CONTENTS

Fig. 1.1 Spinning of Yarn by Cotton Women

Fig. 1.2 Women Weaving Cloth

Fig. 1.3 Methods of Shaping Pots

Fig. 1.7 Black Red Vessels

Fig. 1.9 Potter's Seal

Fig. 1.10 Scribbles of Tamil–Brahmi Script

Fig. 1.11 Incised Pottery found at Kizhadi

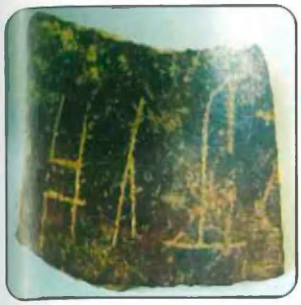


Fig. 1.12 Inscriptions of Kizhadi Tamil Script

Fig. 1.13 Tamil inscribed on a black red pot shell

Fig. 2.1 Munril - Landscape in front of the House

Fig. 2.3 The stone erected with the rooster image engraved

Fig. 2.2 The Erected Stone or Hero Stone

Fig. 2.15 Athiranasanda Pallaveswara Kirugam

Fig. 2.4 Hero stone showing the hero fighting with tiger and elephant

Fig. 2.5 Enthiram

Fig. 2.6 Ural – Plunger

Fig. 2.7 Grinding Stone

Fig. 2.8 Ammi with Kuzhavi

Fig. 2.11 Telescope

Fig. 2.9 Oil Sekku

Fig. 2.10 Sugar Factory

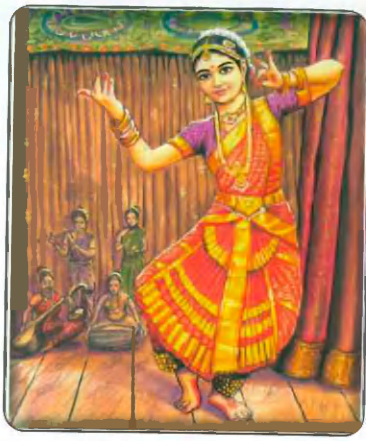


Fig. 2.12 Platform Structure in Silapathikaram

1. One Side Pulling Screen
2. Porumuga Ezhini
3. Karanthuvaral Ezhini

Fig. 2.13 Three Types of Curtains

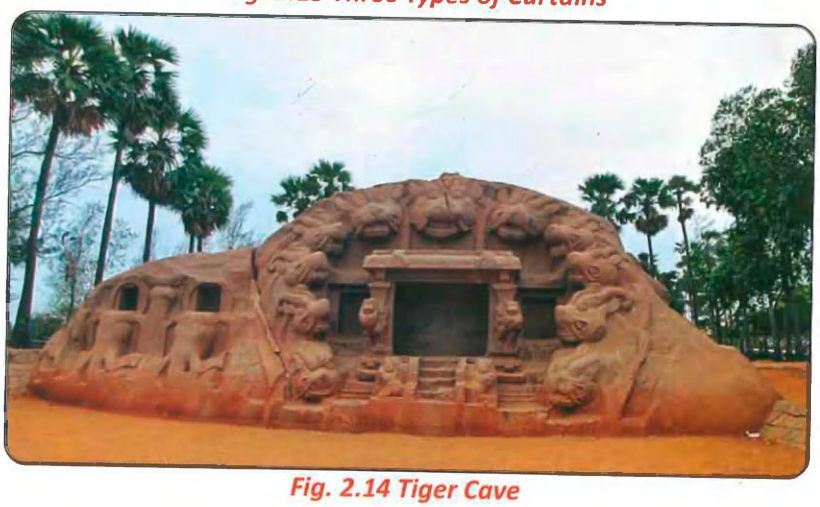
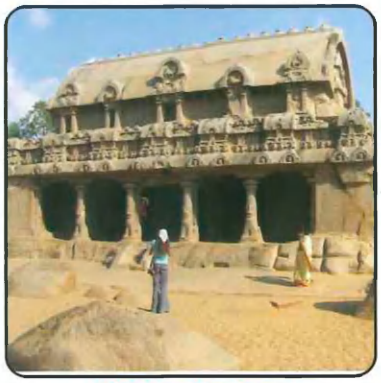


Fig. 2.14 Tiger Cave

Archunan Ratham

Darumar Ratham

Nagula Sahadeva Ratham



Bhiman Ratham

Draupathi Ratham

Fig.2.18 Pancha Pandava Rathas

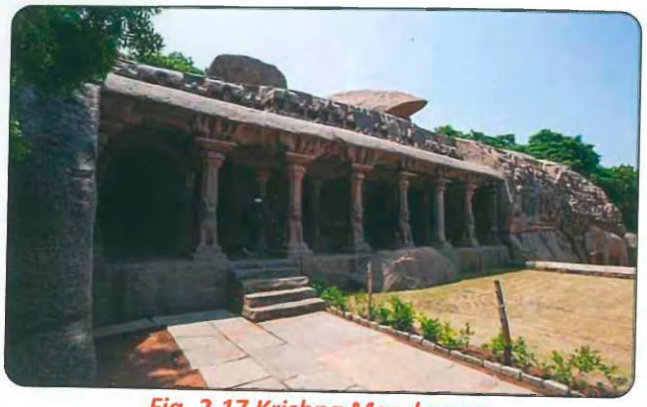


Fig. 2.17 Krishna Mandapam

Fig. 2.19 Ulaganeswarar Temple

Fig. 2.21 Ramanuja Hall

Fig. 2.29
Pragadeeswarar
Temple, Thanjavur

Fig. 2.28 Thiagaraja Swamy Tirukoil, Tiruvarur

Fig. 2.23 Ganesa Ratham

Fig. 2.30 Rajagopalaswamy Tirukkoil, Mannargudi

Fig. 2.31 Gangaikonda Cholapuram, Ariyalur

Fig. 2.33 Sri Kumbeshwarar Temple, Kumbakonam

Fig. 2.20
Mahishasuramarthini Cave

Fig. 2.25 Beach Temple

Fig. 2.22 Varaha Hall

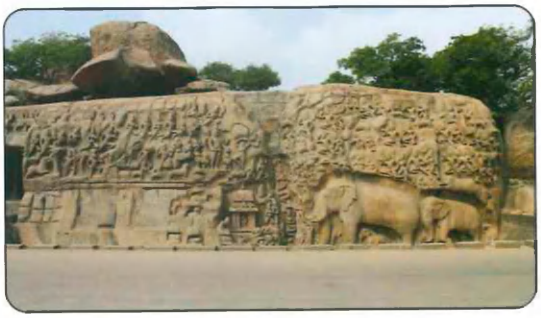


Fig. 2.16 Archuna Penance

Fig. 2.24 Embossed Sculptures

Fig. 2.26 Iratheeswarar Temple, Tharasuam

Fig. 2.27 Thillai Natarajar Temple, Chidambaram

Fig. 2.40 Chettinad Palace

Fig. 2.41 Pillars found in a Chettinad Palace

Fig. 2.42 Chennai Rippon Building

Fig. 2.43 Chtrapathi Shivaji Terminus

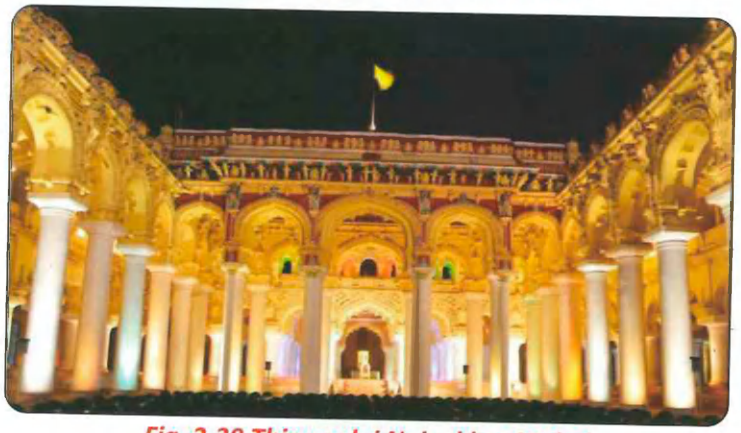


Fig. 2.39 Thirumalai Naiyakkar Mahal

Fig. 2.32 Swedharanyeswarer Temple, Thiruvengadu

Fig. 2.38 Sri Mayuranathaswamy Temple, Mayiladuthurai

Fig. 2.34 Sri Kambahareshwarer Temple, Kumbakonam

Fig. 2.36 Jambulingeshwar Temple, Tiruvanaikoil

Fig. 2.37
Someshwarar Temple,
Kumbakonam

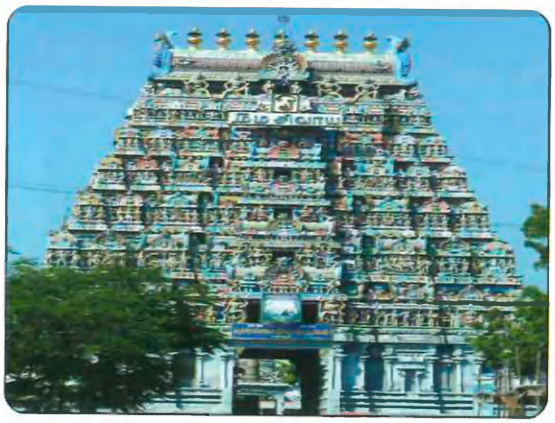


Fig. 2.35 Kalyana
Pasupatheeshwarar
Temple, Karur

Fig. 3.13 Coins of Mauriyas

Fig. 3.14 Coins of the Indo-Greeks

Fig. 3.15 Kushana Type Coins

Fig. 3.16
The coins of Guptas

Fig. 3.17 Stone Beads

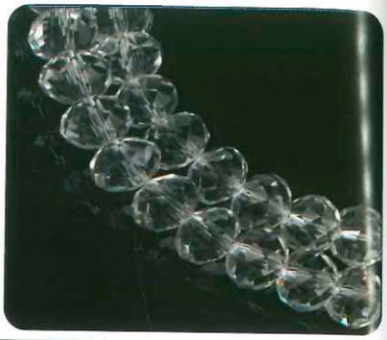


Fig. 3.18 Glass Beads

Fig. 3.19 Flint Beads

Fig. 3.5 Smelting Wastes

Fig. 3.3 Chennakuzhi

Fig. 3.4 Flint Cast Pipes

Fig. 3.1 Damascus Sword

Fig. 3.8 Peruvazhuthi Coins

Fig. 3.7 Pandiya Coins

Fig. 3.12 Punch Coins

Fig. 3.9 Chola coins of the Sangam Period

Fig. 3.11 Malayaman Coins

Makkothai Coin / Kuttuvan Kothai Coin
Fig. 3.10 Chera Coins of Sanga Period

Fig. 3.6 Stamp Coin

Fig. 4.6 Parambu

Fig. 4.13 Sickle

Fig. 4.7
Thalambu

Fig. 4.5 Air (Kalappai)

Fig. 4.12 Catapult

Fig. 4.11 Weight Bearing

Fig. 4.14 Pearl

Fig. 3.20 Conch Beads

Fig. 3.21 Two women buried wearing conch beads

Fig. 4.1 Sluice

Fig. 4.3 The Functioning of Kumizhithoombu

Fig. 4.4 Ice Well

Fig. 4.9 Man Booming

Fig. 4.8 Box Booming

Fig. 4.10 Kavalaiyertam

Unit - I

WEAVING AND CERAMIC (POTTERY) TECHNOLOGY

1.1 INTRODUCTION – HISTORY OF CLOTHING

When the world originated, man was living without clothes like animals. After knowing the air, mixing the water, seeing the earth, feeling the sky, using the fire and gaining knowledge, people were ashamed and wore leaves and barks as clothes. Then they wore the skins of deer, tiger, etc., as clothes. In due course of time, when the situation changed and as a result of people's intelligence there were changes in the clothes they wore and they began to weave cotton yarn into clothes and started wearing them.

1.1.1 Evidences of Clothing in the Sangam Period

In the Sangam Period, the message of wearing foliage, dresses made of barks and girdle is found in the poems of Kurinchi Thinai. The Narikuravas were wearing dresses woven from Maral, a type of cactus and the Nilak Kodichiyar, a leaf dress made from the shoots of the Asoka tree.

Proofs

1. *Natrinai (64:4)*
2. *Kurunthokai (24:4–5)*

From the above proofs, it is understood that people were wearing dresses during the Sangam Period.

1.1.2 Sculptural Evidence

1. *Some of the sculptures found at Amaravathi and Jagkaiyapet, Andhra Nadu, 200 BC – 100 AD show that men wore turbans, a pleated garment hanging down to the knee, flower-designed girdles and small stitched pieces hanging from them.*

Women wore sarees that hung down to their knees. The sculptures show that they used to wear various types of knots made of four – square pieces of cloth on their heads.

2. *Sculptures from 100 AD – 400 AD show that men of those days wear a dhoti, a top and a turban while women wear a saree on their waist and a small piece on top. A cloth is also tied on the head like a turban.*

3. *In some sculptures, the twisted garments are hung in two or three rows, ending to the right below the waist.*

4. *There is only one sculpture in which the female breasts are covered. Sculptures show women were bare-chested.*

5. *A few sculptures say that monks wore clothes made of tree bark, grass and fruit peel.*

1.1.3 Names of Different Types of Clothing

The names of various types of clothing used by the Sangam people can be seen, from the details given in 'Pathuppattu'.

1. Leaf Dress

1. Narikurava women put bunches of mango leaves in between and wore a veil of leaves, which they placed around the bouquets.

Proof

Thirumurugu Lines 201–203

2. Neithal women wore a leafy dress made of shoots, leaves and flowers.

Proof

Pattinapalai, Line 91

2. Dhukil – Kalingam

The king was also wearing dhukil (clothes) which had been washed with mash, The queen wore a flower-designed dress so that her husband would not leave her. During separation from her husband, she wore kalingam (garment) made by dirty thread.

Proof

Nedunelvadai.145–6

From this evidence, it is clear that 'dhukil' is a type of clothing and it is also understood that 'kalingam' is another type of clothing.

3. Katchai – Katchu (Dress)

i) The Chief son (lover) of Kurunji land was wearing a finely carved girdle.

Proof

Kurunji, Line 125

ii) Sirupanartupadai tells us that Archunan wore a broad Kachai (dress) having flower designs.

Proof

Sirupanatrupadai, Line 239

iii) Nalloor Naththathanar while talking about Veeman says that like Archuna, Veeman was also a great warrior and wore the dress having flower designs.

Proof

Nedunelvadai

iv) Nedunalvadai says that the Queen had tied 'vambu' (kachu) on her chest.

Proof

Nedunelvadai Lines 145–150

4. Padam (Shirt)

a) 'Padam' means shirt these days. Perumpanartuppadai says that the soldiers guarding the highways of Thondai Country wore shirts.

Proofs

1. *Nachinarkiniyar Urai, Line 69*
2. *Mullaipattu Thodar, Line 66*

b) During the Sangam Period, 'Yavanans' traded in Tamil Nadu. During their stay here, they wore saree dress on their waist. Above their waist, they wore meipai (shirt).

Proof

Mullaipattu Lines 59–61

5. Sithar – Sitharvai

Dirty torn rags were called 'Sithar' and 'Sitharvai".

Proof

Porunarartrupadai Line 154 & Porunarartrupadai Line 468

6. Kaazhagam

It is a type of garment, worn by priests. It is a garment woven and sent from a town called Kadaram.

7. Aruvai

It is the highest quality fine embroidered dresses. It was worn by kings and the rich.

8. Kandam

The rough cloth used to wrap around the tent like a wall was called Kandam.

Proof

Natchinarkiniyar, Mullai 44

1.2 Weaving Industry in the Sangam Period

A reference to clothing is found in Tolkappiyam, a grammar book that predates Sangam Literature. From this, we know the antiquity of the weaving industry.

Proof

Tholkappiyam 427

1.2.1 Raw Material of Textile Industry – Cotton

Cotton is the raw material for the production of textile industry Literature shows that this had been produced domestically. It is pointed out in the literature that cotton was grown in abundance and looked like a fence around the town.

Proof

Purananooru 299:1

Cotton was cultivated in the Mullai lands. They collected the cotton that had grown and burst out and packed it in bundles and brought it home. This information is understood in the poetic lines of Purananooru.

Proof

Purananooru 393

The Chola King Kulamurtathu Tunjiya Killivalavan fed the Panas and also offered cotton packed in bundles. This is referred to by the poet Nalliraiyanar.

The lyrics in the following songs are about the cotton plant and how cotton was obtained and threads woven.

Proofs

i) ***Purananooru : 324 – 7***

ii) ***Purananooru : 393 – 12***

The nuts were removed from the cotton. It is described that the fluff from which the nut has been removed looked like white clouds.

Proof

Akananooru 133 – 6

1.2.2 Weaving Women (or) Cotton Women

In Sangam literature, women are found to be weavers. Women without male partners did this weaving at home as a small business. Bow is used to separate cotton from its cocoon. Later, Sangam literature mentions that the cotton cocoon was thoroughly pounded to remove the outer skin and the remaining cocoons and dust. The women who removed the cotton and cleaned it by removing the nuts and seeds from it are called 'Cotton Women". This work was carried out by 'Cotton Women' even at night with lanterns.

Proofs

i) ***Nattrinai 247 : 3 – 4***

ii) ***Purananooru 326, 4 – 5***

iii) ***Nattrinai 299 : 7***

The Works of Cotton Women

Weaving the Thread

Cotton was cleaned and ginned by hand and spun into cotton yarn. The thread was spinned by women. They learned the technology of making women's clothes and engaged themselves in the industry.

Fig. 1.1 Spinning of Yarn by Cotton Women

Weaving Cloth

Including women who have lost their husbands, separated from their husbands due to economic reasons, earned their income by undertaking weaving from their houses. Those women who had engaged themselves in such works were called '***Cotton Women***'. The yarn spinned by the cotton women was called '***Panuval***'.

Proof

Purananooru 125 : 1

Fig. 1.2 Women Weaving Cloth

1.2.3 Types of Fabrics

There are evidences from the Sangam Period to show that many types of clothing were woven from the yarns.

1. Thin fabrics
2. Beautiful high quality fabrics like snake skin
3. Rough clothes
4. Silk clothes

1. Thin Fabrics

They enjoyed dressing their waists in clothes like milk spirit, thin-paper woven with very fine thread.

Proof

Malaipadukadam 565

2. High quality Fabrics like Snake Skin

They also spun high quality beautiful clothes with floral designs like snake skin shirts.

Proof

Purananooru 397 – 15

3. Rough Cloth

Evidences say that pure coarse cloth was also produced by peeling off the inner core of the bamboo.

Proof

Sirupanattrupadai 83

4. Silk Clothes

Silapathikaram speaks of weavers who knew the technique of weaving with silk thread and rat hair as 'Nun Vinaikarugar'.

Proof

Silapadhikaram

ii. Other Types of Clothing

i) ***Thirumurugartuppadai speaks of Murugan as a red-robed person.***

ii) ***Women used to wear red clothes during the puberty period.***

iii) ***During day time, women wore silk dresses and at night wore cotton dresses. This is stated by Pattinappalai, a book of the Sangam period.***

There are a lot of evidences to show that women wore dresses during the Sangam period.

Proof

Manimegalai 16–30, Seethalaisathanar

A garment is a cloth that covers the upper body.

iv) ***It is also evident from the statement of Elango Adigal that Sangam women wore separate dresses for night.***

Proof

Elango Adigal; Silambu, 9 – 4

1.2.4 Dye Industry

1. Avuri Plant Dye

Just as the cotton plant helped for yarning, another plant helped the Tamils in the beginning for dyeing. That plant grown in Tamilnadu in ancient times is called Avuri.

Avuri flowers were plucked and soaked overnight in a big tank, while they were soaked like that they turned yellow. Then,

they were filtered and placed in another tank. At that time, it reacted with oxygen and turned into blue colour. This was later called blue dye (Indigo).

2. Konrai Tree Sap

They found a different colour by mixing Konrai tree sap.

3. Dye root, Kasukatti

They made a nice red dye by adding dye root and Kasukatti.

4. Avuri, Saffron, Turmeric, Mustard, Lacquer

Kanchi, Madurai and Mayuram also had dyeing techniques using Avuri, Saffron, Turmeric, haritaki (Kadukkai), Lacquer, etc., Ancient dye pots have been excavated in the Tamil soil.

Proof

Porunarattrupadai 82, 93

There are references about the dyeing art of the ancient Tamils in Sangam texts such as Porunar Artuppadai.

1.2.5 Payment of Taxes to Weaving Industry

1. Professional Tax

* There was a practice of taxing only the 'Weaving looms' during the Sangam period. A non-weaving loom was called 'Madi loom'. It is not taxed.
* In the duty imposed on looms only half the duty is imposed for the Adai looms.
* Some of the weavers had also paid common village tax. Taxes were imposed on the looms according to the country and town.

* Rasu, the poet says that there was a 'road tax' for using the road for the looms.

2. Sales Tax

After weaving, they had gone to other places to sell the woven stuff. The tax paid for selling on streets was called 'Kulavari' (Family Tax). According to the inscription poet Rasu states that the weaving industry had been the most tax-paying industry for the country.

1.2.6 Export

During the Sangam era, cloth was exported to foreign countries from Tamilnadu.

Proofs

i) ***Tamil Nadu clothes were sent to the Gangetic regions like Patalipuram and Kasi.***

ii) ***Artha Sastra of Gautilya in the 3rd century BC mentions the cloth as 'Mathuram'. (Named Maduram as it was sent from Madurai, Pandianadu).***

iii) ***Thin garments were also exported to the countries where Yavanas lived.***

iv) ***There are evidences to show that the ancient Tamils travelled across the sea to Rome and traded.***

1.3 POTTERY (CERAMIC) TECHNOLOGY

Pottery is a type of material used by people for their needs with clay types. A pot is an object made of clay. Pottery making techniques have been traced back to ancient times. This profession

is known as 'Kuyaththozhil' in Tamil and the potters are called 'Kuyavar' in the village.

A large part of the history of pottery belongs to pre-historic pre-literate ancient cultures. Much of this history is received through the artefacts recovered from the archaeological excavations.

1.3.1 Multiple Stages of Pottery Industry

Before Pottery becomes part of the culture, it must have crossed several stages.

1. Clay

Suitable clay should be available for pot making. Archaeological sites where pottery items were found are well-designed and close to locations with readily available sources of clay suitable for heating.

2. Proper Temperature

It should be possible to create a temperature (temperature suitable for heating) at which the clay is transformed into the kiln.

3. Time

There must have been enough time to prepare, shape and make the clay pot suitable for using.

1.3.2 Pottery Making Process

Pottery items are made using a variety of methods. Among them, the Potter's wheel is important.

Potter's Wheel

In the process of 'throwing', the clay is wheeled into the middle of the spinning platform called 'Chakrathali'. The potter rotates the wheel with a stick at the required speed. As the wheel rotates, the solid sphere of fine clay is pressed, squeezed and gently pulled upward and outward to form a vacuum pot.

Then the vacuum pot with the hole should be slightly dried and enlarged with a stone and a plank to close the hole.

Fig. 1.3 Methods of Shaping Pots

Kinds of Rotators

In Tamil Nadu, there are two types of rotators.

1. Ball Point Rotator
2. Cone–slot Rotator

1. Ball Point Rotator

Fig.1.4 Ball, hollow rotator can be rotated with a bar.

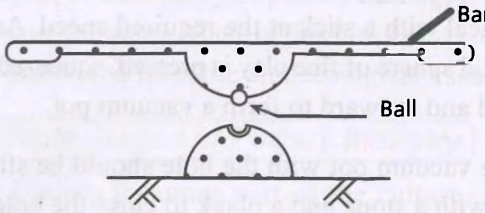


Fig. 1.4 Ball Point Rotator

At the bottom of the wheel, there is a small ball. It has a plinth with a small hollow for fitting it. As it rotates using a rod, it is straight only when it rotates, when it stops rotating, it tilts.

Edgar Thurston has mentioned this in his book 'Castes and Tribes of India'.

2. Cone–slot Rotator

Soil mixed with wood or coconut fiber, black stone.

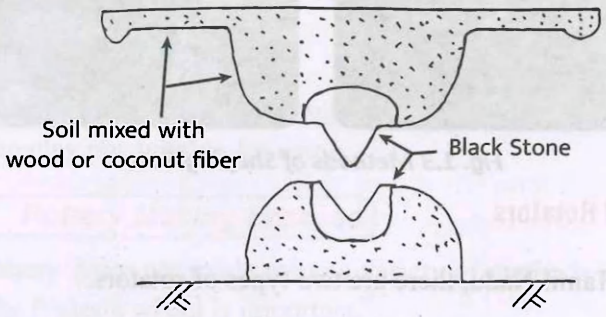


Fig. 1.5 Cone–slot Rotator (Man-pulled)

At the lower part of the upper wheel, there is a black stone area with a conical structure and a flat ring around it. It has a

conical bottom so that it fits just right. The hole can be rotated. The rotator will not incline. Men sit in front of the rotator on the seat and shape the soil. His wife would sit on the ground opposite to him and spin the rotator.

Only a small amount of soil can be placed in ball-point rotator. But, a large amount of soil can be placed in the cone-slot rotator.

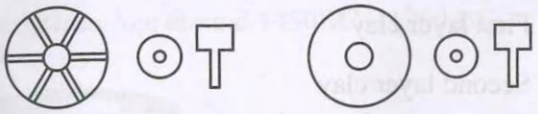


Fig. 1.6 Potter's Identities

Evidences

1. *Both types of rotators are shown on stone carvings on Tiruchengode Hill. The stone and plate are carved along with the rotator.*
2. *In the Kovoorkizhar lyrics, only the cone-slot rotator is mentioned.*
3. *In Tiruchengode Nilaththambiran temple, there is a carved stone and plate board on the Pillaiyar base located in the prakaram on the right side. Stones and planks are used to tighten the soil hole.*
4. *This is mentioned in a song sung by Iyur Mudavanar about Kulamurtaththu Thunjiya Killivalavan Chola.*

1.3.3 Clay Minerals

The primary mineral found in clay is while clay or Kaolinite. It usually includes the following items.

40% Aluminiam Oxide

46% Silicon Oxide

14% Water

Types of Ciay

Generally, two types of clay are found in nature.

1. First layer clay
2. Second layer clay

1. First Layer Clay

It is found in the rock from which it was obtained. It does not contain any sediments. It is heavy, dense and pure.

2. Second Layer Clay or Alluvial Clay

It forms a light sedimentary mixture. It is stored and submerged in water. They are finer and lighter than the primary clays.

Excavation Evidence

The 17 pottery sherds found in the excavation were analyzed by the Geosciences of the University of Pisa in Italy. The pots found at Kizhadi were used for collecting water and for cooking. Based on the nature of the minerals and rock particles found in these pots, it was confirmed that these pots were made locally using a unique pottery technique. It was identified by comparing the local soil sample.

It is understood that the technique of pottery found at Kizhadi, the composition of the elements prove that the nature of the clay remained the same from the 6th century BC to the 2nd century BC, according to the study report by the University of Pisa in Italy.

The research report explains that some of the pottery samples are similar to the soil type found in other parts of Tamil Nadu and the period is considered to be 2nd century BC.

1.4 BLACK RED VESSELS

The Black and Red Ware culture (BRW) is a culture that emerged in North India and Central India during the late Bronze Age and Early Iron Age around 1450BC – 1200 BC.

Fig. 1.7 Black Red Vessels

Black Red Pottery flourished in the Western Gangetic Plains (Western UP) between 1450 BC – 1200 BC. Originally, the grey colour painted pottery culture flourished in the parts of India like eastern Uttar Pradesh. Later, in North India, the black glazed pottery culture emerged in the 16 Mahajanpada of the Haryankoa dynasty, between 700BC and 500BC.

Archaeological artefacts from the Indus Valley Civilizatio in the Punjab and Gujarat regions of India are known from th post Arab period. They are the black and red pottery culture area

1.4.1 The Raw Material of Black-Red Pottery

Spectroscopic analysis of some samples of black and red-war found at Kizhadi were experimented. The results of that study revealed that the red colour of the black-red pottery was due to hamatite, an iron mineral and the black colour was due to the use of organic matter, charcoal.

The ancient potters living at Kizhadi used a unique technique of heating these dark red coloured pots at a temperature of 1100°C.

1.4.2 Nanotechnology in Black Red Pottery

An examination of the pot shell found at Kizhadi excavations reveals the techniques used during the Sangam period really excite us. One of them is the use of elements of nanotechnology in the heating process of the pot.

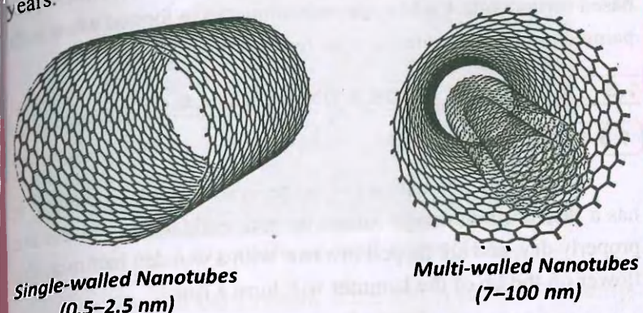
The world renowned journal 'The Nature Scientific Report' published this article.

Carbon Nanotubes

Chemical analysis of the interior pot shells found at Kizhadi confirmed the presence of nanotubes in the black paint. The researchers proved that the carbon nanotubes were responsible for the black coating on the inner side of the pot shell that did not decay or did not lose luster.

The tensile strength of carbon nanotubes is 100 times higher than that of the same size steel. This tenacity is the reason why the

black paint on the pottery does not disintegrate even after 2000 ears.



Single-walled Nanotubes (0.5–2.5 nm)

Multi-walled Nanotubes (7–100 nm)

Fig. 1.8 Carbon Nanotubes

Carbon nanotubes have been discovered in the archaeological excavations. Nano particles and carbon nanotubes have been found in the materials from the excavations in the Mediterranean region and in Damascus steel. These nanotubes date back to 8 or 9th century AD. The carbon nonotubes found at Kizhadi are more than 2400 years old.

Both single-walled nanotubes and multi-walled nanotubes were found in the pottery excavated at Kizhadi. Now, carbon nanotubes are formed by heating a carbon-based compound to a very high temperature i.e. 1200°C. So Sangam people could have made this possible by heating at very high temperatures.

1.4.3 Colouring

Sangam Tamils used to paint different colours while heating the pots. They knew the temperature at which the pots should be heated so that the colours painted in such a manner did not disintegrate or fade.

During that time, dyes would have been prepared from plants trees and vines and plant products which contained a lot of carbon based compounds. Carbon nanotubes must have formed when such painted pots were heated at high temperatures.

1.5 SCRATCH CODES ON VESSELS

1.5.1 Potter's Seal

Wooden mallet is used for the decorative work on pottery. It has a flower or an image carved on both ends. If the vessels are properly dry, and are tapped in a row with a wooden hammer, the flower on the tip of the hammer will form a row.

Fig. 1.9 Potter's Seal

1.5.2 Scratching on Pot

Scratched letters on the pots were also found during the Sangam period. Old Tamil scripts are found in abundance on pot shells. A number of scratch paintings have also been found before the introduction of material-encrusted letters. These are called Grafitti marks. The description of the Indus alphabet written from the right to the left was discovered from the scratch scripts found on the pots.

Fig. 1.10 Scribbles of Tamil–Brahmi Script

The oldest of the scribbles is the 450 year old Indus script. Between the close of the Indus valley civilization and emergence of the Tamil–Brahmi script, there was a typeface. Researchers call such patterns as scratches and symbols. These scratch marks are found in the Copper Age and Paleolithic cultures. It should be noted that such symbols are found on black-red pottery.

Evidences

1. *Excavations carried out at Adichanallur, Korkai and Mangulam in Tamil Nadu have given pot shells with symbols.*
2. *In Sri Lanka, objects with similar indentations were also found in places like Kantharodai, Manthai, Rithiyagama.*
3. *A metal stamp was found at Vattukkottai in Jaffna, Sri Lanka. It is the pattern that the potter inscribes on the vessel. It contained both the Indus script and the Tamil script. The Tamil section is marked as Goventh. The first two forms are identical in the Indus script. The analyst reads it as Cocon. 'Co' means potter, royal potter.*

4. *In Jaffna, Sri Lanka many pot shells have been foun Vettukkadu, Paraman Kirai. It has inscriptions in T (Brahmi) script dating back to the 3rd century BC. M in one piece, the whole word Velaan is found. Potter called Velalar in Sri Lanka and India. It is assumed tha person who made the pot might have carved his name o*

From the above evidence, it is certain that 75% of the symb discovered in South India are found in Tamil Nadu.

Fig. 1.11 Incised Pottery found at Kizhadi

Pre-Tamil Brahmi script was a script that reflected the thinkin of the Paleolithic and Iron Age people. 1001 pot shells inscribed with such scratches found at Kizhadi indicate that Sangam people knew the basic writing system to express their thoughts.

1.5.3 Solar Appearance by Radiation Incision Lines

A pot unearthed in the excavation has six radiating lines inscribed with connecting lines. Each radiation line is coloured by 14 small connecting lines. This gives a clear impression of the pattern of the appearance of a sun.

1.5.4 Tamil (Tamil - Brahmi)

The next available notation to scratch is the Tamil Brahmi Script. They called it Tamil. Pot shells inscribed with Tamil (Tamil Brahmi) symbols have been excavated at Sangam sites.

Evidences

1. *110 cave inscriptions inscribed in Tamil Brahmi script belonging to the Sangam period have been found in more than 32 towns in Tamil Nadu. These are written by Padmasree Airavatham Mahadevan and published as a book.*
2. *56 pot shells inscribed with Tamil Script at Kizhadi excavations were reported by the Department of Archaeology, Tamil Nadu.*
3. *Broken pot shells with some incomplete inscriptions have been found. In one of these, there are personal names like Kuviran Adha(n), Aadhan.*

The name 'Athan' appearing in it is mentioned as 'Athan'. K. Rajan has clarified in his book 'Early Historic Writing System' – A Journey from Graffiti to Brahmi that there was no custom of phonetic coding to distinguish the long vowels from the short vowels in Tamil in earlier times.

Athan

Fig. 1.12 Inscriptions of Kizhadi Tamil Script

The black red pot shell has been found to have six letters Tamil written in a single line. They are 'Kuviran Aath'. The missi letter could have been a fraction of 'n'. So, it must be the name a man. The name of this man is 'Kuviran Aathan'.

Kuviran Aathan

Fig. 1.13 Tamil inscribed on a black red pot shell

1.6 REVIEW QUESTIONS

1. Explain the names of clothes with examples.
2. How was the weaving industry during the Sangam period?
3. Explain the types of fabrics with examples.
4. What are the processes of pottery making?
5. Explain the types of clay with archaeological evidences.
6. Explain the salient features of nano-technology in black red pottery.
7. Write in detail about the scratch marks on the vessels.

Unit - II

DESIGN AND CONSTRUCTION TECNNOLOGY

2.1 BUILDING DESIGN IN SANGAM PERIOD

2.1.1 House in Sangam Period (or) Plot Design

The residences referred to in the Sangam literature as Manai were designed with the structures of Thinnai, Pillar, Base, Courtyard, Staircase, Window, Gate and Maadam. These designs were featured during the development of residential architecture. It can be assumed that these might have bean the residential structures of people of slightly higher economic status.

Plot Description

The word 'Manai' in Sangam literature means dwelling house, family, cowshed, wife, life, a 2400 sqft or pit. Like that, it is found with many objects. Generally, 'Manai' mostly means house in abundance.

The literature speaks about the majesty of manai and the merits of manai setup. Settlements arranged in a systematic and orderly structures are referred to as manai in Sangam literature. This is confirmed by the following verses.

Proofs

i) Nattrinai 79:2

ii) Iyngurunooru 324:3

iii) Akananooru 384:13

iv) Nattrinai 40:1

2.1.2 Classification of Houses or Plots

Two types of houses are generally mentioned in Sang literature.

1. Sirtil
2. Peril

1. The Design of Sirtil

In the Tamil dictionary, the meaning of Sirtil is given as 'liti house', 'small house', 'small mud house' built by girls for playin The literature refers to houses with miniature designs as Sirtil.

Proof

Puranaanooru 56:1

Such houses have pillared structures. The verse makes it cle that they were built with curved legs as pillars.

Proof

Akananooru. 394 :9-10

In front of the house, the structure of the house is clearl visible with a fence of slanting spikes with a pandal structure. I these verses, it is mentioned that 'Sevvaai Sirtil' is said to be sma houses covered with red sand.

2. The Design of Peril

The Sangam literature refers to houses that were designed on a large scale. A large number of houses were in a dilapidated condition with decaying elements of habitable houses and damages caused by termites. This can be known through the following lyrics.

Proof

Puranaanooru 261:1

2.1.3 Design and Use of Parts of the House

1. Munril

'Munril' means the front part of the house. While knowing the culture of old Tamilians, it seems that the use of munril was abundant.

Fig. 2.1 Munril - Landscape in front of the House

Sangam literature speaks of Kurambai, Kudil, Plot, House, Palace. In these, munril was also a part. Landscape in front of the house today remains the part of the high standard of living.

It can be seen that the 'Munril' was also a part of the residence to be used by the people who lived according to the types of land.

During the developing stage, this area is also called 'Muttr
which is present in the house.

Munril Found in Kurinji Land Residence

The Munril settings are seen as open spaces in the Kurinc
Landscaping design. In this structure, plants and vines grow an
spread like a tent, making its place suitable for sleeping and takin
rest. It can be understood from the following lyrics that thes
structures were located in the natural environment due to th
presence of plants like Jack-fruit, Vengai and Jasmine in the fron

Proofs

i) *Purnanooru 320:1–2*

ii) *Nattrinai 77 : 4-6*

iii) *Akananooru 78:7*

2. Iraippai Structure

The descending portion of the corridor is called the Iraippa
This system has been indicated in the literature of the Sanga
period as Irai, Iravanam. It can be seen that the appearance o
Irappai is the same in the design of Kurambas. According to th
land tenure, the roof structures of the built up land tenure, the roo
structures of the built up roofs of Kurambai are visible suggestin
that they have narrow irappai. This is mentioned in the followin
lines.

Proofs

i) *Nattrinai 207:2*

ii) *Puranannooru 129:1*

The multisectioned lofts have been the resting places for the pigeons. It is clear from the following Puranaanooru lines that fire-sticks were inserted into the bottom of the house when it was not in use.

Proof

Puranannooru 315:4

In ancient times, the irappai was a place where some useful items were inserted. This is traditionally followed even today.

3. The Structure of Pial

The place that is set up like a platform in front of the house is called the pial. This structure is referred to by the words Thinnai, Thertri, Vedhigai and Peedigai. The pial is a structure in front of the house and so it can be considered as an extension of the courtyard. It is a system designed based on the different purposes such as sitting, sleeping, resting and playing. The following lines of Puranaanooru confirm this.

Proof

Puranannooru 283:1–2

Reports of stone-paved thinnai structures and cultivation of plants are found in Sangam literary references.

2.2 CONSTRUCTIONS DURING THE SANGAM PERIOD

It is mentioned in Sangam literature that even before 1000 years, Tamilians were experts in architectural techniques in the construction works. As man progressed and began to organize knowledge and oral traditions and processes, architecture emerged as an art.

There is no doubt that houses for people to reside, places for kings, places of worship and public buildings were built.

All these buildings were built of perishable materials and as a result nothing remains. However, religious architecture is at the fore.

2.2.1 Climate Adaptation Framework

The life style of early Tamilians was in harmony with nature. Their houses were built suiting to the climate. The upper floors of the houses were roofless in order to dissipate the heat in summer.

The interior of the houses had a multi-panel system to ventilate the house. During the winter season, people used to close the multi-panel system. This is described by Chandra, Jaffna Su. M. Na, P.65 in Nedunalvadai.

Proof

Nedunalvadai 66–63

In palace-like residences of kings, the entrance rises up high like a hill. There are double doors equipped with handles, latches and devices called Iyavi.

The Primitive Man's House

In Dharmapuri district, there are many stone houses on morel rocks. Each loft is 10ft by 10ft slabs of 9 inches of thickness. Only one end is stopped to rest against the next board. A stone is placed in the middle to fit the correct size. Above these four walls, there is a capstone. It measures about 12' × 12'. A stone weighs about 6 or 7 tons. It is designed based on the technology of splitting the slab of rock by the heat of the rock. It is astonishing that such construction work was done by our Sangam people 10,000 years ago.

2.2 General Elements of Construction Art

The following elements are commonly found in Tamil Architecture. They are

1. Kadaikkal
2. The bearing platform (or) Asthivaram
3. Wall
4. Vimanam (Tower or Roof)

1. Kadaikkal

First of all, there was also a custom of erecting the base structure at a chosen time prior to the construction of the buildings. Kadaikkal is a hole dug in the earth at a particular place at a specific time. This is used for laying foundation.

2. Foundation or Bearing

Adequate evidences have been found to show that solid foundation structures were laid during the Sangam period. It was the first element erected on earth in the early period. Materials like lime and karuppatti were used for that. There were no engineers during that time to set up kadaikkaal as is done now. However, they have built structures that can stand for thousands of years. This was because they made proper use of materials that were easily available naturally in the environment of the day.

3. The wall

A wall is usually a structure that protects a place. Walls are generally vertical structures. It divides the space inside the

building into different rooms and separates the interior of th building from the exterior.

4. Vimanam or Tower

A tower is a tall man-made structure. They are taller than their width and length.

2.2.3 Constructions on Rocks (or) Pallava Architectur

Pallava period architecture is very important. Their architectur is of three types.

1. Temples built after digging the rocks of big hills.
2. Kartali
3. Constructed Temples

1. Temples built after digging the rocks of big hills

Temples built on the top of big hills are called 'Kudaivara Temples'. It is believed that the buildings were designed using wood, bamboo, straw, grass which did not last long. Starting from a certain point of the rock, the rock should be carved properly according to the construction design. Adequate acoustic tests were carried out to ensure the stability of the stones that no cracks were formed.

2. Kartali

In the Tamil architectural art, 'Kartali' is a temple structure built from the top to bottom on the outer side of the rock or mound protruding from the ground.

3. Constructed Temples

As early as the 7th Century, stone-built temples were erected. The chief among them is the Mamallpura Beach Temple. 45 feet high construction temples are the examples of the Tamil Construction technique.

2.3 CONSTRUCTION MATERIALS DURING THE SANGAM PERIOD

During the Sangam period, about 6000 years ago, flint, wood, suthai, bamboo, straw, grass and bricks were used in construction. There are still traces of houses, royal places, commercial establishments and public places built like that. About 6000 years later, black stones were used in construction and buildings.

2.3.1 Major Building Materials

1. Tree

Wood was an excellent early construction material. For thousands of years, wooden building materials have been used. Timber framed buildings have long-lasting stability. There are three types of trees.

1. Male tree
2. Female tree
3. Eunuch tree

(i) Male Tree

Male trees should be selected to make door posts, pillars, balcony, etc., in the house.

(ii) Female Tree

For uthiram, vittam, arch, porch and bearing beam femal trees are suitable.

(iii) Eunuch Tree

Eunuch trees are used for small vittam, frame, handrails, fence

2. Hot Sand

Hot sand is the solid building material made from clay tha is dried and heated in a kiln-like structure.

3. Suthai

It is made of lime. Wooden sticks and lime were used for this Suthai has been in practice for centuries. Later, cement was used instead of lime. Iron bars were used in place of wooden sticks.

4. Bamboo

Bamboo constructions are a strong and lightweight building material. Bamboos were used as a whole or in the broken form.

5. Straw

Straw is one of the oldest building materials. It is very strong. Straw walls are strong enough to withstand heavy loads.

6. Brick

The term brick refers to a unit made of clay. Heated bricks are one of the most durable and strong building materials. Brick is used to make walls and other elements in construction. Brick is an ancient building material. A brick is made of clay-bearing soil, sand and limestone.

2.3.2 Analysis of Kizhadi Excavation

Analysis of the samples of bricks, lime mortar, roof tiles and limestone casing well lining found at Kizhadi at the Vellore University of Technology confirmed the presence of minerals such as silica clay, lime, iron, aluminium and magnesium in each of them. Their combinations are as follows.

(i) Bricks and roof tiles : > 80% Silica

(ii) As Binding Factor : > 7% lime

(iii) Lime Mortar : > 97% lime

A closer look at the above composition reveals that the people of that time had used very high quality construction materials. And the presence of 97% limestone is a proof that Sangam buildings have survived till date because they are very strong.

2.4 HERO STONE (OR) STONES TO DENOTE COURAGE

It is an ancient Tamil tradition to offer final tributes to the dead soldiers and worship after erecting stones. The stones erected in this way are called 'Nadukal' or 'Hero Stones'. This practice has been existing in many parts of the world since the Stone Age. Generally, 'Hero Stones' can be placed for any deceased person. But it is also mentioned in Sangam literature that people used to worship the Hero Stone of the martyrs.

Fig. 2.2 The Erected Stone or Hero Stone

2.4.1 The Period of Stone Erection

In Tamil Nadu, there has been a custom of erecting stone for soldiers since Sangam period. The following lines from Tholkapiyam make this clear.

Proof

Tholkappiyam

2.4.2 The Location of the Stone Erected and other Names

Most of the erected stones are found outside the town, Two or more erected stones are also found at the same place. It is also common for many warriors who die in the same battle to have their tombstones found in the same place.

Location

1. *Three Hero stones were found at Puliman Gombai (Theni district) by the Tamil University department of Epigraphy and Archaeology. Its period is 3rd Century BC.*
2. *The Hero stones were also found during the reign of King Athiyaman who ruled places like Sengam and Dharmapuri.*
3. *In Tamil Nadu during the Chera, Chola and Pandiya periods not only the men who died in the battle, but also the war rooster, a statue engraved with the image of the rooster was set up.*

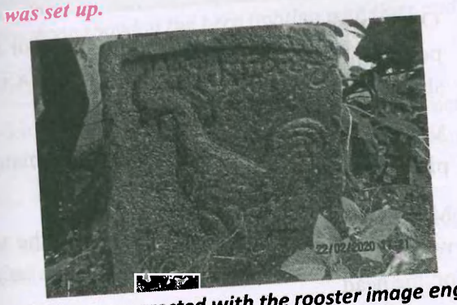


Fig. 2.3 The stone erected with the rooster image engraved

Other Names

The Hero stones are also called by the following names.

(i) Vethiappan Stone (or) Vethiappan Temple
(ii) Vedar
(iii) Krishnarappan
(iv) Meenarappan
(v) Sanyasiappan

(vi) Anjaneya Stone

(vii) Sirameetan Temple

(viii) Oomai Vethiappan

(ix) Double Vethiappan

(x) Savumettu Vethiappan

(xi) Naththamettu Vethiappan

2.4.3 The Structure of the Hero Stone

The arrangement of Hero stones are made in the following ways.

i) On the epitome there is a figure of a warrior in comba posture holding a bow and arrow or with a sword and shield.

ii) Many epitomes also show the hero with many arrows piercing his body.

iii) Mostly, a long cloth is also tied around the warrior's waist. There is no clothing on the body. A hair is seen on the head.

iv) Some players are found with long braids.

v) Some Hero stones are seen as if the hero is fighting with a tiger. (Evidence: in a town called Moththakkal).

vi) Chicken Stones: Hero stones are also found for the dead chickens in chicken fights.

Fig. 2.4 Hero stone showing the hero fighting with tiger and elephant

2.4.4 Inscriptions on the Hero Stones

The king's reign, year, the name of the martyred hero and the news about him, the battle, about bringing cattle, about recovering cattle, etc., are engraved on the Hero stone.

The epitomes usually have circular letters. There are also some Tamil letters.

Evidences

1. *The stone erected for Pedutheeyan Anthavan who died in the Akol fight held at Koodal town.*
2. *Another Hero stone erected for Pathavan from Vel town.*
3. *(i) Iynkurunooru. 352, (ii) Akananooru 297.*

All these indications show that there were inscriptions on the erected hero stones during the Sangam period.

2.4.5 Method of worshipping the Hero Stone dur the Sangam Period

There was a custom of offering flowers and smoke to the Her stones every day. It was called 'salutation to the Hero stone'. It mentioned in books like Purananooru, Silapathikaram, Malaipad Kadaam. Stones were placed around the Hero stone to make a hoard. It is called 'Vallan Padukai God'. They would beat the udukai, perform pooja with Thoppi, a kind of liquor. They also sacrificed animals.

Proofs

i) Purananooru

Next to Sirtoor, at the dawn, they poured fresh water to the planted stone and performed pooja lighting a ghee lamp. Puranaanooru tells the story of the Hero stone being worshipped, that the smoke produced by lighting the ghee lamp rose like a cloud and smelt in the street.

ii) Auvaiyar says that Athiyaman Nedumananji performed pooja with peelisooti liquor.

iii) Silapathikaram says that Senkuttuvan appointed Kannagi's friend, Devanthi to worship the Hero stone erected for her.

2.5 DESIGN OF THE HOUSEHOLD MATERIALS IN THE SANGAM PERIOD

There are evidences of the existence of household items in the Sangam period. How the items were used, and they were designed are found in the evidences.

1. Aryakkal or Enthiram

A tool which is called enthiram (apparatus) is the grinding tool that is found in every house in the villages of Tamil Nadu. Aaryam is a stone tool used to grind ragi into powder. Whole grains can be broken into two. Plant crop, gram, green gram can easily be broken.

Shape

Fig. 2.5 Enthiram

The lower part of the Aryakkal is a fixed round stone. There is a sprout in the middle of it. A round stone is found with a hole in the middle at the top. It revolves around the sprout. There is also a sprout to hold the top stone in order to move it around. When the stone rotates, the grain or the crop placed in the circular hole of the upper stone is ground in between and is broken and falls out.

This instrument is found in all parts of India. There are many epigraphical evidences that this instrument was used in every house even during the Sangam period.

2. Ural – Plunger

Ural is a very simple tool. This tool is used to remove the husk of paddy, to remove the skin of rye and to clean the corn.

Shape

The shape of the ural is like a udukkai. It is made of wo and black stone. It is also called Kunthani which is made of wo The upper part of the ural is like a flat ring with a circular pit the middle.

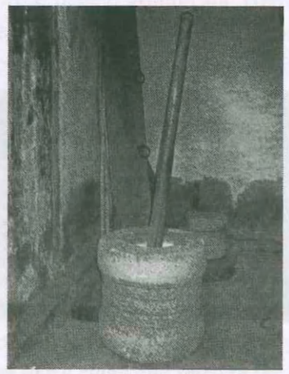


Fig. 2.6 Ural – Plunger

A plunger is a cylinder-like elongated wooden block with an iron rod attached at both ends.

Application

During the Sangam period, to remove the paddy husk, it was pounded with a plunger. Ural has been used to measure the rainfall in rural areas. If the ural has got rainwater in full, it is called a 'plough rain'. A village ural pit was filled with water and measured. The researchers found that it was equivalent to nearly an inch of rain. Other than the urals at houses, here and there it can be seen that ural holes were carved in stone rocks in the forest areas.

Proof

Samana Hermit Cave is located at Jampaik Garat, Thirukovilur Circle, Villupuram district. It has an inscription of Athiyaman Neduman Anji. Ural is carved in front of this cave.

3. Grinding Stone (or) Aatural (or) Sekku

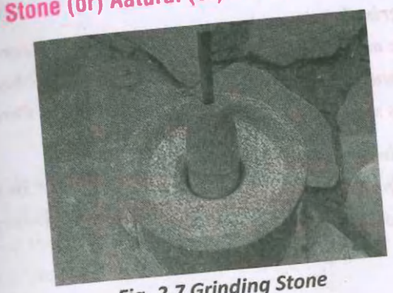


Fig. 2.7 Grinding Stone

Grinding stone is a device used during the Sangam period for grinding rice flour for making Idly, Dosa and Chilli mortar.

Shape

A hole dug in stone; a handle for holding and turning the stone suitable for the pit is the structure of the grinding stone.

Application

Sangam people used to prepare pongal in forest temples away from the town. Sacrifice of chicken, goats and pigs is customary. They cook and enjoy eating them. A grinding stone is required for grinding the necessary chilli paste. The philanthropists provided such grinding stones and their names are engraved on them.

Evidences

1. *In the forest temple on the Kalvarayan hill in Salem di... there is a grinding stone engraved on the rock. On analyzi... it, it is understood that it is dated back to the first Paranthag... Chola.*
2. *A grinding stone is cut on a stone near a temple under... tree at Manaloorpet in Tirukoilur circle. It belongs to 7... Century AD. In it, the words 'Srisalavan Perinaranath... This may be the oldest written inscription.*
3. *An inscription is cut on a large boulder in a forest o... Rasipuram in Salem. In it, in the 12th Century letters, a... statement is found.*

4. Ammi

The Ammi and Kuzhavi are used to grind chilli paste.

Shape

The base part is flat. On the top of it is the rolling Kuzhavi. Turmeric and ginger are first placed on the base stone and crushed with the Kuzhavi. Then, the content is ground by rolling and pulling the Kuzhavi.

Fig. 2.8 Ammi with Kuzhavi

Evidence

There is an Ayyanar temple in Chingee, Villupuram district. There, a long Ammi has beautiful carvings on all four sides. It may be the period of Sambuvarayar.

5. Oil Sekku

Sekku is a tool used to press sesame, groundnut and coconut oil and extract oil.

Structure

Sekku is mostly made of wood. The kuzhavi is made of iron or wood. Sometimes, the kuzhavi is made of black stone. The compressive force is supplied by the kuzhavi. Two cattle are locked to go round the sekku. The process of rotating the sekku is called 'Kaanam'.

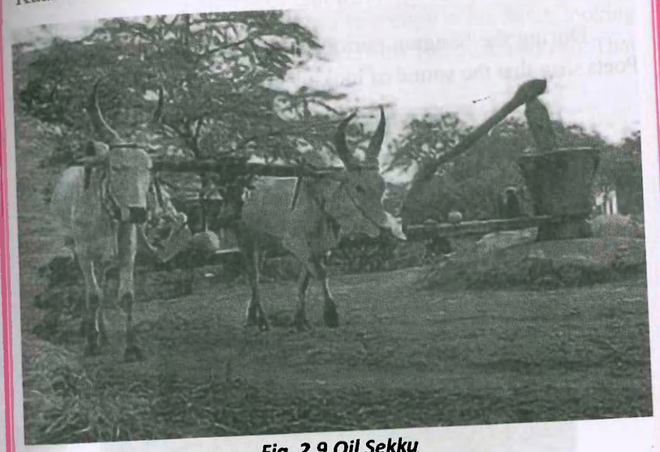


Fig. 2.9 Oil Sekku

Evidences

1. *There is a stone sekku in the town called Ennairam, Villupuram circle.*
2. *There is also a town named Marakkanam.*

6. Sugar Factory

Sugar Factory is the place where devices are found to squeeze out sugarcane juice.

Structure

About 50 years ago, wooden rollers were installed and even the toothed wheels that transferred the force were made of wood. The rollers were rotated by being pulled by cattle. The sugarcane is inserted in the middle of the cylinder and the juice is squeezed out and comes out as solid residue.

During the Sangam period, it was called a locking device. Poets sing that the sound of lock-clang is always heard.

Fig. 2.10 Sugar Factory

Proofs

1. *A song about Veliyarkone Veethividangan, the ruler of Tirukoilur contains lyrics about Sugar Factories.*

2. *A scene in Perumbaanaatruppadai mentions that one can always hear the sound of the sugarcane juicer on the mountainside similar to the trumpeting of an elephant attacked by yaali.*

Perumbaanaartuppadai 257–62

7. Telescope

The Bosala Kings ruled the state of Karnataka. Uralepeedu is the best among the Bosal cities. The twin temples here have many beautiful sculptures. Many Mahabharatha scenes are also found. It was built in the 9th Century AD. In one of the sculpture scenes, his charioteer 'Sanjayan' holding a telescope in his hand, looking at the battlefield and narrates the scene to Thirutharashtiran. That telescope is a long tube.

Fig. 2.11 Telescope

2.6 PLATFORM STRUCTURE IN SILAPPATHIKA

About 2000 years ago, Elango Adigal has given a very deta account of the setting up of the theatre.

Madhavi had a curly hair. At the age of five, she perfor the ritual of learning to dance and learned the art till the age o At the age of 12, she came to the Chola Court to stage her da

Fig. 2.12 Platform Structure in Silapathikaram

2.6.1 Platform Structure

1. Space for the Arena

They chose a suitable land according to the unchanging natu suggested by a learned sculpture writer, for the stage for dancin

2. Fetching Bamboo

On the high sacred hills like Pothigai Hill, among the ta bamboos, they cut down a single bamboo and used it to build dance stage.

Bamboo Scale

According to the information given in books, a piece of bamboo was made into a 'stick' measuring 24 (about 4 feet) in the humb of a well-grown average man. They built a dance stage of 7 Kols (28 feet) wide, 8 Kols (32 feet) long and one Kol (4 feet) high.

Installation of the Upper Board

Pillars were erected on the four sides of the platform and an pper board was fixed on them. A board was also installed on the loor of the arena. Between these two boards they placed a space of four Kols (16 feet) high.

Entrance to the Arena

They arranged two entrances for the performers to enter as well as to exit on the top floor of the arena. They painted images of the four types of Varuna Bhudaas for everyone to worship.

installation of Entrance Lights

They placed illuminant lamps so that the shadow of the pillars did not fall on the stage and the hall.

Ezhinigal (or) Screens

The screens are of three kinds.

One Side Pulling Screen

A curtain that is set up so that it is drawn on one side of the age is called a single curtain.

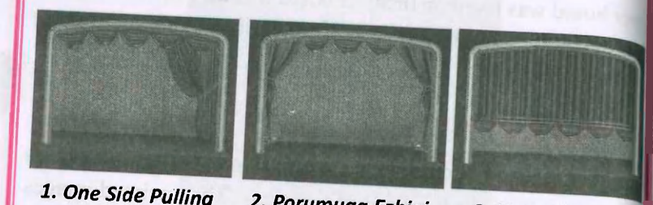
(ii) Porumuga Ezhini

A screen that overlaps in the middle so that it can be pull from either side of the stage is called Porumuga Ezhini.

(iii) Karanthuvaral Ezhini

A screen that descends when needed from the top of th platform is called Karanthuvaral Ezhini.

The above mentioned three types of curtains were arrange nicely.



1. One Side Pulling Screen | 2. Porumuga Ezhini | 3. Karanthuvaral Ezhini

Fig. 2.13 Three Types of Curtains

8. Canopy and Festoons

They also erected a canopy with paintings. All over the stage, the famous pearl garlands like Sari, Thooku and Thamam were hung beautifully.

They built a dance hall with such artistic works.

2.6.2 Thalaikol (Degree for the Students of Drama)

The women who performs well in the dance are given the titles 'Thalaikols'. Thalaikol was made from the hammock of a beautiful silver umbrella taken from him in a battle with a rival king of great renown, who had been defeated.

2.7 MAMALLAPURA SCULPTURES AND TEMPLES

Mamallapuram or Mahabalipuram Temple was built by Rajasimma Pallavar. When the king Narasimha Mamalla went on a picnic with his father, he drew a picture on a rock. On seeing that, his father got an idea to build immortal temples on the rocks. Rajasimhan named the temple after his son Mamallan.

2.7.1 Cave Temples

There are 9 cave temples in Mamallapuram. Those are special inscriptions on events in Hindu mythology.

1. Tiger Cave

Fig. 2.14 Tiger Cave

Saluvan Kuppam cave temple has a different layout among the carved temples in Tamil Nadu. This yaali carving is available with 16 heads. This yaali carving was erected for the Kotravai goddess.

2. Athiranasanda Pallaveswara Kirugam

An inscription found in the mandapa mentions that Shiva w always stay here with Umai and Gugan.

Fig. 2.15 Athiranasanda Pallaveswara Kirugam

3. Archuna Penance

The rock sculpture Archuna penance, a 90 feet rock masterpiece, depicts Archuna's penance to Lord Shiva for Pasupatha Astra during the mid day in summer.

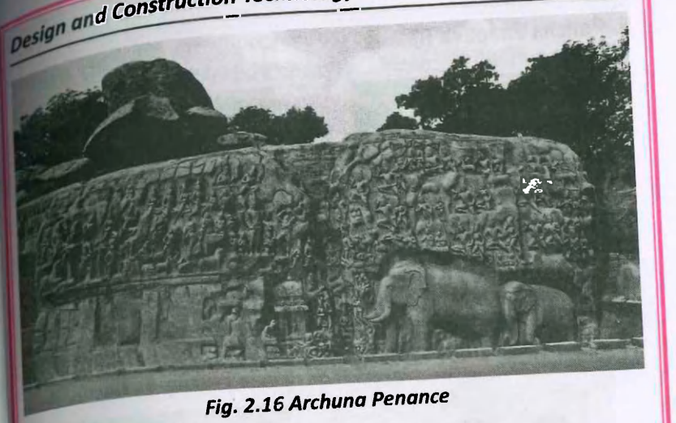


Fig. 2.16 Archuna Penance

4. Krishna Mandapam

According to the legend, Kannan lifted the Govardhana Hill as an umbrella to protect the Gokula shepherds, goats and cows from the rains and storms caused by Indra. The Pallavas have sculptured the same. This is Adhivaraga Cave Temple.

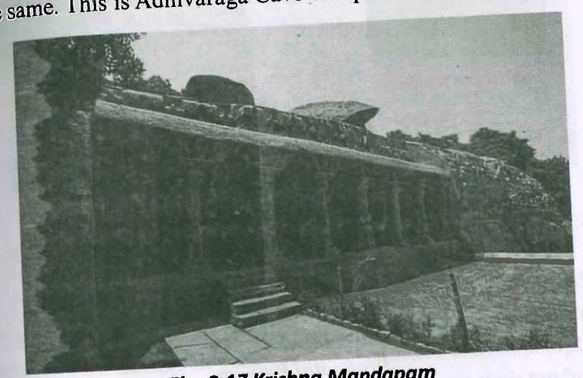
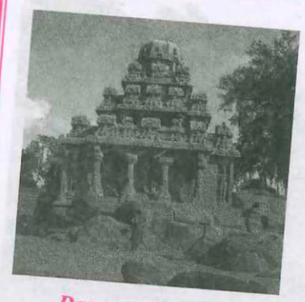


Fig. 2.17 Krishna Mandapam

5. Pancha Pandava Rathas

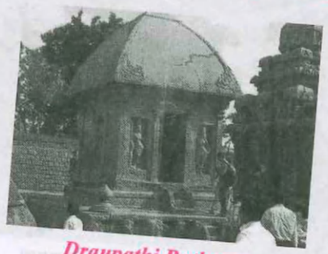


Darumar Ratham

Bhiman Ratham

Archunan Ratham

Nagula Sahadeva Ratham



Draupathi Ratham

Fig.2.18 Pancha Pandava Rathas

In our tradition wherever five elements are together, they are associated with Pancha Pandavas. Hence, all the five temples here are known as 'Panchapandava Rathas'. There are various stone sculptures carved on five chariots namely Darumar Ratham, Bhiman Ratham, Archunan Ratham, Nagula Sahadeva Ratham and Draupathi Ratham.

6. Ulaganeswarar Temple

It is a 7th Century stone temple. The lamp lit in this temple was the harbour beacon during the Pallava period.

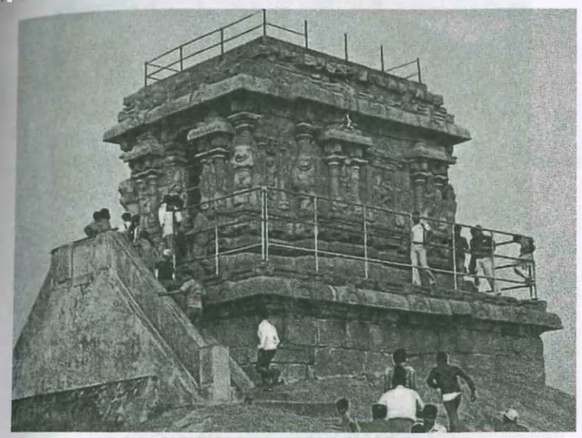


Fig. 2.19 Ulaganeswarar Temple

7. Mahishasuramarthini Cave

In this carved temple, there is a sculpture of the goddess who destroyed Mahishasura. There are masterpieces of sculptures including Somaskandar sculpture and Ananda Perumal sculpture. The goddess seated on a lion facing Mahishasuran with ten hands

holding bow and arrow and fighting against him. This is pres... excellently. She keeps her right leg on the lotus base and her... leg on the lion. The goddess is fighting with Mahishasura... he runs away.

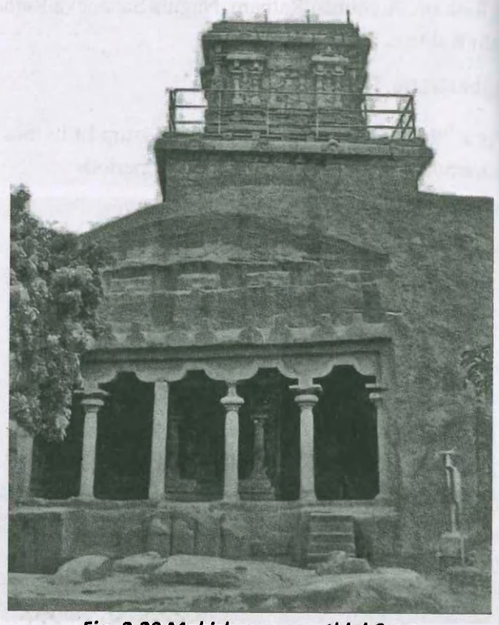


Fig. 2.20 Mahishasuramarthini Cave

8.Raamanuja Hall

Ramanuja Hall was carved for Shiva. It was carved with three sanctum sanctorums namely Shiva, Brahma and Tirumal. Later, this carving for Shiva was destroyed and changed to the carving for Perumal.

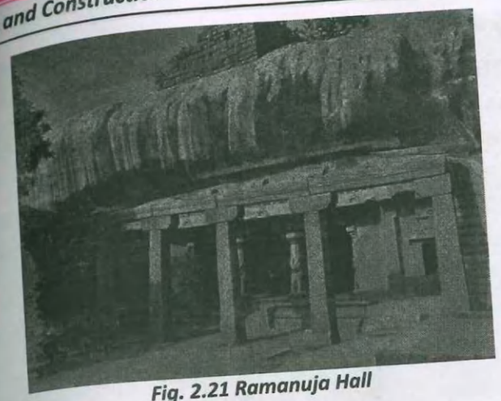


Fig. 2.21 Ramanuja Hall

9. Varaha Hall

On the walls of this carving, there are sculptures of Varahamurthy, Thirumagal seated on a lotus, Kotravai and Ulagalanda Perumal.

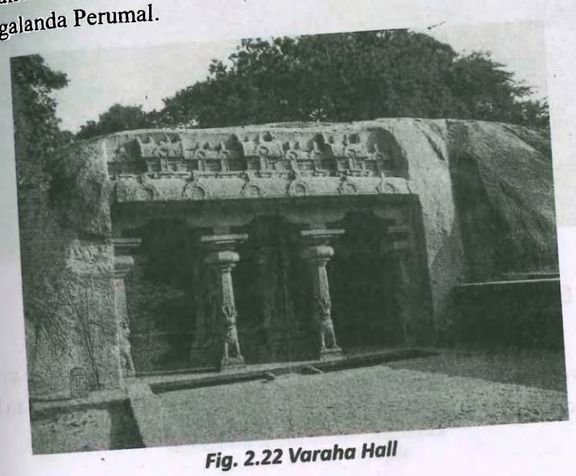


Fig. 2.22 Varaha Hall

10. Ganesa Ratham

This is an undamaged temple carved out of a single st
Ganesa Ratham is the only sculptural temple currently rema
worship at Mamallapuram.

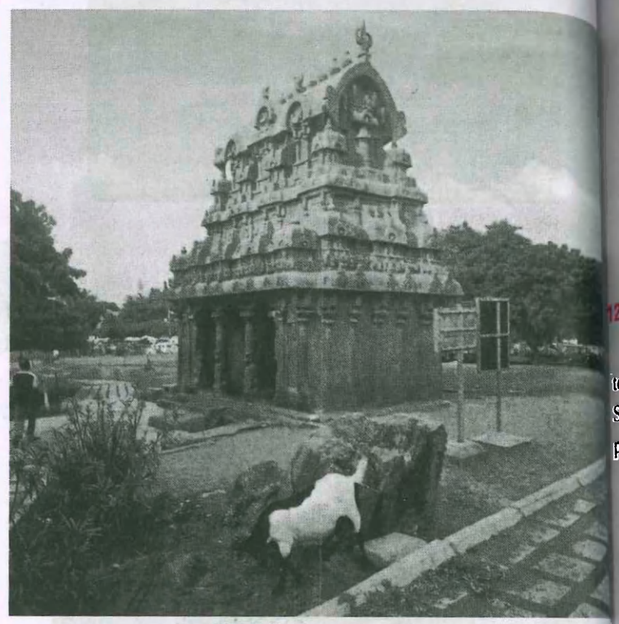


Fig. 2.23 Ganesa Ratham

11. Embossed Sculptures

Emossed sculptures have a three dimensional structure ev
if we look at them from four sides. These sculptures appear to
attached to the wall and are self-contained outside.

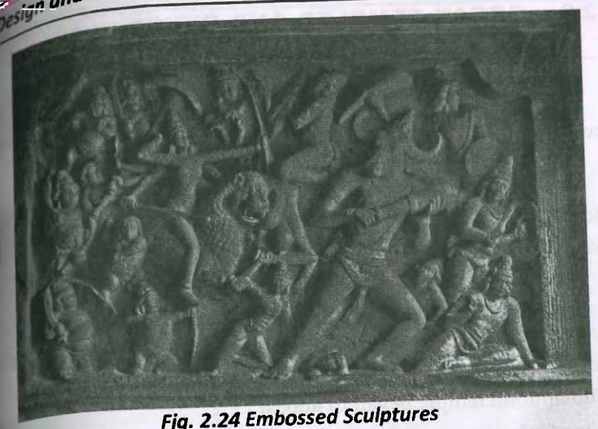


Fig. 2.24 Embossed Sculptures

12. Beach Temple

Mamallapuram Beach Temple was the first constructed temple in Tamil Nadu. The height of this temple is 45 feet. In this, Somaskandar in Linga form and Jalasayana Perumal in sleeping posture are found in damaged conditions.

Fig. 2.25 Beach Temple

2.8 GREAT TEMPLES AND OTHER PLACES OF WORSHIP OF THE CHOLA PERIOD

Architects and historians consider Chola architecture as a continuation of the style pioneered by the Pallavas.

Cholas started building many temples since Vijayalaya defeated the Muthraiyas and established the Chola's rule in Tamil Nadu.

But, the buildings of the Chola period before Rajaraja were not big. However, during the period of Rajarajan and his son Rajendra Chola Thanjai Great Temple and Gangai Konda Cholapuram temple began to appear.

Among these, The Tanjai Great Temple which was completed in 1009 AD is the crowning master piece of Chola architecture. Like this temple, numerous other temples were built by the Cholas in Tamil Nadu. Here, let us see some of the notable temples.

2.8.1 Iradeeswarar Temple, Tharasuram

Although it is smaller than the Gangai Konda Cholapuram and Prahadeeswarar temples, the sculptures in this Airavatham Temple are very intricately carved. The Iradeeswarar temple is arranged like a chariot which is pulled by horses. Indiran's elephant Iravatham lost its colour due to the curse of the hermit Durvasa. The elephant came here and worshipped Shiva and as result it got relief from the curse. Hence, it is said that this temple got its name as Iravatheeshwarar Temple.

Fig. 2.26 Iratheeswarar Temple, Tharasuam

2.8.2 Thillai Natarajar Temple, Chidambaram

Thillai Nataraja Temple has always had a special place among the symbols of the Chola Dynasty. The Sanctum Sanctorum of this temple has been built with golden Vimanam with eleborate stone carvings.

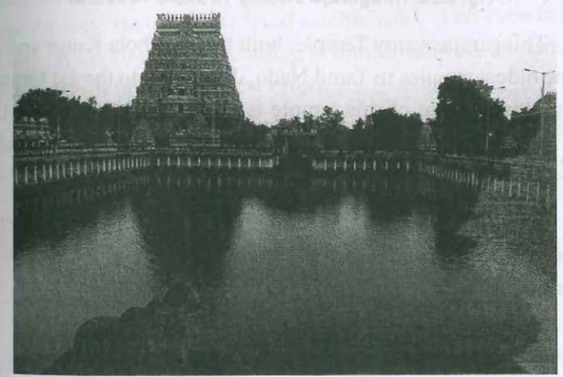


Fig. 2.27 Thillai Natarajar Temple, Chidambaram

Parantaka Chola, the son of Adhitya Chola is said to have b this goldon canopy. Through this, he got the title of 'Ponve Cholan'. During Sivarathiri, Natyanchali dance performan arranged in Nataraja Temple for five days.

2.8.3 Thiagaraja Swamy Thirukoil, Tiruvarur

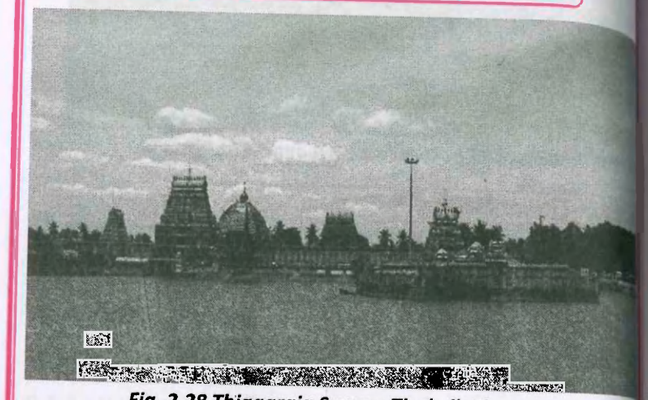


Fig. 2.28 Thiagaraja Swamy Tirukoil, Tiruvarur

Thiagarajaswamy Temple, built by the Chola Kings and o of the oldest temples in Tamil Nadu, dates back to the 1st Centur Th moolasthanam of this temple is divided into two parts. O part is dedicated to Lord Shiva and the other part is dedicated Thiagarajar.

A section dedicated to Vanmiginathar is older than the secti dedicated to Thiagaraja. In Vanmiginathar's Sannithi, instead the usual lingam, a pit (Putru) has been installed.

2.8.4 Pragadeeswarar Temple, Thanjavur

Fig. 2.29 Pragadeeswarar Temple, Thanjavur

It was Rajaraja Chola who had travelled throughout the northern country with many victories. He was fascinated by the appearance of the temples of various sculptural traditions that he was on the way. He wanted to build a noble work of art even better than them in his kingdom. According to some historians, this temple must have been built with great effort.

It is no exaggeration to say that indescribable fine design, imaginative power, subtleties, impeccable order, meticulous calculations and scientific techniques are imbued in the creation of this entire temple.

2.8.5 Rajagopalaswamy Tirukkoil, Mannargudi

The Rajagopalaswamy Temple complex is spread over an area of about 23 acres with 24 Sannidhis, 16 tall towers, 7 courtyards, 7 halls and 9 ponds.

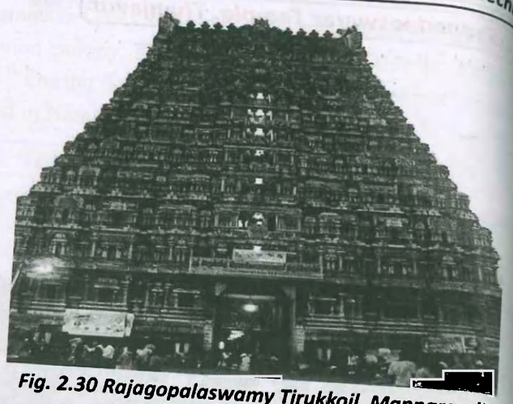


Fig. 2.30 Rajagopalaswamy Tirukkoil, Mannargudi

The temple was built during the reign of Kulothunga C and was renovated by various Chola Kings who came after h Later on, during the reign of Nayak Kings, it was expanded. pond is one of the largest temple ponds in India.

2.8.6 Gangaikonda Cholapuram, Ariyalur

Fig. 2.31 Gangaikondo Cholapurom, Ariyalur

This temple is a testament to the high quality of art and architecture of the Cholas. This temple is famous not only for being built by the Cholas but also for having the largest Shivalingam in South India. The Shivalingam in the Sanctum Sanctorum of this temple is 4 metre high. The historical events of the Chola dynasty and their government inscribed in the copper plate inscriptions in the walls of the temple are more descriptive than any other historical text.

18.7 Swedharanyeswarar Temple, Tiruvenkadu

Among the nine navagraha locations in Tamil Nadu, it is the Budhan. In this temple, Budhan God who offers knowledge, wealth is worshipped by making a separate sannithi. The murals here have been painted to know the important historical information of the Chola empire and the Kings of Vijayanagar.

Fig. 2.32 Swedharanyeswarer Temple, Thiruvengadu

2.8.8 Sri Kumbeshwarar Temple, Kumbakonam

Sri Kumbeshwarar Temple located in Kumbakonam Shivalyam. It is in this temple, Masimaga festival is celeb every year. Mahamaha festival is celebrated every 12 years temple is believed to be 1300 years old.

Fig. 2.33 Sri Kumbeshwarar Temple, Kumbakonam

2.8.9 Sri Kambahareshwarar Temple, Kumbakonam

Sri Kambahareshwarar Temple is located at Tirubuvanam village near Kumbakonam. The construction work of this temple was started by the King Kulothungan who ruled over in the 13th Century. The kings of Chera, Chola, Pandiya dynasties who came after him continued the work and completed the construction. Historians believe that this was the last temple renovated by the Cholas.

Fig. 2.34 Sri Kambahareshwarer Temple, Kumbakonam

2.8.10 Kalyana Pasupatheeshwarar Temple, Karur

Fig. 2.35 Kalyana Pasupatheeshwarar Temple, Karur

The Kalyana Pasupatheeshwarar Temple was buil
the reign of the Cholas. This temple is famous for its five
Pasupatheeshwarar Lingam. There is also a cluster of fi
found here. The lingam appears in the Sanctum Sanctor
bathed in the milk flowing from the udder of a cow.

2.8.11 Jambulingeshwar Temple, Tiruvanaikaval

The Jambulingeshwar Temple at Tiruvanaikaval is bel
to have been built by king Kochenga Chola, one of the early C
kings. In addition to that, some inscriptions written during the
period are still visible on the temple walls.

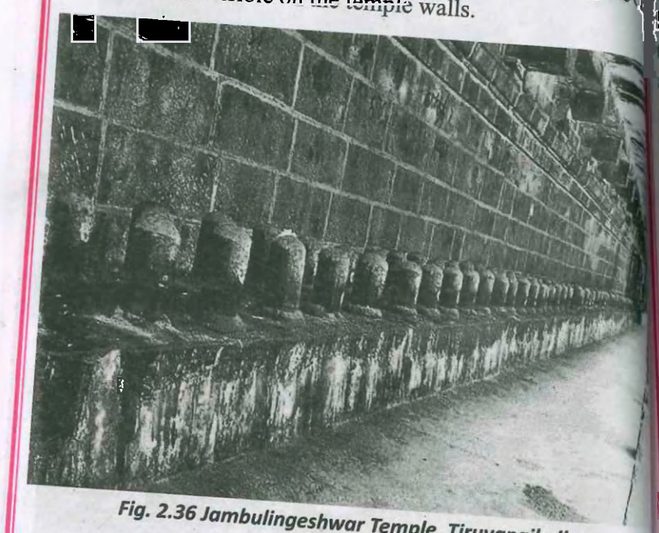


Fig. 2.36 Jambulingeshwar Temple, Tiruvanaikoil

Although the temple was built 1800 years ago, it is still in
good condition due to the maintenance work. An underground water

pring was discovered under the Jambukeshwar Sanctum. Every
ime it is tried to empty the water source, again and again, it fills up.

2.8.12 Someshwarar Temple, Kumbakonam

Someshwarar Temple is located in Kumbakonam. When
ooking at the architechtural design of this temple, it must have
een built before the 13th Century. It was during this period, that
he later Cholas were ruling over Kumbakonam. Actually, this
emple was originally built by the Cholas who worshipped Lord
Shiva and Goddess Parvathi. Later Kings added different designs
to the construction of the temple. But the basic design is Chola
architecture.

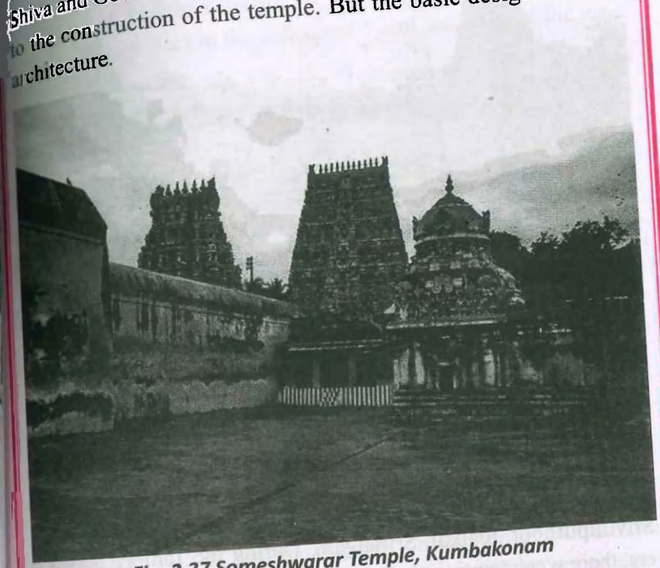


Fig. 2.37 Someshwarar Temple, Kumbakonam

2.8.13 Sri Mayuranathaswamy Temple, Mayiladuth

Sri Mayuranathaswamy Temple is the largest temp
Mayiladuthurai. The oldest records on the walls of this te
are those of Kulothunga Chola. Slightly reconstructed afte
initial construction, the temple still stands a testament to
architecture. The Mayura Natyanjali program held every ye
Lord Nataraja of this temple attracts countless people to this tem

Fig. 2.38 Sri Mayuranathaswamy Temple, Mayiladuthurai

2.9 TEMPLES OF NAYAK PERIOD

In Tamil Nadu, many temples have paintings from the time of the Nayak Kings who ruled in Chingee and Vellore in the 17th Century. During the Madurai Nayakkar era, there were paintings in temples at places like Vellore, Tanjore, Madurai, Natham, Srivilliputhoor, Idaikal, Srirangam. During the Tanjore Nayakar era, there were paintings in Patteeswaram, Chidambaram, Kurichi, Tirumangalakkurichi, Tiruvarur and Avudaiyar Temple. Temples at places like Tiruvannamalai and Sengam have paintings from

the time of the Nayak Kings who ruled over the northern part of Tamil Nadu.

2.9.1 Major Nayakkar Temples

1. Alagar Temple, Andal Temple

In Vasantha Mandpam of Alagar Temple and Srivilliputhur Andal Temple, the paintings of Madurai Nayaka depict the important happening found in Ramayana as series. In the Alagar Temple Vasantha Mandapa paintings, the beginning of Ramayana to the end of Yuddha Kandam are shown. Below each scene, its description is written in the colloquial Tamil language of the time.

The birth scenes of Rama, Lakshmana, Bharatha and Shathruka, their going to school and the death of Dasaratha are depicted in it.

2. Natham Siva Temple

In the front hall of the Amman temple, the birth scenes of Muruga from the Skantha Purana are painted. The front hall of the Swami temple has the image of Ilingama Nayak and various modifications painted on it.

3. Madurai Meenakshi Amman Temple

i) In Madurai Angayarkanni Temple, there are 64 coloured paintings of Tiruvilaiyadal scenes on the north and east sides of the hall walls around the Potramarai Pond.

ii) In one of the mandapams on the top of Potramarai Pond, there is a historical painting of the era of Rani Mangammal. It features scenes of Tadathagai Pratiyar, born as the daughter of Pandya, fighting with the eight

guards, the sceptre festival held annually by the kings and Meenakshi Thirukkalyanam.

iii) The sceptre ceremony painting depicts the scene of Mangammal receiving the sceptre.

iv) In this painting, there is a scene where Muthu Visaya Sokanatha Nayak and Thalavai Ramappaiyan enjoying seeing Meenakshi Thirukkalyanam with Mangammal.

4. Thiruvarangam Temple

i) At Srirangam, the Muthangi Seva procession Thiruvaranganathar is depicted in a beautiful colo painting on the canopy of one of the towers on the w to the temple, past the Rajagopuram.

ii) Bhagavatha legend is elaborately painted on the canop of Thirusutru Mandapam of the Mother Shrine.

iii) The history of the Alwars and the Acharya method ca be seen in colour paintings in the Ramanujar Temp Mandapam.

5. Tanjore Nayak Temple

i) Patteeswaram

In the Shiva Temple here, Thala Purana is painted in Amman Temple Mandapam. The custom of fishing is well depicted in it. The Nataraja dance performance is depicted in the Shiva Temple Tower.

ii) Chidambaram

Chidambaram Sivakamiamman Temple's front porch canopies depict the mythological scenes of Chidambaram and Lord Shiva's

destruction of the Sages of Darugavana. In this painting, Lord Shiva disguised as Pitchandan and the rishi women are behind him taking the centre position. The sages of Darungavana are departing behind Tirumal who is in the form of Mohini.

iii) Avudaiyar Temple

In this painting, the history of Manikka Vasaga is depicted.

iv) Thiruvannamalai

On the road to Girivalam, there is a mandapam called Ezhuthu Mandapam. Lord Shiva marrying Umaiyal, the Ramayana, Kannan's dance with the shephereds' wives and Muruga's marriage to Valli have been depicted as colour paintings.

v) Chengam

Next to Thiruvannamalai, at Chengam in the Perumal Temple Mandapam, Telugu Ramayana scenes have been painted. One of these scenes where Hanuman beats Mandothari holding her hair is different and innovative.

6. Madurai Meenakshi Amman Temple

In this temple, the wedding scene of Meenakshiammai and Sundareswarar is beautifully painted in the swing hall opposite to the shrine of the goddess. Near Devi, Thirumal with Bhudevi pour water to Shiva and arranges the marriage. Eight guardians and Nandidev stand at the back. Nanmugan makes a fire below. Some members of the Royal families are watching this with happiness. Rani mangammal is standing next to Lord Shiva with folded hands.

7. Tanjore Great Temple

On the wall of Praharam surrounding the Sanctum Sanctorum of the temple, paintings of the Nayak period are placed on the top

of the paintings of Chola period. The sight of the guards com their vehicles, praying for elixir in the sea, Durga fighting wi monsters Sumban and Nisumban, Thirumal plucking lotus fl from a pond to receive chakra from Shiva have been painte

8. Thiruvarur Thiagaraja Temple

Paintings have been done on the ceiling of its hall. It d the story of the legendary King Musukuntha Chakravarthy. monkey-faced Musikuntha Chakravathy sits on an elephant comes in procession followed by two attendants moving Samaram (fan).

2.10 UNDERSTANDING MODEL STRUCTURES

2.10.1 Madurai Meenakshi Amman Temple

Madurai Meenakshi Sundreshwar Temple is a Shiva temp located in the middle of the temple located in the middle of t temple city of Madurai. The prominent god and goddess ar Sundareshwarar and Ambigai Meenakshiamman. This temple i also known as Madurai Meenakshiamman Temple. This place i not only an important Shiva temple but also one of the 51 Sakth Peedas of Ambigai.

The Builder of this Temple

People believe that this temple was built by Indran, the king of Heavens. This place is the Sithar Peedam of Sundaranandar, the fourth of Vinayaka's Arupadai Houses, the 274th Sivalayam which has Devaram songs on Shiva, 192nd Devaraththalam. This temple has been worshipped by Rama, Lakshmana, Varuna, Indran, etc.

Structure of the Temple

Madurai Meenakshi Amman temple is spread over an area of ...es. The temple has 8 towers and 2 vimanas. The Karuvarai Vimanas here are called Indra Vimanas. These are supported by 32 stone lions. 64 Sivaganams and 8 white elephants.

The temple measures 847 feet from east to west and 792 feet from South to North. There are 4 towers of 9 levels on the four sides of the temple's main roads.

Builders of the Towers

i) East Tower (Rajagopuram)

It was built between 1216 AD and 1238 AD by the later Pandyas.

ii) West Tower

It was built in 1323 AD by Maravarman Kulasekara Pandiyan.

iii) South Tower

The South Tower was built by the King Viswanatha Nayak in 1559 AD.

iv) North Tower

History says that the construction was started by the King Muthuveerappa Nayak from 1564 AD to 1572 AD and completed by the Vainagaram family in 1878 AD.

In this temple, Potramarai Pond has been set up in an area of one acre.

Halls (or) Mandapas

The beautiful sculptures of the temple are different from t mandapam, with beautiful details and individual features.

1. Attasathi Mandapam

Attasathi Mandapam is located in front of Meenakshi A Sannithi. Meenakshi Tirukalyanam is depicted in the form of st between Vinayagar and Murugan idols on the gate. On the pill located inside, eight forms of Sakthi are beautifully painted.

2. Kambathadi Mandapam

It was built by Krishnappa Nayak-I in AD 1564 – 1572. Th sculptures in this hall have various forms of Lord Shiva. Meenaks Thirukkalyana sculpture is world famous. The Nandhi Mandapa in front of Swami Sannithi is of a single stone.

3. Mandapam with 1000 Pillars

It was built in 1494 AD by Veerappa Nayakkar, the ruler o Madurai. It is larger in size than the other halls in the temple. A wheel representing 60 Tamil years is carved on the canopy above the gate of this hall.

4. Veeravasantharayar Mandapam

It is found in front of the 1000 pillar hall. It is 400 years old and has 7000 sq.ft. area. In the middle of this Mandapam, there is a Nandhi idol facing the God.

Musical Pillars

Meenakshi Amman temple has 5 music pillars on the North road of the temple, 2 music pillars in the 1000 pillar Mandapam and 7 music pillars in the Meenakshi Amman Temple itself.

Sannithis

1. Moolavar Sannithi

The prominent god of this temple is Sundareshwar. He is Swayambu Murthy. He is also called Somasundarar, Sokkar and Sokkanathar. By worshipping him, Indiran got rid of his sins. That was why he built a temple for the Swayambu Lingam. The Porminent God's Vimanam is called 'Indira Vimanam'.

2. Ambal Sannithi

In this site, Ambal (mother) is Meenakshiamman. Her idol is made of green emerald. This Sanctum Sanctorum has 32 lion images, 64 Shiva statues and 8 stone elephants. This Sanctum Sanctorum Vimanam was set up by Devendran. She got the name Meenakshi because she had eyes like fish.

Parrot

In the appearance of Meenakshi Amman, there is also a parrot. The parrot is believed to be saying, repeatedly to remind Ambigai of the devotees' request. When Indiran came to visit this place to get rid of the curse, the parrots helped him in the worship of Shiva.

Other names of Meenakshiamman

For Meenakshiamman, there are innumerable names like Maragatha Valli, Pachaidevi, Tadathagai, Abirama Valli, Karpoora

Valli, Komagal, Sundaravalli, Pandipratti, Manikka Valli a
Mathurapuri Thalaivi.

Pathivirathai

As Meenakshi is the queen of Madurai, devotees are
allowed to see her abisekams. Devotees can see Meenakshiamm
after the decoration is fully over. The first Pooja of this temple
performed to Ambigai Meenakshi. After that, prayers are offe
to Lord Shiva. The reasons for this is that Meenakshi Amm
has always intended to do her faithful duties to her husband. S
before waking up her husband, Ambigai, the wife completes h
Abishekam and gets ready. So the first pooja in the morning
performed to goddess Meenakshi.

2.10.2 Thirumalai Naiyakar Mahal

Thirumalai Naiyakar Mahal or Thirumalai Nayakkar Palace
was built in AD 1636 by Thirumalai Nayakkar one of the Nayakk
Kings who ruled Madurai. It was designed by an architect in th
Italian Sarocenic style. After the construction of the new mandapam
the construction of Rajagopuram was started. But, it remains
unfinished.

Structure

This palace is 58 feet high and 12 feet wide. It is supported
by 248 colossal pillars. The ceiling is painted with mythological
scenes of Vishnu and Shiva.

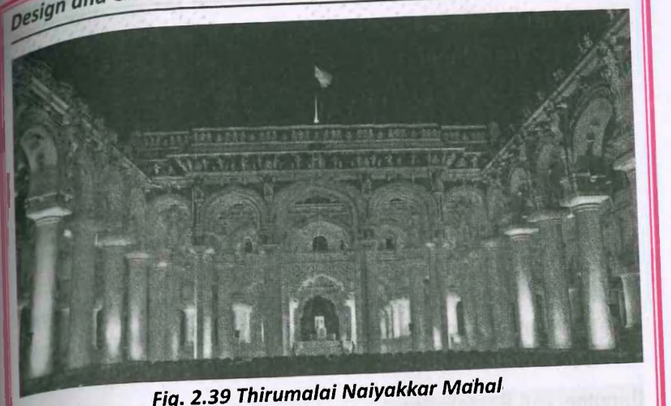


Fig. 2.39 Thirumalai Naiyakkar Mahal

Parts of the Palace

The palace consisted of two main parts. They are

1. Heavenly Address
2. Venue Address

1. Heavenly Address

This area was the residence of the king.

2. Venue Address

This area was the residence of Muthiyalu Nayak, the king's younger brother.

The palace consisted of music hall, theatre, palanquin road, weapon road, place of worship, residences of other royal families and servants, private place (Anthappuram), parks, lakes, etc.,

Limestone Building

Thirumalai Nayakkar building is made of lime called chur na and egg white mixed with a mixture of jaggery, gall-nut, gooset er is coated all over the palace to get a smooth and shiny look.

Inner Courtyard

It must be said that the big white pillars that fill the inner hal of this palace are the favourite of all. This palace was four tim larger than it is today and was completed by Thirumalai Naya The palace was surrounded by a very grand nandavanam, tank anthappuram and durbar.

Damage and Restoration

None of those who came to power after Thirumalai Nayaker's death knew the fame of the palace. Thirumalai Nayakkar's grandson, Chokkanathan took away all the art objects from the palace to shift his headquarters back to Trichy.

Wooden pillars with intricate carvings and jewels were taken to Trichy. The fame of the palace started to decline as he broke the palace in many places and took away the things. The palace also started to lose its beauty due to the overflowing flood of the Vaigai river.

The palace was restored and survives today by Robert the architect of the British government.

Manimandapam

Thirumalai Nayakkar was an ardent devotee of Thiruvilliputhur Andal. It was customary to have lunch after the mid day pooja at Andal Temple every day. When he was in Madurai, he built many

bell halls to guide him to hear the sound of the Andal Temple prayer bells.

ht and Sound Display

Thirumalai Nayakkar Mahal was declared a National Monument in 1971. Since 1981, considering the development of tourism, the Light and Sound show has been going on till date.

2.11 CHETTINAD HOUSES

Chettinad houses are traditional houses in the Chettinad region of Tamil Nadu, Sivagangai district around Karaikudi and some parts of Pudukkottai district.

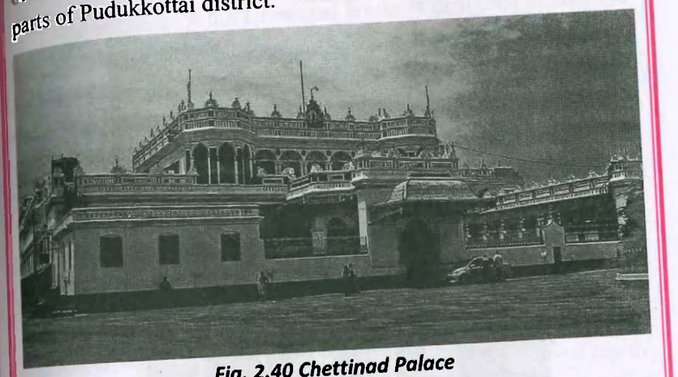


Fig. 2.40 Chettinad Palace

Chettinad Architecture

Built in the 18th Century, 19th Century and early 20th centrury, these Chettinad houses are world renowned for their architecture. There are also houses with 1000 windows. The Nagaraththars used to hold their family functions in their houses themselves. So their houses are like big halls. Architects, experts and researchers from different countries are studying this architecture.

Structures of Houses

These Chettinad houses are built on one acre or two acre plot. The house is built so grandly that the front door faces one street and the back door faces another. The floors of the houses are built upto five feet above the street. In the middle of the houses, large open courtyard are found. These open spaces bring air and light into the houses. The front doors of the houses, the back doors of the houses and other rooms will be arriving in these open spaces. The front and back doors are on the same lines. If someone looks from the back door, he can see who is at the front door. The other rooms also come into these spaces.

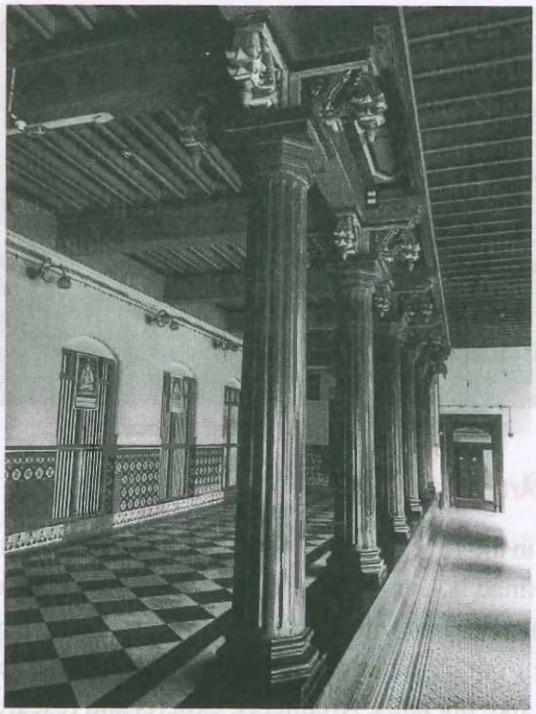


Fig. 2.41 Pillars found in a Chettinad Palace

Teak Pillars

There are many pillars throughout the house. These pillars are made of Burma teak. It is said that these long teak trees were floated in the ocean by the Chettiyars of Nattukkottai when they were in Burma. They tied the teak trees to the ships with chains and brought through the port of Nagapattinam. The front house is made in such a way that it welcomes everyone. There is a spacious courtyard on either side of the entrance door of the house. It has majestic wooden pillars. The front door and the stage have delicate wood carvings.

The entrance of the Chettinad house is designed to surprise us. The exquisite carvings on the doors and on the pedestals are amazing. The 16th and 17th Century sculptural structures of the Nayak period are also a model for the artists of Chettinad. Especially, the doors here are carved with images of gods and goddesses as seen in temples. This has become a cultural symbol.

Idols of deities have been carved on the top of the stage (Nilai). The front of the house is called pattalai (Thinnai). Beyond pattalai comes valavu (courtyard). The house has large teak doors, wooden bureaus, swings and other wood works. Scenes from the Ramayana and Mahabharatha are carved in a row at various places.

The houses have atleast thirty rooms. Some houses like Kanadukathan Palace have more rooms than that. These houses have been painted with attractive colours like green, yellow, red, etc.,

Nowadays, some of the houses are slightly modified and used as star hotels.

Family Partition Issues

It is settled by talking to the relatives. They don't go to the registrar's office and register their deeds. They write internal documents and keep them. Accordingly, one room on the ground floor of a house is for one person. Siblings share the upstairs room directly above. Only in living rooms and kitchens divisions are made and the middle ground is common to all.

Science and Technology

It is said that the walls of Chettinad houses are built with a mixture of lime, gall-nuts, karuppatti mixed with egg white. As it is built without any chemical compounds, it is comfortable here even though it is very hot outside. Unlike normal houses, these Chettinad houses are not whitewashed every year. The construction is such that, it is not required. Eggshells are mixed with lime to paint the walls. It keeps the house cool.

The Five Parts of Houses

Chettinad houses are divided into five sections.

First Section	:	Reception
Second Section	:	Valavu (Utilization section) consisting Murtam and rooms.
Third Section	:	Dining Section (Irandankattu)
Fourth Section	:	Kitchen Section
Fifth Section	:	At the end is the garden.

Houses are constructed as cited above. All the houses are generally built facing east or west direction.

Rainwater Harvesting

As early as the 18th Century, rain water falling into the house was collected and stored through a canal to the public tank in the town.

2.12 INDO - SARACENIC ARCHITECTURE IN THE BRITISH PERIOD

Indo Saracenic architecture is an architectural style used by the British architects in the late 19th Century to construct public and government buildings in the British empire, particularly in British India and in princely states. It evolved with decorative elements from Indo-Islamic architecture, particularly Mughal architecture, British Indian classical style and Hindu temple architecture.

Meaning of Saracen

Saracen is a term used in medieval Europe to refer to the Arabic-speaking Muslim people of the Middle East and North Africa.

The Indo-Saracenic style dates back to 1795 with Western paintings depicting Indian buildings.

2.12.1 Indo-Saracenic Architecture in Chennai

This architecture has a close relationship with Chennai. Chennai is the city with the most buildings in the Indo-Saracenic style of construction.

The first building in Tamil Nadu to use the Indo-Saracenic architecture was the Arcot Nawab's Palace at Cheppakkam in Chennai, which was completed in 1768. This palace has been built on 117 acres.

Fig. 2.42 Chennai Rippon Building

Chennai University Senate Building, Chennai Egmore Railway Station, Victoria Public Hall, Rippon Building and Amir Mahal are the important buildings built in this style.

Salient Features of this Architecture

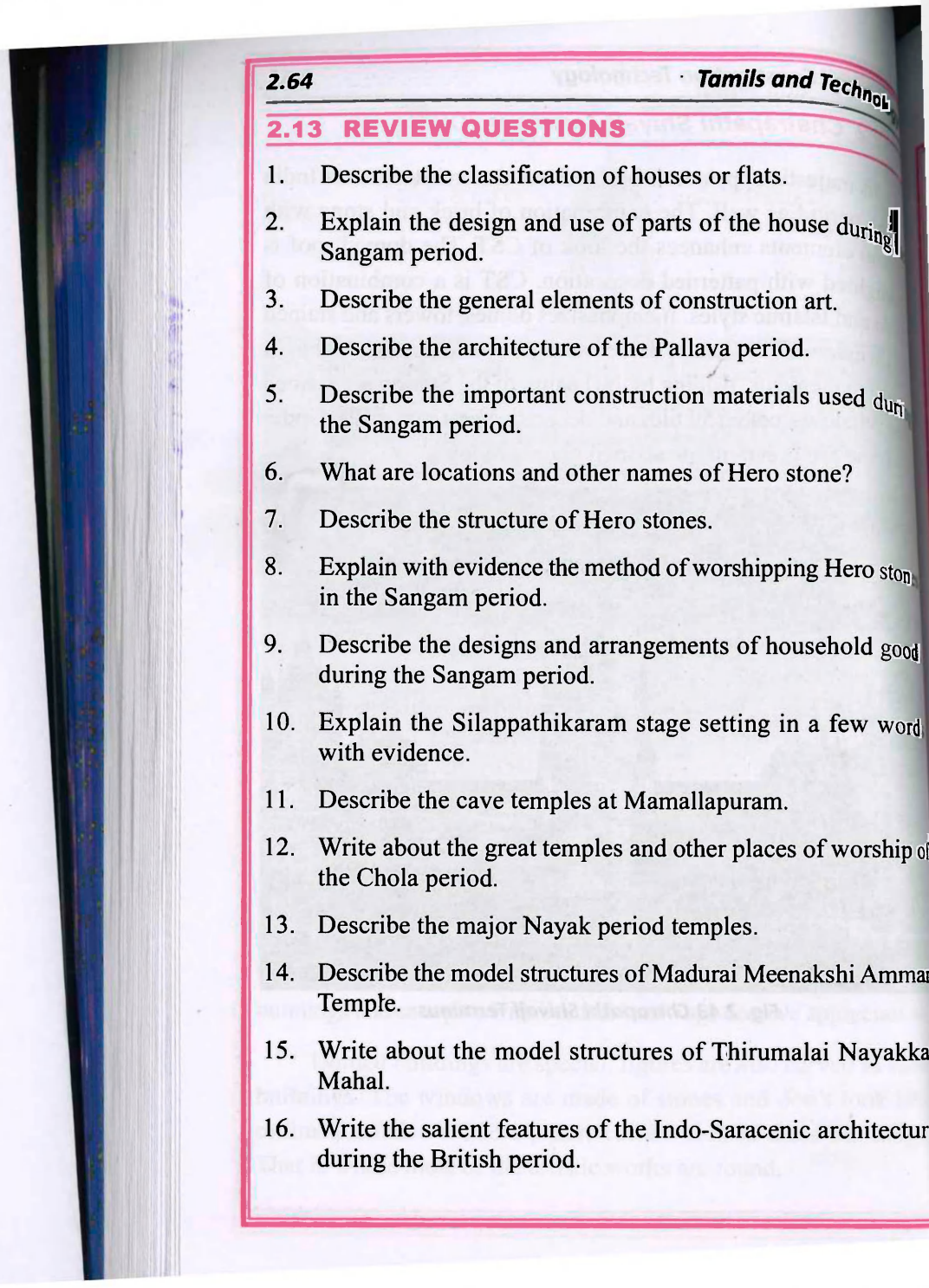
All government offices, courts, railway stations and museums built in the 19th to 20th Centuries are based on Indo-Saracenic arthitecture. The high towers belong to Indian heritage. Domes belong to Islamic art. Beautiful floral carvings at the ends of the buildings and canopies with beautiful carvings deserve appreciation.

Domed buildings are special, figures are also carved in such buildings. The windows are made of stones and don't look like ordinary windows. More pillars can be seen in these buildings. That is where most of the artistic works are found.

2.12.2 Chhatrapathi Shivaji Terminus (CST)

Its majestic appearance best reflects the architecture of India for the period as well. The combination of brick and stone with oriental elements enhances the look of CST. The domed roof is highlighted with patterned decoration. CST is a combination of Hindu and Islamic styles. It emphasizes domes, towers and stained glass windows. The Central dome has eight ornate ribs that highlight Victorian elements. Adding to the beauty of the Station are stained glass windows, colourful tiles and decorative cast iron grills. Under the dome are green ornate stained glass windows.

Fig. 2.43 Chtrapathi Shivaji Terminus



2.13 REVIEW QUESTIONS

1. Describe the classification of houses or flats.
2. Explain the design and use of parts of the house during Sangam period.
3. Describe the general elements of construction art.
4. Describe the architecture of the Pallava period.
5. Describe the important construction materials used duri the Sangam period.
6. What are locations and other names of Hero stone?
7. Describe the structure of Hero stones.
8. Explain with evidence the method of worshipping Hero ston in the Sangam period.
9. Describe the designs and arrangements of household good during the Sangam period.
10. Explain the Silappathikaram stage setting in a few word with evidence.
11. Describe the cave temples at Mamallapuram.
12. Write about the great temples and other places of worship of the Chola period.
13. Describe the major Nayak period temples.
14. Describe the model structures of Madurai Meenakshi Amman Temple.
15. Write about the model structures of Thirumalai Nayakkar Mahal.
16. Write the salient features of the Indo-Saracenic architecture during the British period.

Unit - III

MANUFACTURING TECHNOLOGY

3.1 SHIP BUILDING TECHNOLOGY

3.1.1 Shipbuilding Technology of Tamilians

Shipbuilding refers to the technology and involvement of Tamils in shipbuilding, maintenance and shipping. Tamil Nadu has a long coastline. Maritime trade is discussed in the literature. So it is understood that there must have been many type of ships.

Kammiyar

Tamils excelled in shipbuilding and sea voyages since ancient times. The experts of this department were called Kammiyars. We know that the Tamils have made the sea a part of their lives since the sea and the ships are commonly used in Tamil literature.

Proofs

1. *Only one book titled 'Kappal Sastram' has been taken from Palm leaves.*
2. *D.P. Palaniappa Pillai, who wrote a study from the house of Kalingarayapillai, a Danish monk in 1620 in Tharangambadi, gives a detailed account of the ancient shipbuilding knowledge and technology. The dimensions of the largest vessels are length 179 cubits, breadth 22 cubits and height 173/5 cubits.*
3. *In Tamil Nadu, only the pillar of the upper Chiththamur Jain Temple located in Chingee circle has a sea and a boat carved on it.*

4. *From the statement of Narsaiah, the author of 'Kadaladi' we can know the deep involvement of Tamils in the art of shipbuilding.*

5. *Sangam literature, Ptolemy's topographical manual and Pliny's 'Natural History' cite references to ports and coastal trading centres of Tamil Nadu.*

3.1.2 Predicting Tides

Predicting tides is one of the vessels steering techniques used by Tamils since the Sangam period.

Tamils divided Tide into two types,

1. High Tide
2. Low Tide

1. Kazhi Tide

During Kazhi tide, the sea water moves towards the shore.

2. Sea Tide

As the tide slows down, the sea water moves towards the ocean.

By observing these two tides, the people on the shore would go into the sea.

Proof

It can be known that the Tamils used the natural power called Tide to steer the vessels through the Sangam songs.

3.1.3 Front Harbour and Big Harbour

1. Front Harbour

During the Sangam period, Front Harbour was a port on the outer side of the estuaries. The following Ingurunooru verses of Sangam literature indicate that it refers to the outer part of the estuary.

Proof

Pattinapalai lyrics mention that the ship is anchored in this Front Harbour and the sail is folded.

2. Big Harbour

In estuaries, the outer current is less. So in the Front Harbour, the ship is anchored and the sail is lowered. Then the heavier goods are unloaded. The current at the mouth of the estuary is higher and the sail is hoisted there. Later, it hurries to the Big Harbour, which is the inner part of the estuary. The following lines from Purananooru mention this.

Proof

Purananooru

3.1.4 History of Shipbuilding

Even before Stone Age, about 10,000 years ago, man has known ships. But, they cannot be accepted as proper vessels. First, they started using animal skins or woven fabrics as sails. They were attached to the upper end of a pole erected on a boat and used for long journeys.

Evidences

1. *A plank found at Mohenjodaro depicts a floating sail.*
2. *The ancient Indian text 'Yukthi Kalpatharu' describes various types of ships and their constructions. It gives technical explanation to know the techniques of shipbuilding. It gives details of the types, sizes and materials used in the construction of ships.*

3.1.5 Sangam Fleet

During the first Pandiyan Empire (550 – 950 AD), Chola Empire (850 – 1250 AD), Second Pandiyan Empire (1150 – 1345 AD) Tamilians crossed the sea not only for business but also invaded Sri Lanka and conquered many countries in the eastern regions. Especially under the Pandiyan rule, more than 25 ports were functioning.

3.1.6 Arrival of the Britishers and the disappearance of Tamil shipbuilding art

Due to the arrival of the Britishers, the shipbuilding art began to perish little by little. This is known from the life history of V. O. Chidambaranar.

Proof

Narasaiya 140

In 1789, an order was passed in favour of the East India Company that no Indian carpenters, masons or blacksmiths could work on ships.

The indigenous shipping company of V.O.C started in 1906, was greatly affected by the British India Company by charging low rates and making shipping non-profitable.

Proof

Narasaiya 155

3.2 METALLURGY

Metallurgy is the scientific field that studies the material science, engineering, physical, chemical properties, etc., of metals, intermetallic compounds and mixed metals called alloys.

Metallurgy is a technique generally concerned with the extraction and utilization of elements from their ores.

Historical evidences suggest that South India, particularly Tamil Nadu excelled in metallurgy 2500 years ago. It is known that Tamil Nadu had expertise in iron metallurgy in the world through traditional iron handicrafts such as cattle-related iron products, metal products, bonze utensils, weapons and objects found in India.

Evidence

Damascus Sword

'Damascus Sword' famous all over the world, stands for the excellence of high organic steel made in South India. Special references to such iron objects are found in Greek, Persian and Roman Chronicles. These references date back to the first Century BC.

Fig. 3.1 Damascus Sword

On the high technological techniques used in tin and bronze metallurgy in the Iron Age at Adhichanallur, Professor Saratha Srinivasan has scientifically explained. These metallurgical field evidences, not housed in the Chennai museum are considered to be among the best specimens ever found in the metallurgical excavations.

Proof

Two research papers published by Professor Saratha Srinivasan of National Institute of Higher Studies, Bangalore.

In her research paper, the professor has pointed out the evidence of high organic iron production at Melsiruvalur in South Arcot district of Tamil Nadu.

3.2.1 Investigating the methods of Alloy Formation

By examining these metallic objects with an electron microscope, the properties of the metals are known and the technology involved in the formation is known.

Proof

Professor Saratha Srinivasan in a related study at Adichanallur.

In this proof, she mentions about the types of bonze cast with very fine engravings of iron. They belong to the period 100 BC to 50 BC.

Beta Bronze

This type of bronze is east at high temperature. It is called 'Beta Bronze'. In metallurgy, the 'intermetallic compound' state between two metals is known as the 'Beta State'.

Evidence

Sangam bronze objects found at Adhichanallur belong to Beta Bronze type.

This Beta Bronze is cast with copper and silver at very high temperature. Among these, especially the highest grade Beta Bronze made with 23% silver has greater strength.

3.2.2 Fabrication of Cast Steel by Carbon Sintering

Carbon Sintering is a technology in which ferrous alloys are heated above their melting point and combined with organic matter (carbon).

Wood Steel

Wood steel is cast steel made by mixing iron with organic materials (iron + charcoal + glass) and heating it for several hours at temperature not less than 1400 degrees. This process is called Carbonisation.

Proof

Professor Saratha Srinivasan in her research paper mentioned 'carbonisation' in the formation of cast steel in Melsiruvalur, South Arcot.

This finding is consistent with the evidence found in Tamil Nadu in the 19th Century. Especially, the 'Damascus Sword' which was widely exported in West Asia was made of this type of organic steel.

Widely known worldwide, this superior organic wood steel is developed in South India. It is also said that this word 'Utsu' was derived from the word 'Uruku' and was changed to 'Uku' and became 'Utsu'.

Evidences

1. *The nature of this alloy known as 'Utsu' steel has greatly intrigued metallurgists around the world, including Michael Faraday.*
2. *Examination of the castings found at Melsiruvalur indicates that this is a very high organic steel with 1.5% – 2% organic addition rather than the usual 0.4% organic addition. This study suggests that such steel may have previously been produced in carbon black smelting processes.*

Through such studies and Sangam evidences, the ancient metallurgical technology of South India and the personality of Tamilians in metallurgy are revealed.

3.3 STEEL INDUSTRY

The iron and steel industry in India is one of the most important industries within the country. Evidence of the use of iron by people, especially during the Sangam period has been found by archaeological researchers. It is said that iron industry must have existed since iron was made and used as many products.

Evidence

Recent excavations in the Central Gangetic Valley conducted with the consultation of the archaeologist Rakesh Reddy's wife Aditi Venugopal have shown iron working in India.

Practical Metals

Actually, the practice of producing practical metals first started in India.

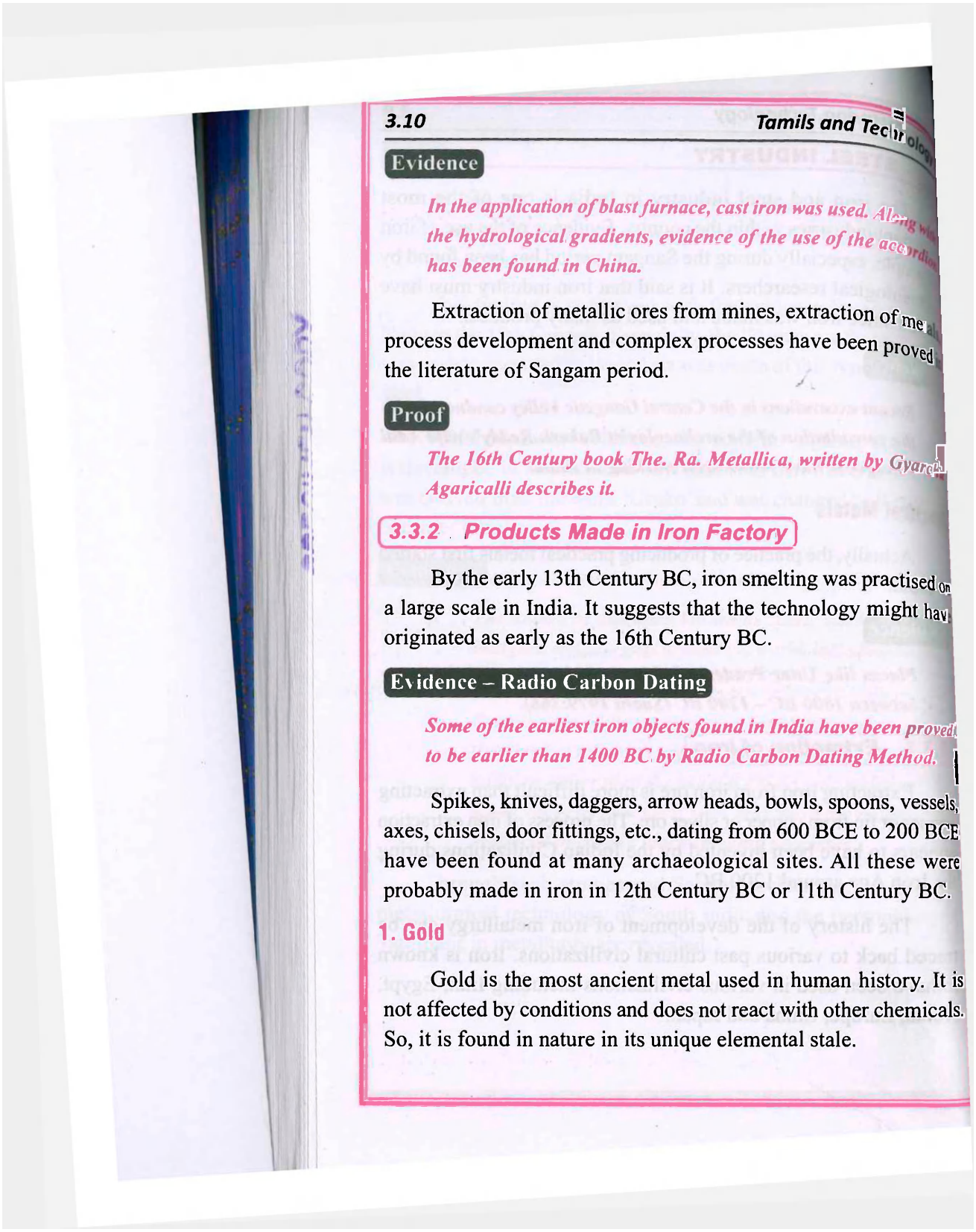
Evidence

Places like Uttar Pradesh, Lahiradewa have iron tools dating between 1800 BC – 1200 BC (Saahi 1979:366).

3.3.1 Extraction of Iron

Extracting iron from iron ore is more difficult than extracting copper or tin from copper or silver ore. The process of iron extraction appears to have been invented by the Indian Civilizations during the Iron Age around 1200 BC.

The history of the development of iron metallurgy can be traced back to various past cultural civilizations. Iron is known to have been used in various civilizations including Iran, Egypt, Nubia, Europe, China and Japan.



Evidence

In the application of blast furnace, cast iron was used. Along wi the hydrological gradients, evidence of the use of the accordi has been found in China.

Extraction of metallic ores from mines, extraction of me process development and complex processes have been proved the literature of Sangam period.

Proof

The 16th Century book The. Ra. Metallica, written by Gyarg Agaricalli describes it.

3.3.2 Products Made in Iron Factory

By the early 13th Century BC, iron smelting was practised on a large scale in India. It suggests that the technology might hav originated as early as the 16th Century BC.

Evidence – Radio Carbon Dating

Some of the earliest iron objects found in India have been proved to be earlier than 1400 BC by Radio Carbon Dating Method.

Spikes, knives, daggers, arrow heads, bowls, spoons, vessels, axes, chisels, door fittings, etc., dating from 600 BCE to 200 BCE have been found at many archaeological sites. All these were probably made in iron in 12th Century BC or 11th Century BC.

1. Gold

Gold is the most ancient metal used in human history. It is not affected by conditions and does not react with other chemicals. So, it is found in nature in its unique elemental stale.

Evidence

Small quantity of natural gold are known to have been found in the stone caves of Esupania during the Sangam period before 4060 BC.

Elements such as silver, copper, zinc and iron are found to have been used to a certain extent in the early cultures.

2. Egyptian Weapons

Egyptian weapons made from meteorite derived iron around 3000 BC were celebrated as knives from heaven.

Evidence

Certain metals such as lead, zinc and copper have been produced by smelting ores at high temperatures in blast furnaces.

The first evidence of metal extraction production dates back to the 5th and 6th Centuries BC.

Evidence

Evidence of this was found in the archaeological sites such as Maidanbec and Ploklin in Serbia.

3. Copper

Evidence of copper separation has been found at Belovoth site. The copper found here belongs to the Kodalinga Civilization and is known to date back to 5500 BC.

4. Bronze Age

Discreet metals were known to have been discovered in the 3500 BCs. The fusion of copper and silver to create bronze, a protective metal sparked a major cultural change. This period is

called Bronze Age.

3.3.3 Iron Industry in the Medieval Years

* Tamilians made weapons like swords and spears by smelting iron and exported them to foreign countries.
* The world's first iron pillar was the Iron Pillar of Delhi erected during the reign of Chandragupta Vikramaditya (375 – 413)
* Swords made in Indian worships are mentioned in the writings of Muhammad al-Quadrisi.
* Indian knives made of Damascus Steel entered Persia.
* During the 14th Century, European scholars studied Indian casting and metallurgical technology.
* During the reign of Mughal Emperor Akbar (1556 – 1605) excellent small guns were produced using the Indian metallurgical principles.

3.4 SMELTING IRON

Tamilians had known the use of iron before the rest of the world knew it. They also had widespread access to the technology of extracting and tooling iron from the natural sources. They might have smelted iron and made weapons wherever necessary as a cottage industry. Such items are found here.

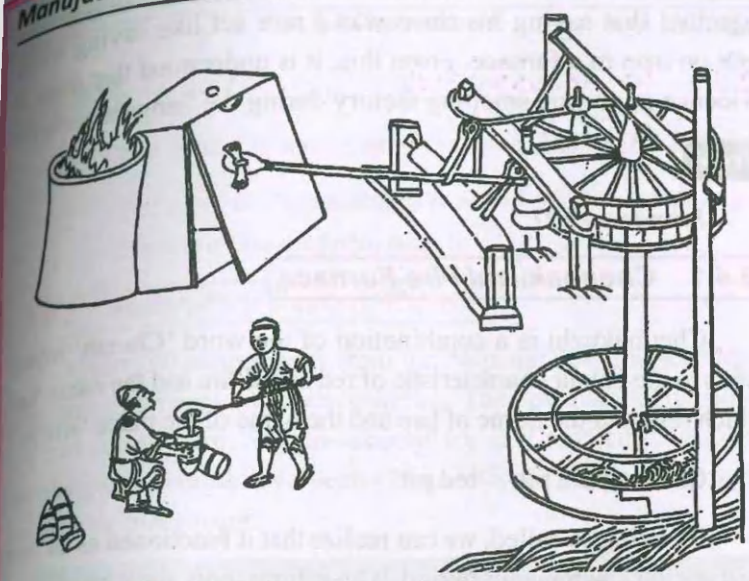


Fig. 3.2 Iron Smelting in the Sangam Period

Evidence

A heap of iron waste was found at Raginipatti Kanmai in the Northern part near Paiyur on the highway from Sivagangai to Thondi. When the iron wastes were broken, the stones looked like iron.

Flint Pipes

The existence of iron smelters is further confirmed by the presence of flint pipes in places where iron waste is found. These pipes might have been used for smelting iron or blowing air through the pipe to keep the fire continuously burning.

Iron Furnaces at Kalayar Koil

In the following lyrics, Iyur Moolangkizhar says that king Venkai Marban, after being defeated by Ukrap Peruvazhuthi,

regretted that saving his town was a rare act like saving w spilt on iron in a furnace. From this, it is understood that ther evidence of an iron smelting factory during the Sangam perio

Proof

Purnanooru 21

3.4.1 Chennakuzhi Fire Furnace

Chennakuzhi is a combination of the word 'Chenth' whic refers to the colour characteristic of red or red fire and the name 'na which refers to the flame of fire and the name of the place 'Kuzhi'

Chen + na + pit – 'red pit'

By being so called, we can realize that it functioned as an iron mill during the Sangam period. The information, data and names obtained confirm that an iron ore plant was operating at this place since the Sangam period.

Large circular pots of clay were probably used for smelting iron. Such pits are found wherever iron scraps are available. These were also called 'Chennakuzhigal' because they spewed fire.

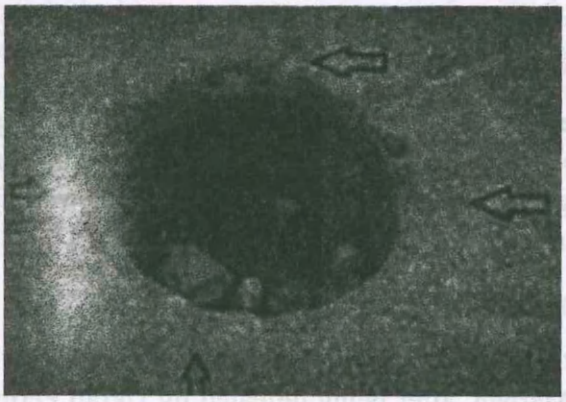


Fig. 3.3 Chennakuzhi

Evidence

1. *It is special to see a Chennakuzhi in Raginipatti Kanmai.*
2. *The pond in Porpanikottai is called 'Neeravi Kulam' and there is a Chennakuzhi near it.*

3.4.2 Secondary Casting Plants

About 200 metres away from the Porpanai Fort, the secondary iron casing furnaces had been operating. The raw material redstones are not found here. So, this secondary raw materials required for the plant should have been obtained from the primary metal separation plant itself.

Fig. 3.4 Flint Cast Pipes

The carbon iron alloy thus obtained is melted in flint iron pots. Then it is poured into flint casting pipes to form the basic structure of long rod–like iron, as can be seen from the flint castings lying

around here. And we can see that the lower part of these flint pipes is buried in the soil and molten metal is poured into it.

Evidence

From Thiruvarangam to Porpanaikottai, in some areas along the ridges with iron wastes, of earthern furnaces of iron smelting plants partially destroyed, flint iron pipes, iron containers for waste disposal have been detected in many places.

3.4.3 Comparison of Sangam Smelting with Modern Smelting

The iron ore laterite rock is broken and pulverized and mixed with charcoal powder to subject it to the primary ore separation where the ore is roasted at high temperatures and enriched with carbon particles. It can be seen in archaeological studies and historical records of metal smelting that it is used as a raw material for the next level of iron smelting. This can be compared with the modern metallurgical practice.

Herbal Use

Iron requires a lot of heat for melting it. They did not burn trees to that extent. Instead, they used herbs to smelt iron, which stands as the evidence of technology.

Location of Smelter

It is natural for factories to be located where raw materials are available. Accordingly, it has been found through the continuous field survey that ores have been mined near the iron ore smelter and the iron ore wastes are found scattered nearby.

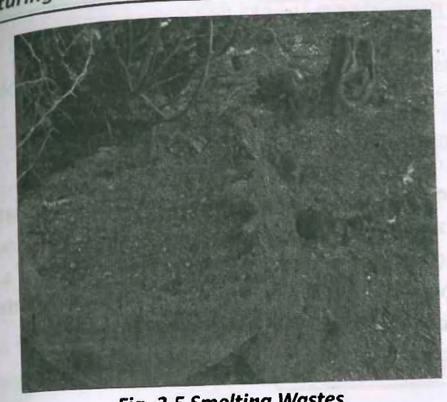


Fig. 3.5 Smelting Wastes

3.5 COPPER AND GOLD COINS AND HISTORICAL EVIDENCES

Coin is 'unit of exchange' for exchanging goods and services. Money is a medium of exchange and currency is a form of money.

Coins of Moovender stamps issued during the Sangam period and coins of Pandyan Kings like Peruvaluthi Coins and Chezhiyan coins are the major contributors. The history and economy of Tamil Nadu can be learned through the coins issued by Moovender regional kings and the Indian economic imbalances can be seen through the coins of other country kings found in Tamil Nadu.

3.5.1 Metals used for Coins

The kings coined gold, silver, bronze, iron and copper to suit their economic status.

3.5.2 Forms of Coins

Coins found in the Sangam period are in square, oblong and round.

Square Copper Coins

In the 18th Century, some square shaped coins dating back to the 4th and 5th Century BC were found in Tamil Nadu. It has the image of an elephant on the front and the image of a bow and arrow on the back. These coins might have been used by the citizens who considered bow as their family symbol.

3.5.3 Parts of a Coin

Similar to that of today's coin, the coins of Sangam era have two parts namely head and flower. One side of these is engraved with a symbol and the other side with another symbol. Especially the coins of the Pandyan Kings have a fish symbol on one side and an elephant or ox symbol on the other side. These belong to the period 5th Century BC to 2nd Century AD.

Evidences

1. *BC coins inscribed with symbols dating back to the first Century have been found in the tombs at Pallalur in Coimbatore district. An elephant symbol is engraved on its head.*
2. *Rajasimhan II's title Srinidhi is found on one side of the Pallavar coins and the bull symbol on the other side found at Kanchipuram.*

3. *Some coins have a fish symbol on one side and one of Chakra, crescent moon, Chaithya tower and umbrella on the other side.*

3.5.4 Images on Coins

Images of the king and deities are also engraved on the coins. Religious symbols are also found in them. These help to know the arts and religions of that time. All the kings who ruled in Tamil Nadu have given importance to the mother tongue and have issued coins with tiger, fish, horse, bull, lion, animal, bird and religious motifs; as well as wood and elephant engraved in square coins.

Evidences

1. *More than 10,000 coins have been recovered from the guarders of soil erosion along the banks of Vaigai, Thenpennai, Tamirabarani, Bhavani and Cauvery rivers. Different figures have been engraved on both sides of these coins.*
2. *Coins of the Roman emperor Augustus Typees (40 BC) have been found in Andhra.*

3.5.5 Coins of Rajarajan Period

Coins of the era of Rajarajan are the most available ancient coins in Tamil Nadu. Roman copper coins have been found as far back as the 1st Century BC.

3.5.6 Coins Expressing Religious Unity and Tolerance

* Coins issued during the reign of Mughal Emperor Akbar had images of Rama and Sita engraved on them.

* During the reign of Nawab of Arcot, many Sa... and Vaishnava deities like Shiva, Vishnu, Ganapathi, Murugan and Hanuman were issued.
* During the reign of Hydhar Ali and Tippu Sultan coins with Shiva–Parvathi images were issued.

From this, there is proof of religious unity and toleran... during their reign.

Coins used by the Royals

The coins used by various kings of Tamil Nadu were made of gold, silver and copper.

Proof

When the poets and minstrels sang in praise of the king, the king gave them gold coins.

3.5.7 Brahmi Characters on Coins

Coins of gold, silver and copper used during the Sangam period are found with Brahmi characters such as Thinnan, Ethiran and Senthan. We can know about Senthan in the Agananooru song.

3.5.8 Miscellaneous Coins

1. Stamp Coin

Stamp coins were in use from the 5th Century BC to the 2nd Century BC. Pandyas were the first to issue stamp coins.

Fig. 3.6 Stamp Coin

Evidence

It is noteworthy that casting nests used for issuing stamps have been found in Tamil Nadu.

2. Pandiya Coins

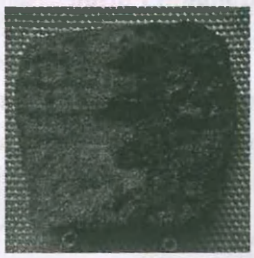


Fig. 3.7 Pandiya Coins

Pandiyas issued copper coins followed by stamp coins. This copper coin is square shaped. In the front part, there is a horse standing to left, under whose are tortoises in two tanks. There is a fish in the background. The name Peruvazhuthi is inscribed in the form of a Tamil–Brahmi line. It dates back to the 3rd Century BC and tortoise found in it reveals the 'Pandiyas' attachment to velvi.

3. Peruvazhuthi Coins

Fig. 3.8 Peruvazhuthi Coins

The Peruvazhuthi coin is a copper coin issued by the Pandiyan Kings of the Sangam period of which the Pandiyan title Peruvazhuthi is inscribed in these coins and shows that they are 2300 years old.

4. Chola Coins of the Sangam Period

The Chola coins of the Sangam period have a standing bull on the obverse and a tiger drawn with lines on the reverse. These are made of oblong square shaped copper cast. This coin has been made mixing the casting method and stamping method. It was around the 3rd Century BC that Tamils had known how to make and use coins by casting.

Fig. 3.9 Chola coins of the Sangam Period

Evidence

A Sangam Chola coin has been found in the Amaravathi river basin. Archaeologists like Arumuga Sitharaman consider its period to be the later part of the 3rd Century BC.

5. Chera Coins of Sanga Period

The Chera coins of the Sangam era are found to be inscribed with bow and some coins have king's head and his name engraved on them.

Makkothai Coin / Kuttuvan Kothai Coin

Fig. 3.10 Chera Coins of Sanga Period

Evidence

Coins of the Chera kings of the Sangam period like Cheraman Kottam Palathu Thunjiya Makothai and Kuttuvan Kothai.

6. Malaiyaman Kasugal

Fig. 3.11 Malayaman Coins

Thirukovilur Malayaman, a regional king lived between A
100 – 300. In the coins issued by them, Thirukovilur, the reg
they ruled, a river, three mountains and a road are seen.

7. Punch Coins

Punch-marked coins made of silver and copper became
standard form of coinage. These punched coins are either squa
or round or rectangular shape.

The symbols on these were struck using punches and prim

Fig. 3.12 Punch Coins

A punch-marked coin weighs about 52 grains (1 grain
64.79 mg.)

8. Coins of Mauriyas

Fig. 3.13 Coins of Mauriyas

Historical evidences from the Sangam period suggest that
the Mauriyas used silver and copper metals and used punch
or punch-marked coins.

9. Coins of the Indo - Greeks

These coins were issued between 2nd and 1st Century BC.
Mostly, they are made of silver. Usually, some are rectangular and
circular in shapes. They also have the name of the ruler who depicts
the puranas. The language in it is Prakrit and the script in Karoshti.

Fig. 3.14 Coins of the Indo-Greeks

10. Kushana Type Coins

The Kushanas were the first dynasty to issue a large number
of gold coins in the 1st and 4th Centuries. Low value was found
in copper coins. The coins had the image and name on the obverse
and deities on the reverse. The language used is Greek.

Fig. 3.15 Kushana Type Coins

11. The coins of the Guptas

The Guptas issued well-minted gold coins. At the top, the kings are found in various guises. Some coins show playing.

Fig. 3.16 The coins of Guptas

3.6 PRINTING OF COINS

3.6.1 History of Typography

During the Sangam era, they used to carve the desired images, shapes, letters, seals, symbols on stone and on board. They developed a habit of making copies by applying ink on them. The method of recording was next dealt with by applying ink to a grooved surface and pressing it onto paper or tin or solid metal or some other material. Then such impressions were made in clay or wax.

3.6.2 Typography in the Early Sangam Period

In the Sangam literature, the forms of cursive and circular writing have been mentioned. Those who wrote these were known as 'Kannezhuthalar'.

Stamping and branding have an early history in Babylonia and China. Letters were inscribed on plates. Next, came the practice of inking the inscriptions and copying them on iron or copper or gold plates.

3.6.3 Minting Money (or) Embossing Money (or) Coin Printing

Minting refers to a manufacturing facility that produces coins used as a country's currency.

Puthina

Puthina indicates the manufacturing facility that produces coins.

Coin Making during the Sangam Period

Coins were first minted 2000 years ago in Lydia (Turkey) during the Sangam period.

The Sangam period coins were minted manually using hammers from pieces of metals such as gold, silver and copper.

The metals were placed in a die mounted on a solid surface. And where one coin is hammered a second coin is placed on the die and hammered on top of it.

Making Medieval Coins

Medieval coin making was more advanced than Sangam coin making. It used metal pre-shaped circular discs and a screw press. This process produced coins of a more consistent quality than the Sangam coinage process.

Making Modern Coins

Modern coins are minted with hydraulic coin machines. They mechanically load the voids inside them. The machines can stamp 100 to 300 tons of coins in a short period of time.

3.6.4 Method of Shaping (or) Single Axial Method

In the 11th Century, during the reign of China's Siskili king B. Cheng first invented the printing press. That process is described in the following steps.

Step-1 : Taking a long piece of clay and inscribing letters on it like the edge of a coin.

Step-2 : The scribed characters are fired separately in the same manner as pottery making.

Step-3 : These solid letters or images were applied on an iron plate with a mixture of paper ash, pine resin and wax. Then iron frame was fixed on it and baked clay moulds were stacked.

Step-4 : The base of the plate is heated by fire. This heat will start to melt the adhesive on the plate.

Step-5 : After softening, it is rubbed with a smooth wooden board. Thus, the prints are evenly printed and the letter or shapes or paintings are pressed all over the iron plate to form a solid pattern.

By this method, thousands of coins can be produced.

3.7 BEADS MAKING FACTORIES

3.7.1 Collecting Raw Materials

During the Sangam period, the people who lived in Kurinji land used precious ivory as tools to dig for gold. White digging for gold, they found the beads in old Tamilian's jewelry and ornaments. The following lyrics make this clear.

Proof

Aganaanooru 282:2–4

The Puranaanooru hymn below explains the hunter's wanderings in search of such beads.

Proof

Puranaanooru 202:1–3

3.7.2 Poozhiyar and Guttuwar

Poozhiyar

The following Pathirtuppathu song explains that the Poozhiyars from the Mullai region were the gatherers of the raw materials for the beads.

Proof

Pathirtuppaththu 21:20–23

Guttuwar

The following Kurunthogai song mentions that people named Guttuwar who lived in Guttanadu on the west coast were engaged in the work of arranging beads.

Proof

Kurunthogai 163:1–2

The Guttuwars had a prosperous life in the beads industry. Yavanas must have bought these beads.

Based on the above evidences, the raw materials of beads have been found in both the lands of Kurinchi and Mullai and

factories have been set up in the Marutha land to produce var... consumer goods. The news was that farmers have found bea... while ploughing the land. The above evidence suggests tha... makers were involved in the collection of raw materials for b...

3.7.3 Bell Making Technology in the Sangam Period

Kuyinar

During the Sangam period, the Kuyinars are seen as be... piercers, tailors and bead embroiderers. They are also known a... Kuyirtunars in Sangam literature.

Bell Making during the Sangam Period

During the Sangam period, the Tamilians used the raw materials of beads found in hilly and forest areas by hammering them into small lumps and breaking them into small pieces and chips. From them, the very small beads are separated as lumps. Many of such chips are classified as unusables due to their irregul... shapes and weight. Beads are made from fine chips only in the required pattern setting.

Heating in a Pot

The beads made from rough chips are placed in a hot oven. The reason why the mouth of the pot is tightly sealed with 'Calcitney Stone', the raw material of the beads is to prevent the heat inside the pot from escaping through the gap in the mouth of the pot, resulting in a uniform colour within the pot. Sometimes many pots with beads are kept at the same time, in a line at low temperature.

Proof

Furnaces used for making algae were found in the excavations by ...anjan (An Archaeological perspective on the Sangam Period, P.59)

3.7.4 Beads Making in Modern Times

In modern times, the broken beads are rubbed with a circular wrench-like tool made of diamond. Then they rub lacquer with ...e help of a tool shaped like a stick made of iron. Then the beads br...ken into chips are kept and polished in a stone oven. Sometimes, unfinished beads are similarly placed in the oven for colour change. These are found in yellow and pink colours.

Proof

Kamakshi says that the different colours are given by the low heat. (Sanga period, Archaeological Lab P.117)

3.7.5 Connecting the Beads

Holes are placed to allow the coloured beads to be well rubbed and smoothed.

Holes are made from both sides of the beads. As a result, in some beads, the holes on both sides are at different angles and do not meet straight.

Thus, those who choose the beads correctly are called 'Vannakan Kuyinar'; those who drill the beads are called 'Thirumanikkuyinar' and those who do the job of polishing the beads with lacquer are called 'Sirukarodar'.

Vannankkan

The word 'Vannakkan' is found in the names of many po in Sangam literary hymns.

Proof

i) Puthukkayaththu Vannakkan Kambur Kizhan (Narrinai 2

ii) Vanakkan Peyan (Perunkathai)

iii) Vadamavannakkan Veri Saththanar (Kurunthogai 27

The dictionary definitions of Vannakkan are bead cutter, carver, bead polisher and dyer.

Proof

Tamil Dictionary (P.573)

Another section of them is called Vannakkan Kam According to Tholkapiya reference, they are painters.

The above evidence indicates the increase in the produc of beads during the Sangam period and their development thro domestic consumption.

3.7.6 Forms of Beads

Excavations have found numerous beads and coral ston Tamil Nadu in cut, ready to drill and polished condition. Therefo several evidences confirm that there must have been various b making factories during the Sangam Period.

Evidence

1. Sand Excavation

On examining the beads found in sand, it seems that the beads must have been made in the following four forms.

1. Circular shape
2. Barrel shape
3. Biconic shape
4. Spherical shape

2. There are more bead making factories in Arikamedu. This area explains the process of cutting into small pieces, drilling, polishing and making conch jewellery.

3.7.7 Types of Beads

Sangam period evidences show that the following types of beads existed since beads of various types and colours were found in Arikamedu.

1. Sea blue green beads
2. Gomedakam
3. Redstone
4. Purple stone
5. Manickam
6. Sapphire
7. Marble
8. Crystal stone

3.8 GEM STONES (CARNELIAN ORNAMENTS)

'Carnelian' is a type of a precious stone. In Tamil Nadu, gem stones were used to make ornaments such as beads, rings, etc., during the Sangam period.

It is usually a red coloured stone. It had been used even here 6000 years ago. Since the Indus Valley civilization, it has been widely used for jewelry making.

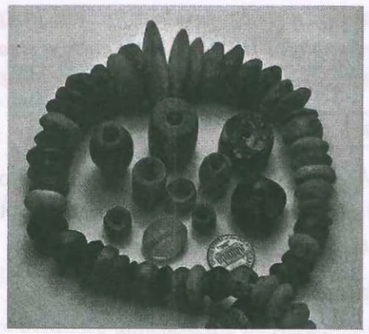


Fig. 3.17 Stone Beads

3.8.1 Making Method of Stone Beads

The stone 'Calsidony' is found naturally as small pebbles. The red colour of Carnelian is obtained by heating this stone. From this, small flakes are broken with a hammer made of deer antler and the temporary shape of the ornament is obtained. Then, more small flakes are broken into it to obtain the desired shape. After that, the beads are drilled. Finally, it is rubbed well and polished.

Thousands of such beads have been found in Sangam settlements. Camelian beads are found on Sangam tombs.

There are evidences of making beads and stones for rings in Sangam settlements.

Evidence

Kodumanal, Thandikudi, Porunthal are the places where they were found.

3.9 GLASS BEADS

3.9.1 History of Glass

Glass beads used for making ornaments found in Sangam excavations in Egypt are believed to date back to 2500 BC.

Early such beads were discovered during the archaeological excavations at Mabunguveyil in South Africa. And these are between 970–1000 AD. Still manufacturing glass beads continues in West Africa especially in Ghana.

Craftsmen and women making grobo beads have been documented from the early 1920s to the present day.

Proof

Bead making in Ghana was first documented in 1746 by John Barbot.

3.9.2 Method of Making Glass Beads

The method of making small glass vases by dipping moulds made of silica compound into molten glass is known to have been in use as early as 1500 BC.

By dipping long tubes in molten glass and blowing it was possible for making various things. This invention was made

in the mid 3rd Century BC. As result, making glass vessels and beads became easier.

Fig. 3.18 Glass Beads

Generally glass beads are made from finely ground glass. Various types of glass such as broken and unused bottles, old medicine bottles, specialty glasses like clear cream jars, ash trays, window panes are finely ground and ground into beads. These glasses give bright colours and shiny surfaces.

Making Coloured Glass Beads

Modern ceramic paints, finely ground broken beads or glass beads can be made by adding pieces of different coloured glass from different sources in a variety of styles, designs and decorative patterns.

3.9.3 Types of Glass Beads

1. Grobo Beads

Grobo beads are made using vertical moulds, shaped from locally quarried clay.

2. Agoso beads

Agoso beads are old dry core powder and glass beads. Usually, there are found in yellow and green colours.

3. Meteyi Beads

There are evidences that Meteyi beads were made on horizontal axes. These are opaque yellow in colour.

4. Adeyun Beads

Adeyun beads are not made in moulds and wet core technique. Finely crushed glass is moistened with water and shaped by hand. Holes are drilled before the beads are heated. These are red in colour.

5. Ketta Avusi Beads

Ketta Avusi beads are made in horizontal moulds. They are cylindrical in shape and blue in colour.

6. Kifa Beads

Kifa beads are made manually with a sharp needle-like tool, mixing crushed glass with a binder.

3.10 FLINT BEADS (OR) TERRACOTTA BEADS

The most ancient art form of mankind is flint figurines. This art appeared before the casting of art forms in stone, wood, ivory, metal, etc., These fling figures don't require greater technology or better tools to make them. The fingers are the tool. Sangam man curved the tools he used to hunt for food in stone. He then painted his thoughts as paintings on rocks. Then he made figures out of clay.

Fig. 3.19 Flint Beads

3.10.1 Process of Sangam Period

Clay or silt and water are added to make a beautiful figure. Then, it is put in a kiln at suitable temperature and later the shape is hardened. Using this method, red, saffron and orange flint objects, tiles, bricks, flowerpots and beads were made.

Proof

1. *Before 2000 BC, the Sumerians wrote down their historical records in cuniform on cylindrical flint objects.*
2. *13 human figurines, 3 animal figurines, more than 600 toys, 28 types of ear rings and beads have been found in flint at Kizhadi excavations.*

3.10.2 Present Method

Flint beads are made in the following steps:

Step-1 Required amount of clay is taken and it is mixed with little water.

Step-2 For making beads, a small ball of clay is taken and it is placed on the bottom of the palm and it is rolled. This will bring the correct round shape.

Step-3 With a toothpick or with an individual stick from the broomstick a hole is made in the middle. That is, the stick should be moved up and down without pressing. By doing like this, the hole of the bead should be made perfect.

Step-4 In this way, beads can be made in required shapes like round, cylindrical, etc., They should be dried for the whole day.

Step-5 Then, the dried beads are kept in the kiln and baked for hardening the images.

3.11 SHELL BEADS

Conch jewelry is made from sea shells. Conch jewelry is a type of shell craft. One of the most common forms of conch jewelry is necklace. They are made up of a large number of beads. Each bead is the entire shell of a small sea snail. A wide variety of conch jewelry including bangles, ear rings are produced. The bead work is found more in them.

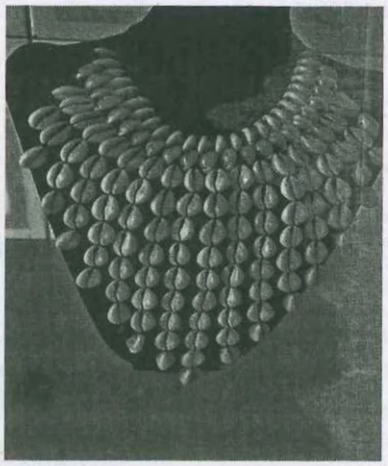


Fig. 3.20 Conch Beads

Evidence

A grave in Britain dating back to 5000–7000 BC has found the skeletons of two women buried wearing necklaces made of coral.

Fig. 3.21 Two women buried wearing conch beads

All conch jewelry is not made from the whole shells. Some types are made from shell parts. Conch jewelry is often found in tropical coastal locations. There, they are given to tourists as clothes or mementos. However, conch jewelry has a very ancient

past. In fact, conch beads are the oldest form of jewelry dating back to 1,00,000 years.

3.11.1 Conch Beads in the Sangam Period

The oldest known jewelry in the world consists of two perforated beads made from sea snail shells. These beads were found in Skul, Israel. Also, these have recently been dated to 1,00,000 to 1,35,000 years ago.

Proof

Prepared from Nassarius Crassianus and Bittersweet clam Glycymetris Nummaria and Nassarius Giposulus.

A pair of beads made from Nassarius sea snail shells around 1,00,000 years ago represents some of the earliest forms of jewelry.

Bead work is the art or craft of making objects with beads. The beads can be woven together with a special thread. Thread can be tied to a soft flexible wire or can be stuck to a surface.

3.12 BONE FRAGMENTS

During the Sangam period, the following items were made and used using bone fragments.

1. Flute

Humanity's oldest musical instrument and oldest artifact is the flute. Ancient flutes made from animals and bird bones from the European upper Paleolithic have been found in the Swabian Alps in Germany.

The flute is the oldest musical instrument in the world as evidenced below. Carbon dating has determined that the flute

is 42,000 to 43,000 old. The flute is made of bird's bone and mammoth's tusk. These tools are part of early modern humans in Europe. The flute might have been used for entertainment or religious rituals.

Evidence

A bone flute was discovered in the Keesenklos Derle in Germany.

2. Axe

During the Sangam period, especially in Northern European, Britain and Southern France double Axe was popular. It was made of bone. Archaeologists consider that it might be the ancestor of the stone beads.

Stone and bone beads were drilled at their narrow ends and became common in Scandinavia, during the late. Neolithic and are found in Megalithic tombs of Western Europe.

3. Chiming Beads

Chiming beads have been in use in Roman culture for over 5000 years. It has also been in use in India since the 2nd Century BC. Various materials are used in making these beads. These materials are cylindrical in shape. A bell is hung in the middle of it. Animal bones, pieces of wood, stones, etc., were used in the early period.

The movement of the wind causes the metal of the bell to strike against the bones, making a pleasant sound.

4. Garlands

Many garlands are made of beads, bones, conch and red stones. The beads in the garlands are made from the size of betel

nut to the size of gourd. Some of them are flat; some are round and some are elongated. All the beads look as shiny as possible.

5. Combs

Sangam people used a variety of combs. They are made of ivory, cow, horn, bone and wood. Combs were made in many forms. Some of them were also used to insert into the hair. Even today in Burma, there is a custom of inserting combs into the hair.

Evidences

1. *A beautifully carved ivory comb with teeth on both sides was found near the skull of a young woman in the grave.*
2. *A V-shaped comb was found in Mohenjodaro.*

Scholars believe that these combs might have been used for combing the hair and keeping them in heads as they were finely made with close teeth.

Evidence

Such a comb called 'Badari' was found in Egypt.

Mohenjo-daro (or) Indus Valley Civilization

Indus Valley people made beads and jewelry from bones. This is known from paintings, sculptures, etc., that they had worn such ornaments. These people used to make and wear their respective jewelry made of ivory, tone, makkal, conch, clay, etc.,

Evidence

A large number of rings made of conch, bone and clay were found in the excavations at Mohenjo-daro in the Indus valley.

3.13 REVIEW QUESTIONS

1. What is Tide (Odham)? Describe its types.
2. Explain metallurgy with evidence.
3. Explain the method of extracting iron from iron factory.
4. Explain the process of smelting iron.
5. Explain the types of coins with evidences.
6. Write about the process of minting money or embossing money or printing coins.
7. Explain the patterns of beads with evidences.
8. Write the method of making stone beads and glass beads with evidence.
9. Explain the types of glass beads.
10. Explain (i) Flint beads, (ii) Conch beads, (iii) Bone fragments.

Unit - IV

AGRICULTURE ANR IRRIGATION TECHNOLOGY

4.1 INTRODUCTION

Our Tamil Nadu has been building and using water structures like lakes, ponds, puddles, dams and sluices for 2500 years. There are many names for these structures in Sangam literature. They are Ilangi, Gayam, Keni, Kotagam, Madu, Stream, Lake, Sluice.

Thus, the fact that there are many names for water bodies in Tamil confirms that the old Tamilians were famous for creating water bodies. They have been using, maintaining and protecting them for over 2000 years. In the last 20–30 years, we have lost much of them and we still continue to lose them. The existing lakes, ponds and dams are continuously losing their capacity.

4.2 DAMS

A dam is an obstruction that stops the flow of an estuary or a stream. Reservoirs created by dams not only suppress floods but also provide water for activities such as irrigation, human consumption, industrial use, aquaculture and maritime transport.

4.2.1 Embankment in the Sangam period

The following lyrics by Tholkappiar of the 5th Century BC make it clear that ancient Tamilians used a stone structure to store and control the waster coming from the river for irrigation.

Proof

Tholkappium, Porul 65

As a dam holds back rushing water; so a warrior becomes proud by being the first to resolutely advance and hold back a rapidly advancing army. The 'Stone Prison' referred to is an embankment.

4.2.2 Stone Dam of Karikalan

Kallanai is the oldest of the dams built in Tamil Nadu during the Sangam period and considered to be the greatest technical achievement and has been in use for more than 2100 years.

Building the Banks of the Cauvery

According to the 7th Century AD, Iranadu Chola named Punniyakumaran built the banks of Cauvery. This is mentioned in the copper plate.

Proof

Cholas – Neelakanda Sastri – Book–1, P.49

It is understood from the following evidence that the people of Sri Lanka were taken captives by a Chola King and to take revenge, Kayavagu who ruled Sri Lanka in the 2nd Century AD, invaded Tamil Nadu and imprisoned the Tamils.

Proof

Sir Lankan Book

These two messages mentioned above are dated AD 2nd and 7th Centuries ago confirm that Karikal Chola built the banks of the Cauvery.

Kallanai is Stone Prison

Karikalan did not build a dam across the Cauvery. He built a stone structure for the Cauvery to divert the water and was referred to as dam or stone prison by Sangam people.

King Karikalan, who wanted to prevent frequent breaches in the lower reaches of the Cauvery and the loss of water to the agricultural lands, built a structure made of huge rocks at the lower end of Thiruvarangaththeevu and strengthened the banks of the Cauvery to permanently stop the breach. This was a great achievement in those days. The technology used for it is more than that.

Proof

In 1853, an English engineer named Baird Sumith made a mention of Kallanai in the book 'Irrigation of Southern India' as a great engineering feat.

Technology of Kallanai

According to the research study, Kallanai is made up of huge rocks stacked one on top of the other and there was only a layer of clay between the rocks. Huge boulders were placed in the unfathomable sandy river bed. As the sand beneath the rock was eroded away by the river water, the rock slowly descended into the sand. They were covered with clay and large rocks were again placed on the rocks. So the underlying rocks were buried deeper. Then again clay was applied and rocks were placed. Again the pressure and load further buried the underlying rocks. As the rocks below were buried, the rocks were deposited on top. Eventually, when the rocks below reached the hard surface, the submergence of rock stopped. According to the research study, a huge dam called

Kallanai was formed by the large rocks placed on top of each o and the clay coating between them.

Evidence

1. *In 1874, 'Sir Arthur Corron' built a dam calle Thauleeswaram across the Godavari based on this ston technolgy.*
2. *'Sir Arthur Cotton' in his book written in 1874 men that many irrigation engineering constructions such river bridges and dams were easy to complete because of techniques learnt from the Tamils on laying foundation*

4.3 LAKE AND POND

4.3.1 Lake

A lake is a relatively large naturally occurring body of water. It is located in a basin surrounded by completely dry land. It helps to filter the incoming or outgoing streams. Lakes are generally larger and deeper than ponds. Most of the lakes are supplied with water by creeks and rivers.

4.3.2 Pond

A pond is a small quiet land-based body of water, either naturally or artificially formed. A pond is smaller than a lake and there are no criteria to differentiate the two.

The size of Pond

A pond is less than 5 hectares (12 acres) and less than 5 meters (16 feet) deep. It is different from river and stream because there is no flowing water in it.

Some ponds are naturally formed. They are fed by rain water from an underwater spring. Other ponds are man-made.

Differences between Pond and Lake

Both ponds and lakes are inland fresh water bodies. Lakes are generally deeper than ponds and have a larger surface area. Ponds have smaller waves than lakes. Some ponds and lakes are easy to identify while others are difficult to determine. In fact, there is no precise scientific difference between the two. What is considered a lake in one area may be a pond in another.

4.3.3 Uses of Lakes / Ponds

Lakes and ponds are used to store water during rainy season and for drinking water and agricultural irrigation during summer. Water stored in lakes and ponds may come from overland runoff during the rainy season through streams or rivers.

4.3.4 Lakes and Ponds in the Sangam Period

The ancient Tamilians were well aware of the importance of collecting rain water and preserving it. That was why Tiruvalluvar placed the power of rain next to prayer to God. Ilango Adigal started his Kappiyam by praising Sun, Moon and Rain.

During the Sangam period, 200 years before, people used to bury old people in Thazhis. Many of them have been found near lakes and ponds.

Evidence

In Madurai district alone, 50 Sangam lakes and ponds have been found near the burial sites of old people. These lakes and ponds are still in use today.

Sangam poets asked the rulers of those days to build water bodies like lakes, ponds and puddles. They pointed out that development in irrigation is the root cause of all success of a country. The rulers accepted and implemented it.

Proof

Kudapulaviyanar, a poet of the 2nd Century BC said to Pandyan Thalaiyalanganathu Seruvenra Neduncheliyan.

Purananooru 18

Pond / Lake built by Karikalan

In Pattinapalai, Kadiyalur Uruthirangkannanar mentions that in the 2nd Century BC, Karikalan destroyed the forest, built ponds and increased the arable land.

Proof

Pattinappalai

4.3.5 Destruction of Ponds / Lakes

Lakes and ponds were built with great technology during the Sangam Period and their destruction was considered a great tragedy. This can be seen in the following Sangam verse of Pulavar Kabilar who lived in the 3rd Century BC.

Pari's Paramba Nadu was attacked and defeated by Moovendars. There was a pond in the country left unmaintained. This song tells about it.

Proof

Kabilar laments that the small pond with curved banks and clear water resembling the eight day crescent on Pari's Parambu Hill with its sharp spear (Vel) and strong shoulders is deteriorating due to lack of protection. The tank which is crescent shaped has a short bank and a high capacity for water. Kabilar feels sad that such a special small pond is being ruined.

4.3.6 Conservation of Ponds / Lakes

The Sanga poet Nakkannaiyar says that the Tamils excelled not only in creating water bodies but also protecting and maintaining them well.

Proof

Aganannooru 252

The song conveys the message like this. The supervisor is protecting the large lake even in the midnight from the heavy rain without sleeping. The lady tells her friend that in the same way, goddess will protect her.

Meaning

There is an acute possibility for the lake to break during heavy rains. At that time, it is very important to protect it from breaking. His job is to prevent it if it breaks down, and if that is not possible, he has to inform the authorities concerned for necessary arrangements; otherwise it will cause huge damage.

Protection

Therefore, it is necessary to protect the lake without sleeping during heavy rains and in the middle of the night. During the Sangam period, there was a formal system for the maintenance and protection of the lake banks, water draining areas, sluices, etc., and distribution of lake water for irrigation. The above song says like

that. The works to be done to build a pond. The steps involved setting up a pond are explained in the following five steps.

- Setting up the pond.
- Setting up draining system for releasing the excess water.
- Making water inlets, sluices for releasing water for irrigation, water outlet from the drainage parts etc.,
- Making large tracts of land suitable for tillage for irrigation.
- Drilling wells to overcome water scarcity.

According to Sirupanchamoolam, one of the Pathinenkeelkannaku books one who performs the above 5 steps will go to heaven.

Sirupanchamoolam 64

Step – 1 :

Step – 2

Step – 3

Step – 4 :

Step – 5

Proof

It is certain from the above Sangam literature that during that era water bodies like lakes and ponds were built in large numbers and were maintained and protected in an excellent manner.

4.3.7 Lake Irrigation / Tank Irrigation

It is estimated that there are more than 39,000 lakes in Tamil Nadu. They were created from the Sangam period till the entry of the British into our country. Ancient Tamils have used many technologies in lake irrigation. Some of them are described with proofs.

Proof

At Athur, 20 km away from Dindugal, three ponds namely Karunkulam, Pagaidai Kulam and Pulvettikulam are located at the same place.

Source : Ancient Wisdom – Irrigation Tanks – by S.M.Ratnavel and P. Gomathinayagam.

Among these three ponds, a large pond is divided into three by two cross banks. Each has a higher level than the other. The first pond has a higher ground level than the second pond and the second pond has a higher ground level than the third pond.

- Very high lands are irrigated using the first tank.
- The lands next to it are irrigated using the second tank.
- Very low lands are irrigated through the third tank.

Archaeologists consider that these ponds are more than 2100 years old. Old peoples' thazhis have been found near them. These ponds are still in use. These ponds are technologically sophisticated and many such Sangam lakes and ponds are still in use today.

4.3.8 Enthals and Thangals

A succession of lakes is called a series of lakes. The first lake is called Enthal because it carries the rainwater flowing from the first lake. The lakes in the back, hold the water flowing from Enthal and other lakes and the water from the catchment areas of the respective lakes. We call them Thangals.

The run off from the lands irrigated by these series of lakes flows into the successive lakes. Through this, irrigation water is used again and again and finally let out. Therefore, series of lakes

are well positioned to store more water and reuse the stored water multiple times.

4.3.9 Kalingals (Draining Part)

Kalingal is the opening used to drain out excess water in lakes and ponds after they are full. The design of the Kalingal should be such that the flood water can escape during the flood season, otherwise, the lake will break. And in series of lakes, if the upper pond breaks, that will also result in the breakage of lower ponds. This will cause mass destruction. Therefore, the role of Kalingals in series of lakes is much more important than the role of Kalingals in individual lakes.

Functioning of Kalingals

Dams are constructed 2 feet above the level of the Kalingals in the series of lakes. Inserting planks between the sub–stones will allow water to accumulate to a height of 2 feet. The total capacity of the lake is the water stored upto the top of the board. If water is stored only upto the Kalingal without the board, then it will be only half the capacity. Each pond is filled with water and the board is laid only when the last pond is full.

Once the final pond is filled with water upto the top of the plank. The plank is placed in the pond above it. Thus, each pond is boarded and finally, it is boarded in the Enthal pond. Only when that is also filled, irrigation will start in all lands.

When the flood is high, the boards in all the ponds will be removed and the flood water is allowed to escape quickly. Thus, steps will be taken to protect the ponds from breaking.

Most of the last ponds will have temples. Once the last pond is filled, Pooja, Abishekam, etc., will be done in it.

4.4.0 Sand Banks of Lakes

Usual Practice

When constructing embankments in lakes, the practice throughout the world is to construct inner walls with clay to prevent seepage and then cover it.

Sangam Practice in Tamil Nadu

Ancient lakes in Tamil Nadu do not have such internal walls. There is no leakage. The banks of the lakes are made with the soil in the respective area.

Technology

Its technology is described in the literature. Sangam literature tells that the banks of the lake were built with mud. Along with the soil in the respective area, some soil compacting materials are added to form semi soil and thus the banks of lakes are formed.

But now, eventhough the best soil is brought from far away and used to build earthern embankments, water leakages occur. Looking at this, it is clear that the technology of our ancestors is simply amazing. The following proof speaks of this.

Proof

Contrary to the opinion of English engineers that it is necessary to build the river banks with wet clay, the ancient Tamils have built the banks of lakes in a perfect way using the soil available in the respective areas, according to Sir. Arthur Cotton.

4.4 SLUICE

A sluice is a gate established to divert water from ponds, lakes or culverts for the irrigation of crops. Dams have many names. They are Sarungai, Puthavu, Mathagu (sluice), Kumizhi, Thoomb Madai. During the Sangam period, these were made of wood or stone. They can be opened and closed manually

4.4.1 Structure and Function

A scientifically constructed system is a sluice. It is set up like a stone box to let out only the required amount of water. There is a hole of half a foot in diameter at the top of this stone box. This hole is called 'Neerodi'. This hole is covered with a stone like a pipe. There are two or three small holes, on the floor of the box. They are called 'Serodi'.

Below the ground level of the lake, a pipe system is laid so that the water flows through the hole in this stone box. When water is needed for irrigation, going deep into water and remove the pipe like structure. Then 80% of water will leave through the Neerodi hole of the lake and 20% of the muddy water through Serodi. This will reduce sedimentation in the lake. In some lakes, stone blocks are erected to mark the location of this sluice.

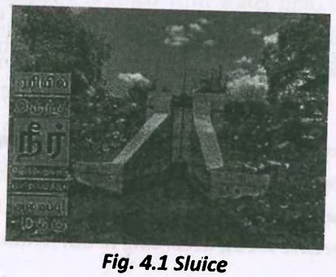


Fig. 4.1 Sluice

4.4.2 Intelligence of Sangam People

Many parts of Tamil Nadu receive rain for only two months a year due to the northeast monsoon. With that, we have to deal with the water requirement for the whole year. Realizing this well, Sangam people used their knowledge to create thousands of lakes / ponds and collected and fully utilized the rainwater of those two months. They invented sluices and culverts and installed them in lakes / ponds to use the collected water economically.

4.5 KUMIZHITHOOMBU OF CHOLA PERIOD

A Kumizhithoombu is a scientifically designed system used to remove water and silt from a lake.

Tamils excelled in irrigation water management. Even 1000 years ago, dams were built to give the people of the area the benefit of water.

The Chola King Rajaraja Cholan cut the Uyyakondan Canal on the Cauvery from Mayanur, supplying water to 1000 lakes along the way. Parantaka Cholan cut the Viranam lake to save Cauvery water from wastage.

4.5.1 The Importance of Kumizhithoombi

The Tamils have been managing irrigation water effectively by establishing a water management system called Kumizhithoombi in the big lakes of Tamil Nadu 2000 years ago. This Kumizhithoombi system not only provided water for irrigation but also prevented the lakes from the formation of silt and losing the depth.

Proof

1. *'Tamil Irrigation System Two Thousand Years Ago' – Kudavayil Balasubramanian.*
2. *'Pity of a Dust Storm on a Waved Lake' – Kula. Shanmuga Sundaram.*

The Causes for Lake / Pond Draining Away

The main reason for the water bodies losing the depth is that when rainwater comes to water bodies like lakes, ponds through drains and streams, they come together with water, silt and sediments.

The Difference between Sluice and Bubble (Kumizhi)

The sluices do the job of draining the water. The bubbles, in addition to draining water, also remove sediments from lakes, ponds and sluices.

4.5.2 Structure of Kumizhithoombi

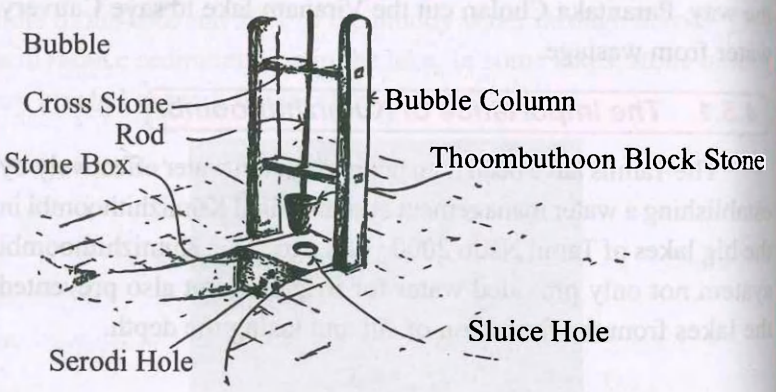


Fig. 4.2 Kumizhithoombu

Bubbles that release water to irrigation canals are not cosntructed like sluices on lake shores. The bubble (Kumuzhi) is set in the lake 200–300 feet away from the lake shore.

A strong embankment is built on the ground level of the lake. Then, a black stone tank is made under it. On the top of the tank, there is a large drain hole for the water to flow. They drill a hole of the same size under the tank and connect it to the irrigation canal outside the lake through a tunnel.

'Thoombukkal' is used to close and open the hole for water to flow into the tank. There is a stone frame to move the Thoombukkal up and down.

There are three small holes on the side of the tank. They are called 'Serodi hole'.

4.5.3 The Mechanism of the Kumizhithoombu

When water is needed for irrigation, they swim in the lakes and dive to lift the thoombu stone that blocks the water hole above the tank. Hence, water required for irrigation is released. In this system under the lake, the water flows through the water hole at a pressure equal to the water level of the lake. The water pressure at the bottom of the lake is high. The pressure inside the stone plate is less. Due to this, slit and slimy water will seep in quickly through Serodi hole.

80% good water comes out of the lake through the Neerodi hole while 20% of the pulp water comes out of Serodi. In the same speed, good water is washed away. The soil water is also washed away. This will reduce silting in the lake.

Fig. 4.3 The Functioning of Kumizhithoombu

Evidences

1. *Rajarajan Thoombu : 'Sembian Mathevi Pereri' is the lake cut by Paranthak Chola's youngest son Kandarathithan in accordance with the wishes of his second wife, Sembian Mathevi. One of the sluices is named Rajarajan Thoombu in the name of Rajarajan.*
2. *The Kumizhithoombi erected during the reign of king Rajarajan contains inscriptions of the king. So it is the property of the government. It means that the Vandals will be punished by the state. Rajarajan has declared through an inscription that he will carry the sand of the feet of those who maintain such Kumizhithoombus.*

4.6 ANIMAL CARE

Animal husbandry is a branch of agriculture that deals with animals that are reared for meat fibre, milk and other products.

This includes daily maintenance, breeding and animal husbandry.

4.6.1 History

When the situation of hunting and gathering food was ineffective, the Sangam people realized the need to have food on hand and attempted to raise livestock. Humans began domesticating animals as early as 13,000 BC during the Neolithic Revolution. They were made before the beginning of agriculture.

Animal husbandry is a business related to the culture of Tamils. Although we say that it was agriculture that was the basis of Indian economy; the real fact is that livestock economy has been the main economy in the World. Animal husbandry was the basis of Indian economy.

4.6.2 Livestock Maintenance at Different Periods

Animal Husbandry in God's time

Animal husbandry is associated with God's incarnation.

Christianity portrays Jesus as the shepherd of the flock and the seeker of the lost or strayed sheep.

In Hinduism, the pastoral life of 'Krishna' is a source of inspiration for cattle breeders.

Animal Husbandry during the Royal Period

During the Sangam period, cattle was a symbol of wealth. If a king wanted to provoke another king to war, the first thing he did was to capture the cattle grazing on the border of the neighbouring country and bring them to his country.

4.6.3 Livestock for Various Activities

1. Livestock for Agricultural Activities

A hundred years ago, those who owned a large number cows were considered farmers of high social status. Ploughin the field, improving the soil, beating the hay, carrying the bags paddy to the houses, oxen were used for such different tasks. F this, it is understood that cattle rearing was considered impor during the Sangam period.

2. Cattle for Nutritious Food

Cows gave milk, curd, butter and butter milk as gifts to the cowherds; and their flesh was for human food.

3. Cattle for Jallikattu and Heroic Sports

Jallikattu is still found to be one of the heroic sports since the Sangam period.

It is said that in the earlier days the custom of giving his daughter in marriage to the hero who tamed the bull he raised was prevalent in the village in Tamil Nadu.

Literature says that cattle were grown like this since the Sangam period.

4. Use of Cow for Labour

As a cow gives more milk actually needed for a calf, it can be used for doing works.

i) To increase the production of crops by pulling the plough.

ii) To bring home the produce from the field.

iii) To pull the cart.

The cattle were first used in the Middle East around 4000 BC. This increased agricultural production to a greater extent.

4.6.4 Characteristics of Domestic Animals

1. Domestic animals must be useful to the breeder.
2. Must be able to thrive well in the care of the breeder.
3. Must be able to reproduce freely and should be easy to grow.
4. Must be able to raise them easily.

The First Domesticated Animals

Sheep were the animals that came with the nomads in the Middle East. At the same time, cattle and pigs were associated with more settled societies. The first domesticated wild animal of the Sangam people was the dog. Later, dogs and semi-wild dogs became part of human herds and came forward for hunting.

Hunting animals such as sheep, pigs and cattle were gradually domesticated early in the agricultural history.

1. Pigs

Pigs were reared between 8500 and 8000 BC.

2. Chicken

Fossil chicken bones dated back to 5040 BC have been found in north east China. Archaeologists believe that the original purpose of poultry farming was as a cockfighting sport.

They were domesticated as wool animals as early as 3000 BC in South Africa.

3. Horses

The domestication of horses began around 3000 BC in the grasslands of Central Asia near the Black Sea and Caspian Sea. Although horses were originally seen as a source of meat, they were used for carrying goods and for riding.

4. Camel

In 1000 BC, Arabian Camels were grown for carrying loads.

5. Elephant

In South Asia, the elephant was domesticated around 6000 BC.

4.7 WELLS DESIGNED FOR LIVESTOCK

4.7.1 Wells

A well is a deep hole dug in the ground to access natural resources. Generally, wells were originally designed by the Sangam people for peoples' and livestocks' drinking purposes. Wells have been used in many cultures around the world for over 8000 years. The first wells would have probably been dug manually or with very simple tools. They stored water and provided access to bring ground water to the surface.

This generation knows only a few bodies of water like lakes, ponds and rivers. But our forefathers created and maintained more than 40 water sources. Renovation and maintenance of those water bodies is enough to prevent water shortage in Tamil Nadu. From the books noted below, it can be understood about well drilling, nature of wells and water levels.

Proofs

1. *Mayamatham: Kodumudi S. Shanmugam mentions that we had an engineering text called 'Mayamatham' which explained constructions like well digging, etc.,*
2. *Gnanavalliyam: This is a book which describes the nature of the land for drilling wells.*
3. *Koolnanool: It is a book that helps us to know the state of water.*

4.7.2 Dew Pond (or) Dew Well

A snow lake is an artificial lake usually located on the top of a mountain. It is generally designed for providing water for livestock. Ponds are used in areas where a natural supply of surface water is not readily available. There are evidences that these ice ponds were used for cattle during the Sangam period.

Proof

In 1865, the Journal of the Royal Agricultural Society mentions about Panikulam. In which it is believed that the source of water is rain instead of snow or fog.

Construction

Ice ponds are usually shallow and saucer–shaped. These are lined with clay and lime on top of an insulating layer of straw on top of the lime underlayer. Lime or charcoal is mixed with the clay to prevent upward burrowing by earthworms. This makes the clay porus.

4.8.1 Types of Land

In the Sangam literature, it is mentioned that the arable land was divided according to its nature and cultivated crops as follows:

1. Hard Field
2. Soft Field
3. Dry Land
4. Waste Land (Kalar Nilam or Purangadu)

1. Hard Field

A hard field is the hard ground. Due to the roughness of the land in Kurinchi and Mullai areas and the lack of water, the land was called Hard Field (Vanpulam).

Proof

Nartinai 59

2. Soft Field

A soft field is the fertile land. As Marutha land is rich in water resources, it is a suitable land for agriculture.

Proof

Puranananooru 42–15

3. Dry Land (Punpulam)

Punpulam is the dry land. It is the non-irrigated, artificially irrigated land. It is the land where rain fed crops are grown.

Proof

Pathirupathu 58–15

4. Waste Land (Kalar Nilam)

Waste land is the land which is unfit for cultivation. It is called salt land because of its high salt content. It is referred to as Purankadu in the Puranananooru song.

Proof

Puranananooru 311: 11, 12

4.8.2 Owners of Agricultural Land

Majority of the peasants cultivated their own lands. They were called by different names according to their soil.

1. Uzhuthunbar (or) Arinvazhnar

They lived by the tip of the plough.

2. Vellalar

They were high class people. They owned lands and also were the owners of water.

They held high positions with the king.

3. Karalar (or) Kalamar

It means the ruler of the cloud.

4. Uzhathiyar

The women farmers were called Uzhathiyars.

4.8.3 Agricultural Tax

During the Sangam period, taxes were levied on land and its produce. Landlords and peasants paid taxes, The land tax was known as Irai or Karai. The production tax was called tax. One sixth of the harvest was collected as tax. Additional grains were stores in places called Kalanjiyams.

4.8.4 Measurement of Agricultural Lands and Materials

The smaller piece of land was called 'ma' and the larger piece of land was called 'veli'. One 'veli' is equal to 100 Kuzhis.

They used Thuni, Nazhi, Ser, Kalam for measuring the quantity of things and thulam, kazhanju for measuring weights.

Ambanam, Nazhi, Pathaku, Marakal were used to measure grains. Scales, Thulakkol were used by people.

4.8.5 Usage of Land and Cultivation

The Sangam Tamils were skilled in preparing the land for agriculture and cultivating it. They knew the nature of the land and acted accordingly.

Paddy fields were cultivated with the help of bullocks. In the lands, the farmers trampled the leaves and drowned them. After the seedlings grew, they were planted in another place. Then, the weeds were removed.

Proof

Weeding is described in Thirukural. Weeding is compared to the king's administration of his country.

Ponair Poottum Event

It is a traditional custom of the farmers to plough the land at the beginning of Chithirai month or during the crescent moon time. This custom is called 'Ponair Pootum Event' or 'Mathi Air' or 'Nalleir'.

Proof

In Silapathikaram, this festival is written under the title 'Air Mangalam'.

Harvest

They were harvested when the crop matured. The harvested paddy was brought to the field and threshed to separate the paddy grains. Paddy grains were collected, weighed and stored in proper containers.

Rotational System (or) Multi-Crop Cultivation

Crop rotation was followed in the Sangam period itself. For example, cotton and small grains were grown in the same season. After that, broad beans were cultivated. Small grains were cultivated in the Kurinji lands. Kosala country farmers cultivated paddy. At the same time, they cultivated various crops.

Natural Fertilizers

Only natural fertilizers were used during the Sangam period. They used natural fertilizers to the fields before and after ploughing. Green manures are still in use today. Fertilizer crops such as Pasunthal, Thakkai Poondu, Agathi, Sanappai, Billi, Avuri were used. Cattle dung was used as manure on the ploughed lands.

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Proof

Kalithithogai 108–60

4.8.6 Selection of Seeds

Even in the Sangam period, Tamils realized how important in agriculture. It is to select seeds and protect them from pests. In the Puranannooru song below, it is mentioned that the seeds were dried and then used for sowing.

Proof

Puranannooru

4.8.7 Irrigation for Agriculture

During the Sangam period, people mainly depended on rain for the water needed for agriculture. Then, they created ponds, lakes, dams, etc., to store water. Later, sluices, Kumizhithoombugal were constructed to regulate the water for irrigation. Sometimes, to control the river floods and to divert water for irrigation, earthern embankments were raised. Finally, the water stored in reservoirs was used for irrigation. Finally, water stored in reservoirs was used for the purposes of irrigation through canals.

People learned to dig wells and use ground water for agriculture as early as the Sangam period. They used cattle for drawing water from wells.

4.8.8 Crops Cultivated in the Sangam Period

Rice, sugarcane, small grains, pulses, coconut, cotton, banana, tamarind, sandal wood, etc., were cultivated during the Sangam period. Paddy was the important agricultural crop. The houses had trees like jack fruit, coconut, and betel nut. They maintained

flower garden at the back of the house and tamarind plants at the front. All the villages became self-sufficient and surplus production was found.

4.9 AGRICULTURAL ACTIVITY (OR) TOOLS AND TECHNIQUES REQUIRED FOR AGRICULTURE

Cultivation was done in a very systematic way during the Sangam period. Ploughing, sowing, fertilizing, weeding, irrigation and crop protection were done properly and people were leading a rich life. They made and used various tools needed for agriculture for ploughing and harvesting.

1. Kalappai

Air was called Airai, Meli, Nanjil, Kalappai. The Air (Kalappai) was made of wood or iron or steel frame with a sharp unit and used to till the land. Cattle were used to loosen the soil.

Fig. 4.5 Air (Kalappai)

2. Parambu

A tool called wooden pole or plank was used to level the land to be cultivated without ridges or ditches.

Fig. 4.6 Parambu

3. Palliyaduthal (or) Pallukkai Steering

It was used to remove weeds and to reduce crop density. It consists of metal or wooden teeth mounted on a wooden frame. This frame was used to clear the field of wield with the help of cattle.

4. Thalambu

While ploughing the Nansei land, a tool called 'Thalambu' was used to break up the clods formed.

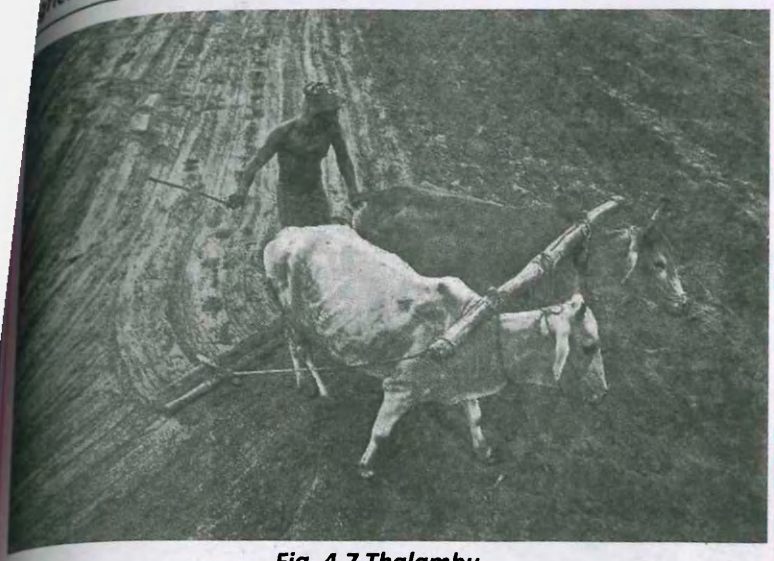


Fig. 4.7 Thalambu

5. Sugarcane Squeezer

A sugarcane squeezer was used to cut the harvested sugarcane and extract the juice from it. Purananooru mentions this.

6. Water Drawing Tools

There are two types of water according to hydrology. They are

i) Secretion Water

ii) Surface Water

i) Secretion Water

As underground water is hidden, it is called secretion water.

ii) Surface Water

The water that flows automatically from ponds, lakes and puddles is called surface water.

Run off water and water that was drawn were used for irrigation using booms. This is illustrated by the following song from Porunar Aartupadai. The term 'boom' is still in use in the villages.

Proof

Porunar Aartupadi Book

Types of Booms

i) Box Booming

The land near the creek is slightly elevated. A triangular basket made of bamboo is tied at both ends with a rope and two people hold it on either side and one person stands on the bank and pulls the water. This is called Box Booming.

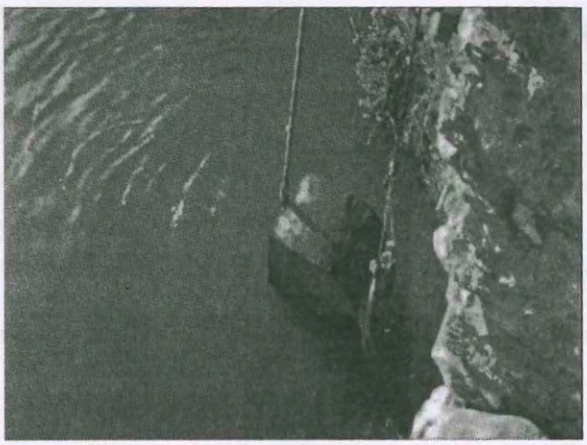


Fig. 4.8 Box Booming

ii) Man Booming

Man Booming is used for shallow wells to a slightly deeper location.

By one or two persons walking on a single stone rotating long pole, the water goes into the container and it rises up. The man on the bank pulls the vertical pole with a rope and diverts the water it to the channel.

Fig. 4.9 Man Booming

Proof

There is a story connecting the Man Booming and Kambar, the poet. The boomer sings a song.

It is said in the Sangam literature that Kambar was astonished when he heard this song.

7. Kavalaiyertam (or) Kabilai

Kabilai refers to cattle. Farmers used a technology called Kabilai to draw water from deep wells for irrigation.

Fig. 4.10 Kavalaiyertam

The water pumping container is made of skin called Pari. It is also made of tin. The poles having the rotating wheel are firmly fitted into the stone so that they extend into the well. By connecting the container, Thondan, etc., they pull the cow with the help of a wheel to make the water to pour out. Blocking the water path with black slabs to allow cattle to pass back and forth is perhaps the greatest engineering technology.

8. Weight Bearing

While digging a well, heavy lifting is a method used in rural areas to take out the well soil.

A tall pole is tied on the bank of the well. A lever is mounted on the shaft. The pole is tied with a rope from the tip.

It is connected in such a way that the horizontal pole rotates on the vertical pole. When the load comes above, it is pulled to the ground through a rope.

Fig. 4.11 Weight Bearing

9. Catapult

They used catapults called Kavans to repel animals and birds. It is said that catapult can be used to target and kill an animal.

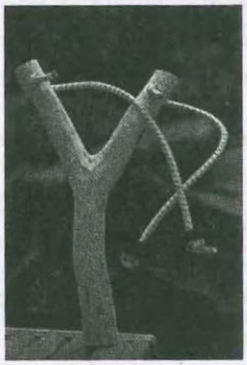


Fig. 4.12 Catapult

10. Loud Speaker

Young women, Kuravan, Kurathis used sound making instruments to drive away the birds.

11. Flares and Blowers

Flares and blowers were used to drive away wild animals especially elephants from the fields.

12. Sickle

The sickle was used to harvest the ripe paddy and corn kernals.

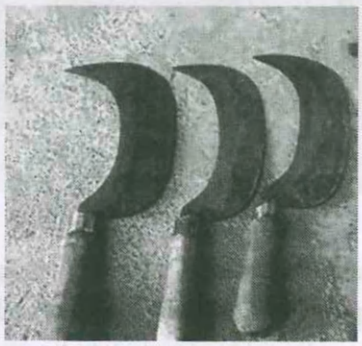


Fig. 4.13 Sickle

13. Sacks

Grains such as paddy, corn and rye were harvested, sprinkled in the field and stored in sacks.

4.10 MARITIME KNOWLEDGE

About 70% of the earth's surface is covered by ocean. The ocean has been known as Sea, Aazhi, Pazhi, Olam, Kayam, Varithi, Nerineer, Valayam, Pirambu, Thozham, Thirai since the Sangam period.

Apart from fishing in the sea, there are many other phenomena such as trade, exploration of mineral resources, discovery of oil resources, climatic changes, conch, pearl, agar, clams and various marine lives, medicinal plants in the sea, estuary areas where

rivers merge with the sea. The nature of the sea was, it had full of bio-diversity. The Sangam people had an understanding of them.

Definition of Sea

Sea refers to a large body of salt water. The salinity of sea water varies widely. Less at the surface and near the mouths of large rivers and more in the depths of the ocean.

4.10.1 Substances Dissolved in Sea Water

The most dissolved solid in sea water is Sodium Chloride. Magnesium, Calcium, Potassium, Salts of mercury and many other elements are dissolved in the watter.

1. Salinity

Ocean salinity is usually measured in parts per thousand. The open ocean has about 35 grams of solids per litre. In general, evaporation and ice formation increase salinity. At the same time, rainfall, melting of sea ice and run off from land reduce salinity.

2. Thermal Condition

Ocean temperature depends on the amount of solar radiation falling on its surface. Surface layers typically have a temperature of 30°C while deep sea water ranges from –2°C to 5°C in all regions. Sea water with a salinity of 35% is at about –1.8°C.

3. pH Value

Sea water is slightly alkaline with an average pH of 8.2 over the past 300 million years. Recent climate change has increased the amount of carbon-dioxide in the atmosphere. 30–40% of the added CO_2 is absorbed by the oceans, forming carbonic acid. This is called ocean acidification. pH is expected to reach 7.7 by 2100.

4. Oxygen Concentration

The amount of oxygen found in sea water depends on the plants that grow in it. These are mainly algae and phytoplankton and certain marine plants engage in photosynthesis and produce oxygen. It dissolves in sea water and is used by marine animals. At night, photosynthesis stops and dissolved oxygen levels decrease.

5. Light

Sunlight falling on ocean is reflected on the surface. Red light is absorbed at depths of a few meters. Yellow and green light reach greater depths. Blue and violet light penetrate upto 1000 metres. Beyond a depth of about 200 meters, enough light is not found for photosynthesis and plant growth.

4.10.2 Life at Sea

Marine life is the life of a variety of organisms that use the oceans as their habitat.

Algae and Plants

The primary producers of the ocean are plants and micro-organisms in the plankton. Half of the world's oxygen is produced by plankton. Algae also play an important role in this. Light can only penetrate 200 meters. Therefore, it is the only part of the ocean where plants can grow.

Animals and other Marine Lives

More animals live in the sea than on land. Some vertebrates such as sea birds, seals and sea turtles return to land to reproduce. But, fish, cetaceans and sea snakes have a completely aquatic lifestyle.

Human Food

The oceans provide substantial food for humans, especially fish. Then they used sea water to extract salt for food. So sea water has become an important part of life today.

Travel

Sangam literature says that humans followed sea turtles to travel by sea. Sailing ships were used for fishing in the seas and for carrying mail packets abroad. When steam ships came into use in place of sailing ships, people started to travel. At the beginning of the 20th Century, they sailed larger and faster ships.

Trade

Trades through sea routes have existed for thousands of years. The Ptolemic dynasty developed trade with India. Arabs, Phoenicians, Israelites and Indians traded in luxury goods like gold and precious stones.

Efficient Production

The ocean provides enormous potential for transporting energy through sea waves. They can be used to generate electricity.

Extractive Industries

There are huge mineral reserves in the seabed. They can be exploited by excavations. It has more advantages than land-based mining. Undersea rocks contain large deposits of petroleum such as oil and natural gas.

4.10.3 Environmental Issues

1. Oceans are polluted as a result of human activities (Marine litter, plastic pollution, microplastics, nutrient pollution, toxins, etc.).
2. Over exploitation (fishing, habitat loss, invasive specie
3. Climate changes in the ocean (increasing sea temperatu decreasing pH value, ice melting, decreasing oxyg level)

4.11 FISHERY

A fishery may be an enterprise that raises or harvests fish and other acquatic lives. Usually, the site where such an enterprise was held was called a fishing ground. About 500 million people worldwide depend economically on fisheries.

4.11.1 Types of Fisheries

There are two types of fisheries based on the sources of water resources.

1. Marine fisheries or Brackish water fisheries
2. Inland fisheries or Fresh water fisheries.

1. Marine fisheries or Brackish Water Fisheries

7500 km includes the coastline and the deep sea beyond. Popular marine fish species include Prawns, Maceral tune, Saratinus and Mombe duck. Marine fish are caught using fishing boats with the help of various types of nets.

2. Inland Fisheries or Fresh Water Fisheries

Acquariums in fresh water resources include canals, ponds and reservoirs. In fresh water minnows and prawns are produced. In this way, more collective fish farming can be done. In this system, a mixture of species is used in a fish pond.

4.11.2 Fisheries of the Sangam Period (or) History of Fishery Industry

Fish plays an important role in the global economy as food. Fishing has been the commercial livelihood of most of the world's nations since the Sangam period to the present day. Fish species live on algae in the ocean. So fish food is more nutritious than other foods. All sides of medicines recommend eating fish food. The Sangam literature mentions fish food and food culture.

4.11.3 Fish Species

The native occupation of the ancient people was hunting and fishing. As the people who lived along the coast were engaged in fishing, it is possible to know that their main food was fish.

Sangam poets say that there were various types of fish as follows.

1. Shark (Agananooru 150:6, 7)
2. Bryde's Whale (Madurai Kanchi 375)
3. Prawn (Agananooru 60.1)
4. Njendu (Sirupanartupadai 194–195)
5. Conch (Agananooru 350)
6. Thali (Ingurunooru 106 – 1 – 3)

7. Ippi (Nartinai 87 : 6–7)
8. Ayirai (Nartinai 272 : 4–6)
9. Ayilai (Agananooru 60 : 5–6)
10. Arai (Kurunthogai, 114 : 6–5)
11. Kediru (Ingurunooru 160 : 3–5)
12. Yamai (Agananooru 160 : 3–5)

So far, more than 32,000 species of fish have been identified.

4.11.4 Ours is a Suitable Country for Fisheries

As our country is near the equator, there is a regular variation in climate. This is an ideal environment for fish to breed more. Short-lived fish species such as Salai, Ayilai, Nethili - lay thousands of eggs. Most fish have a life span of 1 year. The annual average catch is 2.7 million metric tons. But, scientists say there are 3.9 million metric tons of fish in our oceans.

4.11.5 Fish Drying

Sangam people not only cooked and ate the food they got but also dried and processed the leftovers.

The Tamil word 'Unangal' means to dry up. In Sangam songs the word 'Unangal' means sun drying. Selling the fish caught in the sea, eating and processing and drying the leftover fish for food has been the occupation of the people of Neithal land.

The following lines from Agananooru illustrate that the women make the fish brought from the sea fit by drying in sunlight.

Proof

Agananooru 20 : 1–3

4.11.6 Fishermen

Fishing net users

Today we call those who go to sea and do fishing as 'Fishermen'. They have been referred to as 'Valaigner' during the Sangam period. 'Valaigner' means one who fishes with a net. There are references of fishing from water bodies like Madu, Kulam, Kazhani, etc., in Sangam literature.

Thimilon

An Agananooru verse says that the fisherman who went into the sea was called 'Thimilon'. 'Thimil' means 'fishing boat'.

Proof

1. *Agananooru 320 : 1–5*

Thimilon goes to the sea in his fishing boat, spreads his nets and catches the fish. His beautiful sister, wearing leafy dress sells the fish in the streets where festivals take place. This is mentioned in the Agananooru song.

2. *Agananooru 60 : 1–7*

The song is about the rich Porayan Thondi. The daughter feeds her father who goes fishing in a big boat. Father has a net in hand to catch the red prawns in the sea so that the red prawns tremble. The daughter gives him a meal made of white rice made from rice bought by selling salt along with a delicious sour cream and Kodumeen soup.

4.12 PEARL

Fig. 4.14 Pearl

Pearls are closely associated with human history. These are considered to be the oldest germ stones in the world since pre-historic times.

It is believed that pearls were discovered when the primitive man wandered along the beaches in search of food.

Pearl is considered as one of the nine types of gem stones known as precious Navarathnas.

4.12.1 Mode of Pearl Formation

1. Natural Pearl

Pearls are obtained from a creature called a pearl sculptor.

Nature gives us the pearl as a finished product. Nacre is formed on the inner shells of pearl oysters and dark blue oysters.

Naturally produced pearls, when any parasites, small creatures, shells go inside the shell, there is an eruption. At that time, a special

kind of liquid called nacre is secreted to protect itself by covering the object that enters.

The longer the object is in the shell, more layers of nacre liquid will settle on it, turning it into a precious pearl. Similarly, even if a small grain of sand enters, it becomes a pearl. Naturally forming pearls like this are valuable.

2. Artificial Pearl

A pearl is not a mineral. It is formed by two calcium carbonate minerals namely aragonite and calcite. These two minerals differ in their crystallinity.

- Aragonite is formed by red square crystals.
- Calcite is formed by triangular cyrstals.
- Pearls are formed by the ingestion of minerals such as aragonite and calcite, which are mixed with a binding fluid called ganghelin (a protein) in the stomach.

Evidences

1. *The Chinese inserted a small lead Buddha statue into the shell's mouth while it was open. After some time, when the oyster is opened, the Buddha statue is encased in pearly liquid.*
2. *The Japanese would push small grains through the shell's mouth. Nacre liquid settles on it and a well-grown pearl is taken out.*

Duration for the formation of Pearls

Pearls take 5–6 years to form in good water.

Perls take 5–20 years to form in salt water.

A shell produces a total of 60 pearls in its life time.

Nature gives us the pearl as a finished product. Nacre is formed on the inner shell of pearl oystors and dark blue oysters. An excellent pearl will be in the form of spherical shape. However, some other forms are also commonly found.

There is no need to polish or brighten the natural pearls.

4.12.2 Properties of Pearl

Pearls are solid, translucent, white in colour and spherical or oval in shape.

Animuthu

The highest type of spherical pearls is called Animuthu. It is slightly larger in size, highly compressed and shiny with high light penetration.

4.12.3 Sanctity of Pearl

Pearls are generally symbols of purity, holiness, perfection, etc., and represent human qualities such as virtue, love, wisdom, justice, spirituality and fairness.

Proofs

1. *In ancient China, pearl jewelry was believed to bring purity to those who wore them.*
2. *In the Dark Ages, warriors considered that wearing pearl jewelry would give them protection.*

4.12.4 Medical Properties of Pearls

1. If the Pearl is put in skimmed milk, it will float. If pearls are soaked in water and the water is drunk, the acidity in the stomach will be neutralized and intestinal diseases will be prevented.
2. Pearl preserves smooth liver function.
3. It has diabetes control properties.
4. If pearls rich in calcium are worn and when they rub the body, the protein will be dissolved. As a result, the body heat will subside.

Proofs

1. *Medical texts say that pearls give longer life.*
2. *The method of making the pearl into powder with the herbal juice is mentioned in Siddha medical texts.*
3. *Cleopatra, the world's most beautiful woman crushed a pearl and mixed it with wine and gave it to Mark Antony as dinner. This is considered to be the most expensive dinner in the history of the world.*

4.12.5 Pearls during the Sangam Period

The earliest reference to pearls comes from China during the Sangam period. Pearls were gifted to Chinese royalty as early as 2300 BC.

One of the oldest books in China, the 'Sho King', published in 2350 BC, mentions pearls found in the Hewai River and in the series of pearl rewards given after death.

Proofs

1. *Lead Buddha*

China is credited with producing the first cultured pearls by inserting tiny lead Buddha statues into the pearl oysters around 1000 AD.

2. *Pearls in Quran*

Pearls are referred to in holy books such as Quran.

3. *The New Testament*

References to pearls are found in both the New and Old Testaments.

Proofs

Mathew 2 notes; Resurrection 4 notes; Timothy 2 notes.

4. Pearls as Jewelry

Even before the 420 Century BC, it is evident that pearls were used as jewelry. Prior to the period before 4th Century BC, pearls had been used as decorative items in Egypt.

Evidences

1. *A piece of broken pearl jewelry has been found on the body of a Persian Princess in an ancient stone coffin dating back to 420 BC at the Louvre Museum in Paris.*
2. *There is evidence of the pearl trade during the reign of Alexander the Great in the 4th Century BC.*

4.12.6 Pearls in Sangam Literature

There are many accounts of pearls in Sangam literature. It is understood from the following proof that Avaiyar sang that pearls were found in abundance in the Pandyan country and the Pandyan South as World famous for pearls.

Proof

Avaiyar – individual versa

Korkai Pearls

Korkai was the primary capital of the Pandyas till 130 AD. Later it became the port and the second capital of the Pandyas. Here the pearls were highly valued and the pearls found were the best and the following Nartinai and Ingurunooru tell us. It is said in the literature that the pearl trade went on extensively.

Proof

Nartinai 23 : 5–6 Kanakayanar

In the Korkai beach, the sea waves pile up pearls on the shore. Scattered on the beach, these pearls get struck in the hooves of the rich man's horse and hinder it. The following Agananooru verse, says that the pearls are found scattered to this extent.

Proof

Agananooru 130 : 9–11 Venkannanar

Musiri Pearls

Pearls were also found in the port of Musiri, the country of Chera. These pearls were sold in a town called Bandar. The Arabic word Bandar means the port.

2. Caldwell, a Western scholar in his book has also detailed the Pearl Hunting of Bharathavars in the Kayal Port.

4.13.3 Permission and the Role for Pearl Hunting

Since the Sangam era, Pearl Hunting in the sea should be done only after obtaining the king's permission. One tenth of the collected pearls should be given to the king and one twentieth to the Anthanars chanting the mantras. Apart from this, if high quality pearls are found, the king used to buy them from the merchants at a high price.

4.13.4 Convicted Criminals as Pearl Hunters

Sangam literature states that the Pandyas generally conducted 'Pearl Hunting' with 'convicted criminals'. Korkai Pattinam belonged to the Pandyan Kingdom. Evidences suggest that 'convicted criminals' were mostly used for 'Pearl Hunting'.

Proof

It is mentioned in the maritime accounts of Periblues.

4.14 ANCIENT KNOWLEDGE ABOUT OCEANS

An ocean is not just a place where land is covered by water. The ocean floor is geographically distinct from the continents.

4.14.1 Geographical Changes Occurring in the Ocean

Geographical processes occurring under the sea not only affect the marine life but also the land regions. The processes that form ocean basins are slow and occur over tens of thousands and hundreds of millions of years. Solid rocks flow into liquid in the blink of an eye. To understand the sea bed, we must learn to follow geologic time.

Geographical conditions are very important to marine biology. Habitats or places where organisms live are directly shaped by geological processes. The shape of the beach, the depth of water, the underlying mud, sand or rock and many other aspects of marine habitat are determined by this geography.

Fertility of oceans by the Equator

Our oceans cover 72% of the earth's surface. As far as the Equator is concerned, about two-thirds of it is found in the Northern Hemisphere. It is only 61% of Ocean. 80% of the Southern Hemisphere is Ocean.

4.14.2 Classifications of Ocean Basins

The oceans are traditionally classified into four major basins.

1. Pacific Ocean

It is very deep and very large.

2. Atlantic Ocean

It is slightly larger than the Indian Ocean. But, both have average depths.

3. Arctic Ocean

It is very small and shallow.

Mediterranean Sea, Gulf of Mexico and South China Sea

Various such shallow seas are connected to the major ocean basins.

Generally, we divide the oceans into four. But, they are inter-connected. These connections allow sea water, materials and some organisms to move from one ocean to another.

4.14.3 Characteristics of Sea Water

The characteristics of sea water are affected by the following two factors.

1. Nature of water
2. Substances dissolved in water

1. Dissolved solids in sea water come from two main sources

i) Chemical weathering of some terrestrial rocks. They are carried to sea by rivers.

ii) Other materials come from the earth's interior.

2. Ions in Sea Water

Usually, only six ions make up 98% of the solids in sea water.

Sodium and Chloride make up about 80% – 85% of the solids. These affect the salinity of water. The salinity of water severely affects the organisms living in it.

3. Substances that affect the colour of the Sea

The sea is usually blue in colour. In some places, it is blue-green or yellow to brown. The blue colour is the result of many factors.

i) First, water absorbs red light and reflects back blue light.

ii) Secondly, the very small particles in sea water scatter blue light.

Substances that affect the colour of the sea

Dissolved organic matter, Phyto-Plankton living with chlorophyll pigments and non-living particles such as sea ice and mineral deposits affect the colour of the ocean.

Maritime History

Maritime history goes back to thousands of years. In ancient maritime history, evidences of sea-route trade between civilizations date back to atleast 2000 years.

Pre-Historic Boats

It is believed that the first pre-historic boats might have been dug-out boats developed independently by various Neo-lithic peoples. In ancient history, various ships were used for coastal fishing and travel.

There are fossils and traces left in the rhinoceros skeleton that suggest early humans crossed the sea and colonized the Philippine island of Luzon between 777,000 and 631,000 years.

The sea crossing occurred about 53,000 to 65,000 years ago. They might have used large bamboo boats. In the history of whaling, the oldest method by humans around 6000 BC was to simply drive them ashore by placing several small boats between the whales and the open sea and scaring them with noise, small non-lethal weapons, etc.,

4.15 INTELLECTUAL COMMUNITY

4.15.1 Knowledge

Facts, information, interpretations acquired through experience or education or knowing about something or practical understanding is knowledge.

Types of Knowledge

1. Situational Awareness

Knowledge acquired about a particular context or moment or situation is called situational knowledge.

2. Natural Knowledge

Natural knowledge is not the knowledge about nature or the learned knowledge. It refers to naturally acquired knowledge.

3. Academic Knowledge

Knowledge acquired through education can be called literacy.

4. Knowledge to know the Truth

The inner knowledge in the spiritual realm means realizing the truth or transcending illusion and seeing the truth.

4.15.2 Knowledge Society

1. A knowledge society makes knowledge available to all members that can be used to improve the human condition.
2. A knowledge society helps transform information into resources that allow a society to take action effectively.

...3 Information and Communication Technology

The world of information and communication technology has ...ficantly increased the ability to generate raw data and the speed ...hich it is generated. The advent of internet has provided people ...h unprecedented information. The evolution of Web 10 to Web ...0 connect with each other and enable people to become producers.

Innovation in digital technologies and mobile devices provide ...way to connect individuals at any time. ITC's tools provide opportunities for access and empowerment for education, training, employment and livelihoods for all the members of society.

Modern media provide an endless amount of information. However, information alone does not create knowledge. For knowledge creation to take place, reflection is needed to create awareness, meaning and understanding. Critical analysis of information is required to develop knowledge that will help humanity and improve human conditions.

4.15.4 Education

The role of education continues to grow and change as technologies are used to improve global access to information. Education is seen as the basic human right. For a society, reading, writing and basic arithmetic are important for future learning. The advent of ICT allows learners to search for information and develop knowledge anytime and anywhere. Supported by ICT, in a knowledge society, the ability to locate, categorize and sort, information is necessary.

4.15.5 Social Theory

The social theory of knowledge society explains how knowledge is fundamental to the politics. Knowledge is a commodity traded for economic prosperity. In a knowledge society, individuals, communities and organizations create knowledge-intensive work.

A knowledge society promotes human rights and provides equal inclusive and universal access to all knowledge creation.

4.15.6 Principles of UNESCO

The UNESCO World Report presents four principles essential to the development of an equitable knowledge society.

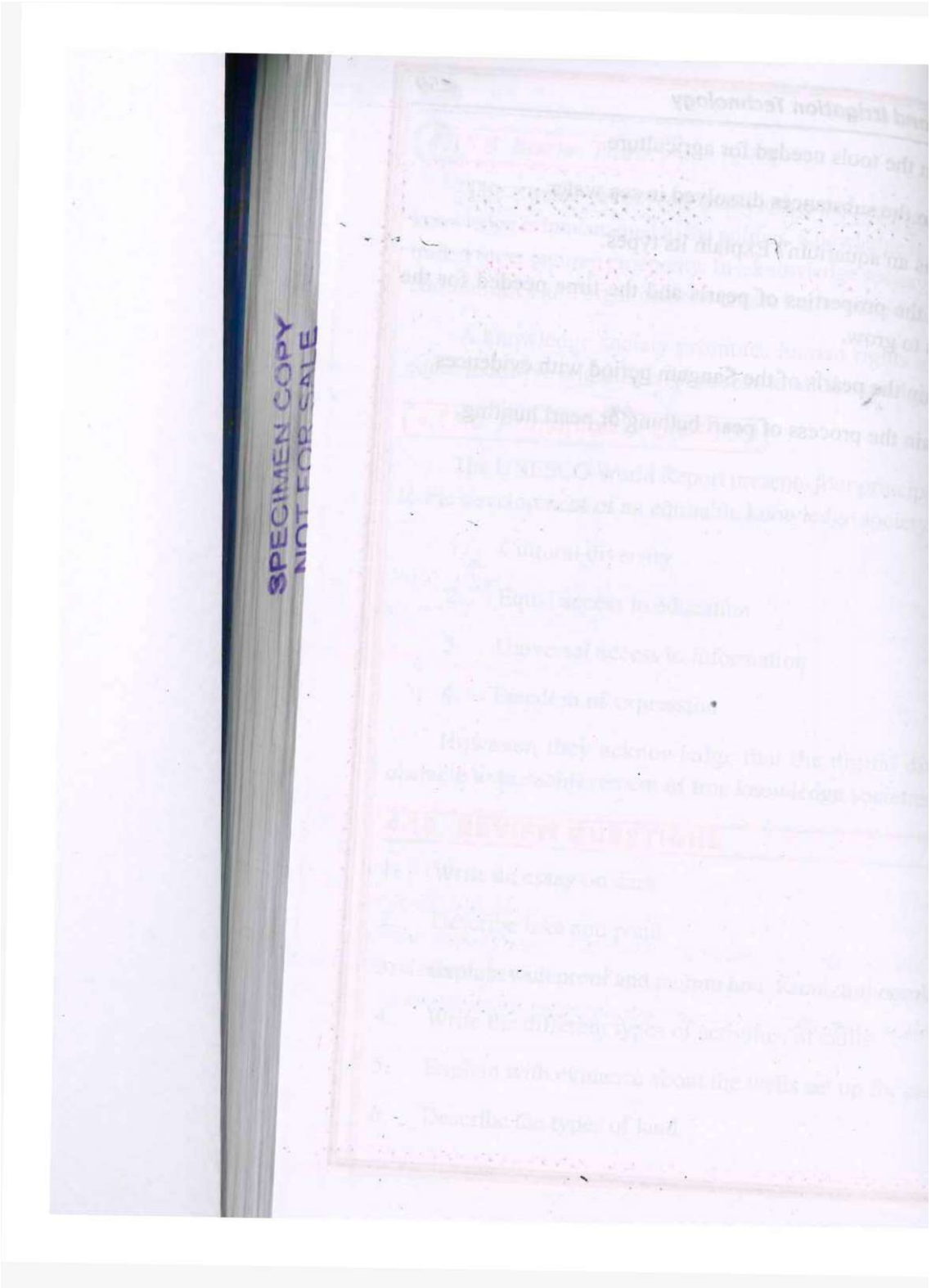
1. Cultural diversity
2. Equal access to education
3. Universal access to information
4. Freedom of expression

However, they acknowledge that the digital divide is an obstacle to the achievement of true knowledge societies.

4.16 REVIEW QUESTIONS

1. Write an essay on dam.
2. Describe lake and pond.
3. Explain with proof and picture how Kumizhithoombu works.
4. Write the different types of activities of cattle.
5. Explain with evidence about the wells set up for cattle.
6. Describe the types of land.

7. Explain the tools needed for agriculture.
8. Explain the substances dissolved in sea water.
9. What is an aquarium? Explain its types.
10. Write the properties of pearls and the time needed for the pearls to grow.
11. Explain the pearls of the Sangam period with evidences.
12. Explain the process of pearl bathing or pearl hunting.



Unit - V

SCIENTIFIC TAMIL & TAMIL COMPUTING

5.1 DEVELOPMENT OF SCIENTIFIC TAMIL

There were three forms of Tamil namely Iyal, Isai and Drama. Time passed and changes began to come. In this world of science, we can no longer thrive and rise in the nuclear age with the three Tamils.

In this spinning rocket age, development is not possible without the support of science. So Tamil should be developed in the field of science.

The riches of science should be brought to Tamil. Along with Muthamizh, science should be added as the fourth Tamil and henceforth it should be called 'Nartamizh'.

So, V.S.Kulanthaisamy was engaged in the attempt of combining both Tamil and Science.

5.1.1 Pioneers who developed Science Tamil

1. P.V. Manicka Nayakar

One of the pioneers in the development of Science Tamil was the engineer P.V.Manicka Nayakar. He was deeply involved in technical terminology and wrote accounting and agricultural (biological) terminology in pure Tamil. Quite to the astonishment of the Westerners, he made calculograph easier to calculate.

2. V. S. Kulanthaisamy

Engineer V. S. Kulanthaisamy is a person with modern scientific knowledge and passion to reach out to the grassroots. He is a world-renowned hydrologist. He has been accepted by the world hydrologists as a thinker. They call his finding as 'Kulanthaisamy Model'.

He is one of the members of the world UNESCO Group of Seven.

5.1.2 Need for Science Tamil

1. Studying Science and Technology in Tamil leads to a different understanding and leads to a different way of thinking.
2. It allows us to explore things in different dimensions and in different contexts.
3. It helps to develop understanding of the Tamil community.
4. It is required to develop the department related matters neglected by the English World.
5. Majority of people in Tamil Nadu get their basic education in Tamil. If these students want to know about science, technology, medicine, the information related to that field should be in Tamil language.

5.1.3 Contributions of Tamil Scholars in Science Tamil

1. Contributions of P. V. Appasamy

In the field of Tamil, P. V. Appasamy's contributions for the development of Science Tamil is very great. From that day till now, he has been striving for Science Tamil. He can be called 'Father of Science Development'. His books are

1. The Story of Atom
2. Inside the Earth
3. X-Rays

He has also written hundreds of Science Tamil articles.

2. Contributions of N. K. Velan

N. K. Velan's contributions to the development of Science Tamil is significant. Velan is one of the notable writers of Science News in Tamil. His books are

1. Going Around the Moon
2. The Story of Electricity
3. Journey into the Earth
4. The Story of the Sea
5. The Story of Light and Sound

He has written more than twenty books.

3. P. L. Samy

Puduvai Collector P. L. Samy's Science Tamil service is immeasurable. He studied plants in literature, description of

animals, fishes, gems, living creatures in Kamban's epic and wrote them in Tamil.

4. Dr. N. Subbu Reddiar

Dr. N. Subbu Reddiar has written science books in Tamil like Rockets, Miraculous Electronics, Ambuli Travel, Cost of Remote World, Radio, Television and Our Body.

5. Kondal S. Mahadevan

Kondal S. Mahadevan is a Tamil Professor who has been developing Science Tamil for many years. He has written the book 'Man on the Path of Science' and many Tamil Science articles.

6. R. K. Viswanathan and J. P. Manickam

R. K. Viswanathan of Annamalai University and J. P. Manickam were the initial researchers. Both of them have written 'Sound and Light', 'Vanak Katchi', 'Alayamani'.

5.1.4 Development of Science Tamil in Various Fields

1. Science Tamil in Broadcasting

Sivapatha Sundaram developed Science Tamil in the field of broadcasting through radio. Apart from him B. P. Thirugnana Sambandar of Presidency College, B. K. Srinivasan, K. Arangasamy Iyengar of Annamalai University, P. Saravanan, R. Ramasamy, S. Sampath, K. Shanmuga Sundaram, Kaliya Perumal of Presidency College are worth mentioning.

2. Work of Journals in Science Tamil

The magazine of Kalaikathir has led to the growth of Science Tamil for more than a quarter of a Century.

The Coimbatore College of Home Science promotes the growth of Science Tamil by publishing a magazine called 'Vinjnanach Sudar'.

3. Science Tamil in Agriculture

S. K. Ganapathy Iyer, V. P. Subbaih Mudaliar, Kathiresan, Kanaka Kumari, Balaramaih, Captain Sevudiminathan, Tirusiromani and Uthamarayan wrote and published Science News related to Agriculture in Tamil.

Apart from them, K. Rajaram wrote and published the books Ocean, Fish, Rain, Good Water, Fire Stones, Aryabhatta, Air in Space and S. Subramaniam wrote and published the Science books Endless Travel, Suriyan Nila, Stars, Stories of the Sky, etc., in Tamil. They have also done translations in Tamil made them suitable for children.

4. Science Tamil in Economics

J. S. Ponnaih, C. Velayutham, K. S. Sonachalam, R. Sevachalam, J. C. Kumarappa (Gandhian Economics), R. K. Shanmugam Chettiar have deeply thought of and written about economics in Tamil. Tesini, P. P. Natarasan, I. T. Chithambaram (Rural Economics) have written economics news in Tamil.

5. Political Science Tamil

Rajaji, M. P. Sivagnanam, Anna, Nedunjezhian, Dinamani Sivaraman, S. S. Marisamy, V. Saminatha Sharma, J. Ramachandran, Principal, Presidency College (Political Organizations) wrote books on politics in Tamil.

5.2 COMPUTER TAMIL (OR) DEVELOPMENT OF COMPUTER TAMIL

Computer Tamil is the unparalleled Tamil gift of the 20th Century. Computing is the basic necessity in today's scientific world. Computers are used in various service centres like business centres, banks, hospitals, transport stations, research centers and houses. All office works are done through computers is well-known, Therefore, computer education is taught as primary education in the education sector nowadays.

5.2.1 Computer and Internet

The communication system 'internet' is the reason why computer education has come to the fore. The internet of computers has shrunk the world to a small village. The main function of the internet is to know and exchange information. The internet functions so easily because people exchange information in their own languages. Internet Tamil was formed due to the necessity of the time that the use of internet should be available to Tamils as well.

5.2.2 Internet – Definition

The internet is like a library. A website is a book. In that, we select a book and go through the particular part we want to read. Similar to that, we can browse internet and get the required information or details. We can also send information through our e-mail page. The above tasks can be done in Tamil itself.

5.2.3 Tamil Websites

There are hundreds of websites. It is an achievement that so many sites have been launched within a few years of the emergence of Internet Tamil. The first computer in Tamil was Thiruvalluvar

in 1983. It was produced by Data Books, a Singapore-based company. A computer program (programmer) developed by Captain Govindarajan and Thanikasalam in 1987 is called pioneer program. Websites such as Tamil Network, Internet Knitting, Tamil Desiyam, Amai, Knitting, Tamil Palakai, Tamil Ulagam, Chennai Library, Madurai University Library, etc., are performing well.

5.2.4 E-Tamil Fonts

The English keyboard is globally uniform in style. But, Tamil has not yet developed that status. So, there are many e-Tamil fonts. Some websites are involved in efforts to integrate these for unicode or making unified fonts. Among them, Madurai Web Concept Project works well. Madurai Tamil Literary E-Synthesizer Project is an online group of Tamil literature (http://tamil.net/projectmadurai/). Tamil books are being digitized on Chenni Library Website and on www.chennailibrary.com, Azhagi, Mayilaitamil, Murasu, Anjal, Aram Thillai, Thiruvalluvar, Ezhilnilai, Tamizhan, Kaniyan are the letters available. Integrating all these into one font is the biggest task of today's Tamil internet.

5.2.5 Online Magazines

Web magazines are those that project

1. Thinnai (http://www.thinnai.com)
2. Pathivugal (http://www.pathivugal.com)
3. Athisha (http://www.athishaonline.com)
4. Vaarpu (http://www.vaarpu.com) (kavithai Thamizh)
5. Nillasaral (http://www.nillasaral.com)
6. Varalaru (http://www.varalaru.com)

Thamizh Thinnai, Muthukkamalam are also included in this.

These online magazines are great for reaching readers without spending much. Another feature is that you can search by date and teacher. It is noteworthy that all the Tamil Web Magazines follow these methods.

All the newspapers published in Tamil have spread their sites on the internet. Tamil people abroad also get to know Indian Tamil Nadu news instantly.

5.2.6 Global Corporations

1. yahoo.com
2. msn.webdania.com/tamil/index.htm
3. news.google.com

All the above have Tamil news sites. It shows the importance given to Tamil language news.

i) inneram.com

ii) adhikalai.com (www.adhikalai.com)

also giving news in Tamil on the internet.

5.2.7 Web Blogs

Web blogs brought decentralization and simplicity to Tamil Internet development. Simple, beautiful web blogs can be made by Tamilians effectively and without spending much money.

It is noteworthy that despite the advent of Facebook and Twitter, the value of Web blogs remains the same in the Tamil region.

Internet Forums

Internet forums are there to share ideas or discussions that you want to share with others. Forums such as opinion, Tamil centre, etc., are very supportive for the exchange of ideas.

5.2.8 Internet Services

The keyboard being different is the hindrance to the development of Internet Tamil today. Efforts are underway to break that barrier.

A software component was found to correct errors when typing Tamil as found in English typing. It is certain that internet Tamil will be a success all over the world.

5.3 DIGITALIZATION OF TAMIL BOOKS

Computer is becoming an indispensable tool in the development of science. Tamilian has introduced Tamil to the internet and has played a major role in its development. Many web sites are also trying to download Tamil e-books that can be read on these websites.

5.3.1 Creation and Use of Tamil e-Books

Creation

Most of the books used today are printed on paper and bound. Similarly, the content of the book should be typed with the help of computer and saved as a file. The file is then uploaded to the internet. This uploaded file is called 'e-books'. These e-books will be added to the repository of the specified web address.

How to use?

When we want to read a particular e-book, the e-book from the internet is downloaded and stored in the computer. When the file is clicked to view it when needed, the file will be converted to active pages and appear on the specified computer screen.

5.3.2 Some e-Books

1. In the name of 'Madurai Project' Dr. K. Kalyana Sundaram and Dr. P. Kumar created some e-books on 1st Thai month, 1998.
2. Dr. T. Nedunchezhiyan, editor of Tamil Department, published C. P. Adithanar Karutharanga e-book in December 2005 at Centenary Special Seminar.

5.3.3 Types of Files of Tamil e-Texts

The files of Tamil e-texts are divided into the following three categories.

1. e-pub,
2. mobi,
3. pdf

1. e-Pub

Among these, e-pub is an open format which is zip format of html files. Its pages can shrink and expand to fit any screen size. This makes it suitable for reading on mobile phones, smart phones and board computers.

2. mobi

mobi is similar to e-pub. But it is not an open level file. It can only be read on Amazon's Kindle devices and softwares.

3. PDF

PDF is the most popular file type. But it is only suitable for computer reading as the page size is not resizable.

5.3.5 Applications of e-Books

* Text sections with multiple pages can be electronically edited and condensed into a portable form. It can be easily carried and used anywhere.
* Normal texts cannot contain more pages with colour photographs. This is due to the possibility of high cost. But, e-books can be published with a large number of colour photographs.
* Pages in e-books can be enlarged as needed. But ordinary texts cannot be used in this way.
* Anywhere in the world, at any time, the required parts can be easily searched and used with the help of search engines on the internet.
* The necessary e-books can be purchased and used through e-commerce.
* Printed books are likely to be out of print. But, e-books can be downloaded instantly whenever needed.
* Information in e-books can be used as documents for a long time. Printed books get damaged or decayed in

due course of time. But, the lifespan of e-books can be extended for a long time.

5.4. TAMIL SOFTWARE DEVELOPMENT

There are three basic technologies used for using Tamil on computer. They are

1. Keyboard
2. Encoding
3. Fonts

5.4.1 Keyboard

A keyboard is a peripheral device. It enables the user to enter text into a computer or any other electronic machine. The keyboard is the most basic way for the user to internet with a computer. It is one of the first technologies to use Tamil on computers.

5.4.2 Encoding

Determining which key to press and which letter should appear is encoding. It is the process of converting data into a format required for many information processing needs.

1. ASCII

To use a language in a computer, each character of the language must be assigned a numerical value. This method is called coding. In this way, English was created to be viewed on the computer. This called ASCII (American Standard Code for Information Interchange).

Similarly, ISCII (Indian Standard Code for Information Interchange) is a common coding system for all Indian languages. After this, TSCII Coding system came into effect.

2. TAM

Tamil Monolingual is a monolingual code developed for typing only Tamil characters.

3. TAB

Tamil Bilingual (TAM) is developed to use the same font for both Tamil and English languages.

4. Unicode

The universal code was created by the Unicode Consortium in 1991 when software development companies came together to set up a coding system needed to handle multiple languages at the same time.

5. TACE

A separate software was required to enter the consonants in Unicode Tamil encoding. To avoid this, Tamil All Character Encoding (TACE) was developed.

5.4.3 Fonts

Fonts are a collection of shapes that are all the same size and in a consistent order. A variety of free fonts are now available for exclusive use. It can be downloaded at *www.tamilvu.org/coresite/html/cwdownload.htm* at Tamil Internet Education Corporation. Similarly, *www.ilasundaram.blogspot.in* also provides 20 beautiful Unicode fonts for printing.

5.4.4 Tamil Typing Practice

1. Windows

There are many software available to type Tamil on computer in Windows XP, 7, 8 with Tamil 99 typing mode.

2. Mac

We can type Tamil through two types of keyboards: Tamil key 99 and Tamil Transliteration, which are provided by default on Mac platform, ipad, phone without interrupting software.

Apart from this, Indic Notes, Murasu Anjal, Ponmozhi text editors help for typing in Tamil on ipad, phone.

3. Android

Tamil 99 keyboard can be used on Android Smartphones and Tablet PCs with keyboards such as Sellinam by Murasu Mail, Ponmozhi by Learn Fun and Tamil key and type Tamil.

4. Linux

Linux Operating Systems have built in facilities for typing in Tamil. These include free software called IBUS (Intelligent Input Bus – IBUS).

5. Tamil Keyboard

Computer keyboards with Tamil 99 typing are available in the market. In this, instead of ; 'q w e r t y', the Tamil characters 'ஆ ஈ உஊ ஐ ஏ ஊ' are printed.

6. Floating Keyboard

Floating keyboards have also been created and are in use for people who do not know how to type to enter characters by pressing the keys on the computer screen with the mouse. It is also called virtual keyboard or online keyboard or web typing.

7. Tamil Online Keyboard

The keyboard which is added to the Bookmark in the Web Browser and typed through it is called online Web Browser Keyboard.

8. Google Input Tools

Google provides a service called Google Input Tools for online input in many languages. It also has a keyboard to input Tamil language in this way.

5.5 TAMIL INTERNET EDUCATION CORPORATION

The Tamil Internet University was incepted by the Government of Tamil Nadu on 17th February 2001 with the aim of bringing Tamil to the world through the internet. Currently operating under the name of Tamil Internet Education Corporation, this organization is implementing kindergarten education programs to provide Tamil language and Tamil culture, etc., to the people living around the world through the internet. The web address is *www.tamilvu.org/index.php*.

Through this scheme, many people were given financial support to develop various Tamil Softwares. The Tamil software developed under this scheme was intended with the objective of providing the Tamil software to the public on behalf of the government.

Tamil Software certification for TAB / TAM compatibility was given by the company and Tamil Computer Association.

5.5.1 Mission of Tamil Internet Education Corporation

The project has three stages of work plans. They are

i) E–Learning programs

ii) E–Library

iii) Development of Computerized Tamil

1. E–Learning Programs

Educational Certificates under this scheme are issued at three levels (Basic, Intermediate and Advanced). Apart from this, Tamil language Bachelor's Degree is also offered.

A Tamil Master's Degree is also offered through the Tamil University, Tanjore.

2. E–Library

This e-library contains rare books, nationalized books, Tamil Nadu Text Books and Institute of Educational workbooks, research papers, periodicals and journals.

3. Development of Computerized Tamil

The University is supervising the development and improvement of Computer Tamil through the following organizations.

(i) Tamil Software Development Fund

This is a grant given to an organization or individual who wants to develop new softwares in Tamil or improve the existing softwares.

(ii) Computer Tamil Council

The Computer Tamil Council is working with the objectives of enriching and strengthening the contributions of Tamil to the internet, encouraging the development of Computer Tamil and Tamil application software, imparting subjective training to students and creating apps.

5.5.2 Tamil Development Movement, Singapore

The Movement was launched in 2001 under the supervision of Singapore's Ministry of Information, with the aim of establishing Tamil as a living and functioning language in Singapore, uniting people of all ages through Tamil and with an intention of promoting Tamil.

5.5.3 Madurai Tamil Literary e-Synthesis Project

A voluntary Non-Government Project for digitization of all books in Tamil has been uploading all the books published in Tamil since 1998. Due to the selfless efforts of Tamils living all over the world, 600 videos have been uploaded to the internet so far.

Web address : *http://www.projectmadurai.org*

5.5.4 Tamil Wikipedia

Wikipedia is an open source repository. Anyone can write articles on wikipedia on any topic. Tamil Wikipedia is a very large encyclopedia containing over one lakh articles in Tamil.

Web address : *https://ta.wikipedia.org*

5.6 TAMIL DIGITAL LIBRARY (OR) TAMIL ELECTRONIC LIBRARY

Tamil e-library is a collection of Tamil digital materials such as e-books, magazines, audio recordings, video recordings and other electronically accessible documents.

Many e-libraries have been established with lakhs of e-libraries. They are doing the work of bringing many good Tamil books to thousands of Tamils who live in places where print books cannot reach through the internet.

5.6.1 Five Concepts of Electronic Library System

1. Digital

An electronic library contains not only text data but also audio, graphics and motion videos in digital data forms. Since all data are digitalized, different types of data can be easily combined and high-level retrieval and other processing can be done.

2. Networking

When these types of electronic libraries appear in multiple locations and are inter-connected through a network, a large virtual library is constructed over the network. It is a 'World Library'. It crosses national boundaries regardless of the distance between actual electronic libraries.

3. Interactive

Electronic library system provides latest functions. It also allows books to be displayed on screen like printed books. Computer makes progress in retrieving books and papers. This system helps the user to display multiple books on the same screen, passing on from a link describing the same idea in another book. It enables

he user to link unknown words, notes and tags at various levels in the book, translate the original text and output the text as voice data and refer to dictionaries and thesauruses at the same time.

4. Multimedia

A user of an electronic library system can use data in various formats such as text, sound, graphics and motion video. These multimedia data are much more comprehensible than conventional books containing only text, graphs and tables.

5. Measurable

In the electronic library system, the available hardware, software and data sources are used to create electronic libraries of varying sizes. An electronic library can be like a national library or as small as a personal library.

5.6.2 Advantages of Tamil e-Library

1. E-libraries are now a favourite sector of businesses and governments as they provide easy access to books, documents and various audio and visual information.
2. A limited amount of information can be stored in traditional libraries. As minimum space is enough to set up an e-library, it is possible to store much more information.
3. Texts, documents, sound and light notes can be easily accessed with simple inputs.
4. Even from wikipedia, blogs, etc., information can be obtained.

5. Digitalization enables multiple users to access the same information simultaneously.
6. An e-library user does not have to go there directly. Information can be accessed from any part of the world through internet connection.
7. It is great that users can use the digital library anytime day or night.
8. The same information can be received simultaneously by different parties.
9. Users can get the information they need from all the content by entering any word, name, title.
10. Images, sound, light information can be enhanced. By refining and storing the available information, it is possible to protect it from destruction.

5.6.3 Problems of Tamil e-library (or) Disadvantages

1. Technology is changing from time to time. Accordingly, e-library should also improve its technology.
2. Migration from stateless data, storage to a more stable system, programming language or operating system.
3. While migrating the data to a new operating system or programming language, data loss also occurs.
4. Data migration is becoming increasingly expensive as technology evolves. Thus, its security becomes very complicated.

5.6.4 Sites where e-libraries are Available

No.	E-Library Sites	Web Addresses
1.	Tamil Nadu State School Textbooks and Secondary Teacher Training Text books for classes 1 to 10	http://www.textbooksonline.tn.nic.in
2.	Tamil Nadu Internet University e-library (Formerly known as Tamil Nadu Internet University)	http://www.tamilvu.org/library/libindex.htm
3.	Connemara e-library	http://connemarapubliclibrarychennai.com /vettukku-oru-noolagam/index.htm
4.	Tamil Internet e-library	http://tamildigitallibrary.in
5.	Chennai Library	http://www.chennailibrary.com
6.	Thamizhagam	http://www.thamizhagam.net/parithi/parithi.htm
7.	Madurai Tamil Literature e-synthesis Project	http://www.projectmadurai.org/pmworld.htm
8.	Ancient books and manuscripts	http://www.thamilheritage.org/oldtext ebook/ebook.htm
9.	Library	http://www.noolaham.org/wiki/index.php
10.	Anna Centenary Library	http://www.annacentenarylibrary.org

5.7 ONLINE TAMIL DICTIONARIES

5.7.1 Dictionary - Definition

A book that compiles all the words in a language in alphabetical order and explains the meaning is called 'Agaramuthali'. It is also called a dictionary.

5.7.2 Glossary - Definition

Not only dictionaries for translating words but also different types of dictionaries are produced. These dictionaries can be used to retrieve and check the meanings of unknown words while reading. They can be used to find long and short words or related terms for a specific term, while also referencing books or documents that contain the words or documents.

5.7.3 Functions of Online Tamil Dictionaries

Online Tamil dictionaries like *dictionary.com* provide instant, direct access to a word's spelling and meaning through large databases. Further, it also provides a lot of supporting information, including its variant spellings, pronunciation, inflected forms, origin and derived forms and footnotes.

Advantages of Online Tamil Dictionaries

Online dictionaries can be used for a wide range of purposes and provide a lot of benefits to people. Some of them are

1. Free

Even if the price of a dictionary is not very high, it can create high cost when people buy dictionaries for different subjects. There are many dictionaries online. They are available free of cost. People don't have to pay even a single paise to use them.

2. Easy Access

The popularity of online dictionaries has grown high. People don't have to tirelessly flip through pages when they want to refer to a word. It is enough just to type in the search box and click search. Therefore, the efficiency offered by online dictionaries allows people to have free time to read additional materials.

3. Readable

Compared to print dictionaries, the font size of online dictionaries is much clearer. People don't have to strain their eyes when looking up a word in an online dictionary.

4. Multi-Functional

Print dictionaries have limited space. Hence, it is not possible to go into more details about each word. On the other hand, online dictionaries can provide a lot of information related to the word, i.e., the synonyms, antonyms, slang words and sentences. This information is found very useful.

5. As a Learning Tool

Online dictionaries remain a great tool for the people who have thirst for knowledge. This means that they are not used by people only to refer to the meanings of words but also for a higher level purpose. In fact, online dictionaries are used as a small tool for entertainment and also for gaining knowledge. They can be used for perfecting the style of writing and speaking and to know different words. Moreover, these dictionaries provide translation features too. The users can know the translation of words in different languages like Korean, Italian, Turkish, Chinese, English, German, Spanish, Japanese, etc., Translations are just a click away.

5.7.4 Uses of Dictionaries

1. Notes and Key Words

A reader sometimes writes part of the book in a notebook with comments or attaches tags at various stages in the book. An electronic library system enables the user to perform these functions automatically. The user can combine tags and enter one line notes for each tag. Obviously, the user can later navigate to such notes or tags by retrieving.

2. Translation

Electronic library system can be used to translate the original retrieved text from Japanese to English or vice versa.

3. Output of Speech

If the user is tired of reading the text output, the user can listen to the text output in the language of his choice. For example, function can be used to retrieve a book in a particular language and can be translated in English or any other language according to the requirement.

4. Other Supporting Reading Activities

The electronic library system has many supporting functions to facilitate reading. The following mentioned below introduce some reading support functions that may be of interest to the users.

(i) Jump Function

The user can jump to start the screen, table of contents or index without moving through the menus or activity history. Shortcut keys can be used to freely navigate to the desired screen.

(ii) Free Screen Setting

The user can freely set the screen size for easy reading. The system automatically performs word wrapping of the text.

(iii) Fonts Change

The user can change for example, the Japanese fonts to some other fonts.

(iv) Mail Function

If the user finds an interesting explanation while reading, the user can mail it.

(v) Saving User's Properties

Each user inherits various attributes. The user does not need to reset the properties for each session.

5.8 WORD CORPUS PLAN (SORKUVAI)

The 'Sorkuvai' (Word Corpus) plan is a project to collate all Tamil words, arrange them in alphabetical order, convert them into proper words, arrange them into meaningful words and try to preserve and develop the language.

Words are the basis of a language. Language can be preserved and improved by saving the words. As the words multiply, the language continues to grow. Certain words in the language are subjected to change from time to time. Some words become obsolete. Some words are newly formed. Compiling all these and publishing them in alphabetic form will be a creative task for development.

5.8.1 Objectives

Certain principles have been implemented as the primary objectives of Word Corpus (Sorkuvai) project. They are

1. Safeguarding the enrichment of words in Tamil language
2. Expanding the vocabulary of Tamil language.
3. Supporting to avoid the intrusion of foreign language in Tamil language.
4. The pride of Tamil language is its richness in words. The objective is to compile the entire vocabulary used in more than 600 academic fields and form their equivalent Tamil words and publish them in the public domain of the website.
5. The primary objective of the 'Sorkuvai' (Word Corpus) project is to collect all the words that have appeared in Tamil dictionaries so far, program them in such a way that the same word does not repeat and make vocabulary of Tamil known to the World.

5.8.2 The Functions of 'Sorkuvai' (Word Corpus)

The Akaramuthali Directorate is taking up the primary task of offering complete support for language development. It compiles all the words of the Tamil language and gives the meanings of the words in English and Tamil. In addition to that, it gives an explanation of the origin of the words. It also provides the developed etymological explanation. The Directorate has created and published in printed books Senthamizh Etymology Peragamuthali with Pictorial explanation of the rare words. It has been uploaded on to the internet also.

5.8.3 The Advantages of Sorkuvai (Word Corpus) Scheme

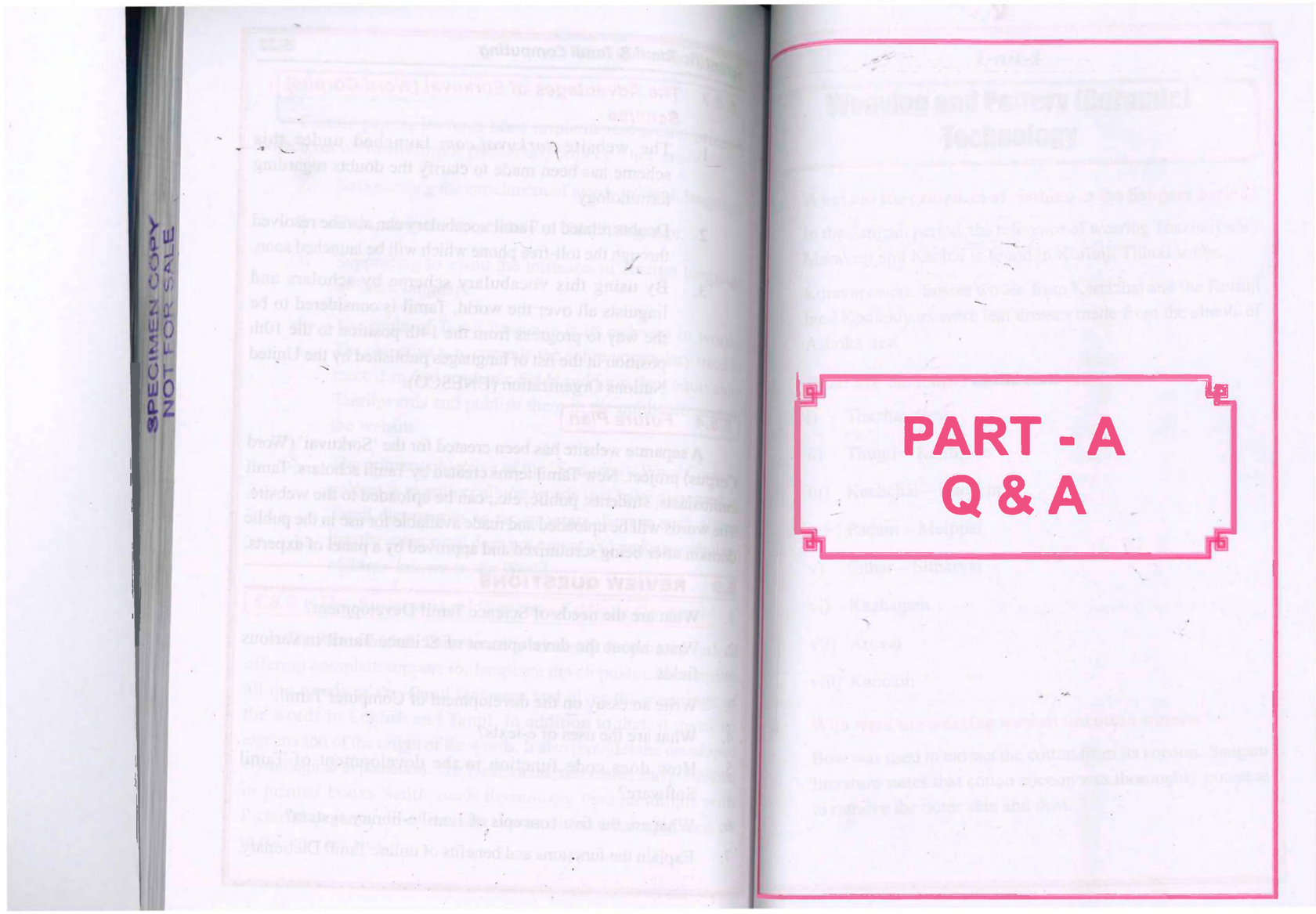
1. The website *sorkuvai.com* launched under this scheme has been made to clarify the doubts regarding terminology.
2. Doubts related to Tamil vocabulary can also be resolved through the toll-free phone which will be launched soon.
3. By using this vocabulary scheme by scholars and linguists all over the world, Tamil is considered to be the way to progress from the 14th position to the 10th position in the list of languages published by the United Nations Organization (UNESCO).

5.8.4 Future Plan

A separate website has been created for the 'Sorkuvai' (Word Corpus) project. New Tamil terms created by Tamil scholars, Tamil enthusiasts, students, public, etc., can be uploaded to the website. The words will be uploaded and made available for use in the public domain after being scrutinized and approved by a panel of experts.

5.9 REVIEW QUESTIONS

1. What are the needs of Science Tamil Development?
2. Write about the development of Science Tamil in various fields.
3. Write an essay on the development of Computer Tamil.
4. What are the uses of e-texts?
5. How does code function in the development of Tamil Software?
6. What are the five concepts of Tamil e-library system?
7. Explain the functions and benefits of online Tamil Dictionary.



The women who plucked the cotton and cleaned it by removing the nuts and seeds from it were called 'Cotton Women'. They were engaged in this work even at night with lanterns.

4. What are the types of fabrics?

i) Fine fabrics

ii) Beautiful high quality fabrics like snake skin.

iii) Coarse fabrics

iv) Silk clothes

5. What are professional tax and sales tax in textile industry?

Professional Tax

* The practice of taxing only the functioning 'Weaving looms' existed during the Sangam period. A Non-weaving loom was called 'Madi loom'. It was not taxed.
* For the Adai looms, only half the duty was indicated as tax.
* Some of the weavers had also paid common village tax. Taxes were imposed on the looms according to the country and town.
* Pulavar Rasu says that there was a 'Passage Tax' (Vasal Vari) for using the road for looms.

Sales Tax

They had gone to other places and sold the woven clothes. The tax paid for selling on streets was called 'Kulavari'.

In general, the weaving industry had been the most tax paying industry for the country, according to the lithographer Pulavar Rasu.

6. What substances are contained in clay soil?

The primary mineral found in clay is white clay or Kaolinite. In this, clay mineral, the following items are found.

i) 40% Aluminiam Oxide

ii) 46% Silicon Oxide

iii) 14% Water

7. Give the meaning of Kachai – Kachu (Girdle)

i) The chief son (lover) of Kurinji land was wearing an elaborate girdle called Kachu.

ii) The chief daughter of Kurinji land was wearing a dress called Kachai.

8. What is sculptural evidence? Give evidences.

Women wore sarees that hung down to their knees. The sculptures show that they used to wear various types of knots made of four–square pieces of cloth on their heads.

Some of the sculptures found at Amaravati and Jagkaiyapet, Andhra Nadu 200 BC – 100 AD show that men wore a turban, a pleated garment hanging down to the knee, a flower-worked girdle and a small stitched towel hanging from it.

9. How did spinning and weaving of cloth take place?

(i) Yarning Thread

Cotton was cleaned and ginned by hand and spun into cotton yarn. Women did the work. They had learnt the technology of manufacturing women's clothes and engaged in the industry.

(ii) Weaving Cloth

Widowed women, women separated from their husbands who had gone out for earning or who had gone out for war reasons took up weaving at home for their earning, Women engaged in such occupations were called 'Cotton Women'. The yarn made of cotton was called 'Panuval'.

10. What are the types of rotators (Thiruvai)?

There are two types of Thiruvais in Tamil Nadu. They are

i) Ball tipped rotator

ii) Cone - slot rotator

Unit-II

Design and Construction Technology

1. How was the design of the house during the Sangam period?

The residences referred to in the Sangam literature as 'Manai' were designed with the structures of 'Thinnai', 'Pillar', 'Attil', 'Murtam', 'Staircase', 'Window', 'Doorpost' and 'Madam'. These designs were featured during the development of residential architecture. It can be assumed that these might have been the residential structures of people of slightly higher economic status.

2. What are the common elements of architecture?

i) Kadaikal

ii) Bearing or Foundation

iii) Wall

iv) Vimanam (Tower) or Roof

3. What do you mean by male tree, female tree and eunuch tree?

Male trees should be selected to make door posts, pillars, balcony, etc., in the house.

Female trees were found suitable for uthiram, vittam, arch, porch and bearing beam.

Eunuch trees were used for beams, frames, handrails and fences.

4. What are the substances and their compounds discovered at Kizhadi excavations?

Sample of bricks, lime mortar, roof tiles and limestone casing well lining found at Kizhadi excavations were analyzed at Vellore University of Technology. It was confirmed that the presence of minerals such as silica sand, lime, iron, aluminium and magnesium was found in each of them.

Their combinations are given below.

i) Bricks and roof tiles : > 80% Silica

ii) As Binding Factor : > 7% lime

iii) Lime Mortar : > 97% lime

5. What are the other names given to Hero stones?

i) Vediappan Stone or Vediappan Temple

ii) Vedar

iii) Krishnarappan

iv) Meenarappan

v) Sanyasiappan

vi) Anjaneya Stone

vii) Sirameetan Temple

viii) Oomai Vethiappan

ix) Double Vediappan

x) Savumettu Vediappan

xi) Naththamettu Vediappan

6. What was the method of worshipping the Hero Stone during the Sangam period?

There was a custom of offering flowers and smoke to the Hero Stones every day. It was called Hero Stone worship. It is mentioned in books like Purunanooru, Silapathikaram, Malaipadukadam, etc., Stones are placed around the Hero Stone to make it a hoard. It is called 'Vallan Padukkai God'. They beat hand-drum, perform pooja with the liquor Thoppi and sacrifice animals.

7. What were the types of houseware designs during the Sangam period?

i) Aryakal (or) Enthiram

ii) Ural – Ulakkai

iii) Attukkal or Attural or Sekku

iv) Ammi

v) Oil Sekku

vi) Karumbalai

vii) Telescope

8. What are the stage structure mentioned in Silapathikaram?

i) Space for Arena

ii) Fetching bamboo

iii) Bamboo scale

iv) Cross beam board

v) Entrance to the arena

vi) Setting the entrance light

vii) Screens (Ezhinigal)

viii) Canopy and festoons

ix) Thalaikol

9. What are the cave temples in Mamallapuram?

i) Pulikugai

ii) Athiranasanda Pallaveshwara Kirugam

iii) Archuna Tapas

iv) Krishnan Mandapam

v) Panchapandava Chariots

vi) Ulaganeshwarar temple

vii) Mahishasuramarthini Cave

viii) Ramanuja Hall

ix) Varaha Mandapam

x) Ganesa Ratham

xi) Embossed Sculptures

xii) Beach Temple

10. What were the major Nayak Period Temples during the Sangam period?

i) Azhagar Temple, Andal Temple

ii) Natham Shiva temple

iii) Madurai Meenakshi Amman Temple

iv) Thiruvarangam Temple

v) Tanjore Nayak Temple

vi) Great Temple of Tanjore

vii) Tiruvarur Thiagarasar Temple.

11. Who built the towers of Madurai Meenakshi Amman Temple?

i) East Tower (Rajagopuram)

It was built between 1216 AD and 1238 AD by the later Pandyas.

ii) West Tower

It was constructed by Maravarman Kulasekara Pandyan in 1323 AD.

iii) South Tower

It was built by Viswanatha Nayak in 1559 AD.

iv) North Tower

History accounts that the construction was started by the King Muthuveerpa Nayak from 1564 to 1572 AD and completed by Vainakaram family in 1878 AD.

A one acre Portamarai Pond has been set up inside this temple.

12. What is Chettinad Architecture?

Built in the 18th, 19th and early 20th century, these Chettinad houses are world renowned for their architecture. There are also houses with 1000 windows. The Nagarathars used to hold

their family functions in their houses. Their houses are like big halls. Architects, experts and researchers from different countries are studying this architecture.

13. What are the five parts of the houses?

Chettinad houses are divided into five sections.

First Section : Reception

Second Section : Valavu (utilization section) consisting murtam and rooms.

Third Section : Dining Section (Irandankattu)

Fourth Section : Kitchen Section

Fifth Section : At the end is the garden.

14. What does Saracen mean?

Saracen is a term used in medieval Europe to refer to the Arabic–speaking Muslim people of the Middle East and North Africa. The Indo-Saracenic style dates back to 1795 with Western Paintings depicting Indian buildings.

15. What is Indo-Sarcenic Architecture?

Indo-Saracenic architecture was an architectural style used by the British architects in the late 19th Centrury to construct public and government buildings in the British Empire, particularly in the British India and in the princely states. This is Indo-Islamic architecture and particularly Mughal architecture. It was constructed in the British Indian classical style and Hindu temple architecture.

16. Designs of Sirtil and Perill - Explain.

(i) The Design of Sirtil

In the Tamil dictionary, the meaning of Sirtil is given as 'little house', 'small house', 'small mud house' built by girls for playing.

(ii) The Design of Peril

The Sangam literature refers to houses that were designed on a large scale. A large number of houses were in a dilapidated condition with decaying elements of habitable houses and damages caused by termites.

17. What do you mean by Kadaikal?

Kadaikkal is a hole dug in the earth at a particular place at a specific time. This is used for laying foundation.

18. What are rock-out temples?

Temples built on the top of big hills are called 'Kudaivarai Temples'. It is believed that the buildings were designed using wood, bamboo, straw, grass which did not last long.

19. What were the important building materials during the Sangam period?

(i) Wood, (ii) Flint, (iii) Suthai,

(iv) Bomboo, (v) Straw, (vi) Brick

20. Describe Hero Stones.

It is an ancient Tamil tradition to offer final tributes to the dead soldiers and worship after erecting stones. The stones erected in this way are called 'Nadukal' or 'Hero Stones'.

21. Ammi, Oil Sekku, Sugarcane factory - Explain.

(i) Ammi: Ammi is a device made of black stone. A black stone is also used as a cylindrical pestle to grind the material.

(ii) Oil Sekku: Oil sekku is a device used to press the sesame, ground nut and coconut oil.

(iii) Sugarcane Factory (Karumbalai): The place where sugarcane juice is squeezed is called sugarcane factory (Karumbalai).

22. What are embossed sculptures?

Emossed sculptures have a three dimensional structure even if we look at them from four sides. These sculptures appear to be attached to the wall and are self-contained outside.

23. What are the other names of goddess Meenakshiamman?

For Meenakshiamman, there are innumerable names like Maragatha Valli, Pachaidevi, Tadathagai, Abirama Valli, Karpoora Valli, Komagal, Sundaravalli, Pandipratti, Manikka Valli and Mathurapuri Thalaivi.

24. What are the salient features of Indo-Saracenic architecture?

All government offices, courts, railway stations and museums built in the 19th to 20th Centuries are based on Indo-Saracenic arthitecture. The high towers belong to Indian heritage. Domes belong to Islamic art. Beautiful floral carvings at the ends of the buildings and canopies with beautiful carvings deserve appreciation.

25. What are the types of Ezhinigal or Screens?

(i) One side pulling screen

(ii) Porumuga Ezhini

(iii) Karanthuvaral Ezhini

Unit-III

Manufacturing Technology

1. Who is Commier?

Tamils excelled in shipbuilding and sea voyages since ancient times. The experts in this department were called commiers. Tamils have made the sea a part of their lives. The sea and vessels are commonly used in Tamil literature.

2. What is Odham (Tide)? What are its types?

Knowing Odham (Tide) is one of the vessels steering techniques used by Tamils since the Sangam Period.

Tamils divided Odham (Tide) into two types

i) High Tide

ii) Low Tide

3. What are Munthurai and Perunthurai?

(i) Munthurai

Munthurai was a port on the outer side of the estuaries during the Sangam period. Ingurunooru verses of Sangam literature indicate that it refers to the outer part of the estuary.

(ii) Perunthurai

In estuaries, there is less current outside. Hence, the vessels are anchored there and the sails are rolled down. Then, the goods are unloaded. As the current is forceful in the estuary, the sails are rolled up and the vessels reach the inner part

of the estuary very fast. This is mentioned in the lines of Purananooru.

4. What is Metallurgy?

Metallurgy is a scientific field that studies the material science, engineering, physical, chemical properties, etc., of metals, intermetallic compounds and alloys.

5. What is beta bronze?

This type of bronze cast at high temperature is called 'beta bronze'. In metallurgy, the 'intermetallic compound' state between the two metals is known as the 'beta state'.

6. What do you mean by wood's steel?

Wood steel is cast steel made by mixing iron with organic materials (iron + charcoal + glass) and heating it for several hours at a temperature not less than 1400 degrees. This process is called Carbonisation.

7. What were the other items made in iron industry?

i) Gold ii) Egyptian weapons

iii) Copper iv) Bronze vessels

8. Explain the meaning of Chennakuzhi fire furnace.

Chennakuzhi is a combination of the word 'Chen' which refers to the colour characteristic of red or red fire and 'na' which refers to the flame of fire and place name 'kuzhi'.

9. What are the metals used for making coins?

Kings coined gold, silver, bronze, iron and copper to suit their economic status.

(vii) Malayaman coins

(viii) Punch coins

(ix) Coins of Mauriyas

(x) Coins of Indo-Greeks

(xi) Kushana type coins

(xii) Coins of the Guptas

18. What were the methods of coin making in the Sangam period?

The Sangam period coins were minted manually using hammers from pieces of metals such as gold, silver and copper.

The metals were placed in a die mounted on a solid surface. And where one coin is hammered a second coin is placed on the die and hammered on top of it.

19. What were the methods of coin making in Medieval times?

Making Medieval Coins

Medieval coin making was more advanced than Sangam coin making. It used metal pre-shaped circular discs and a screw press. This process produced coins of a more consistent quality than the Sangam coinage process.

20. What are the modern methods of coin making?

Modern coins are minted with hydraulic coin machines. They mechanically load the voids inside them. The machines can stamp 100 to 300 tons of coins in a short period of time.

21. Who are called Kuyinars?

During the Sangam period, the Kuyinars are seen as bead piercers, tailors and bead embroiderers. They are also known as Kuyirtunars in Sangam literature.

22. What are the products made using bone fragments?

(i) Flute (ii) Axe (iii) Ringing Beads

(iv) Garlands (v) Combs

23. Describe Conch beads.

The oldest known jewelry in the world consists of two perforated beads made from sea snail shells. These beads were found in Skul, Israel. Also, these have recently been dated to 1,00,000 to 1,35,000 years ago.

Unit-IV

Agriculture and Irrigation Technoiogy

1. What is a dam?

A dam is an obstruction that stops the flow of an estuary or a steam. Reservoirs created by dams not only suppress floods but also provide water for activities such as irrigation, human consumption, industrial use, aquaculture and maritime transport.

2. Explain lake and pond.

(i) **A lake** is a relatively large naturally occurring body of water. It is located in a basin completely surrounded by dry land. It helps to filter the incoming and outgoing steam. Lakes are generally larger and deeper than ponds. Most lakes receive water through creeks and rivers.

(ii) **A pond** is a small quiet land-based body of water, either naturally or artificially formed. A pond is smaller than a lake and there are no criteria to differentiate the two.

3. What do you mean by Thangals?

A succession of lakes is called series of lakes. The part that receives the rain water coming from the first lake is called 'Enthal'. The lakes behind bear the drained water from Enthal and other lakes. So they are called 'Thangals'.

4. What is a Sluice?

A Sluice is a gate established to divert water from ponds, lakes or culverts for irrigation of crops. Sluices have many

names. They are Sarungai, Puthavu, Mathagu (Sluice), Kumizhi, Thoombu, and Madai. During the Sangam period, they were made of wood or stone. These can be opened or closed manually.

5. Explain Neerodi and Serodi.

(i) Neerodi: A scientifically constructed system is a sluice. It is set up like a stone box to let out only the required amount of water. At the top of this stone box, there is a hole of half a foot diameter. The name for this hole is Neerodi. This hole is covered with a stone like a pipe.

(ii) Serodi: There are two or three small holes on the floor of the box. These are called Serodi.

6. How was the intellectual capacity of the Sangam people?

Many parts of Tamil Nadu receive rain for only two months a year due to the northeast monsoon. With that, the water requirement for the whole year has to be managed. Realizing this well, Sangam people used their knowledge to create thousands of lakes / ponds and collected and fully utilized the rain water of those two months. In order to use the collected water sparingly, they set up sluices and installed them in lakes / ponds.

7. What is meant by Kumizhithoombu? Write its significance.

A Kumizhithoombu is a scientifically designed system used to remove water and silt from a lake.

The Tamils have been managing irrigation water effectively by establishing a water management system called Kumizhithoombu in the big lakes of Tamil Nadu 2000 years ago. This Kumizhithoombu not only provided water for

irrigation, but also prevented the lakes from silting up and drying up.

8. What is the difference between sluice (Madagu) and a Kumizhi?

The sluices (Madagu) do the job of draining the water. Kumizhi in addition to expelling water, also removes sediments from lakes, ponds and sluices.

9. What are the characteristics of domestic animals?

i) The domestic animals should be useful to the breeder.

ii) They should be able to thrive in the company of a breeder.

iii) They should reproduce freely.

iv) They should be easily reared.

10. What are the types of land?

i) Hard field

ii) Soft field

iii) Punpulam

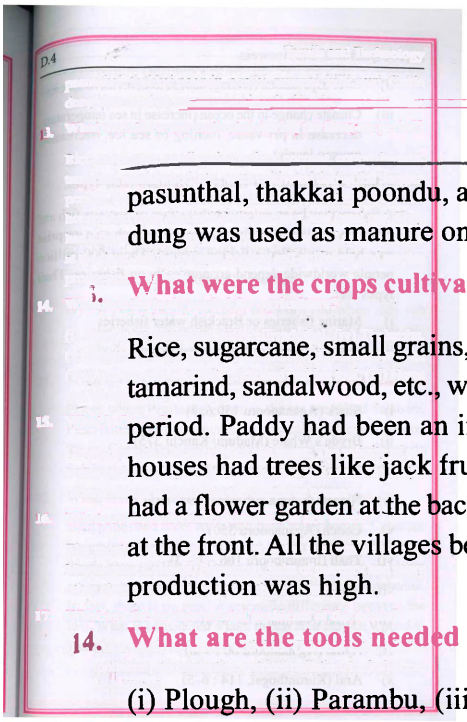
iv) Kalar Field (or) Salt Field (or) Purangadu.

11. How are the owners of the agricultural lands called?

i) Tiller ii) Vellalar iii) Karalar iv) Uzhathiyar

12. What are natural fertilizers?

Only natural fertilizers were used during the Sangam period. They used natural fertilizers before and after ploughing. Green manures are used even today. Fertilizer crops such as



pasunthal, thakkai poondu, agathi, sanapai, billi, auri. Cattle dung was used as manure on ploughed lands.

13. What were the crops cultivated during the Sangam period?

Rice, sugarcane, small grains, pulses, coconut, cotton, banana, tamarind, sandalwood, etc., were cultivated during the Sangam period. Paddy had been an important agricultural crop. The houses had trees like jack fruit, coconut, and betel nut. They had a flower garden at the back of the house and grew tamarind at the front. All the villages became self-sufficient and surplus production was high.

14. What are the tools needed for agriculture?

(i) Plough, (ii) Parambu, (iii) Palliyaduthal, (iv) Thalambu, (v) Sugarcane Squeezer, (vi) Loaders, (vii) Kavalaiyertam, (viii) Cranes, (ix) Catapult, (x) Sound making tool, (xi) Flares and blowers, (xii) Sickle, (xiii) Bags.

15. What is Ocean?

Ocean refers to a large body of salt water. The salinity of sea water varies widely. Less at the surface and near the mouths of large rivers and more in the depths of ocean.

16. What are the substances dissolved in sea water?

The most dissolved solid in sea water is sodium chloride. Magnesium, Calcium, Potassium, Salts of mercury and many other elements are dissolved in the sea water.

17. What are the environmental problems of the ocean?

i) As a result of human activities (Marine litter, plastic pollution, micro plastics, nutrient pollution, toxins) ocean is polluted.

ii) Over exploitation (fishing, habitat loss, invasive species).

iii) Climate change in the ocean (increase in sea temperature, decrease in pH value, melting of sea ice, decreasing oxygen levels).

18. What do you mean by fishery? Mention their types.

A fishery may be an enterprise that raises or harvests fish and other aquatic life. Usually, the site where such an enterprise was held was called a fishing ground. About 500 million people worldwide depend economically on fisheries. Their types are:

i) Marine fisheries or Brackish water fisheries

ii) Inland fisheries or Fresh water fishers

19. List the species of fish.

i) Shark (Agananooru 150:6, 7)

ii) Bryde's Whale (Madurai Kanchi 375)

iii) Prawn (Agananooru 60.1)

iv) Njendu (Sirupanartupadai 194–195)

v) Conch (Agananooru 350)

vi) Thali (Ingurunooru 106 – 1 – 3)

vii) Ippi (Nartinai 87 : 6–7)

viii) Ayirai (Nartinai 272 : 4–6)

ix) Ayilai (Agananooru 60 : 5–6)

x) Arai (Kurunthogai, 114 : 6–5)

xi) Kediru (Ingurunooru 160 : 3–5)

xii) Yamai (Agananooru 160 : 3–5)

20. What are the medical properties of pearl?

i) If the pearl is put in skimmed milk, it will float. If pearls are soaked in water and the water is drunk, the acidity in the stomach will be neutralized and intestinal diseases will be prevented.

ii) Pearl preserves smooth liver function.

iii) It has diabetes control properties.

iv) If pearls rich in calcium are worn and when they rub the body, the protein will be dissolved. As a result, the body heat will subside.

21. What do you mean by Salabam and Muthu Salabam?

Places where Pearls are grown in the sea are called Salabam. Pearl bathing or Pearl hunting is also called Muthu Salabam. Thus, Coral Bathing or Coral Hunting is called Pavala Salabam.

22. What is the difference between a pond and a lake?

Both ponds and lakes are inland fresh water bodies. Lakes are generally deeper than ponds and have a larger surface area. Ponds have smaller waves than lakes. Some ponds and lakes are easy to identify while others are difficult to determine. In fact, there is no precise scientific difference between the two. What is considered a lake in one area may be a pond in another.

23. Explain ice pond or ice well.

A snow lake is an artificial lake usually located on the top of a mountain. It is generally designed for providing water for livestock. Ice ponds are used in areas where a natural supply of surface water is not readily available. There are evidences that these ice ponds were used for cattle during the Sangam period.

24. Explain crop rotation system or what is called intercropping?

Crop rotation was followed in the Sangam period itself. For example, cotton and small grains were grown in the same season. After that, broad beans were cultivated. Small grains were cultivated in the Kurinji lands. Kosala country farmers cultivated paddy. At the same time, they cultivated various crops.

25. What are the other names given to the ploughing tools?

(i) Aerai (ii) Meli (iii) Nanjail (iv) Kalappai

26. Who is a Valaigner (net caster)?

Today we call those who go to sea and do fishing as 'Fishermen'. They have been referred to as 'Valaigner' during the Sangam period. 'Valaigner' means one who fishes with a net.

27. How long do pearls take to grow?

Pearls take 5–6 years to form in good water.

Perls take 5–20 years to form in salt water.

A shell produces a total of 60 pearls in its life time.

28. What are the classifications of ocean basins (Padugal)?

(i) Pacific ocean

(ii) Atlantic ocean

(iii) Artic ocean

(iv) Mediterranean sea, Gulf of Mexico and South China sea.

29. What are the substances that affect the colour of the sea?

Dissolved organic matter, Phyto-Plankton living with Chlorophyll pigments and non-living particles such as sea ice and mineral deposits affect the colour of the ocean.

30. What is knowledge? What are its types?

Facts, information, interpretations acquired through experience or education or knowing about something or practical understanding is knowledge.

Types of Knowledge

(i) Situational Awareness

(ii) Natural Knowledge

(iii) Academic Knowledge

(iv) Knowledge to know the Truth

31. What are the functions of Knowledge Society?

(i) A knowledge society makes knowledge available to all members that can be used to improve the human condition.

(ii) A knowledge society helps transform information into resources that allow a society to take action effectively.

32. What are UNESCO's Principles for Knowledge Society?

(i) Cultural diversity

(ii) Equal access to education

(iii) Universal access to information

(iv) Freedom of expression

Unit-V

Science Tamil and Computer Tamil

1. What are the file types of Tamil e-books?

The files of Tamil e-texts are divided into three categories and used accordingly. They are

i) e-pub

ii) mobi

iii) pdf

2. Write any two advantages of e-books.

1. Anywhere in the world, at any time, we can easily search and use the required parts with the help of search engines on the internet.

2. The necessary e-books can be purchased and used through e-commerce.

3. What is a keyboard? What is it used for?

A keyboard is a peripheral device. It enables the user to enter the text into a computer or any other electronic machine.

4. What is the function of encoding?

Determining which key to press and which letter should appear is encoding. It is the multiple information processing of converting data into the format which are essential for the requirements.

5. What is bilingual code?

Bilingual code is developed to use the same fonts for both Tamil and English languages.

6. What is Unicode?

The universal code was created by the Unicode Consortium in 1991. The software development companies came together to set up a coding system needed to handle multiple languages at the same time.

7. What are the three levels of the Tamil Internet Education Corporation?

i) E-learning programs

ii) E-library

iii) Development of computerized Tamil

8. Define dictionary.

A book that compiles all the words in a language in alphabetical order and explains the meanings is called Agaramuthali. It is also called a dictionary.

9. What is Sorkuvai (Word Corpus) Project?

The Sorkuvai (Word Corpus) Project is a project to collate all Tamil words, alphabetize them, convert them into proper words, arrange them into meaningful words and try to preserve and develop the language.

10. State three objectives of Sorkuvai Project.

i) Conservation of vocabulary in Tamil language.

ii) Enlarging the vocabulary of Tamil language.

iii) Helping to avoid foreign language intrusion in Tamil language.

11. What are the functions of Science Tamil magazines?

The Science Tamil magazines enable the readers to a different way of thinking. They help us to explore things in different dimensions and in different contexts. They help to develop understanding of the Tamil Community. They support us to develop the department related matters neglected by the English world. They help to make science, technology, medicine and the information related to that available Tamil language.

12. What are the five concepts of electronic library system?

(i) Digital (ii) Network (iii) Interactive

(iv) Multimedia (v) Measurable

13. Write any two advantages of Tamil e-library.

(i) E-libraries are now a favourite sector of businesses and governments as they provide easy access to books, documents and various audio and visual information.

(ii) A limited amount of information can be stored in traditional libraries. As minimum space is enough to set up an e-library, it is possible to store much more information.

14. Write any two disadvantages or problems of Tamil e-library.

(i) Technology is changing from time to time. Accordingly, e-library should also improve its technology.

(ii) Migration from stateless data, storage to a more stable system, programming language or operating system.

15. Write any two uses of Sorkuvai (Word Corpus) scheme.

(i) The website *sorkuvai.com* launched under this scheme has been made to clarify the doubts regarding terminology.

(ii) Doubts related to Tamil vocabulary can also be resolved through the toll-free phone which will be launched soon.

MODEL QUESTION PAPER - 1
GE3252 – TAMILS AND TECHNOLOGY

Time : 3 Hrs. *II- Semester* *Max : 100 Marks*

Part – A **(10 x 2 = 20 marks)**

Answer all Questions.

1. Who were called 'Paruthi Pendir' (Cotton Women)?
2. How does spinning and weaving of cloth take place?
3. What is Hero Stone? Write any four names given to Hero Stone.
4. What Indo-Saracenic architecture?
5. Explain the meaning of Chennakuzhi furnace.
6. What is beta bronze?
7. What do you mean by Neerodi and Serodi?
8. Explain Thangalgal.
9. Write any two advantages of e-books.
10. Explain Unicode.

Part – B **(5 x 16 = 80 marks)**

Answer Question No.11 compulsorily.

11. How was the weaving industry during the Sangam period? Explain.
12. (a) Explain the design and uses of parts of the house during the Sangam period.

    (or)

    (b) Describe the structure of Hero Stones.
13. (a) Explain the extraction of iron in iron factory.

    (or)

    (b) Explain the process of printing coins.
14. (a) Explain with proof and picture how Kumizhithoombu works.

    (or)

    (b) Explain the tools required for agriculture.
15. (a) Write an essay on the development Computer Tamil.

    (or)

    (b) What are the five concepts of Tamil e-library system?

MODEL QUESTION PAPER - 2
GE3252 – TAMILS AND TECHNOLOGY

Time : 3 Hrs. *II- Semester* *Max : 100 Marks*

Part – A **(10 x 2 = 20 marks)**

Answer all Questions.

1. Who were called 'Paruthi Pendir' (Cotton Women)?
2. Mention the sculptural evidence of clothing during the Sangam period. Give examples.
3. What are the materials and compounds found during Kizhadi excavations?
4. Write a note on the architecture of Chettinar.
5. Explain conch beads.
6. What is called Odham (Tide)? What are its types?
7. Mention the substances that affect the colour of the sea.
8. Define sluice (madhagu).
9. What is keyboard? What is it used for?
10. Explain 'Sorkuvai Project' (Word Corpus).

Part – B **(5 x 16 = 80 marks)**

Answer Question No.11 compulsorily.

11. Explain the features of nanotechnology in black red pottery.
12. (a) Explain the architecture of Pallavar period.

    (or)

    (b) Describe the major Nayak period temples.
13. (a) Write the method of making stone beads and glass beads with proofs.

    (or)

    (b) Explain (i) Flint beads, (ii) Conch beads and (iii) Bone fragments.
14. (a) Describe lake and pond.

    (or)

    (b) Explain the process of pearl hunting or pearl bathing.
15. (a) Write about the development of Science Tamil in various fields.

    (or)

    (b) Explain the functioning and uses of online Tamil dictionaries.

துணைநூற்பட்டியல் (Bibliography)

1. தமிழக வரலாறு - மக்களும் பண்பாடும் - கே.கே.பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்)
2. கணினித் தமிழ் - முனைவர் இல.சுந்தரம் (விகடன் பிரசுரம்)
3. கீழடி - வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை - ஆற்றங்கரை நாகரிகம் (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies).
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

13. திருமலை நாயக்கர் அரண்மனை - தமிழ் விக்கிப்பீடியா
14. திருமலை நாயக்கர் - தமிழ் விக்கிப்பீடியா
15. மாமல்லபுரம் புடைப்புச் சிற்பங்கள் - தமிழ் விக்கிப்பீடியா
16. www.pothunalam.com
17. https://en.m.wikipedia.org
18. https://ta.m.wikipedia.org/wiki/நடுக்கல்
19. https://en.wikipedia.org/wiki/acc
20. https://athiyamanteam.com/
21. https://www.britannica.com/construction
22. www.tnarch.gov.in
23. https://en.m.wikipedia.org
24. https://www.keetru.com/index.php
25. மட்பாண்டம் - தமிழ் விக்கிப்பீடியா
26. https://www.tamilvu.org/coresite/html/cwincubation.htm
27. www.irjtsjournal.org
28. https://en.m.wikipediaorg/wiki
29. https://www.wikiwand.com/black
30. பணடைத தமிழகத்தின் சமயம் - தமிழ் விக்கிப்பீடியா
31. Maritime trade of ancient Kalinga - Dr.Prafulla Chandra Mohanty, Orissa review, Nov.2011
32. https://ta.wikipedia.org/w/index.php
33. www.tagavalaatruppadai.in
34. www.tamilvu.org (https://www.tamilvu.org)
35. www.sorkuvai.com

36. https://ta.m.wikipedia.org/wiki/எண்ணிம_நூலகம்#
37. மண்பாண்டம் - தமிழ் விக்கிப்பீடியா
38. https://www.madehow.com/volume-4/pottery.html
39. www,tnarch.gov.in
40. கருப்பு மற்றும் சிவப்பு மட்பாண்டப் பண்பாடு - தமிழ் விக்கிப்பீடியா
41. https://www.maduraimeenakshi.org
42. செட்டிநாட்டு வீடுகள் - தமிழ் விக்கிப்பீடியா
43. https://www.vikatan.com
44. சங்ககாலம் 2001 தொல்பொருள் ஆய்வகம், காமாட்சி, தமிழ்பல்கலைக்கழகம்.
45. எல்.பி., சங்க நூல்களில் மணிகள், சாயி, உலகத் தமிழாராய்ச்சி நிறுவனம், சென்னை (1980)
46. https://openthemagazine.com
47. Keezhadi excavation site - wikipedia
48. Keezhadi - Wikipedia
49. நாணயங்கள் - டாக்டர் பரமேஸ்வரி லால்குப்தா, நேஷனல் புக் டிரஸ்ட், புது டில்லி, 1975, பக்கம் 13-14.
50. Ancient wisdom - irrigation Tanks - S.M.Ratnavel and P.Gomathinayagam.
51. நாணயங்கள் - தமிழ் விக்கிப்பீடியா.