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Ritual Application of Mensuration Rules in India : An Edition of Ganāśa's Kuṇḍasiddhyudāhṛti with Mathematical Commentary

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Ritual Application of Mensuration Rules in India: An Edition of Gaṇeśa's *Kuṇḍasiddhyudāhṛti* with Mathematical Commentary

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ABBREVIATIONS

KSU: *Kuṇḍasiddhyudāhṛti* of Gaṇeśa.

L: *Līlāvatī* of Bhāskara.

MKS: *Maṇḍapakūṇḍasiddhi* of Viṭṭhaladikṣita.

1. INTRODUCTION

1. 1. *Kuṇḍasiddhyudāhṛti*

The *Kuṇḍasiddhyudāhṛti* is a prose commentary on nine verses (39–47) of

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Viṭṭhaladikṣita's *Maṇḍapakunḍasiddhi*, and deals with the mensuration of eight kinds of *kunḍas*. The *KSU* is interesting to the student of the history of Indian mathematics as well as to the student of Hinduism because the work, which contains many citations from the *Līlāvatī* of Bhāskara, shows us how the traditional mathematics (*gaṇita*) was employed in a field other than mathematics and astronomy (*jyotiṣa*).

1. 2. Author

The *KSU* was written by Gaṇeśa, son of Śrīdhara, in Nandigrāma¹⁾ (Nandod, Gujarat) some time between A.D. 1619, when Viṭṭhaladikṣita composed his *KMS* [RAGHAVAN 1968: 182], and A.D. 1836, when the manuscript used for the present edition of the *KSU* was copied (see 1. 7. below). We know a Gaṇeśa, who wrote a commentary called *Śiromaṇiprakāśa* upon the *Siddhāntaśiromaṇi* of Bhāskara in Nandigrāma in the early seventeenth century; but his father was Keśava [PINGREE 1971: 106b–107a, 1981: 126]. Keśava was in turn the grandson of the famous Gaṇeśa (born A.D. 1507), who wrote no less than ten works on *jyotiṣa*, including the *Buddhivilāsinī*, a popular commentary on the *L* [PINGREE 1971: 94–106]. The existence of abundant citations in the *KSU* from the *Līlāvatī* shows that our Gaṇeśa also was versed well in the traditional mathematics, although we cannot trace his lineage beyond his father.

1. 3. Kunḍa

Kunḍas are pits on the ground for holding ceremonial fire in religious ceremonies. They are classified into eight according to their shapes: *caturasra* (square), *yoni* (vulva), *ardhavalaya* (semi-circle) or *ardhacandra* (half-moon), *tryasra* (triangle), *vṛtta* (circle), *ṣaḍasri* (hexagon), *padma* (lotus), and *aṣṭāsri* (octagon). On a certain ceremonial spot, for example, these eight *kunḍas* are arranged on the eight cardinal points surrounding a central *vedī* (fire-altar). The arrangement in that case starts from the east and proceeds clockwise in the above order; and the ninth *kunḍa*, which is either *caturasra* or *vṛtta*, is placed in the north-east by east [MKS 31–32].

Every *kunḍa* has to measure, without regard to its shape, an area determined according to the number of *havanas* (oblations) in the particular ceremony in which it is used²⁾. A failure in the measurement of *kunḍas* is said to cause something unfavourable to the *yajamāna* (sacrificer)³⁾. Thus arises a mathematical problem: to draw those geometrical figures with reasonable exactness in area by means of

1) See the concluding verse of the *KSU* (p. 110 below).

2) See Sec. 3.0 below.

3) Viṭṭhaladikṣita, in commenting upon the irregular hexagonal *kunḍa* (MKS 43), cites a half *śloka*:

mānādhikye bhaved rogo mānāhīne daridratā/

(In the case of excess of area, there will be a disease;
in the case of defect of area, there will be poverty.)

a rope (*sūtra*) and a pair of compasses (*karkāṭa*). The nine verses (39–47) of the *MKS* give a solution to this problem, while Gaṇeśa carries out computations of the areas of the *kuṇḍas* obtained.

1. 4. Place-value system

Gaṇeśa uses a place-value system, in which eight units make the next higher unit, for fractions of the linear measure *aṅgula* (finger breadth). This simply results from the table of linear measures used in the *MKS* itself⁴⁾:

1 <i>hasta</i>	=	24 <i>aṅgulas</i> ,
1 <i>aṅgula</i>	=	8 <i>yavas</i> ,
1 <i>yava</i>	=	8 <i>yūkās</i> ,
1 <i>yūkā</i>	=	8 <i>likṣās</i> ,
1 <i>likṣā</i>	=	8 <i>bālāgras</i> , etc.

Similar tables are recorded in various works such as the *Bṛhatsaṃhitā* [VARĀHAMIHRA 1968: 57, 1–2], *Gaṇitasārasaṃgraha* [MAHĀVĪRA 1963: 1, 25–31], and the *Purāṇas*⁵⁾. The *MKS* takes the above table to be a variable system; that is, the *hasta* is defined as one-fifth of the total height of an individual *yajamāna* with his hands stretched upwards⁶⁾. It may be pointed out in this connection that Gaṇeśa does not seem to follow any principle when he obtains approximations of fractions: he sometimes carries out his computations down to the fourth place (*bālāgra*) below the *aṅgula*, but is usually satisfied with the second place (*yūkā*). Again, he seems, in a few cases, to count fractions as a unit when they are no less than half, but usually cuts them without regard to their magnitudes.

1. 5. Quotations

Gaṇeśa's computations of the areas are based exclusively on the mensuration rules of the *Līlāvati*. He cites the following rules:

- 1) algorithm for squaring a number (*L* 19) [in Sec. 1];
- 2) algorithm for taking the square root (*L* 22) [in Sec. 2];

4) *MKS* 3–4:

kṛtordhvaabāhoḥ samabhūgatasya kartuḥ śarāṃśaḥ prapadocchritasya/
yo vā sa hasto 'sya jināṃśako 'pi syād aṅgulaṃ tattadibhāṃśakā ye//
yavo yūkā ca likṣā ca bālāgraṃ caivamādayaḥ/
kṛtamustīḥ karo ratnir aratnir akaniṣṭhikā//

(One-fifth of <the total height of> the sacrificer, who is standing on tiptoes on a plane surface of the earth with his hands stretched upwards, is a *hasta* (cubit), and a twenty-fourth of it shall be an *aṅgula* (finger breadth). One-eighth of each of *yava*, *yūkā*, *likṣā*, *bālāgra*, etc. is <the measure of> its succeeding one. A *kara* (cubit), with the fist clenched, is a *ratni*, and a *ratni*, without the little finger, is an *aratni*.)

- 5) *Vāyupurāṇa*, chap. 101, 115–127; *Matsyapurāṇa*, chap. 258, 17–18; and [BHOJA 1966: chap. 9, 4–5]. cf. also [KIRFEL 1920: 331].

- 6) See footnote 4 above.

- 3) sides of a right triangle (*L* 136),

$$c = \sqrt{a^2 + b^2} \text{ [in Sec. 2]}$$

$$b = \sqrt{c^2 - a^2} \text{ [in Sec. 8. 2];}$$

- 4) *āvādhās* (*L* 165) and perpendicular (*L* 166) of a triangle,

$$a_1 = [a - (b+c)(b-c)/a]/2$$

$$a_2 = [a + (b+c)(b-c)/a]/2$$

$$h = \sqrt{b^2 - a_2^2} = \sqrt{c^2 - a_1^2}$$

[in Secs. 6. 1, 6. 2, and 8. 1];

- 5) area of a triangle (*L* 166),

$$S = ah/2 \text{ [in Secs. 2, 4, 6. 1, and 8. 1];}$$

- 6) area of a rectangle (*L* 173),

$$S = ab \text{ [in Secs. 1, 8. 1, and 8. 2];}$$

- 7) area of an equi-perpendicular quadrilateral (*L* 173),

$$S = h(a+c)/2 \text{ [in Secs. 6. 2 and 8. 2];}$$

- 8) perpendicular of an equi-perpendicular quadrilateral (*L* 184),

$$h = \text{perpendicular of the triangle formed by } b, (c-a), \text{ and } d \text{ [in Sec. 8. 2];}$$

- 9) circumference of a circle (*L* 199),

$$c = (3927 \cdot d)/1250 \text{ [in Sec. 2];}$$

- 10) area of a circle,

$$S = cd/4 \text{ (*L* 201) [in Sec. 2]}$$

$$S = (3927 \cdot d^2)/5000 \text{ (*L* 203)}$$

[in Secs. 2, 3, 5, and 7];

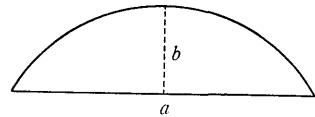
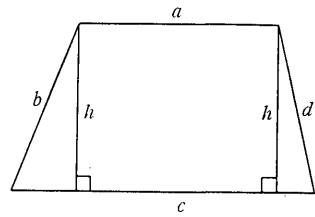
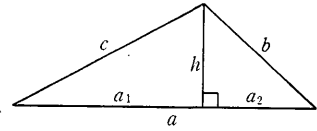
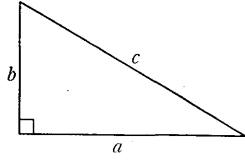
- 11) *śara* of a segment of a circle (*L* 204),

$$b = [d - \sqrt{(d+a)(d-a)}]/2 \text{ [in Sec. 6. 2];}$$

- 12) sides of circumscribed regular polygons (*L* 206–208),

$$a_3 = (103923 \cdot d)/120000 \text{ (triangle) [in Sec. 6. 1]}$$

$$a_8 = (45922 \cdot d)/120000 \text{ (octagon) [in Secs. 8. 1 and 8. 2].}$$



1. 6. Editions of the *Maṇḍapakaṇḍasiddhi*

The *MKS* has been published at least six times. In editing the *KSU*, we consulted 3) and 6). The other editions have not been available to us⁷⁾.

- 1) With the author's own commentary. Lithograph edition. Benares 1875.
- 2) As the first work in the *Kuṇḍagrāṇthavimśati*. Bombay 1887.
- 3) With the author's own commentary and Mahādevamiśra's Hindi commentary. Kāśī 1908.

7) The information given here has been obtained from [RAGHAVAN 1968: 182–183] and [GUPTA 1981: 96].

- 4) With a Hindi commentary. Bombay: Venkateswara Steam Press, 1916.
- 5) With B. Pathak's Sanskrit and Hindi Commentaries. Benares: Hitchintak Press, 1926.
- 6) With Vāyunandamiśra's Hindi commentary. Under the title, *Kuṇḍamaṇḍapasiddhi*. Vārāṇsi: Master Khelāḍilāl Saṃkaṭāprasād Saṃskṛt Pustakālaya, 1980 (7th printing; first printing 1936?).

1.7. Manuscript

Government Oriental Manuscripts Library, Madras, D 13403. Title: *Kṣetragaṇita*⁸⁾. Script: Devanāgarī. Ff. 1–8. Complete. 9 to 10 lines to a page. About 40 *akṣaras* to a line. Paper, 24.5 × 10 cm. Bound in modern book form together with a *Tithinirṇaya* (D 3120). Every leaf is slightly injured by worms, but there is no difficulty in reading. Contains no geometrical figures; but the phrases such as “darśanam”, “darśanam patrapṛṣṭhe”, “darśanam pūrvapatre”, “tatra kṣetradarśanam yathā”, etc. indicate that the original text did have ones. The date of the ms. is known from the colophon, which reads:

samvat 1894 āśvinakṛṣṇā maṅgalavāra=2 November 1836.

1.8. Apparatus

In the ms., the nasals standing before a consonant are almost always expressed by the *anusvāra*, and the labial nasal ‘m’ at fullstops also follows the same convention in most cases. We have corrected them without mention. The ms. uses the letter ‘v’ for ‘b’ in the words *laṃba*, *bahiḥ*, *bṛhat*, and *subodha*; we have given their correct forms in the text. We have also corrected silently the reduplication of consonants after ‘r’, which occurs in the words *ardha*, *ūrdhva*, *paryanta*, *vartate*, and *vardhana*. We have also corrected freely irregular *saṃdhi*. Other corrections are mentioned in the footnotes. The *daṇḍa* for punctuation is rarely used in the present ms. We have supplied it according to the context.

1.9. Symbols used in the text

- <A> indicate that A has been supplied by the present editor.
[A] indicate that A is physically damaged or lost.

2. TEXT: KUṆḌASIDDHYUDĀHṚTI OF GAṆEŚA

- (1b) śrīgurur jayatitarām/
śrīgaṇeśaṃ mahālakṣmīm natvā kurve samāsataḥ/
gaṇeśābhidhadaivajña<ḥ> kuṇḍasiddher udāhṛtim//

8) This title seems to have been employed by the cataloguer simply as indicating the field of the work [RAGHAVAN 1969: 155b, 268b]. We have taken “kuṇḍasiddhyudāhṛti” to be the title of the work on the basis of the expression, “kurve...kuṇḍasiddher udāhṛtim,” in the introductory verse.

2. 1. caturasrakunḍam

dvighnavyāsam⁹⁾ iti (*MKS* 39)/
darśanam (See Fig. 1)/
kṣetraphalam adhikṛtyocyate/ tatra
samaśrutau tulyacaturbhujē ca tathāyate¹⁰⁾ tadbhujakoṭighāta (*L* 173)
iti bhāskaroktyā/ prakṛte samaśrutitulyacaturbhujasyāśya bhujakoṭi 24/24/
anayor ghāte bhujavarga eva bhavati¹¹⁾/ atas tulyacaturbhujē bhujavarga eva
kṣetraphalam iti tātparyārthaḥ/
sthāpyo 'ntyavarga (*L* 19)
ityādinā tathā kṛte satī jātām ekahastakṣetraphalam 576//

2. 2. yonikuṇḍam

atha yonikuṇḍam āha/
kṣetre jināṃśe purataḥ¹²⁾ śarā<m>śān iti (*MKS* 40)/
atra jināṃśa¹³⁾-24-kṣetrasya śarāṃśā 5 ete svīyaraḍāṃśenāṅgulādyenānena¹⁴⁾
0/1/2 yutā jāta ekahastayonikuṇḍe vardhanāṅkaḥ 5/1/2/ ayam eva dvyaḍiguṇaḥ
san dvyaḍihaste bhavet/ evaṃ sarvatra/ darśanaṃ yathā (See Fig. 2)/
atra kṣetraphalam/ atra pūrvāgrād yāmyottararekhāprāntadvayagāmisūtra-
dvayottham¹⁵⁾ ekaṃ tribhujam/ bhūmis tu yāmyottararekhaiva/ tathā yāmyo-
ttarasūtrāgrāt pūrvāpararekhāpaścimāntagāmisūtradvayottham¹⁶⁾ aparam/ (2a)
vṛttārdhadvayābhyaṃ ekaṃ vṛttaṃ ca/ evaṃ kṣetratrayam/
pūrvāparayāmyottararekhāsāmpātāḍ¹⁷⁾ ūrdh<v>aṃ caturasrapūrvabhujā-
vadhi prāgapararekhāmānam aṅgu<lāni> 12/ idaṃ vardhanāṅkena 5/1/2 yutaṃ
jāto labdha<ḥ> 17/1/2/

lambaguṇaṃ bhūmyardhaṃ spaṣṭaṃ tribhujē phalaṃ bhavātīti (*L* 166)
bhāskaroktyā bhūmyardhaṃ 12 lambena nighnaṃ jātām uparitryasrakṣetra-
phalam 205/7¹⁸⁾/ athādhahasthakṣetraphalam¹⁹⁾/ tatra yāmyottaraprāgapara-
sūtrasāmpātāḍ²⁰⁾ adhaścaturasasya paścimabhujāvadhi pūrvāpararekhāmānam
aṅ<gulāni> 12/ ayam evādhahasthasya²¹⁾ lambaḥ/ bhūmyardhaṃ²²⁾ tad eva
12/ atrāpi

lambaguṇaṃ (*L* 166)
ityādinā kṣetraphalam 144/ atha vṛttārdhadvayaphalam/ tatra
vṛttakṣetre paridhiguṇitavyāsapādaḥ phalam (*L* 201)
ityādinā phalānayanārthaṃ paridhivyāśajñānāya prāgaparayāmyottararekhā-
sāmpātāḍ²³⁾ caturasasya yāmyabhujāvadhy athavottarabhujāvadhi yāmyotta-
rasūtramānam eko bhujah/ tanmānaṃ yāmyottarasūtrārdhatulyam aṅgulāni
12/ evaṃ ca tasmāt sāmpātāḍ²⁴⁾ caturbhujasya paścimabhujāvadhi pūrvāpa-

9) nyāsam in the ms. 10) tathāyane. 11) namati. 12) tu paraḥ for purataḥ. 13) jināṃśā.
14) -āṅgulodīnānena. 15) -dvayorddham. 16) -dvayocham. 17) -sayānād for -sāmpātāḍ
18) 20/5/7. 19) athādhahastha- for athādhahastha-. 20) -sāmpādanād. 21) evādhahasthasya.
22) Inserts pari before tad. 23) sāmyānāc. 24) sāmpānāc.

rarekhāmānam 12 aparo bhujaḥ/ saiva koṭiḥ 12/ vṛttārdhaprāntadvayagā-
mibhujakoṭiprāntaspr̥ktiryaksūtram karṇaḥ/ evaṃ jāta<ṃ> caturbhujāntaḥpā-
titryasram/ tatra karṇajñānā(2b)ya

tatkr̥tyor yogapadaṃ karṇa (L 136)

iti bhuja-12-koṭi-12-vargayor 144/144 yogo 'yam 288/ asmāt
tyaktvā²⁵⁾ (L 22)

ityādinā padaṃ jātaḥ karṇaḥ 16/7/6/1/²⁶⁾ ayam evoddiṣṭavṛttakṣetre vyāsaḥ/
asmāt paridhyānayanam

vyāse bhanandāgnihata²⁷⁾ (L 199)

ityādinā/ vyāsaḥ 16/7/6/1/ ayam bhanandāgni-3927-hataḥ 66643/7/4/²⁸⁾
khabāṇasūrya²⁹⁾-1250-bhakto jātaḥ paridhiḥ 53/2/4/ ataḥ paraṃ kṣetraphalā-
nayanam

vṛttakṣetre paridhiguṇitavyāsapādaḥ³⁰⁾ phalam (L 201)

ityādinā/ paridhinā gomūtrikayā³¹⁾ guṇito vyāsaḥ 904/6/ asya caturthāṃś<o>
jātam uddiṣṭavṛttakṣetre phalam 226/1/4/ eva<ṃ> trayāṇāṃ yoge jātam
ekahastayonikuṇḍe kṣetraphalam 576/0/4/³²⁾

athavā

vyāsasya varge bhanavāgninighna³³⁾ (L 203)

ityādinā vṛttakṣetre phalam/ tatra vyāsaḥ 16/7/6/1/ asya vargaḥ 288/0/0/2
bhanavāgni-3927-guṇaḥ 1130991/2/5/6/³⁴⁾ pañcasahasrabhakto jātam kṣetrapha-
lam tad eva 226/1/4/³⁵⁾

atra likhyācatuṣṭayam adhikaṃ tan na doṣāya/ uktaṃ ca

svalpāntaratvād avahūya yogād

iti vacanāt/ iti yonikuṇḍam//

2. 3. ardhacandrakuṇḍam

athārdhavalayam/

svaśatā<ṃ>śayuteṣubhāgahīneti³⁶⁾ (MKS 41)/

atrāpi jināṃśakṣetrasyeṣvaṃś<ā>ḥ 4/6/3/1/5/³⁷⁾/ ayam svaśatāṃśena 0/0/3/0/4
yutaḥ 4/6/6/2/1/ anenaiva dharitrī 24 hīnā (3a) 19/1/1/5/7/ anena vyāsārdhena
“madhyā<n>” nāma pūrvāparadakṣiṇottara<sūtra>sampātāt “kṛtavṛttadale
'grato” “jivā<ṃ> vidadhātva indudalam” bhavati/ darśanam (See Fig. 3)/

vyāsārdham dvighnam³⁸⁾ jāto vyāsaḥ 38/2/3<3/6>/ vyāsasya vargaḥ 1467/
1/5/4/3/³⁹⁾ bhanavāgninighna<ḥ> 5761740/1/6/4/5/⁴⁰⁾ ayam pañcasahasrabhakto
jātam vṛtte phalam 1152/2/6/2/ etad vṛttakṣetraphalam/ asyārdham jātam
vṛttārdhakṣetraphalam 576/1/3<1>//

2. 4. tryasrakuṇḍam

atha trya<sra>kuṇḍam/

25) panktaṃ for tyaktvā. 26) 16/7/6/11, corrected. 27) va- for bha-. 28) 6642/5/5.

29) -vāna- for -bāṇa-. 30) -guṇitaḥ vyāsapādaḥ. 31) gūmūtrikayā. 32) 516/0/4.

33) -hata for -nighna. 34) 1130990/0/5/16. 35) 2/6/1/41. 36) -bhāgeṣv iti. 37) 9 for 6.

38) dvi in margin. 39) 14/6/7/1/5/4/3. 40) 57/61/740/1/6/4/5.

vahnyaṃśam⁴¹⁾ purato nidhāyeti (verse 42ab)/
 atra kṣetrāphalam/ tatra caturviṃśāṅgulātmake madhyasūtre vahnyaṃśam⁴¹⁾
 aṣṭāṅgulā<ni> saṃyojya jāto lambaḥ 32/ caturasrapaścimabhujē 24 caturth-
 āṃśadvayaṃ ṣaṣṭaṅgulātmakam saṃyojya jātā bhūḥ 36/
 lamba⁴²⁾-32-guṇam bhūmyardham <1>8
 spaṣṭam tribhujē phalam bhavatīti (L 166)
 jātam kṣetrāphalam 576//

2. 5. vṛttakuṇḍam

atha vṛttakuṇḍam/
 viśvāṃśaiḥ svajināṃśakena sahitair iti (MKS 42cd)/
 atra caturviṃśatidhābhaktakṣetrasya trayodaśāṃśāḥ 13/ ete svajināṃśakenān-
 kenāṅgulādyena⁴³⁾ 0/4/2/5/3⁴⁴⁾ sahitā jātam vyāsārdham 13/4/2/5/3/ anena
 vyāsārdhena sampātāt kṛte vṛtte vṛttakuṇḍam⁴⁵⁾ bhavati/ darśanam (See Fig. 5)/
 kṣetrāphalam vyāsārdham driguṇam 27/0/5/<3b>2/6/ vyāsasya varge
 733/4/⁴⁶⁾ bhanavāgninighne 2880516 pañcasahasrabhakte jātam kṣetrāphalam
 576/0/6//

2. 6. 1. viśamaśaḍasrikūṇḍam

atha śaḍasrikūṇḍam/
 bhakte kṣetre jināṃśair dhṛt<i>mitalavakaiḥ
 svākṣīṣailāṃśayuktair iti (MKS43)/
 atra jināṃśakṣetrasya dhṛtyaṃśāḥ⁴⁷⁾ 18/ ete svākṣīṣailāṃśena 0/2 yutā jātam
 vyāsārdham 18/2⁴⁸⁾/ anena vyāsārdhena kṛte maṇḍala “indudikṭaḥ”⁴⁹⁾/
 tenaiva vyāsārdhamitakarkaṭenendudikṭaḥ⁵⁰⁾ kṛtaṣaṭcihneṣv ekam ekam hitvā
 sūtrāṇi dadyāt/ madhyamaṅguloṣāṃ nāṣe “netraramyaṃ ṣaḍasram” bhavati/
 tathā kṛte sati darśanam patrapṛṣṭhe (See Fig. 6. 1)/
 atra mahattrikoṇadvayaṃ niṣpannam/ tad yathā—ekam uttarāgram anyad
 dakṣiṇāgram/ uttaradikto vahnidikparyantam⁵¹⁾ eko bhujah/ evaṃ cottara-
 dikto nairṛtīm yāvad aparah/ nairṛtīm ārabhyāgneyī<m> yāvat tṛtīyah⁵²⁾/
 uttarāgrād ārabhya tṛtīyabhujaparyantamadhyasūtram lambaḥ/ evaṃ eva
 digvaiparityenāparam/
 tatrāda⁵³⁾ vṛttāntastribhujasya bhujajñānam/ vṛttavyāse 36/4 “tridvyaṅk-
 āgninabhaścandair”⁵⁴⁾ hate 3793189/4⁵⁵⁾ “khakhakhābhārārkasambhakte”
 (L 206–208) jātam trayāṇām bhujāṇām mānam 31/4/7/ atra tṛtīyabhujam

41) vahvaṃśam. 42) lambaḥ. 43) -āṅguloddīna. 44) 02 for 2. 45) vṛttam kuṇḍam.

46) 1 for 7. 47) dhṛtyaṃśāḥ. 48) 180/2/0. 49) -dikṣū, corrected in margin.

50) -mitikarkaṭendudikṣū, corrected in margin. 51) vahir- for vahni-. 52) tritīyah.

53) Here is mistakenly repeated a long passage, which actually belongs to the next section (2.6.2).

The repetition begins: “rekḥādvayaṃ kuryāt”; and ends: “phalam tad eva”. The words, “rekḥā” and “phalam tad eva”, have been encircled.

54) -āgnir nabhaś-. 55) 1793/89/4.

bhūmiṃ prakalpyānyau bhujau bhujāv iti prakalpya lamba ānīyate/ “tribhujē bhujayor yogah 63/1/6 tadantaraguno 0/0 bhuvā 31/4/7 hrtaḥ” (L 165) phalam 0/0/ labdhena⁵⁶) bhūr dviṣṭ<h>aikatroṇā 31/4/7 ’nyatra yutā 31/4/7 dalitā jāte⁵⁷) āvādhe 15/6/3/4/ svāvādhākṛti<h> 249</>6/2/3/ bhuja-31/4/7-kṛtiḥ 999/1/1/6/1⁵⁸) antaram 749/2/7/3/1⁵⁹) mūlam jāto lambaḥ 27/3/0/ ayam caturthāṃśono vyāsa eva lamba iti siddham/ lambena 27/3/0 bhūmyardham 15/6/3/4 guṇitam jā[ta](4b)m uddiṣṭatribhujē kṣetre phalam 432/5/

athāsya mahattributionasya triṣv api bhujeṣu trīṇi tryasrāṇi bahiḥsāgrāṇy⁶⁰) eva lagnāni santi/ ekam uttarato ’gnidiggāmibhujalagnam dvitīyam uttarato nirṛtidiggāmibhujasaktam tṛtīyam nairṛtidikto ’gnidiggāmibhujasamlagnam/ tatraikasya tribhujasya phalam āniya triguṇam vidhāya pūrvaphale samyojya kṣetraphalam syāt/

tatra tṛtīyatribhujē mahattributionalambād bahirbhūtam vyāsaturīyakhaṇḍa- <m> lambarūpam pratyakṣato dṛśyate ’to vyāsacaturthāṃśo laghutribhujē lambaḥ 9/1/0/ bhūmis tu mahattributionasya tṛtīyabhujatṛtīyāṃśaḥ/ yato mahattributionasya tṛtīyabhujād bahirbhūtam yal laghutribhujam tasya da[kṣ]i- [ṇ]ān nirṛtau bhujadvayaprāntau mahattributionasya tredhāvibhaktasya madhyakhaṇḍaprāntalagnau pratyakṣato dṛ[ś]yete a]taḥ sa eva bhūmiḥ/ tanmānam 10/4/2/2⁶¹) atrāpi lambena 9/1/0 bhūmyardham 5/2/1/1 guṇitam jātam bahi[rbh]ūtatribhujē kṣetraphalam 48/0/4/2⁶²)

trayāṇām tribhujānām samatvād⁶³) idam triguṇam 144/1/4/6/ (5a) idam pūrvaphale ’smin 432/5⁶⁴) yojitam 576/6/4</6> pūrṇam phalam//

2. 6. 2. samaśaḍasrikunḍam

atha prakārāntareṇa śaḍasrikunḍam ucyate/

athavā jinabhaktakunḍamānād iti (MKS 44)/

jinabhaktakunḍamānasya tithibhāgā<h> 15 sva-15-khabhūpa-160-bhāgena 0/0/6 hīnāḥ 14/7/2/ jātam vyāsārdham⁶⁵) 14/7/2/ anena kṛte <vṛtte> vidhudiktaḥ samaśaḍbhujaiḥ śaḍasram jātam darśanam ca (See Fig. 6. 2)/

atra pūrvāparam paraspasamlagnam viśamacaturbhujadvayam dṛśyate/ atra vyāsaturīyā bhūḥ 29/6/4/ mukham tu pūrvāpararūpam vyāsārdhatulyam 14/7/2/ yato yena vyāsārdhena vṛttam kṛtam tenaiva vyāsārdhena vidhudiktaḥ samaśaḍbhujā dattāḥ santy ato vyāsārdhatulyam⁶⁶) mukham eko bhujah kalpitaḥ/ lamba<h> svamukhād⁶⁷) yāmyottararekhāvadhiḥ/ atha⁶⁸) mukhād bahir bhūtam⁶⁹) yad vyāsārdhakhaṇḍam śararūpam dhanuravadhi⁷⁰) vartate tanmānam āniya vyāsārdhād apanīya lambamānam syāt/ tadānayanam yathā jyāvvyāsayogāntareti (L 204)/

jyā-14/7/2-vyāsa⁷¹)-29/6/4-yogā-44/5/6-ntara⁷²)-14/7/2-ghāta-666/4/5-mūlam 25/

56) dvi before bhūr, corrected. 57) jāto. 58) 991/0/1. 59) 749/2/6/5. 60) -sāṣṭany.

61) 0/4/2/3. 62) 3 for 2. 63) samatvāna. 64) 3 for 2. 65) māsārdham.

66) vyāsārdhatulyam. 67) sumukhād. 68) atatha, ta deleted. 69) varhir, first r deleted.

70) -āvadhir. 71) vyāsaḥ. 72) ntarah.

6/4/ vyāsaḥ 29/6/4 tadūnaḥ 4/0/0 da(5b)litaḥ 2/0/0 śaraḥ syāt/ anena śareṇa vyāsārdhaṃ 14/7/2 hīnaṃ jāto lambaḥ 12/7/2/ “caturbhujē ’nyatra samānala-mbe lambena 12/7/2 nighnaṃ ku-29/6/4⁷³)-mukhai-1/4/7/2-kya-44/5/6-khaṇḍaṃ” (L 173) 22/2/7⁷⁴) nighnaṃ 2/88/4/5 jātaṃ ekaviṣamacaturbhujasya kṣetraphalam/ dviguṇaṃ 577/1/ / evaṃ ekahasta ekāṅgula-m 1 ekayavaś cāntaraṃ patatiti sthūlaṃ//

athavordh-v>asthabhujasampātadvayād adha-h>sthabhujasampātadvayā-vadhi pūrvāparaṃ rekhādvayaṃ kuryāt/ evaṃ kṛte sati caturbhujasya yāmyottaraṃ bhujadvayaṃ parimṛjya vyāsasya catvāri khaṇḍāni samānāntarāṇi jāyante/ tayo rekhayor yad yāmyottararekhaḥ saha sampātadvayaṃ tasmād yad yāmyottarabhujasampātadvayāvadhi yad vyāsaturyakhaṇḍamānaṃ sāvādhā 7/3/5/ yāmyottaragatavyāsāgraniḥśṛtaṃ vyāsārdhamānaṃ bhujadvayaṃ kārṇa-rūpaṃ bhujāḥ 14/7/2/ tataḥ

svāvādhābhujakṛtyor antaramūlaṃ prajāyate lamba (L 166)

ity anenāpi sa eva lambaḥ 12/7/2/ evaṃ lambam āniya

caturbhujē ’nyatra (L 173)

ityādinā phalaṃ tad eva 288/4/5//

2. 7. padmakhaṇḍaṃ

atha padmakhaṇḍaṃ āha/

aṣṭāṃśa ca yata iti (MKS 45)/

kṣetrasyāṣṭamāṃśa(6a)vṛddhyā caturasrāntarāptavṛttacatuṣṭayaṃ⁷⁵) kuryāt/ pañcamavṛttaṃ svasyāṣṭatri-m>śāṃśena⁷⁶) 0/0/5 ūnitenā pūrvavyāsārdhena⁷⁷) 14/7/3 vṛttaṃ kuryāt/ darśanaṃ ca pūrvapatre⁷⁸) (See Fig. 7)//

atha kṣetraphalānayanam/ tatra caturthavṛttavyāsaḥ 24⁷⁹)/ asmād

vyāsasya varga (L 203)

ityādinā jātaṃ caturthavṛttiyaṃ kṣetraphalam 452/3/1/ pañcamavṛttavyāsaḥ 29/6/6/ asmād api

vyāsasya varga (L 203)

ityādinā kṣetraphalam 699/4/1/ anayor antarārdhaṃ 123/4/4 pūrvakṣetraphale yojitaṃ athavā pañcamavṛttakṣetraphale hīnaṃ jātaṃ kṣetraphalam 575/7/5/ yūkātrayī namati na doṣāya//

2. 8. 1. viśamāṣṭāsrikuṇḍaṃ

athāṣṭāsrikuṇḍaṃ āna/

kṣetre jināṃśa⁸⁰) iti (MKS 46)/

jināṃśakṣetrasyāṣṭādaśāṃśaiḥ⁸¹) 18 “svāṣṭadvibhāgena⁸²) 0/5/1/1 yutaiḥ” 18/5/1/1/ anena vyāsārdhena kṛt-e> “vṛtte vidigdiśor antarato ’ṣṭasūtrais tṛtīyayuktaiḥ” nāma cihnadvayaṃ vibhāya tṛtīyayuktair arthāc caturthayuktair

73) 2/9/6/4. 74) 22/7/2. 75) caturasramanyāpta-. 76) -āṃśenana, first na deleted.

77) kunītena 2/7/3 yutapūrva- for ūnitenā pūrva-. 78) sūrya- for pūrva-. 79) 14.

80) jināṃśa. 81) -daśāṃśāḥ. 82) svaṣṭāsvi- for svāṣṭadvi-.

ity arthaḥ/ iti kṛte 'ṣṭakoṇe darśanam ca (See Fig. 8. 1))

atha kṣetraphalam/ tatra vyāsārdham 18/5/1/1 (6b) dviguṇam jāto vyāsaḥ 37/2/2<2>⁸³) “dvidvi nandeṣusāgaraiḥ⁸⁴) 45922 vṛttavyāse 37/2/2/2⁸³) samāhate⁸⁵) 1712<2>08/7/4/4⁸⁶) khakhakhābhrārka-120000-sambhakte” (L 207–208) labdham aṣṭāśrikṣetraspaṣṭabṛhadbhujamānam 14/2/1/1/ atra pūrvāpara-yāmyottararekhādvayacatuḥsāmpātān madhye bṛhadbhujatulyam samacaturbhujam niṣpannam/ tasya yāmyottarasanmukham⁸⁷) yat⁸⁸) pūrvapaścimabhujadvayam tadagrā<d> vṛttasāmpātāvadhi yad rekhākhaṇḍam tadyojitam⁸⁹) dakṣiṇottarāyatam koṭidvayam jāyate/ tadrekḥākhaṇḍānayanārtham upāya<ḥ>/ aṣṭāśrabhujāḥ karṇaḥ⁹⁰)/ tadagrān madhyacaturbhujasya koṇāvadhi nīyamānā rekhā koṭiḥ/ caturbhujakoṇāsaktakoṭyagrāt karṇasya dvitīyaprāntagāmisūtram bhujāḥ/ bhujakoṭyoḥ⁹¹) <sa>māna<tva>m pratyakṣato dṛśyate/ bhujakoṭyor yo vargayogaḥ sa karṇavarga iti gaṇite pratipāditam/ tasmāt karṇavargād ekasya varge 'panīte⁹²) 'nyataro 'vaśiṣyate/ tasya mūlam bhujakoṭimānam syāt/ prakṛte bhujakoṭyoḥ samānatvāt karṇavargārdhamūlam eva bhujako(7a)ṭimānam syāt/ tasmād aṣṭāśribhujatulyasya karṇasya 14/2/1/1 vargo 'yam 203/4/4/ ardham 101/6/2/ asmāt phalam jātam bhujakoṭimānam 10/1/⁹³) etad eva pūrvoddiṣṭarekhākhaṇḍam/ idam uddiṣṭamadyasthacaturbhujasya yāmyottaradiṇmukhapūrvapaścimabhujaprāntayor yojyam/ ato dviguṇam vidhāya 20/2 madhyacaturbhujasyaṣṭāśribhujatulyasya pūrvapaścimabhujayoḥ 14/2/1/1 yojitam jātam dakṣiṇottaradiṇmukham koṭidvayam 34/4/1/1/ ubhayapārśve 'ṣṭāśribhujō bhujāḥ 14/2/1/1/ evam jātam yāmyottarāyatam āyatacaturbhujam/ asya bhujakoṭyor hananam “tathāyate” (L 173) syād iti jātam kṣetraphalam 492/3/6/7/ asmād āyatacaturbhujāntaḥpātidakṣiṇottarapārśvadvayasthatribhujadvayasya phalam ānīya śodhyam/ tatra kṣetradarśanam yathā (See Fig. 8. 1)/ mahābhujō bhujāḥ 14/2/1/1/ pūrv<od>diṣṭarekhākhaṇḍadvayam bhujadvitayam/ asya kṣetraphalānayanam/ “tribhujē bhujayor yogaḥ 20/2 tadantaraguṇ<o> 0/0 bhuvā 14/2/1/1 hr̥taḥ” phalam 0/0/ labdhena⁹⁴) “dviṣṭ<ḥ>ā bhūr ūnayutā dalitā” (L 165) jātāvādhā 7/1/0/4/⁹⁵) (7b) āvādhākṛtiḥ 50/7/0/1/ bhujākṛtiḥ 102/4<1>/ etayor antaram 51/5/0<7> mūlam jāto lambaḥ 7/1/6/4/ “lambaguṇam bhūmyardham 7/1/0/4 spaṣṭam tribhujē phalam” (L 166) 51/4/3/ etad dviguṇam jātam ubhayatribhujaphalam 103/0/6/ evam pūrvaphalād asmāt 492/3/6/7 śodhitam jātam 389/3/0/7/ asmin pūrvapaścimakōṭyoḥ pratyekam saṃlagnakoṇadvayasya⁹⁶) phalam ānīya yojyam/ tatphalānayanam yathā/ mahābhujō bhujāḥ/ pūrvapaścimarekhākhaṇḍam koṭiḥ/ evam evāparam bhujakoṭidvayam/ evam militvā jātam āyatacaturbhujam/ bhujakoṭyor hananam “tathāyate” (L 173) syād iti jātam kṣetraphalam 144/3/5/3/ asmāt pūrvatribhujaphalam etad 51/4/3 śodhitam jātam koṇadvayaphalam 92/7/2/3/ etāvad evāparakoṇam⁹⁷) ato dviguṇam etat 185<6>/4/6/ idam pūrvaphale

83) 27 for 37. 84) dvigu- for dvidvi-. 85) samāhatete. 86) 3/5/8 for 7/4/4.

87) -sasan- for -san-. 88) yataḥ for yat. 89) Inserts sa after tam. 90) karaṇaḥ. 91) -koṭyor.

92) 'paniyate. 93) 10/1/0. 94) labdhā. 95) 6 for 0. 96) -dvayayoḥ. 97) koṇar.

'smin 389/3/0/7 yojitam jātam pūrṇaphalam⁹⁸⁾ 575/1/5/5//

2. 8. 2. samāṣṭāsrikunḍam

“athavāṣṭakoṇam”/

madhye guṇe vedayamair iti (MKS 47)/

śakrāmśāḥ <14>/ ete “nijaśyabdhi-47-lavena”⁹⁹⁾ 0/2/3/0 yuktā jātam vyāsārdham 14/2/3/ anena caturasramadhyāt kṛte vṛtte yathoktadiśāṣṭā(8a)sri syāt/ darśanam patrapṛṣṭhe (See Fig. 8. 2)//

atra “dvidvinandeśusāgaraiḥ” “vṛttavyāse 28/4/6 samāhate 1313082/1/4¹⁰⁰⁾ khakhakhābhārākasambhakte” (L 207–208) jātam aṣṭāsribhujamānam 10/7/4/2/ atra yathāvat¹⁰¹⁾ teṣu bhujesv ekabhujasyobhayaprāntāt¹⁰²⁾ sanmukhāparabhujaprāntadvayaṃ yāvan nīyamānam sūtradvayaṃ kuryāt/ evaṃ kṛta āyatacaturbhujam pārśvayor viśamacaturbhujayutam¹⁰³⁾ jāyate/ tatrāyatacaturbhujam tu tribhujadvayakārṇasamyogajanyam¹⁰⁴⁾/ prakṛta āyatacaturbhujasya vṛttavyāsaḥ¹⁰⁵⁾ kārṇaḥ 28/4/6/ aṣṭāsribhujō bhujāḥ 10/7/4/2/ tatra¹⁰⁶⁾

doḥkārṇavargayo<r> vivarān mūlaṃ koṭir (L 136)

ity uktatvāt kārṇavargo 'yaṃ 757/4/6 dorvargaś ca <1>19/5/5/6/ anayor antaram 637/7/0/2¹⁰⁷⁾/ asmān mūlaṃ jātā koṭiḥ saivāyatacaturbhujē jñeyā 25/2/1/

tathāyate tadbhujakoṭighāta (L 173)

iti kṛte jātam āyatacaturbhujaphalam 276/3/4/ atha viśamacaturbhujasya/ tatrāyatacaturbhujakoṭi<r> bhūḥ 25/2/1/ aṣṭāsribhujō mukham 10/7/4/2/ etattulyam evāparam/ bhujadvayaṃ bhūprāntadvayalagnam/ evaṃ viśamacaturbhujam/ tatra¹⁰⁶⁾ lambānayanam

samānalambasya caturbhujasya

mukhonabhūmiṃ parikalpya¹⁰⁸⁾ bhūmim/

bhujau bhujau tryasravād eva sādhye

tasyāvadhe¹⁰⁹⁾ lambamitis tataś ca// (L 184)

uktavaj¹¹⁰⁾ jāto lambaḥ 8/2/3/2/

lambena nighnam kumukhaikyakhaṇḍam (L 173)

ityādinā jātam kṣetraphalam <1>50/2/1/4/ etad evāparaviśamacaturbhujasyāto dvighnam etat 300/4/3 pūrvānitāyatacaturbhujaphalena yutam jātam kṣetraphalam 576/4/3//

gaṇeśaḥ śrīdharasuto nandigrāmanivāsakaḥ/

subodhārtham kṣetravidām akarod gaṇitam sphuṭam//

samvat 1894 āśvinakṛṣṇā 14 maṅgalavāra// śrī //

98) pūrvaphalam. 99) lamvena. 100) 57 for 82. 101) yathāvadat, da deleted.

102) ekamabhujā- for ekabhujā-. 103) -bhujam yutam. 104) -jamnyam.

105) vṛttaḥ vyāsaḥ. 106) Inserts a *daṇḍa*. 107) 3 for 2. 108) prakalpa. 109) tasyāvādhe.

110) utapiśo.

3. COMMENTARY

3.0. Introductory remarks

As is stated in the Introduction, the size of a *kuṇḍa* is determined according to the number of oblations to be made in that particular ceremony in which it is used. Table 1 shows the areas of *kuṇḍas* prescribed by Viṭṭhaladikṣita (MKS 35). He also mentions others' opinions (MKS 36).

Table 1

Number of oblations	Area of <i>kuṇḍa</i>
50	1 square <i>aratni</i>
10^2	1 square <i>ratni</i>
10^3	1 square <i>hasta</i>
10^4	2 square <i>hasas</i>
10^5	4 square <i>hasas</i>
10^6	6 square <i>hasas</i>
10^7	8 or 10 or 16 square <i>hasas</i>

The square-shaped *kuṇḍa* is the basis of the construction of *kuṇḍas* of other shapes; in other words, the rule for drawing a *kuṇḍa*, except for the square *kuṇḍa*, is given in terms of the side of the square *kuṇḍa* of the same area. Thus, the rules may be characterized as transformation-rules that keep the areas unchanged, and the rules given in MKS 39–47 can actually be applied to *kuṇḍas* of any size, though Gaṇeśa only deals with *ekahastakuṇḍas* or *kuṇḍas* of one square *hasta*, except in one place (Sec. 2.2) where he makes an erroneous statement about *yonikuṇḍas* of other sizes (see Sec. 3.2, *Remark 1*).

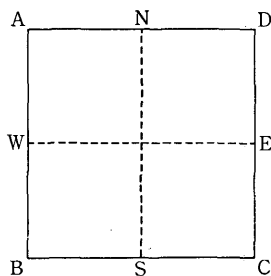
Viṭṭhaladikṣita gives in advance the sides of the square *kuṇḍas* of one square *hasta* to ten square *hasas* (MKS 37).

Table 2

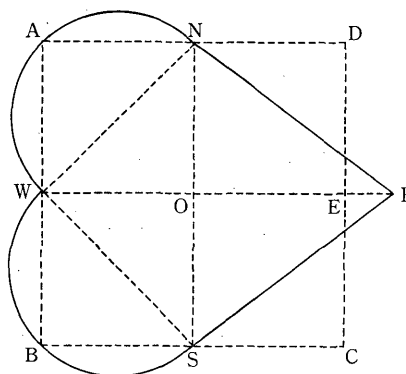
Area of square <i>kuṇḍa</i>	Side (<i>a</i>)
1 square <i>hasta</i>	24 <i>aṅgulas</i> 0 <i>yava</i>
2 square <i>hasas</i>	34 <i>aṅgulas</i> 0 <i>yava</i>
3 square <i>hasas</i>	41 <i>aṅgulas</i> 5 <i>yavas</i>
4 square <i>hasas</i>	48 <i>aṅgulas</i> 0 <i>yava</i>
5 square <i>hasas</i>	53 <i>aṅgulas</i> 5 <i>yavas</i>
6 square <i>hasas</i>	58 <i>aṅgulas</i> 6 <i>yavas</i>
7 square <i>hasas</i>	63 <i>aṅgulas</i> 4 <i>yavas</i>
8 square <i>hasas</i>	66 <i>aṅgulas</i> 7 <i>yavas</i>
9 square <i>hasas</i>	72 <i>aṅgulas</i> 0 <i>yava</i>
10 square <i>hasas</i>	75 <i>aṅgulas</i> 7 <i>yavas</i>

3.1. Square *kuṇḍa* (MKS 39: Fig. 1)

$$S = a^2 \dots (1)$$



$$AB=BC=CD=DA=a$$

 Fig. 1. Square *kuṇḍa*

 Fig. 2. Vulva-like *kuṇḍa*

$$\begin{aligned} a &= 1 \text{ hasta} = 24 \text{ aṅgulas:} \\ S &= 24^2 \text{ square aṅgulas (L 173)} \\ &= 576 \text{ aṅgula}^2 \text{ (L 19).} \end{aligned}$$

3. 2. *Kuṇḍa* shaped like a vulva (MKS 40: Fig. 2)

$$\begin{aligned} EP &= (5a/24) \cdot (1 + 1/32) \dots (2) \\ a &= 1 \text{ hasta} = 24 \text{ aṅgulas: } EP = 5 + 5/32 = 5; 1, 2 \text{ aṅgulas.} \end{aligned}$$

(The right-hand side of the semicolon indicates the fractional part in the octonary system. See Sec. 1.4 above.)

$$\begin{aligned} OP &= 12 + 5; 1, 2 = 17; 1, 2 \text{ aṅgulas.} \\ SN &= 24 \text{ aṅgulas: } S_1 = \triangle PNS = (1/2) \cdot 24 \cdot 17; 1, 2 \text{ (L 166)} \\ &= 205; 7 \text{ aṅgula}^2. \\ OW &= 12 \text{ aṅgulas: } S_2 = \triangle WNS = (1/2) \cdot 24 \cdot 12 \text{ (L 166)} \\ &= 144 \text{ aṅgula}^2. \end{aligned}$$

$$\begin{aligned} d &= NW = SW \\ &= \sqrt{ON^2 + OW^2} = \sqrt{OS^2 + OW^2} \text{ (L 136)} \\ &= \sqrt{12^2 + 12^2} = \sqrt{288} = 16; 7, 6, 0, 7, \dots \approx 16; 7, 6, 1 \text{ (L 22).} \\ c &= 3927 \cdot d / 1250 \text{ (L 199)} \\ &= 3927 \cdot 16; 7, 6, 1 / 1250 = 66643; 7, 4, 7 / 1250 \\ &= 53; 2, 4, 1, \dots \approx 53; 2, 4, \text{ aṅgulas.} \end{aligned}$$

$$\begin{aligned} S_3 &= \text{sum of the areas of two semicircles NAW and SBW} \\ &= cd/4 \text{ (L 201)} \\ &= 53; 2, 4 \cdot 16; 7, 6, 1/4 = 904; 6, 0, 0, 2, 4/4 \\ &\approx 904; 6/4 = 226; 1, 4 \text{ aṅgula}^2; \text{ or} \\ S_3 &= 3927d^2/5000 \text{ (L 203)} \\ &= 3927 \cdot 16; 7, 6, 1^2/5000 = 3927 \cdot 288; 0, 0, 2, 3 \dots / 5000 \\ &\approx 3927 \cdot 288; 0, 0, 2/5000 = 1130991; 2, 5, 6/5000 \end{aligned}$$

$$=226; 1, 4, 5, 4, \dots \approx 226; 1, 4 \text{ } aṅgula^2.$$

$$S=S_1+S_2+S_3=576; 0,4 \text{ } aṅgula^2.$$

Remarks.

1) Having obtained $EP=5;1,2$ for $a=1$ hasta, Gaṇeśa remarks: *ayam eva dvyādiḡṇaḥ san dvyādiḡhaste bhavet/ evaṃ sarvatra/* “This (*i.e.* $5;1,2$), when multiplied by two etc., would be $\langle$ the value of $EP\rangle$ in the cases of $\langle$ *kuṇḍas* of $\rangle$ two square *hastas* etc. So is it everywhere (*i.e.* for *kuṇḍas* of any shape).”

This statement is of course wrong because what are doubled, tripled, etc. in *kuṇḍas* of two square *hastas* etc. are not their lines but their areas.

2) The excess $0;0,4$ in the area S is designated “*likhyācatuṣṭaya (=likṣā-)*” by Gaṇeśa, but it should be “*yūkācatuṣṭaya*”. On the other hand, Viṭṭhaladikṣita, having obtained $S=576;0,4,5$ ($S_3=226;1,4,5$ according to him) in his own commentary, correctly remarks:

atra likṣāpañcakam yūkācatuṣṭayam cādhikam//

Here, the excess is five *likṣās* and four *yūkās*.

3) Viṭṭhaladikṣita in his commentary mentions a sort of proof intended for those who do not know mathematics, and prescribes how to multiply numbers in the octonary system:

yo gaṇitānabhijñāṣa tena caturasraṃ kuṇḍam taṇḍulādīnā pūrayitvā tān eva taṇḍulān yonyādikuṇḍeṣu dattvā tatpūrtau toṣavyam iti/ atrāṅgulayavayū-kālikṣāḥ kṛtvā gomūtrikādirītyā gaṇayitvāṣṭabhir bhāge gṛhīte phala upary upari ca vojyamāne phalāny utpadyante¹¹¹⁾//

One who does not know mathematics should be satisfied when *kuṇḍas* beginning with the one shaped like a vulva are filled with exactly the same grains of unhusked rice and so on that a square *kuṇḍa* $\langle$ of the same size $\rangle$ has been filled with. Here, when one has multiplied $\langle$ the numbers $\rangle$ arranged $\langle$ in the places of $\rangle$ *aṅgula*, *yava*, *yūkā*, and *likṣā* $\langle$ severally $\rangle$ in the manner of *gomūtrikā* (lit. urine of a cow) etc., divided $\langle$ each product $\rangle$ by eight, and added each quotient to the next higher place, the $\langle$ true $\rangle$ results $\langle$ for each place $\rangle$ are produced.

4) Requirement for the transformation. The transformation has to keep the area unchanged:

$$a^2 = \pi(\sqrt{2} a/4)^2 + a(a + EP)/2, \quad \text{or } EP = (1 - \pi/4)a.$$

Comparing this with (2), we have $\pi = 201/64 = 3927/1250 - 39/40000$.

5) The *Śāradātilaka*, 3.53cd–55ab, prescribes:

$$EP = a/5.$$

3.3. Semicircular *kuṇḍa* (MKS 41: Fig. 3)

$$\left. \begin{aligned} t &= (a/5)(1 + 1/100) \\ r &= OP = OQ = a - t \end{aligned} \right\} \dots (3)$$

$$a = 24 \text{ } aṅgulas: a/5 = 24/5 = 4; 6, 3, 1, 4, 6, \dots \approx 4; 6, 3, 1, 5.$$

¹¹¹⁾ *phalādy utpadyate*, in the text we have used (see Sec. 1.6 above).

$$\begin{aligned}
 t &= a/5 + (a/5)/100 \\
 &= 4; 6, 3, 1, 5 + 4; 6, 3, 1, 5/100 \\
 &= 4; 6, 3, 1, 5 + 0; 0, 3, 0, 4, \dots \\
 &\approx 4; 6, 3, 1, 5 + 0; 0, 3, 0, 4 \\
 &= 4; 6, 6, 2, 1.
 \end{aligned}$$

$$\begin{aligned}
 r &= a - t \\
 &= 24 - 4; 6, 6, 2, 1 \\
 &= 19; 1, 1, 5, 7. \\
 d &= 2r = 2 \cdot 19; 1, 1, 5, 7 \\
 &= 38; 2, 3, 3, 6 \text{ angulas.} \\
 d^2 &= 38; 2, 3, 3, 6^2 \\
 &= 1467; 1, 5, 4, 3, 0, \dots \\
 &\approx 1467; 1, 5, 4, 3.
 \end{aligned}$$

$$\begin{aligned}
 S_1 &= 3927d^2/5000 \text{ (L 203)} \\
 &= 3927 \cdot 1467; 1, 5, 4, 3/5000 = 5761740; 1, 6, 4, 5/5000 \\
 &= 1152; 2, 6, 2, 1, \dots \approx 1152; 2, 6, 2 \text{ angula}^2. \\
 S &= S_1/2 = 1152; 2, 6, 2/2 = 576; 1, 3, 1 \text{ angula}^2.
 \end{aligned}$$

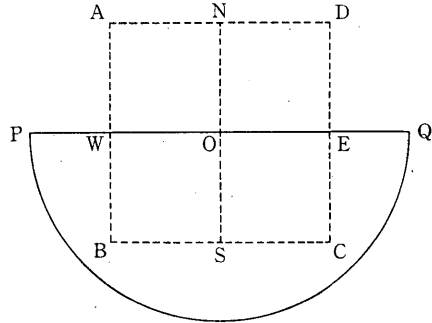


Fig. 3. Semicircular kuṇḍa

Remarks.

- 1) Viṭṭhaladīkṣita mistakenly obtains $S_1 = 1152; 2, 6, 4$ and hence $S = 576; 1, 3, 2$.
- 2) Requirement for the transformation:

$$a^2 = \pi r^2/2.$$

By assuming $r = a - t$, we have: $t = (1 - \sqrt{2/\pi})a$. A comparison of this with (3) will give $\pi = 500000/159201 = 3927/1250 - 182327/199001250$. See Sec. 1.5 above for $\pi = 3927/1250$.

- 3) Śāradātilaka 3.55cd-57ab prescribes:

$$r = a - t, \text{ where } t = a/5.$$

3.4. Triangular kuṇḍa (MKS 42ab:

Fig. 4)

$$\left. \begin{aligned} t &= AQ = BR = a/4, \\ u &= EP = a/3. \end{aligned} \right\} \dots (4)$$

$$\begin{aligned}
 PW &= a + u \\
 &= 24 + 24/3 = 32 \text{ angulas.}
 \end{aligned}$$

$$\begin{aligned}
 QR &= a + 2t \\
 &= 24 + 2 \cdot (24/4) \\
 &= 36 \text{ angulas.}
 \end{aligned}$$

$$\begin{aligned}
 S &= \triangle PQR \\
 &= (36/2) \cdot 32 \text{ (L 166)} \\
 &= 576 \text{ angula}^2.
 \end{aligned}$$

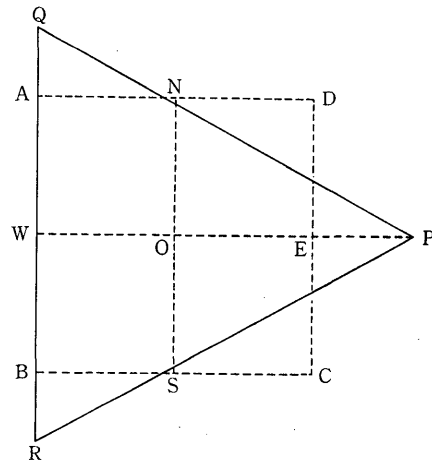


Fig. 4. Triangular kuṇḍa

Remarks.

- 1) The triangle prescribed by Viṭṭha-

ladikṣita is not equilateral. If an equilateral triangle be required in this case, one has to satisfy the requirement,

$$a^2 = (\sqrt{3}/4)(a+2t)^2, \text{ where } t=AQ=BR,$$

EP being consequently determined. This equation may be rewritten as:

$$t = (1/\sqrt{3} - 1/2)a.$$

2) *Śāradātilaka* 3.57cd-58 only gives $t=a/4$, being silent about the point P. It is not certain whether this implies that the triangle in consideration was equilateral. See Rāghavabhaṭṭa's commentary on *Śāradātilaka loc. cit.* for several interpretations.

3.5. Circular *kuṇḍa* (MKS 42cd: Fig. 5)

$$r=OP=(13a/24)(1+1/24) \dots (5)$$

$a=24$ *āṅgulas*:

$$r=(13a/24)(1+1/24)$$

$$=13+13/24$$

$$=13+0;4,2,5,2,5, \dots$$

$$\approx 13;4,2,5,3 \text{ āṅgulas.}$$

$$d=2r=27;0,5,2,6 \text{ āṅgulas.}$$

$$d^2=27;0,5,2,6^2$$

$$=733;4,1,0,0,4,3,4,4$$

$$\approx 733;4,1.$$

$$S=3927d^2/5000 \text{ (L 203)}$$

$$=3927 \cdot 733;4,1/5000$$

$$=2880515;6,7/5000$$

$$\approx 2880516/5000$$

$$=576;0,6,4,6,5, \dots$$

$$\approx 576;0,6 \text{ āṅgula}^2.$$

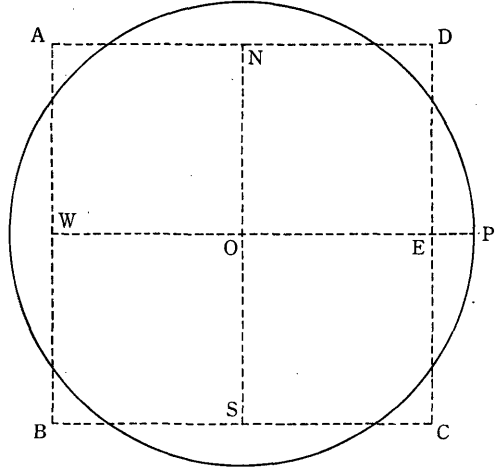


Fig. 5. Circular *kuṇḍa*

Remarks.

1) Viṭṭhaladikṣita obtains $S=576;0,6,5 \text{ āṅgula}^2$.

2) Requirement for the transformation:

$$a^2 = \pi r^2; \text{ hence } r = a/\sqrt{\pi} \dots (5a)$$

Or, by assuming $r=a/2+t$, we may rewrite the equation:

$$a^2 = \pi(a/2+t)^2; \text{ hence } t = (1/\sqrt{\pi} - 1/2)a \dots (5b)$$

By comparing (5a) with (5), we have $\pi = 329776/105625 = 3927/1250 - 2569375/132031250$. The difference amounts to about 1/50. This is twenty times as large as those in the cases of the *kuṇḍas* shaped like a vulva and the semicircular *kuṇḍa* (see Sec. 3.2, Remark 4 and Sec. 3.3, Remark 2 above).

3) *Śāradātilaka* 3.59 prescribes: $t=a/18$.

4) To transform a square into a circle is a traditional problem which can be traced back to the *śulbasūtras*. Baudhāyana (1.58), Āpastamba (3.2), and Kātyāyana (3.13) prescribe [DATTA 1932: 140-143]: $t = (\sqrt{2} \cdot a/2 - a/2)/3 =$

$$(\sqrt{2}-1)a/6.$$

3. 6. 1. Irregular hexagonal *kunḍa* (MKS 43: Fig. 6. 1).

$$r = OP = (18a/24)(1 + 1/72) \dots (6.1)$$

$$a = 24 \text{ āṅgulas:}$$

$$r = 18 + 18/72 = 18 + 0;2 = 18;2 \text{ āṅgulas.}$$

$$d = 2r = 36;4 \text{ āṅgulas.}$$

$$\begin{aligned} PR = RU = UP \\ &= 103923d/120000 \\ &\quad (L 206-208) \\ &= 103923 \cdot 36;4/120000 \\ &= 3793189;4/120000 \\ &= 31;4,7,0,2, \dots \\ &\approx 31;4,7 \text{ āṅgulas.} \end{aligned}$$

$$\begin{aligned} RH &= [RU \pm (PR + PU) \times \\ &\quad (PR - PU)/RU]/2 \\ &\quad (L 165) \\ &= RU/2 = 31;4,7/2 = 15;6,3,4 \text{ āṅgulas.} \\ RH^2 &= 15;6,3,4^2 = 249;6,2,3,4,2,0 \approx 249;6,2,3. \\ PR^2 &= 31;4,7^2 = 999;1,1,6,1. \\ PH &= (3/4)PT = \sqrt{PR^2 - RH^2} \\ &= \sqrt{999;1,1,6,1 - 249;6,2,3} = \sqrt{749;2,7,3,1} \\ &= 27;2,7,7, \dots \approx 27;3,0 \text{ āṅgulas.} \end{aligned}$$

$$\begin{aligned} S_1 &= \triangle PRU = PH \cdot RH \\ &= 27;3,0 \cdot 15;6,3,4 = 432;5,1,6,4 \approx 432;5 \text{ āṅgula}^2. \\ TH &= PT/4 = d/4 = 36;4/4 = 9;1 \text{ āṅgulas.} \\ FG &= RU/3 = 31;4,7/3 = 10;4,2,2,5,2, \dots \approx 10;4,2,2 \text{ āṅgulas.} \\ S_2 &= \triangle TFG = (FG/2) \cdot TH = (10;4,2,2/2) \cdot 9;1,0 \\ &= 48;0,4,2,1 \approx 48;0,4,2 \text{ āṅgula}^2. \\ S &= S_1 + 3S_2 = 432;5 + 3 \cdot 48;0,4,2 = 432;5 + 144;1,4,6 = 576;6,4,6 \text{ āṅgula}^2. \end{aligned}$$

Remarks.

1) Viṭṭhaladīkṣita obtains $S_1 = 432;5,1,6$ and hence $S = 576;6,6,4$. He mentions that S can also be obtained from $S = 12 \cdot S_2$.

2) Gaṇeśa says that the geometrical property, $PH = PT - PT/4$, "has been well established" (*iti siddham*). He also says that the property, $RF = FG = GU$, is "observed by means of the direct perception" (*pratyakṣato drśyete*). See also Section 3. 8. 1, Remark 2.

3) Requirement for the transformation:

$$a^2 = \sqrt{3} r^2, \text{ or } r = \sqrt[3]{3} \cdot \sqrt{3} a/3.$$

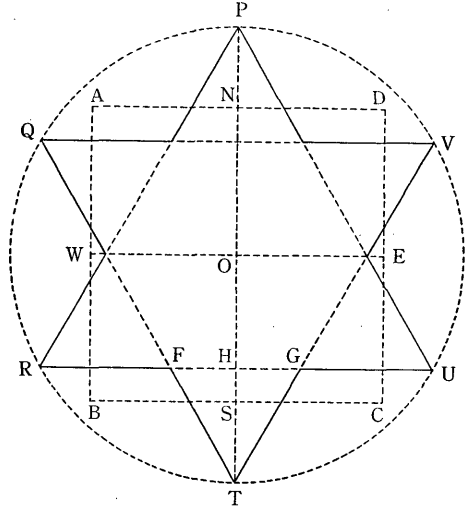


Fig. 6. 1. Irregular hexagonal *kunḍa*

$$\begin{aligned}
 d_4 &= 2 \cdot r_4 = 24 \text{ angulas}; \\
 d_5 &= 2 \cdot r_5 = 29;6,6 \text{ angulas}. \\
 S_4 &= 3927d_4^2/5000 \text{ (L 203)} \\
 &= 3927 \cdot 24^2/5000 \\
 &= 2261952/5000 \\
 &= 452;3,0,7,7, \dots \\
 &\approx 452;3,1 \text{ angula}^2. \\
 S_5 &= 3927d_5^2/5000 \text{ (L 203)} \\
 &= 3927 \cdot 29;6,6^2/5000 \\
 &= 3927 \cdot 890;5,1,4,4/5000 \\
 &= 3497580;1,7,7,4/5000 \\
 &= 699;4,1,0, \dots \\
 &\approx 699;4,1 \text{ angula}^2. \\
 S &= S_4 + (S_5 - S_4)/2 \\
 &= 452;3,1 + 123;4,4 \\
 &= 575;7,5 \text{ angula}^2; \text{ or} \\
 S &= S_5 - (S_5 - S_4)/2 = 699;4,1 - 123;4,4 = 575;7,5 \text{ angula}^2.
 \end{aligned}$$

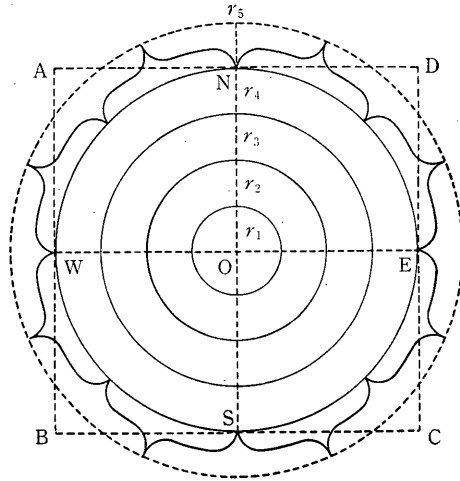


Fig. 7. Lotus-like kunḍa

Remarks.

- 1) Viṭṭhaladīkṣita obtains $S_5 = 699;4,5,0$ and hence $S = 575;7,7 \text{ angula}^2$.
- 2) Requirement for the transformation:

$$a^2 = [\pi(a/2)^2 + \pi r_5^2]/2, \text{ or } r_5 = \sqrt{2/\pi - 1/4} \cdot a.$$

By comparing this with (7), we have $\pi = 184832/58825 = 3927/1250 + 1369/2941250$.

- 3) The *Śāradātīlaka*, 3.62–63, prescribes a circle with three inner circles, but without pedals. The size of the outermost circle is the same as that of the circular kunḍa.

3.8.1. Irregular octagonal kunḍa (MKS 46: Fig. 8. 1).

$$r = OP_1 = (18a/24)(1 + 1/28) \dots (8.1)$$

$$a = 24 \text{ angulas};$$

$$\begin{aligned}
 r &= 18 + 18/28 \\
 &= 18 + 0;5,1,1,1, \dots \\
 &\approx 18;5,1,1 \text{ angulas}.
 \end{aligned}$$

$$d = 2 \cdot r = 37;2,2,2 \text{ angulas}.$$

$$P_1P_2 = P_2P_3, \text{ etc.}$$

$$= 45922d/120000$$

$$\text{(L 207–208)}$$

$$= 45922 \cdot 37;2,2,2/120000$$

$$= 1712208;7,4,4/120000$$

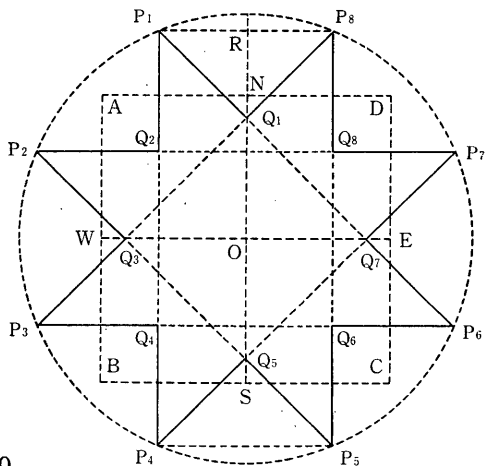


Fig. 8. 1. Irregular octagonal kunḍa

$$\begin{aligned}
 &=14;2,1,1,3,\dots\approx 14;2,1,1 \text{ } \text{aṅgulas.} \\
 P_1Q_2 &=P_2Q_2, \text{ etc.}=\sqrt{P_1P_2^2/2}=\sqrt{14;2,1,1^2/2} \\
 &=\sqrt{203;4,4,0,5,2,1/2}\approx\sqrt{203;4,4/2} \\
 &=\sqrt{101;6,2}=10;0,5,5,\dots\approx 10;1 \text{ } \text{aṅgulas.} \\
 P_1P_4 &=P_1Q_2+Q_2Q_4+Q_4P_4=P_1P_2+2\cdot P_1Q_2 \\
 &=14;2,1,1+2\cdot 10;1=34;4,1,1 \text{ } \text{aṅgulas.} \\
 S_1 &=\text{area of rectangle } P_1P_4P_5P_8=P_1P_4\cdot P_1P_8 \text{ (L 173)} \\
 &=34;4,1,1\cdot 14;2,1,1=492;3,6,6,7,2,1\approx 492;3,6,7 \text{ } \text{aṅgula}^2. \\
 P_1R &=[P_1P_8\pm(P_1Q_1+P_8Q_1)(P_1Q_1-P_8Q_1)/P_1P_8]/2 \text{ (L 165)} \\
 &=P_1P_8/2=14;2,1,1/2=7;1,0,4,4\approx 7;1,0,4 \text{ } \text{aṅgulas.} \\
 P_1R^2 &=7;1,0,4^2=50;7,0,1,0,2,0\approx 50;7,0,1. \\
 P_1Q_1^2 &=10;1^2=102;4,1. \\
 Q_1R &=\sqrt{P_1Q_1^2-P_1R^2}=\sqrt{102;4,1-50;7,0,1} \\
 &=\sqrt{51;5,0,7}=7;1,3,7,1,\dots\approx 7;1,6,4 \text{ } \text{aṅgulas (Gaṇeśa's value).} \\
 S_2 &=\triangle P_1Q_1P_8=P_1R\cdot Q_1R \text{ (L 166)} \\
 &=7;1,0,4\cdot 7;1,6,4=51;4,2,7,3,2,0\approx 51;4,3 \text{ } \text{aṅgula}^2. \\
 (\text{If we use a more accurate approximation } Q_1R &=7;1,3,7, \text{ we have} \\
 S_2 &=51;2,0,1,4,7,4.) \\
 S_3 &=\text{area of } P_1P_4Q_5P_5P_8Q_1=S_1-2S_2 \\
 &=492;3,6,7-2\cdot 51;4,3=389;3,0,7 \text{ } \text{aṅgula}^2. \\
 S_4 &=\text{area of } P_2P_3Q_4Q_2=P_2P_3\cdot P_2Q_2 \text{ (L 173)} \\
 &=14;2,1,1\cdot 10;1=144;3,5,3,1\approx 144;3,5,3 \text{ } \text{aṅgula}^2. \\
 S_5 &=\text{area of } Q_2P_2Q_3P_3Q_4=S_4-S_2 \\
 &=144;3,5,3-51;4,3=92;7,2,3 \text{ } \text{aṅgula}^2. \\
 S &=\text{area of the } kuṇḍa=S_3+2\cdot S_5 \\
 &=389;3,0,7+2\cdot 92;7,2,3=389;3,0,7+185;6,4,6=575;1,5,5 \text{ } \text{aṅgula}^2.
 \end{aligned}$$

Remarks.

- 1) Viṭṭhaladikṣita computes, instead of S_2 , $2\cdot S_2=P_1Q_1^2=102;4,0$ (which should be $=102;4,1$). His value of S is $576;2,0 \text{ } \text{aṅgula}^2$.
- 2) Gaṇeśa, in computing P_1Q_2 , uses the geometrical property that $\triangle P_1P_2Q_2$ is an isosceles right triangle, saying that the property $P_1Q_2=P_2Q_2$ "is observed by means of the direct perception" (*pratyakṣato dr̥ṣyate*). But he does not use the same property in the computation of S_2 . It seems that, to Gaṇeśa, the simpler was not always the better.
- 3) The word *koṇa* occurs three times in this section in the sense of *trikoṇa* or a triangle.
- 4) Requirement for the transformation:

$$a^2=4(\sqrt{2}-1)r^2, \text{ or } r=\sqrt{\sqrt{2}+1}\cdot a/2.$$
- 5) The *Śāradātīlaka* does not prescribe for the *kuṇḍa* of this shape. See Remark 4 of the next section.

get a better result.

2) Viṭṭhaladīkṣita's method (cf. Fig. 8. 2). For the computation of P_1P_2 , he cites a śloka from an unknown source:

candrartunandākṛtibhir vyāsārdhe <ca> samāhate/
khakhakhābhṛāgnisambhakte//
 P_1P_2 etc. = $22961r/30000 \approx 10;7,4,2,3$ *āṅgulas*.

For the computation of S_1 and S_2 , he utilizes the versed sine:

$t = UT = [d - \sqrt{(d + P_2P_3)(d - P_2P_3)}] / 2$ (L 204)
 $\approx 1,0,5,4$ *āṅgulas*.

$P_1P_4 = d - 2 \cdot t = 26;3,3$ *āṅgulas*.

$S_1 = P_1P_4 \cdot P_1P_8 = 288;4,4$ *āṅgula*².

$P_2Q = r - (P_1P_8/2 + t)$
 $= 7;6$ *āṅgulas*.

$S_2 = P_2Q \cdot (P_2P_3 + P_1P_4) / 2$
 $\approx 144;5$ *āṅgula*².

$S = S_1 + 2 \cdot S_2$
 $= 577;6,4$ *āṅgula*².

3) Requirement for the transformation:

$a^2 = 2\sqrt{2} r^2$, or $r = \sqrt[4]{2} a / 2$.

4) The octagonal kuṇḍa prescribed in the *Śāradātilaka*, 3.64–66, is not a regular octagon. See Fig. 8. 3, where:

$EP = a/24$, and

$RQ = RT = (\sqrt{2}/4)a$.

This will make the area,

$S = (133/144)a^2$.

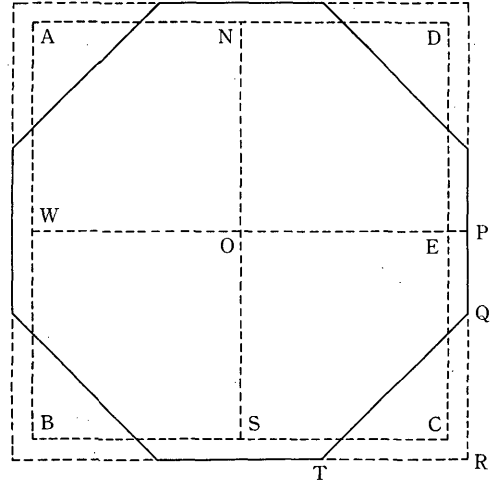


Fig. 8. 3. Octagonal kuṇḍa in the *Śāradātilaka*

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4. Appendix

Maṇḍapakuṇḍasiddhi 31–47 (on Kuṇḍa)

prācyās catuṣkoṇabhagendukhaṇḍatrikoṇavṛttāṅgabhujaṃbujāni/
 aṣṭāsrīśakreśvarayos tu madhye vedāsri vā vṛttam uśanti kuṇḍam//31//
 āśeśakuṇḍair iha pañcakuṇḍi caikaṃ yadā paścimasomaśaive/
 vedyāḥ sapādena kareṇa yad vā pādāntareṇākḥilakuṇḍasamsthā//32//
 viprāc chrutyasraṃ ca vṛttam ca vṛttārdham tryasri syād vedakoṇāni vāpi/
 sarvāṇy āhur vṛttarūpāṇi cānye yonyākārāṇy aṅganānāṃ tu tāni//33//
 siddhiḥ putrāḥ śubham śatrunāśaḥ śāntir mṛticchide/
 vṛṣṭir ārogyam uktaṃ hi phalaṃ prācyādikuṇḍake//34//
 śātārdhe 'ratniḥ syāc chataparimite ratnivitataṃ
 sahasre hastaṃ syād ayutahavane hastayugalam/
 caturhastaṃ lakṣe prayutahavane śaṭkaramitaṃ
 kakubbhir vā koṭau nṛpakaram api prāhur apare//35//
 lakṣaikavṛddhyā daśalakṣakāntaṃ karaikavṛddhyā daśahastakaṃ ca/
 koṭyardhadigviṃśatilakṣalakṣadale munīṣvartukṛṣānuhastam//36//
 vedākṣiṇi yugāgnayaḥ śaśiyugāṇy aṣṭābdhayaś trīṣavo
 'ṣṭākṣā vahnirasā rasāṅgakamitā netrārṣayo 'kṣasvarāḥ/
 aṅgulyo 'tha yavāḥ kham abhram iṣavaḥ kham pañca śaṭ sāgarāḥ
 sapṭābhram munayas tv amī nigaditā vedāsrake bāhavaḥ//37//
 kuṇḍatrayi dakṣiṇayonir aindryāḥ saumyāgrakā syād itarāṇi pañca/
 paścādbhagānīndradigagrakāni yonir na koṇe na ca yonikuṇḍe//38//
 dvighnavyāsaṃ turyacihnaṃ sapāsaṃ sūtraṃ śāṅkau paścime pūrvage 'pi/
 dattvā karṣet koṇayoḥ pāsaturye syād evaṃ vā vedakoṇaṃ samānam//39//
 kṣetre jināmśe purataḥ śarāmśān samvardhya ca svīyaraḍāmśayuktān/
 karṇāṅghrimānena likhendukhaṇḍe pratyak puro 'ṅkād guṇato bhagābham//40//
 svaśatāmśayuteśubhāgahinasvadhārītrīmitakarkaṭeṇa madhyāt/
 kṛtavṛttadale 'grataś ca jīvāṃ vidadhātv indudalasya sādhusiddhyai//41//
 vahnayaṃśaṃ purato nidhāya ca punaḥ śroṇyoś caturthāmśakaṃ
 cihneṣu triṣu sūtradānata idam syāt tryasri kaṣṭojjhitam/
 viśvāmśaiḥ svajināmśakena sahitaḥ kṣetre jināmśe kṛte
 vyāsārdhena mitena maṇḍalam idam syād vṛttasamjñam śubham//42//
 bhakte kṣetre jināmśair dhṛtimitalavakaiḥ svākṣiśailāmśayuktair
 vyāsārdhān maṇḍale tanmitadhṛtaguṇake karkaṭe cendudiktaḥ/
 śaṭcihneṣu pradadyād rasamitagūṇakān ekam ekaṃ tu hitvā
 nāśe sandhyartudoṣāṃ api ca vṛtikṛter netraramyaṃ śaḍasram//43//
 athavā jinabhaktakuṇḍamānāt tithibhāgaiḥ svakhabhūpabhāgahinaiḥ/
 mitakarkaṭakodbhave tu vṛtte vidhudiktaḥ samaśaḍbhujaiḥ śaḍasram//44//
 aṣṭāmśāc ca yataś ca vṛttaśarake tatrādimam karnikā
 yugme śoḍaśakesarāṇi carama svāṣṭatribhāgonite/

bhakte ṣoḍaśadhā śarāntaradhṛte syuḥ karkaṭe 'ṣṭau chadāḥ
sarvām tām khana karṇikām tyaja nijāyāmocakām syāt kajam//45//
kṣetre jināmśe gajacandrabhāgaiḥ svāṣṭākṣibhāgena yutais tu vṛtte/
vidigdiśor antarato 'ṣṭasūtrais tṛtiyayuktair idam aṣṭakoṇam//46//
madhye guṇe vedayamair vibhakte śakrair nijarṣyabdhilavena yuktaiḥ/
vṛtte kṛte digvidiśo 'ntarāle gajair bhujaiḥ syād athavāṣṭakoṇam//47//

(This text is based on the two editions we have consulted. See Sec. 1. 6 above.)

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ガネーシャ作クンダ設営解説

林 隆 夫

ガネーシャ作 Kuṇḍasiddhyudāhṛti 「クンダ設営解説」は、ヴィッタラディークシタ作 Maṇḍapakūṇḍasiddhi 「マンドパとクンダの設営」(A.D. 1619)の中のクンダに関する9詩節に対する、散文による註釈書であり、8種のクンダの面積計算を行なう。

クンダとはある種のヒンドゥー教の宗教儀礼に於て聖火をしつらえるために地面に掘られるくぼみであり、その平面的な形によって8種ある。即ち、正方形、女性生殖器、半円(又は半月)、三辺形、円、六辺形、蓮、八辺形の形をしたクンダがある。しかしすべてのクンダは、その形にかかわらず、個々の儀礼でその火に注がれる油(havana)の回数に応じてあらかじめ決められた面積をもたねばならない。もしも面積に誤りがあると、祭主(yajamāna)に不幸が起こるといわれる。かくして数学的問題が生ずる。即ち、ロープ(sūtra)とコンパス(karkāṭa)を用いて、決められた面積をもつそれらの図形を描くこと。ヴィッタラディークシタは Maṇḍapakūṇḍasiddhi 39-47 でその作図法を与える。一方ガネーシャは、パースカラⅡが Līlāvati (A.D. 1150) で与えた数学公式を用いて、それら得られた図形の面積を詳細に計算し、ヴィッタラディークシタの作図法の妥当性を例証する。

このように Kuṇḍasiddhyudāhṛti は、インドの伝統的数学(gaṇita)が数学や天文暦学以外の分野に応用された極めて興味深い例を我々に提供してくれる。

Text は A.D. 1836 に書写された写本(Government Oriental Manuscripts Library, Madras, D 13403)に基づく。また Commentary では、ガネーシャの面積計算を逐次追跡し、若干の注も加えた。