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Editors

K. Rajan

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V.P. Yathees Kumar

K. Bakialakshmi

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VOLUME - I

Scientific Investigations at the Neolithic Site of Molapalayam, Coimbatore District Tamil Nadu, India

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Abstract

Molapalayam is a Neolithic site located in Coimbatore district of Tamil Nadu. The site was identified in 2019 and was excavated in 2021 and 2024. Given the lack of evidence of Neolithic culture in many parts of Tamil Nadu, the site has revealed clear-cut habitation evidence. This site has provided reliable evidence for Southern Neolithic culture in the western-most part of Tamil Nadu

near the Palghat Gap. The site contains diverse material remains of human burials, ceramics, grinding stones, animal remains and botanical remains. These materials have been studied to understand the nature of human occupation at the site. Petrographic studies have been undertaken on the Neolithic ceramics and the sediments and rocks from the site have been investigated. The results indicate agro-pastoral economy of the communities that were involved in cattle rearing, sheep-goat pastoralism and rainfed agriculture. Four human skeletons were found and three of them belong to the sub-adult category. Radiocarbon dates indicate that the site is dated to 1600 to 1400 BCE with a possible extension beyond this range. The people had cattle and sheep-goat, and hunted wild animals. They produced diverse ceramics. The Neolithic people seem to have exploited the congenial environmental conditions of the Siruvani river valley and the flanks of the Western Ghats. They had trade and exchange relationships with coastal communities. We have evidence of marine shells and limited copper objects, indicating the long-distance exchange network. This paper presents the Neolithic adaptation patterns in the region based on scientific analyses of various materials excavated from the site.

Keywords: Neolithic Culture; South Indian Neolithic Culture; Archaeozoology; Archaeobotany; Geoarchaeology; Ceramic Petrography

I. Introduction

Molapalayam 10°55'49.8"N 76°49'20.0"E is a Neolithic site in Coimbatore district of Tamil Nadu. It is the southern-most and Western-most settlement of Southern Neolithic culture. The site was identified in 2019 and was excavated in 2021 and 2024. The multi-disciplinary scientific investigations at the site are presented by a team of researchers.

Previous Research

There has been extensive research on the megalithic burials and Early Historic evidence in Tamil Nadu and Paiyyampalli has been the only excavated Neolithic site with radiocarbon dates (IAR 1964-65: 22-23; 1967-68: 26-27). B. Narasimhaiah (1980) as a part of Archaeological Survey of India's activities and later the Ancient History and Archaeology Department of the University of Madras have explored and excavated a few sites in the northwestern part of Tamil Nadu, but there exists no significant understanding of the Neolithic cultural developments in Tamil Nadu other than a few sites as at Paiyyampalli, Dailamalai, Togarappalli and Mullikkadu, and the limited range of material culture from later contexts (Narasimhaiah 1980; Dayalan 2010; Venkatasubbiah 2012 Rajavelu 2017). At the site of Paiyyampalli, evidence of the Neolithic period

stratigraphically preceded the Iron Age material remains. The archaeological site of T. Kallupatti, south of Madurai, produced traces of lingering Chalcolithic elements and Neolithic ceramic forms (IAR 1976-77, pp. 46-47; IAR 1979-80, p.69; Selvakumar 1996: Fig. 66), and no radiocarbon date is available for this site. The site produced evidence of a pre-russet-coated and painted ware phase with late Neolithic ceramics (Selvakumar 1996: Fig. 66). R. Ramesh who explored the Salem region identified several sites with polished stone axes (Ramesh 2016), but produced insufficient evidence of ceramics or other settlement evidence. However, traces of Neolithic ceramics and ash deposits have been reported from several sites in Tamil Nadu.

In Kerala, polished stone axes have been reported at several sites, but Neolithic habitation evidence is eluding (Gurukkal and Varier 1999). The megalithic site of Umichipoyil in Kasaragode district has produced ceramics of Neolithic affiliation (Jayashree Nair 2005, 2007). There are reports of polished stone axes in the region of Kaladi in the Periyar River valley of Kerala, collected by Mr. K.A. Ali. However, the associated material vestiges are missing in this area. On and off, finds of polished stone axes are reported in popular media; but these axes as small, attractive and transportable objects were collected as curios or as objects of reverence and worshipped in shrines under trees in Tamil Nadu. Not only the axes, but also pointed or rounded natural pebbles are placed along with the axes for worship. Sometimes the natural pebbles are mistaken for celts or polished axes. Many of these axes seem to have been constantly subjected to the cultural formation process in history and have been transported to new contexts.

With regard to the Neolithic culture of South India several studies have been undertaken and the early investigations gave considerable importance to the ash mounds and the associated material remains (Foote 1887, 1916; Subbarao 1948; Allchin 1960, 1961, 1963; Zeuner 1960; Majumdar and Rajaguru 1966; Paddayya 1973, 1993a, 1993b, 1995, 1998, 2019; Paddayya et al. 2005; Rami Reddy 1976, 1990; Khrisat 1999; Boivin 2004; Johansen 2004; Fuller, Boivin and Korisettar 2007; Venkatasubbiah 2007, 2011, 2012; Krishna 2010; Morrison, Reddy and Kashyab 2015; see, Korisettar, Venkatasubbiah and Fuller 2001;(Johansen and Bauer 2024)). Several ash mound sites have been identified in Karnataka and Andhra Pradesh. K. Paddayya has classified the Southern Neolithic cultures into five zonal traditions and the southern limit of one of the zones (III) has been till the northern boundary of Tamil Nadu (1973). Nambirajan (1984) reports that some of the sites in Coimbatore have produced Neolithic pottery; but he does not specify the sites. A few of the sites of Tamil Nadu are classified as Neolithic in Korisettar, Venkatasubbiah and Fuller 2001, and this classification is primarily

based on the finds of polished stone axes. It appears that in the archaeological explorations there has been more stress on the celts or polished stone axes, rather than the ceramic and other artefact assemblages in classifying and understanding the Neolithic cultures in Tamil Nadu and Kerala. The problem in Kerala has been the lack of significant, prominently visible habitation sites of Neolithic, Iron Age and Early Historic, due to the mountainous terrain in which natural forces and environment greatly contribute to the formation processes. In recent years, Neolithic remains have been excavated at Chettimedu and Valasai by University of Madras; at Chennanur by Tamil Nadu State Archaeology (Paranthaman and Venkataguru Prassana 2025). This site has been dated from 2199 BCE to 1759 BCE (Rajan et al. 2025).

The first author has explored microlithic sites in the Coimbatore region near Marutamalai area, and at these sites, quartz microliths are found in a higher frequency. P. Rajendran (1989), K. Rajan of Victoria College, Palakkad (Personal communication, 2019) and Sujana Stephen (2017) have explored for prehistoric sites in Palakkad area and identified microlithic sites and a few late Palaeolithic sites.

The region of Coimbatore has been explored by K. Rajan (1994) and Yathees Kumar (2012) for Megalithic and Early Historic sites (Nair 2014). The site of Kodumanal excavated by Y. Subbarayalu and K. Rajan (2008) at first and by K. Rajan subsequently for several seasons (1994, 2014, 2015) and Tamil Nadu State Archaeology has produced extensive evidence for Early Historic occupation along with evidence of Tamil-Brahmi script to fourth-fifth century BCE, bead-making and several other industrial and trade activities revealing that it was an exclusive trading and industrial production centre of the Early Historic times in the context of Indian Ocean Traohade (Rajan 2014, 2015, 2017). The megalithic burials are extensive in South India, but their chronology has not been clear as is the case of the Iron Age material culture.

Perur, an important site of megalithic and historical affiliation, has been excavated by Archaeological Survey of India (IAR 1970-71: 32-33) and Tamil Nadu State Archaeology Department (Shetty 2003). This site produced evidence for Early Historic and medieval contexts and Period I produced a thicker variety of black-and-red ware.

Kerala has produced a large variety of megaliths (Peter 2002; Darsana 2010; Abhayan 2018). In the Palakkad region of Kerala, megalithic burials have been studied by Cherian Poulose (1990), Shinu Abraham (2002), KoyuRajan (Indian Express, Palakkad, 29 July 2019), Sanalkumar (2012) and Sujana Stephen (2017).

In the Noyyal river valley, the site of Kaliamangalam (or Kalimangalam, close to and west of Molapalayam at 76° 47' 47" E; 10° 54' 54" N; Rajan 1997:38; Rajan, Yathees Kumar and Selvakumar 2008: 97) has been reported with habitation remains and cairn circles and a few other burial and habitation sites have been reported in this area. Despite the findings of ash mound like features, hammer stone and polished stone axes as at Kovilpalayam or SarcarSamakkulam (Rajan, Yathees Kumar and Selvakuar 2008: 102; DCH 2011: vii), definite Neolithic settlement evidence has been missing in this area.

Geology of the Study Area

The geology of the Western Ghats region falling in Coimbatore district is ancient Precambrian terrain with a dominance of metamorphic rocks such as Charnockites, Granitic Gneiss, and they constitute the faulted edge of the Deccan Plateau according to the established geological investigations. The main geological features of this region consist of intrusive granites, limestone, quartzites, and laterite caps; the river valleys of Bhavani and Noyyal have alluvial deposits and soils of red and black, developed by weathering and along with the landforms such as plains and ridges.

The Major rock types are listed below.

Peninsular Gneissic Complex:

The foundational rock, including hornblende-biotite gneiss, granites, and granite gneiss. Charnockites: High-grade metamorphic rocks common in the Southern Granulite Terrain.

Khondalites: Garnet-sillimanite gneisses, characteristic of the region's metamorphic history.

Intrusives: Pegmatites, quartz veins, and basic/ultrabasic intrusions.

Laterite & Bauxite: Found in capping layers on higher hills, significant for mineral deposits.

Geological Processes and Features

Faulted Escarpment: Formed during the breakup of Gondwanaland, with steep western slopes and gentle eastern slopes.

Weathering: Intense chemical weathering creates thick residual soils (laterites, red soils) and calcic nodules.

Rivers like Bhavani and Noyyal cut through the terrain, depositing alluvium in plains and forming fertile floodplains.

Landforms: Includes structural hills, linear ridges, pediments, and valley fills, shaped by structural and denudational forces.

Significance

The geology dictates soil types (red, black, alluvial) and hydrogeological conditions, influencing water resources.

The region's ancient and diverse rocks make it a key part of India's geological heritage, with mineral potential like limestone and granite.

The Neolithic site at Molapalayam (10°55'49.8"N, 76°49'20.0"E) is located on the hilly regions of the Noyyal River valley (Figs. 1-3), which is a part of the Kaveri River basin network. The Noyyal river flows through multiple lithological formations, comprising of igneous and metamorphic rocks, namely, migmatite, charnockite and khondalite from Southern Granulite Terrain (SGT), while the other regions have exposures of Peninsular gneissic complex (PGC) (Source: Bhukosh Geospatial data repository, Geological Survey of India). Further, various intrusions of granite, diorite and quartzites are also exposed in these hilly regions (Fig. 1). The major minerals present in these bed rocks are quartz, orthoclase, microcline, plagioclase, muscovite, biotite and other mafic minerals, such as amphiboles and pyroxene. The weathering and erosion of these rock types resulted

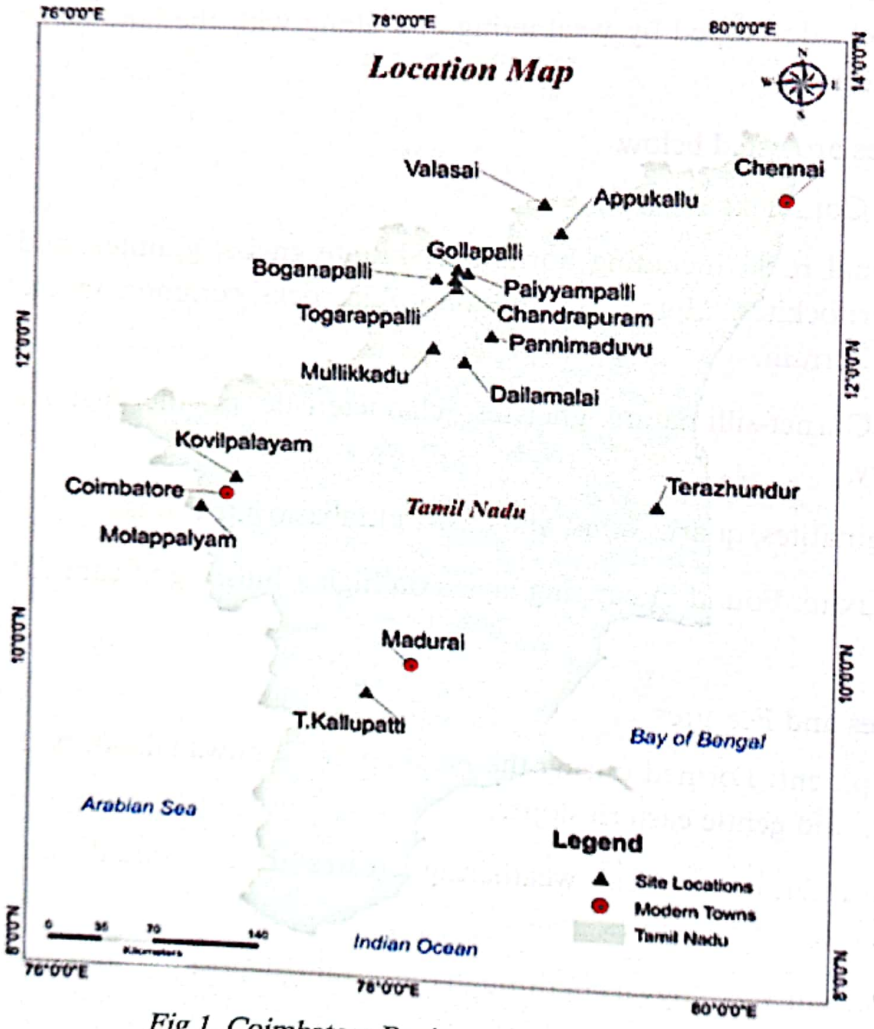

Fig 1. Coimbatore Region and the site location

in the formation of alluvial deposits in the foot-hills (Figs. 1-3). This region is very rich in clay and sand deposits. In the Molapalayam excavation research project Supriyo Kumar Das, Sharmila Bhattacharya, P. Udayaganesan and M Gautham contributed to the understanding of geology, sediments, rocks and lithics

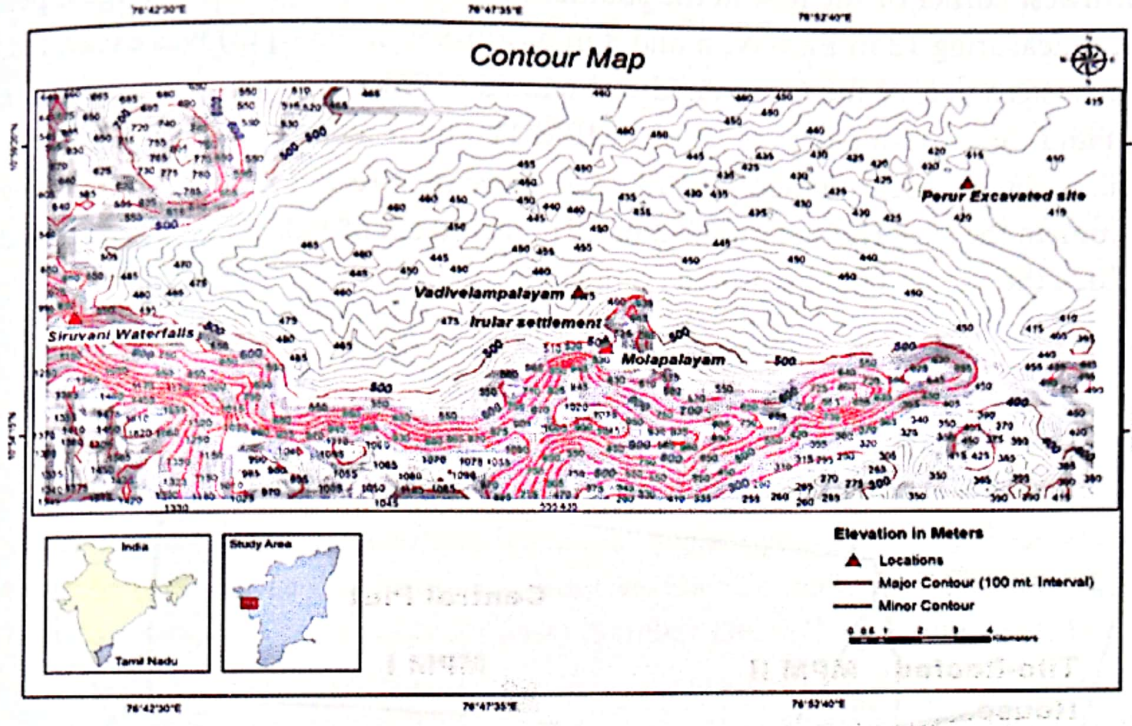

Fig 2. The site surrounded by hillocks (Courtesy: Thamaraikkannan)

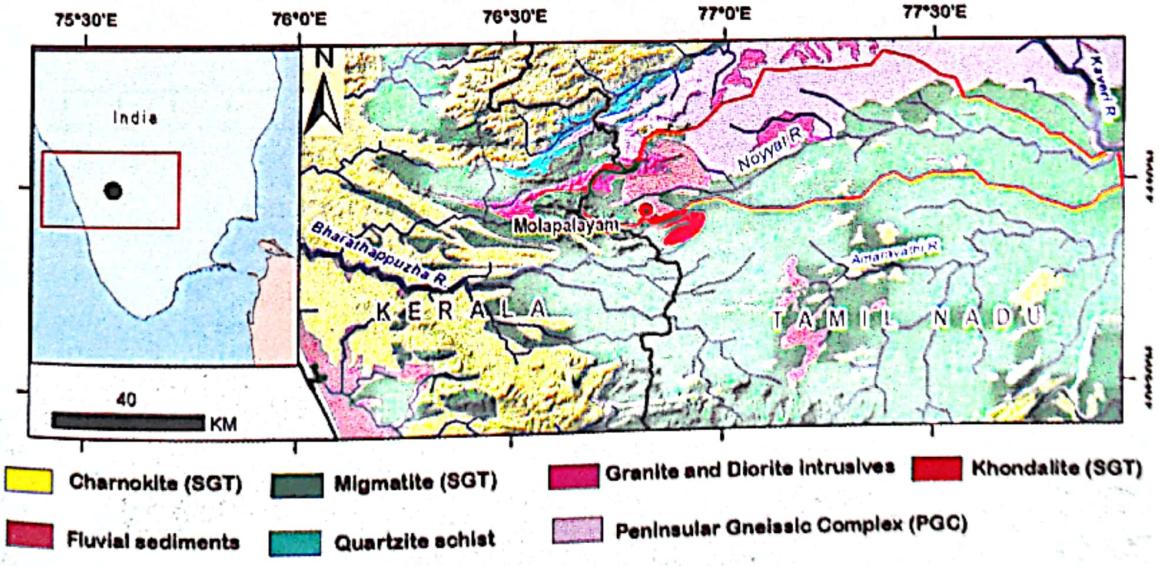

Fig. 3. Geological map of the study area (Molapalayam) which lies under the Noyyal River Basin (red line) indicating the major litho-types in the regional area (Source: Bhukosh Geospatial data repository, GSI; https://bhukosh.gsi.gov.in/Bhukosh/Public)

II Excavation in 2024

In 2024, two trenches were excavated in the plot located to the south of the plot excavated in 2021 (Figs. 4-5). The datum point of the site was a concrete pillar located in the southwest corner of the plot in the centre of the site and northwest corner of the plot in the southern boundary of the site. A large Open Area measuring 12 m East-West and 8 m North-South (96 sq m) was excavated. The western part of the Open Area was named MPM III and it measured 6 m x 8 m and the eastern part was named MPM IV and it measured 6 m x 8 m. The locus/context-based method and the grid system were followed to accurately document the site. The site revealed more than 100 cm of habitation deposits and in 2024 the site was not excavated completely.

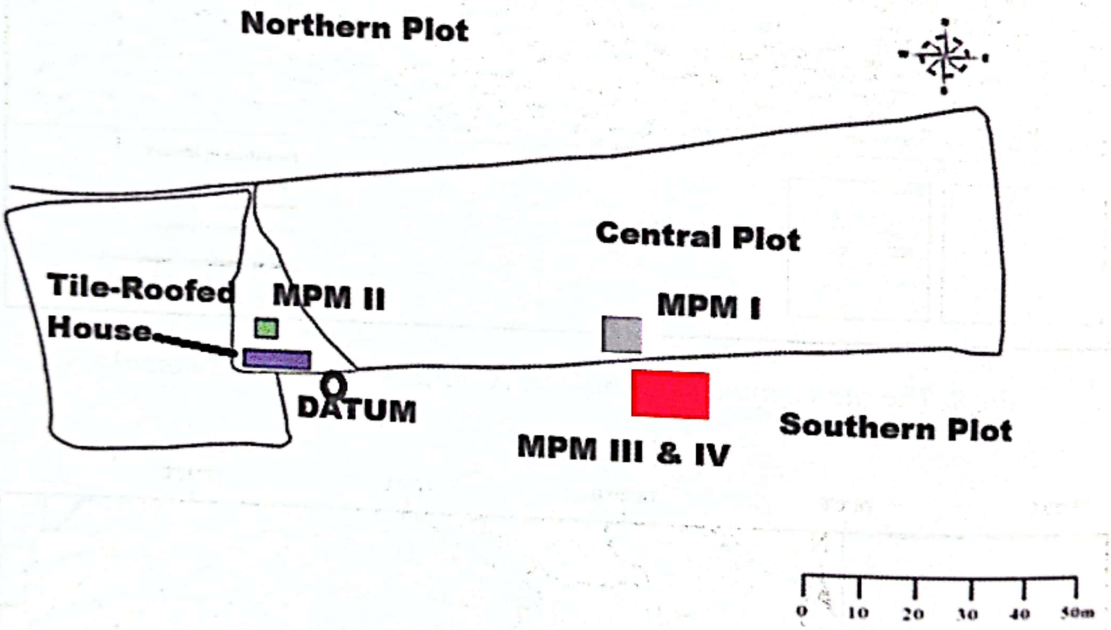

Fig. 4. Site Map of Molapalayam and the Trenches

Fig.5. Molapalayam with rainfed millets and surrounded by Hills

III. Scientific Studies of the material from Molapalayam

The excavated materials from the site of Molapalayam are under further analysis and some of the select materials have been subjected to scientific studies and the results are presented below.

A. Faunal Analysis from Molapalayam: Summary

Animal bones from the Southern Neolithic culture have been studied by researchers (Venkatasubbiaiah et al 1992; Paddayya et al. 1995). Faunal remains from the site of Molapalyam were studied by Abhayan, M. Ajit and their team at the Department of Archaeology at Kerala University (Fig. 6). Atotal of 47,212 fragments of bones were analysed. Among these, a total of 17,397 have been identified to various taxonomic positions, i.e., Number of Identified Specimens (NISP). The remaining 29,815 were Unidentified Fragments (UF). A total of 28 species of animals were identified, which include domestic mammals such as Cattle (Bos indicus), Buffalo (Bubalus bubalis), Goat (Capra hircus), Sheep (Ovis aries), Pig (Sus domesticus), and Dog (Canis familiaris), and wild mammals such as Nilgai (Boselaphustragocamelus), Blackbuck (Antelope cervicapra), Four-horned Antelope (Tetracerus quadricornis), Gazelle (Gazelle bennetti), Indian Muntjac (Muntiacusmuntjak), Chital (Axis axis), Sambar Deer (Cervus unicolor), Indian Rhino (Rhinoceros unicornis), Leopard (Panthera pardus), and Wild cat (Felis chaus), Common house rat (Rattus rattus), Squirrel (Funambulus palmarum), Indian Hare (Lepus nigricollis), Bat (Megaderma lyra). Other animals include Duck (Anatidae), Indian Flapshell Turtle (Lissemys punctata), Monitor Lizard (Varanus sp.), carp fish (Family Cyprinidae), molluscs such as Common Indian Apple Snail (Pila globosa), Chank Shell (Turbinellapyrum), and Clam.

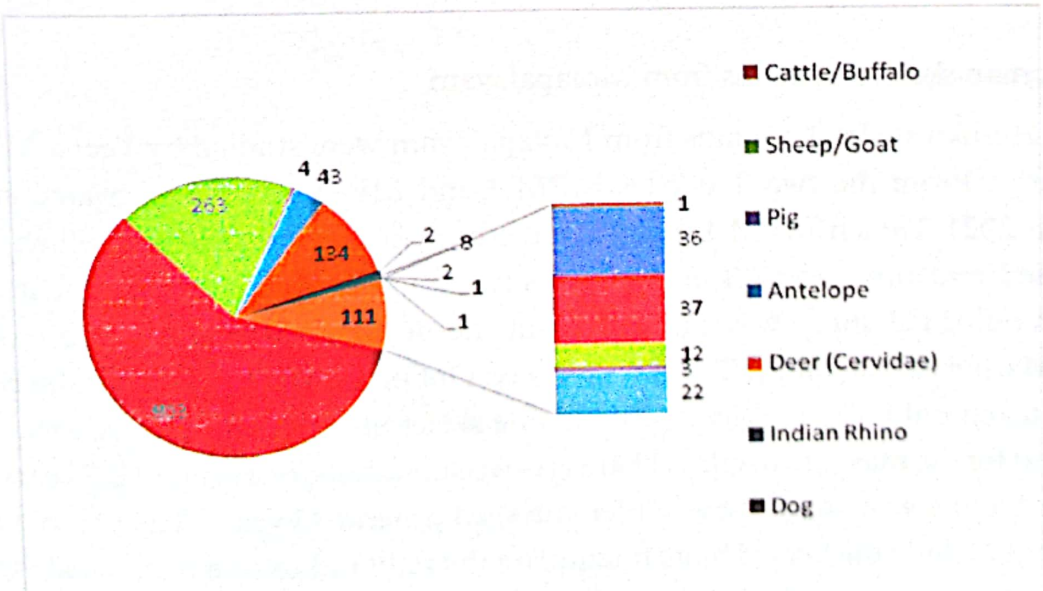

Fig. 6.Pie diagram showingthe proportion oftaxonomic identifications from Molapalayam

The predominance of cattle, buffalo, goat, and sheep remains indicates that animal domestication constituted a major component of subsistence at the site. The substantial presence of embryonic and neonatal bones of cattle and goats provides strong evidence for local breeding and domestication practices. Alongside domesticates, the recovery of faunal remains representing various wild species, particularly deer and antelope taxa, suggests that hunting also played a supplementary role in the subsistence economy. The scarcity of pig remains points to limited exploitation of this animal. Occasional consumption of turtles and monitor lizards is indicated by their remains, while avifaunal evidence suggests that birds were also hunted. The presence of carp fish remains reflects the exploitation of freshwater resources, likely obtained from nearby water bodies. Furthermore, the recovery of marine shells points to long-distance contacts or exchange networks. Particularly noteworthy is the presence of rhinoceros remains, a taxon rarely reported from South Indian archaeological contexts and one that lies well beyond its present-day zoogeographical range, underscoring the exceptional nature of this find.

Bone Modifications

Bone modifications are generally interpreted as the result of human intervention in animal remains. Out of a total of 47,212 bones, 1,224 specimens exhibited various kinds of evidence of modification. These modifications include different grades of charring, cut marks, carnivore-gnawing marks, and tool-making evidence. The observed bone modifications provide valuable insights into human behaviour and subsistence practices associated with fauna during the Neolithic period.

B. Human skeletal remains from Molapalayam

Human skeletal remains from Molapalayam were studied by Veena Musrif-Tripathy. From the two Trenches MPM I and MPM II were excavated at the site in 2021 Trench MPM I yielded three human skeletal remains, which were exposed and brought to Tamil University by undercutting the sediment. The anthropological study was carried out at the department of Maritime History and Marine Archaeology, Tamil University. Out of the three skeletons, the bones were taken out for two individuals and one skeleton was kept in the sedimentary context for the museum display. There are two sub-adults, one around 2.5 years and other 3.5 to 4 years and one adult female aged around 45 years. The pathological findings include the healed bone fracture on the right radius of a female individual and the enamel hypoplasia on one child aged 3.5 years.

In 2024, two trenches were excavated in the plot located to the south of the plot excavated in 2021. From Locus Trench III 015 a skull was exposed in highly disturbed condition. Preserved parts include, few cranial fragments, almost complete mandible and 23 teeth, including inside the crypt. On the basis of the dental crown formation, this child belongs to 2.5 years old. This finding is suggestive that children were buried in supine position from the Neolithic period. There is a need to conduct further excavation to verify this hypothesis. The petrous samples are given for the aDNA studies and if it is successful, it will shed more light on these settlers.

C. Archaeobotanical Remains

Southern Neolithic and Deccan Chalcolithic cultures have yielded extensive evidence for agriculture (Kajale ; Fuller 2002, 2003a, 2003b, 2003c, 2006a, 2006b, 2007; Korisettar 2020). In Tamil Nadu, very little botanical remains have been recovered from the Neolithic context. The excavations at Molapalayam have produced very rich evidence for Neolithic agriculture. At the first level, the archaeobotanical samples could be directly collected during the excavations, and also in the sieving for artifacts. Special attention was given to collect botanical remains from the soil samples, as instructed by Satish Naik and several samples were floated at the site itself. Primary recovery of samples were done at the site and sent to Deccan College lab.

Archaeobotanical investigations at the Neolithic site of Molapalayam were conducted by Satish S. Naik and Adithya Remesan with the objective of reconstructing subsistence strategies, palaeodiet, and environmental adaptations of the site's inhabitants. During Season One (2020–21), representative archaeobotanical samples from trenches MPM I and MPM II were analysed by Satish S. Naik at the Palaeobotany Laboratory, Deccan College, Pune, using a low-power stereo microscope. The study involved systematic identification, documentation, and photographic recording. The recovered plant remains include kodo millet (Paspalum scrobiculatum); pulses such as black gram (Vigna mungo), green gram (Vigna radiata), horse gram (Macrotyloma uniflorum), and hyacinth bean (Lablab purpureus); fruit seeds of Indian jujube (Ziziphus mauritiana); and green vegetable seeds of Lunki/Lutanki (Trianthema triquetra).

Archaeobotanical materials collected during Season Two (2024–25), comprising trenches MPM III and MPM IV along with four trial trenches (TT1, TT2, TT3, and Grid F6), were examined in detail by Adithya Remesan under the guidance of Satish S. Naik. Approximately 175 kg of soil samples were collected

from multiple grids and loci and catalogued under 64 individual sample numbers. All samples were processed at the Archaeobotany Laboratory, Deccan College, using the wet flotation technique. The recovered charred remains were dried, sieved, and systematically sorted, with charcoal, artifact fragments, molluscan shells, and other materials carefully separated and curated.

The archaeobotanical assemblage reveals a diverse range of small millets and pulses. Identified taxa include little millet (Panicum sumatrense), proso millet (Panicum cf. miliaceum), brown top millet (Brachiariaramosa), foxtail millet (Setariaitalica), Setaria sp., and barnyard millet (Echinochloa cf. colona), with Panicum and Setaria being dominant. These drought-resistant crops indicate a rain-fed agricultural system practiced under semi-arid to sub-humid climatic conditions. The absence of large cereals such as wheat, barley, and rice strongly suggests a subsistence strategy focused on indigenous millets and pulses. The cropping pattern reflects a seasonal agricultural calendar, with millets cultivated during the monsoon and legumes in the post-monsoon period, ensuring food security and ecological resilience.

In conclusion, the archaeobotanical evidence from Molapalayam demonstrates a stable millet- and pulse-based agro-pastoral subsistence system adapted to semi-arid environmental conditions. The findings highlight regional diversity in Neolithic diets and support models of multiple pathways to food production and increasing social complexity in peninsular India.

The materials excavated in 2021 come from the lower levels of the site which are placed around 1600-1400 BCE and they show different crops. However the materials from 2024 from the upper levels of the site which have not been dated reveal more crop varieties. This could be due to limited samples from the first season and also poor preservation. Only further investigations could shed light on this.

D. Ceramics

Excavations at the site yielded several hundreds of ceramic sherds. The ceramics included burnished ware and they were mostly handmade varieties (Figs. 7-8). Most of the pottery is of burnished variety. Ceramics with reserved slip painting were reported. They had wavy line decorations. Their designs seem to present a prelude to the russet coated and painted of the early historical period. Three terracotta head-rest fragments were also found in the excavation. The ceramic vessels clearly prove the Neolithic character. A fine, thin variety of black and red ware was also found at the surface as well as in the excavation. The ceramic varieties reported from the excavations are:

- Burnished Black ware
- Burnished Dark Brown ware
- Burnished Black and Red Ware
- Burnished Reserved Slip Ware
- Red Ware
- Rusticated Ware
- Perforated Ware
- Painted Pottery

Fig. 7. Burnished Ceramic Ware

Fig. 8. Neolithic Pottery from Molapalayam

Scientific analysis of the ceramics is being undertaken by Ravikant Prasad, K. Krishnan and V.N. Prabhakar at IIT Gandhinagar (Prasad 2023-24). From the overall assemblage, a total of 17 representative sherds were sent for scientific studies. These include burnished red ware, black ware, coarse red ware, black-and-red ware, and reserved slip ware. Firstly, its porosity was determined by the density analysis kit (Mettler Toledo) at IIT Gandhinagar (IITGN). Further, the sherds were cut and thin sections were prepared. The thin-section analysis, included identifying the mineralogy and texture of the non-plastic inclusions (tempering material). The study was carried out using a polarizing microscope (Leica:DM4 M) at IITGN followed by semi-quantitative analysis of the thin-sections using a point counter (compatible with Leica DM4 M) with a stepping stage attached to the rotating stage. The procedures mentioned adhere to established methodologies for ceramic thinsection studies (Middleton et al. 1985; Stoltman 1991; Whitbread 1986; Miksa and Heidke 2001; Quinn 2013).

The mineral inclusions present in the thin-sections are quartz, feldspars (orthoclase, microcline and plagioclase), mica and hornblende. The geology of the area in and around the site consists of mafic and felsic rock formations. Of the above-said minerals, orthoclase and microcline feldspars along with mica are present in felsic rocks, while plagioclase and hornblende are dominant in mafic rocks. From this, it appears that the clay deposit exploited by the potters in this region seems to be from an alluvial area where the discharges coming from both formations meet (Fig. 3). From the textural analysis, we understand that there are four textural groups. It must be noted that these variations in texture are primarily due to differences in clay paste preparation techniques (Krishnan and Rao 1994). From the seventeen

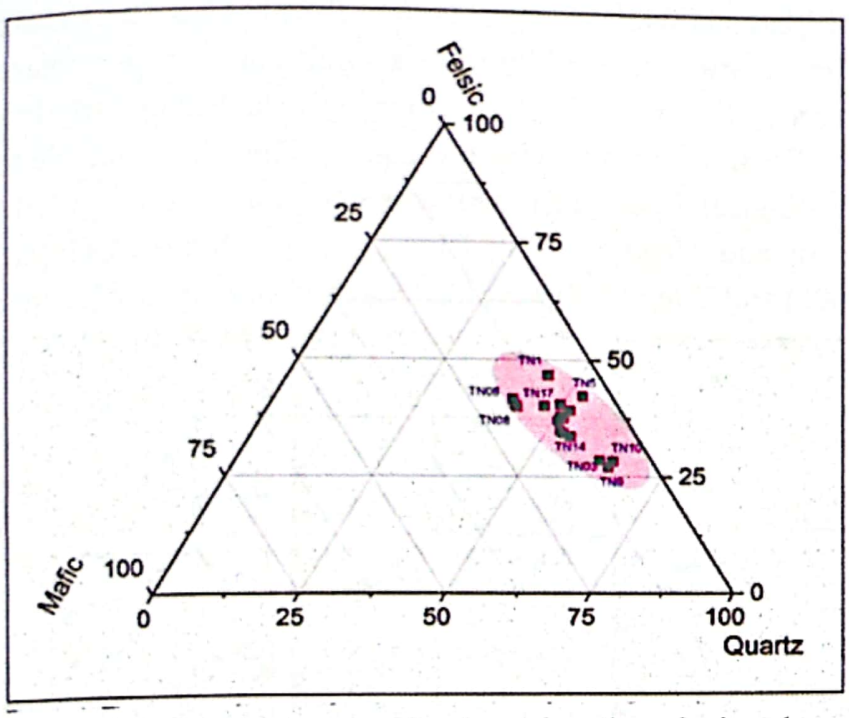

Fig. 9. The ternary diagram showing proportion of mineralogy of temper grains with respect to quartz, felsic and mafic minerals indicate a single segregated scatter suggesting a common source for temper materials

samples analyzed, four paste recipes are found. They are clay pastes with (a) silt and fine sand, (b) domination of coarse sand, (c) domination of medium sand and (d) equal proportions of medium and coarse sand. Such paste recipes point towards the existence of different paste preparation techniques that may have been the identity of a workshop. Thus, it is possible to assume that different ceramic workshops having marginally different paste preparation traditions/ techniques existed here during the Neolithic period. Based on the major minerals present, a ternary diagram having three vertices of quartz, felsic (mica, orthoclase, microcline) and mafic minerals (plagioclase hornblende, augite and hypersthene) was drawn and the same indicated single cluster (Fig. 9), which further confirms that a single source of raw material was exploited. A comparison of the mineralogy of the tempering materials (non-plastic inclusions) present in the ceramics and the local rocks revealed a complete agreement suggesting that the raw materials used for the preparation of ceramics were obtained from the surrounding region. Further, a look at the grain size and shape of the tempering minerals suggests that they are less transported. Quartz and feldspar (orthoclase and microcline), the dominant minerals, having angular to sub-angular shape (Fig. 10) suggest that they were obtained from a primary deposit. Such a primary deposit is available within the valley. The sizes of some of the grains from thin-sections TN-07, TN-09, TN-10, TN-13, TN-17; that exceed 500μm (quartz and microcline) further support this inference.

The study reveals the presence of four types of clay paste. Whilst, plotting the porosity of these ceramics, it is evident that the clay paste group A and C have

minor variations in their porosity while clay paste group B and D have maximum variations (Fig. 11). The variation of porosity from a single ceramic assemblage points towards differences in clay processing by various individuals. Similarly, less variation in porosity implies uniformity in clay processing. These are relatable to the functional and technological aspects of manufacturing these ceramics. Works by Rye (1981), Krishnan and Hegde (1987), Rice (1987), Whitbread (1995), Krishnan and Shah (2005) and Tite (2008) have also reached similar conclusions.

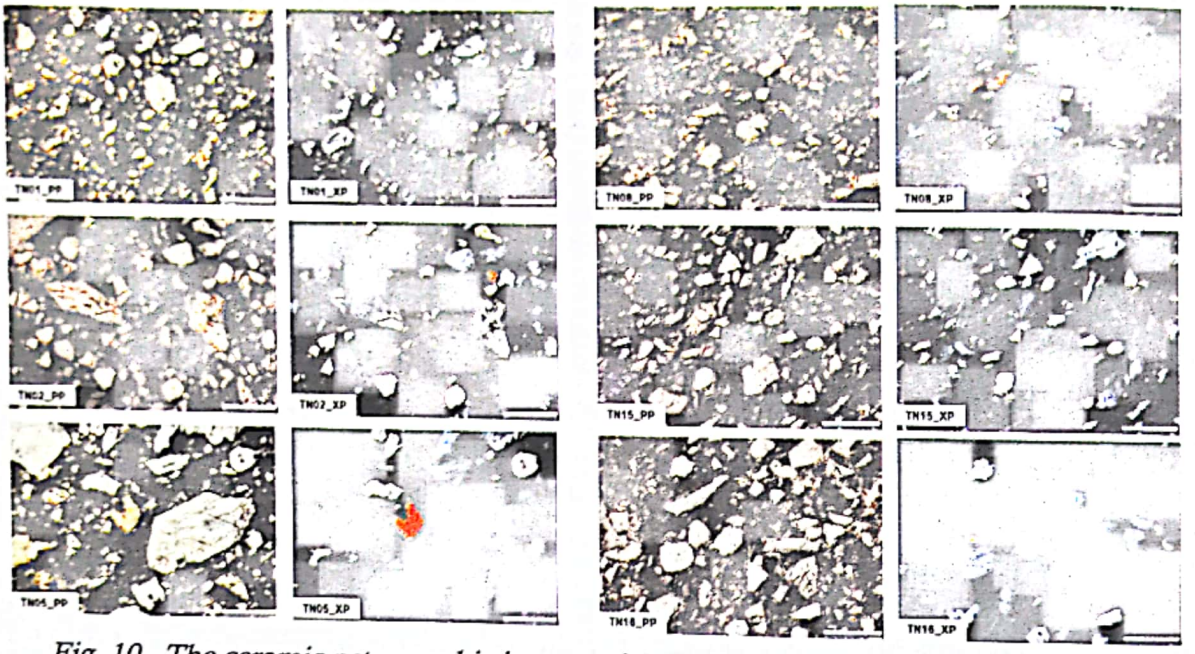

Fig. 10. The ceramic petrographic images of few of the samples which are identified as major fabric types of Molapalayam ceramics. The major minerals in inclusions contain mostly quartz and feldspars. However, the minor minerals are biotite, muscovite, plagioclase and heavy minerals are also present. Most of the matrix are micaceous and ferruginous with minor carbonates. The scale bar represents 0.5 cm.

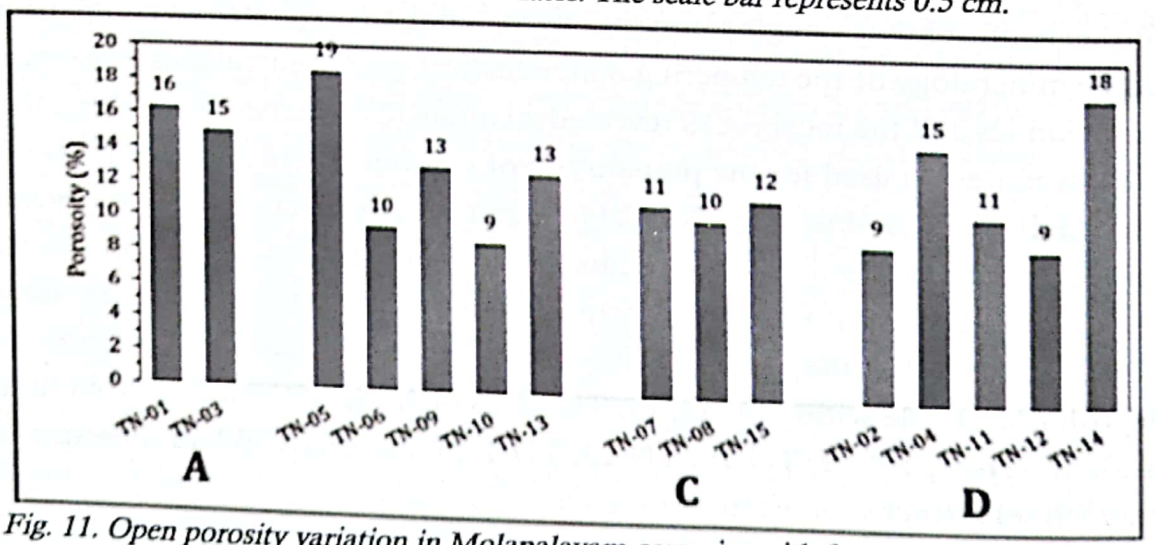

Fig. 11. Open porosity variation in Molapalayam ceramics with four paste groups, A, B, C and D. Out of these paste groups, B and D show a wide variability in porosity, while A and D show less variability in porosity. Wide variability in a single paste group is an indicator of a large range of vessels potentially made for various functions.

While science has multiple methods of research and interpretations, archaeology is a human science and it needs to adopt social science approaches for interpretations. In 2023, I (first author) visited Neykarappatti near Palani in Tamil Nadu, with my student Akalya and found a farmer applying insecticide powder on his cow around 5 PM. I was a bit shocked to find this. When I asked, the farmer said, cows suffer due to mosquito bites and we used to apply ash over the body of the cow, now since we do not have ash,nowadays we apply the insecticide powder. Then I remembered my childhood experience of the cattle shed maintained by in the villages of Thanjavur. The problem of such cattle shed was cleaning the accumulated cow dung. One of the issues of maintaining cattle in a confined location is cleaning the cow dung. When cattle freely move the dung is spread across the landscape. When they are confined, management of dung is a problem. When I checked the published literature on the Mundari tribe of South Sudan (Evans-Pritchard 1940; Feron and Tasnier 2021; Belinda 2024), I realized the possibility of the Southern Neolithic people burning the cow dung and using the ash for various purposes. The Mundari people burn cow dung and use the ash (Fig. 12). Cow urine and dung is used variously in Indian tradition. Some of people in South India have the tradition of symbolically applying ash all over the body or as triple horizontal lines during special occasions. These could be a residue of old pastoral practice. Perhaps the Southern Neolithic people might have used ash in the similar way as do the modern Mundari people of South Sudan.

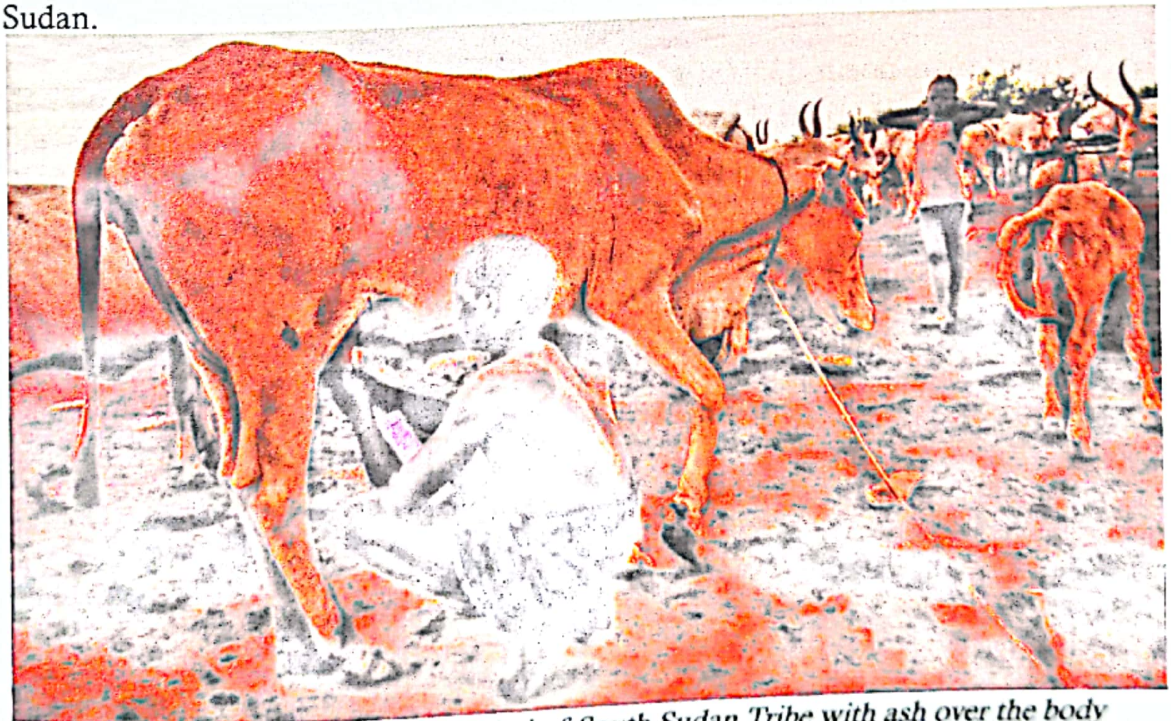

Fig. 12. A person from the Mundari of South Sudan Tribe with ash over the body Courtesy: Wikimedia Common License:LudekGeograf (talk / contribs)

Another case of flashlight from the fieldwork emerged in Madurai, Coimbatore and Erode. The cattle need to be fed well. Hence, the cultivation of crops and some species of grass is meant only to feed the animals, even today. While the grains from cultivated plants served humans, the plant stalks were used for animals and for thatching houses.The evidence from the Sangam Tamil text and the ethnographic parallels suggests this. Thus, we can understand that the early settlers utilized both animals and plants to their maximum advantage both functionally, aesthetically and symbolically.

Interpretations: Evidence of Crops from Tamil Literature

The evidence from the excavation reveals the agro-pastoral economy of the Neolithic people of Molapalayam. No iron objects have been found in the excavation and no evidence of smelting has been reported. Only lithic artifacts are encountered at the site.

Sangam Tamil dated in the early centuries of the Common Era narrates a vibrant rural culture with a few urban settlements. Agriculture, pastoralism and hunting-gathering are spoken vividly. The archaeobotanical data has been presented above. Some of the archaeobotanical data from Molapalayam is correlated with the references in the Sangam literature here. However, there are terminology issues as to what millet is referred to by the poets in the composition, as they use different terms for the millets and in some cases, we are not able to equate the terms with contemporary millet names. Hence, the data need to be looked at cautiously.

Puranarunu poem 335 (Srinivsan 1986) mentions that only the crops of varagu(Kodo millet), tinai, horsegram and beans are the ideal food grains and others are not. All these four food items were perhaps the traditional food, introduced much earlier.Hence, they are spoken as great food items in the Early Historic Sangam Tamil literature. All these have been identified at Molapalayam.

"கருங்கால் வரகே இருங்கதிர்த் தினையே
சிறுகொடிக் கொள்ளே பொறிகிளர் அவரையோடு
இந்நான் கல்லது உணவும் இல்லை" Purananuru 335

Purananuru 34 mentions that varagu is eaten with the meat of wild hare. Wild hare bones are represented in the animal bones of Molapalayam.

"புறவுக் கருவன்ன புன்புல வரகின்
பாற்பெய் புன்கம் தேனொடு மயக்கிக், 10
குறுமுயற் கொழுஞ்சூடு கிழித்த ஒக்கலொடு" Purananuru 34

Kodo Millet (VaraguPaspalum scrobiculatum)

Kodomillet is known as varagu in Tamil. It is known as Kodra/Koden (Hindi/Gujarati/Marathi), Varagu (Tamil), Harka/Arike (Kannada/Telugu), and Koovaragu (Malayalam). Kodo millet is spoken as an important food in the Early Historic period. The Sangam Tamil poem in Purananuru 120 mentions that varaguwas cultivated in the rainy months, after ploughing the land. The Sangam poems add that its stem is black and it is eaten by birds and deer. It is also mentioned that the varagu is beaten and the rice is cooked with milk and eaten along with honey (Purananuru 34; Srinivasan 1986: 758-760).

Purananuru120mentions the crops of varagu, tinai and avarai beans. It refers to the cultivation fields.

"In the fields with intense heat,
where vēngai trees grow on the raised,
red land and heavy rains have poured
and drenched the land, fine soil is
plowed and turned often and seeded,
harrows comb the fields and remove the
weeds with their roots, letting plants grow
with many stems, big with flourishing ears,
and when the black stalks grow tall, to the
color of a peahen that has just hatched eggs,
they cut the new millet that has matured
abundantly above and below,
and then when sesame seed blackens,
it is time to reap the white pods of densely
growing avarai beans, and in every
settlement, in the huts roofed with grass,
they share the clarified liquor that has been
buried and matured in liquor jars, and cook
fragrant lentils in ghee along with rice.
Women with large arms serve food in plates,
in the brave land ruled by a victorious king,
the father of the young women with luxuriant,

black hair. In his land, swaying bamboos rustle

on tall peaks. Poets have sung to him without end,

the man who listened to the jingles of the warrior

anklets of enemies running away from him,

a victorious king who longed for war, like Murukan.

Will this prosperity be ruined?"

Purananuru 120, translation by Vaidehi Herbert (https://sangamtranslationsbyvaidehi.com/)

Little Millet (Samai,Panicum sumatrense)

Little millet is known as Kutki (Hindi), Saamai/Samai (Tamil), Saame/Saave (Kannada), Chama (Malayalam), Samalu (Telugu), and Sava/Halvi (Marathi). Although some texts mention that Samai is found in the Tamil texts, we could not locate its precise name and not in the concordance prepared by Pandiyaraja (https://sangampedia.net/).

Pulses

Pulses are known as Payaru in Tamil. It is a common term for all kinds of pulses and sometimes, it is not clear what is referred to by the poets. The pulses

Kuruntokai 10 refers to the flowers of pulses.

பயறு போல் இணர பைம் தாது படீஇயர் Kuruntokai 10/2

Kuruntokai 338 refers to the deer eating the crops of pulses.

செழும் பயறு கறிக்கும் புன்கண் மாலை Kuruntokai 338/4

Ainkurunuru 47 mentions about the cultivation of pulses after harvesting crops. It could be paddy. We have not found paddy at Molapalayam. It is also possible that rice was cultivated in the Siruvani river valley near the riverine tracts west of Coimbatore.

அரிகால் பெரும் பயறு நிறைக்கும் ஊர Ainkurunuru 47/3

Akananuru 37 refers to cooking of horse gram, pulses (green gram?) and milk.

கொள்ளொடு பயறு பால் விரைஇ வெள்ளி Akananuru 37/12

Akananuru 262 talks about cow eating the crop of pulses.

பாசிலை அமன்ற பயறு ஆ புக்கு என Akananuru 262 /4

Akananuru 339 refers to the pods of pulses.

பற்று விடு விரலின் பயறு காய் ஊழ்ப்ப Akananuru 339 /4

Purananuru 297 mentions about the pods after the removal of the grains.

பைம் பயறு உதிர்த்த கோதின் கோல் அணை Purananuru 297/3

Black gram (Uzhuntu, Vigna Mungo)

Black gram is known as Urad Dal (Hindi/North), Uddu (Kannada), Ulundu (Tamil), Uzhunnu (Malayalam), and Minumu/Minapappu (Telugu). It is not clear if this has been found in Tamil literature.

Green Gram (Pachchai Payaru, Vigna radiata)

Green gram is known as Moong Dal (Hindi/North India), PachaiPayaru (Tamil), Cherupayar (Malayalam), Pesaru Pappu/Pachalu (Telugu), and Hesaru Kaalu (Kannada). It is mentioned in the Sangam texts.

Horse gram (Kollu Macrotyloma uniflorum)

Horse gram is known as Kollu (Tamil), Ulavalu (Telugu), Huruli (Kannada), Kulthi/Kulath/Kulith (Hindi/Marathi/North India), and Gahat (Nepali/Uttarakhand). It is mentioned in the Purananuru poem 335, as cited above. A few other poems are also refer to horse gram.

Patirrupattu (75/11), the poem of the Chera country, mentions that in the land which was cultivated with white varagu, which could mean kodo millet, after the harvest, they cultivated horse gram. It is an important reference to the later cultivation of horse gram and other pulses, in the post-monsoon winter season, a practiced adopted even today in some regions.

வெள் வரகு உழுத கொள் உடை கரம்பை Patirrupattu 75/11

Hyacinth bean (Avarai/Mochai Lablab purpureus)

Hyacinth bean is known as Sem/Shim (Hindi/Bengali), Avarai/Mochai (Tamil), Ghevda/Val (Marathi), Avarekalu (Kannada), Chikkudu (Telugu), Amarakka/Amara (Malayalam), and Surti Papdi (Gujarati). Avarai is mentioned in the above Purananuru poem 335 as one of the traditional foods of the Tamil country. It is not clear if it refers to Mochai.

Proso millet (Pani Varagu, Panicum cf. miliaceum)

Proso millet is known as Chena/Cheena/Chinwa (North India, Hindi, Bengali, Punjabi), Variga (Telugu), Pani Varagu/Varagu (Tamil), and Barri/Vari (Marathi/North India). The precise name of this crop in the early literature is not known.

Brown top millet (Kulasamai, Palappul, Brachiariaramosa)

Brown top millet is known as Banspate (Nepali/Hindi), Makra, Murat, Bennakkihullu, Kaadubaraguhullu (Kannada), Chapar/Chapsura (Marathi), and

Pala pul or Anda korra (Telugu/South India). Its status in early Tamil literature is not clear.

Foxtail millet (Tinai, Setariaitalica)

Foxtail millet is known as Kangni (Hindi/Sanskrit/Urdu), Tinai (Tamil), Navne (Kannada), Thina (Malayalam), Kaon/Kaon dana (Bengali), and Kang (Gujarati). It has numerous references in the Sangam literature. It has been reported very commonly at the site of Molapalayam season 2024. The fields of tinai and the sheds-on-stands (wooden terraces) created to chase away the birds that eat the grains are spoken vividly in the Sangam literature. It was cultivated on the hills as part of shifting cultivation. Tinai was also eaten with milk in the early historic period. The birds were chased using drums and catapult-like devices or sling stones, and the sheds became the centre of the love poems, narrating the internal relationships between the hero and heroine in the Sangam texts. Although tinai specifically means foxtail millet, it could have been used for all millets in the poems. Although Srinivasan says enal is a tinai crop, it could also mean varagu plant.

Kuruntokai 72 mentions tinai cultivated in the hill regions.

"மாமலைப்
பரீஇ வித்திய ஏனல்
குரீஇ ஒப்புவாள்" Kuruntokai 72 : 3-5

Kuruntokai 291 refers to the Jhum field (shifting cultivation) where tinai was cultivated.A lady chases away the bird with an instrument calledKulir, whose nature is not known.

"சுடுபுன மருங்கில் கலித்த ஏனல்
படுகிளி கடியும் கொடிச்சி கைக்குளிரே" Kuruntokai 291

Narrinai 44 talks about the tinai crop with curved stem and long leaves in the front-yard ready to be harvested. It refers to the farmsteads and people who lived nearby the field itself.

"நீடிலை விளை தினைக் கொடுங்கால் நிமிர" Narrinai 44 : 6

Kuruntokai 25 compares the Tinai plants with the legs of egrets.

"தினைத்தா ளன்ன சிறுபசுங் கால
ஒழுகு நீர் ஆரல் பார்க்கும்
குருகும் உண்டு தான் மணந்த ஞான்றே" Kuruntokai 25

Kurinjippattu 35 refers to birds eating the small or little (?) millet. It appears that tinai could be a common name for all the millets.

"நல்கோட் சிறுதினைப் படுபுள் ஒப்பி" Kurinjipattu 35-38

Narrinai 122 mentions about the tinai cultivated in the high mountain areas. The tinai crop had black stem and red tinai.

"இருங்கல் அடுக்கத்து என்னையர் உழுத
கருங்காற் செந்தினை கடியு முண்டன" Narrinai 122 : 1-2

Malaipadukadam 107-108 refers to the ripe millet. Here it could also mean varagu plant.

"பொய்பொரு கயமுனி முயங்கு கைகடுப்ப
கொய்பதம் உற்றன குலவுக்குரல் ஏனல்" Malaipadukadam 107-108

Ainkurunuru 263 mentions about the wild boars eating the enal crops resembling the touch stone used for testing gold.

"நன்பொன் அன்ன புனிறுதீர் ஏனல்
கட்டளை அன்ன கேழல் மாந்தும்" Ainkurunuru 263 : 1-2

Malaipatukatam refers to women beating tinai to separate its grains.

"திணைகுறு மகளிர் இசைபடு வள்ளையும்" Malaipatukatam 342.

Akananuru 348 mentions women taking care of tinai crops sitting on a tree-house or wooden terrace or stand. They chase away the birds.

"களிறுஅணந்து எய்தாக் கல்முகை இதணத்து
சிறுதினைப் படுகிளி எம்மொடு ஒப்பி" Akananuru 348 : 9-10

Akananuru 348 mentions about the tinai crop harvested by women and were singing while harvesting the crop.

"அடுக்கல் ஏனல் இரும்புனம் மறந்துழி
யானை வவ்வின தினைஎன நோனாது" Akananuru 348 : 10-11

Akananuru 368 refers to women protecting the tinai crops. It is clear that women were involved in such tasks and mainly young women and girls in the teen age did this task.

"தோடுவளர் பைந்தினை நீடுகுரல் காக்கும்
ஒண்தொடி மகளிர்க்கு ஊசலாக" Akananuru 368 : 3-4

Kuruntokai 54 refers to the people who protect the enal crops using slingstones to chase away the birds eating the crops. Here kavan refers to the device of sling stone and not catapult

"ஏனல் காவலர் கவண்ஒலி வெரீஇக்

கான யானை கைவிடு பசுங்கழை" Kuruntokai 54 : 2-3

Narrinai 104 mentions about the birds which eat the crops of tinai.

"குறக்குறு மாக்கள் புகற்சியின் எறிந்த
தொண்டகச் சிறுபறைப் பாணி அயலது
பைந்தாள் செந்தினைப் படுகிளி ஒப்பும்
ஆர்கலி வெற்பன்" Narrinai 104 : 4-7

Narrinai 317 : 2-4 compares the tinai plant with the peacock, and the parrots which eat the crop, had red beaks.

"பூம்பொறி ஒருத்தல் ஏந்துகை கடுப்ப
தோடுதலை வாங்கிய நீடுகுரல் பைந்தினை
பவளச் செவ்வாய்ப் பைங்கிளி கவரும்"- Narrinai 317 : 2-4

Narrinai 147 mentions about the tinai crop cultivated near the hill area and the parrots or birds that eat the crops.

"தேம்படு சாரல் சிறுதினைப் பெருங்குரல்
செவ்வாய்ப் பைங்கிளி கவர" Narrinai 147 : 2-3

Tirumurugarrupatai 218-219 refers to worship of Murugan with tinai rice and sacrificed of goat as an offering to Murugan, along with the hoisted flag of rooster.

"சிறுதினை மலரொடு விரைஇ மறிஅறுத்து
வாரணக் கொடியொடு வயிற்பட நிறீஇ" Tirumurugarrupatai 218-219

Tinrumurugarrupatai 241-243 refers to "red" tinaigrains which were mixed with blood and were offered to the god Murugan by the hill women. This text is dated to a later period.

"உருவப் பல்பூத் தூஉய் வெருவரக்
குருதிச் செந்தினை பரப்பி குறமகள்
முருகு இயம் நிறுத்து" Tirumurugarrupatai 241-243

Perumpanarruppatai 167-168 refers to the rice of pasuntinaimooral, which could be a millet and the dish made of this millet was offered to people along with milk by the king Tondaiman Ilantiraiyan, the king of Kanchipuram in Tondaimandalam. Here the grains are compared to the tiny baby crabs.

"இருங்கிணை ஞெண்டின் சிறுபார்ப் பன்ன
பசுந்தினை மூரல் பாலொடும் பெறுகுவீர்" Perumpanarruppatai 167-168

Barnyard millet (Kuthiraivali, Echinochloa cf. colona)

Barnyard millet is known as Sanwa or Jhangora in Hindi, Kuthira vali (or Kuthirai, volly) in Tamil, Udalu/Kodisamain Telugu, Oodalu in Kannada, and Kavadapullu in Malayalam. It is a common weed in the paddy fields of modern Tamil Nadu. It could have been referred to the Sangam Tamil texts and its ancient name is not known.

Gender Role

The Sangam Tamil poems speak about the gender roles in early agriculture and also the part played by children in the community. Mainly young girls, boys in their teens, were perhaps involved in the task of protecting the crops from birds and animals. The Sangam poems portray the context of agrarian fields located a little away from the settlement.

Conclusions

Molapalayam is a late Neolithic site of Southern Neolithic culture and it perhaps fell in the second millennium BCE, with occupation extending from 1600-1400 BCE and the site could be dated back in an earlier and as well slightly later time period. The Neolithic people mainly used stone and bone tools, but had access to copper in a very limited quantity. They were agro-pastoral communities and were involved in hunting-gathering as well and also maintained long distance connections and exchanged their produce for marine shells and perhaps even salt.

The study of animal bones, human remains, botanical remains, ceramics and antiquities from the site of Molapalayam reveals that the people of Molapalayam had semi-sedentary, or more or less sedentary existence involving in rain-fed agriculture of millets and pulses as practiced till 20th century CE. They had settled at the mountain base of the region because of the presence of water and vegetation for animals in the mountains and suitability for rain-fed agriculture, and also the dry nature of the raised lands of the Noyyal valley, which is less prone to flooding. Cultivation of crops is normally undertaken in the Tamil month of Adi, as we could see the farmer undertaking the same practice in 2024, right on the Neolithic settlement (Fig. 4). The crop of grass cultivated for animal feed grew naturally with rain from the Southwest monsoon. There is a possibility that the people lived here in the high rainfall season at least from the months of May to December. They perhaps used the hills for grazing their cattle andmigthto have utilized the river Siruvani or Noyyal throughout the year, and more particularly in the dry seasons. It is likely that they could have shifted to the area near the Siruvani river in the drier months of January to May. There is a possibility of finding more sites in the neighbourhood of the river Siruvani. It is possible that the young members

of the family stayed at the site, while adult members moved with the cattle to the hills and to the rivers. They had diverse dietary sources involving animal meat, both domestic and wild, fish and millets and pulses. They buried the dead within the residential area. They perhaps used the cattle dung by burning to keep the area clean and to help avoid mosquito bites to the animals. The site has ash deposits like other Neolithic sites of Southern India. The parallels from the Mundari tribes of East Africa suggest that the practice of applying ash over the body is very much related to the practice of ash over the body to keep mosquitoes and insects away. Thus we can understand that the early settlers utilized both animals and plants to their maximum advantage both functionally, aesthetically and symbolically.

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