations are reporting in the same region. Terms as 'deposit', 'bed' and 'midden' used in the texts interchangeably without a proper definition of the physical characteristics of a midden.

As Sullivan and O'Connor state (1993, 776),

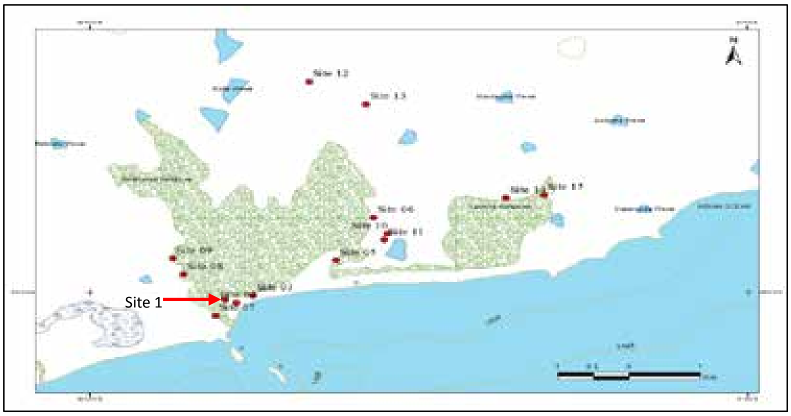
> *"A common phenomenon in tropical coastal environments is the contiguity in both space and time of prehistoric shell middens and cheniers. Discriminating between different types of shell deposits is a difficult task, often compounded by culturally derived shell deposited on the surface of natural shell ridges."*

The present study will not examine the attributes of coastal shell beds in Sri Lanka (Refer Katupotha for extended geological reviews of the matter) and explicitly focusing on the shell middens. Gill (1954) compiled the list by generalising the attributes of Aboriginal shell middens. Though there are no universal laws of midden formation, Gill's attribute list can be adapted to find a way to define the local shell middens. Further, it can be developed ethnoarchaeologically by reviewing the attributes of Mesolithic shell middens and the recent kitchen middens.

2. Background

The early scientists as Wayland (1919), Wadia (1941) and PEP Deraniyagala (ARCM, 1941, F2) believed the coastal shell formations were results of a land upheaval event. Latterly, Katupotha reported and emphasised the Pleistocene and Holocene sea-level fluctuations as the agent of the formation of the coastal shell beds (1989; 1990). Hungama Formation (HF) in Southern Sri Lanka is such a mid to late Holocene formation extending from Hungama to Bundala. Three high sea-levels episodes occurred between 6240 and 2270 yr BP was the causative of the formation (Katupotha, 1994, 142).

While such natural formations are forming, the culturally created debris was also accumulated in the association of such contexts. Contrary to the coastal shell beds, these "coastal kitchen middens" has a cultural origin and formed through the accumulation of the refuses discarded by the coastal inhabitants. It requires a systematic approach to identify and interpret these two types accurately.



Map 1.
Sites recorded from the Kalamatiya wildlife sanctuary and in association of the Lunama lagoon.

There are numerous archaeological studies commenced in the HF with distinct approaches. In most cases, it was prehistoric studies lead archaeologists to probe the cultural formations in the region. Deraniyagala provided a brief account of a deposit he probed in Kalamatiya and proposed as a possible midden of Late Holocene (1992, 93). Further, from a site at Patirajawela, he recorded artefacts (n=328) and faunal remains within the shell stratum (Deraniyagala in Kaurampas et al., 2012). The site was reprobed by Kourampas and others (2012) but was unable to reveal any obvious evidence for human input in the intershell matrix within the part they have excavated (ibid, 09). This raises the concerns of defining a shell midden by based on its artefactual contents.

In another study, Adikari and Risberg (2007) commenced a regional survey with a series of coring to examine the stratigraphy of all the coastal shell beds in HF. Coring data did not provide a clear notion of the content in the shell bearing context and even the sites they located from Hamgodana near Malala Levaya mentioned as a possible midden by considering the artefacts and charcoal recovered from the coring (2007, 04) was not conclusive. Most recently, Kulatilake and others' (2014) excavation of a burial in the Miniathiliya shell deposit in HF included Mesolithic cultural traits defined as a shell midden. However, the motives were not provided of the conclusion, and the researchers focused on the content of the burials. Among these, the coastal Mesolithic burial excavation of Pallemalala by Somadeva and Ranasinghe (2006) clearly stated the studied deposit is a natural chenier formation, which was used by the hunter-gatherers as a habitation floor.

Katupotha's radiocarbon dates show two clear phases of the formation of coastal shell beds and the human habitation on them (1995, 1042, 1054, 1059). While identifying many studied sites as coastal shell beds, he assumed the Karagan Lewaya (3050±100 BP) and Udamalala (4050±50 BP) as 'shell middens sites' by considering its location ("*shells on the coastal hills and dunes were left by early inhabitants during their daily activities*") and content (Katupotha, 1988a, 127; 1988b, 346).

In most studies, the artefacts in the deposits were outweighed while the shell matrixes were simply described. The correlation between shell population, size variation, densities and shell species and other attributes were not subjected to a detailed analysis. Factors like these should examine to get a proper definition for the middens in the HF. There are numerous attribute lists to describe a shell midden. Among these, Gill's list of nine attributes has to be one of the most cited and applied in many contexts over the world. The present study is attempting to test the applicability of these attributes to the coastal shell midden in Sri Lanka in a hope to provide a roadmap for the future local studies to follow as a general checklist of attributes.

3. Methodology

3.1 Field survey and sampling

After reviewing the previous studies, a field survey was designed under three phases.

- Phase I - Regional survey in 2011: Field walk in the region from Rakawa to Lunama. Kalamatiya was identified as a potential site to be studied.
- Phase II - Testing in 2012: an area from shoreline to inland, ca. 3.7 km^2 was surveyed in the Kalamatiya sanctuary and periphery by ground walking. An unsystematic vertical grab bag samples from the exposed sections was done to identify the shell size variation and soil composition
- Phase III - Data Recovery in 2014: Subsurface horizontal sampling done at a selected site in a unit of 1mx0.5m. For a detailed quantitative record, and analysis of the assemblage bulk sampling, column sampling and random sampling (Kipfer, 2007, 219) was done. To ensure the relationship and pattern identification, an equal volume of soil bagged from each layer and sieved at the laboratory—this sieving process aids to reduce the bias of shell size variation as small shells.

3.2 Materials

Shells of the phylum Mollusca are the main faunal remain retrieved and belong to the classes of Pelecypoda (Bivalves) and Gastropoda (univalves). The inclusions such as lithics, wastage, vertebrate faunal remains, potsherds, stones, charcoal in shell matrix were recorded separately. Material type and relative chronological sequence considered placing the artefacts in cultural and event sequence. Identifications, confirmation and nomenclatural of shells were made by using the field guides and online catalogues as Marine Species.org and Rotterdam Natural History Museum collection and by Malik Fernando. Bones were identified by Kelum Manamendra-Arachchi. The terms and technology of the lithics are adapted from the Deraniyagala (1992) classification and classified by Nimal Perera.

3.3 Data Analysing

The present study use both qualitative and quantitative methods. Taxonomic lists, habitats, species preferences, conditions of the shells, artefact typologies, stratigraphic frequencies of the artefacts and the faunal remains were prepared. Every single faunal remain will be named here as a *specimen* either it is completed or fragmented. Identifiable specimens were used to calculate the Minimum Number of Individuals (MNI) and the Number of Identified Specimens (NISP) (Brewer, 1992). Only the complete shells and beaks were used to count the MNI. NISP recorded to examine changing taxonomic frequencies through time. Highly fragmented specimens were not counted and weigh as a bulk of each context. The relationships between shell size and distribution in each context, conditions of the shells, economic values of the shells, material other than shells in the deposit are considered to obtain analytical data outputs.

Anatomy and axis measurements are taken by following the available standard references (Fernando, 1977., Powell, 1976., Muckle, 1985; Fernando, 2009). Length and width of each collected shell were measured to the nearest 0.01mm. As the size of the shells is a concern, a particular reference chart was prepared for measuring left and right valves of *Meretrix sp.* shells (fig. 1) illustrating fifteen shell sizes in the height range of 5 mm to 50 mm. The molluscs remain types (burnt, broken, fragment, whole shell and so on) were defined and analysed according to the classification of Carter and others (1999). Size less than <15mm in length was considered as 'non-edible' or 'non-economic'.

Grain size analysis was done to identify the formation of the sedimentary deposit. Few samples of 50 ml were tested. The organic materials and silt were washed with water, and the remained sediment treated with Hydrochloric Acid (HCL) / Sulphuric acid (H_2SO_4) conc solution of 10 ml for 30 minutes for removing the calcareous particles. The grain sizes and the shapes are classified accordingly to the Archaeological Site Manuel of the Museum of London.

No dating attempt was made, and the stratigraphic sequences of the dated sites in the region will be used for relative dating.

4. Results

4.1 Field Survey

In the whole study, fifteen sites recorded from the exposed sections. One site contained archaeological materials which named as the site 1, will be based to the present study.

4.1.1 Site 01 - Kalamatiya Sanctuary (60 04’ 56.9’’ N - 800 56’ 08.6’’ E)

A shell midden identified from an exposed near-vertical bank of a shell mining pit in a site located on a headland between the sea and lagoon. Grey coloured patch of shells ca. 15cm thick exposed in the section of in situ deposit includes some bone fragments and possible wastage of lithic manufacturing, and these features indicated a possible *‘shell midden’*. The feature appeared to be a small, relatively shallow lens when comparing with the extensive shell beds in surrounding and much beneath layers.

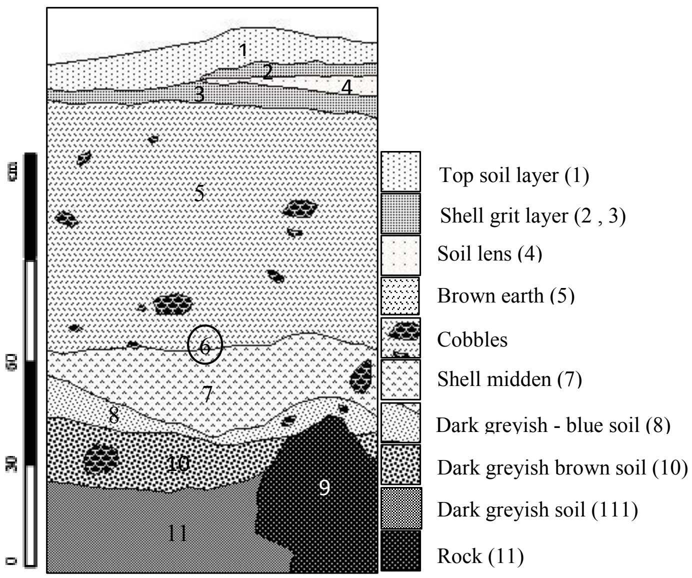


Figure 1
Stratification ofo Site 01 - after excavation
(Numbers are given for the contexts)

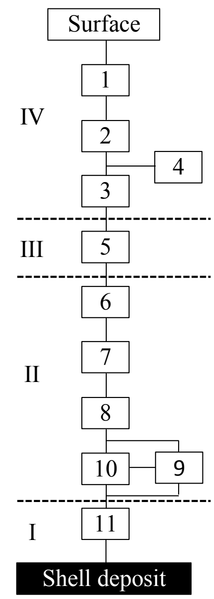


Figure 2
Matrix chart of the Site 01

4.1.2 Contexts and Phasing

Nine layers were recorded and sorted into eleven contexts (fig. 1 and 2). Considering the transposed primary contexts, use related primary contexts and natural secondary contexts (after Kipfer, 2007, 23), the stratigraphic sequence of the deposit divided into four phases; i.e. phase I - pre-occupational phase, phase II - Mesolithic habitation, phase III - historical, phase IV - recent (*terminus post quem* 1900 AD with *Lissachatina fulica* shells). Phase II comprises with contexts 7, 8 and 10 has the traits of a cultural sequence.

4.2 Size and content of the deposit

The shell deposit consists of shallow layers of 10 - 25 cm. The shell deposit’s non-sedimentary content included shells, fragments of bones, charcoal, lithic and product waste of quartz and chert (two types), stones and four potsherds. Bones include both fish bones and terrestrial animals.

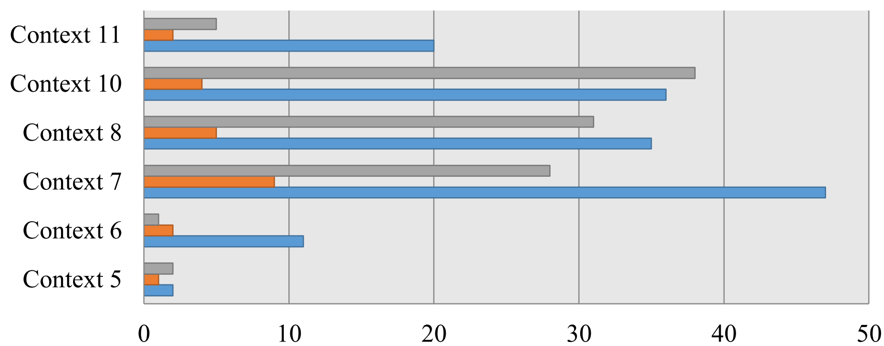
4.2.1 Taxonomic list and NISP (molluscs)

Total NISP of shells is 5165 (*Meretrix meretrix*- 4923/ abundance rate 95%, *Cerithidea cingulata*-115/abundance rate 2% and other species - 127/abundance rate 03%) and identified with 15 proper taxas, one undefined taxon and two undiagnostic shell types (Table 01). C7 shows the highest taxonomic abundance (n=12). From the total number of *Meretrix* shells from all strata, 47% (n=2393) retrieved from the 7th context, and it is 96.5 % of the shells in that particular context. Abundance rate of the other eleven species in the context is 3.5%. Four of these species having one occurrence (n=1) while another four species appear less than eight. A detailed list of NISP of each taxon from the contexts is given in table 1 and chart 1.

Table 1
Molluscs species frequency (by NISP) in each context, Site 01
(colour key given below)

	Species	**Context 01**	**Context 2-4**	**Context 05**	**Context 06**	**Context 07**	**Context 08**	**Context 10**	**Context 11**
1	*Meretrix meretrix*	5			412	2309	935	926	336
2	*Anadara granosa*				12	9	8	10	
3	*Donax cuneata*			1	1		1		
4	*Saccostrea sp.*				1				
5	*Umbonium vestiarium*			1	2		1		
6	*Cerithidea cingulata*	2	Shells not counted (recent dump-ing)	11	34	26	28	10	
7	*Acavus heamestoma*				7	18	15	1	
8	*Aulopoma hofmeisteri*			1	19	10	22	4	
9	*Oigospera polei*					1	1		
10	*Beddoma trifasiatus*				2	2			
11	*Lissachatina fullica*	2							
12	*Papyridea soleniformis*?				1				
13	*Tapes sulcarius*					1		1	
14	*Purpura persica*							1	
15	*Cryptonatica operculata*					1			
16	*Eunaticina sp.*?				4	2	1		
17	Extinct bivalve species?				1		1		
18	Bivavle shell (calcareous)					1			

Traces of cultural occurrence | indirect evidence / small part of a shell
Direct evidence with whole or acceptable part of shell



	Context 5	Context 6	Context 7	Context 8	Context 10	Context 11
Land	2	1	28	31	38	5
Marine	1	2	9	5	4	2
Lagoon	2	11	47	35	36	20

Chart 1
Frequencies of lesser molluscs species (by NISP) in each context against their habitat range in Site 01 (without M. meretrix)

4.2.2 Habitats of the molluscs

The total 18 species are representing a diverse range of habitats as four lagoon/ brackish water species, seven marine species, five terrestrial species and two possible marine species. The habitat preferences are range vertically from subtidal zone to dendrocolous. Three aquatic species most commonly represented in the samples inhabit shallow water and water's edge of intertidal mudflats. The known ecological attributes of the identified species are listed in Table 2.

Table 2
Ecological preferences of the molluscs recovered from Site 1

Brackish water - lagoon | Marine | Land

	Species	Habitat
1	*Meretrix meretrix*	Intertidal or uppermost intertidal or subtidal or whatever
2	*Anadara granosa*	Intertidal silty bottom with relatively low salinity -brackish water, littoral area
3	*Saccostrea sp.*	Intertidal zone attached to hard substrates and also in mangroves
4	*Cerithidea cingulata*	Intertidal mudflat and shallow pools, upper shore and at depth of 0.3 to 0.5 m, edges of lagoons, muddy sands, muddy banks of brackish water channels and in and out of water at edge
5	*Donax cuneata*	Shallow inshore waters off gently sloping sandy beaches
6	*Umbonium vestiarium*	Intertidal sandy beaches, and restricts to mid tide zones and avoids sand of finer grade or sand mixed with mud
7	*Papyridea soleniformis*?	Marine
8	*Tapes sulcarius*	Marine sandy bottom
9	*Purpura persica*	Marine, rocky shore near low tide level and intertidal rock pools
10	*Cryptonatica operculata*	Marine
11	*Eunaticina sp.*?	Shallow tidal flats to 20-40 meter depths
12	*Acavus heamestoma*	Terrestrial - arboreal snail commonly found in the natural forests and home gardens that are in close proximity to natural forests and have dense canopy of large trees and a well-developed layer of shrubs and saplings
13	*Aulopoma hofmeisteri*	Terrestrial gastropod
14	*Oigospera polei*	-
15	*Beddoma trifasiatus*	Arboreal gastropod
16	*Lissachatina fullica*	Terrestrial – arboreal
17	Extinct bivalve species?	-(possible marine and deep water?)
18	Bivavle shell (calcareous)	-(Possible marine)

4.2.3 Size of shells- Meretrix meretrix (NISP and MNI)

The size of the shells will use as an underlying assumption for the analysis. Shells of dominating *M. meretrix* divided into fourteen size ranges. Non-economic (<13mm - 15mm) shells divide into five size ranges and edible shells (15mm-50mm) into nine size ranges. Data reported through the NISP and MNI (Table 03).

Table 3
Size variation frequencies of Meretrix meretrix (NISP and MNI) in each context in the Site 01

Context	Total weight of valves (g) (including fragments)	NISP	MNI	Size categories (by the No. of shells concerning the shell size scale - by NISP)													
				1 (>05mm)	2 (5-7mm)	3 (7-8 mm)	4 (8-11mm)	5 (11 - 13 mm)	6 (13 - 15 mm)	7 (15-18 mm)	8 (18 - 21 mm)	9 (21 - 24 mm)	10 (24-27 mm)	11 (27-30 mm)	12 (30-35 mm)	13 (35-40 mm)	14 (40-50 mm)
1 - 4	*(Shells from a later filling. Not counted)*																
5	No shells include																
6	78.7	412	235	153	103	75	19	28	16	9	5	3	1				
7	11570	2309	1226	59	116	123	87	87	151	279	616	632	142	12	1	4	
8	1389	935	493	239	220	155	79	71	56	50	37	17	4	3	4		
10	615	926	501	179	165	148	132	72	59	56	50	37	17	4	3	4	
11	114.2	336	169	102	91	46	27	27	13	10	13	4	1	0	0	1	1
Total	13766.9	4918	2624	732	695	547	344	285	295	404	721	693	165	19	8	9	1

4.2.4 Non-mollusc fauna - marine and terrestrial

Numerous specimens of faunal remains recovered (n= 82 from C6 - 5, C7 - 7, C8- 36, C9 - 10, C11-24) (including 09 vertebrae, 10 fish otoliths, 02 teeth). Only *Rusa unicolor* (sambur) by its right astragalus bone and *Epinephelus malabaricus* (*Eng.* - Malabar grouper, *Sin* - Gas Bola / Gal Kossa) by its otolith could identify to the species level. Other remains of bony fish (fish vertebrae, otoliths, and tooth), birds (patellar, malleolus, and condyle of the tubular bones) mammals (tubular bones and tooth) were retrieved. Faunal remains are fragmented and covered with a highly cemented brown mud-sand layer (Fig. 03).

Figure 3
Faunal remains from the Site 01
(except the lower right sample from the site 08. Drawn by the author)

4.2.5 Lithics : 59 lithic recovered from the C6 (n=7), C7 (n=23), C8 (n=9) and C10 (n=20)

(potential edge - point tool (n=1), possible micro blade (n=1), flakes (n=40), cores (n=9), core with used marks (n=2), manuport pebbles (n=5), used hammer stone (n=1). Raw materials are chert (brown and yellowish brown), quartz (milky and clear types) and granitic gneiss (Fig. 03).

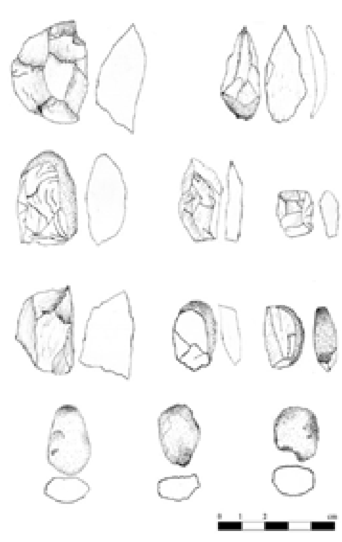


Figure 4
Some selected lithic from the context 07 of the sampling unit of Site 01 (Drawn by the author)

4.2.6 Pottery

Two red ware potsherds found from the upper horizon of the context 05 and two small pieces of burnt clay (<2.5 cm) recovered from the lower horizon of the context 06.

4.2.7 Charcoal

Inclusions of charcoal and ashy soil are characteristic to context 07 and rarely noticed from the lower contexts. The charcoal is highly fragmentary.

4.3 Soil and contents

The whole stratigraphic unit of the site has zonal soil with distinct horizons. Lower horizons have silty clay texture with aggradation of lagoon silt while upper horizons gradually change to sandy clay. A unit of 100 g soil from context 7 contained organic and silt (27.77 g), shell grit (12.79 g) and sand (59.49 g). Sand grains are very fine (1/16 - 1/8 mm) to medium sand (¼- ½ mm) and angular in shape and low to mid in sphericity.

5. Analysis and discussion

As the present study is focusing on the applicability of Gill's list of attributes to the Sri Lankan context, the headings are given below are adapted from his text.

5.1 The presence of charcoal, burnt wood, blackened shells and such evidence of fire.

Gill (1954, 249) shows the charcoal, burnt wood, and campfires are indicators of shell middens. Though there is abundant charcoal both within and surrounding the shell deposit, there is no clear sign of localisation which can interpret as a campfire. However, the charcoal and the ashy soil in the C7 is a sign of long term accumulation. These ashes could be residues of, i.e. dry palms, hay or dry leaves which are not leaving charcoal traces.

The most significant feature is a large number of fragmented shells with colour staining of dark grey. This is an indicator of the molluscs cooked by putting them into an open fire. Similar colouration and the texture noticed from the shell middens in other countries as well (Bindon et al., 1978, 169, Carter et al., 1999, 90) and used as an analytical basis to separate middens from natural deposits. The colour staining and texture of the chenier shells characterised by white tinged shells in the clean yellowish sand which can distinguish from the midden contents, which is dark and contained organic burnt organic materials. Further, some bone fragments have visible burnt marks.

5.2 The charcoal and shells often have a rough stratification and no fine features of sedimentation such as commonly found in water-laid deposits.

While the distribution of the fragmented shells (both burnt and unburnt) showing a higher accumulation within the context 7, such remains along with the other artefacts were received from the contexts beneath. Though the contexts can define with the indistinct colouration and by the content, no visible stratigraphic units could be identified from the site 01, except from the contexts 05 and 11, which have sedimentary contents, and no artefacts.

5.3 The presence of aboriginal implements, and/or of numerous unworked flakes of flint. Commonly found also are pebbles of hard rock which could not occur there naturally.

Lithic found from the contexts 06, 07, 08 and 10 are prominent and are the most apparent material evidence of the human agency in the formation of the site. The assemblage contained some artefacts and pebbles. Comparing with the other finding in Sri Lanka (Deraniyagala, 1992), flakes, and lithics made from quartz and chert can assign into the Mesolithic phase. Though the assemblage is not large, it includes smaller flakes, irregular cores, waste products from microlith production and the absence of any definable tool types is significant. Available flakes and cores suggest on-site manufacturing. On the locations of implement manufacturing, it is possible to occur artefacts as quartz lumps and untouched flakes (Allen, 1989, 114). The diversity of the raw materials indicate they were transported from the surrounding to the campsite. Quartz nodules may obtain from river pebbles as the cortex of many flakes remained with water warn surface. For precise identification, stone assemblage classified into the following classes (Attributes of Deraniyagala (1992) were considered).

Class I - Edge trimmed artefacts without form trimming.

Type 1. small edge trimmed flake
subtype (a) scraper

Class II - Potential edge and point tools without use marks or secondary trimming

Class III - Cores (nuclei) displaying negative scars from flake or blade production

Class IV - Waste flakes, namely by-products of knapping

Class V - Nonflaked stone artefacts, including manuports with use marks and grind-stones

Class V - Nonartefactual lithic ecofacts

It should note a site studied by Deraniyagala located opposite shore of the lagoon (Henagahapugala- Site 57) provided the most recent date of 1240 BC for the use of stone tools in Sri Lanka (Deraniyagala, 1992, 97).

Also, it should note the presence of potsherds in the termination phase of the shell midden. Though the remains are negligible due the size of the remains, midden studies might shed light to the current discussion of the Mesolithic hunter-gatherer transition in Sri Lanka (Deraniyagala, 1992, 19, Somadeva, 2006, 82, 287).

5.4 The presence of shells which do or could live on the contiguous coast

Gill proposes the presence of shells, always of extant molluscs, which do or could live on the contiguous coast as a sign to define a midden. It has been noted that there is a very close correlation between the shells of the middens and the facies of marine life present on the adjoining coast. The changes in coastal physiography are accompanied by equally significant changes in the molluscan fauna and thus also in the shells of the middens (Gill, 1954, 249).

Katupotha and Wijayananda assume the fossil shells found in shell deposits of the Southern coast of Sri Lanka are perhaps lived in the intertidal zone of embayments and lagoons that extend 3km or more inland from the present seashore in the middle Holocene (Katupotha and Wijayananda, 1989, 228). Shell middens in Patirajawela represent only a single species of intertidal (Deraniyagala, 1992, Kourampas et al., 2012). Findings from the Miniathiliya shows a range of species of land, estuarine and marine habitats (Katupotha 1995; Kulatilake et al., 2014, 3).

In the present study, *Meretrix meretrix* dominates all other 17 mollusc species recorded (Table 1), it is fair to assume the adjacent environment was more of brackish water lagoon similar to present Kalamatiya-Lunama lagoons. Other species as *Anadara granosa*, *Saccostrea sp* and *Cerithidea cingulate* are also commonly consumed. Though the *M. meretrix* is not reported from the current biome, still they can find from the lagoons eastward of Kalamatiya. These most common aquatic species in the samples inhabit shallow water and water's edge of intertidal mudflats.

The NISP of the seven marine species is 23, which is only 8.2% of the total number of shells (calculated without *M. meretrix*). From these, *Donax cuneata*, *Papyridea soleniformis*, *Tapes sulcarius,* and *Purpura persica* are edible and *Umbonium vestiarium, Cryptonatica operculata* and Eunaticina sp are common shore species which have a lustrous shell. As there are few non-edible shells reported, it is hard to conclude their origin.

The NISP of the 05 terrestrial species is 151 (54.1%). The presence of wetland species as *Aulopoma hofmeisteri, Acavus heamestoma* and *Beddoma trifasiatus* is highly significant as the current conditions of the environment are semi-arid. We have proposed the possibility of micro-climatic changes in the intermediate zone of Sri Lanka during the mid to late Holocene of Sri Lanka is currently studying (Siriwardana, 2015). Further, the ecomorphology of the *A. heamestoma* is significant as much as their presence in a semi-arid region. The reduced size and the shape of these shells in the midden are highly distinct from the modern live species, suggests a regional micro-evolutionary process, and this matter is also continuing as a further study. However, the morphological characteristics, nature and the abundance of the terrestrial shells indicate mangrove or forest vegetation associated with the lagoon environment. Such a diverse environment with abundant coastal resources might attract the Mesolithic hunter-gatherers toward a more sedentary lifestyle.

5.5.a. Midden shells are of edible species and edible sizes

5.5.b. Sometimes aboriginal kitchen middens give evidence of a degree of selection which could not apply to marine shell beds. Middens often have local layers which consist almost entirely of specimens of one genus.

Here, the traits similar to the Gills fifth and sixth attributes will be discussed together.

5.5.1. Edible species and degree of selection

Gill (1954, 251) and Attenbrow (1992, 15) had defined non - edible species based on their size. If an individual animal is too small to provide a reasonable amount of flesh, it was considered as non-edible. Edibility often depends on the maximum size to which a particular species grow. Gill states it as *"in the emerged shell beds there are numerous shells of species too small for food"*. Diagnostic elements representative of each taxon is determined, then sorted and counted in establishing the minimum number of individuals (MNI).

Context 7 recorded the highest MNI (n=1226) of *M. meretrix*. The shells in this context are mostly fragmented and contained 11.5kg of shell debris (84% of whole meretrix shells) showing clear burnt and shucking features. Though the MNI of this species shows the preference of the consumers, the negative survival rate of the diagnostic elements of the dominating taxa's level underestimates the actual frequencies. Therefore, the higher preference for a single species is apparent when thinking of both denominators. The preference for this single species reported in prehistoric subsistence from the other prehistoric cultures as well (Rao et al., 1988, 41, Allen, 1989, 101). A secondary preference can see from the *Anadara sp*. which was also usually consumed species world over and often recorded from middens as well (Biagi, 1994, 24, Carter et al., 1999,88, Rainbird, 2004, 105, Bourke and Hua, 2009, 176).

NISP of the other mollusc species is little when compared with the dominant species. Except for *Meretrix sp.,* the shell weight of all other species in the deposit is 355 g (<0.8% of the whole assemblage), and MNI is 5% from the whole. The reasons as less tasty than the predominant types, may not occur in sufficient abundance to gather or were less accessible as those in deep water might cause to prefer a single species (Siriwardana, 2013). The species as *Cerithediea cingulate, Umbonium vestiarum, Aulopoma hofmeisteris, Oligospera polei, Beddomia trifasiatus* are non-edible as they do not provide a sufficient portion of meat. *Acavus heamestoma* do not show any sign of usage.

The occurrence of the non-edible molluscs in the midden contexts can occur naturally or as a result of the accidental collection along with the edible shells. Similar events recorded ethnographically as well (Siriwardana, 2009). Also, it should note the species in the modern middens (*Perna sp.*) of the region are lacking in the archaic middens.

5.5.2. Size

Midden shells are usually compositing with edible sizes or so-called *'economic species'* (Taylor, 1891, 89, Gill, 1954, 251-2., Anderson, 1981, 114, Raab, 1992, 72, Carter et al., 1999, 91, Siriwardana, 2013, 248). On the other hand, natural shell beds have numerous shell sizes at all stages of growth, including sizes too small for food (Gill, 1954, 251-2). As Gill shows, Aboriginal people tended to collect the individuals in a larger size (adult) range of a species. However, this can depend on the size of the shell population available when collecting (Attenbrow, 1992,16).

Shells of dominating *M. meretrix* received from the contexts of the Site 01 divided into fourteen size ranges (Table 03). The stratigraphic distribution pattern of these shows a clear difference in the ratio. Shells measuring 15 mm to 50 mm forms the most substantial portion of mollusc's remains in the midden context (C7) and it is 89.2% while the size class 01 mm - 15 mm make up less than 10.8% of the same layer. The shell sizes in the lower units show individuals measuring 01 mm - 15 mm (78.8%) followed by those measuring 15 mm - 50 mm (21.2%). Individuals classed above 21 mm constitute less than 5.5% in the context 8-10 while the context7 has 38.4% of individuals above that range (chart one and table 3).

As the above data derived from two unequal units, again, the fourteen sizes were separated into two size groups by assigning seven sizes into each group. Yet the results give a ratio of 1:3 of small vs large shells in C 7, which is varying from 4:1 to 22:1 in the other contexts. It should note that these other contexts provided a small number of shells. Further, the fragmented shells were observed as derived from the large shells in the C7 it is 84% of the whole fragments of shells. Hence, the consequent of the above ratio should be higher than the antecedent.

Further, it should note the size variation noticed among the burnt/fractured shells and the unburnt/fractured shells. The full shell sizes were drawn from the table and classed into the ranges of 8-9 and 10-11, respectively. Though all are in a mixed matrix, this variation can occur as a result of collecting shells within two different times in a single season or two distinct periods. The taphonomic features of the two types show a tendency in favour of the second. It can assume the location was in frequent use from time to time, and the inhabitants might have a mobile lifestyle either along the coast or from inland to the coast.

It should note that some researchers draw the attention of the cases where the small bivalves less than <15mm were used and even transported to the inland (Rowland, 1994, 120) and the possibility of phenotypically and genetically caused size reduction through time in a population (Randklev et al., 2009, 206). Also, Burchell and others (2007) suggest a scientific method to analyse the measure of shellfish collection strategies by using size variations. As they hypothesised the intensive gathering of shells gives a higher population of mature growth, the selective gathering gives a more significant proportion of adult shells, and casual collection gives a mixed-age profile (Burchell et al., 2007 poster). These perspectives should be raise and consider by future researchers in Sri Lanka.

5.6. As midden shells are collected by hand from where they live, their surfaces are not worn as is the case with most beach shells.

Some of the complete shells of *M. meretrix* have a sheeny surface. Generally, the shells are well preserved and do not indicate any sign of water rolling. A thinly cemented mud layer on the shells and bones is the only visible post-depositional alteration. This indicates a later inundation of the midden by the increasing levels of the lagoon water, a sign of sea-level changes (Katupotha and Wijayananda, 1989). The molluscs might collect by hand, and there is no direct evidence except the shells size to identify the retrieval method.

5.7 The fracture of the shells.

Researchers (Taylor, 1891, 90, Gill, 1954,251., Bindon, et al., 1978, 168, Cann et al., 1991, 166) stated that shells in middens have different fracture patterns which differ from the shells in natural shell beds as a result of the method of collection and processing. Adikari and Risberg used this same criterion to interpret the anthropogenic shell accumulations at Hamagodana in Southern coastal Sri Lanka (2007, 06).

There were few articulated shells in the stratigraphic sequence, and most of the shells are fragmented. 13.8 kg of fragmented shells recorded from all the contexts shows a clear sign of intentional break opening of the bivalves and the gastropods. Fractures are common in the dominant species *Meretrix* and noticeable in the *Anadara* and *Perpura persica* shells. The angular fractures of these shells are not visible from the other shells in the same context suggest the human agency. Studying fracture patterns can assist in defining the shell matrixes even in the cases where the debris are mixed with the natural formations (Hughes et al., 1978, 160).

5.8 Middens have in addition to the shells have aggregations of the bones of land and sea animals used for food by the aborigines.

Bones belonged to both terrestrial and aquatic species were recorded. All the bones are fractured, and only the processes of limb and rib bones remain. A Large number of vertebrae with distinct centrum and transverse process have belonged to *Osteichthyes* (bony fishes). A one larger trunk vertebra from the C07 can belong to a fish long as ca. 1.5m. As identified through the otoliths, *Epinephelus malabaricus* (Malabar grouper) (Gas Bola / Gal Kossa in Sinhala) were fished. The juveniles of this species found in estuaries and from mangroves. Mature animals migrate towards near-shore and outer reef systems to depths up to 120 m and adults growing largest up to 130 cm (Rome and Newman, 2010, 07) and most famous for spearfishing (Schembri and Tonna, 2001, 131). Further, the recorded fish tooth is from a bottom feeder.

Burnt bones of *Rusa unicolor* (sambur) show the levels of big game hunting. Large fragmented bones are from terrestrial mammals. The fragmentary level does not aid to identify its species as well. Small rib bones and limb bones are belonged to birds and possibly of the aquatic birds. However, the species could not identify.

These faunal remains reported from context 8 and 10 with lesser shells indicate the inhabitants consumed the birds (aquatic) and marine animals as well as terrestrial mammals. It was only in a certain period which formed the C07 they primarily consumed the molluscs. The region has higher biodiversity consisting of 24 mammals and 168 bird species. Also, a large number of marine (n=185) and lagoonal-freshwater (n=35) fish species are a potential food source. In some cases, molluscs were considered as a famine food when all other sources are not available. As can be seen from the present site, the inhabitants relied on the other sources and then started to harvest molluscs extensively along with the other animals.

6. Conclusion

The present study was based on a coastal shell midden overlying a natural shell bed. The stratigraphic sequence from C 6 to C 10 indicates habitation of Mesolithic hunter-gatherers who relied on the coastal resources for their subsistence. Their changing preferences of aquatic and terrestrial fauna against the molluscs' sources are visible through the archaeological record. Virtual exclusion of all other faunal remains, including fishbone, the excavated faunal assemblage consisted entirely of the remains of shellfish. The large quantity of shells recovered from the Context 07 the nature of the shells indicates the features of a midden. The entire assemblage dominated by a single species (*M. meretrix*), with some variability demonstrated in the second most commonly occurring species, most evident in a comparison of the lower levels. Lagoon species dominate the entire archaeological shell assemblage indicating this habitat as a key resource procurement zone throughout the occupation of the site. It can suggest these inhabitants had ichthyophagy subsistence, and the fishing may limit to the littoral area as the vertebrae are belonging to small animals. Inhabitants then highly relied on small game hunting apart that of small fishes. The exploitation of shell sources was not frequently visible at these levels, and it becomes dominant only at context 07. One large bone piece (from a large mammal) recovered from the site showing characteristic round, the symmetric shape of its corners and at the core. It seems abraded intentionally, but for an unknown reason. However, it can assume the inhabitants at site 01 access to the near-shore - lagoonal fish sources and done spearfishing (?) as well. Therefore, it is good to say the inhabitants not strictly depend on molluscs while they had abundant fish sources. Their 'ichthyophagy' or fish-eating lifestyle combined with the all available aquatic life forms. Seeking for larger molluscs is thence pivotal but not a sole resource.

The present study attempted to reorder these noticeable features through one of the most accepted criteria of shell midden study provided by Gill (1954). This should not consider as a final remark or a definite checklist for the shell middens in Sri Lanka. Each midden has its own identity, and the researchers must familiarise with what they are handling. For instance, two different strategies of mollusc gathering presented by Meehan (Meehan, 1982, 69 in Campbell and Schmidt, 2001, 113) and Anderson (1981, 1981, 114) were conclusive, but their studied sites were located in a soft shore and a rocky shore respectively. Hence, every single site should study as a unique which has its depositional history. We would like to suggest to working in the kitchen middens somewhat cautiously as every single shell has its own story to tell only if the researcher has time to listen. The excavators must do perform an in-depth study of the regional environment, current ecology, climate changes and so on as all such have a direct or indirect link with the midden and then to the interpretation. The kitchen midden studies in Sri Lanka is still developing; hence the studies can take fresh initiatives.

As it was noted from the present research, it can be developed to study the encounter - contingent prey choice, or the gathering process and the contribution of women as the gatherer and many such concerns of the past human behaviour. On the other hand, there are possibilities of studying the micro-climatic changes occurred in the intermediate zone of Sri Lanka as we have proposed in 2015 (Siriwardana, 2015) which will provide answers to the matters raised in the present study and will open many questions to working on.

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References

Adikari, G., and Risberg, J. 2007. Sediments and archaeology along the Southern coast of Sri Lanka, Archaeologia, Journal of archaeology, Vol.03, pp. 1-10.

Alexander, V.M.C. 2009, One archaeologist's midden is another's shell mound: Defining the criteria for describing and classifying shell mounds, A thesis submitted in partial fulfilment of the requirements for the degree of Bachelor of Arts with Honours in the Department of Archaeology, University of Sydney.

Allen, H., 1989. Late Pleistocene and Holocene settlement patterns and environment, Kakadu, Northern Territory, Australia, IPPA Bulletin 9, pp. 92- 117.

Anderson, A., 1981. A model of prehistoric collecting on the rocky shore, Journal of Archaeological Science, vol. 08, pp. 109- 120.

Attenbrow, V., 1992. Shell bed or shell midden, Australian Archaeology 34, pp. 3-21.

Bartosiewicz, L., Lydia Z. and Clive B., 2010. A tale of two shell middens: the natural versus the cultural in "Obanian" deposits at Carding Mill Bay, Oban, Western Scotland, ed. by Amber M. and Tanya M. in Integrating Zooarchaeology and Paleoethnobotany: A Consideration of Issues, Methods, and Cases, Springer, New York, pp 205-225.

Bernaldez, E., Del Carmen L., Jose L., Felipe V., Esteban G., Jose L., Laura E., Aurora, O., Maria B., Miguel G. and Ana V., 2008. Biostratinomy of natural shell heaps: differences between these heaps and human heaps in archaeological sites, 2nd Archaeomalacology Working Group Meeting Abstracts, Santander, 19-22 February 2008, pp. 7-8.

Biagi, P., 1994. A radiocarbon chronology for the aceramic shell middens of coastal Oman, Arabian Archaeology and Epigraphy, Munsguard, No. 5, pp. 17- 31.

Bindon, P., Dortch, C. and Kendrick, G., 1978. A 2500-year-old pseudo shell midden on Longreach Bay, Rottnest Island, Western Australia. Australian Archaeology, No.8, pp. 162-171.

Bird, W., Jennifer R., Peter V., and Anthony B, 2002. Explaining shellfish variability in middens on the Meriam Islands, Torres Strait, Australia, Journal of Archaeological Sciences, No. 29, pp. 457- 469.

Bourke, P. and Hua, Q., 2009. Examining late Holocene maritime reservoir effect in archaeological fauna at Hope Inlet, Beagle Gulf, North Australia, Ed. A. Fairbrain, S. O. Conner and M. Marwick in Directions in Archaeological Science, pp. 175- 188.

Brewer, D., 1992. Zooarchaeology method, theory and goals, Ed. Michael B. Schiffer in Archaeological method and theory, Vol. 4, Tucson: The University of Arizona Press, pp. 195-244.

Burchell, M., Cannon, A. and Grocke R., 2007. Growth increment analysis as an archaeological measure of shellfish collection strategies, Poster presentation at the 1st International Sclerochronology Conference, July 17-21, 2007, Florida

Campana, S., 2004. Photographic Atlas of Fish Otoliths of the Northwest Atlantic Ocean, Canada: National Research Council.

Campbell, C., and Schmidt L., 2001. Molluscs and Echinoderms from the Emily Bay Settlement Site, Norfolk Island, Records of the Australian Museum, Supplement 27, pp. 109-114.

Cann, J., Deccker, P., Wallace, C. and Marray V., 1991. Coastal aboriginal shell middens and their palaeoenvironmental significance: Robe Range, South Australia, Transactions of the Royal Asiatic Society of Sothern Australia, 115 (4), pp. 161- 175.

Carter, M., Lilley, I., Ulm, S., and Brian, D., 1999. Mort Creek site complex, Curtis Coast: site report, Journal of Queensland Archaeological Research, Vol. 11, pp. 85- 104.

Deraniyagala, S.U., 1992. The prehistory of Sri Lanka, Part I & II, Department of Archaeological Survey, Sri Lanka.

Faulkner, P. and Clarke, A., 2004. Late-Holocene occupation and coastal economy in Blue Mud Bay, Northeast Arnhem Land: Preliminary archaeological findings, Australian Archaeology, No. 59, pp. 23-30.

Fernando, D.H., 1977. Lamellibranchiate fauna of the estuarine and coast areas in Srilanka, Bulletin of fisheries research station, Vol. 27, Sri Lanka, pp. 29-54.

Fernando, M., 2009, Shells of the Sri Lanka seashore, Sri Lanka: Ministry of Environment.

Gassiot, E., Ignacio, C. and Virginia G., 2008. Archaeomalacology and paleoeconomy, The shell middens into the prehistoric subsistence practices in the Caribbean coast of Nicaragua (1400 cal. BC TO 1000 cal. AD), 2nd Archaeomalacology Working Group Meeting Abstracts, Santander, 19-22 February 2008, p. 15.

Gill, E.D., 1954. Aboriginal kitchen middens and marine shell beds. Mankind 4(6), pp. 249-54.

Hughes, P., Sullivan, M. and Brangan, D., 1978. Are there prehistoric shell middens on Rottwest Island?, Australian Archaeology, No. 08, pp. 158- 161.

Hunn, E., 2011. Ethnozoology, Ed. by E. Anderson, D. Pearsall, E. Hann and N. Turner in Ethnobiology, New Jersey: John Wiley and Sons Inc., pp. 83-96.

Jayabal, R., and Kalyani M., 1986. Age and growth of the estuarine clam Meretrix meretrix (L) inhabiting the Vellar Estuary, Mahasagar Bulletin of the National Institute of Oceanography, 19 (2). pp. 141- 146.

Katupotha, J., 1988 a. Hiroshima University radiocarbon Date I, West and South coast of Sri Lanka, Radiocarbon, Vol. 30, No. 1. pp. 125-128.

Katupotha, J., 1988 b. Hiroshima University radiocarbon Date II, West and South coast of Sri Lanka, Radiocarbon, Vol. 30, No. 3. pp. 341- 346.

Katupotha, J. and Wijayananda, NP, 1989, Chronology of inland shell deposits on the Southern coast of Sri Lanka, Quaternary Research, 32, pp. 222-228

Katupotha, J., 1989 a. Coastal landforms during the Holocene epoch in Sri Lanka: are they comparable to those in Brazil and Venezuela?, Proceedings of International Symposium on Global Changes in South America during the Quaternary, Brazil, pp. 188- 191.

Kipfer, B., 2007. The archaeologist's fieldwork companion, Malden: Blackwell Publishing.

Kourampas, N ., Simpson, I., Diaz, A., Perera, N. and Deraniyagala, S., 2012. Geoarchaeological reconnaissance of Pleistocene sites in Southern SL: Fahien - lena rockshelter and tool bearing sediments of the Iranamadu Formation, Ancient Ceylon, No. 23, pp. 1- 26.

Kulatilake, S., Perera, N., Deraniyagala, S. U. and Perera, J., 2014, The Discovery and Excavation of a Human Burial from the Mini-athiliya Shell Midden in Southern Sri Lanka. Ancient Asia, 5: 3, pp. 1-8.

Meehan, B.M., 1982. Shell Bed to Shell Midden. Canberra: Australian Institute of Aboriginal Studies.

Muckle, R., 1985. Archaeological considerations of bivalve shell taphonomy, Canadian Thesis Services, National Library of Canada, Canada.

Narasimham, K.A., Muthiah, P., Sundararajan, D., and Vaithinathan, N., 1988. Biology of the great clam, Meretrix meretrix in the Korampallam Creek, Tuticorin, Indian Journal of Fisheries, Vol. 35 (4). pp. 288-293.

Pethiyagoda, D. and Jayawardena, DE, 1978, Report MR/G16, CGS mineral reconnaissance report 1/1978, The geology of shell beds along the Hungama - Hambanthotha coastal areas, Unpublished report, Geological Survey Department, Sri Lanka.

Powell, A.W.B., 1976. Shells of New Zealand, Christchurch: Whitcoulls Publishers.

Raab, L., 1992. An optimal foraging analysis of prehistoric shellfish collecting of San Clemente Island, California, Journal of Ethnobiology, Vol. 12. pt. 1, pp. 68-80.

Rainbird, P., 2004. Archaeology of Micronesia, Cambridge: Cambridge University Press.

Rao, K., Rajan, C.T. and Ramadass, K., 1988. Molluscan shell deposits along Pinnakkayal- Valinokkom coast and their exploitation, Central Marine Fisheries Research Institute Bulletin, 42, pp. 40- 41.

Randklev, C., Wolverton, S. and Kennedy, J., 2009. A biometric technique for assessing prehistoric freshwater mussel population dynamics (family: Unionidae) in North Texas, Journal of Archaeological Science, No. 36, pp. 205- 213.

Rowland, M.J., 1994. Size isn't everything; Shells in mounds, middens and natural deposits, Australian Archaeology, No. 39, pp. 118-124.

Schembri, P. and Tonna, R., 2011. Occurrence of the Malabar grouper Epinephelus malabaricus (Bloch & Schneider, 1801) (Actinopterygii, Perciformes, Serranidae), in the Maltese Islands, Aquatic Invasions, Vol. 6, Supplement 1, S129–S132.

Siriwardana, Thilanka., 2009. Utilisation of Marine Mollusc: An Archaeomalacological study, Unpublished BA Dissertation, Department of Archaeology, University of Kelaniya, Sri Lanka

Siriwardana, Thilanka., 2012. Marine and brackish water molluscs as food in Sri Lanka: from ancient times to the present, First Palaeobiodiversity Symposium, 2012, Biodiversity Secretariat, Ministry of Environment, Sri Lanka. pp. 242- 252.

Siriwardana, Thilanka., 2014. History of the use of molluscs in Sri Lanka from ancient times to the present: An Archaeomalacological Study, Ed. Malik Fernando, Ministry of Environment and Renewable Energy Biodiversity Secretariat.

Siriwardana, Thilanka, 2015, Formation of shell middens in the association of shell beds, Unpublished MSc Dissertation, Postgraduate Institute of Archaeology, University of Kelaniya, Sri Lanka

Somadeva, R., 2006. Urban Origins in Southern Sri Lanka. Studies in Global Archaeology 3. Uppsala: Uppsala University.

Somadeva, R. and Ranasinghe, S., 2006. An excavation of a shell midden at Pallemalla in Southern littoral area of Sri Lanka: Some evidence of prehistoric chenier occupation in c. 4th millennium BC, Ancient Asia, Journal of Society of South Asian archaeology, Vol. I, pp. 15-24.

Stein, J., 1992. Analysis of Shell midden, Ed. by Julie K Stein in Deciphering a shell midden, San Diego: Academic Press, pp. 1- 24.

Sullivan, M. and O'Connor, S., 1993. Midden and cheniers: implications of Australian research, Antiquity, Vol. 67, No. 257, pp. 776- 788.

Sullivan, M., Hughes, P. and Barham, A., 2011. Abydos Plain-Equivocal archaeology, Changing perspectives in Australian Archaeology, pt. II, Technical Report of the Australian Museum Online, 23 (2), pp. 7- 29.

Taylor, A., 1891. Notes on the shell-mounds at Seaford, Little Swanport, Papers and proceeding of the Royal Society of Tasmania, pp. 89-94.

Ulm, S., Carter, M., Reid, J. and Lilley, I., 1999. Eurimbila Site 01, Curtis coast: site report, Queensland Archaeology, Vol. 11, pp. 105-122.

Wadia, DN, 1941. The Beira lake of Colombo-Its fluctuations and relation to recent changes of the sea level, Journal of Royal Asiatic Society, Ceylon Branch, 1941, Vol. XXXV, No.94. pp. 91-95.

Wayland, E.J., 1919. Outline of the stone ages of Ceylon, Spolia Zeylanica, Vol. XI-part 41, The Colombo Museum. pp. 85- 125.