MENSURATION IN ANCIENT INDIA
“In all those transactions which relate to worldly, Vedic or (other) similarly religious affairs, calculation is of use”. (1:9)

“What is the good of saying much in vain? Whatever there is in all the three worlds, which are possessed of moving and non-moving things—all that indeed cannot exist as apart from measurement”. (1:16)

—Mahāvīra’s Gaṇitasāra-sangraha
Foreword

THE interesting human experience of using the materials of the world requires measuring length, area, volumes, weights etc. This need was satisfied by all cultural groups in a variety of ways in which fingers, hands, body length, weights of grains, etc., were used.

This activity, developed systems of mensurations over the whole world and they were used to measure the objects and form standardised patterns of human behaviour for transactions of trade, commerce, division of property, paying for labour, measuring time, etc., in different times and areas.

In India also, this effort of standardization of mensurations has a long history. In this effort many experiments were made and many systems were developed. Mrs. Srinivasan has taken great care in analysing these systems of measuring length, area, volume, weight and time by the study of written and archaeological data. Besides, she has compared the local practices that were existing till recently and some that continue to exist.

Besides, the comparison of the mensurations of different countries, she has given a succinct account of the common elements of this branch of human activity.

Her work, therefore, fulfils a long standing requirement in this field. It will be an useful work for archaeologists and historians and also will provide an extremely interesting reading to the general reader.

Department of Ancient Indian History, Culture and Archaeology
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BARODA.

—R. N. Mehta
Preface

IN recent years a good number of monographs have come up on the economic history of ancient India, but no work has so far been published on an important aspect of this economic history, namely the weights and measures of ancient India. This work aims in filling that need.

In a large number of works in ancient India on political science, mathematics and astronomy, certain aspects of weights and measures have been described. The present work deals with gathering of all those materials along with the references in epigraphs and correlate them with the weights and measures mentioned in the literature of the other civilizations relating to that period.

I am deeply indebted to Dr. R.N. Mehta, Head, Department of Archaeology, Maharaja Sayajirao University, Baroda, whose encouragement and inspiring guidance made it possible to plan and complete this work. I would like to record my humble gratitude to him for the interest he took in guiding me through.

I offer my thanks to the artists of the department of Archaeology, M. S. University of Baroda, for preparing the charts and photographs.

Numerous scholars have contributed directly or indirectly on this subject and I have drawn extensively from their works. I express my thanks to all those scholars, whom I have quoted in this study.

I am thankful to Mr. S. Balwant, proprietor, Ajanta Books International for having taken a personal interest in printing and publishing this book.

10-11-78

—Saradha Srinivasan
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## Abbreviations

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<tr>
<td>AGAS</td>
<td>Andhra Pradesh Government Archaeological Series</td>
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<tr>
<td>BSOAC</td>
<td>Bulletin of the School of Oriental and African Studies</td>
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<td>CBI</td>
<td>Corpus of Bengal Inscriptions</td>
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<td>CH</td>
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<td>EC</td>
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<td>Hyderabad Archaeological Series</td>
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<td>IHQ</td>
<td>Indian Historical Quarterly</td>
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<td>JASB</td>
<td>Journal of the Asiatic Society of Bengal</td>
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<td>JAHRS</td>
<td>Journal of the Andhra Historical Research Society</td>
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<td>JBBRAS</td>
<td>Journal of the Bombay Branch of Royal Asiatic Society</td>
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<tr>
<td>JBRBS</td>
<td>Journal of the Bihar Research Society</td>
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<td>JIH</td>
<td>Journal of Indian History</td>
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<td>JMSUB</td>
<td>Journal of the Maharaja Sayajirao University of Baroda</td>
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<td>JNSI</td>
<td>Journal of the Numismatic Society of India</td>
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<td>JOIB</td>
<td>Journal of the Oriental Institute, Baroda</td>
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<td>JRAS</td>
<td>Journal of the Royal Asiatic Society</td>
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<td>JTSML</td>
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Introduction

A STUDY of the evolution of measures and weights in any civilization constitutes one of the important parameters for assessing and understanding its growth. For example, even today the ancient Egypt is remembered for its contributions to astronomy, while ancient Greek and Roman civilizations are remembered, for setting the foundations of modern mathematical standards and for the development of currency as means for transacting trade and business. The very evolution of economic history of a civilization gets intimately linked with the growth of its weights, measures and coinage.

For the primitive man and even animals, the earliest concepts relating to measurements would be in relation to distances and sizes of objects, which would serve to help him in his day-to-day activities. A monkey will have to understand the distance to jump across and also will have to have the concept of the size of other animals to decide to fight or flee. Thus this basic need, as the knowledge of man increased, led to the ideas on linear measurements, weight, volume, etc.

Similarly, with the needs of lifting materials such as carrying food or prey, lifting of materials for building shelter or carrying firewood, etc., ideas about relative weights of objects must have evolved, which further would have led to standardized weights and measures for promotion of trade and
business transactions. This should have progressed to the
designing of more and more sophisticated instruments for
weighing such as balances, scales and weights. The older
methods of barter system for trade transactions proved to be
cumbersome and difficult, particularly, while dealing with
heavy objects and products that can decay. This naturally,
led to the development of coinage system, which has now
become the backbone of all economic activities. The study of
the extent to which these systems evolved due to internal
capabilities and the extent of outside influences on these
systems can go a long way to understand not only the growth
of the civilization of a nation, but also can contribute to assess
the impact of its international relationships through the ages.

In India, even though many studies have been made in
relation to currency in ancient India, no serious study appears
to have been made to trace the evolution of measures and
weights. It was, therefore, considered worthwhile to critically
examine the old literature and epigraphical references, with a
view to trace the evolution of concepts of measures and
weights in ancient India and also to compare these develop-
ments along with the contemporary developments in other
known ancient civilizations.

A brief examination of this subject relating to western
India, through the period 7th century A.D. to early 14th
century A.D., formed a small part of Ph.D. thesis presented
by the author to the M.S. University of Baroda.

Even though, that study was restricted to a small part of
India over a limited period, it revealed the fact, that different
regions in India had different types of units of measures and
weights, and that they also differed from period to period
linked with changing dynasties, rather than to a standardized
commercial system. This variety and fluctuations noticed in
this earlier study, led to the belief that the concept of measures
and weights in India had many differences and variations in
different parts of the country at different periods. All the same,
there had been a flourishing trade existing within the country
and also with traders from abroad. Such commercial contacts,
should have brought about certain common features in the
concepts of measures and weights in the country as a whole,
which are examined here. To a large extent this evolution appears to be linked with the growth of mathematics as a discipline. The great contributions made in the field of astronomy in ancient India also indicate the advances made in India in terms of measurements of time, stellar movements, distances between planets, their movements, etc.

In India, just as in all other phases of activities, even in relation to measures and weights, there appears to have existed an undercurrent of unity in diversity. This aspect also has been considered in this work.

A brief account relating to the study on measures and weights in ancient India will be relevant to understand the scope of this work.

Measures and weights have an older history than that of currency. Excavations at the Indus valley have disclosed various types of weights current in India, during the 3rd millennium B.C. The term pramāṇa meaning measure was classified into four types namely, māna (measure of capacity) tulā māna (measure by weight), avamāna (linear measurement) and kāla pramāṇa (measurement of time). Vedic measures were simple, meeting the needs of day-to-day-life. For linear measurements, different parts of human body were regarded as units. A man's stride was known as prakrama. By the same way, for the measure of capacity prasṛṭī, meaning a handful, was used. Similarly aḷḷaḷa meaning two hands joined together which was double of prasṛṭī was also in common use.

Later on these simple practical units were further developed. Sulva sūtra portion of Dharmasūtras refers to a variety of linear and area measurements.

Kauṭilya describes several kinds of balances, thereby showing the appreciation for the need of accuracy in weighing even in early times. Several tables were used for measuring gold, silver and other articles. For the sake of convenience, cubic measures were also used for measuring out grains. Manu, Yājñavalkya and later on Vijñāneśwara followed almost the same systems of Kauṭilya, with slight variations.

Astronomical and astrological books, which were abundant in ancient India, furnish tables for measurements of space and time. Aryabhaṭa I (born in 476 A.D.) in his Āryabhaṭīya, has
allotted a chapter on mensuration called \textit{ga\-\text{n}ita p\text{\=a}da}. Var\={\=a}hamihira refers to mensuration in his \textit{Brhatsa\=m\=hita}. There is a similar chapter in \textit{Brahmasphutasiddh\=anta} (628 A.D.) of Brahmagupta. While commenting on it, Pruthudakas\=ava\=min (860 A.D.) added mathematical details to the original. The greatest luminary Bh\=\={\=a}skar\=ac\=arya refers to \textit{P\=at\=igan\=ita} in \textit{Siddh\=anta \=Sirom\=ani} (1150 A.D.). In his astrological work \textit{Karanakui\=uhala} various terms relating to time occur. Jains did not lag behind in astronomical and astrological works. \textit{Bhagavatis\=utra} (5th arya) and \textit{Uttar\=\={\=a}\=hyayanas\=utra} inform us that knowledge of s\=ankhyana (arithmetic) and jyoti\=sa are two of the essential accomplishments of a Jaina saint. These subjects formed a part of his training. The most important sources for Indian weights and measures are the works on mathematics. \textit{P\=at\=igan\=ita} is the name given to that branch of Indian mathematics which deals with arithmetic and mensuration. Lalla (8th century A.D.) wrote the work \textit{P\=at\=igan\=ita}. Mah\=\={\=a}v\=ra\=s \textit{Ga\=n\=itas\=arasangr\=aha} is an important treatise on mathematics. \textit{P\=at\=igan\=ita} of \=Sr\=irdhar\=ac\=arya was written somewhere between 850 A.D. and 950 A.D.

The author of another \textit{P\=at\=igan\=ita} is An\=\={\=a}ntap\=ala, brother of Dhanap\=ala (12th century A.D.). \textit{Ga\=n\=itatilaka} or \textit{P\=at\=igan\=ita} of \=Sr\=ipati is another important mathematical work of 11th century A.D. Bh\=\={\=a}skar\=ac\=arya's \textit{Lil\=avati} has a table for measures and weights which was adopted in that work. These must have been current in his time. Many mathematicians have exerted themselves in commenting upon \textit{Lil\=avati}. It was even translated into Persian by Fayzi under Akbar. In Takhura Ph\=eu\=r\=u's \textit{Ga\=n\=itas\=ara\=kaumud\=i} and \textit{Dravyapar\=ik\=\=a}, written in Prakrit, it refers to weights, measures and coinage. Besides these, there are certain Kannada works on mathematics and astrology. \=Sr\=irdhar\=ac\=arya (1049 A.D.) had composed in Kannada \textit{\=J\=atakatilaka}. R\=\={\=a}j\=\=aditya (1120 A.D.) was the author of six works namely (1) \textit{Vyavah\=ara ga\=n\=ita} (in mixed prose and poetry) (2) \textit{K\=\v{e}t\=ra ga\=n\=ita} (in poetry), (3) \textit{Vyavah\=ara ratna}, (4) \textit{Lil\=avati} (5) \textit{Jaina ga\=n\=ita sutrod\=ahara\=na} and (6) \textit{Citrah\=asuge}.

In the Gujarati commentary on \textit{Ga\=n\=itas\=ara} of \=Sr\=irdhara, along with the measures and weights given in the mathematical works, local weights and measures used in day-to-day
transactions are also given.

The medical books like Caraka samhita, Suśrutā samhitā and Sārangadhara samhitā refer to many cubic measures. Tables regarding linear measurements occur in Samarāṅgaṇa-sūtradhāra, Aparājitapṛccha, Viśwakarmā, Vāstuśāstram and Mayamatam. In these works, the different types of angulas and their usages are explained.

In addition to these, the renowned fragmentary Bakṣali manuscript, written in Prakrit on birchbark in the Sarda script, discovered in 1881 A.D., furnishes interesting data about weights, measures and currency of ancient India. There are other manuscripts regarding astronomy, astrology and mathematics which have not yet been published. These may furnish many interesting data. There are some scattered references to weights and measures in the inscriptions also.

The very fact, that falsification of weights and measures was considered as a cognizable offence by the Dharmasastras, clearly indicates the existence of a well-controlled system for the maintenance of standards relating to weights and measures in ancient times. In addition to these, the examination of Dravidian literature and the literature of Bengal also lead to interesting information, which also is included in this work.

The various literary and epigraphic data relating to measures and weights in India through different ages and in different parts are presented in this treatise with a view to examine the evolution of the concepts relating to measures and weights and also to see to what extent an undercurrent of linkage and unity existed in all these in the wide diversity that was apparent.
Linear Measures of Ancient India

QUITE early in history, man took to measuring various things. Of the various types of measures, the linear measures had an earlier origin, because man would require to cut sticks of required sizes, or chop fruits or meat of required lengths, etc. For such purposes, he could use the parts of his own body as the standards, for that would measure the length which is always a distance between two points. Length could be defined by some natural or artificial standards or as multiples of those standards. A close look at the early linear measurements indicates, that the units of linear measurements used, were mainly derived from the parts of the human body all over the world. The finger, the palm or hand-breadth, the foot and the cubit were the principal measures. These natural units, eventhough had their limited uses to meet the needs of the ancient man, suffered from lack of standardized accuracy required for settling disputes or manufacturing standardized materials or parts thereof. The variations of human body are obvious and therefore for standardization at a later stage the body measurements of some particular person, were considered as the units of measuring in a particular area, so that the measurements at least in that area can become more standardized. Often these standards based upon the measurements of a person (a ruler, or the headman or the deity in the
local temple) were a matter of sentiment, but once accepted they helped to meet local exigencies and served the limited purpose for which they were created.

In view of the great variations in the actual values of these natural measures and also in view of the increasing interest in precise astronomical and geodetic measurements, as the civilizations progressed, more precise standardization of the linear measurements became necessary. Prototype-physical standards appear to have been devised and placed in temples or other places, where they could remain secure and be used as standard references.

The use of standardized measuring rods, scales and reeds appear to have been in vogue in India and other parts of the world from very ancient period. The oldest reference to the use of measuring rod for measuring or surveying a field in ancient India is seen in Rg Veda.1 The finding of a slip of measuring scale made of shell from Mohenjo Daro2, an ivory scale from Lothal3, a fragmentary rod at Harappa4 and another from Kālibangan5, assert the use of measuring scales in ancient India. Similarly, graduated scales can be seen from the Sankereh tablets of Babylon (2500 B.C.)6 and also from the ruins of the ancient city of Lagash or Lagas.7 Ezekiel (600 B.C.), who wrote in Babylon, mentions the measuring of the tabernacle with reeds.8 The Egyptians attempted to delineate the property lines, obliterated by the repeated floodings of the river Nile, through their Nilometer.9 These clearly indicate that through ages man had attempted to improve his methods of measurements.

In this review, the linear measurements in use in ancient India, are examined and are compared with the corresponding measures, known to be in use in the corresponding period in other old civilizations in the world, with a view to compare the standards of measurements.

In ancient India, though the units were initially based on natural physical standards, they admitted by general consent many practical and imaginary dimensions also.

Moreover at different places, at the same time and at different periods in the same region, the units appeared to vary a great deal. The smallest unit of linear measure was
considered to be a paramāṇu (atom). Of the other measures, trasareṇu, vālāgra, likṣa, yūkā and yava each succeeding in eight times the previous one (octonari system) are also known. Except yava, all the other measures seem to be of very minute analysis, probably of little value for any practical purpose. Such impractical measures were reported elsewhere also and continued over a long period. For example the Babylonians started with the breadth of a line. Abul Fazl defines the digit in terms of barley corns and the barley corns in terms of the hair, from the mane of a Turkish horse.\footnote{11}

Aṅgula (finger-breadth or digit) can be considered as the smallest practical linear-measure in ancient India. This is the basic unit and all other linear-measure units depend on this. Hence this review is begun with the concepts relating to aṅgula (or the digit) and its equivalents in different systems. A definite standard measure can be considered from aṅgula, which is the length of the middle finger of an adult man having a height of at least six feet, \textit{i.e.} a man of full height.\footnote{12} It had a length of approximately three-fourths of the modern inch (1.9 cms).

According to Śulva texts, an aṅgula is a unit of measurement equal to 14 grains of anu plant (\textit{Panicum miliaceum}) or 34 sesame seeds\footnote{13}, while according to Hindu\footnote{14} and Jaina literature\footnote{15}, 64 sesame seeds or 8 yava (barley corn) constitute an aṅgula. Buddhist literature\footnote{16}, however, refer to an aṅgula of 7 yava or 49 sesame seeds.

Based on these varying equations of length of an aṅgula with the size of grains and seeds, different systems have advocated varied equations, as discussed below.

Jaina canons mention three types of aṅgulas; utsedhāṅgula or sūcyāṅgula (needle-like finger), pratarāṅgula (plane finger) and ghanāṅgula (solid finger), \textit{i.e.}, the units of linear, area and solid measure respectively (linear, square and cubic measure). Sūcyāṅgula is linear and single dimensional. The product of sūcyāṅgula by itself, gives pratarāṅgula and this when again multiplied by sūcyāṅgula gives ghanāṅgula. Tiloyoponnatti\footnote{15}, refers to a pramanāṅgula which is equal to 500 sūcyāṅgula or vyavahārāṅgula. This seems to be a measuring rod, or such other device of about 500 aṅgulas long.
Mediaeval texts on architecture like Bhoja's *Samarāṅgaṇa-sūtradhāra* and Bhuvanadeva's *Aparājitopchha* mention three other types of *aṅgulas*, namely *jyeṣṭha* measuring 8 *yavas*, *madhyama* measuring 7 *yavas* and *kaniṣṭha* measuring 6 *yavas*. *Jyeṣṭha* was used in measuring cities, villages, lakes, etc., *madhyama* for measuring temples, palaces, houses, etc., and *kaniṣṭha* for measuring furniture, carriages implements, etc. *Mātrāṅgula* referred to in *Viśwakarma Vāstuśāstram* and *Mayamatam* was the length of the middle parva or mark of the middle finger or the thumb of the owner or sthapati. *Dehalabdāṅgula* is calculated on the basis of the statue of the principal deity. In *Viśwakarma Vāstuśāstram*, 3 *vṛihis* (paddy) are considered as an *aṅgula*. Śukra considers 5 *yavas* as an *aṅgula*. Sārangadeva, the celebrated writer of *Saṅgitaratnākara*, while describing the sticks (danda) on *Vina*, refers to *aṅgulas* of 4½, 5, 5½, 7, 8 and 9 *yavōdaras*, indicating that breadth at the centre of *yava* was considered as a unit for measurements. According to him 6 *yavas* was the settled standard measure for an *aṅgula* in arithmetical calculations.

As indicated so far, since, there were three types of *aṅgulas* equivalent to 6, 7 and 8 *yava* measures mentioned in *vāstuśāstras*, efforts were made to find their equivalents in terms of modern inches and centimeters as shown in Chart I. 6 *yavas* were found to make 0.769 inches (1.9 cms); 7 *yavas* nearly 0.896 inches (2.22 cms) and 8 *yavas* nearly 1.024 inches (2.55 cms).

The inch (2.5 cms) was originally a thumb-breadth. In the Roman duodecimal system, it was defined 1/12 of a foot and was introduced as such into Britain during the Roman occupation. The finger-breadth or the digit among Egyptians (zebo) and Hebrews (ezba) was 0.74" (1.87 cms) and among Greeks it was 0.8" (1.9 cms). The Roman digit was 0.73" (1.85 cms) and Uncia was 0.97" (2.46 cms) which is closer to the present inch. In the Arabic law book, *Ṣāra Vikāya*, it is stated that each finger breadth was equal to 6 barley corns, the bellies laid towards each other. It can, therefore, be surmised, that the units, whether it was *aṅgula* or digit, measured somewhat between 0.7" (1.78 cms) to 1" (2.54 cms) in the ancient period and was considered as a standard linear
Three Types of aṅgulas using Yava
measure.

The use of three types of āṅgulas in ancient India was confirmed by Abul Fazl also in Ain-i-Akbari. He mentions three types of linear measures of 8, 7 and 6 barley corns respectively. The longest one was for measuring lands, roads, etc., the middle for measuring temples, wells, etc., and the shortest for furniture, palanquin, etc. Thus he seems to have followed the mediaeval texts of architects. Based on the āṅgulas many units of measurements were proposed in ancient India, as described below.

Dhanurgrha mentioned by Kauṭilya was a unit of four āṅgulas. This measure seems to be similar to the four finger breadth or the palm of Greeks, which was 3" (7.7 cms). The palm of Jews (tefah), Romans and Egyptians (shep) and Arabians (qabda) was 2.9" (97.4 cms). This measure seems to be similar to that referred to as muṣṭi of four āṅgulas by Bhoja.

Tala was a measure of five āṅgula according to Bhoja. The distance between the top of the middle finger and the thumb when fully stretched was a tala according to Alberuni.

Dhanurmuṣṭi of Kauṭilya was of 8 āṅgulas. Even in the 11th century, Bhoja refers to a measure ṭuṇi, which is also of 8 angulas and hence it is likely to be the same as dhanurmuṣṭi.

Pāda or pada is another important part of the body used for linear measure. A foot usually means the length of the sole, from the heel to the first digit of the toe. It is often confused with steps. In practice, it is seen that sometimes length was measured out both by sole length as well as by steps and hence it appears to be a variable unit in the past.

Baudhāyana mentions a pāda of 15 āṅgulas and a kṣudrapāda of 10 āṅgulas. Kātyāyana refers to a pāda of 12 āṅgulas. Kauṭilya refers to a pāda of 14 āṅgulas which was accepted by Bhoja also. Śama, śala and pariraya were the other names for pāda according to Kauṭilya. The term śala occurs in Atharvaveda also. This term pāda is, however, unknown to Buddhist literature.

All these writers appear to use the term pāda synonymously with the foot.
When the land survey was undertaken by Kulottunga Coʻla I, his foot measurement was taken as a unit (Śripāda)\textsuperscript{34}. This might be the Royal standard. Here, there is a doubt as to whether Śripāda represented the foot or the step. It is more likely to be a step, rather than the foot as in the case of the Roman concept of a mile.

Pāda also means a quarter. The four-footed animals are termed catuṣpāda. In poetry 1/4th part of a given verse is called a pāda.

In astrology also the stars and the houses are divided into four pādas. A quadrant of a circle is termed pāda. Hence this term pāda can also be interpreted as one-fourth of a bigger unit as seen in the Jaina literature\textsuperscript{18} and Purāṇas.\textsuperscript{14} They consider 6 aṅgulas as a pāda. This obviously is one-fourth of a hasta of 24 aṅgulas.

The term pāda appears to have been used for the square measure also. Āvarta means enclosed or surrounded. Hence pādāvarta mentioned in the Maitraka inscriptions\textsuperscript{36} may be referring to an area or square land measured by so many pādas on adjacent sides. It may also refer to one-fourth of a bigger unit, perhaps a cubit or a dāṇḍa or a rājju as the measure. In vāstu, pāda means a square of suitable size. Its dimensions are variable.

The foot of the Greeks, Romans and Jews was calculated from the basis of 16 times the digit. As the length of the digit varied, so the length of the foot also varied. The Greek foot was 12.16" (30.9 cms); the Roman (Pes) 11.64" (29.5 cms), the royal Egyptian 13.95" (35 cms) and royal Babylonian 13.9" (35 cms). The foot measure used in mediaeval England was 13.2" (33.32 cms). The chih of China varies from 11" (27.9 cms) to 15.8" (40.2 cms).\textsuperscript{21}

Till recently in certain areas in North Arcot district in South India, the length of the foot of the Goddess of the temple of Kampulapāliyam near Nārāyaṇavanam, which is approximately 10.25" (26 cms), was taken into consideration as the standard measurement of the country foot\textsuperscript{28} in that area.

These clearly indicate, that the foot (pāda) was one of the earliest linear units, probably starting first with the length of the average human foot and later the length of the specific
foot. (King or headman or deity).

Gokarna was another linear measure of 11 aṅgulas according to the Samarāṅgaṇa sūtradhāra. Etymologically it means cow’s ear and it is equated to the distance between the tip of the anāṃika or ring finger and the thumb, both being stretched out according to Al-beruni.

Vitasti or Vīdati (Pali) was known to Brahminical, Jaina and Buddhist literature. It is the distance between the tip of the thumb and the small finger at the widest possible stretching or in other words the span. It also depicts the distance from the wrist to the tip of the middle finger, when stretched. It is 13 aṅgulas according to Śulva texts and 12 aṅgulas according to Kauṭilya, Jaina and Buddhist texts.

Pāṇini mentions a diṣṭi also along with vitasti. The word dīthi occurs in Karoṣṭi manuscripts from Central Asia, corresponding to the Iranian distay, equivalent to a span. In the Samarāṅgaṇa sūtradhāra, a vitasti was of 12 aṅgulas and diṣṭi was of 7 aṅgulas. The span of ancient Jews (Zeret) was 8.8” (22.5 cms), the Greeks 9.1” (23.1 cms) and the Assyrians 10.8” (27.4 cms). Vīdati as used in Persia was 10.7” (27.2 cms). The scales of Gudea maintain a 10.44” (26.4 cms) measure.

Prādeśa is another span measure which according to Śulva sūtras was of 12 aṅgulas, while according to Bhoja it was 9 aṅgulas.

Hasta, the popular hand measure, is the cubit of 24 aṅgulas. It is in colloquial use even today as ‘hāth’ in North India and ‘mūlam’ in Dravidian speaking areas. The Śulva sūtras, Purāṇas, Jaina literature, Arthaśāstra, treatises on architecture like Mayamatam and Samarāṅgaṇa sūtradhāra refer to a hasta of 24 aṅgulas (192 yavas). In Lalitavistāra also a hasta constituted 24 aṅgulas. It may be noted here, that since 7 yavas were equal to an aṅgula in Lalitavistāra, hasta was of 168 yavas according to that work.

Architectural works, in addition to the hasta of 24 aṅgulas refer to three other types of hastas also. For measuring vimāna a hasta of 25 aṅgulas, termed as prājāpatya hasta, and for building (vāstu), a dhanurmuṣṭi hasta of 26 aṅgulas were used. For measuring villages, dhanurgīha hasta of 27 aṅgulas was advised. It is interesting to note that till recently the timber
in the forests was measured with bigger cubit, which is a cubit plus four aṅgulas. All the same 24 aṅgula-hasta could have been used for these things also.

It seems that these variations might have been helpful in measuring objects of widely different lengths. Longer units would help in measuring larger area in fewer repetitions, while the smaller measures would help where more accuracy was needed.

Kauṭilya’s prājīpatya hasta or oratni was of 24 aṅgulas. For measuring balances, cubic measures and pasture lands, a hasta of 28 aṅgulas was prescribed by Kauṭilya. A hasta measuring 54 aṅgulas for measuring timber forests was also advised by Kauṭilya.

If Kauṭilya’s aṅgula is considered as three-fourths of an inch, 24, 28 and 54 aṅgulas will be equal to the modern 18”, 21” and 40.5” (±5.7, 53.34 and 102.87 cms). Concepts relating to hasta had changed during different periods, as could be seen from Junagadh inscriptions. In the Junagadh inscription of Rudrādāman issued in the year 72 (151 B.C.—52 A.D.), the repairs to the breach made in the Sudarṣana lake was recorded in terms of hastas. As indicated in Aparājitapṛchcha, for larger measurements referred to in Rudradāman’s inscription, the unit of hasta was equal to eight aṅgulas and when Skandagupta repaired the tank, the unit of hasta indicated by him was almost treble to that of Rudradāman.

Different types of cubits were in vogue in other places also. Ezekiel (600 B.C.), who wrote in Babylon, mentioned that the courts and open spaces around the temple were measured, by a reed of 6 cubits, each of which was a palm breadth longer than the cubits of the measuring line.

In some inscriptions, it is definitely stated that the hasta of the king was used for measuring land. In the Vāillabhāṭṭa-swāmin temple inscription, a piece of land was measured on the basis of the hasta of the king (Parameśwariya hasta). The land referred to in this inscription covered a flower garden measuring 270 hastas in length and 187 hastas in breadth. Sivacandra hasta refers to the forearm of King Sivacandra and the term Darvākarma hasta (the forearm of Darvākarma) occurs in the inscriptions from Bengal.

The cubit of 24 fingers, which is the old Arabic cubit, was variously called the common, post, hand, or legal cubit (dhira,
amma, barid, yad and shari\textsuperscript{10}. The cubit relating to the pyramids however was 20.6\textdegree{} (51.6 cms).

The Jewish civil cubit of five palms or 20 finger-breadth was 18.25\textdegree{} (46.25 cms). The Jewish sacred cubit of six palms, the Royal Babylonian, the Arabian, the Russian and the Chinese cubit of 24 fingers were 19.5\textdegree{} (49.7 cms), while the Nilometer cubit measured 20.76\textdegree{} (52.5 cms) and the Roman cubit was 17.4\textdegree{} (44.1 cms). The Arabian royal cubit (\textit{dhira malik}) of 28 fingers or 7 palm breadth was also known and it measured 21.22\textdegree{} to 21.26\textdegree{} (53.85 to 53.89 cms).\textsuperscript{21}

According to \textit{Śāra Vikāya}, an Arabic law book, the \textit{Zira} was of 24 fingers and each finger measured 6 barley corns.\textsuperscript{31}

\textit{Aratni} which is equal to 24 \textit{aṅgulas} appear to be synonymous with \textit{hasta} and cubit, since it is also the portion of the hand from the elbow to the tip of the middle finger. This length of 24 \textit{aṅgulas} is accepted by \textit{Śulva sūtras}\textsuperscript{13}, \textit{Arthasastra}\textsuperscript{12}, \textit{Bṛhatsamihita}\textsuperscript{34}, Buddhist\textsuperscript{16} and Jaina literature\textsuperscript{15}. Utpala, however, takes it to be a smaller cubit with the fist-closed.\textsuperscript{34} 21 \textit{aṅgulas} were considered as \textit{ratni} and 24 \textit{aṅgulas} as \textit{aratni} in the \textit{Samarāṅgaṇa sūtradhāra}.\textsuperscript{17} Thus majority of the literature confirm the fact of \textit{aratni} to be a cubit. It may be noted here that \textit{arasni} in Persia was 21.4\textdegree{} (54.35 cms).

The present day cubit is one-half of the British yard and hence an ordinary \textit{hasta} or \textit{aratni} of 24 \textit{aṅgulas} can be safely ascertained as half a yard.

\textit{Gaz} was also a type of measuring standard. Abul Fazl records seven types of \textit{gaz}. \textit{Gaz-i-sauda} (\textit{Gaz} of traffic) consisted of 24 digits plus 2/3 of a digit. This measure, according to him was the length of the hand of an Abyssinian slave of Harun-Al-Rashid and was equal to the cubit of the Nilometer. He also has referred to different types of \textit{gaz}, having 24, 25, 28, 29, 31 and 70 \textit{digits}. The last one was used for measuring rivers and plains.\textsuperscript{11} During the time of Moghuls, several types of \textit{gaz} were in vogue. Sikandar Lodi's \textit{gaz} was 39 \textit{digits} or 41\frac{1}{2} Sikandaridis (30.09\textdegree{}, 72.2 cms). Humayun's \textit{gaz} was 39 \textit{angusts} or digits, Akbar's \textit{Ilahi gaz} was 41 \textit{digits} (31.00\textdegree{} or 81.3 cms) and Shah Jehan's 40 \textit{digits}.\textsuperscript{35} The \textit{Ilahi gaz} at Agra during 17th century A.D., was 33\textdegree{} (83.8 cms). In the east coast during 17th century A.D., the \textit{hasta} or \textit{covad} was
about 18" (45.7 cms) and in Gujarat 27" (68.5 cms) according to the Portuguese records.\textsuperscript{36}

Prakrama of the Baudhāyana Śulvasūtra and the Śatapatha Brāhmaṇa was equal to two pādas (30 angulas) and might be even 3 pādas according to Āpśambha\textsuperscript{13}. Prakrama literally means a stride and is very rare in literature and epigraphical records. It may be noted here that the Roman step was 29" (73.6 cms) and the Greek 30.4" (77.2 cms).

Jānu, which literally means knee, is mentioned in Śulva sūtras as a measure of 32 angulas.\textsuperscript{31}

Danda, which literally means a rod, was considered to be of 4 hastas or 96 angulas. Dhanus, musala, nālīka and akṣa were its other names according to Jaina literature.\textsuperscript{16} Kauṭilya mentions three types of danda, first measuring 96 angulas, the second measuring 108 angulas used by builders for measuring roads and fort walls and a third danda of 192 angulas used in measuring such lands which are gifted to Brāhmaṇas.\textsuperscript{12}

Jaina\textsuperscript{18} and Buddhist literature\textsuperscript{16} stick to 96 angulas as a danda. Varāhāmihira was on safer side in mentioning a dhanus as of 4 hastas and a danda between 4 to 5 hastas.\textsuperscript{34} Though danda was not mentioned in the Abhidhānappadīpika, yasti of 84 angulas was mentioned, which might be closer to a danda.\textsuperscript{16} Akṣa having 1¼ angulas mentioned by Pataṅjali\textsuperscript{37} and Śulva sūtra\textsuperscript{13} may also be a measurement rod.

Yuga of the Śulva sūtra was 86 angulas and vyāyāma 96 angulas\textsuperscript{13} Samarāṅgaṇa sūtradhāra refer to a danda of 106 angulas\textsuperscript{17} also.

The Kannada gale, Telugu kola and Tamil kol are the counterparts for danda in the respective regions. Bherunda gale\textsuperscript{28}, Parvāra gale\textsuperscript{39}, Ovantaramalla gale,\textsuperscript{40} Benkalva gale (13 span), Bhūguḍha gale (18 span), Tambla gale (rod of Tamil country)\textsuperscript{42} Dhanavinḍa gale (25 span)\textsuperscript{14} and Agradimba gale\textsuperscript{45} were the various measuring rods, stated in the Kannada inscriptions. Śrīpāddakkol (the rod of the king’s foot with reference to Kulottunga I)\textsuperscript{46} and Maḷigaikkol (the rod of the palace)\textsuperscript{47} and kaḍigaikulattukkol\textsuperscript{48} were mentioned in the Cola records. The varying length of the rods is given in the records as 4, 12, 13, 16 or 18 spans, 36 or 48 steps and 12, 14, 16 or 20 feet. There are also references to
measuring rods 24, 32 or 34 feet long.

Different types of kolas of varying length were also found in Telugu inscriptions. They are reṇḍu jenala kola (2 spans)50 20 jenala kola (20 spans)61, 22 jenala kola (22 spans)52, muppai reṇḍu jenala kola (32 spans)63 (muppai means 30 and jena or span is about 7 inches). Adugu in Telugu means foot and hence the term 30 adugula kola may mean the pole having 30 foot length. Mura is a Telugu measure corresponding to a cubit.

In the Kannada records, the terms Paṭṭyamattavūra daṇḍa (the measuring rod of the village of Paṭṭyamattavūra)68 and Eḍenāḍa daṇḍa (the measuring rod of Eḍenāḍa country)67 also occur showing the regional variations.

Sometimes the gift of lands is reported to have been measured with Rājamāṇadanda, which might be the royal standard or the length of the rod assigned by the Government concerned. Rāja daṇḍa of Viśvakarma Vaṣṭūśāstram was double the size of ordinary daṇḍa of 96 aṅgulas.10

Though the daṇḍa is a linear measure, when used in the epigraphical records, it might perhaps also mean square daṇḍas, that is, a number of daṇḍas each way.

The pole of the ancient Greeks was of 100 fingers measuring 6.3' (1.93 metres) and their fathom of 96 fingers measured 6.1' (1.85 metres). The Roman pole was 9.7' (2.957 metres). The daṇḍa of ancient India also varied from 6' to 10' (1.83 to 3.04 metres). Moreover the daṇḍa in the inscriptions refer to the measuring rod of varying lengths at different periods. But the mathematical works generally agree to 95 aṅgulas for a daṇḍa which falls between 6' to 8' (1.83 to 2.44 metres) varying with aṅgulas measure.

Abul Fazl equates the pole (bea) of the Arabs to four gaz (96 digits) which is the same as the Indian daṇḍa.11

Vamśa mentioned by Vasiṣṭha59 and Bhāskarācārya60 was of 10 hastas or 240 aṅgulas. The term vamśa literally stands for bamboo. According to the Gujarati commentary on Śridhara's Pāṭiganita, vamśa was equal to 3 daṇḍas or 312 aṅgulas.61

Kiṣku or kamsa was two vitasti's plus one dhanurmuṣṭi or 32 aṅgulas according to Kauṭilya.12 It was a measure employed
for measuring forts and palaces. Kauṭilya mentions a kiṣku of 42 aṅgulas also, for measuring the ground for the campment of the army, forts and palaces. Mahāvira also mentions a kiṣku of 42 aṅgulas for measuring wood.\(^6\)

The term kiṣku is used in Aranyakaparva of Mahābhārata.\(^6\)

Kiṣku, rikku and kuchchi of Jaina literature are of 48 aṅgulas.\(^1\)

According to Purāṇas\(^4\) and the Samarāṅgāṇa sūtradhāra\(^5\), it is a measure of 42 aṅgulas. Childers equates kikku of the Buddhist literature with hasta, but phonetically it could be identified with kiṣku. Kiṣku and vitasti are synonymous according to Al-beruni.\(^2\)

Bāhu apparently meaning an arm, was 36 aṅgulas according to Baudhāyana.\(^3\) Kauṭilya’s bāhu did not seem to have any connection with this, since he specified bāhu as the distance of 3 rajjus plus 2 daṅgas on each side (128 daṅgas in circumference).\(^4\) Bāhu was also termed as a śamya according to Baudhāyana and śamya of Āpastambha also measures 36 aṅgulas.\(^5\) According to Mayamatam, ratni, aratni, hasta, bhūja and bāhu are synonymous.\(^6\)

Yaṣṭi or yatthi (Pāli) occurs in the sense of a staff in Buddhist literature measuring 7 ratanas or 84 aṅgulas.\(^1\) In the Śatapatha Brāhmaṇa the term veṇu yaṣṭi occurs, meaning a bamboo staff.\(^1\) Yaṣṭi or dhanurdaṇḍa is of 96 aṅgulas according to Mayamatam.\(^9\) Till recently yaṣṭi is 28×28 sq. cubits or 1/336 of a hala in Sylhet.\(^3\) This indicates that on linear scale yaṣṭi might be equated to 28 cubits. It has also been suggested that a yaṣṭi might be 2 vitastis. Yaṣṭi occurs only in the Sena land grants.\(^4\)

Usabha which frequently occurs in Jātakas was considered as 20 yaṣṭi or 1/8th of a goruta.\(^5\)

Vyāma according to Śulvasūtra\(^1\) and the Śatapatha Brāhmaṇa\(^4\) was 120 aṅgulas. It is the height of a puruṣa, with his arms stretched up. According to Kauṭilya a vyāma, was 84 aṅgulas and used for measuring ropes and for digging.\(^6\) Aśvalāyana prescribes vyāma for measuring the dimension of a ground, where a deceased person is to be cremated.\(^6\) Vyāma was stated as 84 aṅgulas by Bhoja.\(^7\)

Vyāyāma was 96 aṅgulas, according to Baudhāyana.\(^6\) It was the space between the two tips of the middle fingers of a
man with outstretched hands, while standing. The term \textit{vāma} in Gujarati stands for the measure \textit{vyāyāma}. In Thailand it is termed as \textit{va}.

The distance, known as \textit{mār}, in Tamil speaking areas and \textit{baralu} in Telugu are of 72'' (1.8 metres). These relate to the extent of tip to tip of the extended hands of a man. An inscription from Candalur, refers to a gift of land measured with a pole of 12 \textit{baralu}.

If Baudhāyana's \textit{aṅgula} was taken as 3/4'' inch, then \textit{vyāyāma} would be synonymous with \textit{mār} and \textit{baralu}.

\textit{Yuga} measuring 86 \textit{aṅgulas} occurs in Śulva texts. According to Jaina literature and Bhoja, \textit{yuga} is synonymous with a \textit{danḍa} of 96 \textit{aṅgulas}. Probably it is four times the limits of a measure, perhaps \textit{hasta}, if Nighantu is considered.

\textit{Iṣṭā} measuring 88 \textit{aṅgulas} is another linear measure occurring in Śulva texts only.

\textit{Aksa} is the other name for \textit{danḍa} of 96 \textit{aṅgulas} according to Jaina literature. But the Śulva texts mention an \textit{aṇśa} of 104 \textit{aṅgulas}. Patañjali also refers to this measure.

\textit{Puruṣa} or man's length was 120 \textit{aṅgulas} according to Baudhāyana and Āpastamba. They probably use the term \textit{puruṣa} as synonymous with \textit{vyāyāma}. Kautilya mentions a \textit{puruṣa} measure of 107 \textit{aṅgulas}, which was used in building sacrificial altars and also mentions another \textit{puruṣa} measure, equal to a \textit{danḍa} of 96 \textit{aṅgulas}. According to Varāhamihira, a normal man measures 96 \textit{aṅgulas} (4 \textit{hastas}), low man measures 84 \textit{aṅgulas} (3\ 1/2 \textit{hastas}) and finest man 108 \textit{aṅgulas} (4\ 1/2 \textit{hastas}). This seem to refer to a standardized unit and not that of the individual. According to Bhoja also \textit{vyāma} of 84 \textit{aṅgulas} was synonymous with \textit{puruṣa}. Thus the measures \textit{puruṣa} and \textit{vyāma} appear to have been used loosely, both to mean a particular unit by some, while others used it for the heights of a man with hands stretched up, approximately measuring between 1.5 metres to 2 metres. The longest measure mentioned in the Śulva texts and Brāhmaṇa literature was \textit{puruṣa}. Since the main aim in these literatures was building fire altars, the measurement bigger than a \textit{puruṣa} was probably not necessary.
PLATE I
Linear Measures in Ancient India in Relation to the
Parts of the Body

\[ \text{VITASTI (3\text{\textdegree})} \quad \text{ARATNI (24\text{\textdegree})} \quad \text{PADA (15\text{\textdegree})} \quad \text{PRAKRAMA - (30\text{\textdegree})} \]

\[ \text{PRAKRAMA (PACE) - 3 or 3\frac{1}{2} PADAS} \quad \text{VY\text{\textdegree}AMA (4ARATNI = 96\text{\textdegree})} \quad \text{PURUSA-VY\text{\textdegree}AMA (5ARATNIS - 120\text{\textdegree})} \]
All these above measurements are in relation to the parts
of the human body (see plate 1).

Nālika, nala, nalu, nali, nādi, nāluka and nalva are terms
regarding other linear measures, occurring in inscriptions and
in literature.

In the Jaina literature and the Arthasastra the nālika
stands for a dāṇḍa of 96 aṅgulas. In the Ādityapūrāṇa, 30
dhanus of 96 aṅgulas was a nalva. Nāli was equal to dhanus.
In the Mārkandeyapurāṇa, the term nādika measures 48
aṅgulas. Nādi measures 96 aṅgulas and nalva measures 30
dhanus of 106 aṅgulas in Samarāṅgaṇa sūtradhāra. Al-beruni
has stated 40 dhanus of 96 aṅgulas as nalva which was
1/25th of a kroṣa. Nala appears in Pañcatantra and in
Bhāgavata in the sense of a reed. Thus, nāli, nālika and nādi
can be said to measure 96 aṅgulas while nādika 48 aṅgulas and
nalva 40 or 30 dāṇḍas.

Generally, nala in Sanskrit means a measure, rod or dāṇḍa.
The length varies in different places according to local customs
and usages. In the Sankareh tablets, six types of reeds viz.
small, medium, large, double small, double medium and
double large reed measures were used in Babylon. The ancient
Greek measure Xylon, meaning a walking staff was of 3 cubits
or 4.6 ft. (1.39 meters).

The term nala is used in the records of Guptas, Pālas and
Senas in the sense of dāṇḍa. This term mostly occurs, in the
inscriptions in the Eastern India, and rarely in Western and
Northern India and is absent in South. During the time of
Guptas, it looks as if the actual measurements were done by
nalas mainly. In some of the copper plates, the nala is quali-
fied by the figure 8 and 9 (aśṭaka navaka nalābhyaṃ; aśṭaka
navaka nalena). In the Paharpur copper plates dated Gupta
year 159 (479 A.D.) the nala was qualified by the figure 6 × 6
(ṣaṭka nalairapavinceya). However, from the copper plates
of the time of Kumāragupta (5th century A.D.) to those of the
time of Vijayasena (the Barrackpur copper plates—12th century
A.D.) the nala measuring 8 × 9 was the common measure.
Nalas were also associated with the names of certain persons
or plates. The term Vṛṣabha Śaṅkara nala occurs in the
Naihāti copper plate of Vallālasena (12th century A.D.) and
āñuḷīḷā plate and Saktipur plate of Lakṣmaṇasena (12th century A.D.) Viśabha Saṅkara was the biruda of Vijayasena. Samatātiya nala, was evidently the measuring standard used in the Samatāta country or South East Bengal and also in the Khaḍi viṣaya of Puṇḍravardhana-bhukti (North Bengal). A nala current in Varendri (ṭatrapyā deśīya samya-vahāra nalenā) occurs in Tarpadigi plate of Lakṣmaṇasena.

In the Govindapur copper plate of Lakṣmaṇasena measurement of 56 cubits, prevalent in that region was mentioned (ṣatpaṅcāśata hasta parimita nalenā). In the Sunderban copper plate of Lakṣmaṇasena, a standard of 22 cubits (dwātrimśatihastena parimita) was used. These show, that local standards differed from place to place.

Moreover, the nulas appear to have been measured in different hastas. The hasta of Śivacandra was used in the Faridpur copper plate of Dharmaḍitya (during Gopacandra's regnal year 18). In the Baigrām copper plate (448 A.D.) and in the Barrackpur grant of Vijayasena, the term Darvīkarma hasta measuring $8 \times 9$ nulas occur. Darvīkarma may perhaps be a personal name or a common term for an employee in charge of demarcation. In the Kāhla (Lucknow museum) plates of Kalachuri king Mahārājādhirāja Soḍhadeva, successor of Mahārājādhirāja Maryādasāgaradeva (V.S. 1135), several land grants were made in terms of the measure nalu. Since a land measuring 3/4 nalu was also given as a grant, it must be a fairly big unit representing a large area.

In two records of Govindacandra and his mother Rālhana-devi (1189 A.D.) from Pāli, the term nāluka occurs. The former records 10 nālukas and the latter 20 nālukas.

Chebrolu inscription of Jaya (S.S. 1157) refers to 6 na which is translated by Kielhorn as nālvamu or furlong.

In the Gagaha plate of Govindacandra (V.S. 1199) of Kanauj, Mahārājaputra Rājyapāladeva gifted certain lands measuring in nālu and paṅca.

Till recently in Sylhet, nala refers to a linear measure of 7 cubits. Nālva is considered as of 100, 120 or 400 cubits by different authors. The Vaijayanti refers to a nālika, nālvika, and nāla measuring $5 \frac{1}{2}$, 8, 9 or 400 hastas.

Raiju which literally means a rope, was used for land
surveying. Rajjuka and Rajjugakaha-amachcha were the land surveyors according to the Jātakas and inscriptions of Aśoka and those of Śātavāhanas. In the Prakrit Sānchi Stūpa inscription (no. 23) the donor was Rajjuka Uttara. In the Malavalli Pillar inscription of the Raja Hariputra Viṣṇu-kada Cutukulanandā Śātakarnī, an order concerning a gift of land to an officer Rajjuka Mahattara is mentioned.

Rajju of Kauṭilya was of 10 daṇḍas, while that of Śrīpati was of 20 daṇḍas. If Kauṭilya’s daṇḍa of 196 aṅgulas is taken into account, then both will indicate the same measure. According to Mayamatam, it was 8 daṇḍas of 192 aṅgulas. The word pāsa, occurring in the Royal Asiatic Society’s copper plate grant of Bhima II of Gujarat may be synonymous with rajju. A feudatory Mahipala was said to have given 340 pāsas in a village Bhukarada, producing four khaṇḍas of grain.

Measuring by hempen rope was mentioned by Abul Fazl. Ancient Greeks measured the distance by a cable of 60 Greek feet (61 British feet or 18.5 metres). Just like the inch tape or centimetre tape or the modern measuring chains, measuring by a particular rope, must have been common in many areas. Measuring by rope is convenient, when the sides of a particular land is not in straight lines, as in the case of ponds.

In the Tamil speaking areas, the rope measuring 32 yds (29.25 meters) was in vogue till recently. The British chain, better known as Gunder’s chain, is 66 ft or 1/10th of a furlong (26.11 metres). Ten sq. chain is an acre.

Krośa and Gavyuti: Unlike the previous measures, these represent long distances. The word krośa literally means a cry, shriek or yell. The word gavyuti or goruta (Gauta—Pāli) applies to the distance upto which the bellowing of the cow can be heard. Kiosses in Siberia also has the same meaning. The distance, represented by kiosses however, varies from place to place. The Tamil word kūppidudoorum, refers to the distance from which a shout can be heard. Krośa and goruta, occur mainly in literature and hardly in inscriptions. There seems to be different types of krośas. Kauṭilya mentions a krośa equal to 100 ḍhanuṣ or 1/4 of a yojana.
krośa mentioned by Bhoja was 1/8 of a yojana or 1000 daṇḍas.17 Sukra quoting from Manu refers to a krośa of 4000 hasta or 1000 daṇḍas²⁰ᵃ. On the other hand in the Mārkaṇḍeya-purāṇa¹⁴, Jaina literature¹⁵ and in the mathematical works of Bhāskara²⁰, Mahāvīra²⁰ and Śridhara²¹, references to a krośa of 2000 daṇḍas are given.

In Aśoka’s 7th pillar edict, it is stated that he laid out camping grounds, provided with wells and rest houses, along the high roads at intervals of ½ krośas²¹.

A peep into Strabo’s account, vaguely helps to deduce the distance represented by a krośa. “They (i.e. Agromoni) construct roads and set up a pillar at every 10 stadia.”²¹ Greek and Roman stade was 604 ft (185 meters) and the stadion of Hebrews 558 ft (160 meters). Anyone of these multiplied by 10 might be the Magadha krośa, which is closer to the modern mile.

Sukra refers to a krośa of 500 daṇḍas quoting from Prajāpati. A krośa of 250 daṇḍas is also mentioned by him. The Villages were measured by a krośa of 500 daṇḍas according to the Mayamatam. Dr R.N. Mehta comes to the conclusion from his excavations at Vadanagar that a krośa is approximately a kilometre. Perhaps the hasta of 8 aṅgulas as indicated in the Aparājitapṛchchha or the aṅgulas equalling to 3 vrihis as mentioned in the Viswakarma Vāstuśāstram might have been taken into account.

Al-beruni also compared krośa to a mile.²² According to Abul Fazl the kos or kuroh of Gujarat was 50 jaribs and it was the greatest distance, at which the bellowing of the cows can be heard. Some of his statements, however, are not corroborated by any other writer.

The Moghul kings established a different kuroh or kos. Sherkhan fixed the kos at 60 jaribs. Each jaribs contained 60 Sikandari gaz. Each Sikandari gaz was equal to 41½ Sikandaris, which was equal to 30″ (76.2 cms). Therefore, the kos comes to 1.7 miles (2.75 km) according to modern calculations. Akbar recognised a kos of 5000 Ilahi gaz with the value of one Ilahi gaz being 41 digit. Jehangir ordered Serais to be built at every 8 kos between Lahore and Agra. The distances between these Serais varied from 9 to 13 miles. According to this, Kos
in the period of Jehangir, varied from 1.1 mile (1.77 km) to 1.7 miles (2.75 km). Shah Jehan fixed the kos as 5000 Zira-iptadshahi, each Zira measuring 42 angulas.

Some writers have stated that 2000 or 1000 dhanus make one gavyūti or goruta. This tends to suggest that gavyūti and krośa are synonymous. But in Märkaṇḍeyapurāṇa 4 krośas are considered to be a gavyūti and 8 krośas as a yojana.

Hieun Tsang describes a yojana as equal to 8 krośas of 500 dhanus. But generally either 4 krośa or 4 gavyūti is considered as a yojana.

An old Turkish verse equates kos or kuroh with mil which was 400 paces (a pace = 324 yavas).

Dr Cunningham, adopting the value of hasta as 25 angulas has come to the following conclusion:

- 4 hastas or 100 angulas = 6.052' = 1 dhanus
- 400 hastas or 100 dhanus = 605.2' = 1 nalva
- 4000 hastas = 100 nalva = 6052' = 1 krośa

This is closer to the 10 stadia mentioned by Megasthenes. The kos of Gangetic provinces, appears to be about 2½ miles (3.35 km) in length, while in Punjab it is 1½ miles (2.25 km) and in Bundelkhand and Mysore it is 4 miles (6.44 km). The Tamil kādam is equated with gavyūti in the lexicons. However, it is doubtful, since a kādam is generally considered to be equal to 10 miles (16.09 km).

Yojana is the most controversial linear measure, with the least unanimity among the scholars. It has been referred to in Rāmāyanā, stating the distance of the sea, which Hanumān crossed to be of 100 yojanas. The ancient Tamil work Maṇi-mekalai refers to a distance of 400 yojanas. These indicate yojana as a big stretch of length representing several miles.

There appears to be two different types of yojana according to the ancient Indian literature. One of 4000 dandaśas and the other of 8000 dandaśa. According to the Arthaśāstra, the Lalitavistāra, the Gaṇitāsāra of Śrīdhara and the Aparājita-prachā, 4000 dhanus were equal to a yojana, whereas Brahmagupta, Āryabhaṭa, Jaina canonical literature, Mahāvīra, Bhāskara and Śripati assert, that a yojana is equal to 8000 dhanus. The Vaiṣayanti refers to a
Kosala yojana of 4 gavyūti and Magadha yojana which is half the size of the former. According to Kauṭilya, a yojana was of 4000 dhanus. If, however, Bhaṭṭasvāmin’s interpretation of it is considered, it must be exactly double of that. Further, the controversy arises as to which type of dhanus, Kauṭilya has taken into account. Kauṭilya has mentioned a general dhanus of 96 aṅgulas, gārhapatya dhanus of 108 aṅgulas and Brahmadeya dhanus of 192 aṅgulas. If aṅgula is considered as an inch (8 yava was an aṅgula according to Kauṭilya) then the different yojanas would be 6.06 (9 km), 6.63 (10.62 km) and 12.12 (19.5 km) miles. If aṅgula is considered as 3/8", then these would be 4.54 (7.3 km), 5.1 (8.2 km) and 9.09 (14.5 km) miles. Since yojana generally refers to a distance and not length of lands, the general dhanus is more relevant. Jaina canons, Purāṇas, Mahāvīrācarya, Śrīdhara and Bhāskara, refer to yojana of 8000 dhanus (768,000 aṅgulas). And hence, it would be 12.21 miles (19.5 km) if the aṅgula was considered as an inch and 9.09 miles (14.5 km) if the aṅgula was considered as 3/8".

Kannada writer Rājaditya, in his Vyavahāraganita considered 800 dāndas (76800 aṅgulas) as a yojana and hence it might be 1.21 miles (1.93 km) or 0.9 miles (1.09 km).

According to Bhuvanadeva, though 8000 dāndas is a yojana, a dānda measured only 32 aṅgulas. Hence the yojana according to him would be approximately 3 miles (4.83 km).

In stating the distances of one place from another, the Chinese travellers Fa-Hien and Hieun Tsang have expressed them in yojanas. The latter has also stated them in li measures. Fa-Hien has stated the distances in yojanas in full numbers and never in fractions, while Hieun-Tsang expressed them in round figures of 10, as 500 li or 600 li. Moreover, the distances mentioned by them from one place to another failed to indicate, whether it was from periphery to periphery or from the official centre, as in the present day.

Hieun Tsang has mentioned that a yojana is a day's march for a royal army; there were three types of yojanas; one of 16 li found in the sacred writings of Buddha, 30 li which was common reckoning in India and 40 li according to the old
Chinese records. 8000 dāṇḍas comprise a *yojana* according to him.\(^{101}\)

The army's march, as stated by Kauṭilya, differ from Hieun-Tsang's description. The lowest quality army, according to Kauṭilya, can march a *yojana* [5-5/44 miles (8.2 km) according to Shamasstry] a day, that of the middle quality one and a half *yojana* and the best quality two *yojanas*.\(^{102}\)

The *nāligai vaṭī*, i.e. the distance covered in a *nāligai* (24 minutes), is 1¾ miles (2.59 km) in Southern districts. This is roughly the distance covered by infantry in present time. If the army moves for eight hours, taking this *nāligai vaṭī* as the standard \((\frac{13}{4} × \frac{1}{3} × 8)\), the distance covered in a day will be 26¾ miles (42.91 km). Hence, the *yojana* mentioned by Kauṭilya might be between 12 to 13 miles (19.31 to 20.92 km).

From one of the accounts of Hieun Tsang it is clear that a *yojana* is equal to 16 *li*. The account is as follows. When on a visit to Rājagṛha, Anāthapiṇḍika, a merchant of Śrāvasti, became a Buddhist and invited Buddha to visit Śrāvasti. The distance from Rājagṛha to Śrāvasti was forty-five *yojanas*. Buddha set out to reach the city by sixteen *li* a day and he took forty-five days in travelling from Rājagṛha to Śrāvasti.\(^{103}\)

Many scholars give different values to the *yojana* of the Chinese traveller. General Cunningham has asserted the *yojana* of Hieun Tsang to be as 6.75 miles (10.86 km) and that of Fa-Hien as 6.71 miles (10.79 km). V.A. Smith considered a *yojana* of Hieun Tsang as 6.5 miles (10.5 km) and of Fa-Hien as 7.25 miles (11.67 km). M. Julien and probably Dr Stein referred the *yojana* of Hieun Tsang as 8 miles (12.87 km) and M. Giles was of the opinion that a *yojana* of Fa-Hien was between 5 (8.05 km) to 9 miles (14.48 km) while Rhys Davids took its distance as about 9 miles (14.48 km) and Childers 4½ (7.29 km) to 9 miles (14.48 km).\(^{104}\)

Fleet considered that there were three types of *yojanas*: general *yojana* of 9.09 *miles* (14.58 km), Magadha *yojana* of 4.54 miles (7.3 km) and the third *yojana* of 12.12 miles (19.5 km). The last one, he interpreted from the root ‘yuj’ to yoke and hence it is said to represent the distance which a pair of bullocks could draw a fully laden cart in a day. According
to his interpretation 12.12 miles (19.5 km) were equal to 100 *ji* of Hieun Tsang. Major Vost, after a detailed analysis, interpreted the three *yojanas* of Fleet as 5.3 (9.03 km), 10.6 (17.85 km) and 14.2 (22.85 km) miles respectively. He deduced the *yojana* of Fa-Hien and Hieun Tsang as 7.05 (11.3 km and 5.3 (9.03 km) miles respectively.\(^5\)

Several modern scholars have tried to infer the distance measured by the *yojana*, from astronomical facts provided by our early writers. In the *Āryabhaṭīyam*, the diameter of the earth and moon were given as 1050 and 315 *yojana* respectively. In the *Brahmasphuṭasiddhānta* (628 A.D.)\(^{104}\) and *Siddhāntasirīmāṇi* (1150 A.D.), it is rendered as 1581 and 480 *yojanas* respectively.\(^{104}\) The *yojana* of *Āryabhaṭīyam*\(^7\) was taken as equal to \(7\frac{1}{2}\) miles (12.07 km) and the *yojana* of *Brahmasphuṭasiddhānta*\(^{104}\) was considered as 5 miles (8.05 km). So the diameter of earth and moon according to *Āryabhaṭa* would be 7875 miles (11700.95 km) and 2,626 miles (3803.62 km) and according to Brahmagupta they would be 7905 (12727 km) and 2400 miles (3864 km) respectively. It may be interesting to note that the actual equatorial diameter of earth is 7927 miles (12762.47 km) and polar diameter is 7900 miles (12619 km) and the diameter of the moon is 2162 miles (3480.8 km). This closeness of the data, however, may be due to eagerness of the scholars to prove that the ancient astronomical works have given the accurate data. If we really take into consideration the equation of *Āryabhaṭa* in relation to *aṅgula* and *yojana*, then one can note considerable disparity as can be seen from the following details.

*Āryabhaṭa* in *Daśagitikāsūtra* of *Āryabhaṭīyam* has stated the diameter of earth and moon as 1050 and 315 *yojanas*\(^6\) respectively. He has also stated that a *yojana* was of 8000 *puruṣas* (96 *aṅgula* for *puruṣa pramāṇa*). When calculated on this basis, according to him the diameter of earth and moon will be 9535.4 miles (15352 km) and 2863.3 miles (4609.43 km) respectively.\(^{105}\)

Bhāskara’s calculations widen the error still further. Since Bhāskara himself has stated in *Līlāvati*, that 8000 *danās* or 768,000 *aṅgulas* were a *yojana*\(^4\), the *yojana* can be calculated on the basis of 12.12 miles (19.5 km) or 9.09 miles (14.58 km)
depending on whether his *āṅgula* is equal to 1" or 3/4" respectively. The calculations shown in the Appendix I indicates to a certain extent, the length of the *yojana* as considered by different authors, in terms of miles and kilometres. It appears to vary between 1 mile (1.56 km) to 13 1/2 miles (21 km) according to different writers.

As has already been stated, considering an *āṅgula* as equal to be 1", the *yojana* of Kauṭilya comes to 6.06 miles (9.7 km) and that of the others to 12.12 miles (19.5 km). According to Bakṣali manuscript which refers to an *āṅgula* as 6 *yavas* (3/4"), the *yojana* measures 9.09 miles (14.58 km). Taking into consideration, the yoking distance and the army’s march, *yojana* of 12.12 (19.5 km) seems to be more plausible.

Measuring by yoking distance is still common in certain places in India. *Kurgi* in Marathi speaking areas is a land measure, which is the distance that may be ploughed and sown in one day, with a pair of bullocks and drill plough. The extent varies from two to eight acres. *Kurige* in Kannada is a seed drill or sowing machine drawn by oxen. *Kurige* also is a land measure like *kurgi*.

The old English word for *furlong* was *furlang* (660 ft) and was derived from *furh* meaning furrow and *lang* meaning long. Thus the furrowing length was considered as furlong. It is, therefore, interesting to note measuring by yoking distance was in vogue in other parts of the world also.

For the sake of completion of the information available on the linear measures in ancient India, two novel linear measure tables described by Bhoja in his *Yukti-Kalpataru* are given below. The first table is a kind of novel measurement used in the design of several Royal appendages. Here, each succeeding measure form a multiple of ten with regard to the one preceding it (a decimal system).

<table>
<thead>
<tr>
<th>10 hastas</th>
<th>1 Rāja hasta (hasta of the King)</th>
</tr>
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<tbody>
<tr>
<td>10 Rāja hasta</td>
<td>1 Rāja daṇḍa</td>
</tr>
<tr>
<td>10 Rāja daṇḍa</td>
<td>1 Rāja catra</td>
</tr>
<tr>
<td>10 Rāja catra</td>
<td>1 Rāja kaṇḍa</td>
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<td>10 Rāja kaṇḍa</td>
<td>1 Rāja.puruṣa</td>
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<tr>
<td>10 Rāja puruṣa</td>
<td>1 Rāja pradhāni</td>
</tr>
<tr>
<td>10 Rāja pradhāni</td>
<td>1 Rājakṣetrama</td>
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</table>
The other table relates to nine times the preceding measure

<table>
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<th>Unit</th>
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<tr>
<td>9 tantu</td>
<td>1 sūtra</td>
</tr>
<tr>
<td>9 sūtra</td>
<td>1 guṇa</td>
</tr>
<tr>
<td>9 guṇa</td>
<td>1 pāśa</td>
</tr>
<tr>
<td>9 pāśa</td>
<td>1 raśmi</td>
</tr>
<tr>
<td>9 raśmi</td>
<td>1 raṣju</td>
</tr>
</tbody>
</table>

These equivalents were not mentioned by any other writer. Even Bhoja himself has not mentioned these in his *Samarāṅgana sūtrakāra*.

Before concluding, a comparison of the evolution of the Indian linear units with the evolution of British units will not be out of place.

The inch (2.54 cms), which corresponds to the Indian *aṅgula* (8 yava=1") was introduced in Britain during Roman occupation as a thumb’s breadth. It was 1/12th of the foot in the Roman duodecimal system.

The yard of 36 inches has its origin in the Tudor times. By tradition (often stated as fact), Henry VII, in the 16th century A.D., is supposed to have decreed, that the yard should thenceforth be the distance from the tip of his nose to the end of his thumb with the hand stretched fully. It is half *vyāyāma* of the Indian system.

The mile was defined by the Romans as 1000 paces, each pace being equal to 5 Roman feet. This mile of 5000 feet later became the English mile, possibly in the reign of Henry VII, but definitely through a statute of Elizabeth I, as measuring 5280 feet. This mile corresponds to 1000 *prakramas* of ancient Indian literature.

A study into the different scales of ancient India along with the scales of Gudea and Sankereh tablets also reveal certain common features. The scales of Harappa and Mohenjo daro reveal the use of both binary and decimal systems. The foot and the cubit measures [13.2" (39.5 cms) and 20.7" (52.6 cms)] found in Harappa and Mohenjo daro correspond to the units of ancient Egypt. The houses in Lothal can be measured in terms of foot, the unit in each case being 13.2" (39.5 cms). The rules of Gudea are engraved scales showing a resemblance with the Assyrian span scale of 10.8" (26.4 cms), while Sankereh tablets reveal use of decimal systems. The general
statement, the binary and decimal systems were prevalent in India, however, does not seem to tally with the literature. Decimal system can be seen, only in the bigger units in Karnāṭaka, where the villages are grouped together in hundreds and thousands, namely Belvala 3000, Bānāwasi 12,000, Nolambāvadi 32,000 and Gangāwaḍi 96,000 etc. Perhaps, these are all in accordance with Mahābhārata, Manu and Viṣṇu Smaṛtis, where for administrative purposes, the grouping of 10, 20, 100 and 1000 were advised. Here also, these divisions might probably be only an approximation. Instead of expressing numbers like 2986 or 12012, the round numbers like 3000 and 12000 might have been conveniently used.

The prevalence of quarternary system perhaps might have been found easier for calculation and particularly for division. Moreover, since almost all the linear measures prevalent were derived from the parts of human body the decimal system was not possible. For example, we had measures like span which was 1/8th of the human body and cubit was 1/4th of the body. The various measures derived from human body are shown in Plate I.

Aṅgula, aṅgust or digit seems to have been the most important unit and even the minute variations in this unit, created a vast difference in the bigger units. In ancient India a hasta or the cubit seems to have been the basic unit, for expressing the linear measures.

The measure smaller than the aṅgula namely aṇu, trasareṇu, rathareṇu, vālāgra, liksa, yuka, and yava follow octonari system. The bigger units pada (6 aṅgulas), vitasti (12 aṅgulas), aratni or hasta (24 aṅgulas), vyāyāma (84 aṅgulas) and dāṇḍa (96 aṅgulas) seem to follow duodecimal system. If yojana is considered as 4 kroṣas, then it can even be stated as being quarternary in relation to the bigger units also.

Finally, it will be interesting to note that in using the various parts of the body for measuring, a remarkable coincidence is seen with the measures found in Babylon, Egypt and Rome, as brought out in Chart II. This chart also brings out all the relevant equivalents of the linear measures used by different writers in the past in India.
References

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5. Details are not published yet.
8. Ezekiel X, 5; XIII, 16.
10. Hindu, Jaina and Mathematical Works mostly mention these measures. According to Buddhist texts these measures are 7 times the previous one.
12. *Arthasaśstra*, ch. XX, p. 117.
   *Śatapatha Brāhmaṇa*, Vol. III, ch. III.
   *Markandeyapurāṇa*, p. 240.
   *The Report and essays of the Sixth Gujarati Sahitya Parishad* p. 53-70.
15. *Jambudiva Paṇḍatti-Samgaha*. In the last page, the table states the kṣetramāna in Jambudiva Paṇḍatti. Tiloya paṇḍatti, Anuyogadvāra and Jyotīṣa makaranda are given in detail.
27. *India as known to Pāṇini*, p. 253.
   *JOIB*, XVIII, p. 20.
32. CBI, No. 13 and 14, p. 80 and 84.
33. ibid, No. 6.
34. India as seen in the Brhat Samhita of Varahamihira, p. 342.
35. Agrarian system of Mughal India, Appendix A, p. 354. The author has analysed several authorities in this aspect.
36. From Akbar to Aurangzeb, p. 338.
37. India in the time of Patañjali, p. 138.
38. EI, XVI, p. 331.
39. KI, II, No. 38.
40. EI, XII, p. 336. 290.
41. EI, IV, p. 65.
42. KI, II, Na. 16.
44. IA, IV, p. 279.
45. EI, IV, p. 204.
46. IE, p. 408.
47. Colas, p. 540, 543.
48. ibid, p. 452, 465, 523.
49. South Indian Polity, p. 151, 156, 158, 159, quoted in IE.
50. SII, V, No. 139.
51. ibid, No. 1084.
52. ibid, No. 1144.
54. SII X, No. 448.
55. ibid, No. 509.
57. ibid, p. 213.
58. EI, XXVII, p. 54.
60. Līlāvati, ch. 1, paribhāṣa V, 5-7.
61. JNSI. VIII, p. 146.
61a. Gaṇitāśārasangraha, appendix IV.
62. Mahābhārata, Aranyakaparva
63. Bengali Itihāsa, p. 85.
64. EI, XXVI, p. 1
65. Jātakas I, 64, 70; IV, 17, 2; 142, VI 580,
    Dictionary in Pali Language, p. 537.
66. Āśvalāyanagrhyasūtra, 1X, 1,9.
    EI, VIII, p. 233.
67. Suggestion by Mehta, R.N.
68. EI, VIII, p. 233
69. Pahcatantra, I, 96.
71. CBI, No. 7, p. 55.
72. ibid, No. 4, p. 46.
73. ibid, No. 36, p. 263.
74. ibid, No. 41, p. 306.
75. EI, XXI, 1211.
76. CBI, No. 40, p. 298.
77. ibid, No. 37, p. 274.
78. ibid, No. 39, p. 291.
79. CII, IV, Pt. II, No. 74.
80. EI, V, p. 113.
81. EI, VI p. 39.
82. EI, XIII, p. 216.
83. Vaijayanīti, p. 40.
85. EI, II, No. 230, p. 38.
86. Luders List, No. 1195, EI, X, p. 138.
88. IA, XVIII, p. 108.
90. Gaṇitasastrasaṃgraha, ch. I.
91. Aśokan Abhilekhan, p.149. Fleet considers, Adakośikyani as 8 krośas.
92. Strabo XV, 1, 50.
93. JMSUB, XVII, p. 110.
95. JRS 1903, p. 65.
96. JRS 1906, p. 1011.
97. Manimekala, “Nāganāṭju nanooru yojanai”.
100. Rājaditya’s Vyavahāragaṇita, quoted by Manappa Bhat in, “Mathe-
natics in Karnāṭaka of the middle ages,” Bharata Kaumudhi I, p. 127; JRS, 1907, p. 655.
101. Ancient Geography of India, Introduction.
102. Arthaśāstra, p. 392.
103. JRS, 1912, p. 229.
104. Mahābhāskariyam, p. XLVI.
105. Bakhṣali manuscript, Introduction.
106. Yuktikalpataru, p. 21, p. 62.
<table>
<thead>
<tr>
<th>Sciurus niger</th>
<th>Archipiélago</th>
<th>Isla marginal</th>
<th>Altitudinal</th>
<th>Hábitat</th>
<th>Sábana</th>
<th>Ambiente</th>
<th>Matrizes/Maní</th>
<th>Métricas y Massaraba</th>
<th>Vínculos fauna</th>
<th>Habitat</th>
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<tr>
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*According to Aditya Praman*
THE evolution of area measures in ancient India appears to have started far later than the evolution of linear measures. While the references to linear measures, can be traced to early Vedic period, the earliest reference on area measures, appears to be seen in *Baudhāyana dharmasūtra*, which belongs to 1000 B.C. The need for area measures seems to have arisen in relation to gift of lands. Even though entire villages were granted by charter on many occasions, a large number of land gifts appear to be related to smaller plots of land necessitating the measurements to be indicated in the records. The information about area measures, though available in ancient Indian literature and inscriptions, are not often comprehensive and there is considerable uncertainty about the exact area, which many of the land measures used in those periods, actually represented. Further, no common standard appears to have existed in ancient India on area measures. The same unit appears to have had different values in different places at the same period and also at the same place in different periods. This naturally makes it difficult, for anyone to correctly project an evolutionary pattern, in defining the development of area measures in ancient India. The present attempt tries to bring together, most of the relevant information relating to the area.
measures, used in different places in India at different periods and attempt to link them to some common base.

An examination of the various area measures used in ancient India, brings out the fact that four different approaches were made in demarcating land areas:

1. The most commonly used approach appears to be related to the use of a variety of danças of definite hastas (cubits). The most common measure belonging to this category was nivartana. Many other measures using different rod measures were in use particularly in South India such as mattar, kamma, paṭṭi, etc.

2. The second approach was by plough measures as hala, vādha, sīrā, etc.

3. The third approach was related to the quantity of seed sown as in kulyavāpa, āḍhavāpa, drōṇavāpa, etc.

4. The fourth approach was according to the yield of land as in bhūmi.

The information on various measures in each of these categories are presented in their order of popular use and the details on these are given in a chronological order, to understand the varying concepts relating to these measures from time to time and in different regions in ancient India.

Nivartana (niyattana of Jain texts): This is the most extensively used term for area measure in the literary and epigraphic records. However, it seems to vary considerably in the size of the area it denoted in different records. The earliest reference to nivartana occurs in Baudhāyana dharmasūtra (third praśna). In this, a brāhmin was described to be cultivating six nivartanas of fallow land to support his family, giving a share to the owner also. The term used for this is śaṇṭivartanī². Here the area was not defined clearly except to state that the brāhmin ploughed it with two bulls.

In Śatātapa samhita³ and Brhaspati samhita⁴, a nivartana is described as representing an area of 30×30 sq. danças, with the length of the danḍa being 10' cubits. Therefore, according to them a nivartana is 300×300 cubits, which will be equal to about 4.5 acres (1.8 hectares). Kauṭilya, also considers nivartana as being equal to 3 rajus or 30 danças, but he has a different measure for the danḍa. According to him, each danḍa
measured 192 āṅgulas as specified for gifts to brāhmans. Thus, his nivartana would be 160×160 sq. yds, which would be equivalent to about 5 acres (2 hectares) assuming that an āṅgula was equal to an inch. If his āṅgula is considered as equal to \( \frac{1}{4} \) inch as mentioned by some authors, then it would be 120×120 sq. yds which would be about 3 acres or 1.2 hectares only. Kauṭilya also described a danda of 96 āṅgulas, in which case the nivartana area will be half of the above calculations.

Śukraniti, quoting Prajāpati and Manu gives two different equivalents for nivartana. According to Prajāpati and Manu as quoted in it, a nivartana was equal to 25×25 dandas, but they differed in their concept of the length of a danda. Prajāpati considered a danda to be equal to 5 hastas, while that of Manu was 4 hastas, making a nivartana being equal to about \( \frac{3}{4} \) acre and \( \frac{1}{4} \) acre (0.3 and 0.2 hectares) respectively.

In Nilaṅgha’s commentary on Mahābhārata a nivartana was described as 20 rods (probably 20 rods each way). The actual length of the rod is not clear.

Vijñāneswara in his Mitākṣara, also referred to nivartana as 30 dandas square. However his danda was of 7 hastas, thereby making a nivartana equal to 210×210 cubits (about 2\( \frac{1}{4} \) acres or 0.9 hectares). The same opinion is adhered to by Ballālasena in his Dānasāgara.

Hemadri’s Caturvargalantāmani is a valuable lexicon quoting several authors on different subjects. Dānakhaṇḍa in that work is a veritable compendium on giving gifts, wherein he quotes Matsyapurāṇa as holding the view, that a nivartana is 210×210 cubits square. However, in his Vratakhaṇḍa, he indicates that the danda according to Brhaspati was of 10 hastas, while according to Matsyapurāṇa it was 7 hastas, thereby once again the two views namely, a nivartana being 300×300 cubits according to one and 210×210 cubits according to another are presented.

The later mathematical works of repute, instead of clarifying the position relating to the actual area representing a nivartana, added further confusion by different writers giving entirely different values. Śrīpati in his Gaṇitatilaka states, that a nivartana, is of 2 rajjus, a rajju being 20 dandas. This makes it equal to 160×160 hastas, giving an approximate value
of 1½ acre (0.5 hectares) for a nivartana. Bhāskarācārya considered it to be of 20 vamśa square and his vamśa was equal to 10 hasta making it 200 × 200 hastas or nearly 2 acres (0.8 hectares).

In the Gujarati commentary on Śrīdhara’s Pāṭiganīta, the term netana is used, which is probably a local term for nivartana and is said to represent 312 × 312 hastas, which will be about 5 acres (2 hectares). Till as late as 19th century A.D., a netana measure corresponding to 5 acres (2 hectares) was in use in Bihar.

Situation is the same, even in relation to the inscriptions relating to nivartana. Inscriptions covering almost all over India at one time or other refer to nivartana. Inscriptions of Sātavāhanas, Vākātakas, Pallavas, Kadambas, Cālukyas of Badāmi, Kalachuris, Rāṣṭrakūtas, Cālukyas of Kalyāṇi, Paramāras, Gahadvālas, Yādavas and their feudatories refer to nivartana in their grants.

The earliest record to mention nivartana, was from Nasik cave inscriptions. Rājan Gautamiputra Sātakarni donated 200 and 300 nivartana of land to the mendicant ascetics. In the Hirahadagalli grant (1st quarter of 4th century A.D.) of Śivaskandavarman, two nivartanas of land in the village of Apitti were given as gift.

Nivartana appears to have been measured by different dāṇḍas at different places. In the Godachi plates of Kattiarāsa dated 578 A.D., twenty-five nivartanas were measured by the royal standard (rājamāna dāṇḍa). In the Kolhapur inscription of Śilāhāra Vijayāditya (Śaka 1055), a grant of ¼ of a nivartana was measured by Kūṇḍi dāṇḍa. In another inscription from Kolhapur during the time of Bhoja II (Śaka 1112-1115), terms uttamā nivartana and kaniṣṭha nivartana occur.

In certain land grants, vague references are made about the measurement of nivartana. In the Abhona plates of Śaṅkara-gana (Kālachuri Samvat 347), a grant of 100 nivartanas of land in the village, Vallisaka in Bhogavardhana viṣaya is recorded. “Udbhaya Cāṭvārimśaka nivartanaṁ bhuminivartanaśatam” is understood by V.V. Mirashi as forty dāṇḍas on either side i.e. 1600 sq. dāṇḍas. Here, the length of the dāṇḍa is not mentioned.
In the Kadambapād德拉 grant of Paramāra king Naravarman, 20 nivartanas of land were measured with a rod, and the land was 96 parvas in length and 42 parvas in breadth. The measurement of the parva is not mentioned. If a parva is equal to 4 hastas, then the nivartana would be 1.6 acres (0.6 hectares). All these show that nivartana is an area measure and the area it represented depended upon the length of the rod used. Maruturu of Telugu records and mattar or mattru of Kannaḍa records are considered as terms equivalent to nivartana.

The length represented by danda varied from 2, 4 or 8 hastas in literature and also from area to area in epigraphical records. Unless the actual length of the danda is clear, it will be difficult to arrive at a proper value for nivartana out of the epigraphical records. Still several scholars have dealt with nivartana, arriving at different conclusions. One method of arriving at the value of nivartana is deducing it from other known measurements. Since Brhaspati and Yājñavalkya have stated that a nivartana is 1/10th of a gocarman, one can deduce the dimensions of a nivartana from gocarman. Here also there is no definite accepted relationship. As for example Matsyapuraṇa states that a gocarman is 2/3 of a nivartana. Again, the area represented by gocarman is not clear. This will be dealt with in detail while discussing gocarman.

In the Nagari plates of Ananga Bhāma III, dated Śaka 1151 and 1152, 18 vāṭīs in Pūrṇagrāma were granted to a brāhman Dikṣita Rudrapāṇiṣarman. The area of 18 vāṭīs of land is referred here as a gocarman. Pramoda Abhidhāna, an Oriya dictionary published in 1942 refers to a vāṭī as comprising 20 acres. Since nivartana is said to be 1/10th of a gocarman, a nivartana would be 36 acres according to this. It may be noted that the area represented by vāṭī was also not uniform.

According to Wilson’s glossary a vāṭī of land in Orissa is 20 mānas. A māna which is otherwise known as bigha, is said to be equal to 25 gunṭhas in Cuttak. A gunṭha (measuring 121 sq. yds. or the fortieth part of an acre in some places) is regarded as 16 bisvas, while a bisva is 1/20th of bigha. Based on this, the vāṭī can be regarded as 12½ acres (5 hectares). On the other hand, if 18 vāṭīs constituted a gocarman, then a
nivartana would be $22\frac{1}{2}$ acres (9 hectares). Both these calculations seem to be far off the mark of our ancient seers. Moreover, the 17th century work Dānamayūka states that a gocarmān is $2/3$ of a nivartana. Thus the approach to arrive at the area of nivartana, through its relationship to gocarmān of vāṭi adds to the confusion only.

One scholar concludes, that since the term nivartana literally means ‘turning back’ it probably indicates measuring of lands by an individual, starting from a particular point, going round the field and returning to the starting point within a certain time, thereby marking the exact boundary of the field covered, during the course of the round. A similar custom seems to have prevailed in Russia also. The Baskeers were said to have the habit of selling land by the day, i.e. as much of land as a man can go round on his feet, from sun-rise to sun set. Naturally, the area it represents is bound to differ, since the rate of walking differs from individual to individual. Perhaps the distance covered by a certain individual in a day, might have been used as the standard. However these are only conjectures.

From the Kasakuḍi plates of Pallava Nandivarman II, it seems nivartana and pāṭṭi are synonymous. The Sanskrit portion of the plates ‘Sāmanya nivartanadvaya maryādaya’ is a literal translation of the Tamil portion of the same grant ‘Samānya renḍu pāṭṭipadiyai’. No deduction can be made from these statements, since the exact area of a pāṭṭi is not known.

According to P.V. Kane the word nivartana was derived from the root ‘vṛit’ meaning encompass or surround with the prefix ‘ni’ and hence it is an area ploughed in a day by a team of six or eight oxen (ni=six or eight). Dr. D.S. Bose has come to the conclusion that the sq. nivartana of Brahma, quoted by Śukra is equal to 2500 sq. yds. (0.2 hectares), while in the Ārthaśāstra it is equal to 3600 sq. yds. (0.3 hectares). Dr. Pran Nath suggest, that brahmadeya nivartana is the area of land granted to a brāhmaṇ and is equal to an English acre. Dr. Altekar takes as 5 acres (2 hectares) and Dr R.S. Sharma
considers it as 1 ½ acre (0.6 hectares). 39 Dr. S.K. Das states
that nivartana is an area sufficient to support one man from
its produce. 40

All these differences appear to be mainly due to the varying
length of the cubits and the measuring rods used by different
people without any recognized standard. Even at present, in
different areas the measuring rods and areas represented by
the term bigha differ. Bombay bigha (3925 sq. yds.) is equal to
about 2 ⅓ Bengal bigha (1 Bengal bigha = 1600 sq. yds). Thus
nivartana seems to vary from 5 acres to 0.5 acres (2 hectares to
0.2 hectares) in different periods at different places.

Gocarman has been mentioned in many of the literary works
cited above. Gocarman literally means the area of land, that
could be covered by the hides of cow slaughtered in a sacrifice
and was granted as the priest’s sacrificial fee. 41 The term
gocarman has been interpreted in different ways. It is said to
indicate a piece of land large enough, to be encompassed by
straps of leather from the hide of a single cow, according to
Nilakantha’s commentary on Mahabharata. 42 According to
Parasara Samhita 43 and Bhraspati Samhita 44, gocarman is that
area of land, where one thousand cows could freely graze in
the company of hundred bulls (or one bull). Another, variant
reading of Bhraspati, quoted by Hemadri in Vratakhanda
states, the gocarman is equal to 80 nivartanas and a nivartana
is of 30 rod (square), with the rod measuring 10 cubits.
Sattatapa samhita agrees to the same. 45 Vijnaneswara slightly
differs by stating that the danda measures 7 cubits. 46 According
to the former it will be 45 acres (18 hectares) and the latter it
will be 22 ½ acres (9 hectares) approximately.

In contradiction to these, Hemadri quoting from
Matsyapurana in his Dahanakanda section states, that a
gocarman is 2/3 of a nivartana. In the same section he refers
to Vasiṣṭha having stated that a gocarman is 150 x 150 cubits. 10
According to these calculations gocarman may be close to a
hectare (2.47 acres). Vṛddha Vasiṣṭha and Parāśara (quoted by
Hemadri in Dānakhanda) indicate that hundred cows and a
bull can occupy a gocarman. 10 According to Viṣṇu Samhita,
gocarman is that much of land of whatever extent, the crops
raised on which will maintain a man for one year. Like
Hemādri, Aparārka also quotes most of these concepts.
According to Monier Williams and Wilson, gocarman is the
land measuring 300 × 10 ft; but this statement does not coin-
cide with any of the authorities quoted above. Thus the area
represented by the term gocarman is very confusing.

The term gocarman mainly occurs in Eastern India in the
grants of Ganga kings. In the Nagari plates of Ananga Bhima
III (Śaka 1151, 1152), the area of 18 vāṭis is referred to as
gocarman. A vāṭi in Orissa is equal to 20 mānas or 20 bighas
according to Wilson’s glossary as referred to earlier. Hence a
vāṭi is 12½ acres. The Oriya dictionary Pramoda Abhidhāna
(published in 1942) however, regards māra as equal to one
acre and vāṭi therefore will be equal to 20 acres. Hence
gocarman must be either 225 acres according to the former
and 360 acre according to the latter, both representing a large
areas. Perhaps these may be comparable with the statements
of Bhāspati and Parāśara. Gocarman, perhaps, may be
derived from gocara meaning the grazing field of the cow.
Pasture lands, which cannot be cultivated, might have been
donated as large areas to people. The area of a gocarman,
if it is taken in this sense, can only be an approximate measure
indicating a vast area.

Mattal, mattar (Kannada), maru, marturu or maruturu
(Telugu) are common terms used for measuring lands in
Karnātaka and Andhra Pradesh.

There is a vague reference in an inscription from Udari,
where it is given, that 100 kammars as being equal to a mattar. This reference relates to one Heggade Rajaya’s son, Heggade
Timmana, and daughter Heggade Chandave, who got a temple
of Sakalesvara constructed and for the feeding of the brāhmans
and for offering boiled food to God, had granted 53 kammars of
rice land and 50 kammars of wet land, aggregating to 1 mattar.
Another epigraph from Balambige refers to ‘kamma 50 kammars
50 antu mattarondu . . . kamma 60 . . . kamma 40 antu mattar-
ondu’ suggested that 100 kammars constituted a mattar.

Another inscription dated 1218 A.D., equates 2 hādas +35
kambas, 1 hāda+35 kambas+35 kambas+35 kambas totalling: 3 hādas and 140 kambas with 2 mattars 15 kambas. This, therefore suggests 100 kammmas or kambas are equal to a mattar. There are several other inscriptions mentioning gifts of 145 and 175 kammmas. It may be a way of expression or the term mattar may perhaps be more than 100 kammmas. It is interesting to note from the Talgunḍa inscription that one mattar of land was taken to yield two khaṇḍikas or khaṇḍugas of grain.

For the measurement of mattar several rods (daṇḍa or gale) such as Rājamānandaṇḍa, berunda gale, agradimba gale, Dhāṇavinodha gale (35 spans), Ovantaramalla gale (13 span), Bhūguda gale (28 span), Kirīya gale (small rod), Ṭāmbla gale (Tamil Country), etc., were used. In the Salotgi inscription, it is mentioned, that Mahāmadaleśvara Gounarāsa gave to the God Traipuruṣa at the agrahāra of Panithage, in the Badala thirty six, two hundred mattars of cultivated land, measured by the Ṭāmbla rod; two mattars of land in Bālambige, measured by magau rod; and three mattars of paddy fields measured by small (kirīya) rod in Singanakaṭṭe near Makiriyinti. Similarly in an inscription from Yewur several mattars were measured by Dhāṇavinodha gale, Elave gale and Ovantara gale. These show that several rods were used for measuring the mattar by the same person in the same gift of lands even in the same area.

In the Western Cāluṅkya records the term gaunigana mattar occurs. In an inscription of Vikramādiṭṭya VI, dry land measuring 40 kāla mattars, were given away as gift. Kai mattar is another term found in the Karnāṭaka records. Martu, marturu, matturu or maruturu are the Telugu counter parts for the term mattar. Though these terms were generally used for measuring wet land, it was not quite rigid. In the Hanamkonḍa inscription (Śaka 1001) and Bothpur inscription (Śaka 1181) maruturu is associated with both dry and wet lands. Marutelu and martulu are the plural forms of maruturu and sometimes the word mā itself referred to marturu. Several types of maruturu occur in the records from Andhra Pradesh. Mitṭa-kommu marturu might refer to some field in a higher level since mitṭa is high or rising ground. Pahimdivaya maruturu may be a certain measure of land, which brought an.
income in cash and not in kind. 61 Ghada maruturu 62 and kunta maruturu 63 are other types of maruturu. All these inscriptions are, however, silent about the area of the land these terms covered. 64

Kamma or Kamba, undoubtedly is smaller than a mattar mentioned in the inscriptions from Karnataka. 66 Literally this term means a rod or a stick, derived from the Sanskrit word stamba.

Paṭṭi is a common land measure in extreme South. This term is also used in Gujarat. It also means a sheepfold or a plot of land. In South, the names of the villages and hamlets often end with the suffix paṭṭi, thereby denoting an area of land. Paṭṭi also denotes a pole in Karnataka and different poles were used for measuring different soils. One pole or patti was used for black soil and other for masab or mixed soil and a third for tari or rice land. Within each classified soil also, the area represented by paṭṭi appears to have differed. As for example in black soil the pole or paṭṭi varied from 24 to 48 kurgis or drill plough’s day’s work. 66a

Paṭṭi is referred to as a piece of land in Halsi grant of Ravivarman. 66 In the Gorantla plates a gift of 800 paṭṭis of land at the village of Tanlikonda is recorded. 67 In the Candalur grant of Kumāraviśnu out of 800 paṭṭikas of land at the village of Candalur, the king offered 432 paṭṭikas as brāhmadeya, gift to brāhmans. 68 Several paṭṭikas occur in the Kaira grant of Cālukya Vijayarāja 69, which indicated the use of the term paṭṭi in Gujarat also. Till recently in Karnata the paṭṭi varied from 24 to 48 kurgis. According to the soil, one kurgi varied from 2 to 8 acres. Further, it is difficult to conclude about the area represented by the term paṭṭi, since the variations relating to the soil types appear to be too many. As stated earlier from the Kasakuḍi plates of Pallava Nandi-varman, paṭṭi and nivartana appears to be synonymous. This has been referred to under nivartana.

Kuḷi which literally means a pit, is used as a unit for area measure in extreme south only. Kuḷi was measured by different types of koles (measuring sticks) namely Kadigai-kulattukkol 70, māḷigaikol 71, nālučāṅkol (4 span) 72, pannirucan kol (12 span), padināručāṅkol (16 span) 73, etc. During the
time of Nṛpatuṅgavarman in an inscription, it is stated that 27,000 kuṭi of land were divided among various people, each kuṭi measured by a pannirucānkol (12 span rod). Therefore in the time of Nṛpatuṅgavarman, a kuṭi must have measured \[12 \times \left(\frac{2}{3}\right)^2 = 81\] sq. ft.

However, kuṭi measure is known to have varied from 144 sq. ft. to 576 sq. ft. in Karnaṭaka, Kerala and Tamilnādu. It is also considered as 1/240 of a pādagam.

Mā stands for the fraction 1/20 in Tamilnādu and Kerala in their mathematical tables. Hence Dr. D. C. Sircar considers 1/20th of a veli or 2.5 kāni or 2 sei as mā. In one of the inscriptions from Tiruvāvudur, during the time of Rājendra I (regnal year 6), a mā was considered as equal to 100 kuṭis, measured by māligaikol.71 Till recently in Tamilnādu and Kerala mā was equal to 240 kuṭis (3.17 acres, 1.3 hectares), which was the same as pādagam.

The measures described above are the measures using daṇḍas or hastas as the linear measure units. The following area measures were derived from plough measures, which was another system used for measuring cultivated lands.

Hala literally means a plough. A large plough was known as hali, jitya, lāṅgala and śirā according to Pāṇini. But whether all these expressions were used as units of measurement is not clear. Dvihalya and trihalya mentioned by Pāṇini appears to represent areas cultivated by two or 3 ploughs respectively.75

Manu refers to various kinds of ploughs. His commentator, Kullūkabhaṭṭā explains, that the area measure using a plough drawn by eight bullocks as dharma hala, that drawn by six for the cultivators (madhyama hala), that drawn by four was used for house-holders (grhasta hala) and the one drawn by three bullocks used for the brāhman (brahma hala)76. Atri sambhita however, refers to four kinds of hala drawn by eight, six, four and two bullocks.77 Bṛhspati has stated that a hala should be eight āṅgulas long and four āṅgulas broad; but he has not specified hala as a land measure. The statement by Bāna that “Haiṣa bestowed hundred villages, delineated by thousand ploughs” can refer to either the extent of land given away in hundred villages measured by thousand ploughs.79

It is difficult to ascertain the exact area that could be culti-
vated with one plough. If the soil presents a congenial condition and if the oxen are healthy, the area is bound to be more. The size of the plough is also an important factor in determining the extent of the land that can be ploughed in a given time. As the grades of soil were of different categories and the size and the capacity of the oxen also differed, the extent of the plough measure could not have been uniform throughout. When plough (hala) occurs as a measurement, it refers to that much of a land which can be cultivated by a plough in a given time at the given place. Only the time factor could have remained uniform.

Epigraphic evidence of hala measure usage are available in plenty. The term hala occurs in the inscriptions of many dynasties like Śatāvahanas, Pallavas, Rāṣṭrakūṭas, Cālu-kyas, Paramāras, Kalachuris and Cāhamānas. In a Prākṛt inscription from Nāgārjunakoṇḍa, pertaining to the time of Mahātalavāri Aḍavī Catiśri and Śrī Cātumūla, the former gave away hundreds of thousands of ploughs of land. In the Pallava grant of Śivaskandavarman (4th century A.D.) a lord Bappa was called the bestower of 100,00 ox or cow ploughs. In these cases, either the hala used may be smaller one, mentioned by Bṛhaspati or just poetic exaggerations.

The term bhikṣu hala, occurs in one of the Kārla cave inscription. Hieun Tsang has stated that the lands, which were given to the Saṅgha, were under the control of monks. Since the monks were not agriculturists, the lands were allotted to agriculturists, who had to give 1/6th of the produce from that land to the Saṅgha. The Saṅgha had to provide bulls, the land for cultivation etc., but was not responsible for any other requirements. Perhaps the measure used for this may be like brahma hala or as in the case of brahmādēya danda in the land grants to brāhmans, a liberal measure might have been used.

In the Paithān plates of Rāṣṭrakuṭa Govinda III (794 A.D.), the term grāma hala occurs, which indicates the measure used in that village. The Udayendiram plates of Nandivarman (8th century A.D.) refer to bhōga hala. In the Harṣa stone inscription of the Cāhamāna Vigrahamāja of V.S. 1030 (970 A.D.) a term bṛhad hala occurs. In the Bhatera plates of
Govinda Keśavadeva (1044 A.D.) and Mahārāja Yaśovarmadeva the term bhū hala occurs. These indicate the existence of hala measures of different sizes apart from the hala measures related to different number of cows or oxen used.

The term halavāha used in the Bombay Asiatic Society copper plate of Bhimadeva II and Paramāra Dhārāvarśadeva, means that much of land that could be ploughed with one plough. The Hathal inscription of Dhārāvarśadeva (V.S. 1237) refers to an area of land that could be ploughed with two ploughs. The Charkhari state inscription of Paramārdideva, records a grant of land which could be tilled by five ploughs in a day.

Haele seems to be of a local variations of the term hala. In the Sanderav stone inscription of Kelhāṇadeva (V.S. 1221) of the Cāhamāna dynasty of Sambhar, Analadevi granted one haele of Yugandhari and that some rathakāras also granted another haele of Yugandhari. This may perhaps mean the yield of jowar in the land. Hara used as corn measure in Kathiawar may also perhaps be a variation of hala, which may also mean the produce by a hala.

In a copper plate of Candella Madanavarmadeva, 7½ drōnas of seed are stated to have been used for sowing 10 halas i.e. one hala required 3/4 drōna of seed. A hala cultivated 34 amśas in Depalpur at the time of Bhoja Paramāra. In the Sunak grant of the Cālukya king Karna, it is stated that 4 halas of land, required 12 pāilam of seed corn for sowing. Hence 1 hala required 3 pāilam or 12 seers of seed. Plough measure is still current in some areas. Kurgi in Marathi is a land measure that refers to that much of a land ploughed in one day with a pair of bullocks and a drill plough, the extent varying from two to eight acres. According to Buchanan, the usual extent which can be cultivated by one plough is 10 large bighas or 15 Calcutta bighas of 5 acres (2 hectares). In Sylhet district, hala corresponds to about 10½ bighas or 3½ acres (1.6 hectares). One plough cultivates 10 large bighas or 5 acres (2 hectares) in Dinajpur and 6 acres (2.4 hectares) in Orissa while in South India it will be 2½ acres (1 hectare) of wet land and 5 acres (2 hectares) of dry land.
Sri Padmanath Bhattacharya gives the following table relating to the measures in Sylhet.

7 cubit = 1 nala
1 nala × 1 nala = rekhā
.4 rekhā = yaṣṭi
28 yaṣṭi = kedāra
12 kedāra = hala

Thus according to this table hala will be equal to 65,856 cubits that is 3.4 acres⁹⁸ (1.5 hectares).

Vādha is an unusual term occurring in the Mahoba plates of Paramārdideva, where it is stated that 5 ploughs could cultivate 60 sq. vādhus.⁹⁹ Therefore 12 sq. vādhas could be cultivated by 1 plough. Dr. Pushpa Niyogi arrived at the conclusion, that a vādha is equivalent to 1371.33 sq. yds.⁹⁴

Sirā occurs in Ṛgveda, Taittiriya Brāhmaṇa and Vājaseniya Samhitā, and Pāṇini’s grammar meaning a plough.¹⁰⁰ In the Rahan copper plates of Madanapāla and Govindacandra the term sirā denotes the extent of land cultivable by four ploughs.²⁵

Kula is an enigmatic term mentioned by Manu.¹⁰¹ According to the commentators Govinda, Kullākabhaṭṭa and Rāghavānanda, kula or kulya is as much of land as could be cultivated by two ploughs. Nandana, however, interprets kula as the share of one cultivator.¹⁰²

In this connection it will not be out of place to refer to the furrow length, which was termed as furlong in Britain. This was in use, till recently which indicates that plough measures were in use in other countries also.

There are many area measures which relate to the quantity of seeds sown. In many of the inscriptions, the terms like pāṭaka, kulyavāpa, drōṇavāpa, ṛdhavāpa, khārivāpa, pravaravāpa, unnāna or udamāna, khaṇḍika, or khaṇḍuga, mūḍa, etc., which indicate the measure of quantity sown. This system appears to have been followed till recently in many areas. In Tamil speaking areas the measure kottai viraippādu stands for the area required to sow a kottai of paddy (21 marakkal), and it is said to be equivalent to 1.6 acres (0.6 hectares).

In north Arcot district in Tamilnādu, the measurement kāṇi is based upon the sowing capacity, which differs for
irrigated and unirrigated lands in the ratio of 5:24. Irrigated lands required 7½ Madras measures (Madras measure having a stuck capacity of 105 c.m.) and unirrigated land required 36 Madras measures for sowing per kāni.

_Kulyavāpa, ādhavāpa and drōnavāpa_ are terms mainly mentioned in the inscriptions from Bengal. It is hardly seen in the literary records, except in the lexicons. According to Kullukabhaṭṭa (15 century A.D.), the commentator of Manu, _kula_ or _kula_ is as much of a land that can be cultivated by two ploughs. The word _kula_ also means a winnowing basket and _vāpa_, the act of throwing or scattering. Therefore, the term _kulyavāpa_ appears to be associated with the _kula_ measure of seed.

There is a controversy among scholars as to whether these terms _kulyavāpa, ādhavāpa and drōnavāpa_ are to be considered as the lands, which could be sown either by a _kula_, _ādhaka_ or _drōṇa_ quantity of seeds either directly or by transplanting the seedlings coming out of these quantities of seeds. The following information supports the view, that these measures represent the quantity of the seeds sown. Lexicographers, Medini, Viśva and Hemacandra mention that 1 _kulya_ = 8 _drōṇa_ = 32 _ādhaka_. _Kulya_ does not find its place in mathematical works, but the measure _khāri_, equivalent to 16 _drōṇa_ s, has found its place and so also _ādhaka_, which is considered as equal to 4 _prasthas_. According to Amara, the word _khārivāpa, drōnavāpa_ and _ādhavāpa_ indicate the area of land that could be sown with seed grains of one _khari, drōṇa_ or _ādhaka_. Almost the same terminology was used by Hemacandra in his _Abhidhāna Cintāmāni_. Modern lexicographers, however, differ with each other. According to Wilson, 1 _ādhaka_ was equal to 4 seers. Hence a _drōṇa_ would be 16 seers and _kulya_ 128 seers. According to Śabadakalpadruma, a _drōṇa_ is equal to 32 seers. Then _ādhaka_ and _kulya_ would be 8 and 256 seers respectively. In the Bengali compilation of Śabadakalpadruma the equivalents are _ādhaka_ = 16 or 20 seers; _drōṇa_ = 1 maund 14 seers or 2 maunds. Hence one _kulya_ would be between 12 to 16 maunds. Monier Williams states that in Bengal, the equivalent of _ādhaka_ is 2 maunds or 164 lbs. This seems to be too big a unit. According to Apte's dictionary _ādhaka_ is 7 lbs 11
ozs, which almost tallies with Śabdakalpadruma. Thus the values attributed to these measures varied extensively among different scholars. This is probably because the usages were different in different regions.

Many scholars have suggested different concepts. Pargitar has suggested that transplantation was common and that kulyavāpa indicated that area of land which was required to plant the seedlings of paddy seeds of one kulya in weight. He explained this from the Faridpur plate, where kulyavāpa was measured by 8 × 9 nalas, with kulyavāpa becoming a little more than an acre (3\frac{1}{4} bighās). He came to this conclusion, by assuming a nala as of 16 cubits and a cubit of having 19 inches. But in Pāharpur plates, the kulyavāpa was measured by 6 × 6 nalas. Hence kulyavāpa must have been measured by different nalas at different places. Sometimes the nala of 8 × 9 appears to have been measured by the hands of a particular person as can be seen by the use of the terms Dharvīkarma hasta, Śivacandra hasta, etc.

Dr. D.C. Sircar, analysing the various facts came to the conclusion, that both the systems of planting seedlings and of sowing seeds were prevalent in Bengal. One maund of paddy seeds was required for 3 bighas for sowing, while seedlings of the same weight of paddy required 10 bighas of land for planting. Seedlings of 1 kulya (16 maunds of paddy) required 128 to 160 bighas, for plantation. Hence a kulyavāpa will be equal to 128 to 160 bighas, drōṇavāpa 16 to 20 bighas and āḍkavāpa 4 to 5 bighas according to the transplantation concept. However, according to the system of direct sowing seeds these measures would be equal to 38 to 48 bighas, 4\frac{1}{2} to 6 and 1\frac{1}{2} to 1\frac{1}{2} bighas respectively. Dr Sircar used the following table for his calculations.

<table>
<thead>
<tr>
<th>Measure</th>
<th>Equivalent</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 muṣṭi (8 handful)</td>
<td>1 kuñci</td>
</tr>
<tr>
<td>8 kuñci (64 handfuls)</td>
<td>1 puṣkala</td>
</tr>
<tr>
<td>4 puṣkala (256 ″)</td>
<td>1 āḍhaka</td>
</tr>
<tr>
<td>4 āḍhaka (1024 ″)</td>
<td>1 drōṇa</td>
</tr>
<tr>
<td>8 drōṇa (8192 ″)</td>
<td>1 kulya</td>
</tr>
</tbody>
</table>

The earliest record to mention kulyavāpa, as a unit of measurement is in the Dhānāidāha copper plate inscription of Kumāragupta I (432 A.D.) and drōṇavāpa in Bāigrām copper
plate inscription (448 A.D.)\textsuperscript{108} and āḍhavāpa in the Pāhārpur grant (479 A.D.).\textsuperscript{107}

The relations between drōṇavāpa and kulyavāpa can be ascertained from the Pāhārpur copper plate inscription. The lands donated in that inscription were $1\frac{1}{2}$ vāstu drōṇavāpas at Veṭa-gohali, 4 drōṇavāpas at Prṣṭhimapaṭṭaka + 4 drōṇavāpas at Goṣatapuṇja + 2$\frac{1}{2}$ drōṇavāpas at Nitva-gohāli, these all together equal to $1\frac{1}{2}$ kulyavāpa, would be 8 drōṇavāpas.\textsuperscript{107}

In some of the inscriptions, the term vāpa is not mentioned, yet the implication is clear from the context, that the term referred to the area of the land in which that much of seed could be sown.\textsuperscript{110}

Hemacandra mentions drōṇika and khārika as synonyms for drōṇavāpa and khārivāpa.\textsuperscript{104} In a copper plate of Paramārdi-deva dated V.S. 1233, 7$\frac{1}{2}$ drōnas of seed was required for sowing a particular land.\textsuperscript{111} In the Vāillabhaṭṭaswāmin temple inscription, it is mentioned that 11 drōnas of barley were required for two fields, the areas of which are not otherwise mentioned.\textsuperscript{113} According to this inscription, that was the standard in use in Gopagiri. Kulyavāpa, āḍhavāpa and drōṇuvāpa are summarized by Dr. Sachindra Kumar Maity as follows:

\begin{align*}
1 \text{āḍhavāpa} &= 1.2—1.5 \text{ bighas} = 0.45—0.56 \text{ acres} \\
4 \text{āḍhavāpa} &= 1 \text{ drōṇavāpa} = 4.8—6 \text{ bighas} = 1.8—2.24 \text{ acres} \\
8 \text{drōṇavāpa} &= 1 \text{ kulyavāpa} = 38.4—48 \text{ bighas} = 14.4—17.6 \text{ acres} \\
5 \text{kulyavāpa} &= 1 \text{ pāṭaka} = 192—240 \text{ bighas} = 72—88 \text{ acre.}\textsuperscript{113}
\end{align*}

Another land measure with the term vāpa as the suffix, is khanḍukavāpa used in the Penukuṇḍa plates of the Western Ganga King Mādhava, in which a grant of a plot of land measuring 65 kedāras and 27 khanḍukavāpas is recorded.\textsuperscript{114}

In an inscription from East Bengal a term pravartha occurs. Owing to lacuna, the word which follows pravartha could not be deciphered. But it can be stated, that the text referred to the purchase of an uncertain area of waste land, measured by kulyavāpa together with one pravarthavāpa. Since the price for pravarthavāpa was two dinaras and the price of waste but cultivable land was four dinaras per kulyavāpa, Pargiter concludes that pravarthavāpa must be half of kulyavāpa.\textsuperscript{115} It is
preferable to conclude that pravarthavāpa is a fraction of kulyavāpa.

In a plate of Subhikṣarājadeva from Pândukeśvar, the terms khārivāpa, drōṇavāpa and nālikavāpa were mentioned. Nālikavāpa is a new term not found in the literature or other inscriptions. Dr Sircar concluded, that a nāli must be 1/16 of a drōṇavāpa. In Childers’ Pāli dictionary nāli or nālika is explained as the same as Sanskrit prastha. It appears to be of varying sizes. Tamil nāli is said to be smaller than the Sinhalese nāli, while the Sinhalese nāli is said to be half as much as the Magadha nāli. In the Mādhāinagar copper plate and Sunderban copper plate of Lakṣmaṇasena, khārika is mentioned. Perhaps it may be khārivāpa of Amarakośa. Evidently it will be better to conclude that nālikavāpa is smaller than drōṇavāpa while khārivāpa is bigger than drōṇavāpa.

Several Maitraka grants mention another measure prasthayavāpa. This may mean a measurement of land with a sowing capacity of a prastha of seeds. Since prastha is 1/4 of an āḍhaka, prasthayavāpa may be 1/4 of āḍhakavāpa, i.e. 0.4 to 0.5 bighas.

It is interesting to note that in almost all the terms ending with vāpa, the lands are mentioned as kṣetra and not as kedāra except in the Penukoṇḍa plates of Mādhava. Kṣetra normally refers to a field and kedāra refers to water-logged area. Generally, unless it is a water-logged area, direct method of sowing is adopted. Hence these measures can be considered as referring to the direct method and not the transplantation of seedlings.

Another point to note is that till recently the terms kulavāy, doṇ, āḍhā, are current in the eastern districts of Assam. Though these names sound similar with kulya, drōṇa and āḍhaka, there is hardly any similarity in the areas they represented.

Pāṭaka as a land measure bigger than drōṇa or drōṇavāpa, is also found in the inscriptions from Bengal. To mention a few examples, in the Ānulia copper plate inscription of Lakṣmaṇasena, the land granted was 1 pāṭaka, 9 drōṇas, 1 āḍhavāpa, 37 unnānas and 1 kākiṇika. In the Gunaigarth copper plate of
Vainyagupta dated 507 A.D., 11 pāṭakas of land are referred to as having been donated in a single village. The information given in Gunaiaghar plates helps to calculate the equivalent of pāṭaka in relation to drōṇavāpa. These plates refer to separate lands whose areas are as follows:

<table>
<thead>
<tr>
<th>Plate</th>
<th>pāṭakas</th>
<th>Drōṇavāpas</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7</td>
<td>9</td>
</tr>
<tr>
<td>2</td>
<td>28</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>1½</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>8¾</td>
<td></td>
</tr>
</tbody>
</table>

After mentioning these areas, the grant states that the total area was 11 pāṭakas. Hence 2.25 pāṭakas is equal to 90 drōṇa-vāpa that is 1 pāṭaka is equal to 40 drōṇavāpas.120

Since 8 drōṇavāpa is equal to a kulyavāpa, 1 pāṭaka will be equal to 5 kulyavāpa or 640 to 800 bighas. This calculation appears to be hypothetical and improbable, because these grants of lands would be too large an area (11 pāṭaka would be 7040 or 8800 bighas)116 for gifting away. If the pāṭaka is based on sowing rather than transplanting then it would be 2112 to 2640 bighas which also would be a very large area for a gift.

A different calculation emerges for pāṭaka in the Śaktipur plate of Lakṣmaṇasena122, where a brāhmaṇa Kuvera was given a gift of 6 pāṭakas in Rāghavahāṭa, Vārahakena, Vālīhiṭa, Vijaharapura, Dāmaravaḍā and Nimāpāṭaka. The first three together with Nimāpāṭaka measured 36 drōṇas. Vijaharapura and Dāmaravaḍā measured 2 pāṭakas and the total was 89 drōṇas. Hence two pāṭakas should be taken as 53 drōṇas. Thus the size of the pāṭakas appear to differ in different areas. It is not clear as to whether the pāṭaka was a land measure or represented a part of a village. According to Abhidhānacintāmaṇi it refers to half of a village.123

In the Naihāṭi copper plate of Vallālasena the term bhūpāṭaka is mentioned instead of pāṭaka (7 bhūpāṭakas, 7 drōṇas, 1 āḍhaka, 34 unmānas 3 kākas).124

From all these we can only conclude that the term pāṭaka refers to an area far bigger than hectare or even part of a village.
Unmāna or udamāna or udāna is a common measure mentioned in the inscriptions of Bengal.

From the Naihāṭi copper plate of Vallālasena, it is clear that 40 unmāna is smaller than an ādhavāpa, since the grant refers to 7 pāṭaka, 9 drōṇas 1 ādhaka (ādhavāpa) 40 unmānas and 3 kākas (kākini).\(^{124}\)

The lost Sunderban copper plate of Lakṣmaṇasena has been translated in different manners, by different authors. The grant consisted of a plot of land of a village called Maṇdalagrāma, along with a homestead, measuring 3 bhudrōṇa, 1 khādika, 23 unmāna and 2½ kākini according to the standard of (dvādasाṅgula adhika hastena, dvātrimśadhasta parimitomānena) 32 cubits, a cubit equalling 12 aṅgulas. In this sense unmāna would be \(32 \times 32\) cubits = 1024 sq.yds = 1/9 bigha (0.15 acre).\(^{125}\) However, Dr D.C. Sircar has suggested that the first part of the inscription suggested a cubit of 36 aṅgulas (27 inches) and the second to the nala of 32 cubits.\(^{126}\) Considering an ādhika to be of 5 bighas, 45 unmāna would be 1 ādhavāpa. All the same, this cannot be considered as conclusive, because the medical text Caraka Samhitā\(^{127}\) and Sārangadhāra Samhitā\(^{128}\) equates unmānas with drōṇa. If this evaluation is considered, unmāna, perhaps may be equal to a drōṇavāpa. However, it will be safer to conclude that it is a bigger unit than kākini but smaller than ādhavāpa.

Kākini or kāka is another term common in the copper plates from Bengal.\(^{129}\) Perhaps this term stands for kāṇi mentioned in the literature. W.W. Hunter in his "A Statistical Account of Bengal" refers to kāṇi, which is a little over an acre in the Daaca and Mymensingh districts of Bengal.\(^{130}\) In Sandvīp in the Noakhali district of South East Bengal, 16 kāṇi is a don (drōṇa) and a kāṇi is of 20 gaṇḍas or 80 kadās. Since 30 kānis are regarded as pakhi measure of land (3622 sq. cubits) in Faridpur, one kāṇi will be 120 sq. cubits (0.4 acre).\(^{131}\) In Tamil speaking areas kāṇi is still in vogue which varies from 1 to 1.32 acres (0.4 to 0.6 hectares).

Gaṇḍā appears in the India office copper plates of Lakṣmaṇasena, where 1 drōṇa, 1 āḍha, 28 gaṇḍas minus 1 kāka was given as gift.\(^{131}\) Dr. Sircar vaguely surmises that gaṇḍa may probably be a substitute for udmāna. It is 1/20th of a kāṇi.
according to him while according to Wilson it is 1/5 of a *kānī*. From the measures current in Sandvip in Noakhali district the following equations are available:

- 4 kadās = 1 gāṇḍā
- 20 gāṇḍās = 1 kānī
- 16 kānīs = 1 don (drona)

According to this table one *gāṇḍā* would be 6 sq. cubits which is also current in Sylhet.

*Kariṣa* occurs only in the Buddhist records. In *Suvanṇakakkata Jātaka* and *Sālikēdāra Jātaka* farms of 1000 *kariṣas* are mentioned. According to Childers, 1000 *kariṣas* would be 8000 acres. Rhys Davids has taken *kariṣa* as the area of land on which a *kariṣa* of seed can be sown. Childers also states that it is a superficial measure of 4 *ammana*. The *ammana* was probably of 4 bushels. According to this a *kariṣa* would be 16 bushels or 9 to 10 maunds of grain. 9 to 10 maunds can be sown in an area of 10 to 11 acres. According to a scholar, the 1000 *kariṣa* mentioned in the *Jātaka* would be 10,000 or 11,000 acres and that seems to be quite a large area. Probably the *Jātaka* records are associated with poetic exaggerations. In *Kalinga-Bodhi Jātaka* the term *rājakariṣa* is mentioned. This perhaps may be a royal measure.

*Vrihipīṭaka* occurring in a Maitraka grant, literally means a plot of land, where the standard sized basketful of paddy could be sown.

*Tumu* is another land measure, mentioned in a large number of inscriptions, generally in Andhra. According to Mallana it comprises of 25 *kuntas* and according to Brown it is 1/20th of a *puṭṭi*. *Tumu* is also used as a measurement for weight. So, in the inscriptions when they are used as *iddumu cenu* (two tumus of land), *reḍḍi muttumu* (three tumus of land), *pandumu cenu* (ten tumus of land), etc., it probably represents the sowing capacity. In the Pakala inscriptions dated Saka 1242, it is recorded that in the reign of Mahāmandaleśwara Kākatīya Rudradeva Mahārāja, the komaṭis of Nellore gave wet land having the sowing capacity of 5 tumus. This further confirms the fact that this term in relation to area measure represents the sowing capacity. Some scholars doubt
that these terms may represent the yielding capacities of land rather than the sowing capacities.

*Mūde* mentioned in the Alupa and Kadamba inscriptions, from South Kanara, may also refer to the land having a sowing capacity of a *mūde* or *mūdaka* of corn.

*Adda* occurs as land measure in the inscriptions from Guntur, Mahubnagar and Khammamett districts in Andhra Pradesh. *Adda* is a measurement for wet land, measured in terms of sowing capacity.

*Khaṇḍika, khaṇḍuga or khaṇḍuva or khaṇḍu* were generally units for dry land in Andhra and Karnāṭaka areas but it is not always rigid. It can also define the area of wet land; but only the areas will be different. It can be said to represent 6400 sq. yds. of dry land and 10,000 sq. yds. of wet land. It is also a unit of weight equivalent to *khaṇḍi* or *puṭṭi*. As a dry measure, it varies very much from region to region. For example it is 409,600 tolas in Belgaum, 13,440 tolas in Mysore and 128,000 tolas in Coorg.

A copper plate from Nagamangala (777 A.D.) indicates, that Prithvi Kongāṇi Mahārāja Vijaya Skandadeva donated several *khaṇḍugas* of land for garden, house site and irrigation along with some waste land for a Jain temple. The editor suggests that it refers to that much of a land needed for sowing several *khaṇḍugas* or *khaṇḍuga*, a khanduga being equal to 3 bushels of seeds. In another inscription belonging to the time of Kongāṇi II, Avimita gave several *khaṇḍis* of land to a brāhmaṇ Devavarman. In the Gaṇeśgadh copper plates of Maitraka king Dhruvasena I (Gupta year 207) eight *khaṇḍas* of land measuring 300 *pādāvartas* and two cisterns in the village of Haryāṇka were donated to a brāhmaṇ Dhammila. Hence one *khaṇḍa* would be 37½ *pādāvartas*. *Kha* which is found in a number of inscriptions, might be an abbreviation of *khaṇḍuka*.

*Kolaga* is also a land measure occurring in the inscriptions from Karnāṭaka and Andhra. This may represent the sowing capacity. *Solage, salage* and *sollage* occurring in the various Karnāṭaka grants also refer to the same sowing capacity.

*Puṭṭi* which occurs in Andhra inscriptions is of 500 *kuntas*. 

Puṭṭi is also a weight and hence it could be the sowing capacity or even yielding-capacity. As a weight it is a ton, according to Brown’s Telugu dictionary. The sowable capacity of I puṭṭi of grain would be 80 acres by transplantation method and 40 acres by direct sowing. The former is known as callakamu and the latter is known as udupu in the West and East Godavari districts and nareta in Nellore district. Several inscriptions refer to puṭṭi, puṭṭendu cenu (one puṭṭi of land), aidu-puṭṭala-cenu, (five puṭṭis of land), padi-puṭṭa cenu (ten puṭṭis of land)\textsuperscript{58}, pamḍṛendu puṭṭa-cenu (twelve puṭṭis of land)\textsuperscript{54}, etc. There seems to be different kinds of puṭṭis also and one such term is gal-puṭṭi.\textsuperscript{155}

Bhūmi literally means a land. It is referred to in Śatapatha Brāhmaṇa, in relation to land gifts.\textsuperscript{156}

This measure has been utilized earlier, in Vākāṭaka and Gupta inscriptions. In the Chammak copper plate inscriptions of Mahārāja Pravarasena II, the village of Cārmānaka was measured by 8000 bhūmi according to the royal measure.\textsuperscript{157} In the Dudia plates of Pravarasena II, issued in his twenty-third regnal year, grants were made in the Arammu rajya, 25 bhūmis of land at Darbhamalaka in the Candrapura confluence were granted to Yaksarāya and 60 bhūmis at the village of Karma-kara in the Hiraṇyapura bhoga to Kaliśarman.\textsuperscript{158} From these records, the area which this term represented, could not be ascertained. But Dr. Mirashi, however, translated bhūmi as nivartana.

In certain places the term bhūmi clearly refers to the yielding capacity. In the Gauhati plates of Indrapāla, the bhūmi allotted is specified as land in which 4000 measures could be grown (Chatuḥsahasropattika bhūmau).\textsuperscript{\textsuperscript{159}} Similarly in the Nowgong copper plate of Balavarman, the land called Hensive, with a producing capacity of 4000 measures of rice (dhānyachatus-sahasropattimati Hensive, abidhāna bhumiḥ), was given as gift.\textsuperscript{\textsuperscript{160}} Two copper plate grants of Ratnapāla of Pragjyotisha (1st half of 11th century A.D.) refer to a price of land, each producing 2000 measures of rice (dhānyadvīsahasropattika bhūmau).\textsuperscript{\textsuperscript{161}}

In the Cambā copper plate inscription of Somavarmadeva and Āṣāṭadeva bhū, bhūmi, and bhū maṣaka occur as land
measures. The editor surmises bhūmi to be a superficial measure and bhū as the shortened form for bhūmi. Bhūmaśaka is regarded as one fourth of a bhūmi. Certain inscriptions refer to bhūmi in the sense of a land as in the case of 'nilam’ in the South Indian inscriptions.

There are certain terms which does not come under any of the above categories, but were prevalent in local usage. The information available on these terms are given below.

Vāṭi or vāṭika generally means a garden, enclosure or fence. This term is very common in the inscriptions from Orissa. It is defined in Mayamatam as of 5120 sq. daṇḍas, the latter being 4 cubits each. According to this calculation a vāṭi will be 4.48 acres. According to Wilson’s glossary, it is 20 mānas.

The terms vāṭika, māna and guṇṭha can be ascertained to a certain extent from the Kendupaṭha plates of Narasimha II (Śaka 1217). The land measuring 100 vāṭikas was granted to Bhīmesavaravarman in four pieces. The first plot was in the village Vakalagāma. The land measured 60 vāṭikas 7 mānas and 20 guṇṭhas, out of which cattle lands covered 26 vāṭikas 2 mānas and 15 guṇṭhas. Hence the area allotted was 34 vāṭikas, 5 mānas and 5 guṇṭhas. The second plot in Gadhaigrāma measured 40 vāṭikas, 17 mānas and 1 guṇṭha, of which the cattle track was 11 vāṭikas, 0 mānas 3 guṇṭhas. The remaining 29 vāṭikas, 17 mānas and 23 guṇṭhas were allotted. The third plot was in the village of Kalingagrāma measuring 10 vāṭikas, 17 mānas and 8 guṇṭhas. Of this the pasture land covered 1 vāṭika, 16 mānas and 23 guṇṭhas. The remaining 9 vāṭika, 0 mānas and 10 guṇṭhas were granted. The fourth plot measured 31 vāṭikas, 15 mānas and 6 guṇṭhas, out of which cattle track and pasture land covered 4 vāṭikas, 17 mānas and 19 guṇṭhas. Therefore, the land allotted was 26 vāṭikas, 17 mānas and 12 guṇṭhas. The total land granted is, therefore, as follows:

<table>
<thead>
<tr>
<th>vāṭikas</th>
<th>mānas</th>
<th>guṇṭhas</th>
</tr>
</thead>
<tbody>
<tr>
<td>34</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>29</td>
<td>16</td>
<td>23</td>
</tr>
<tr>
<td>9</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>26</td>
<td>17</td>
<td>12</td>
</tr>
</tbody>
</table>

vāṭikas 100 0 0
Here, māna consisted of 25 gunthas and 20 mānas make a vātika. Since the māna is now regarded as equal to an acre in Orissa a vāṭi must be 20 acres.

Gunṭha or gunṭa is a common land measure in the inscriptions from Andhra and Orissa—this is considered as 1/25th of a māna at present. Hence, it can be considered as 2 acres. Generally it varies from 120 to 200 sq. yds. Till recently a gunṭha is 1/40th of an acre in Karmāṭaka. People do not use fortieths when they divide a gunṭha, but divide it into sixteenth of an anna. $8\frac{1}{4}'' \times 8\frac{1}{4}'' = 68\frac{1}{15}$ sq. ft. is an anna and 16 such anna is a gunṭha (sq. ft. or 121 sq. yds.).

Till recently in Kairatnagar zamindari a gunṭha is a chain of 60 country feet of unirrigated land and 56 country feet of irrigated land. The country foot is the length of the foot of the goddess, in the temple of Kampūlapāliyam, which is equal to $10\frac{1}{4}''$.

Timpira is a rare term mentioned only in the inscriptions from Orissa. In a charter of Dharmarāja Mānabhitā (695-730 A.D.) of Sailodhβhava family of Kengoḍa in Orissa, land was measured in timpira.

Pratyāṇḍaka occurs in a single inscription, from Tiḍguṇḍi, during the time Vikramāditya II (1083 A.D.). King Munja’s ancestor Bhīma, was described as the lord of 4000 pratyāṇḍakas (Pratyāṇḍakaka chatusahasradeśādhipati).

Kunta is a common term in the Andhra inscriptions and 12×12 sq. hastas according to Sārasangroha gaṇita. An inscription, dated Śaka 1140, states that one Vailama setti gave 200 kuntas of wet land to the god, Gaurīśvara Mahādeva. Another record registers a gift of 13,000 kuntas, given by Rudra Pergade for the religious merit of Rudra Mahādeva.

Matlhu occurs as a measurement for waste land as well as garden land. The Pillamāri inscription of Śaka 1130 refers to 4 matlus of garden land, 2 matlus of waste land.

Viṣa or viṣamu is referred in Taṇḍuvāyi inscription and is considered as two acres.

Paṭṭu occurring in Kuricheḍu inscription (Saka 1092) and Timmasamudram inscription cannot be identified.

Kuchchela occurring in the Andhra records is considered as 25 to 29 acres.
Gorru is an unspecified land measure occurring in a few inscriptions. At present at Guntur, gorru is equal to 3.167 acres. It varied from 5, 4, 4.6 and 1.1 acres in South Arcot district till very recently.

Baralu is a linear standard, measured with a pole of 12 yards. An inscription from Candalur refers to a gift of lands measured with a pole of 12 baralu.

Pedda gadyamu is mentioned in the Mellacherumu inscription of Śaka 1233. Pedda means big in Telugu and gadyamu, may have some connection with gajamu or yard.

Ceṭulu is a measure employed for measuring house-sites in Andhra. It literally means an arm’s length.

Mullu and muḍlu also occur in connection with house-sites. A Pālakol inscription refers to mullu in connection with grhaṇṣṭra. Another inscription also refers to muḍlu for a grhaṇṣṭra. Perhaps these terms may be the same as mura or muralu, which is equal to ¼ yards, corresponding to Tamil muḷam.

Patiṅḍu or patuka is another measure of land mentioned in the inscriptions from Andhra. Patuka or patiṅḍu in Telugu means ¼ of anything.

Khāris of land occurs in the Andhra inscription dated S.S. 1352. It is not clear, whether it refers to the sowing or the yielding capacity.

Hāda (Sanskrit Pāda) mentioned in Kannada records is considered as ¼ of a nivartana.

Pātha is mentioned in the Timāna grānt dated 1207 A.D. The Mehara King Jagadekamalla, perhaps a feudatory of Cālukya Bhima II, made a gift of 55 pāthas of land in each of the two villages, Kambalanti and Pulasara. According to Wilson and Dr. D.C. Sircar, it is equal to 240 sq. ft. and perhaps may be synonymous with pāṭaka of Bengal and pāḍagam of extreme south. It has already been seen that pāṭaka is a very big-land measure leading to several acres.

Pāḍāvarata can be interpreted in several ways. Etymologically the term suggests the measure by foot. It is one foot each way or 1 foot square. When the land survey was conducted in the time of Kulottunga Coḷa I, his foot measurement (Śrīpāḍa) was taken as the unit. This may be the case
with the Maitrakas also, where the royal standard was perhaps taken into consideration. In one of the gifts of Maitraka king Dharasena II from Pālitana along with the other gifts the king gave sixteen pādāvartas as a gift. This is too small an area to be gifted and mentioned in a grant. In another inscription of Dharasena II, three hundred and thirty-five pādāvartas of cultivated land were given to a dīkṣita. The land was in five pieces, 120, 100, 90, 15 and 10 pādāvartas. Ten pādāvartas would be a very small size to be cultivated. Perhaps this may be for a building site or even a well since it was an agricultural land. As in the case of the Roman concept of mile, the step rather than the foot might have also been taken into account.

Till recently, in some of the villages in South India, the foot measure of the Goddess of the local temple which is $10\frac{1}{4}$" was taken into account, while measuring land. Here it represents only the foot and not a step.

Pādāvarta has another interpretation also. The term pāda stands for $\frac{1}{2}$ of a circle or square or any thing. Hence, it may be taken as $\frac{1}{4}$ of a bigger unit.

Pāsa may be the equivalent of rajju of Kauṭilya. During the reign of Bhīma II, Mahipāla gave 350 pāsas of land yielding 4 khanḍikas to one Mādhava. Measuring by hempen rope was mentioned by Abul Fazl. The ancient Greeks used the cable of 61 ft (600 Greek feet). The rope measure of 32 yds. was in use in Tamilnādu till recently.

Kedāra or keyār, which was current till recently in Sylhet, can also be traced in the Penukoṇḍa plates of Mādhava, where a grant records 65 kedāras of land in Karmatuvaṅkaṭetra, which could be sown with 27 khanḍukas of seed (800 to thousand seers). Kedāra literally means a water-logged area. According to Padmanath Bhattacharya’s table, a kedāra is 0.3 acre in Sylhet. Nihar Ranjan Roy has given the following table which includes kedāra.

<table>
<thead>
<tr>
<th>Measure</th>
<th>Equivalent</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 krānti</td>
<td>= 1 kaḍā</td>
</tr>
<tr>
<td>4 kaḍā</td>
<td>= 1 gaṇḍā</td>
</tr>
<tr>
<td>20 gaṇḍā</td>
<td>= 1 pana</td>
</tr>
<tr>
<td>4 pana</td>
<td>= 1 rekha</td>
</tr>
<tr>
<td>4 rekha</td>
<td>= 1 yaṣṭi</td>
</tr>
<tr>
<td>7 yaṣṭi</td>
<td>= 1 poā</td>
</tr>
<tr>
<td>4 poā</td>
<td>= 1 kedāra or keyār (7/8 bigha)</td>
</tr>
</tbody>
</table>
This table and the table of Padmanath Bhattacharya agree that 28 yasti make one kedara. Whether the kedara mentioned in the Penukonda inscription is also of the same area is not certain.

Kani is still in vogue in South India. Since as a fraction it is 1/80, Dr D.C. Sircar came to the conclusion that it is 1/80 -of a veli. Actually the term “kani nilam” refers to a tract of land. Kani is mentioned in the ancient Tamil works Tolkappiyam and Nalaadiyar.100

In some places kani is 1/8th of a veli. This term varies from 0.75 to 1.5 acres. In certain Tamil-speaking areas, the land measure is an area in which a certain quantity of seed can be sown, but this is only an estimate. In North Arcot-district 7½ Madras measures are required to sow a kani of irrigated land and 36 Madras measures are required to sow a kani of unirrigated land. The Madras measure is called padri and was used till recently in Madras bazaars, having a stuck capacity of 62½ fluid ounces in terms of volume or about 110 tolas of weight of rice, but when heaped it will be about 122 tolas.

Kani in E. Bengal is a little over an acre in the Dacca and Mymensing district. In the Faridpur district it is equal to 120 sq. cubits. In Sandvip, in the Noakhali district, kani is equal to 1/6th of a don (drona) or equal to 20 gangas or 80 kaadases.100 In Oriya it is only a hand’s breadth.

The term kakanika measuring 256 yds in Mayamatam does not seem to have any connection with kani.

Muntrigai or mundiri is actually the fraction 1/320. As a land measure it is 1/320th of a veli. According to mathematical works it is 1/320 of any measure. Mundiri occurs in the ancient Tamil works Tolkappiyam and Nalaadiyar.100

Sri, which literally means a field, occurs as a land measure in the inscription from Tamilnadu and Kerala.191 It is 276×276 sq. ft. or 1.75 acres (0.7 hectares) at present.

Kuli is of 576 sq. ft. and 100 kulis make a maka and 20 maas a veli. Literally kuli means a pit, maka means 1/20th and veli a fence.

It may be noticed from all these area measures of ancient India described above, most of these area measures were used
generally for making gifts of land and later on for cadastral surveys. The same terms appear to denote different regions even in the same period and also appear to be different in the same region from period to period, just as in the case of the linear measures in ancient India.

In different regions, the approach towards measuring out the lands appeared to have been different. The use of danda of definite hastas appear to be in vogue in many regions from very ancient times, even though the length of the danda was not uniform at all places. The area measures namely nivartana and gocarman, though used extensively in most of the regions, it is really very difficult to say exactly what extent of area they really represented. Probably, at each place a local standard danda and a local definition of the number of danda squares were adopted purely as local standards in relation to these area measures.

Certain type of area measures were purely regional. The terms mattr, marutu, kamba, etc., were used mainly in Andhra and Karnataka regions, while the terms patti, kul, ma, veli, kani, etc., were used in the far South.

For agricultural lands the plough measure like hala appears to have been used more extensively. The plough measure concept appears to be in vogue even in other ancient civilizations also, as seen from the present day furlong, which arose out of the furrow-length.

On the Eastern regions, the area measures associated with the quantity of seed sown or based on the yields, were used more extensively than in the other regions.

Area measures based on sowing capacity was used in other ancient civilizations also. For example the Palestinian jugon (which is equal to 13 Roman jugera) is also called korean, because the land required a kor of seed for sowing. Jugon is approximately 8.1 acres (about 3.2 hectares).^{192}

Thus on the whole the area measures of ancient India appears to have been based purely on local standards and usage without any all India standardization, just as in the case of the linear measures of those times. Many of these measures have been in use till very recently in many areas.
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   “Mundiri merkāṇi mikuvelai” *Nālaḍiyār* 364.
THE earliest concepts of volume measures must have arisen in India in relation to giving offerings at Vedic rites and also in giving alms and gifts of grains and valuables, as well as, for rough measures in cooking and other activities. *Mushti*, which is a handful, would have been the earliest and the easily conceivable volume measure for such purposes. Both the palms cupped together either to receive or to give grains, food, etc., can also be a very early practice. Thus, *mushti* (palmful) and *añjali* (the double palmful) must have been the basis for conceiving larger volume measures in ancient India. In the Vedic literature, the volume measures like *añjali* and *prashti* are mentioned. In the subsequent periods, many volume measures came in to use on regional basis, without any standardization of general nature. Some of the terms were the same, but the actual volume they represented differed from area to area and also from period to period even in the same area, just as in the case of linear measures and area measures described in the earlier chapters. In this chapter, the various volume measures in use in ancient India are mentioned in the order of increasing volumes and in each case the references are given in the chronological order of the period in which they were in use. Efforts were also put in to indicate the volume equivalence they represented in relation to each reference.
Before going into the details of each measure, it would be worthwhile to point out briefly a peculiarity in the use of volume measures, such as kuḍava, prastha, ādhaka, drōṇa, etc., as weight measures also in ancient India. An example of a similar nature can be noted in the modern term ounce. The same term ounce, when it is used as a volume measure it is nearly 28.5 cc, and as a weight measure it is 28.5 gm., taking into consideration the fact that 1 cc of water at 4°C is equal to 1 gm weight. In a similar way in the past in India, the volume and weight measures were primarily used for the measuring of grains, using the hollow volume measuring vessels. These were equated with the weight of that amount of grain which that vessel can deliver. Here again two variations are possible. Since the grain can be measured out in a heaped measure, the weight will be more than the stuck capacity of the same vessel. These two variations, along with the confusion, relating to whether one is talking about volume or weight in a given reference, have created great difficulty in equating the values given by different authors, at different times and at different places in ancient India. Efforts have been made in this study, not only to present the information as available in the inscriptions and literature, but also finally to present them in a tabular form trying to bring out their possible equivalents.

It will also be relevant to mention another aspect here. Sāṅgadhrāśa in his medical treatise had to use very small weights and volume measures using seeds of various types (e.g. marichi, mustard, sesame, barley, etc.) and relate them to the terms like ādhaka, etc., in his table relating to weights and volume of drugs and materials used for making medicines. These will also be referred to in this study.

Muṣṭi, which represents the closed fistful is the oldest volume measure mentioned in Vedic literature. A fist size will vary considerably from individual to individual. A muṣṭi of paddy is found to be approximately 60 cc on an average. 60 cc of paddy approximately weighs 32 gms. Muṣṭi would have been the most convenient form of measure to give alms, gifts of grains, etc., in ancient India. Pidi is the counterpart of muṣṭi in Dravidian languages. Mahāvīra's ṣodaśika might also-
be a muṣṭī. A muṣṭī is said to be equivalent of pala by many authors.

Prasṛṭī designates, primarily, the hollowed hand stretched out to receive what is offered. It occurs first in Śatapatha Brāhmaṇa as a measure of capacity meaning a handful. Two palas or two muṣṭīs constituted a prasṛṭī according to the Purāṇas.

Aṇjali means two handfuls joined together; that is double of prasṛṭī. In the Purāṇas and mathematical works, this is also termed as kuḍava or seṭīka. Kuḍava according to Bhāskara-cārya is a vessel made of earth or similar material, which is in the shape of a cube measuring $3\frac{1}{2}$ aṅgulas in every dimension. Since Bhāskara considers 8 yavas for an aṅgula, his aṅgula can be equated with an inch. Thus the volume of kuḍava would be $(42\frac{1}{2}$ c. aṅgulas or 550 cc approximately). Kuḍava according to the medical text Sārangadharā samhitā is a vessel made of mud, wood or bamboo having 4 aṅgulas diameter and 4 aṅgulas in height.

Considering aṅgula as 6 yava pramāṇa, which is equal to $\frac{3}{4}$", a kuḍava would be about 330 cc. This is in relation to Magadhamāṇa. Sārangadharā refers to a Kalingamāṇa also, which is slightly different from Magadhamāṇa. The term kuṭaka appearing as a measure for salt in Harṣa stone inscription may probably denote a kuḍava. In Avadānaśataka, kuḍava is termed as kavaḍa. Modern chāvdo of Gujarāt seem to be the same as kuḍava.

Kunchi occurs in Varāhapurāṇa consisting of 4 prasṛṭī or 8 muṣṭīs. This may be synonymous with mānika of the medical texts.

Prastha is a common term in Purāṇas and mathematical works measuring 8 prāṣṭīs. A vessel of 5 aṅgulas in height and 4 aṅgulas in diameter (पञ्चाङ्गुलाक्ष्य पाविक चतुर्गुलाक्ष्य विस्तृतम्), is a prastha according to Śukra. Since according to Śukra an aṅgula is of 5 yavapramāṇa, which is equal to 0.6 inch, his vessel measuring a prastha will be equal to about 37.7 c. inches (514.58 cc) if it is cylindrical and if it is cuboidal ($2''\times2''\times3''$)
then it would be 12 c. inches (196.65 cc) in capacity. According to Varāhapūraṇa, a prastha, which is also termed as puṣkala, is equal to 64 muṣṭis, which will be 4 times larger than in other references. In Kaṇakkusāram\textsuperscript{11}, a text book in Malayālam, prastha is considered as being equal to an idangali, which is approximately 2 litres.

A solitary inscription from Mathura refers to a prastha of salt.\textsuperscript{12}

Taking into consideration the fact, that a muṣṭi is approximately 60 cc and since a prastha is equal to 8 prasṭis or 16 muṣṭis, a prastha can be just short of a litre in volume and this fits in with that of Śukraniti. According to Sārgadharā, dry and liquid measures are one and the same upto kuḍava. From prastha onwards liquids are measured by a standard, double that of dry materials.\textsuperscript{13}

प्रस्थाविदमानमार्गम् दिगुर्ण तद्देववाद्योऽः।
मार्गं तथा तुलायाष्ट्र दिगुर्णं स न वचस्तिःस्मृतं ! 1:35

Aḍhaka (ālaka-Pāli) is used as a measure of weight as well as capacity. It is generally accepted as $\frac{1}{4}$ of a drōṇa of 4 prasthas. However, Śukra\textsuperscript{9} differs slightly, since he states that 5 prasthas make an aḍhaka.

Varāhamihira distinguishes two types of aḍhakas, one for measuring water (water aḍhaka) and another for measuring other materials (ordinary aḍhaka). The water aḍhaka of 50 palas was referred to by him for measuring rainwater. He uses this water aḍhaka for selecting the suitable building sites as follows. According to him, the earth dug out of a pit in the house site, when filled into the water aḍhaka, should weigh 64 palas, if the site is suitable for building construction. That obviously indicates that the soil should have a density of at least 1.28 for building construction. Lighter weight or loose soils would be unsuitable. Varāhamihira states that these measures are according to Magadhamāna.\textsuperscript{14} This concept of an aḍhaka having 50 palas, is also confirmed by Kauṭilya\textsuperscript{15}, who considers the state revenue measure of drōṇa, as being equal to 200 palas, a drōṇa being equal to 4 aḍhakas.

Monier Williams equates an aḍhaka with 7 lbs. and 11 ounces, which does not fit in with the above calculations, but
appears to be more in keeping with Sārangadharā and Caraka18 who consider an ādhaka to be equal to 128 palas. Dr. D.C. Sircar describing the Bengali measures based on mediaeval Bengali measures described by the medieval Bengali writers on Smriti, such as Kullukabatṭa, Raghunandana, and Pañcānana Tarkaratna17 gives the following table of weight measures.

| 8 muṣṭi (handful) | = kuṇchi |
| 8 kuṇchi (64 handful) | = puṣkala |
| 4 puṣkala (256 ” ) | = ādhaka |
| 4 ādhakī (1024 ” ) | = drōṇa |
| 8 drōṇa (8190 ” ) | = kuṭya18 |

Here along with Śrīpati4, these authors appear to consider an ādhaka to be equal to 256 palas or muṣṭis.19 The various tables of measures according to different authors are given at the end of this chapter. This higher value for the Bengali measures is in keeping with the Bengali compilation of Śabdakalpadrumā (quoted by Dr D.C. Sircar), where a Bengali seer was double the kacha seer used in Western India. Thus the same term ādhaka also appears to have been used to denote different volume and weights in different parts of India at various times.

Ādhaka and prastha are mentioned in the Mathura inscriptions12 of Haviṣka, in relation to an endowment for feeding the brāhmins. In the Bijapur inscription20 of Rāṣṭrakūta Dhāvala, ādhaka is used as a measure for wheat and barley. In the Parasurāmēsvara inscription21 from Bhubaneswar, grain was measured by ādhaka.

Drōṇa literally means a trough, vessel or bucket. In Rgveda22, it specifically designate in plural for vessels holding soma juice. It is uniformly accepted as a measure constituting 4 ādhakas or 128 prasṛtis.

From the Arthaśāstra of Kautilya15, it appears there were four kinds of drōṇas, namely harem measure (16½ palas), servants measures (175 palas), public measure (187½ palas) and king’s measure (200 palas). There is an uniform difference of 12½ palas between them. According to medicinal texts6, there is also a fifth variety measuring 256 palas.

In the Chauhan inscriptions23 mention is made of kumāra drōṇa and drōṇī. According to Sārangadharā24 drōṇī was a bigger unit than drōṇa and was equal to 4 drōṇas. In the
Paññārāyaṇa inscription the term drōṇakhārī occurs. This might be taken as comprising two words drōṇa and khārī. The terms drōṇa and drōṇavāpa as land measures occur mostly in Gupta inscriptions, which refer to the sowing capacity of the land.

According to Sārangadhara, kalaśa, nalva, ghaṭa, armanā and unmāṇa are all synonymous with drōṇa.

Khārī in Rgveda refers to a measure for Soma juice. This term frequently occurs in inscriptions and literature. 16 drōṇas make one khārī, according to Arthaśāstra, Purāṇas and mathematical works. Śukra differs in stating that 20 armanas (120 ādhatas) as a khārika. From Lilāvati it is clear that khārī or khārikā of Magadha should be a cube measured by one cubit. A vessel measured by a cubit in every dimension is a ghanahasta, which in Magadha is called khārika. “It should be made of twelve corners or angles formed by surfaces”. (Since the hasta mentioned by Bhāskara is 24" the volume would be 8 c. ft. (i.e., 0.25 c c). Khārī according to medical texts and Abhidānappadipika is of 4 drōṇas, while according to Jīvaśāman it is equal to 20 drōṇas. Khārī as a measure for grains is mentioned in Kalhaṇa’s Rājatarāṅgini. Perhaps, the present day khārbar (ass load) might have derived from khārī.

In a grant of Somavarmandeva and Āsatadeva, khārī occurs as a measure for grain. Donakārī, mentioned in the Paññārāyaṇa inscription is explained by the editor as the same as the corresponding Marwari word dōlī. Otherwise the expression may be taken as comprising drōṇa and khārī. In an inscription of Subhikṣarājadeva from Pāṇḍuksēvar, khārivāpa is mentioned as a land measure. It seems to refer to an area of land, where one khārī of seed can be sown.

According to Abul Fazl and Moorecraft a khārī is equal to 1960 palas. Considering a pala to be 3½ tolas, khārī corresponds to 177 129/175 lbs. Wilson considers khārī as equal to 3 bushels and kharwar as 700 to 850 lbs.

Māṇī or māṇika seems to be another controversial unit of measure. Māṇika consists of 2 kudavas or a prastha according to the medical texts and Ain-i-Akbari whereas it is of 4 drōṇas or 64 prasthas according to Mahāvīra. The difference is too wide in the ratio of 1:128.
While describing the equitable distribution of food, Divyavādāna mention one mānika per unit (eka mānika bhaktasyavasiṣṭa). In Abhidānappadipika mānika and drōna are considered as synonymous.

In the Partāpgarh inscription, the word, māni is used as a measure, for seed, while in the Bhinmāl stone inscription the term māna is mentioned.

The term mānika occurs mostly in the inscriptions from Andhra. Salt, milk, ghee and oil were measured by this unit. There seem to be several types of mānikas, namely, Sanyambadi-mānika, Deva-mānika and Nandi-mānika. Sanyambadi-mānika might be the mānika used at a place known as Sanyambadu. Nandi mānika might have had the figure of nandi on it. Mummuḍi Bhīma mānika was named after the king of that name. In Andhra records mōna and mānika seem to be synonymous. Whether māni or mānika has any connection with māna as a measure of weight is not clear.

Pravartika is mentioned only by Mahāvīraśārya, comprising of 5 khāris. Since the term pravartika stands for something round, pravartika may be a cylindrical vessel. Pravartavāpa, as a land measure meaning the sowing capacity of the land occurs in the inscriptions from East Bengal and it is a conjecture that it measures half of a kulyavāpa. In the Alagum inscription of Anhantavarman (regnal year 62), several pravarti of paddy were given as gift. Dr. Sircar points out that pahti measuring 10 maunds in Orissa may perhaps be the same as pravarta.

Kumbha occurs mostly in literature. There is no unanimity in the quantity it represents. 20 drōnas make one kumbha according to Kauṭilya and Purāṇas while 15 drōnas make one kumbha according to Śrīdhara and Śrīpati. Mahāvīra considers kumbha as constituting of 400 drōnas. In Anuyoga-dvāra sūtra, three types of kumbhas, jaghanya measuring 15 drōnas, madhyama measuring 20 drōnas and uttama, measuring 25 drōnas are classified. According to Bhaviṣyapuruṣa and Sārangadhara 2 drōnas make a kumbha, which is otherwise termed as sūrpa.

Ammanam is a peculiar measure consisting of 11 drōnas according to Abhidānappadipika. Childers considers this a-
a superficial measure equal to 4 karīsas. It is synonymous with drōṇa according to Sārangadharma. Śukra mentions the māna as being equivalent to 8 āḍhakas. The measure ambanam referred to in the Sangam literature Padippuppattu, may be similar to this. The editor considers ambanam as equal to a marakkāl, The term ammanam in Ceylon stands for a measure of 46.08 gallons, which is a far bigger measure than ambanam.

Kalaśa is synonymous with drōṇa according to Sārangadharma. In Śukra’s Nītisāra, kalaśa is used in the sense of a pitcher. In certain areas in South India, till recently kuḍam and combu, meaning pitcher were used for measuring oil. Al-beruni equates kalaśa with Khvarizmain ghur.

In the Janvara inscriptions of Gajasinghadeva and Kelhańdeva (V.S. 1218) and in Bhimāl stone inscription of Udayasimhadeva (V.S. 1306), kalaśa was mentioned as a measure for ghee, while in the Sanchor stone inscription muga (mudga) was measured by kalaśa.

The measure kalasi equivalent to 16 maunds was current till recently in Gujarat. For measuring milk, however, a kalaśa of 5 seers was used.

Vāha is the biggest cubic measure mentioned in the tables given in the books of mathematics and law. 200 drōṇas make one vāha according to Śridhara, Śripati and Kauṭilya, while Mahāvīra considers 320 drōṇas as one vāha. Sārangadharma refers to a vāhi constituting 4 drōṇas, whereas according to Caraka, vāha is 128 drōṇas. For vāha Childers gives the meaning of a cart load, measuring 20 kharis or 80 drōṇas. With so much of variations, it is difficult to form any conclusion, excepting to state that vāha represents a very large measuring.

In Gujarat galli is a bullock cart load and this was equal to 30 maunds (600 kg). In the Telugu bāmḍi means a cart. Bāmḍi, bāmḍi peru, bāmḍi kaṭṭu stand for cart loads. It is possible that a bullock cart had a quantity of merchandise and this quantity might have been considered as a definite unit for purpose of calculations. Generally articles like cotton, betel leaves, etc., seem to have been measured by the above mentioned terms.

Ghaṭa or ghaṭika literally means a pot. Kauṭilya refers to
a *ghaṭika* equivalent to a quarter of a *waraka*, the latter being 84 *kuḍumbhas* in case of butter and 64 *kuḍumbhas* in case of oil. A *kuḍumbha* is synonymous with *kuḍava* or *ghaṭa* according to Sārangadhara\(^{13}\) and is equivalent to a *drōṇa*. *Ghaṭa* or *ghaṭika* might be a pot shaped vessel for measuring.

The term *ghaṭaka* occurs in the Mathura inscription of Haviśka.\(^{12}\) Rajor record\(^{64}\) refers to a levy of 2 *pālikas* on every *ghaṭaka-kupaka* of clarified butter and oil. In the Siyodoni records\(^{55}\), a tax of a *ghaṭika pala* of milk from every iron pan of confectionaries is mentioned. *Ghaṭaka* as a capacity measure occurs in the Bakṣāli manuscript\(^{58}\) a also.

*Gōni* literally means a sack and its Dravidian counterpart is *kōni*. Sārangadhara\(^{5}\) considers *vāhi*, *drōṇi* and *gōni* as synonymous, measuring 4 *drōṇas*, while Caraka\(^{16}\) considers *gōni* as synonymous with *khāri* and *bhāra* which also measures 4 *drōṇas*.

The term *gōni prasṛti*, mentioned in the Mathura praśasti\(^{58}\) of the reign of Vijayapāla, is mentioned by Colebrooke\(^{57}\) as a combination of *gōni* meaning a large measure equal to 4 *khāris* and *prasṛti* meaning a handful equal to 2 *palas*. In the Dubhund stone inscription\(^{58}\) of Kachchapaghaṭa Vikramasimha, (V.S. 1145) a tax of one *vimśopaka* was laid on each *gōni*. A land with a sowing capacity of 4 *gōnis* of wheat is also mentioned.\(^{55}\)

At present *guna* in Gujarat is equivalent to 5 maunds or a quintal, which is almost the same in South India, but is termed as *kōni*.

*Pāli, pālika, pāila, pāyali* āre terms which occur mostly in inscriptions and rarely in literature. These terms are used in measuring oil and ghee. In Rajor inscription\(^{64}\), Partāgarh inscription\(^{39}\), Arthuna inscription\(^{69}\), Nadlai stone inscription (V.S. 1189)\(^{60}\) of Rāyapāla and Vāillabhaṭṭasvāmin temple inscription\(^{61}\), the term *pālika* occurs; while in the Mathura praśasti of the reign of Vijayapāla\(^{56}\) and Anavāḍa stone inscription\(^{61}\) of Sārangadeva the term *pāli* is used for measuring oil and ghee. In Junagadh inscription\(^{62}\) of Sāmantasimha, Sanchor stone inscription\(^{63}\) of Pratāpasimha, in two of the Nadlai stone inscriptions\(^{64}\) of Rāyapala (V.S. 1202 and 1203), the term *pāila* occurs. Perhaps all these terms may be synonymous. Opinions.
-differ about this measure. Dr. Bhandarkar on local enquiries at Godwad came across the following table:

| 4 pāila  | = pāyali |
| 5 pāyali | = māna  |
| 4 māna   | = sei    |
| 2 sei    | = man   |

In the Gañitasāra of Śrīdhara a different table is given:

| 4 pāvala | = pāli |
| 4 pāli   | = māna |
| 4 māna   | = sei  |
| 3 sei    | = padaka |
| 4 padaka | = hāri |
| 4 hāri   | = māni |

From this table Dr. Sandesara\(^{47}\) concludes that pāila or pāilī is equal to 4 lbs.

The word pāilām occurs on the Sunak grant of the Cālukya king Kārna I, which was identified by Buhler as equal to modern pāyali (4 seers or 2 kg). J.J. Modi\(^{48}\) holds that pāilām is the same as pallu or pallo of Gujarat representing 6\(\frac{1}{5}\) maunds. Padmanath Bhattacharya\(^{47}\) gives a different table according to certain quarters in Sylhet:

| 7\(\frac{1}{5}\) seers (paddy) | = pūra |
| 16 pura                       | = bhuta |
| 16 bhuta                      | = pāila |

Unlike in Gujarat, where seer seems to weigh 1.2 lbs, the seer in Sylhet is about 2 lbs. Hence pāila would be 16 maunds. Perhaps this may be like the Gujarati term palo meaning a large vertical cylindrical container of earthen or bamboo chips for storing corn.

A peep into Sanchor inscription\(^{49}\) a proves, that pāila is a smaller measure than a maund. Here it is stated that Kamalādevi, queen of Pratāpasimha renovated the temple of Vaseśvara. For the maintenance of the temple a gift was made of a field as well as two pāilis on every mān of each commodity from the custom house.

In the Nadlai stone inscription\(^{50}\) of Rāyapāla (V.S. 1200), rauta Rājadeva made a grant consisting of one vimśopaka coin from the value of the pāilas accruing to him and two pālikas from the palas of oil due to him from every ghanaka or oil
mill. In this text it is clear, that pāila and pālika are different and since vimśopaka itself is not of very high denomination, both pāila and pālika might not be very big units.

Pāli in Gujarati stands for a big ladle or spoon. G.H. Ojha’s conclusion that pālika is the same as pula comprising 6 tolas (69.98 gm) is nearer to this. According to Wilson a pāli of gram is equal to 5 to 8 seers and pāvali 3½ seers. In the present Mahārāṣṭra state, the term pāvali constitutes ¼ of a maund. Pāli in Gujarat is 1/440 of a kalasi, the latter being 16 maunds (5.97 quintal). Hence the pāli in Gujarat comes to about 1.3 kg. The term pāvali generally stands for a quarter and pāvali a cup or cylindrical vessel. It is not out of place to mention that in Chinese, pālo is a drinking cup of about 500 gms. Pāli in Karnāṭaka is 2.332 kg. From the above facts pāli, pālika, pāvali and pāli are supposed to be different terms measuring differently. At present the different terms are used as follow:

1. pāvali ¼ or 4 seers
2. pāvali cup
3. pāli big ladle or spoon
4. pālo a large vertical cylindrical container for storing.

There are certain measures which are found only in South Indian literature and inscriptions. In the Tirumukkūdal inscription of Virarājendra, most of the following measures found in Tamiḻnāḍu are mentioned. They are śeviṇḍu, āḷakkku, uḷakkku, uri, nāḷi. kuruni, padakkku, tūṇi and kalam, and they were not only current in the mediaeval times in South India, but also continued till recently with slight variations. The following table was given by Dr. Atleker which was in vogue till recently:

<table>
<thead>
<tr>
<th>Measure</th>
<th>Equivalent</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 śeviṇḍu</td>
<td>āḷakkku (220 cc)</td>
</tr>
<tr>
<td>2 āḷakkku</td>
<td>uḷakkku (400 cc)</td>
</tr>
<tr>
<td>2 uḷakkku</td>
<td>uri (800 cc)</td>
</tr>
<tr>
<td>2 uri</td>
<td>nāḷi or paḍi (1.6 litre)</td>
</tr>
<tr>
<td>8 nāḷi</td>
<td>marakkāl (12.8 litre) or kuruni</td>
</tr>
<tr>
<td>2 kuruni</td>
<td>padakkku (25.6 litre)</td>
</tr>
<tr>
<td>2 padakkku</td>
<td>tūṇi (51.2 litre)</td>
</tr>
<tr>
<td>3 tūṇi</td>
<td>kalam (152.6 litre)</td>
</tr>
</tbody>
</table>
(The figures in bracket were calculated by the author as stuck capacity).

Śēvidu is the smallest measure of capacity mentioned in the inscriptions from South India. Perhaps śēvidu might have been derived from the Sanskrit word sētika. Śēvidu might have been used as a measure of weight as well as capacity, since in an inscription of Nṛpatunga\(^71\), kāyam (asafoetida) and ghee were measured in śēvidu.

Ālākku which is a measure for fluid as well as grains is 1/8 of a Madras measure till recently and was a common term in South Indian inscriptions. It is about 200 cc in volume. Ālākku may be a derivation from the Tamiḻ word, ‘aḷayu’ meaning a measure.

Uḷakku which is one fourth of a Madras measure till recently was also common in South Indian inscription measuring 400 cc.

There were several types of uḷakku. Uḷakku measured by Arulmoḻidevan nāli was current in the time of Rajendracoḻa in Kālahasti.\(^72\) In Vedāraṇyam itself there were several measures. Uḷakku measured by the measure of Tirumaraikkādan\(^73\) was popular. Tirumaraikkadu is the Tamiḻ translation for Vedāraṇyam. Vedavananāyakan measure\(^74\) most probably might be the same and perhaps both may be temple measures. During the time of Kulottunga Coḻa III (1207 A.D.) an uḷakku of ghee measured by Karuṇākaran nāli\(^75\) was gifted to the deity Tirumaraikkadu Uḍayan. During the time of the same king in 1181 and 1182 A.D., the uḷakku was also measured by Vedavananāyakan nāli\(^73\). During the time of Rājarāja I (1000 A.D.) in Vedāraṇyam an uḷākku was measured by kāna nāli.\(^76\) Videlviduga uḷakku\(^71\) mentioned in the Pallava inscriptions might be the measure current at that period.

Uri, which frequently appears in the South Indian inscriptions consists of 4 aḷākkus. There seems to be different uris also. Pirudu māṇikka uri\(^71\) of Pallava records might refer to the standard of Nṛpatunga’s queen. Uri has a stuck capacity of 800 cc and a heaped capacity of 850 cc.

Nāli may be a derivation from nala, meaning a hollow stalk, generally of bamboo. The nāli measure is shaped like a stalk of a bamboo. As a cubic measure, in almost all the
inscriptions belonging to the kings of South India this term is of frequent occurrence.

Several types of nāḷi occur in the inscriptions. Ādavallān nāḷi must be referring to the measure at Cidambaram.77 Arulmoḻidevan nāḷi, suggests the standard of Parakesari Rajendra Cola I, while Rājakēsari nāḷi, the standard of Rājarāja. Arulmoḻidevan nāḷi was smaller than Rājakēsari nāḷi. 1\frac{1}{2} of Arulmoḻidevan nāḷi would measure 1 nāḷi of Rājakēsari, as understood by the Tirumukkǔdal inscription of Virarājendra.69 In Vedāranyam, during the time of Rājarāja I (10th century A.D.) kāṇa nāḷi, Karunākaran nāḷi78 are mentioned. Vedavana nāyakan nāḷi80 and Tirumaraikakkāṉ nāḷi81 mentioned on the inscriptions from Vedāranyam perhaps may be the temple measures. As has already been stated, Tirumaraikkkāṉu is the Tamil equivalent for the Sanskrit name Vedāranyam. An inscription82 from Tiruvarūr Thyagarāja-svāmy temple, refers to purṇidangondu nāḷi equal to a tuḍai ulakku. Kāṇa nāḷi was considered as half of Parakesari nāḷi.83 In the Pandyan inscriptions pilaya nāḷi, māṇaya nāḷi, nālva nāḷi84 Nārāyana nāḷi85 and karu nāḷi occur.86 A Ganga inscription from Kanchipuram refers to Ariyennavalla nāḷi.87 Paṅcavāra nāḷi88 is the measure decided by Paṅcavāra committee.

Generally a nāḷi is $\frac{1}{2}$ of a measure and is also known as paḍi. Madras measure (paḍi), when heaped, weighs 132 tolas and has a stuck capacity of 120 tolas or 62\frac{1}{2} fluid ounces (1.6 litres). In Madurai, Cidambaram and other areas, half of this is considered as the paḍi. Hence, nāḷi, in and around Madras must be double of other areas in the South. In certain areas nāḷi and paḍi are synonymous.

Idangaḷi, edangaḷi or yeďangaḷi89 is a term found only in Kerala inscription. It is a cylindrical measure 2\frac{3}{4}'' high and 6\frac{1}{4}'' in diameter or 85 cubic inches (1328 cc) in capacity. It is said to hold 57,600 grains of kalama nella, a kind of paddy90.

Marakkāḷ consists of 8 Madras paḍis. It was formerly considered as a measure of 750 c. inches, but later on fixed as 800 c. inches according to Wilson.91 Princep91, however, considered a marakkāḷ to be equal to 27 lbs, 2 oz, 2 dr of water or 2\frac{1}{4} Imperial gallons. The standard as fixed in 1846 makes 3 marakkāḷ equal to 28 lbs, 12 oz, 13 dr, 22 gr or 2\frac{1}{4}
Imperial gallons. Makrakkāl also seems to have differed in different areas in the past also. Marakkāl measured by Ādavallān and Rājakesari measures were current in and around Tanjore area. Marakkāl measured by Pēriḷamai measure in South Arcot district must be larger than the ordinary marakkāl, since it was equivalent to 10 and not 8 nāḷis. In South Arcot district another marakkāl, measured by the Mādēvi (corrupt for Mahādevi) measure also occurs. At Annamalai, marakkāl was fixed by Annama measure and at Takkolam by Kavaramoḷi measure. Uchchilinna Nārāyaṇamarakkāl was used in Tirupati. It may be noted that the marakkāl is bound to differ with different nāḷi measures. That Kāṇa nāḷi was half of Parakesari nāḷi can be ascertained from 11th century inscription from Pirimiyam. When marakkāl is measured with kāṇa nāḷi, it would be half of the marakkāl measure by Parakeśari nāḷi. Panchavāra marakkāl was less than ordinary marakkāl by an uri (i.e. Panchavāra marakkāl was measured as 7 nāḷi and a uri by Rājakesari measure) Rājakesari marakkāl measured 8 nāḷis by Rājakesari nāḷi.

Though the measure marakkāl was in usage generally in South, it differed in capacity in each district. In Sholinghur and Ārṇi, marakkāl was 2½ heaped paḍis while in Tirupati as in Madras it was 8 heaped paḍis and in Vellore 4 heaped paḍis. Hence this measure seems to have variations associated with the local usage.

Padakku mentioned often as a corn measure in the South Indian inscriptions comprises 16 nāḷi. It was in vogue till recently. Padakku and tūṇi occurs in Tolkappiyam. Altekar considers padakku as equal to 12 lbs., while according to Princep it is 54 lbs and 4 ozs. (The latter seems to be closer to the author’s calculation). The Gujarati commentary on Gāṇirāsara refers to a padākku as comprising 12 maunds, which is a very big unit.

Tūṇi consists of 32 nāḷi or 1½ maunds. Though this is often found in the inscriptions, it was out of usage. According to Kōṇakkusūram it is ¼ of a kalam.

Kalam literally means ‘a lot’, thereby showing that this term stands for a large volume. It was prevalent till recently in South India. Kalam in and around Madras is double that of
the other areas in the South. 96 nājis or 12 marakkāls normally make one kalam, which is roughly equal to 3 maunds of rice. The capacity of kalam also seems to vary at different places. According to the Tirumukkudal inscription⁶⁹ of Vīrājendrā one kalam of Rājakēsari measure was equal to 1 kalam + 1 tuṇi + 4 nājī of Arulmōlidevan kalam, thereby showing that a kalam of Rājakēsari measure is bigger than the kalam, measured by Arulmōlidevan kalam.

Parra or parai is of 5 marakkāls.⁷⁰ It is referred to in the ancient Tamiḻ work Śilappadikāram.⁹⁴

Podhi¹¹ constitutes of 20 idangālis or 640 āḷakkus. Podhi literally means a big heap. Parra and podhi are common measures in Kerala.

Kōṭṭai⁹⁸ is another measure peculiar to Tamiḻnādu and Kerala and varies from 21 to 24 marakkāls.

The measures in Kerala and Tamiḻnādu are similar in their nomenclature, but they seem to differ in their capacities. The following tables are from the Malayālam work Kaṇakkusāram.¹¹ The figures in the brackets are equivalents worked out by the author.

Table I

| 360 nelmani | = cavaḍa (13 c.c.) |
| 5 cavaḍa    | = āḷakkku (65 cc) |
| 8 āḷakkku   | = chirunāḷi (520 cc) |
| 4 chirunāḷi | = edangaḷi (208 litres) |
| 20 edangaḷi | = podhi (41.63 litres) |

Table II

| 4 chirunāḷi | = prastha (2.08 litre) |
| 4 prastha    | = āḍhaka (8.32 litre) |
| 4 āḍhaka     | = drōṇa (3.28 litre) |
| 16 drōṇa     | = khāri (552.48 litre) |

These measures have been in use in Kerala till very recently. These are certain measures which can be traced only in Andhra and Karṇāṭaka regions.

Gidda according to Vyavahārāgaṇita⁹⁶ is ½ of a sallage. The Vardhamānapuram inscription⁹⁷ (A.D. 1244) refers to gidda. It may be a gill or liquid ounce.

Garemata or spoon is referred to in an inscription⁹⁸ as a measure of oil, but its quantity is not specified.
Sontige mentioned in the Ratta inscription⁷⁹, can be translated as a ladleful.

Citti¹⁰⁰ is also a very small measure and is ¼ of a sola.

Sallage¹⁰¹ or sola¹⁰² is a most popular measure for grains. According to Pāvalūru Mallana¹⁰³, it is a ¼ grain measure with a capacity to hold 900 grains. Sallage is ¼ of a mānika or ½ of a tumu according to Wilson¹⁰¹. At present it is ¼ of a balla.¹⁰⁵

Balla is a common measure referred to in Karnāṭaka inscriptions¹⁰³, for measuring rice, oil, ghee, curd, etc. It is ¼ of a kolage. In Tulu it is equal to a seer. According to Wilson¹⁰⁷ it is of 48 double handfuls (anjali).

Kumca or kumchamu as a measure for grains and liquids is found in the inscriptions from Andhra. According to Wilson¹⁰⁸ it varies from 1/10 seer, 3½ seer, and 8 to 14 seers. Kumca is ¼ of a tumu and equal to 4 mānikas. Mummudi Bhimakumca¹⁰⁹ Prolakumca¹¹⁰ and kollakumcamu¹¹¹ are the different types of this measure found in the inscriptions.

Kolaga¹⁰¹ as a measure for grains is common in Karnāṭaka. Wilson considers kolaga as a measure weighing 3 bushels or 1/20 of a khanduga¹¹². 4 ballas make a kolaga, according to Rājaditya’s Vyawahāraganita. In Mysore, Sultani kolaga was 16 seers, while Kṛṣnarāja kolaga was 8 seers and khararu kolaga was 10 seers. In South Kanara sikka kolaga and geni kolaga were in vogue. But generally kolaga was 1/20 of a khandi.

Tumu, a common measure in Andhra, is 1/20 of a puṭṭi or khandi. It is also used as a land measure.

An inscription¹¹³ dated Saka 1230 mentions biyayumu tumuḍu (one tumu of rice), minimulu tumu (one tumu of black gram), etc. Mummudi Bhimatumu¹¹⁴, Nanditumu¹¹⁵, are other types of tumus. Pandumuney¹¹⁶ (10 tumus of ghee), and iddumabiyamu¹¹⁷ (2 tumus of rice) are also referred to in inscriptions.

Puṭṭi is the biggest cubic measure found in the literature and inscriptions¹¹⁶ from Andhra and constitute 20 tumus, having a capacity of 14941.653 c. inches.¹¹⁹ It is the same as khandi or khanduga. Pella puṭṭi is a smaller puṭṭi, measuring 80 kumcas, while malaca puṭṭi, which is a bigger one, measures 400 kumca.¹²⁰ It is also used as a weight equal to a ton and
also used as a land measure.

*Khaṇḍuga* is the counter part for *puṭṭī* in Karnāṭaka. *Khaṇḍi* in Mahārāṣṭra and Gujarat are also synonymous. It is a weight as well as a measure of capacity and varies in different places for different articles.

Generally *khaṇḍi* constitute 20 maunds. Since the maund itself differs from place to place *khaṇḍi* also differs. According to Rājāditya 20 *kolaga* make a *khaṇḍuga*. It is difficult to surmise from a Cera inscription\textsuperscript{121} whether *khaṇḍuga* represents weight or volume.

There are certain measures which are rarely found in the inscriptions and hardly in literature and they are difficult to be identified properly.

*Tauva* or *tamuva*\textsuperscript{122} which is ciphered as ‘ta’ was found in Andhra inscriptions, for measuring green gram, ghee etc., without any specification.

*Vajjani* of sugar-cane juice is mentioned in an inscription\textsuperscript{123} from Dharwar.

*Kōṇa* of salt and ghee occurs in the same inscription.\textsuperscript{123}

*Halige* and *koda*\textsuperscript{124} were used as measures of oil in Karnāṭaka inscriptions.

The volume measures in general appear to have followed the quaternary system, except in few cases measured by Śukra in his Śukranīti.

The regional variations appear to be not merely in the type of usage of a particular measure, (whether as volume measure, weight measure or land measure), but also in actual quantities they represented. Till very recently the measures in Eastern India appeared to have been twice the size of the corresponding Western Indian measures. For example, till recently the *man* was equal to 40 *seers*, but the weight of a *seer* was 32 and 40 *tolas* in Gujarat and Mahārāṣṭra, it was based on 80 *tola* as a *seer* in Bengal and 118 *tola* as a *seer* in Orissa. The name of the measures in Kerala and Tamilnādu remained the same, even though the quantity represented by the corresponding Kerala measure was smaller in volume.

Many rulers appear to have established their own measures, usually larger in size than that of his predecessor, probably to show his greatness. We have such examples in the Coja
dynasty in the South and also in Karṇāṭaka. Some of the big temples in the South appear to have had their own measures like Ādvallān measure, which is the measure related to the Cidambaram temple, usually larger in volume than the common measures.

It was found difficult to relate these ancient Indian measures to the ancient Western measures, because just as in India, various European regions also appeared to have followed different measures and systems. Neither the names nor the volumes represented by them could be calculated and equated, with these ancient Indian measures.

It can be concluded, that the volume measures in ancient India evolved not on a carefully standardized but on the basis of regional standards and local usages and remained so for long periods of time, as useful basis for various transactions.

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### CHART I
Measurement of Capacity

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MENSURATION IN ANCIENT INDIA
### CHART II

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Weights in Ancient India

COMPARED with the measurement of length and volume, measurements of weights are later developments, the reason being that weights and balances are complicated equipments unlike the linear measures, where parts of the human body can be used.

Weights and balances were used for weighing precious metals¹ in the beginning and later on for other commodities. As in the case of linear and cubic measures, in the weights also minute particles like trasareṇu, aṇu, etc., are mentioned in the literature. The weights of sesame, paddy, etc., are of hardly any use while measuring materials other than precious metals, few medicinal herbs and spices. Since the evolutions of smaller weights were associated with the weighing of precious metals and precious stones in ancient India, it is being dealt with separately later on. Palam is the recognized practical weight measure in general use in ancient India and was perhaps equated with the weight of a handful of paddy. This seems to be reasonable though a primitive approach.

Palam or pala as a common weight standard can be traced from literature and epigraphs. Pala is considered equivalent to 1/40 of a viss or visa in Tamil country. Since viss is equal to modern 3 lbs, 1 oz and 5.94 dr, the pala would be 34.5 grams.
A muṣṭi of paddy also approximately weighs 32 grams. Wilson² considers palam to be weighing between 35 to 39 grams and according to the revised table in 1846, the palam is considered to be equal to 1 oz and 3.75 grams, that is 34.61 gms.

The term palam occurs in several South Indian inscriptions. To quote a few examples, during the time of Rajendra Coḷa 1° (1020 & 1022 A.D.) the gift of a bell metal (bronze) plate was measured in palam. Cooked vegetables prepared in the temples were also measured in palams in an inscription dated 1264 A.D., during the time of Jātavarman Sundara Pāṇḍya⁴. In several inscriptions sugar was weighed in palam⁵.

An interesting equivalent for palam is rendered in a 11th century inscription from Tirumalavādi (Trichy district) during the time of Rājarāja⁶, when a silver vessel weighing 5 palams or 77½ kaḷanjus was given by the Queen to the temple of Vaidyanātha. According to this inscription a palam is equivalent to 15.55 kaḷanju. Since a kaḷanju weighs approximately 45 to 50 grains, palam must be 46 to 51 grams approximately, during 11th century A.D. in Trichy district.

Prastha is considered as a weight by Mahāvīra⁷ for weighing metals other than gold and silver and is equal to 12½ palas. Kalhaṇa⁸ in Rājataraṅginī refers to the erection by Lalitāditya Muktāpida of Bhṛhad Buddha (Great Buddha), which reached up to the sky (colossal image) with thousands of prasthas of copper. According to the Petersburg dictionary a prastha is estimated as equal to 16 palas. Prastha as a cubic measure is equal to 16 handfuls. Hence, it can also be considered as equal to the weight of 16 handfuls or 500 to 550 grams.

Sei generally occurs in the inscriptions and literature from North India. In the Gujarati commentary on Śrīdhara’s Patiganita⁹, a sei is equivalent to 16 paili or 1/16 of a kalasi. Since kalasi is 16 maunds, sei may perhaps be equivalent to a maund. Dr. Bhandarkar¹⁰ considers sei as of 20 pāyalis, while Pandit Ram Karna¹¹ opines it as of 15 seers. 64 handfuls make a sei according to Takkur Pheru’s Gaṇitasāra which is about 2.24 kg¹².

A few inscriptions are acquainted with sei. In the Manglana stone inscription¹³, it is mentioned as a weight for
korada corn, while in the Bhimāl stone inscription it occurs as a weight for wheat. In Lalrai stone inscription of Lakkana-pāla and Abhayapāla, it is referred to as a weight for barley and corn.

*Seer* is a different weight from *sei*. In Madras State 8 palams constitute a *seer* and is 1/5 of a *viss*. Considering *viss* or *vīsa* as 3 lbs, 1 oz, 5.94 dr, a *seer* would be 275 to 280 grams approximately. *Seer* in Gujarat is of 466.5 grams or 1/40 of a maund. The *seer* seems to have varied considerably throughout the ages. According to Abul Fazl, the *seer* which was used formerly in Hindustan was equal to the weight of either 18 *dams* or 22 *dams*. In the beginning of Akbar’s reign, however, it had the standard of 28 *dams* in weight, but it was raised to 30 *dams* before the *Ain* was written. The *dam* should have weighed 222.7 grains. The *seer* of Jehangir was of 36 *dams* and of Shah Jehan 40 *dams*. Hence the *seer* varied from 600 to 850 grams. At present generally a *seer* is considered as equal to 466.5 grams. The Greek *mina* was 430 grams, while the Hebrew *mina* 500 grams.

*Viss* or *vīsa* is a weight standard, used till recently in South India. The term *vīsai* in Tamil, literally means division and *vīsam* the fraction 1/16. Perhaps *viss* may be a derivation from the Sanskrit word *vihita* meaning distributed. Till recently it was equal to 5 *seers* or 40 palams or 1/8 of a *maund* or 3 lbs, 1 oz, 5.94 dr. Alberuni mentions a measure named *bisi* equal to 1/12 of a *kalasa* or 1/4 of a māna or 1/16 of a *panti*. Whether these have any connection with *vīsa* is difficult to ascertain. He compares *bisi*, with Khwarizmian *sukkhkh*, which is 1/12 of a *ghur*.

In an inscription of Vikramāditya II (732 A.D.) from Karṇāṭaka *vīsa* is mentioned along with several gifts. *5 vīsa* on each *bhanda peru* (*heru* is 60 *seers* or sack of corn) was mentioned.

Sir Walter Elliot gives the representation of two old iron weights. One is circular, weighing 3 lbs, 1 oz, 4 dr and has on one side the boar crest (Cālukyan emblem) and above it a sun and moon and on the other it is engraved “Pramādīcha Sam, vi 1” i.e. Pramādīcha Samvatasara, 1 *vīsa*. The other is octagonal weighing 12 ozs, 2 dr. It has on the front only a
sword, with the sun and moon and below them the words ‘Pramādicham vi ¼, i.e. ‘a quarter vīsa stamped in Pramādicha Samvatsara’.

Māna, mānako, māṅangu and māṅangulu (Telugu) are derivation | from the Sanskrit work māna to measure. Wilson19 considers māna as a derivation from Persian māneh but his argument is not valid, since maneḥ is a small weight. The māneh varies from 400 to 900 gram in Persia, Egypt, Syria, etc.

In the Gujarati commentary on Pātiganita9 in one table a mān is considered to be equivalent to 24 palas, which is a small measure. Pāvaluru Mālana20 gives varying tables for maṅangulu ranging from 40 to 80 seers.

An inscription dated 732 A.D. during the time of Vikramāditya II17 from Karṇāṭaka refers to māna, peru, veesa and bhanda peru. Māna occurs in Bhimāl stone inscription while mānaka occurs in Bijapur inscription11 and māṇi in Lekha-paddhadi for weighing wheat, barley etc.21 Maṅangulu is a common weight for corn in the Andhra inscriptions.

All these terms may be somewhat referring to the customary Indian scale of weight man or anglicised maund. The māna in Karṇāṭaka was still recently 16 seers, while in Madras it is 40 seers (about 25 lb). Man varied from 20, 40, 46 and 64 seers with difference in the weight of seer also. According to the Indian Regulation VII 1833, 80 tolas are equal to a seer and 40 seers a maund. Tola weighs 180 grains. Hence man weighs \(\frac{180 \times 80 \times 40}{15 \times 10} = 38.5\) kg22.

In the Mughal period man was the customary Indian scale of weight, 40 seers = 1 man was almost used throughout except for certain regions in the East. North West and in Deccan, where it either intermingled or coexisted with the other systems of weight. Man-i-Akbari was based on the seer of 30 dams and was equivalent to 55.32 lb while Man-i-Jehangiri was based upon the seer of 36 dams, and was equal to 66.38 lb. Man-i-Shahjehani was measured by the seer equalling to 40 dams and hence man was 73.76 lbs.

The English factors, who visited Surat found ¼ man equal-
ing to lbs 27 or 27.5 lbs in 1611 A.D., while in 1614 A.D., the \( \frac{1}{4} \) mana weighed 33.19 lbs. Mana varied with different materials.\(^{23}\)

Just as the basic measurement talents of Hebrews (30 kg) and of Greeks (25.8 kg), mana or mañangu or maund was the basic unit for bulk weight in India.

*Bhāraka* or bāra literally means bulky or heavy. 20 *tulas* make one bhāra according to Kauṭīlyā\(^{24}\), Śrīpati\(^{25}\) and Sāranga-dhara\(^{26}\), while 10 *tulas* make one bhāra according to Mahāvīra\(^{7}\) and Hemacandracārya.\(^{27}\) There is a great deal of confusion with the measure *tula* itself. *Tula* consists of 100 *palas* according to Hemacandra\(^{27}\), 200 *palas* according to Mahāvīra\(^{7}\) and 500 *palas* according to Śrīpati\(^{25}\) and 2400 *palas* according to Pāṭiganaṇṭa.\(^{9}\) In Dvyāsraya commentary\(^{28}\) of Pūrṇakalāsa gaṇi, achita or sakaṭ (cart load) is equal to 10 bhāras. According to Alberuni, bhāra, which is 2000 *palas* is almost equal to the weight of an ox.

Salt seems to have been weighed in bhāraka in an inscription from Bhutai in Panchmahal district in Gujarat, dated the 3rd year of Toramāṇa.\(^{29}\) Bhāra occurs as a measure for sugar, jaggery, Bengal madder cotton and coconut in Arthuna inscription\(^{30}\) of Paramāra Cāmuṇḍarāya (V.S. 1136). Bāra as a measure of salt occurs in the Hastikuṇḍi inscription\(^{11}\) of Rāṣṭракūṭa Dhavala.

20 mañangu make a bhāram in South India. It also varies from 20 to 28 *tulāms* the latter being 100 to 200 palams. Bhāram is equivalent in some places to 960 seers\(^{31}\). 4 *khāṇḍis* make 1 bhāra in Savantwaḍi district. Though bhāra was in usage, till recently, it was not found in the mediaeval inscriptions or texts from South India.

According to Wilson\(^{30}\) bhāra is used as a weight for weighing cotton in Gujarat, equal to 20 dhāris of 48 seers or 960 seers, while according to Moreland\(^{32}\) and Yule\(^{33}\) bhāra and candil (perhaps khaṇḍi) are one and the same. The weight bhāraseems to differ with metals and cotton. The Arabian weight bahar is equivalent to 20 maunds. Perhaps this may have some connection with bhāra. The units seer, viṣa, mañangu and bhāram seem to have entered Tamiḻnādu through Andhra and Kārṇaṭaka influence. They are almost absent in Cera, Coḷa and Pāṇḍya records.
Hāraka was a measure of weight of barley corn mentioned in the Lalrai inscription of Kelhaṇadeva (V.S.1167)\textsuperscript{14}, Sevaṇi-stone inscription of Aśvarāja\textsuperscript{34} and in Arthuna inscription.\textsuperscript{30} Dr. Bhandarker suggests that hāraka is the same as the Marathi 'hāra' meaning a larger basket of particular form and of loose texture. 24 mana or 6 sei is a hāri, according to the Gujarati commentary on Pāṭīgaṇita\textsuperscript{9}. In the Kutch district, a hāra is half of a kalasi, that is 8 maunds, while in Nāvsari it was 7 maunds. Perhaps, this may be like the weight heru of Kānṭaṇaka, which varies from 1/10 of a khaṇḍī to 1/20th of a khaṇḍī.

Kalasi according to the Gujarati commentary on Pāṭīgaṇita\textsuperscript{9} is of 16 sei. Kalasi is 16 maunds in some parts of Gujarat. In Jamnagar for measuring milk, it is a cubic measure of 5 seers and for measuring grains and other liquids it is 20 maps.

Kalasi is used, as a measure for oil in the Janvara inscription of Gajasinghadeva and Kelhaṇadeva (V.S. 1218)\textsuperscript{35} and as a weight for butter in the Bhimāl inscription of Udayasimha-deve (V.S. 1336)\textsuperscript{10}. Alberuni\textsuperscript{16} equates kalasi with khwarizmian ghur or equivalent to 12 bisi or 48 mān.

The weight of kalasi varies in different places according to Mirat-e-Ahmadi\textsuperscript{36}. In certain areas in South India till recently, kudam and cembu, meaning a pitcher is used as measure for oil.

Mūḍa was equal to 10 kalasis according to the Gujarati commentary on Śrīdhara, which is also current till recently, in Kutch. Mūṭa or Mūṭaka of Lekhapaddhati\textsuperscript{37} is 100 or 24 maunds according to the editor, while Dr. D.C. Sircar\textsuperscript{38} testifies that mūḍa is equal to 40 pakka seers.

Jagaḍu Shah's distribution of thousands of mūḍas of corn, during the three years of great famine in 1313 A.D. to 1316 A.D. was described in Jagaḍucarita\textsuperscript{39} and Prabandha Paṅsaṣati.\textsuperscript{10}

In the Arthuna inscription\textsuperscript{30} of Paramāra Cāmunḍarāya (V.S. 1136), salt and barley were measured by mūṭaka. Perhaps mūḍa or mūṭaka may be a desi word derived from Tamil word muṭṭai meaning a bagful and generally measures either 48 or 64 Madras measures. Mot stands for load in Hindi and muth for bullocks' rack saddle in Marathi. Mūḍa or mūṭaka might have been derived from any one of these.
Padakku mentioned in the Gujarati commentary on Pāṭiganīta is of 3 seers. Padakku occurs only in South Indian inscriptions with a capacity of 28 or 42 litres. This term padakku can be traced from the ancient Tamiḻ work Tolkāppiyam.

Khando, khandika or khandi, seems to be of big bulk and more common in Karpāṭaka and Andhra areas.

In a copper plate from Nagamangala (777 A.D.), Prithvi Kongani Mahārāja Vijaya Skandadeva donated several kandugas of land for garden, house site, irrigation along with waste land, for a Jain temple. The editor suggests as much of a land needed for sowing a khanduga or 3 bushels of seed. In another inscription 10 khandugas of paddy were mentioned as a gift to a brāhmaṇ.

During the reign of Bhima II (Cālukya), Māhipāla gave 350 pāsas of land yielding 4 khandikas to one Mādhava.

Several inscriptions refer just to kha which stands for khanduga or khandi. Khanduga and khandaga in Kannāḍa is synonymous with khandi in Marathi and Gujarati.

At present khanduga is used in Kannāḍa and Telugu speaking areas as a weight of 192,200 tolas for silk, sugar, drugs and cotton. As a dry measure it varies from 409,600 (Belgaum), 134,440 (Mysore) and 128,000 tolas (Coorg) in different places. Khandi varies with different articles also: Khandi at Masulipatnam has 3 weights, namely 488 lbs. for tobacco, 500 lbs for metals, hardware, etc., and 560 lbs. for sugar, dates and soft articles. Generally 20 kolages are equivalent to a khandi. In the Portuguese records in the 17th century, it is spelt as candil.

Tula comprises 500 palas according to Anuyogadvāra-sūtra and Śripati’s Gaṇitatilaka, while it is 200 palas according to Mahāvīra. Hemacandra and Sārangadhara refers to a tula of 100 palas which constitute 400 tolas. Tulām varies from 100 to 200 palas in South India. It varies considerably and it is also considered as equal to 5 viss. To give an example, in Coimbatore district 100 palams make a tulam, a palam being 8 tolas each weighing 180 grains troy. Hence the tulam would be 7.8 lbs. Wilson considers tulā as a weight between 145 to 190 ounces (4 to 5 kg). Tolu of Gujarath seems to correspond to this unit and considered to be equal to 10 seers.
There are certain measures which are current in Andhra and Karnāṭaka which are given as follows.

Kalage was a common measure mentioned in these inscriptions⁵⁰. 8 seers constitute a kolage in Hassan district. Till recently several kolages were in usage. Sultani kolage of 10 seers, sikka kolage and geni kolage are a few to mention. Normally kolage is 1/20th of a khaṇḍi. This term kolage is also used as a volume measure.

An inscription in the time Raṭṭa chief Kārtavīrya (1024 A.D.)⁵¹ refers to mana, balla, sallaga heḍaru and kolage.

Salige or solage is 1/64 of a kolage.

Heḍaru may be perhaps heru or goni measuring 1/20 of a khaṇḍi.

Weights relating to precious metals and stones

Weights and balances were first used for weighing gold dust and not, as might be supposed, for commercial transactions. The earliest commercial use of weighing was about 2500 B.C. in the Aryan civilization in the Indus sites⁵² and perhaps to a limited number in the Sumerian cities of Mesopotamia.⁵³ In Egypt all the evidence shows commerce by barter only, the first indication of the use of the balance in ordinary trade being as late as 1350 B.C. The earliest pictorical evidence of weighing in Egypt, dating back to the period of Dynasty V, shows the balance in use only by goldsmiths and jewellers or for weighing gold ingots of one of the temple treasuries.⁵⁴

Sanskrit name for balance is tulā, which occurs first in Vājasaneyi Samhita⁵⁵ in relation to weighing gold (hiranyakāra tulā). The term māṣa as a weight occurs as early as Kathaka Samhita⁵⁶, thereby showing that seeds were used for weighing precious metals.

Using seeds for weighing precious metals is a common practice all over the world. Even at present the weight standard carat (3½ grains) is actually the weight of the seed of carob tree (caratonia siliqua), an evergreen Mediterranean tree.

In ancient India, the seeds of guṇja (Abrus precatorius or Adenanthera pavonina), yava (barley), sesame seeds, etc., were used for weighing precious metals and stones. Weighing by guṇja or ratika, is still in vogue, in case of precious metals,
precious stones, and medicinal herbs.

Weighing by guṇja, ratika or manjādi is a common phenomenon all over India. Weight is also bound to vary slightly, since the seeds cannot be of the same size and weight. Several authors, have tried to come to certain conclusions, but nothing can be taken as the perfect weight.

In literary works like Manu\textsuperscript{57} and Yājñavalkya\textsuperscript{58}, trasareṇu (particle) likṣa (louse), rājasaraspa (black mustard seed) and gaurasarṣapa (white mustard seed) are given as weights. These are very minute measures. Trasareṇu is just discernible as a glancing particle in the slanting beams of the morning (or afternoon) sun, coming into a room through a chink or orifice of a window. This seems to be only an imaginative measure since actual measure of this dust particle will not be possible with the instruments then available. Further there can be no practical use for such a weight.

8 trasareṇu make a likṣa and 3 such likṣa make a rājasaraspa, 3 rājasaraspa were equal to a gaurasarṣapa and 6 of the latter, yava according to Manu\textsuperscript{57} and Yājñavalkya\textsuperscript{58}. Alberuni\textsuperscript{59} testifies 4 mundri as a pada and 4 pada as a kala and 6 kala as a yava. Hence the weight of kala and gaurasarṣapa perhaps may be the same.

Caraka\textsuperscript{60} and Sārangadhara\textsuperscript{61} in their medical texts give a table which is slightly different. 6 trasareṇu form a marici and 6 of the latter form a rājika, 3 rājika form a sarṣapa and 8 of the latter a yava. 864 trasareṇu make a yava according to this calculation, while according to Manu\textsuperscript{57} and Yājñavalkya\textsuperscript{58} 432 trasareṇu make a yava. Thus the basic measurement itself seems to be controversial and varies by 1:2 ratio. Sārangadhara gives two measurements namely Magadha and Kalinga. According to the former 4 yava make a guṇja and the latter 2 yava make a guṇja. This vast difference may be either due to the type of seeds or perhaps the Magadha mana itself is double that of Kalinga mana. Moreover there is a different reading for marici as mariṣa. The former stands for a speck in the beam of sunlight, while the latter for seeds of amaranthus.

Mudri, mundri or mundrigai is mentioned rarely in the literature. 96 mudris make a yava according to Alberuni\textsuperscript{69}. In South India the term mundri stands for the fraction 1/320.
This fraction seems to be very important, since ratika or guñja is 1/320 of a pala, according to Kautilya, Manu, Yājñavalkya and Bakṣāli manuscript. Alberuni has omitted the term ratika, hence the difference in his calculations.

Gaṇḍaka is mentioned only by Mahāvīra, which is 1/4 of a guñja. The weight of gaṇḍaka may be perhaps equal to a yava. A mode of reckoning by fours is also termed as gaṇḍaka.

Leaving aside all these measures, which seem to be impractical, it seems that actual measure starts with taṇḍula, ratika or guñja, which still remains as jewellers’ weight in India. Taṇḍula was equated with a weight of 8 gaurasarasopa, according to Varahāmihira and Caraka. Use of taṇḍula or unhusked rice seems to be common all over India. It is termed as nel in Dravidian languages and is 1/4 of rati.

Ratika or guñja or maṇjādi (Abruṣa precatorius seed, Sanskrit-guñja, ratika; Hindi-rati, ghungechi; Bengali-kunch; Tamil-gundumani; Telugu-gurīginja; Malayālam-kākani; Kannada-gunj; Gujar-chanthi, rati, guñja) is the measure commonly used by jewellers all over India. Though the seeds have several varieties of colour, the red one with the black eye is usually used, as the weight for gold and silver. The term maṇjādi is found mostly in South Indian literature and inscriptions. Someśvara in Mānasollāsa considers guñja and maṇjādi as synonymous, while in Hemādri’s Vratakhaṇḍa, he quotes Viṣṇugupta as stating 2 guñjas as a maṇjādi.

Adenanthera pavonina (Marathi-thoraligunj; Hindi-bari-gumchi; Tamil and Malayālam-anaiikundumani or maṇjādi; Telugu-gurivenda) unlike the creeper abrus is a large tree, bearing scarlet red seeds, which are also used as jewellers’ weights. The seed roughly weighs 4 to 5 grains or two of abrus seeds.

Several modern scholars have weighed the ratika (abrus) and has arrived at different conclusions. According to Prinsep 1.875 grains constitute a rati. Adenanthera according to Elliot is 5.3 grains. 1.934 grains make a guñja according to Wilson.

Tavernier gives different values for rati at different places for diamonds and pearls. Mangelip (maṇjādi) weighed 1 3/4 carats or 4.36 grains in Golconda for diamonds, 5 grains in
Goa and 7 grains in Bijapur also for diamonds. Pearl rati was 2.77 grains. Mañjādi according to Wilson is of 4 grains and equal to a carat.

Ancient writers have used guṇja, ratika and andī as synonymous. From the data of the ancient Indian writers, it is not clear whether they took abrus or adenanthera as a rati or guṇja. When Manu has stated 2 rati as a silver māṣa and 5 rati as a gold māṣa, perhaps, the former must have been adenanthera and the latter abrus. In the same way, when Bhāskarācārya⁷³ has stated that 8 guṇjas make a ratika and 5 ratika a valla, he must have taken guṇja for abrus and ratika for adenanthera. Varāhamihira’s andī comprising 4 yavas may be ratika. In the Gujarati commentary on Śrīdhara’s Paṭīganīta⁹, there were two tables for gold, 5 guṇjas make a gold māṣa and 3 ratika make a gold valla, while for silver, 5 guṇjas make a māṣa. It is not clear, whether the author considers ratika and guṇja as belonging the same type of seeds.

Both abrus and adenanthera are in usage as jewellers’ weights. In Mahārāstra and South India two rati make a mañjadi, thereby showing the former as abrus and the latter adenanthera.

Valla (it is a type of wheat) would be equivalent to 3 guṇjas of 2 ratikas according to Bhāskara and in the commentary on Śrīdhara’s Paṭīganīta⁹. Weighing by vāl is still common in Gujarati and varies from 1½ to 2 rati. There is a variation in Mirat-e-Ahmadi⁷⁴, where 3 māṣa is considered as a vāl.

Māṣa (Phaseolus radiatus) occurs as early as in Kathaka Saṃhitā.⁷⁵ 5 guṇjas make a māṣa, according to Manu⁵⁷, Yājñavalkya⁸⁸ and Kautilya⁷² in measuring gold. Mahāvīra refers to it as paṇa.⁶⁵ Śukra⁷⁶ and Bhāskara⁷⁷ differ from others. The former measures māṣa as of 10½ guṇjas and the latter 10½ guṇjas. In the Gujarati commentary on Śrīdhara’s Paṭīganīta⁹, there are two tables, one mentioning 5 guṇjas as a māṣa and the other 3 ratika as a valla. The latter table coincides with Bhāskara⁷⁸, who considers 3 guṇja as a valla. 4 kākanis constitute a māṣa according to Nārada and 4 andīs (guṇja) according to Varāhamihira⁶⁶. Analysing various authors Colebrook⁷⁷ has stated that there are four types of māṣas comprising 5, 6 and 16 ratikas and a silver māṣa of 2 ratikas.
All these differences may have been due to the guñja or ratika and whether it is adencnthera or abrus.

Prinsep notices māṣa of 2, 4, 5 and 16 grains, while Colebrook considers it as 17 3/4 grains and Coderington found māṣa varying between 10, 16 and 20 grains.

Coins which were unearthed from Taxila weigh from 2, 5 to 2.86 grains. These Mr. Walsh attribute to the silver masaka coins.

8 rati make a māṣa according to Babur's Memoirs.

In 17th century Gujarat māṣa varied from 10, 16 and 20 grains.

The term māṣa was common till recently as jewellers' measure and varied in different states. To state a few examples, in Madras the weight of māṣa was 15 grains, in Sholapur and Nasik it was 16 grains, but in Kolaba only 9 grains. On the whole 8 guñjas are considered as a māṣa. At present it is stated as 1/12 of a tola and hence it will be about 15 grains or 1 gm.

Suvarṇa or karṣa comprises 16 māṣas in weighing gold. Here also since the māṣa itself differs, the weight of suvarṇa also differs.

80 guñjas make a karṣa according to Manu, Yajñavalkya, Kauṭilya, Amara and Mahāvīra. Bhāskara differs from others by stating 168 guñjas as a karṣa, while according to Śukra 100 guñjas is a karṣa. In weighing silver Mahāvīra refers to a karṣa or purāṇa of 80 guñjas.

Śukra used the word karṣa for weighing rice in one place and stated that karṣa was 1/100th of a prastha, thereby indicating that it must have been used for weighing other commodities also. In Babur's memoirs 4 māṣa is considered as a tang and 5 māṣa as a miskal.

Suvarṇa as a weight was of 5 dharaṇas or 50 guñjas according to Abhidānapadika. Karṣa was also used as a coin denomination weighing one karṣa in weight. It was referred to as kāhapanas as well as suvarṇa in the Buddhist literature. Suvarṇa was referred to alongwith śatamāna, in Śatapatha Brāhmaṇa. Cunningham considered karṣapana as the seed of Bellerica Myrobalan (Terminalia Bellerica) which reaches upto 140 grains in weight.
**WEIGHTS IN ANCIENT INDIA**

*Karṣapaṇa* was a silver coin weighing 32 *ratis* (57.6 grains), while *suvarṇa* was a gold coin weighing 80 *ratis* (146.4 grains). In Ceylon a coin of the *kaḷanju* weight is called *kāhapaṇa*.

*Dharana* consists of 10 *palas* or 3200 *guṇjas* according to *Manu* and *Yājñavalkya* with regard to measuring gold, while *Mahāvīra* equates it with 40 *guṇjas* or 8 *paṇas*. Bhāskara's view seems to have been accepted in the Gujarati commentary on *Gaṇitasāra*. Varāhamihira's *dharana* is 1/10 of a *pala*. Since *pala* is of 320 *guṇjas*, *dharana* must be 32 *guṇjas* only according to Varāhamihira.

Silver *dharana* is 32 *kriṣṇalas*, according to *Manu*, *Yājñavalkya* and *Mahāvīra*. Kauṭilya differs from others by stating that 16 *māṣa* or 20 *saibya* seeds, constitute a *dharana*. If Kauṭilya's silver *māṣa* is considered as equal to 1/2 *guṇja*, then *dharana* will be of 8 *guṇja* seeds.

*Manu*'s gold *dharana* is heavier by 100 times than the silver *dharana*, while *Mahāvīra*'s gold *dharana* is 40 *guṇjas*, silver *dharana* is 52 *guṇjas*. Bhāskara's gold *dharana* is the lightest, weighing 24 *guṇjas*, which was also accepted by Gopālabhata. Bālaṁbhaṭṭa was also of the same opinion, even though he considered *dharana* and *kaḷanju* as synonymous. These vast numerical differences may perhaps be due to the type of *guṇja* used, whether *abrus* or *adenanthera*. Perhaps the similarity in the names may be a coincidence and have no connection in the weights concerned, or the value of gold might have gone up in Bhāskara's time.

*Satamāṇa* was 320 *ratikas* or 160 silver *māṣas* or 10 *dharana* according to *Manu* and *Yajñavalkya*. *Yājñavalkya* applied *pala* to *satamāṇa* and Vījñāneśwara equates it to a *niśka*. *Satamāṇa* literally means measuring by hundred and it is believed that *satamāṇa* was 100 *ratis*. However, *satamāṇa* was of 320 *ratis* as quoted by *Manu* and *Yajñavalkya*. In *Abhidānapadipika* a *pala* is considered as equal to 100 *guṇjas*. Since sometimes the term *satamāṇapala* occurs, *satamāṇa* and *satamāṇa pala* may be one and the same.

From the etymology of the word *satamāṇa* and from *Satapatha Brāhmaṇa* certain scholars adhere to the 100 *ratis* as a *satamāṇa*, since there is a definite reference to a *satamāṇa* of 100 parts i.e. 100 ratis. The verse "*suvarṇam rajatam hiranyam"
nānārupātayā śatamānāṁ bhavati śatāyur vai puruṣah," meaning that gold and silver will be the fee for the sake of variety to the manifold form of the deity, and that daksīṇa will be śatamāna, since the human being lives for one hundred years. Karaka the commentator of Katyāyanasrutasūtra has described the śatamāna as vrittakarou raktika śatāmanau (literally two round objects, weighing one hundred ratis).

Dr. D.C. Sircar analysing these facts came to the conclusion that 100 pieces making a śatamāna must be the South Indian mañjadi (adenanthera povonina) which is double the size of ratika. Mañjadi roughly weighs between 4 to 5 grains. Dr. Sircar, on the basis of epigraphic evidence also had opined that the non-Aryan weight system was adopted for śatamāna. The use of the multiple 16 is considered to be non-Aryan, since it was used by the pre-historic people of Indus valley. The śatamāna must be referring to 100 pieces of some non-Aryan measure probably mañjadi. This may be a correct view, since 96 mañjadi are considered as a tola in certain parts till recently. Instead of 96, a round figure of 100 might have been used.

During the time of Babur 96 ratis or 12 mūsa were considered as a tola. It has been observed by Prinsep that there is a closer accordance with the English gold assay scale, inasmuch as 96 ratis in a tola exactly represented the 96 carat in the gold assay pound and the dhān (śrīvī grain) which was the quarter grain. Perhaps śatamāna may be referring to the present tola. This reminds one, about the weight measure hundred-weight, which is equal to 112 pounds troy or 50.8 kg and not hundred-pound weight as the name suggests.

The British apothecaries' ounce and troy ounce consists of 480 grains or 30 grams. If adenanthara is considered śatamāna weight it will be somewhat closer to an ounce.

Pala which is considered synonymous with śatamāna is accepted by most of the authors as consisting of 4 karṣas or dharaṇa or 320 guṇjas. Bhāskara though accepted 4 karṣa as a pala in weight, it was 672 guṇjas according to him while one of the tables of the Gujarati commentary on Śrīdhara's Pātiganita it was 480 ratikas. There is an enormous difference between Bhāskara and others on this.
The glorious silver image of Parihäsakeśava (Viṣṇu)-erected by Lalitāditya Muktāpīda was made of thousands of palas of silver, according to Kalhaṇa. Since the phrase 'thousands of palas' was used, a pala cannot be a very big measure.

Pala and muṣṭi are considered as synonymous. Muṣṭi depicts a volume. Hence the weight of the amount of any substance perhaps paddy, that can be held in a muṣṭi or handful, must have been taken to be a pala. Pala or muṣṭi is considered as 4 tolas by Manu and 4 or 5 tālas, according to Yājñavalkya. If we consider the present tola which is 11.66 gms, according to Manu, it will be 46.64 gms, while according to Yājñavalkya it can be 58.3 gms.

Tola, as the name itself suggests, is that which is measured in a tulā (balance). This is rarely used in ancient literature as well as in inscriptions. In Rājatarangini, Lalitāditya Muktāpīda is said to have placed eightyfour thousand tolakas of gold for preparing the image of Muktakeshava (Viṣṇu). Stein identifies tolaka with tola and considers it to be equal to ¼ of a pala. Prinsep has given several weights for tola varying from 18.7 to 19.4 grains at different places.

In 17th century A.D., in Surat and Ahmedabad a tola of gold weighed 50 grains, while a tola of diamond weighed 58 carat or 62 ratis. Taking rati as 2.75 grains, a tola of diamond would be 172.5 grains.

The present jeweller's tola is 11.662 gms. or 180 grains in most of the places and is known as Bombay bullion tola. Bombay tola is also used for weighing saffron and spices. In certain places it varied for gold as in Amaravati district in Mysore where a gold tola weighed 216 grains. But at present tola weighing 11.66 gms has been used all over India. It is not out of place to mention that the Egyptian gold standard beqa weighed 12.96 gms and the Persian silver standard 11.53 gms.

Kaḷanju (Caesalpinia crista; Kubera-Sanskrit; karanja-Hindi, Gujarati, Kannada: nata natta karanja-Bengali; gajaga-Marathi; gacaca kaya-Telugu; Kazanchikuru-Malayalam-Kazhichikay-Tamil) is a term which often occurs in South Indian epigraphical records. Kaḷanju is actually the name of a prickly climbing species of caesalpina, the weight of the seed.
varying between 45 to 50 grains. The earliest reference in Tamil literature is from Puranānūru. Since in certain inscriptions the attribute por is added before kaḷanju (porkaḷanju), it can be considered that either kaḷanju is a measure of gold or a gold coin. In an early Pāṇḍya inscription of Māranjaḍaiyan, it is clearly stated that a kaḷanju is equivalent to a Kṛṣṇakaca. Another inscription refers to a kaḷanju as being equivalent to a nīśka. A 11th century Coḷa inscription from Tirumalavāḍi equates palams with 15 kaḷanjus.

No definite calculation can be made from these statements. Someśvara in Manasollasa considers 30 maṇḍadi as a kaḷanju. The same calculation occurs in a late Sanskrit work Ratna parikṣa. Bālambhaṭa considers two guṇjas as a maṭjaṭika or manjasṭa which is 1/20 of a kaḷanju. Kaḷanju, or maṇḍadi and kunri (kunrimani) were very common weight standards for gold. A Coḷa inscription from Kaṇchipuram refers to 18 kaḷanju, 3 maṇḍadi and 1 kunri thereby showing that maṇḍadi is a bigger unit (adenanthera) than kunri (abras).

Weights and balances in ancient India

Excavations conducted during the past two decades in a number of sites revealed objects that were identified as weights. In Taxila, Besnagar, Kaundinyapura Sālihuṇḍam and in other sites have disclosed several weights belonging to as early as 3rd millennium B.C. Though the origin of Indus system was independent, its relationship with Mesopotamian and Egyptian systems is within the range of probability. The system used in binary in case of smaller weights and decimal in the case of larger ones, the succession being in the ratio 1, 2, 4, 8, 16, 32, 64, 160, 320, 640, 800, 1600, 3200, 6400, 8000 etc. The ratio which was maintained by the Indus people seems to have been adopted in the later period to some extent and the number 16 became deep-rooted in the numismatic ratios. The unit of weight at Mohenjodaro has the calculated value of 0.875 gram and the largest weight 10.970 kg.

Even though a large number of weights were found, it is surprising that only a few scale pans had come to light. A few scale pans of red pottery, copper and iron with holes for suspension prove the existence of common balances. A
PLATE I
One Pan Balance on Greco-Buddhist Relief

PLATE II
Balance in Ajanta Caves
Coin from Rajgir

painting in cave no. 17 in Ajanta (6th century A.D.),\textsuperscript{109} represents a trader weighing in a double pan balance. On the obverse of an oblong coin from Rajgir,\textsuperscript{110} a common balance is depicted.

Specimens of naraji or one pan balance have been found in Arang in Madhya Pradesh and also in Sirpur (8th Century A.D.).\textsuperscript{111} The earliest of this type at Pompeii is of 78 A.D. In the panels depicting Sibi Jātaka in Amaravati, and Nāgarjunakoṭṭa\textsuperscript{112}, one-pan balances have been identified. In the Gandhāra sculptures\textsuperscript{113} the single-pan balances have come out very clearly. A relief on the back side of the Mira temple at Ahar shows a grocer using a balance for weighing.\textsuperscript{113a}

The prototype of the beam balance is frequently represented on scenes depicting the weighing of precious metals in Egypt from the fifth dynasty onwards. Drawings in Papyrus and tombs showed that common balance was employed for weighing large ingots of precious metals in Egypt. The most ancient balance so far discovered is in Egypt constructed at the 5th millennium B.C. It was made of lime stone, 8.5 cm. long with a fulcrum hole in the middle and suspension hole at each end for the ends that supported the scale.\textsuperscript{114} Roman craftsmen had an excellent bronze balance during the time of Constantine (337 A.D.).

The zodiacal sign tulā or libra shows the antiquity of common balances. The ancient Indian name for balance was tula. This term occurs in Vaiṣṇava Samhitā\textsuperscript{15} with reference to weighing gold (hiraṇyakāra tulā), thereby showing that
weighing was limited to precious metals. *Satapatha Brāhmaṇa*\(^{116}\) refers to weighing of a man’s good and evil deeds in the next and in this world. Balances were considered among the household objects according to Vaiśiṣṭha.\(^{118}\) Falsifying of balances was a social crime according to Āpastambha\(^{117}\) and the person who used false balances was to be debarred from śrāddha ceremonies. Buddha considered cheating through false balances and deriving profit thereby, as a kind of *mithyāajīva*\(^{118}\).

Every four months, the government has to check balances according to Kauṭilya\(^{119}\) while according to Manu\(^{120}\), checking should be done every six months; Yājñavalkya\(^{121}\) prescribes heavy punishment for those who make and use false balances.

Falsification of balances by deceit is mentioned in Amos (VIII:4-5) in the old Testament and it is condemned in Proverbs (XX:23). Using different kinds of weights to one’s own advantage is also mentioned in Deuteronomy (XXV:13) and Proverbs (XX 10 and 23).

Kauṭilya enumerates sixteen types of balances. Of these ten varieties are of light weight with single-scale pan. Beginning with a lever of six *āṅgulas* in length and of one *pala* in the weight of its metallic mass, there were ten different types of balances with levers increasing successively by one *pala* in the weight of their metallic masses. According to this description the length and weight of balances can be tabulated as follows:

<table>
<thead>
<tr>
<th>Type No.</th>
<th>Length</th>
<th>Weight in metallic mass</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>6 <em>āṅgulas</em></td>
<td>1 <em>pala</em></td>
</tr>
<tr>
<td>2.</td>
<td>14 &quot;</td>
<td>2 &quot;</td>
</tr>
<tr>
<td>3.</td>
<td>22 &quot;</td>
<td>3 &quot;</td>
</tr>
<tr>
<td>4.</td>
<td>30 &quot;</td>
<td>4 &quot;</td>
</tr>
<tr>
<td>5.</td>
<td>38 &quot;</td>
<td>5 &quot;</td>
</tr>
<tr>
<td>6.</td>
<td>46 &quot;</td>
<td>6 &quot;</td>
</tr>
<tr>
<td>7.</td>
<td>54 &quot;</td>
<td>7 &quot;</td>
</tr>
<tr>
<td>8.</td>
<td>62 &quot;</td>
<td>8 &quot;</td>
</tr>
<tr>
<td>9.</td>
<td>70 &quot;</td>
<td>9 &quot;</td>
</tr>
<tr>
<td>10.</td>
<td>78 &quot;</td>
<td>10 &quot;</td>
</tr>
</tbody>
</table>

These balances were used in weighing probably all kinds of commodities. The heavy balances were of six types. Of these *Samavarttatulā* had its lever 72 *āṅgulas* long and it weighed 53 *palas* in metallic mass. Kauṭilya explains these types of balances as “a scale-pan of 5 *palas* in the weight of its metallic mass being attached to its edge, the horizontal position of the
lever, when weighing a karṣa shall be marked (on that part of the lever) where held by a thread, it stands horizontal”. To the left of the mark, symbols such as 1 pala, 12, 15 and 20 palas shall be marked. After that, each place of tens upto 100 shall be marked. In the place of akṣas the sign of nandi shall be marked (akṣas are the place of five and multiples of five. Nandi is the symbol of Swastika).

Parimani is the largest type of heavy balance mentioned by Kauṭilya. It has a lever of 16 aṅgulas and 106 palas of weight in metallic mass. On its lever marks per 20, 50, 100, etc., are indicated. The weights of the public balance (vyāvahārīka), servants balance (bhājani) and balance of the harem (antapura bhājani) were 95, 90 and 85 palas these balances.

The heaviest type of balance was made of wood, with a lever eight cubits long. The lever had measuring marks and it was erected and fixed on a peacock like pedestal. Counterpoise weights were used in weighing heavy commodities.\(^{132}\)

In Mahā Nārada Kassapa Jātaka\(^{123}\), a weighing house is referred to. Weights were added gradually one by one on the weighing scale and when the weights were placed the end of the balance would be swung up.

Yājñavalkya\(^{124}\) refers to the practice, to draw a line on the wall of the weighing house to ensure accuracy in weighing. When the weights and the things to be weighed are on a level with the mark made on the wall at the weighing house, the weight is supposed to be perfect. He refers to experts in weighing (tulādhāranavid).

Manasollāsa\(^{126}\), a 12th century work by the western Cālukyan king Someśwara Bhulōkamallā, describes details about the balance (tulālākṣanam) used by the lapidaries in ancient India. He prescribes a heavy beam (daṇḍa) measuring about 12 aṅgulas in length at the ends of which there should be two rings (mudrika) for hanging the pans which should be made of bell metal (kānsya) with four string holes for suspension. The central rod (kantaka) measuring about 5 aṅgulas should be placed under an arch (toraṇa) by means of holes at ends. The arch should be held by a string while weighing and the vertical position of the central rod should determine the exact weight. Obviously here the author describes the common balance with two pans.
Thus the antiquity of weighing can be traced back to Indus civilization and Vedic period. Weighing appears to have started with precious metals in the beginning, since for other commodities barter must have been in practice. Though archaeologists have tried to prove the existence of decimal and binary systems, from the literature mostly the use of binary systems is available with regional variations.

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30. *EI*, XIV, p. 295
31. Wilson, p. 77.
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33. Hobson Jobson, p, 155.
34. El, XI, p. 28.
36. Mirat-e-Ahmadi, supplement, p. 140.
37. Lekhapaddhati, 100, 106.
38. Indian Epigraphical Glossary, p. 207.
40. Pancaśī Prabhandha Sambandha, p. 6, it is 100 sounds according to the editor, p. 190.
41. SII, XXI, 21, 183.
42. Padukku mun-tünikkilavi; Tolkäppiyam Eluttaddikāram, 239.
43. Ia, II, p. 151.
44. Ia, V, p. 109.
45. Ia, XVIII, p. 108.
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47. JAHRS, XXXII, p. 111.
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51. JBRRAS, p. 199.
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   Vedic Index, I, p. 371.
56. Vedic Index, II, p. 56.
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83. Abhidhānapadcīka, 479, 480.
85. Satapatha Brāhmaṇa, XII, 2, 22.
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87. JRAS, 1901, p. 876.
88. Ceylon coins and currency, p. 162.
89. IHQ, VII, p. 697.
90. JRAS, 1937, p. 301.
91. JNSI, XV, p. 142.
92. Kātyāyanaraustasūtra, (492) p. 213.
93. Rājaratangini, IV, p. 143.
94. ibid.
95. Purāṇāṇuṛ, 11,12.
96. MAER, 90 of 1908.
97. MAER, 181 of 1912, SII, IV, no. 5.
100. SII, Vol. I, 84.
106. Further excavations at Mohenjo-Daro, p. 400-465.
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112. Amaravati sculptures in the Madras Government Museum, p. 143, 228, 30, PL XXVII, fig. 16, PL V, p. 35.
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113a. Arts Asiatiques, XI, p. 63-64, fig. 6,7.
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116. Vasiṣṭha dharma sūtra, XIX, 1823.
120. Manu, 8,403.
124. Yājñavalkya II, 100-102,
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<td>Gujarati commentary on Śridhara’s Pāṭīgaṇīta (14 century A.D.)</td>
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<td>Śukra’s Nītīśāra</td>
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| 16 svetasarṣapa = māṣaka |
| 3 likṣa = rājasarṣapa |
| 3 rājasarṣapa = gaurasarṣapa |
| 4 mudri = pada |
| 4 pada = kalā |
| 6 gaurasarṣapa = yava |
| 6 kalā = yava |
| 8 sarsavi = yava |

| 2 māṣa = gunja |
| 2 māṣa = gunja |
| 3 yava = kriṣṇala |
| 4 yava = anḍī |
| 4 gaṇḍaka = guuja |
| 2 yava = ratika |

| 5 gunja = k arma |
| 5 gunja = k arma |
| 5 k riṣṇala = māṣa |
| 4 anḍī = māṣa |
| 5 gunja = 3 gunja = 5 gunja = 3 ratika = v alla 10 gunja = māṣa |
| 5 paṇa = v alla māṣa |

| 16 k arma māṣa = 16 suvarṇa māṣa |
| 16 māṣa = karṣa |
| 16 māṣa = karṣa |
| 16 paṇa = 16 māṣa = 16 māṣa = 10 māṣa = |
| 8 paṇa = 8 v alla |
| 8 v alla = dharaṇa dharaṇa |

| 4 karsa = palam |
| 4 karsa = palam |
| 4 suvarṇa = pala |
| 4 karṣa = 4 karṣa = 4 karṣa = 20 dharaṇa = |
| 4 pal a = pala pala pala pala |

16 v alla = gadyāna 16 v alla = gadyāna
### Measurement of Silver

<table>
<thead>
<tr>
<th>Manu &amp; Yājñavalkya</th>
<th>Kauṭilya</th>
<th>Mahāvira</th>
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<tr>
<td>2 kriṣṇala = māṣa</td>
<td>88 gaurasarṣapa</td>
<td>2 gunja = māṣa</td>
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<tr>
<td>16 māṣa = dharana</td>
<td>16 māṣa or saibya seeds = dharana</td>
<td>16 māṣa = dharana</td>
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<td></td>
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<td>2½ dharana = karṣa or puraṇa</td>
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<td>10 dharana = sātamaṇa</td>
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<td>4 karṣa or</td>
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<tr>
<td></td>
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<td>10 dharana = pala</td>
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</tbody>
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Measurement of Time in Ancient India

All over the world, measurement of time was invariably related to natural phenomena, associated with the movements observed among the celestial bodies. In ancient period, the sky was the giant clock and calendar as well as an almanac. Even before realising the details of the movements of planets and positions of the stars, people could still appreciate and understand the phenomena, like day and night, the waxing and waning of the Moon at regular intervals and monsoons occurring at definite intervals. Time was understood as a continuous motion that cannot be stopped, neither hurried nor delayed. It was considered to be without beginning and without end.

Regarding the celestial factors that governed the time, sun was the most important one. Even the ancient astronomers, for whom earth was the centre, the sun was given the place next to the earth. The recurrence of days and nights at regular intervals was attributed to the revolution of the sun and not to the rotation of the earth. The day is apparently the most obvious and simple unit of measurement. A day is a period of 30 muhūrtas (24 hours). Its principal characteristic of
alternate daylight and darkness repeats itself in regular cycles.

Waxing and waning of the Moon is another obvious unit in helping to determine the months. The waxing and waning occur with good regularity. The seasons arrive in a consistent sequence. These are the natural phenomena which governed the time factor in the ancient world. These natural factors helped to serve the day-to-day needs of the society, which did not require any great accuracy, because of the simple and leisurely life. With the first streaks of Sun's rays, man and animals started their chores and even the birds came out of their nest. With the setting of the Sun, men and animals went for resting and the birds flocked inside their nests. During the day, men had to do his daily routine of collecting food, fire-wood and after a tiresome day had to retire for rest. The variations in the seasons helped man to decide about the farming operations, the type of protective dresses to wear and plan his day-to-day operations depending on the weather conditions, which he could predict fairly well to meet his limited needs.

It is difficult to say definitely, as to when and how the counting of time began. According to eminent scholars, the Egyptians were using a calendar as long ago as 4236 B.C. The Jewish religious calendar starts with the supposed date of creation by Jehovah, while the Chinese chronology starts from 2391 B.C.

The Vedic Aryans had the knowledge of time in relation to sunrise, noon, sunset, day, month, fortnight, seasons, half year (ayana), year and yuga. The term muhurta is found in Rg Veda in the sense of 'moment'. while in Brähmana literature it denotes a division of time, namely one thirtieth of a day (48 min or $\frac{2}{3}$ hour).

As the activity of man became more and more organised and as his social links also became well established into civilized living, he felt the need to subdivide day into definite divisions to organise his activities in a more systematic manner. That is to say, as the civilization progressed, the need for appreciation of the time element also grew. The ancient Indians divided the day initially into 30 muhurtas or 60
nālikas as the practical measures of time. Thus the simple reckoning appears to be 360 days a year, 30 days a month and 30 muhūrtas a day, two nālika equalling a muhūrta.

The nālika itself had to be further subdivided into smaller units, for greater accuracy. This, particularly was needed to calculate more precisely, the planetary positions, in astronomical and later on in astrological calculations, as also in musical and poetic meters.

In the past all over the world, the calculations based on the movements of the planets and constellations were based on geocentric idea, that is, on the concept that earth was stationary, with other planets of the zodiac moving around it. Clear-cut ideas about the zodiac was understood in India by about 500 A.D. as can be seen from Sūryasiddhānta and Āryabhatīya (500 A.D.). Āryabhaṭa was the first known astronomer-mathematician in India, who expounded the theory of revolution of earth which was refuted by later writers in India. This important discovery of Āryabhaṭa was not known to the West, who still attribute the credit for this theory to Copernicus, the Polish astronomer, who in the 16th century A.D. clearly demonstrated, that the planets including the earth revolve on their own axes and move in orbits around the Sun. Even in the 17th century A.D., when Galileo, the Italian astronomer, though confirmed the Copernicus theory, had to repudiate the theory later, because of the confrontation with the inquisition threats. Thus, even though Āryabhaṭa had given this correct concept in 5th century A.D., both in India and abroad this fact was ignored and India appears to have accepted the theory again, only after the West had accepted the Copernican theory in 17th century. It is, however, interesting to note, that even before Āryabhaṭa, Aristarchus of Samos, Greek mathematician proposed that sun was the hub of our planetary system and earth was revolving around it, even as early as 3rd century B.C. Pythagoras and Philotaus also followed the same doctrine. This was, however, refuted by Aristotle and later on by Ptolemy.

Thus a very important concept in the field of time measurement, even though it came to light as early as 3rd century B.C., it required nearly 19 centuries to pass off before getting
the recognition due to religious bigotry and ignorance of the masses. This very fact makes the naming of the 1st Indian satellite as Āryabhaṭa quite aptly and reflects the correct thinking of the people concerned in naming the satellite.

In relation to the development of time concepts certain interesting factors are worth consideration at this stage. According to ancient astronomers, the zodiac was divided into 360°. The year which consisted of 12 months of 30 days comprises 360 days. The divisions of time in the chart I, except in Mahāvīra’s Gaṇitasārasamgraha, were divisions into 360 unit. The year, according to Jupiter’s cycle is also 60, which is one-sixth of 360. This number 360 is not an imaginary number. That is the only number divisible by the numbers 1 to 9 except 7. Taking advantage of this, the zodiac must have been divided into 360. Since the number 360 is convenient for calculations, this must have been kept as the base by the astronomers and astrologers.

After the Vedic age, astronomers like Āryabhaṭa I, Brahma-gupta I, Varāhamihira and Bhāskara I made their contribution to the Indian astronomy. Along with this, astrology also developed, which interested the planetary movements linked to the destiny of the man. In this discussion the time factors mentioned in the books on astronomy or jyotiṣa and mathematics are considered to start with, since they formed the main basis for time measurements in ancient India.

The term jyotisā is derived from the root ‘jyut’ or ‘dyut’, to shine and therefore it is a science of the movements of the luminous bodies. Another expression for it, is nakṣatra darśana or observation of stars. Astronomy (as derived from astron, a star and nemō—to classify or arrange) is a science, which deals with the distributions, motions and characteristics of heavenly bodies. As has already been stated, since the movements of the planets govern the time, jyotiṣa or astronomy is the most important science, to be considered while discussing evolution of concepts on time. Since astronomy needs precise calculation mathematics goes hand in hand with astronomy. It is no wonder that ancient astronomers were eminent mathematicians also.

In the following study the various entities of time measure-
ments that were used in ancient India are given, starting from the smallest unit of time used in the literature of different periods. There are some variations in the usage and concepts relating to many of the smaller units, even though the concepts relating to nōlika and muhūrtā remained uniform. All the variations are summed up in the comparative charts (charts I and II).

Division of the day into thirty muhūrtas has been accepted by all the ancient Indian seers. Considering a muhūtra as of 48 minutes, the equivalents of the other smaller units in terms of modern minutes and seconds have been calculated by the author in chart I, to understand the proper relationships between these otherwise confusing terms of unitage of time. The equivalents in seconds and minutes are given within brackets wherever possible.

The terms like paramāṇu, anu,trasareṇu and āvalī which occur in ancient Indian literature seem to denote very minute items of matter, including minute span of time. It is difficult to evaluate them with any of the present known measures. More information is available on the following measurements of time, even though they appear to denote different lengths of time according to different scholars.

Truṣṭi, which is also a very small unit of time, has been mentioned by several authors, as giving varying time equivalents. According to Kauṭilya⁴, truṣṭi is equal to 0.06 seconds, while according to Bhāgavata⁵ and Brahmmapurāṇa⁶ it is 0.0005 seconds. Vaṭeṣvara and Nārada⁸ consider truṣṭi as the time taken to pierce a lotus petal, which is equivalent to 0.00008 seconds of the modern time measurements. Musical works⁹ refer to a truṣṭi of 8 to 16 nimeṣas or 1/10 of a guru. A guru is the time taken to pronounce a guruvāksara or a long consonant. Thus the term truṣṭi appears to connote different lengths of time according to different authors.

Tāṭpāra (speck) constitute 100 truṣṭis according to Bhāskara¹⁰ and Śripati¹¹ (0.003 sec). Vaṭeṣvara calls 100 truṣṭis as a lāva, which works out to 0.0008 second. The term vedha in Bhāgavata¹⁰ and Brahmmapurāṇa¹⁰ also is said to consist of 100 truṣṭis, but is a slightly bigger unit (0.047 sec).
long consonant was considered as a unit of time. It is generally accepted as a space of 0.4 second. The term *laghu-vākṣara* (short consonant) and *guruvaḵṣara* (long consonant) connote different time factors. The time taken to pronounce a short consonant is one *laghu* and two *laghus* make a *guru* in poetical works.⁹

*Mātra* is a fixed time limit, which is still in usage, in both musical and poetical works. The time taken to pronounce five short syllables (*laghuvaḵṣara*) is considered as a *mātra* according to Bharata’s *Nātyaśāstra*¹² and other works on music.¹³

Kallinātha, in his commentary upon *Sangītaratnākara*,¹⁴ draws a clear distinction between the *mātra* of the poetical meter and the *mātra* of musical meter. In connection with the poetical meter, the time taken to pronounce a short syllable is meant by the word *mātra*, while in the musical time measurement (*tāla*) it should be regarded as the time measured in pronouncing 5 short syllables. Here also certain works on music and dancing differentiate the *mātra* between *mārgi* and *deśi* styles. In the former, the time taken to pronounce 5 *aṅkaṅsara* stand for a *mātra*, while in the latter it is equal to 4 *aṅkaṅsaras*.

In the ancient Tamil work *Tolkappiyam*,¹⁵ twinkling of the eye is considered as a *mātra*. In Tamil the time taken to crack the finger is also called *mātra*.

_Uchchhvaṣa_ (0.75 sec) was considered as 1/7 of a *stoka* by Mahāvīra.¹⁶

_Prāṇa_ is the time taken to pronounce 10 *guruvaṅkṣara*, according to Brahmagupta¹⁷ and *Sūryaśiddhānta*¹⁸ (4 sec). Vaṭeśvara² and Bhāskara¹⁰ refer this term as *asu* (4 sec).

_Lava_ is a controversial unit and seems to be a superficial measure. The time taken to pierce a lotus petal is considered as *lava* according to *Vaṭeśvara siddhānta*, while it is the time taken to pierce 800 petals by a needle according to musical works.⁹

_Lava_ according to Kauṭilya⁴ constitutes 2 *truṭis* (0.12 sec), while according to Vaṭeśvāra it is equal to 100 *truṭis* (0.008 sec). According to Bhāgavata⁶ and *Brahmapurāṇa*, 300 *truṭis* make a *lava* (0.142 sec). It is to be noted that all these authors used a different concept of time for their *truṭi*. Mahāvīra...
considers lava as a bigger unit of time, consisting of 49 uchchavāsas (37.4 sec), that is 7 stokas. It seems that Jains must have taken number 7 as the figure because of its being the largest indivisible unit number.

Kṣaṇa, according to Monier Williams, is a moment of twinkling of the eye or any instantaneous point of time. Kṣaṇa, according to Bhāgavata and Brahma purāṇa is of 5 nimesas (1.28 sec), while according to the nyāya works of Śrīdhara and Udayana, kṣaṇa is the smallest unit of time (0.0035 sec). In contrast to this, kṣaṇa, mentioned in Abhidhānacintāmaṇi, is a bigger unit of 4 seconds.

A late Tamil work Tālasamudram, gives an entirely different meaning for kṣaṇa. When 8 lotus petals are kept one over another and picked with the needle, the time taken to prick a single petal is kṣaṇa.

Kṣaṇa is the smallest unit of time according to Sāranga-deva. He considers kṣaṇa as 1/8 of a lava, which is in relation to poetic meter.

Nimeśa is the most common unit of time which, however, varies with each and every author. Nimeśa literally means a wink or twinkling of the eye. According to Vaijayanti, it is the time between two aksarapatakas. 4 truṭis make one nimeśa. According to Kauṭilya, while (0.24 sec) 3000 truṭis, according to Bhāskara (0.09 sec); 10,000 truṭis according to Bhāgavata and Brahma purāṇa. Nimeśa is omitted by Āryabhaṭa, as well as Mahāvīra. In modern usage a nimeśa is put as the equivalent of a minute.

Kāṣṭha also varies with each and every author for its duration of time. It is 5 nimesas according to Kauṭilya (1.2 sec), 15 nimesas according to Bhāgavata and Brahma purāṇa (6.4 sec), 18 nimesas according to Manu and Bhāskara (1.6 sec). Nyāya works of Śrīdhara and Udayana consider it as equal to 3.2 seconds. Kāṣṭha referred to in Vedāṅgajyotisha is equal to 1.16 seconds.

Palam mentioned by Bhāskara and Vaṭeśvara is of 24 seconds. This may be considered as equal to vināḍi of Brahmagupta.

Kalā has been accepted by several writers as equivalent to 30 kāṣṭhas. On calculation, according to Kauṭilya, a kalā will
be of 36 seconds, while it will be 48 seconds according to Siddhānta Siromani. Manusmriti Viṣṇupurāṇa and Siddhānta Sekhara refer to a kalā of 96 seconds.

Works on music refers to several types of kalās. Bharata mentions three different types of kalās. Kalā in the citra style is of 2 mātrās, in vṛtti style is of 4 mātrās and dakṣina style is of 8 mātrās. Bharata also refers to a kalā or 6 nimeṣas. The changing value of kalā is conspicuous in latter works on music. In Sangītaçudamani of Jagadekamalla and Sangītamakaranda of Nārada, kalā is equated with half of laghu, the latter consisting of the time taken to pronounce a short vowel.

Kalā mentioned in Vedāṅgajyotiṣa is a bigger unit of time. According to this work, a kalā will be equivalent to 2.4 minutes and 603 kalās would make a day.

On the contrary, kalā mentioned in Abhidhānacintāmani seems to be a very small unit of time comprising only 8 seconds.

Nāḍika, nālika or ghaṭika generally indicate 24 minutes; this has been explained by several authors, while describing ghaṭi or kapala (clepsydra or water-clock). The Indian water-clock is an arrangement for measuring, by means of the water and a jar or bowl, the duration of nadi, nadika, ghati or ghatika.

In Sūryaprajñapāti, the water-clock is said to be made of a thin plate of brass or copper, capable of holding a prasṭha of water weighing 12½ palas. It had a small hole at the bottom through which water entered into the cup, when it was floated in water contained in a bigger vessel. In 12 nāḍikas the vessel would be filled 183 times. Hence within a nāḍika 15½ prasṭhas of water would get filled.

In the Buddhist work Divyavadāna, a water-clock is described in a detailed manner. At the bottom of a water-jar holding a drōṇa of water, a hole should be made of a gold pin. The pin must be made of gold of a quantity of suvarṇa, drawn out four aṅgulas in length, quite round or square. The water will be completely emptied during a nālika.

In Sūryasiddhānta also the nāḍika is determined by a water-clock. A copper vessel (in the shape of the lower half
-of a water-jar), which has a small hole in its bottom has to be placed upon a clean water in a basin. It sinks exactly 60 times in a day and night. This represents 60 nādikas per 24 hours. Brahmagupta’s water-clock also tallies with this.

According to Kaṇṭilīya32, the duration of the time required for the passage of one ādhaka of water to pass out of a pot, through an aperture of the same diameter as that of a wire of 4 aṅgulas in length and made out of 4 suvarnamāṣakas is a nādika. The diameter of the wire of 4 suvarṇamāṣakas, when drawn into 4 aṅgulas length, is not mentioned.

In Tamil the water-clock is termed as nālikai vāṭṭil, through which a nāli or alakkus of water is made to drip down and the time taken for the vāṭṭil to be emptied is a nālikai.33 Dividing the day into nāli, which is equal to 24 minutes, is still in usage in Tamil-speaking areas and is used in South Indian almanacs.

Muhūrtā is the only term where almost all the writers are unanimous in stating that it is \(\frac{1}{36}\) of a day. The thirty-fold division of the day as well as night is vaguely mentioned in a single passage in Rg Veda.34 This has been compared by Zimmer34 with the Babylonian concept of sixty-fold division of the day. The division of the day into 24 hours was first proposed by the Greeks.

Āhōrātra (day and night) is the most natural phenomenon comprising 30 muhūrtas or 24 hours. It is measured from sunset to sunset by Babylonians and Mohammedans. A Hindu day starts with the first streaks of the rising sun. Here again there are controversies. Āryabhaṭa35 has propounded two systems, audhāyiku (the beginning of the day with sun rise at Lanka) and ardharōrika system (beginning of the day at the midnight at Lanka), Brahmagupta accepts the mean sunrise at Lanka, while Bhāskara37 follows the mean sunrise at Ujjain. Varāhamihira38 in his epicyclic cast in the Suryasiddhānta in Pancaśiddhāntika follows the ardharōtika system, Lanka is an imaginary island in Indian ocean having the same longitude as Ujjain (75°.52’ East of Greenwich), but situated on the Equator.

If the length of the day is measured with an accurate clock, it is variable throughout the year. The day has to be reckoned
either by *nakṣatra* or *tithi* in the Hindu calendar. For religious purposes to fix up festival days, the Hindus, Babylonians and Greeks followed the lunar day which is known as ‘*tithi*’ in the Hindu calendar. This is practical, since calculation through a visible sign (moon) is easier than other celestial bodies, which are not so easy to locate through the naked eye.

*Vāma* or *Prahāra* stands for $\frac{1}{6}$ of a day (3 hours). With a view to regulating the occupations of the king, his day and night were each divided into eight divisions of 90 minutes or $\frac{1}{4}$ praharas. There used to be a night watch for each prahara.

*Nakṣatras* are the lunar mansions, named according to the conspicuous star group marking the moon’s path. The lunar zodiac was earlier divided into 28 parts and later on into 27. In *Rg Veda*, it is used in the sense of a star. The earliest reference about *nakṣatras* is from *Aitareya* *Nakṣatra Kalpa*. In *Taitriya, Kathaka* and *Maitrāyani Sanhitās*, *Aitareya Brāhmaṇa* and *Vedāṅgajyotīsa*, the names of the *nakṣatra* were mentioned along with the Vedic deity.

This terms *nakṣatra* has been interpreted in various ways. In *Śatapatha Brāhmaṇa*, it is explained with a legend and is resolved into *na-kṣatra* (no-power). The *Nirukta* refers to the root ‘*naks*’, to obtain. Aufrecht and Weber derived it from *nakta-tra*, ‘guardian of night’ and more recently the derivation from ‘*nak-kṣatra*’ which means ‘having rule over night’ seems to gain acceptance.

The Indian names for the *nakṣatras* differ from the Greek astronomical names, as can be seen from the following table:

**TABLE I**

<table>
<thead>
<tr>
<th>Indian Name</th>
<th>Astronomical Name</th>
</tr>
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<tbody>
<tr>
<td>1. Āsvini</td>
<td>Arietis</td>
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<tr>
<td>2. Bharaṇī</td>
<td>Musca</td>
</tr>
<tr>
<td>3. Kṛttikā</td>
<td>Aleyni</td>
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<tr>
<td>4. Roṭiṇī</td>
<td>Aldebaran</td>
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<tr>
<td>5. Mṛgāśīrṣa</td>
<td>Orionis</td>
</tr>
<tr>
<td>6. Ārdrā</td>
<td>Betelgues</td>
</tr>
<tr>
<td>7. Punarvasū</td>
<td>Pollux</td>
</tr>
<tr>
<td>8. Puṣya</td>
<td>Canori</td>
</tr>
<tr>
<td>9. Āśleṣa</td>
<td>Hydrai</td>
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<td>Astronomical Name</td>
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<tr>
<td>10. Maghā</td>
<td>Regulus</td>
</tr>
<tr>
<td>11. Pūrva-Phālgunī</td>
<td>Leonis</td>
</tr>
<tr>
<td>12. Uttara-Phālgunī</td>
<td>Denebola</td>
</tr>
<tr>
<td>13. Hasta</td>
<td>Corvi</td>
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<tr>
<td>14. Citrā</td>
<td>Spica</td>
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<tr>
<td>15. Swāti</td>
<td>Arcturus (Bootis)</td>
</tr>
<tr>
<td>16. Viśakhā</td>
<td>Libra</td>
</tr>
<tr>
<td>17. Anūrādhā</td>
<td>Scorpionis</td>
</tr>
<tr>
<td>18. Jyeṣṭhā</td>
<td>Antarus</td>
</tr>
<tr>
<td>19. Mula</td>
<td>Scorpii</td>
</tr>
<tr>
<td>20. Purvāśādha</td>
<td>Sagittarii</td>
</tr>
<tr>
<td>21. Uttarāśādha</td>
<td>Sagittarii</td>
</tr>
<tr>
<td>22. Śrāvaṇa</td>
<td>Aquilae Ablair</td>
</tr>
<tr>
<td>23. Dhanistha (śraviṣṭha)</td>
<td>Delphin</td>
</tr>
<tr>
<td>24. Šatabhiṣak</td>
<td>Aquarīi</td>
</tr>
<tr>
<td>25. Pūrva Bhādrapada</td>
<td>Markab</td>
</tr>
<tr>
<td>26. Uttar Bhādrapada</td>
<td>Pegasi</td>
</tr>
<tr>
<td>27. Revatī</td>
<td>Piscium</td>
</tr>
</tbody>
</table>

The *nakṣatra abhijit*, which occurs between *Uttarāśādha* and *Śrāvaṇa* is not counted at present, though mentioned in Vedic literature. The Chinese system of *sieu* had at first 24 *nakṣatras* and later was increased to 28 at about 1100 B.C. They are not integrated with a religious system as in the Hindu and the Greek calendars.

The system of quoting dates by *nakṣatras* is as old as quoting by *tithis*. This system is more prevalent in South Indian literature and epigraphy. As early as the famous story of Kovalan in *Śiloppadikaram* (756 A.D.), *nakṣatras* are mentioned. For example, a day would be distinguished as the 6th *tithi* of the moon in the dark half, with the moon in *nakṣatra Śrāvaṇa*. Thus the day gets a more specific fixation in the lunar month, which has a bright half and a dark half.

*Week days* are the meeting ground for the calendar all over the globe. The 7 day cycle, is probably a convenient division of the lunar month of 28 days. It is probably helpful for fixing a day of rest after protracted work for a fixed number of working days.

The ancient Vedic Aryans had a *sadāha*, a cycle of six
days and there were no separate names attached to these days. The Egyptians had a ten-day week or decade, the tenth day being the market day and after marketing people can rejoice.

The Babylonians had at first a week of 5 days, which is approximately $\frac{1}{4}$ of a lunation and later on increased it to 7 days, which is approximately $\frac{1}{2}$ of a lunation. The Babylonians named the day after the planets, in the order of their apparent distance from the earth, and identified them with their chief gods, who were said to have some special power under them.

1 2 3 4 5 6 7
Planet Saturn Jupiter Mars Sun Venus Mercury Moon
God Ninib Marduk Nergel Shamash Ishtar Nalu Sin
(Pestilence) (king) (war) (justice) (love) (writing) (agriculture)

Further the day was divided into 24 hours, and each of the 7 gods was supposed to keep watch over each hour of the day in rotation. The day was named after the god, who kept watch at the first hour. Thus on Saturday, the watching god for the first hour is Ninib or Saturn and the day was named after him. The succeeding hours of Saturday were presided over as follows:

1234567 891011121314 15161718192021 22232425
Watching god
1234567 1234567 1234567 1234

The 25th hour is the first hour of the next day and the presiding planet is Sun. Hence Sunday comes after Saturday. To the Babylonians, Saturday was dedicated to the god of pestilence and they avoided work on that day for fear of offending the deity. These week days were observed in pre-Christian era, by Assyrians, Babylonians, Egyptians, Greeks, Romans and Jews.

The great propagandists of the seven-day week were Jews, who conferred on the week days some sanctity by inventing the creation myth, in the opening chapters of the Bible (Genesis ch. 1 and 2). The Jews did not adopt the planetary names for the days, but first, second and so on upto the Sabbath day. The seventh day which was the end day of the Babylonians, was the day of rest for Jehovah after his laborious creation.
Jews attached so much sanctity to Sabbath day that they would not do any work on that day. Taking advantage of this, Romans attacked Jerusalem on the Sabbath day, and carried the city, without a fight, because the Jews would not do such profane things as fighting on a Sabbath day and led by their priests, they expected Jehovah to bring punishment on the offenders for the sacrilege.44

The Christians changed the Sabbath day from Saturday to Sunday, since they would not have the same day as the Lord’s day as the Jews.

For naming the important days of Christian liturgical year such as Holy Thursday, Good Friday, Holy Saturday, etc., the week days were utilised. Here they had some difficulties. The Jewish festival of Passover, on which Christ is alleged to have been crucified, took place on the first full moon after vernal equinox and it had no reference to week days. The Christians wanted the Resurrection on Lord’s day. Hence the Bishops decided that the Easter, that is, the Resurrection of Christ should be considered having taken place on a Sunday, following the first full moon after the vernal equinox. This resulted in having Easter on any day between March 22 and April 25, with an amplitude of 35 days.

Here, it is unlike the Hindus, who have to adjust their religious festivals in relation to Sun and Moon and not in relation to the week days. The Christians have to satisfy the Sun (vernal equinox), the Moon (full moon) and the Babylonian seven-day planet hierarchy for fixing the Easter day (day of Resurrection of Jesus). From this pivotal day, the other important religions festivals are determined. For example, Good Friday is two days before Easter and Palm Sunday seven days before Easter Sunday. Hence finding out the date of Easter in a given year is not an easy task.

The Romans had the eight-day week, in which the eighth-day was a market day on which the country people went to the city to sell their product, do their own purchases, and attended to public and religious affairs. In or soon after 250 A.D. the Roman world had the seven-day week using the planetary names, which can be understood from a well-known statement by Dion Cassius (first quarter of the 3rd century A.D.). In his
37th book, he has mentioned the capture of Jerusalem by Pompeii in 63 B.C. on a Saturday, owing to the reverence of the Jews for Saturday (their Sabbath day). He further remarks that the week days, originated in Egypt and it was of recent growth in Rome and was in general use in his days.\(^a\)

It was the Christian Emperor Constantine who confirmed the venerated day of the Sun as a general day of rest and hereby the seven-day planetary week became definitely substituted for the nondinal eight days week.

Week days in India is also a later development. In the end of Sārdulakarnadāna, in Divyavadāna the planets were mentioned but not in the same order of the week days. Venus, Jupiter, Saturn, Mercury, Rāhu and Ketu were mentioned followed by Sun and Moon. According to M. Sylvian Levi, they are not found in the Chinese translation which was translated in 3rd century A.D. Jayaswal argues that perhaps they must have been left out in the Chinese translation, because they might have been difficult in translating. This argument does not seem to be valid.\(^b\)

In the second praśna of Baudhāyana dharmasūtra\(^b\) during tarpāṇa the following verse is mentioned.

"Om, I satiate Āditya; Soma, Angāraka; Budha; Bṛhaspati; Sukra; Śaniścara; Rāhu; Keṭu." Since the planets are mentioned in the same order as the week days, perhaps the week days might have been hinted. It is not very certain whether they have any connection with week days, since Rāhu and Ketu were also mentioned in the end. This is the Hindu concept of navagraha (nine grahas). Āryabhaṭa (499 A.D.) in Kālakriyāpāda\(^b\) mentions the 24 hours of the day and also the same rule similar to the Latin writer Firmicus Maternus (334 to 354 A.D.) and the Greek writer Pavlus Alexandriners (378 A.D.) in relation to the hours and their ruling planets, namely Saturn, Jupiter, Mars, Sun, Venus, Mercury and Moon; beginning with Saturn which is the farthest from the Sun.\(^b\)

Whether by intention or coincidence, the Jewish system was followed, even though no logical conclusion could be added for linking any particular planet with any particular day or any part of the day.

Since, the Hindu astrological order of the planets start with
Sun followed by Moon, Mars, Mercury, Jupiter, Venus and Saturn, the Hindu calendar also follows the same order, which fits in with the Jewish system also.

The earliest known genuine instance of the use of the planetary name of a day in India is in 484 A.D. found in the Eran Inscription of Budhagupta from the Saugar district, which mentions the date as the (Gupta) year 165 on the twelfth tithi of the śuklapakṣa of Āśāda and Suragurordivas. The term Suraguru applies to Brhaspati, the preceptor of the gods (Jupiter). The next instance is found in a copper plate grant of the eastern Cālukya King Viṣṇuvardhana II, from Nellore District.

Whether the week days were the outcome of the Western influence or a legacy from Syria, it has to be accepted, that they did not originate from India. But some how, the days of the week have been interpreted by Hindu astrologers as auspicious and inauspicious. In this also, no doubt, they are carried away by the Babylonian superstitious beliefs, along with their ingenuity of naming each day after a God. This led to the beliefs that the planets, representing Gods, rule the human destiny and let in a flood of astrological superstitions from China and India in the East and Roman Empire in the West. Even the iconoclastic Arabs appeared to have had great faith in astrology. Leaving aside the astrological factor, the week days have played part in determining the chronological investigations. The very first reference where the week day has played part, is in connection with fixing the dates of the Last Supper and crucifixion of Christ. By means of the week days occurring in the Gospel narratives of the New Testament, it is ascertained that these events must have happened in one of the three years namely 29 A.D., 30 A.D. or 33 A.D., although it will always remain a disputed point in which of the three years these events really happened.

By the same way, though the seven-day week became a tool for inventing myths by the astrologers, it became a problem, when religious festivals had to be calculated. Hence, the major religious festivals could not be disturbed, but they continued to be adjusted to season by the use of intercalary months.

Determined efforts have been made to get rid of the seven-
day week and the superstition grown around it. The makers of French revolution introduced a ten-day week (decade) like the Egyptians three thousand years earlier. The Bolsheviks experimented with a five-day week and a six-day week and ultimately returned to the seven-day week. The ancient Iranians had no week days, but named the days of the month after a god, e.g., day of Ahura Mazda, day of Mithra, etc. Later on they also adopted the seven-day week.

At present the seven-day week is accepted by all, except some Jewish Rabbis. The introduction of an extra day at the end of each year or two extra days during each leap year, which belong to no week, is considered as a sacrilege by them. Fortnight (pakṣa) comprises 15 days or half a month. Pakṣa is entirely based on the Moon’s revolution. The dark half (kṛṣṇapakṣa) ends with the new moon (amāvasyā) and the bright half (suīlapakṣa) ends with the full moon (pournamāsa). Special names are given to the fortnights in Taittiriya Brāhmaṇa namely Pavitram, Pavaiṣyan, Pūtaḥ, Medhyah, Yaśah, Yaśasvān, Āyuḥ, Aṃrtaḥ, Jīvah, Svargah. Lokah, Sahasvān, Sahīyan, Ojasvan, Sahamāna, Janayan, Abhijayan, Sudravīnāh, Dravinodaḥ, Ardra-pavitrah, Harikeśah, Modah and Promodah.

In this connection, reference may be made to about a fortnight of 13 days. In Mahābhārata, Vyāsa during his conversation with Dhritrāṣṭra seems to have told that he has known fortnights with 14, 15 and 16 days but never of one consisting of 13 days, which occurs once in 1000 years and since such one has occurred at that time there would be a great onslaught. Later works Muhūrta Gaṇapati and Muhūrta Cintāmanī also refer to the occurrence of lunar fortnight of 13 days.

There is a lot of controversy on this statement. According to Dr M.N. Saha the full moon cannot fall on the thirteenth day after the new moon, probably the observers occasionally used to miss the first day of appearance of the thin crescent after full moon, due to the moon’s nearness to the Sun or some other reason. The Moon is generally invisible for two or three nights round about new moon, and this was probably
the origin of widespread mourning for three nights.64 Swami-
kkannu Pillai asserts that the fortnight of 13 days occur
periodically. Accordingly to him it has occurred in 1805, 1813,
1830, 1847, 1849, 1861, etc., and the statement that the fort-
night of 13 days occur once in 1000 days is not correct.62
According to Swamikkannu Pillai the lunar fortnight of 13
days occurred on July 14th and August 24th in 1914; when the
great war broke out.

This controversy is similar to the Id moon or crescent,
which is sometimes visible on the second day and sometimes
on the third. The visibility may also differ in different places.
If the Moon is sighted on the third day, obviously, one day in
a fortnight will be counted less.

Month is a natural division of time unlike the week. There
are two types of months namely solar and lunar.

As has already been stated, according to ancient astrono-
mers earth was considered to be at the centre and stationary
while the Sun was revolving around it. They divided the
circle of the Sun's path into 12 zodiacal signs each of 30° arc.
The time required for the Sun to pass completely from one
sign to another, or the time during which the Sun remained in
one sign, constituted the solar month or saura māsa.

Lunar month is the time of one lunation. The moon
actually traverses the sky, that is, starting from one point and
returns to the same point in about 27½ days but since the Sun
moves in the same direction it takes a little longer time to
reach the Sun length, which makes it 29.5 days as the length
of the lunar month. The month either starts with the full
moon (purnimānta) or new moon (āmanta). The Greek, the
Roman and the Jewish months started with the new moon.

The phases of the Moon is very important for the fisher-
men and the hunters. Moreover, the full cycle of the Moon
coincide with menstrual cycle of women, which was deemed
to be of great significance by the primitive tribes.

Islamic countries followed the Babylonian system of
reckoning days by the Moon and the first day of the month
started from the evening of the appearance of the thin crescent
of the Moon in the western horizon after the new moon and
the successive days are known as the second, third day of the
Moon.

A month of 30 days and a year of 12 months was generally accepted by most of the ancient countries. The term māsa is repeatedly mentioned in Rg Veda. In Vedic literature, both āmanta as well as purnimānta systems of reckoning are mentioned. In Taittirīya Brāhmaṇa, along with the names of half months (fortnight), the following 13 names of the months are also mentioned (one adhimāsa or the extra month).

Arunah, Arunarajah, Pundarikāh, Viśvajit, Abhijit, Ārdraḥ, Pinamāna, Unnavān, Rasavān Iravān, Sarṇoṣadaḥ, Sambharah and Mahasvān (13th month).

The names of the months according to Rg Veda and Jaina calendar are as follows:

<table>
<thead>
<tr>
<th>Modern names</th>
<th>Rg Vedic names</th>
<th>Jaina names</th>
<th>English names</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Śrāvana</td>
<td>Nabhās</td>
<td>Abhinanda</td>
<td>July-August</td>
</tr>
<tr>
<td>2. Bhādrapada</td>
<td>Nabhāsyā</td>
<td>Supratiṣṭa</td>
<td>August-September</td>
</tr>
<tr>
<td>3. Asvāyuja</td>
<td>Iṣa</td>
<td>Vijaya</td>
<td>September-October</td>
</tr>
<tr>
<td>4. Kārtika</td>
<td>Urja</td>
<td>Prithivardhana</td>
<td>October-November</td>
</tr>
<tr>
<td>5. Mārgasira</td>
<td>Sahas</td>
<td>Śreyan</td>
<td>Nov-December</td>
</tr>
<tr>
<td>6. Pauṣa</td>
<td>Sahasya</td>
<td>Śiva</td>
<td>December-January</td>
</tr>
<tr>
<td>7. Māgha</td>
<td>Tapas</td>
<td>Śiśira</td>
<td>January-February</td>
</tr>
<tr>
<td>8. Phālguna</td>
<td>Tapasyā</td>
<td>Haimavān</td>
<td>February-March</td>
</tr>
<tr>
<td>9. Caitra</td>
<td>Madhu</td>
<td>Vasantā</td>
<td>March-April</td>
</tr>
<tr>
<td>10. Vaiśākha</td>
<td>Mādhava</td>
<td>Kusumasambhava</td>
<td>April-May</td>
</tr>
<tr>
<td>11. Jyeṣṭha</td>
<td>Śukra</td>
<td>Nidāga</td>
<td>May-June</td>
</tr>
<tr>
<td>12. Āśāda</td>
<td>Śuci</td>
<td>Vanavirodhi</td>
<td>June-July55</td>
</tr>
</tbody>
</table>

The names of the month later on were derived from the lunar asterisms. In this, the months were generally named according to the constellations in which the full moon appears. As for example, the month in which the full moon appears in the Asterism Citra (spica or virginis) is Caitra.

The names of the solar months, however, were borrowed from the names of the zodiacal constellations in which the Sun was situated, as it is observed in Kerala State. It is in vogue in Southern almanacs even today. It is difficult to state the date, when this adjustment of the months to nakṣatras
took place. These names are frequently mentioned by Manu. The Sanskrit names of the zodiacal signs are as follows:

Meṣa (Aries), Riṣabha (Taurus), Mithuna (Gemini), Karkaṭa (Cancer), Simha (Leo), Kanyā (Virgo), Tulā (Libra), Vṛṣchika (Scorpio), Dhanus (Sagittarius), Makara (Capricorn), Kumbha (Aquarius), and Mīna (Pisces).

It is to be noted that since the orbit of the earth is elliptical, all the solar months are not of the same duration, but vary from 29 to 32 days. Because of the inequality and the difference in duration between solar and lunar months, sometimes two lunar months may begin in a solar month. In that case both the lunar months are called by the same name, the first being the intercalary (adhika) and the second as natural (nīja). A more definite rule is that the lunar month in which no sankrāṇti occurs is called adhika and bears the same name as that of the next lunar month which is called nīja or śuddīha or prākrīti to distinguish from the intercalary month. The latter is the month in which adjustments are made. Less frequently, two solar months occur in the same lunar month. In that case there will be a lack of one lunar month corresponding to the second sankrāṇti that is one month suppressed (kṣaya māsa).

Solar months are observed in Tamilnadu, Kerala, Bengal and Punjab. Mostly other states follow lunar calendar.

The panchāngas based on Śūryasiddhānta (9th century A.D.) vary slightly in different places. One lunar month generally ends and the next begins during the course of the solar month. The solar month taken as the current civil month received the name of the first lunar month as in Tamil country but in Bengal and Punjab, the name of the second. Therefore, the successive Cittirai and Vaikāsi in Tamilnadu, and Meḍam and Edavam in Kerala will be called Baisakho and Jyoiśṭho in Bengal and Baisākhi and Jyeśṭha in Punjab.

Moreover, when the days are stated in the present Gregorian calendar, the dates will not be the same in every year. Meṣa sankrāṇti which was on March 16 on 400 A.D., was on March 27 in 1700 A.D., and was on April 13 in 1976 A.D. By the same way the date of Diwali does not fall on the
same date in all the years.

Seasons (ṛtu) which are natural phenomena have been classified differently in different nations. Egyptians calculated their seasons in relation to the annual flooding of the Nile, which had been the most important feature in their civilization. Between successive risings of the water, the Egyptians designated three seasons; the season of the inundation, the season of the sowing and the season of the harvest. These natural happenings were associated with the heliacal rising of the dog star, *Sirius*, the brightest star they saw in the sky.

In European countries the four seasons, summer, spring, autumn and winter were in vogue. This classification is in relation to the weather conditions occurring due to the regular cycle of the summer and winter solistice and the autumn and the vernal equinox.

In ancient India the season can be traced from *Ṛg Vedic* period. The term cāturmāṣya or four-monthly denotes the festival of the Vedic ritual held at the beginning of the three seasons of four months each, into which the Vedic year was divided. The Vedic sacrifices commenced with the beginning of each season. *Vaiśvadeva* coincided with Phālguṇī full moon, the second *Varuna* praghāṣas coincided with the Aṣāḍa full moon and the third Śākamedha with the Kārttīki full moon. There were, however, alternate datings. The festival can also be held at Cāitrī, Śrāvani and Agraḥāyani full moon. The first mentioned *Vaiśvadeva* sacrifice must be the starting of the summer followed by spring; the second *Varunapraghāṣas*, as the name suggests relates to the rainy season and the third Śākamedha the winter season. This division of three seasons are enumerated in the *Brāhmaṇa* literature also.\(^6^6\)

In one passage of the *Ṛg Veda* the terms *vasanta* (spring) *grīṣma* (summer) and *śarad* (autumn) are given. In another passage five seasons namely *vasanta*, *grīṣma*, *varṣā*, *śurad* and *hemanta* and *śīśira* are mentioned. In the *Brāhmaṇa* literature *hemanta* and *śīśira* have been divided and thus six seasons are mentioned. This six-fold divisions may be a later development after the *Ṛg Vedic* period, for use in the agricultural operations.
The names of the seasons differ in *Taittiriya samhita* and *Satapatha Brähmana*.67

**TABLE III**

<table>
<thead>
<tr>
<th>Seasons</th>
<th><em>Taittiriya Samhita</em></th>
<th><em>Satapatha Brähmana</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Vasanta (spring)</td>
<td>Mādhava and Mādhava</td>
<td>Rathagriṣṭa and Rathanjaia</td>
</tr>
<tr>
<td>Griśma (sum mer)</td>
<td>Śukra and Śuci</td>
<td>Rathasvena and Rathacintra</td>
</tr>
<tr>
<td>Varṣa (Rainy)</td>
<td>Nābhās and Nabhāsya</td>
<td>Rathapratia and Asamartha</td>
</tr>
<tr>
<td>Śarad (Autumn)</td>
<td>Iṣa and Urja</td>
<td>Tarkeya and Ariṣṭanemi</td>
</tr>
<tr>
<td>Hemanta (Winter)</td>
<td>Sahas and Sahāsya</td>
<td>Senajit and Susena</td>
</tr>
<tr>
<td>Śīśira (cool months)</td>
<td>Tapas and Tapasyā</td>
<td>Tapas and Tapasyā</td>
</tr>
</tbody>
</table>

The Jaina calendar68 mentions five seasons namely rains, autumn, dewy, spring and summer, the seasons commencing with *Asāḍa*. It will not be out of place to mention here that Kauṭilya also referred to the year beginning with the summer solstice at the end of *Asāḍa*. Perhaps, since the year commenced with the rainy season, the name *varṣa* has been acquired for the year. Buddhist calendar refers to three seasons, namely, *hemanta, griśma* and *varṣa*.68

*Ayaṇa* (the period of 6 months) stands for just one half of a year. There are two *ayaṇas* namely *Uttarāyaṇa* and *Dakṣiṇāyaṇa*. They refer to the north-ward and south-ward courses respectively of the Sun. According to *Vedāṅga Jyotiṣa*, *Uttarāyaṇa* (sun’s northern phase) takes place when Sun and Moon join in *Dhanisṭha* (Delphinus) at the beginning of *Māgha*, while *Dakṣiṇāyaṇa* in the month of *Srāvaṇa* at the half of *Āśleṣā*.69 Kauṭilya60 has also recorded the traditional occurrence of the *ayaṇas* in *Āśleṣā* and *Srāvaṇa*. These two days denote the winter and summer solstices.

*Samvatsara* or year: most of the countries considered the year to consist of 360 days, divided into 12 months in ancient days. This was on the basis of 12 full periods of the moon, which is roughly 30 days. Egyptians have preserved a story of how they found out the mistake and rectified it into 365 days. The year continued to be 360 days and the last 5 days were supposed to be the birth days of gods, born out of illicit union between *Seb* and *Nut* namely *Orius, Iris, Nephthys, Set* and *Arulis*, five chief gods of the Egyptian pantheon. Ancient Egyptians noticed that 365 days cannot be the exact length of
the year, since the heliacal rising of the bright star *Sirius* and the arrival of the annual flood of Nile at the Egyptian capital did not coincide. The bright star *Sirius*, which stood for the Egyptian goddess *Isis* and was carefully observed for ritualistic purposes by the priests who noted down that the Sun returned to the same point, not after intervals of 365 days, but only after 365½ days. The Egyptian priests kept this knowledge only to themselves for a long period, so that it enabled them to predict the date of the annual flood and maintained their influence and hold on the public. The attempts made by Ptolemies (320 B.C.-40 B.C.) to reform the calendar was opposed by the priests. Later Julius Caesar reformed the calendar which is nearly the modern Gregorian calendar, with a leap year occurring every fourth year.

The Aztecs had a completely different duration for the year. The Maya people, who lived in southern Honduras, Guatemala and Yucatan dwelt on great vistas of time. The calendar of the Aztecs or Maya people was based on a different type of calculation. The Maya calendar year consisted of 260 days, 20 day names attached to the numbers 1 to 13 both reentering cycles, which ran concurrently. Since there are 20 names and only 13 numbers, the number attached to any name increases by 7 at each recurrence, while 13 is deducted, if the total exceeds the number.

The 260-day sequence or *Tonalpohualli*, perhaps, might be the primitive calculation of the period of gestation, that is, the period from conception to birth. This indeed must be analogous to the Indian concept of the period of pregnancy to 10 months, in which the periodic month must be 27 days or *nakṣatra māsa*. For keeping count of the seasons there was a year of 365 days composed of 18 months of 20 days each, with an extra 5 days at the end of the year. These five days formed a period of extreme misfortune called "Uayeb" and other names descriptive of their dire nature.

Solar as well as lunar years are mentioned by Vedic seers. The early astronomers in India divided the Sun’s path into twelve zodiacal signs each of 30° arc. The Sun, passing in its annual course, starting from the first sign *Meṣa (Aries)*, enters and leaves in turn each of the twelve signs, thereby completing.
the circle of 360°. This complete circle is associated with the revolution of earth around the Sun. This they considered as 360 days and has been so recorded in the Rg Veda.

In Sāmaveda sūtras different types of months and years are mentioned. They refer to (1) years with 324 days, i.e., periodic years with 12 months of 27 days each, (2) years with 351 days, i.e., periodic years with 12 months of 27 days each, plus another month of 27 days, (3) years with 354 days, six months of 30 days, and six months with 29 days (in other words lunar cycodic years), (4) years with 360 days (ordinary civil [sāvana] years), (5) years with 378 days which Thibault clearly shows, are third years, in which after two years of 360 days, 18 days were added to bring about correspondence between civil and solar years of 366 days. Years of 366 days were mentioned in Vedāṅga Jyotiṣa and by Garga.\(^63\)

The insufficiency of the lunar year is apparent from the passages in Taittriya Samhita\(^63\) and Satapatha Brāhmaṇa\(^64\), where the chaos in sowing and reaping was dealt with.

Hence the ancients regarded the year as 360 days (lunar year) which is less than the tropical year by 5\(\frac{1}{2}\) days. The difference in six years will be 31\(\frac{1}{2}\) days. So every sixth year one month is intercalated to make up for the difference. This intercalated month is termed as udvatsara, śaniśrasa (slippery), samsarpa, malimula or malimulu. At present this is known as adhimāsa (extra month) or mala māsa (unclean month).

The Jain works Sūryaprajñāpti and Kālalokapraṇakaśa\(^65\) refer to four types of years.

1. Nakṣatra samvatsara
2. Yuga Samvatsara (cyclic year of 60 lunar months)
3. Pramāṇa samvatsara
4. Śani samvatsara

Nakṣatra samvatsara (sidereal year) is of 12 kinds as Śrāvana Bhādrapada, etc. When Jupiter completes the whole circle of constellations once, it is called a nakṣatra samvatsara of 12 years. This is calculated as 12 nakṣtramāsas = 12 × 27\(\frac{2}{3}\) days = 327 days + \(\frac{5}{12}\) day.

Yuga Samvatsara consist of 60 lunar months plus two intercalary months. This can be calculated as follows:

Lunar year = \(29\frac{\frac{5}{12}}{12} = 354\) days + \(\frac{5}{12}\) days.
Intercalary lunar year = $12 \times 30\frac{1}{2} = 366$ days. Once in 30 solar months there will be one intercalary month.

Pramāṇa samvatsara is of five kinds namely nakṣatra (sidereal) ṛtu (seasonal), Candra (lunar) Āditya (solar) and intercalary lunar years.

Nakṣatra and lunar years have already been explained above. Ṛtu samvatsara is of 360 days and is also called karma (work) and sāvana (engagement) samvatsara. Solar year is of 366 days consisting of 12 months of $30\frac{1}{2}$ days.

According to this the following calculations can be made:

| Solar year | 366 days | Solar month | $30\frac{1}{2}$ days |
| Rtu, Karma or Sāvana year | 360 days | Kārma month | 30 days |
| The lunar year | 354 days | Lunar month | 29 days |
| Nakṣatra year | 327 days | Nakṣatra month | 27 days |
| Intercalary | 383 days | Intercalary month | 31 days |

Thus in a yuga or cycle of 5 years (1830 days) there are 60 solar months or 61 sāvana months, or 62 lunar months of 67 nakṣatra months. The intercalary months are considered for the adjustment in the total number of days. Leaving aside these calculations, the different types of years which were in use can be summed up as follows.

1. Civil year of 360 days of 12 months which was most common. An intercalary month was added every sixth year. It is still in vogue in most of the almanacs.

2. Sidereal year: Āryabhaṭa, Brahmagupta and Bhāskara calculated the year from the heliacal rising of a bright star at the intervals of 365 and 366 days. They observed that the same stars returned year after year at the same time and place and the path of the Sun and Moon amongst them could be followed. The heliacal rising of a nakṣatra is its first visible rising after its conjunction with the Sun, that is, when it is at sufficient distance from the Sun to be seen on the horizon, at its rising in the morning before Sun rise, or at its rising in the evening after sunset. This is termed as sidereal year (sider-star) or astral year. The Nirāyaṇa Hindu almanac follows the system.

3. The solar year of the one complete revolution of the earth around the Sun starts with Sankrānti and not with full
moon or new moon. Generally, it starts with *Masa Sankranti* in the month of *Caitra*. Purely solar reckoning is adopted in Bengal, Punjab, Tamilnadu and Kerala.

4. *The luni-solar year* is the year which begins with the first *ritti* of the bright half of *Caitra*. Here the year begins with the new moon after *Mina Sankranti*, except when *Caitra* is an intercalary month. This is observed as *Yugapadi* in Karnataka and Andhra and *Gudipada* in Maharashtra at present. This date falls generally in March. It may be noted that the earliest Roman calendar, which contained 10 months comprising of 304 days started with the first of March.

*The twelve-year cycle of Jupiter:* This is the time taken by Jupiter to make a complete circle around the Sun. The names of the samvatsaras or years are determined in two different ways. It has been stated by Varahamihira, “with whatever nakṣatra (Jupiter) the counsellor of Indra, the lord of the gods attains (his) rising, the year is to be spoken of (as) having the application of that (nakṣatra), in accordance with the order of the month”. Here the term rising indicates the heliacal rising. Jupiter becomes invisible for some days in the western horizon, before and after his conjunction with the Sun, that is when the Jupiter comes nearer the Sun. It is then said to be resting. This state of invisibility remains for a period of twenty-five to thirty-one days. After this when Jupiter becomes visible in the east, he is said to rise.71

Varahamihira gives the names of twelve-year cycle starting with *Karīka*. The names are given to the *samvatsaras*, according to the particular *nakṣatras*, in which the heliacal rising takes place. Of the twenty-seven *nakṣatras*, two are assigned to each of nine of the twelve months and three to each of the remaining three months. The names of the lunar months are used as the names of the *samvatsaras* of the twelve-year cycle of Jupiter.

Twelve-year cycle of Jupiter is now determined by the mean sign system, with the aid of mean longitude of a heavenly body which is the longitude of an imaginary body of the same name, conceived to move uniformly with the mean motion of the real body.
TABLE IV

Registration of the names of the samvatsaras from nakṣatras

<table>
<thead>
<tr>
<th>Name of grouping of nakṣatras</th>
<th>Name of the months allotted to samvatsaras</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kṛttikā, Rohini</td>
<td>Kārtika</td>
</tr>
<tr>
<td>Mrīga, Ārdra</td>
<td>Mārgaśīrśa</td>
</tr>
<tr>
<td>Punarvasu, Pusyā</td>
<td>Pausa</td>
</tr>
<tr>
<td>Āśleṣā, Maghā</td>
<td>Māgha</td>
</tr>
<tr>
<td>Pūrvaphālgunī, Uttraphālgunī, Hasta</td>
<td>Phālguna</td>
</tr>
<tr>
<td>Citra, Śvāti</td>
<td>Caitra</td>
</tr>
<tr>
<td>Viśākha, Anūrādha</td>
<td>Vaiśākha</td>
</tr>
<tr>
<td>Jyeṣṭha, Mūla</td>
<td>Jyeṣṭha</td>
</tr>
<tr>
<td>Purvāsādha, Uttarāsādha (Abhijit)</td>
<td>Āśādha</td>
</tr>
<tr>
<td>Śrāvāṇa, Dhanistha</td>
<td>Śrāvāṇa</td>
</tr>
<tr>
<td>Satārāaka, Pūrva Bhādrapeśa,</td>
<td>Bhādrapada</td>
</tr>
<tr>
<td>Uttara Bhādrapeśa</td>
<td></td>
</tr>
<tr>
<td>Revati, Aśvini, Bharaṇī</td>
<td>Aśvina (Aśvāyuja)</td>
</tr>
</tbody>
</table>

Āryabhaṭa in his Āryabhaṭīya, in Kālakriyāpāda states, "the revolutions of Jupiter, multiplied by the signs (12 raṣi) are the years of Jupiter, the first of which is Aśvāyuja". Brahmagupta in Brahmasphuta siddhānta also puts this in similar words. In this system, the signs are intended to be according to Jupiter’s mean longitude. Suppose that on a certain day Jupiter’s mean longitude is 10 signs and 12 degrees, then he is in the 11th sign. Then, counting from Aśvāyuja, we have Śrāvāṇa as the current samvatsara.

The usage of this cycle of twelve years is now very rare. It is almost unknown to people in many parts of India. Heliacal rising and setting is mentioned only in almanacs for religious purposes. When Jupiter is invisible some duties and ceremonies such as marriage, pilgrimage, etc., are to be avoided. Hence the dates of his resting periods are considered necessary, in order to fix the auspicious times for such occasions.

The cycle of twelve animals (one animal per year) is common from Turkestan to Japan which is as follows: rat, ox, tiger, hare, dragon, serpent, horse, goat, monkey, cock, dog.
and bear. Its relationship to Jupiter cycle is not clear.

The Mayans observed a cycle of 13,515 days, comprising 52 ritual years of 260 days each. The Indians, however, followed a 60-year cycle (5 Jupiter cycles).

Jupiter cycle of sixty years: In this reckoning each calendar year received a name from a given list of sixty names which is as follows:

1. Prabhava
2. Vīhava
3. Śukla
4. Pramoda
5. Prajāpati
6. Aṅgīrasa
7. Śrīmukha
8. Bhava
9. Yuyan
10. Dhātri
11. Iśwara
12. Bahudhānya
13. Pramāthin
14. Vīkrama
15. Vṛṣa
16. Citrabhānu
17. Subhānu
18. Tāraṇa
19. Pārthiva
20. Vyāya
21. Sarvajit
22. Sarvadhārin
23. Virodhin
24. Vikṛta
25. Khara
26. Nandana
27. Vijaya
28. Jaya
29. Manmatha
30. Durmukha
31. Hemalambha
32. Vilambin
33. Vikārin
34. Śārvārina
35. Plava
36. Śubhakṛt
37. Śobhakaraṇa
38. Krodhin
39. Viśvāvasu
40. Parābhava
41. Plovaṅga
42. Kīlaka
43. Saumya
44. Śādharaṇa
45. Virodhikṛt
46. Paridhāvin
47. Pramādin
48. Ānanda
49. Rākṣasa
50. Anala or Nala
51. Piṅgala
52. Kālayukta
53. Śiddhārthīn
54. Raudra
55. Durmati
56. Dundubhi
57. Rudirodgarin
58. Raktaṅsa
59. Krodhana
60. Kṣaya or Aksaya

Āryabhaṭa and Brahmagupta gave no rule for finding the samvatsaras of the sixty-year cycle. Only in Brhatsamhita and
Sūryasiddhānta the sixty year cycle is mentioned. The former starts with Prabhava, while the latter work starts with the year Vijaya as the first of the series.

The years of Jupiter or Jovian cycle of sixty years, were classified by Varāhamihira into twelve yugas of five years each, the yugas being known after their respective presiding divinities, namely (1) Viṣṇu (2) Surejya (Bṛhaspati) (3) Bālabhid (Indra) (4) Mutaśa (Agni) (5) Traṣṭa, (6) Ahirbudhaya (7) Potr (Mars) (8) Viśvadeva (9) Soma (Moon) (10) Śakrānala (Indrāgni) (11) Aśvin and (12) Bhaga. The five years of yugas are known as (1) Samvatsara (2) Parivatsara (3) Idavatsara (4) Vatsara and (5) Idvatsara.76

Calculation of Jovian year seems to differ from each and every Hindu authorities. Most of the writers, however, conclude that, the duration of the Jovian year to be 361.02 years of 361 days and 30 minutes, which is roughly 4 days less than the sidereal year.

The Jovian calendar or Bārhaspatya samvatsara as consisting of 12 years is at present a misnomer for the following reason. If heliacal rising is considered as the basis for the Jovian calendar, since the interval between two risings is generally 399 days, in twelve sidereal years there will be only eleven Bārhaspatya years, that is, there will be only eleven conjunctions of the Sun and Jupiter. Hence in a cycle of twelve Jovian years, there will be only eleven conjunctions instead of twelve. Similarly when we consider the sixty year cycle, since there are roughly four days difference between luni-solar calendar, and the Jovian calendar, in every 85 or 86 years one year will have to be expunged or suppressed. Expunction means, the omission to give the samvatsara its name, so that it does not affect the duration of the cycle. The general rule is that, the name of the samvatsara current in Meṣa Sānkṛānti of any year is attached to the whole year, not withstanding the fact, that another samvatsara may have begun before its close. As for example when the 9th samvatsara, Yuvan, is current in Meṣa Sānkṛānti, but ends two months later when the 10th samvatsara should begin, still the whole year will be considered only as Yuvan.

In this there is a difference in northern and southern
reckoning subsequent to 900 A.D. Prior to 900 A.D. as can be seen from the grant of Rāṣṭrakūṭa King Govinda III, both in the north and south the expunction was followed. The grant was issued on the bright fortnight of Vaiśāka of the year Subhānu (corresponding to 804 A.D.). This has taken into account the expunction. The Anumkonda inscription of the Kākatiya King Rudradeva dated as Śaka 16 Citrabhanu, which corresponds to 19th January 1163, does not take expunction into account, since on the northern reckoning it should have been Vijaya and not Citrabhānu.

From the examination of the epigraphical records chronologically, the following facts emerge. The names of the years according to Jupiter’s sixty year cycle, are only occasionally met within the of Northern India, while they are very common in South India. The use of 12 year cycle is found in seven inscriptions so far; five records of the Mahārājas Hastin and Sambhobha and two grants of Kaḍamba chieftain Mrigeśavarman. The earliest inscriptions to record the year according to the sixty year cycle are from Nāgārjunakonda. Records at the time of the Ikṣvāku King Vīrapuruṣa Datta (second half of the 3rd century A.D.) and another of his son Ehuvula Sāntamula (close of the 3rd and early part of 4th century A.D.) refer to samvatsara Vijaya. The date of the former corresponds to 273 A.D., while the latter to 333 A.D. The next is in the Mahākūta pillar inscription of Cālukya Mangaleśa (597-610 A.D.) of Badāmi, dated in the year Siddhārtha (Siddhārthin).

It will be interesting to note that the Chinese history and the annals of the Chinese emperors, were written with reference to cycles of 60 years. 60 year cycle was in use in Chaldea under the name of Sosos. Cycles of 600 years called Neros and another 3600 of years were also in vogue in Chaldea.

Yuga as a cycle was mentioned as early as in Rg Veda. The expression ‘daśame yuga’ applied to Dīrghatamas in one passage in Rg Veda, is translated by Wilson, as a lustrum of five years, whereas in the Vedic Index it is given as tenth decade. In Rg Veda, yuga appears to have had different meanings. It refers to a short period as well as long periods of time.
The cycle of four yugas, kali, sayana, treta and krita as a cycle of yuga occurs first in Brāhmaṇa literature. In Yajur Veda the terms samvatsara, parivatsara, idavatsara, idvatsara and vatsara occur. It is not clear, whether these constitute a yuga or years. In Vedāṅga jyotisa it is clearly stated that a cycle of five years constitute a yuga. According to this work, the cycle starts with the bright fortnight of the month of Māgha and ends with dark fortnight of Pauṣa.

Later on each yuga seems to have developed into a very big unit of time with several years. Āryabhaṭa considers kṛta, treta, dvapara and kali having equal number of years, which is 1,080,000 years and the total yuga or mahāyuga to be of 4,320,000 years. In Varāhamihira's Pañcasiddhāntika and in purāṇas the duration of each yuga vary considerably.

In Varāhamihira's Romaka siddhānta in the Pañcasiddhāntika a yuga is said to comprise 2850 years, while in Sūryasiddhānta it is said to be of 4,320,000 years.

According to Brahmagupta, kṛtayuga consist of 1,728,000 years. Tretā of 1,296,000 years, dvāpāra of 864,000 years, and kaliyuga of 432,000 years and the total being 4,320,000 years. This coincides with the Puranic idea of the yugas calculated in the order of 4:3:2:1 on the total number of years.

Manvantara according to Brahmagupta and Purāṇas is a period consisting of 71 repetitions of four yugas, while Āryabhaṭa considers a manvantara to be of 72 repetitions of the four yugas. In the beginning of kṛta, there is a sandhya or junction of 14,4000 years. In the beginning and at the close of treta, there is a junction of 108,000 years and similarly in the beginning and at the close of dvāpāra there is a junction of 72,0000 years, while at the beginning and close of kali 36,000 years. The present manvantara is called Vaivasvata, after the patriarch of the manvantara Viśvāsana. Kalpa is considered to be the day time, of one day of the God Brahman. I4 manvataras plus the junction periods is said to constitute a kalpa, according to Purāṇas and Brahmagupta. In the beginning and at the close of each manvantara there are sandhis or junctions, each equal to the measure of kṛta. Thus, one kalpa will be equal to (71×14) yugas +15 sandhis=
994 yugas + 15 × 1,728,000 years = 994 yugas + \frac{15 \times 1,728,000}{4,320,000}

yugas = 994 yugas + 6 yugas = 1000 yugas = Brahma's day. Āryabhaṭa\textsuperscript{91}, however, considers a kalpa to be of 14 × 72 yugas which comes to 1008 yugas.

At the end of the day time of Brahma, everything is said to get destroyed and in the night, chaos prevails and is supposed to be followed by his starting the creation again. This process of creation and destruction is said to alternate during the life of a Brahma, which is called a Mahākalpa and is said to last for 100 years, each composed of 360 such days and nights. Then everything is supposed to be overwhelmed (mahāpralaya) by the final deluge, until another Brahma comes spontaneously into existence. Here again, Āryabhaṭa in Kālakriyāpāda\textsuperscript{92} expressed that even Brahma cannot cover the whole span of universal time, since the time has no beginning nor end. The idea seems to be that a Brahma dies followed by another Brahma and so on as a continuous process.

Bhāskarācārya in Siddhāntā śiromani\textsuperscript{93}, also asserts a similar opinion starting that “since this same time had no beginning, I know not how many Brahmans have passed away”.

According to Sūryasiddhānta we are said to be in the kali yuga of the twenty eighth caturyuga (cycle of four yugas), in the seventh manvantara, in the first kalpa, in the second half of the life of Brahmā. According to the calculation of Sūryasiddhānta we are still only in the dawn of kali age, which lasts for 36,000 years. The day time with all its deprived characteristics fully developed, will not begin until 32,890 A.D. This day time period will remain for 360,000 years followed by a twilight period of 36,000 years.\textsuperscript{89}

This type of lengthy duration of an enormous period is also found in pre-historic China. Between 7 B.C. and 22 A.D. a treatise on the calendar, written by Lin Hein, the imperial librarian of whom Sartoon\textsuperscript{94} reports, refer to a period of 23,639,040 years.

The Greek and Roman\textsuperscript{89} astronomers sought for a period, in which different planetary revolutions were completed. It is termed as exelimos by Greeks and annus magnus or mundanus by the Romans. This represents a period of evolu-
tion and revolution, in the course of which, any given order of things run through an appointed course and is completed by returning to the state from which it started. They adopted exelimos, beginning and ending with the conjunction of the Sun, Moon and the planets that corresponds to the first point of Mesā, which conjunction of course involved a new moon and the vernal equinox. This conjunction is also indicated by Āryabhaṭa in Kālakriyāpāda, The yuga (i.e. the Mahāyuga or caturyuga) the month and the day began altogether at the beginning of the bright fortnight of Caitra.

To sum up, time as a measure on dimension, is based on its relation to natural phenomena. The bigger units of time like the day, month, seasons and year are in relation to the rotation of the earth on its axis, causing the day and night; revolution of the Moon around the earth resulting in the concept of months and the revolution of the earth around the Sun leading to the sequence of seasons and calculation of the years.

In developing the smaller units of time, quite an ingenuity has been used by people in the past, particularly in the absence of the mechanical clocks as in modern times. The smaller units of time in ancient India like paramāṇu, anu truṭi, tatpara, etc., are impractical. The units like guruvakṣara, mātra, etc., has greater usefulness for measure of meters in music than for calculation of time. These types of minute divisions are seen in the Jewish measurement of time also. They have divided their hour into 1080 parts or halequim, each haleq equalling 33 seconds. A haleq is further divided into 76 regaim. It is difficult to equate these minute divisions and correlate them with the units in other countries.

No doubt most of the time units are the legacy of the past, dividing the day by 24 hours and the hour into 60 minute and minute into 60 seconds which has its relations with the division of the zodiac into 360°. The Egyptians and the Jews had the day divided into 24 hours, while the Indians divided the day into 30 mūhūrtas or 60 nādikas, with 2½ nādikas making an hour. Even today the Hindu almanacs use the nādikas for calculations of time.

There are two systems relating to the calculations relating to a day, either as beginning at midnight or at the dawn
(aridharatrika or audhayika systems). The Egyptians began their day at dawn, while Babylonians, Jews and Muslims calculated it from sunset to sunset.

The Indian day is calculated in the almanacs in relating to tithis and nakṣatras. A day is normally known as the day of the fortnight, for example, prathamā, dwitiyā, etc., or of any of the 27 nakṣatras like Aświni, Bharaṇī etc. The tithi or nakṣatra, which is identified with a day is that tithi or nakṣatra which was current at sunrise on the day in question.

Though the tithi or nakṣatra may have ended, the next minute after sunrise, and the next tithi or nakṣatra may have been current for the whole of the remaining day, it is the tithi or nakṣatra current at sunrise which gives its name to the day. Nevertheless, in numerous inscriptions, the tithi or nakṣatra quoted is not at which was current at sunrise on the day in question, but that which commenced at some part of the day and would be current at sunrise, only on the next day.

At present in the almanacs, Indian time is kept in ghaṭikas (1/10 of a day or 24 minutes). Each ghaṭika (nāligai in Tamil) is divided into palas (Tamil vinādi or 1/8 of a ghaṭika or 24 seconds). The day is not reckoned from midnight to midnight as in European calendar, but from sunrise to sunrise. Since there are as many panchāṅgas as the number of cities in India, the sunrise is not the same in all places. Hence, one central place is selected and with necessary corrections, it is applied to other places. The central latitude in Equator and central longitude is 75° 46'6" East of Greenwich in which an imaginary island, Lanka in Indian ocean is taken into account. This Lanka has no connection with Śrī Lanka (Ceylon).

The next unit of time, the week, which has been discussed in detail earlier is not of Indian origin but derived from Babylonian times. For verifying Indian dates the week day is very important. Indian dates is pronounced as often unverifiable, in the absence of week days. To ‘verify’ a date, is to show that it is equivalent to a particular day, month, year and almost all the details and that it would be inconsistent with any other day, during a certain number of years. For instance, a date such as Tuesday 10th tithi and nakṣatra Ārdra without reference to month, can be verified as a rule only for a period.
of 3, 7 or 10 years, because at this period it will recur with same details. If the year is also cited, then all the details can be seen consistent with the given year and not with any other year for the next 3, 7 or 10 years. When a date is given merely with *tithi*, *nakṣatra* and year without a week day, it cannot be verified, because, in every year, a combination of such a *tithi* and *nakṣatra* is bound to recur. Hence the date and year cannot be free from error.99

For the Christians the week days are very important, since they wanted the Resurrection of Christ, to be placed on a Sunday. It is to be noted that nowhere in the Bible, the day of the crucifixion is mentioned. Christ was alleged to have been crucified on the Jewish festival of Passover, which is the first full moon after the vernal equinox.

The fortnight, which is a division of half of a month is the easiest to calculate. Moon as well as crescent, is easily visible without any mechanism and counting is easy. Month, which is generally a twelfth of a year, is counted from the movements of Sun and Moon. The word ‘māsa’ also means Moon. Another synonym for the moon is ‘māsakṛt’. Similarly the English word month is derived from Moon. The passage in Psalms 18, 19 “He appointed the moon for seasons” indicate the basis for lunar months. The ancient astronomers also noted that the Moon moved from star to star and came back to the first star in 27 solar days. Since the Sun also moves in the same direction the *nakṣatra māsa* or sidereal month actually takes 29.5 days.

Another way of counting the Moon’s phases, which is very easy and practical, is from new moon to new moon, or full moon to full moon, which is roughly 30 days. This system was followed by Babylonians and at present by Islamic countries. In India the exact length of the period is calculated as 29½ days. Actually the moment of new moon is the moment when Sun and Moon have the same longitude. That is, the same distance measured from a fixed point in the heavens. Various aspects of life and activities in the past were reckoned with the Moon. Hunting with the help of Moon was an aid to economic planning of the ancients. Nine Moons of pregnancy, six Moons between sowing and reaping were facts that were
important to everybody and were easily ascertained.

Solar month is a variable unit, which is the time taken by Sun in its motion over 30°, of the ecliptic. The commencement of the solar month is termed sankrânti, that is the moment when the Sun enters a constellation of the zodiac Solar months vary from 29, 30 to 31 days. It is not necessary, that the days should be the same in all years. As for example, Cittirai (caitra) had ordinarily 31 days, but it also had only 30 days in certain years.

The solar calendar is described by some authors as lunar-solar calendar, since the months are named after the zodiacal constellations, in which the Sun is situated.

Calculation of the commencement of lunar month is characterized with more certainty, since the moon's phases are patents and observable facts; whereas the course of the sun cannot be perceived. It is difficult to ascertain with certainty as to at which definite stage on a particular day the Sun is placed. Hence the astronomical commencement of a solar month varies, unlike the lunar month, where there is uniformity throughout. At present in Orissa, the solar month Amlî or Vilayati eras begin on the day of the sankrânti irrespective of the moment it commences. In Bengal, when the sankrânti takes place between sunrise and midnight (or between 0 hrs. and 18 hrs. Lanka), the solar month begins on the next day. When it occurs after midnight (45 ghatikas), the solar month commences on the third day. In Tamilnadu, if the sankrânti takes place on any day before sunset (12 hrs. Lanka), that day is the first day. If sankrânti takes place after sunset (between 12 hours and 24 hours Lanka time), the next day is the first day. In Kerala the day between sunrise and sunset is divided into five equal parts. If the sankrânti falls within the first three parts, the month begins on the same day, otherwise on the following day. Even in these, the opinions differ a lot, among the astronomers of the past and present.

Seasons are important factors in determining the year. The simplest of all types of time reckoning is by correlating between synchronous natural events. For example, from the blooming of certain plants and the appearance of birds, the on coming rain can be forecasted. In Egypt, flooding of the Nile,
was an important factor in predicting the seasons.

Most of the activities of the primitive men were dependent on seasons. Agriculturists followed the seasons for sowing and harvest. Hunters and fishermen, relied on the seasons to assess the seasonal migration of animals and fish.

In ancient India, the years starting with Madhu and Mādhava were later replaced by Caitra and Vaiśākha. Caitra and Vaiśākha were described as spring month in Mahābhārata.¹⁰¹

Later on Phālguna and Caitra were considered as spring months.¹⁰² This is due to the solar or lunar years being not reconciled with the tropical year. The solar year is longer by 0.0165 days than the tropical year. Hence in 1800 years, the seasons will fall back by a month and this is what had happened in the calculations of the years.

The next and most diversified astronomical constant is the year. The earliest divisions of the year must have been based on the seasons. The first month of the year appears to have been based on certain astronomical sequences, but later on some important event like the foundation of a new city, as in the case of Rome or with the movement of people from one area to another as in Israel or with some religious significance. These also coincided with certain cardinal points in the year. To give a few examples Mosaic law has enacted that Abib, the month in which the Israelites came out of Egypt, was to be observed as the first month of the year. It was in this month the feast of Passover was celebrated and that green ears of corn were brought to the priests as the first fruits of the harvest. The earliest ripening of barley in Palestine was in April, with the first month of the year starting at about the time of vernal equinox (April 22nd). After the captivity of the Israelites, the names of the months were changed, the first being Nisan. In order to keep the first month at the correct position, thirteenth month was intercalated.

The earliest Roman calendar started in March containing ten months comprising 304 days. Greeks had the year first divided into three seasons, spring, summer and winter and later on autumn was added. Winter began with the heliacal setting of the Pleiadas and ended with vernal equinox. Spring
continued until the heliacal rising of Pleiadas; summer until the heliacal rising of Arcturus and autumn occupied the remainder of the year, until and next heliacal setting of Pleiadas. This also coincided with the four cardinal points, namely the two solstices and two equinoxes. The coldest and the longest night is 22nd and 23rd of December, which is the winter solstice and the hottest and the longest day is 21st or 22nd June which is the summer solstice. These are the times when the Sun is farthest from Equator. 20th or 21st March and 22nd or 23rd September are the days, when the day and night are equal since the Sun crosses the Equator on these days.

The Hindus had the idea of tropical year, that is the year which brings the seasons round at the same time of the year as given in Vedāṅga jyotiṣa. In Vedāṅga jyotiṣa, Daksināyana is counted from half of Āśleṣa (113° Hydrai), while Uttarāyana is counted from the beginning of Dhaniṣṭha (290° Delphin) in the month of Māgha. According to Varāhamihira, Daksināyana occurred in Punarvasū in (Cancer) Kataka 90° and Uttarāyana in (Capricorn) Makara 270°. In 700 A.D. Uttarāyana fell on 21st December while in 1600 A.D. on 29th December and at present it comes on 13th or 14th April and occurs in Ādra nakṣatra. Apart from these controversies, it can be stated that in the time of Vedāṅga jyotiṣa (3000 B.C.), the year started (Uttarāyana) in or after winter solstice.

In Tamilnādu, Kerala, Bengal and Punjab, the year starts with Mesā Sankrānti which falls at present on 13th or 14th April. 50 years ago, it was in April 11th, and 5000 years ago, if any reckoning has been kept, it would have begun on 15th February. Actually, the Kaliyuga era is said to have started from 18th February in 310 B.C. The commencement of this reckoning can be considered as having started in, at about vernal equinox.

In places like Andhra, Karnāṭaka and Mahārāṣṭra, where the lunar calculations are observed, the year starts on the first day after new moon on Caitra which falls in March, however, in places like Gujarat, the year starts with Diwali following Mahāvīra's parinirvāna following the new moon day starting with Kārtik, which falls in October. They must have followed
the autumn equinox for their calculations.

The changes in the dates are due to the precession of the equinoxes. Additions of an intercalary month helps to bring back the seasons to the same position.

The calendars were modified from time to time by experts. Even the present Gregorian calendar has a discrepancy of 0.0079 days or 11 min. 14 sec. longer from the tropical year. In 10,000 years it will amount to a cumulative error of 2 days, 14 hours and 14 minutes, but the error is not very significant. This difference would cause the seasons to drift gradually backwards over centuries.

In ancient India, for the eras several reckoning were in use. There were reckonings connected with kings (Vikrama era, Nevari era, Lakṣamaṇasena era) and with religious heads (Jain Nirvāṇa era, Buddhist Nirvāṇa era).

Though our literature is abundant with water clock, sundial and gnomon, so far archaeologist have not unearthed in any of these things. On the other hand in Egypt the sundial, water clock and plumb line dated about 500 to 1500 B.C. and the decorations on the tomb of Sermut 1500 B.C.) and the calendar on the temple gateway of Kalasasaya at Tiahuanaco are in existence.

Even though the Western calendar and time measurements have come into practical use in the country, each era in India still adopt their own regional calculations in their almanacs for following their religious practices.

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15. Tolkāppiyam, Eluṭhathadikaram, 6, 'Kaṇṇimai noṇi ena vavve māṭṭirai'.
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22. Abhidhānaacintāmaṇi, V, 136-137.
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    Vedāṅga Jyotiṣa (Yajur) V. 2, (Rig) 8.
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    Āryabhatiya, Gītikāpāda, X, 18-19.
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80. EI, XXXC, p. 1.
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| ČHART I |
|-----------------|-----------------|-----------------|
| Āryabhaṭiyam (499 A.D.) | Vaṭeśvara Siddhānta (800 A.D.) | Siddhānta Śiromani (1150 A.D.) |
| Brahmasphūta Siddhānta (628 A.D.) | | |
| 100 truṭi | = lava | |
| | (0.0008 sec.) | |
| 100 lava | = nimeśa | |
| | (0.08 sec.) | |
| 4½ nimeśa | = guruvakṣa | rochchāraṇakāla (0.4 sec.) |
| | | |
| 4 guruvakṣaro | | |
| chchāraṇakāla = kaṭṭha (1.6 sec) | | |
| 10 guruvakṣaro | | |
| chchāraṇakāla | = praṇa (4 sec.) | 10 guruvakṣaro |
| 6 praṇa | = vināḍī (24 sec.) | chchāraṇakāla = āṣu (4 sec.) |
| 6 āṣu | = palam (24 sec.) | 6 āṣu | = palam (24 sec.) |
| 60 palam | = ghaṭika (24 min.) | 60 palam | = ghaṭika (24 min.) |
| 60 ghaṭi | = dinam | 60 ghaṭi | = dinam |
### Chart II

<table>
<thead>
<tr>
<th>Manu and Visñupurāṇa (3rd century B.C. to 2nd century A.D.)</th>
<th>Arthaśāstra (100 B.C. to 2nd century A.D.)</th>
<th>Bhāgavata and Brahmāpurāṇa (600 A.D. to 1030 A.D.)</th>
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<td>3 āṇu = trasareṇu</td>
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<td>(0.047 sec.)</td>
<td>(0.0005 sec)</td>
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<td>(0.142 sec)</td>
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<td>3 lava = nimeśa</td>
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<td>30 kāṣṭha = kalā</td>
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<tr>
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<td>15 laghu = nālika</td>
<td>2 nālika = muhūrta</td>
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<td>(48 min)</td>
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<td>2 nālika = muhūrta</td>
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<td>30 muhūrta = (day)</td>
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<td>30 muhūrta = (day)</td>
<td>30 muhūrta = (day)</td>
<td>30 muhūrta = (day)</td>
</tr>
<tr>
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<tr>
<td>30 muhūrta = (day)</td>
<td>30 muhūrta = (day)</td>
<td>30 muhūrta = (day)</td>
</tr>
<tr>
<td>(24 min)</td>
<td>(48 min)</td>
<td>(24 min)</td>
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<p>| dinam |</p>
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<tr>
<th>Gaṇitasārasaṅgraha (850 A.D.)</th>
<th>Siddhānta śekhara (1040 A.D.)</th>
<th>Siddhānta śiromaṇi (1150 A.D.)</th>
<th>Nyāya kaṇḍali (9th century A.D.)</th>
<th>Abhidhānacintāmaṇi (11th century A.D.)</th>
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<td>(5.3 sec)</td>
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<td>7 stoka=lava</td>
<td>(37.4 sec)</td>
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Conclusions

IN the foregoing chapters, the various measures—linear, area, cubic, weights and time—used in ancient India were traced chronologically from the smaller units to the larger ones. In tracing these, efforts were made to indicate (i) the way in which the concepts of these measures evolved through various periods; (ii) the influence of the other civilizations on this evolution; and finally (iii) how in different regions at the same period and also in the same region at different periods, the values associated with the measures of the same name differed. To a cursory reader the information available in the literature and epigraphical records on these measures, cannot but lead to confusion and make him come to the conclusion that there was no uniformity in mensuration concepts in ancient India and that in the development of these measures, no definite system or approach was existing in the past. A critical examination of these, however, will bring out the facts that there was an undercurrent of unity in the development of concepts relating to these measures, even though in the final forms of practical usage, different regions followed different practices associated with local traditional usages. Even today, in spite of the standardization rules relating to the various measures, the traditional usages in different regions continue to be in vogue.
For example calculations of time in the astrological works and also for use in almanacs, still the units of time like nālīka, muhūrtā, etc., are used. With minor variations all over India, use of these terms are common to fix the dates for religious rites, for casting the horoscopes, etc. Some of the land measures like chain lengths, special rod lengths, terms like kāni, guntha, etc., are also in regular local usage.

The cubic measures like padī, nāji, pāili, etc., are also in use in different areas, though the actual quantity connoted by these terms, still differ in different regions. It looks as if the original concepts regarding all these measures had a common origin, which in course of time due to variations in usage arising out of local needs and habits got modified into a sort of a local system of measures, which were understood by the local people. Since the trading was well known within the country and also with countries abroad, people must have been aware of the equivalents of these measures in different regions.

This feature is not unusual only for the measures in ancient India. This same feature can be seen in an aspect of this huge subcontinent, such as culture, language, food habits; clothing habits, etc., where there is apparently marked differences in different regions, but still maintaining an undercurrent of unity in all these also. This feature is the natural sequence of the vastness of the country, with exposures to various cultural influences both from within and from abroad and also to a considerable extent to the ethnic differences in different parts of the country.

The linear measures, which are the earliest to evolve, have their origins in relation to the human limbs, since they provided the most easily available standards to a reasonable extent and fulfilled the limited practical needs. In almost all parts of India the aṅgula as a concept constituted the most practical smallest linear measure. The hasta (cubit) was another widely used measure and from these, the other larger units got derived. Though these measures normally related to the man of average build, since there can be some variations in the size of individuals, variations did come in. In some regions this was standardized to some extent by trying to fix the dimensions relating to a particular individual (local chief,
king or the local deity). In addition to this varying factor, another concept in all these measures also added to the confusion. There was a tendency to adopt three different quantum of value for different measures depending upon the use to which the measure will be applied. The Vāstuśāstras mention three different kinds of āṅgulas namely kaniṣṭha (small) madhyama (medium) and uttama (large). Similarly the length of the rod or daṇḍa varied in measuring the lands given to Brāhmans, measuring furniture and for measuring forests. The king or chieftains had their own measuring rods. These remind one of the Biblical measures such as the length of the cubit for the tabernacles being different from common cubit. The Jews had a common cubit, sacred cubit, as well as a Royal cubit. Though in 20th century A.D., these appear to be odd and is difficult to equate them with modern measures, these appear to have been well understood by the people of those times and have been well recorded in the literature and epigraphs. The monographs on Vāstuśāstras have provided sufficient information to the artisans and masons to create cities and various construction without difficulty. In Mohenjo-daro, the well formed baths, roads, the buildings etc., clearly indicate that the people had their own standards for measurements, without which, such constructions would not have been possible.

For longer distances, Indians used the measures gavyūti or kroṣa, which is the distance from which the bellowing of a cow or human voice can be heard and yōjana, which is the yoking distance in a day or walking distance within a certain time. These sort of measurements were in vogue in other countries also. Chinese li, which is considered in text books as \( \frac{1}{4} \) of a mile, is actually the distance covered by a coolie with a standard burden. He is expected to cover so many li per day according to the nature of the country and such coolie day stages are all in multiple of 10 li. In parts of China, where there are no reliable maps the li distances are known. Every 10th li, there was a stage posts, at which the coolies used to take rest, roughly one rest every hour. In mountainous countries, the stage posts are closer, though in the Chinese view, they are still 10 li apart. From the commercial point of
view, the calculation of the distance in terms of time appears to be logical. In mountain regions, notably Alps, guides give distances in terms of hours.

Areas were measured by the *danḍas* or by the amount of seeds required for sowing or by the yield of the land (*kulyavāpa* etc.). This is like the word acre, which was originally applied to an enclosed land without any specific measurement. It came to mean an area ploughed in a day by a yoke of oxen. On poor light soils, the area of an acre would exceed than that on rich heavy soils. The expected yield from the two types of acres was roughly the same. In South-East Asia the cultivators measure the area of their rice fields, by the number of baskets of seed sown in it. The quality of the land is stated, in terms of the number of baskets of paddy they expect to harvest, compared with the number sown. Thus a 3 basket field of 50 baskets land, will yield in an average year, 150 baskets. The former is interested in knowing about the seed required for sowing and the yield, rather than geometry. This was simple and sensible to him though it gave no indication of the area of the land. This same principle applies to the Indian area measures like *kulyavāpa*, *drōṇavāpa*, etc. Hence to calculate them with modern measures will be difficult.

Great accuracy in weighing precious metals and stones was developed. The use of the seeds of uniform size, which was in vogue in ancient India and other places continue to be in use even today among the jewellers. The common balance as well as one-pan balance depicted in coins and sculpture, indicate that weighing was a common phenomenon among traders.

The intimate connection between the coinage and the weight system is also well known. The standard unit of precious metals became the standard units of value and this became the coin, when stamped with the royal insignia. Some of the names of the coins indicate this relation in many cases. However, later on as the values of the metals varied, the face value of the coins became different from their intrinsic values.

In spite of the regional variations for weighing articles other than precious metals, the terms *palam*, *viss* and *man* (*maṇaṅgu*, *maṇaṅguli*), seem to be in usage in several parts of
India. *Man* is a derivation from the Sanskrit word ‘*māna*’, to measure. The weight it represented varied in different periods in different areas. Even in Mughal India, *man-i-Akbari* weighed 55.32 lbs, while *man-i-Shah Jehani* weighed 73.76 lbs. For weighing large bulks the terms like cart-load, ass-load and head-load were used in the past and continued still in certain places.

It appears that the cubic measures were often interlinked with weights. Since, primarily the grains were measured, the volume measures must have been equated with the weight of the amount of grain which a particular vessel can deliver. The hollow vessels used for measuring grains, oil, etc., must have had some relationship to the weight also. For example *muṣti*, which is the most convenient form of measure to give alms, gifts of grains, etc., is equated with the *pala*. Approximately a *muṣti* of paddy is found to be about 60 c.c. and weighs 32 gms. Several writers have often equated volume measures like *ādhaka* and *drōṇa* with several *pala* which is a weight measure and this indicates that cubic measures were interlinked with gravitational measures. It is not out of place to mention here that the ounce of the present day when it is used as a cubic measure is nearly 28.5 cc. and it is 28.5 gm taking into consideration the fact that 1 cc. of water at 4°C is equal to 1 gm in weight. In the past in India also a similar idea must have been adopted.

As in the case of varying values for *man*, in South India, the *nāḷi* and *pāḍi* varied during the regime of different kings. *Aruḷmoḷidevan nāḷi* the standard of Parakesari Rajendra Coḷa, was smaller than that of Rājakesari nāḷi, the standard of his father Rāja Rāja. That is 1\( \frac{2}{3} \) of *Aruḷmoḷidevan nāḷi* would measure 1 nāḷi of Rājakesari. These differences might perhaps be due to the change in the prosperity of the country.

Temple measures were also different in many regions. Generally the measures in a particular region was the measure used in the temple of that place. *Āḍavallān nāḷi* refers to the temple measure of Cidāmbaram which was current in that place.

All these somewhat resemble the concepts relating to the *shekel* of the sanctuary (Exodus 38:24), *shekal* of the king.
CONCLUSIONS

(Samuel 34:26), etc., mentioned in the Bible, showing different weight standards of Jews of that time.

Time is a recurring cycle, in which the events repeat themselves in periodic sequence. This recurring cycle is the result of the rotation and the revolution of the heavenly bodies. Hence, just like the other corresponding civilizations, natural phenomena were taken into account. The keen observations, particularly in relation to the planetary and stellar movements lead to a system of time measure, which enabled ancient Indians to predict exactly several phenomena like eclipses, meteors etc. For minute details, the duration was calculated by the cracking of the finger, wink, etc. These developed into bigger units leading finally to exeligmos like kalpa, manvantara, etc.

Without the modern sophisticated equipments, development of accurate systems to calculate them, indicates the great observation power and skill of our ancient mathematicians and astronomers about which our Nation can feel proud of. To quote an example, the 5th century astronomer Āryabhaṭa suggested that the planets including the earth revolved round the Sun. But the credit for expounding this heliocentric theory is attributed by the Western scientists to Copernicus, who expounded this theory in 16th century A.D.

No doubt the various measures mentioned above were not standardized as in the twentieth century A.D. In modern era, the standard of length may be defined as the distance under specific conditions between two parallel lines, engraved upon a material standard bar (line standard), or between two flat and parallel end surfaces of such a bar (end standard). Compared to this, the ancient standards look somewhat crude and absurd, and not scientifically exact or precise, but were easier to use and understand. If the criterion for good scale is for convenience, then the primitive measurements are convenient in their socio-economic context.

Finally the quaternary system appears to have been quiet prevalent. Though the archaeologists have suggested the existence of decimal system in weights, as far as literature is concerned mainly quaternary or binary systems are seen in relation to mensuration.
YOJANA FROM DIFFERENT SOURCES

1. According to Kauṭilya 4,000 dhanus or 384,000 aṅgulas is a yojana.

\[
\frac{384,000}{1760 \times 12 \times 3} = \frac{200}{9} = 606 \text{ miles (9.7 km.)}
\]

2. If the aṅgula is considered as \(\frac{1}{8}\) of an inch, then it will be:

\[
\frac{200}{9} \times 4 = 4.54 \text{ (7.3 km.)}
\]

3. If Bhāṭṭasvāmin’s interpretation is taken, the answer for no. 1 and 5 will be double, i.e., 12.12 miles (19.5 km.) or 9.09 miles (14.58 km.).

4. According to Purāṇas, Mahāvīra, Śrīdhara, Bhāskara and Jaina canonical literature 768,000 aṅgulas make one yojana

\[
\frac{768,000}{1760 \times 3 \times 12} = \frac{480}{9} = 12.12 \text{ miles (19.5 km.)}
\]

If the aṅgula is considered as 1”.

\[
\frac{480}{9} \times \frac{1}{4} = \frac{120}{9} = 9.09 \text{ miles (14.58 km.)}
\]

If the aṅgula is considered as \(\frac{1}{8}\)”.

5. The Kannaḍa writer Rajāḍitya considers 7680 aṅgulas as a yojana. Hence, his yojana measures 1.21 or 0.9 miles (1.93 or 1.08 km).

6. In Samarāṅgaṇaśūtradhāra, 106 × 1000 × 8 aṅgulas are mentioned as yojana.

\[
\frac{1000}{12} \times \frac{8}{12} \times \frac{10}{8} = \frac{1000}{9} = 13.3 \text{ miles (21.4 km.)}
\]

considering aṅgula as 1”.

7. In the Bakṣali manuscript, though 768,000 aṅgulas are considered as yoj ṇa, an aṅgula measures 6 yavas or \(\frac{1}{4}\)”.

Hence,

\[
\frac{768,000}{1760 \times 3 \times 12} \times \frac{1}{4} = \frac{120}{9} = 9.09 \text{ miles (14.58 km)}
\]

make one yojana.

Weights and measures in the 19th century

Kanarese

4 seer = solage
16 solage = balla
16 balla = kolagam
20 kolagam = khandiga
14 seer = kalsi
3 kalsi = mudy

Telugu

4 gidda = sola
2 sola = tavva
2 tavva = kunchamu
4 kunchamu = tumu (6 lbs-4 ozs)
20 tumu = putty

Malabar

10 yadangazhi = parrah
1 yadangazhi = 113\frac{1}{6} c inches

Madras

10 pagoda = palam = 3 tola
8 palam = seer (9 oz 10 drams)
5 seer = viss (3\frac{1}{6} lbs)
10 seer = dhadiyam
8 viss = maund (25 lbs)
10 maund = pothy
2 pothy = baram
2 gundumani = manjadi
20 manjadi = kalanju
44 manjadi = 1 rupee (180 grains)
12 kalanju = palam
\[(5\frac{1}{2} \text{ tolas})\]
100 palam = tulam

**Trichy**

3 tola = palam
8 palam = kutchha seer
5 kutchha seer = viss
25 palam = pukka seer
8 pukka seer = tulam (15.4 lbs)
32 tulam = candy (403 lbs)

**Cubic measures**

In cubic measures, generally the contents in cubic inches of any heaped measure, is the weight in heaped measure and generally rice or 9 sorts of grains are used. It has been found that raw rice averages 113 tolas weight to 100 c. inches. Madras measure is 117 tolas weight when stuck and 128 tolas when heaped. The volume of the Madras measure is 104 c. inches when heaped.
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