Ritual Application of Mensuration Rules in India: An Edition of Ganesa's Kunidasiddhyudahrati with Mathematical Commentary

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R ritual Application of Mensuration Rules in India: An Edition of Gaṇeśa’s Kuṇḍasiddhyudāhṛti with Mathematical Commentary

Takao Hayashi*

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ABBREVIATIONS

KSU: Kuṇḍasiddhyudāhṛti of Gaṇeśa.
L: Lilāvati of Bhāskara.
MKS: Maṇḍapakundásiddhi of Viṭṭhaladikṣita.

1. INTRODUCTION

1.1. Kuṇḍasiddhyudāhṛti

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

* Dept. of Mechanical Engineering, Doshisha University, Kyoto.
Viṭṭhalaḍīkṣita’s *Mandapakundasiddhi*, and deals with the mensuration of eight kinds of *kundas*. 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 *Lilāvati* 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 Gaṇeṣa, son of Śrīdhara, in Nandigrāma1) (Nandod, Gujarat) some time between A.D. 1619, when Viṭṭhalaḍīkṣita 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 Gaṇeṣa, who wrote a commentary called *Śiromaniprakāśa* upon the *Siddhāntaśiromani* 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 Gaṇeṣa (born A.D. 1507), who wrote no less than ten works on *jyotiṣa*, including the *Buddhivilāsini*, a popular commentary on the *L* [Pingree 1971: 94–106]. The existence of abundant citations in the *KSU* from the *Lilāvati* shows that our Gaṇeṣa also was versed well in the traditional mathematics, although we cannot trace his lineage beyond his father.

1.3. *Kunda*

*Kundas* 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), *sadasri* (hexagon), *padma* (lotus), and *aṣṭāsri* (octagon). On a certain ceremonial spot, for example, these eight *kundas* are arranged on the eight cardinal points surrounding a central *vedi* (fire-altar). The arrangement in that case starts from the east and proceeds clockwise in the above order; and the ninth *kunda*, which is either *caturasra* or *vṛtta*, is placed in the north-east by east [MKS 31–32].

Every *kunda* 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 *kundas* 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

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1) See the concluding verse of the *KSU* (p. 110 below).
2) See Sec. 3.0 below.
3) Viṭṭhalaḍīkṣita, in commenting upon the irregular hexagonal *kunda* (*MKS* 43), cites a half *slokha*:

\[ \text{mānādhiyake bhaved rogo mānāhine daridratiḥ} \]

(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 (karkata). The nine verses (39–47) of the MKS give a solution to this problem, while Gaṇeṣa carries out computations of the areas of the kundas obtained.

1.4. Place-value system

Gaṇeṣa 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 itself:

1 hasta = 24 aṅgulas,
1 aṅgula = 8 yavas,
1 yava = 8 yūkās,
1 yūkā = 8 likṣās,
1 likṣā = 8 bālagras, etc.

Similar tables are recorded in various works such as the Bṛhatamāhātā [VARĀHAMHĪRA 1968: 57, 1–2], Ganitasarasamgraha [MAHAVĪRA 1963: 1, 25–31], and the Purāṇas. 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 upwards. It may be pointed out in this connection that Gaṇeṣa does not seem to follow any principle when he obtains approximations of fractions: he sometimes carries out his computations down to the fourth place (bālagra) 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

Gaṇeṣa’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];
3) MKS 3–4:

kṛtordhavalōhoḥ samabhūgatasya kartūḥ śarāṃśaḥ prapadocchritasya/
yo vā sa hasta ’syā jīnamsakō ’pi syād aṅgulaṃ tattadibhāmsakā ye//
yavo yūkā ca likṣā ca bālagraṃ caivaṃdayaḥ/
kṛtamūsthī karo ratnir aratnir acaṃtiṣṭhīka//

(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, bālagra, 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.)

4) Vīṇospurāṇa, chap. 101, 115–127; Maitospurāṇa, chap. 258, 17–18; and [ΒΝΟΗΑ 1966: chap. 9, 4–5]. cf. also [KIRPEL 1920: 331].

5) See footnote 4 above.
3) sides of a right triangle (L 136),
\[ c = \sqrt{a^2 + b^2} \] [in Sec. 2]
\[ b = \sqrt{c^2 - a^2} \] [in Sec. 8.2];

4) \( \text{avādhās} \) (L 165) and perpendicular (L 166) of a triangle,
\[ a_1 = \frac{[a - (b + c)(b - c)]}{a}/2 \]
\[ a_2 = \frac{[a + (b + c)(b - c)]}{a}/2 \]
\[ h = \sqrt{b^2 - a_2^2} = \sqrt{c^2 - a_1^2} \]
[in Secs. 6.1, 6.2, and 8.1];

5) area of a triangle (L 166),
\[ S = \frac{ah}{2} \] [in Secs. 2, 4, 6.1, and 8.1];

6) area of a rectangle (L 173),
\[ S = ab \] [in Secs. 1, 8.1, and 8.2];

7) area of an equi-perpendicular quadrilateral (L 173),
\[ S = \frac{h(a + c)}{2} \] [in Secs. 6.2 and 8.2];

8) perpendicular of an equi-perpendicular quadrilateral (L 184),
\[ h = \text{perpendicular of the triangle formed by } b, (c-a), \text{ and } d \] [in Sec. 8.2];

9) circumference of a circle (L 199),
\[ c = \frac{(3927d)}{1250} \] [in Sec. 2];

10) area of a circle,
\[ S = \frac{cd}{4} \] (L 201) [in Sec. 2]
\[ S = \frac{(3927d^2)}{5000} \] (L 203)
[in Secs. 2, 3, 5, and 7];

11) \( \text{sara} \) of a segment of a circle (L 204),
\[ b = \frac{[d - \sqrt{(d+a)(d-a)}]}{2} \] [in Sec. 6.2];

12) sides of circumscribed regular polygons (L 206–208),
\[ a_3 = \frac{(103923d)}{120000} \] (triangle) [in Sec. 6.1]
\[ a_8 = \frac{(45922d)}{120000} \] (octagon) [in Secs. 8.1 and 8.2].

1.6. Editions of the *Māṇḍapakūṇḍaśiddhi*

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 us.\(^7\)

2) As the first work in the *Kundagrāntavimśati*. Bombay 1887.
3) With the author’s own commentary and Mahādevamīrā’s Hindi commentary. Kāśi 1908.

\(^7\) The information given here has been obtained from [RAGHAVAN 1968: 182–183] and [GUPTA 1981: 96].
5) With B. Pathak’s Sanskrit and Hindi Commentaries. Benares: Hitchintak
Press, 1926.
6) With Vāyunandamiśra’s Hindi commentary. Under the title, \textit{Kuṇḍaṃ-
am- đopasiddhi}. Vārāṇasi: Master Khelādlāl Saṃkṣaṭāprasād Saṃskṛt Pustakālaya, 1980 (7th printing; first printing 1936?).

1.7. Manuscript

Government Oriental Manuscripts Library, Madras, D 13403. Title: \textit{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 \textit{Tithinirnaya} (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: sanvāt 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 lamba, bahīḥ, bhṛhat, 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, ārdhva, paryanta, vartate, and varthana. We have also corrected freely irregular samdhī. 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

\(\langle A\rangle\) indicate that A has been supplied by the present editor.
\[A\]\ indicate that A is physically damaged or lost.

2. TEXT: \textbf{KUṆDAŚI/DDHYUDĀḤRTI OF GAṆEŠA}

(1b) śṛigurur jayatitarām/
śṛigaṇeśam mahālakṣmīṁ natvā kurve samāsataḥ/
ganeśābhīdhadaiva[vajñā\(\rangle\) kuṇḍasiddher udāḥṛtim/.

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 “kuṇḍasiddhyudāḥṛti” to be the title of the work on the basis of the expression, “kurve...kuṇḍasiddher udāḥṛtim,” in the introductory verse.
2.1. caturasrakunḍam

dvighnavyāsasam⁹) iti (MKS 39)/
darśanam (See Fig. 1)/
kṣetraphalam adhikṛtyocaye/ tatra
samaśrutau tulyacaturbhuje ca tathāyate¹⁰) tadbhujakotighāta (L 173)
itī bhāskaroktyā/ prakṛte samaśrutitulyacaturbhujasyāsa bhujakoṭī 24/24/
anayor ghāte bhujavarga eva bhavati¹¹) / atas tulyacaturbhuje bhujavarga eva
kṣetraphalam iti tātparyārthaḥ/ sthāpyo 'ntyavarga (L 19)
ityādinā tathā kṛte sati jātam ekahastakṣetraphalam 576) /

2.2. yonikuṇḍam

atha yonikuṇḍam āhā/

kṣetra jināṁśe purataḥ¹²) śaraḥṃśān iti (MKS 40)/
atra jināṃśa¹³)-24-kṣetrasya śaraṁśā 5 ete sviyadāṁśaṅgulādyenānena¹⁴)
0/1/2 yutā jāta ekahastayonikunḍe vardhanāṅkaḥ 5/1/2/ ayam eva dyādiguṇaḥ
san dyādihaste bhavet/ evaṃ sarvatra/ darśanāṃ yathā (See Fig. 2)/

atra kṣetraphalam/ ata pūrvāgrād yāmyottararekhāprāṇātadyagātisūtra-
dvayothham¹⁵) ekām tribhujam/ bhūmis tu yāmyottararekhāva/ tathā yāmyot-
tarasūtrāgrāt pūrvāparakhāpaścīṃtāntagātisūtra-dvayothham¹⁶) aparām/ (2a)
vrīttārdhadavyābhīyāmaṃ ekac vṛttam ca/ evaṃ kṣetra-drayam/
pūrvāparayāmyottararekhāsaṃpātād¹⁷) urydh<yam caturasrapūrvabhuja-
vadhī prāgaparakhāhamānam aṅgu<andāya ityadina yam eva 6/5/1/2/ yutam
jāto labdhhaḥb> 17/1/2/

lambuṇām bhūmyardham spaṣṭaṃ tribhuje phalam bhavatīti (L 166)
bhāskaroṣṭī bhūmyardham 12 lambena nighnaṃ jātām uparitryasraksētra-
phalam 205/7) athādaḥāsthakṣetraphalam¹⁹)/ tatra yāmyottara-prāgapa-
sūtrasāmpātād²⁰) adhāṣaṭuṣaṛasya pācimabhūjāvadhi pūrvāparakhāhamānam
ah< (gūlānya) 12/ ayam eva dhāvasthasyayā) 21) lambah/ bhūmyardhaṃ²²) tad eva
12/ atrāpi

lambuṇām (L 166)

ityādinā kṣetraphalam 144)/ atha vrīttārdhadvyayaphalam/ tatra
vrīttāksētṛe paridhi-gunitavyāsāpādaḥ phalam (L 201)

ityādinā phalānayanārthaṃ paridhi-vyāsaṣajñānāya prāgaparayāmyottararekhā-
sāṃpātāc²³) caturāsraya yāmyabhūjāvadhī athṛottara-bhūjāvadhī yāmyottar-
sūtra-tramānaṃ eko bhujah/ tannānaṃ yāmyottarāsātra-vratyām aṅgulāni
12/ evaṃ ca tasmāt sāṃpātāc²⁴) caturbhujasya pācimabhūjāvadhī pūrvāpa-

9) nyāsām in the ms. 10) tathāyane. 11) ṇamati. 12) tu paraḥ for purataḥ. 13) jināṃśā.
14) -āngulodinanena. 15) -dvayordham. 16) -dvayocham. 17) -sayāṇād for -sāmpātād
18) 20/5/7. 19) athādaḥśra for athādaḥaṃṭha. 20) -sāmpādanād. 21) evādhasrasya.
22) Inserts pari before tad. 23) śayānāc. 24) sāmpānāc.
rarekhāmānam 12 aparō bhujāḥ/ saiva koṭiḥ 12/ vṛttārdhapāntadvayāgā-
mibhujākoṭiprāntasṛketirākṣādūtraṁ karnaḥ/ evam jāṭaḫ m ca
caturbhujaṁtāḥpā-
tīrtyasyaṁ/ tatra karnaṁjñānāः(2b)ya
tātkṛtyor yogapadaṁ karna (L 136)
iti bhua-12-koṭi-12-vargayor 144/144 yogo 'yam 288/ asmāt
tyakvā (L 22)
itiyādnā padam jāṭaḥ karnaḥ 16/7/6/1/26) ayam evoddiṣṭavṛttakṣetre vyāsaḥ/asmāt paridhyānayanam
vyāse bhanandāgniḥata (L 199)
itiyādnā/ vyāsaḥ 16/7/6/1/ ayaṁ bhanandāgni-3927-hataḥ 66643/7/4/728) khabānasūrya (28)-1250-bhakto jāṭaḥ paridhiḥ 53/2/4/ ataḥ param kṣetraphalā-
nyayanam
vṛttakṣetre paridhigunitavyāsāpādāḥ (29) phalam (L 201)
itiyādnā/ paridhīnāṁ gomūtrikāya (31) guṇito vyāsaḥ 904/6/ asya caturthaṁō(o) jāṭam uddiṣṭavṛttakṣetre phalam 226/1/4/ eva<ṃ> trayāṇāṁ yoge jāṭam ekahastayonikunḍe kṣetraphalam 576/0/4/ (32)
ātavā
yāsasya varge bhanavāgīnīghna (33) (L 203)
itiyādnā vṛttakṣetre phalam/ tatra vyāsaḥ 16/7/6/1/ asya vargaḥ 288/0/0/2
bhanavāgni-3927-gunah 1130991/2/5/634) paṇcasahasrabhakto jāṭam kṣetraphalām tad eva 226/1/4/ (35)
ātra likhyācatuṣṭayas adhikam tan na doṣāya/ uktaṁ ca
svalpāntaratvād avahūya yogād
iti vacanat/ iti yonikūṇḍam//

2. 3. ardhacandrakunḍam
athārdhavalayam/
svaṣātaḥ(ṃ)sayuteśubhāgahīneti (MKS 41)/
ātṛāpi jināṁśakṣetrasveṣyamsā(h) 4/6/3/1/5/ (37) ayaṁ svāṣātaṁśena 0/0/3/0/4
yutaḥ 4/6/6/2/1/ anenaiva dharitīrī 24 hinā (3a) 19/1/1/5/7/ anena vyāsārdhena
“madhyāṅ(ṇ)” nāmā pūrvaparadakśotpottara<śūtra>sampātāt “kṛtvāttradale 'grato” “jivā(ṃ) vidadhātv indudalāṁ” bhavati/ darśanam (See Fig. 3)/
vyāsārdhāṁ dvighnaṁ (38) jāto vyāsaḥ 38/2/3/3/6/ vyāsasya vargaḥ 1467/1/5/4/38) bhanavāgīnīghna(h) 5761740/1/6/4/5/ (40) ayaṁ paṇcasahasrabhakto jāṭam vṛtte phalam 1152/2/6/2/ etad vṛttakṣetraphalam/ asyārdham jāṭam
vṛttārdhakṣetraphalam 576/1/3/1/)/

2. 4. tryasrakunḍam
atha trya(sra)kundam/

25) panktām for tyaktvā. 26) 16/7/6/11, corrected. 27) va- for bha-. 28) 6642/5/5.
29) -vāna- for -bāna-. 30) guṇitaḥ vyāsāpādaḥ. 31) gomūtrikāya. 32) 516/0/4.
33) -hata for -nighna. 34) 1130990/0/5/16. 35) 2/6/1/41. 36) -bhāgeśv 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.
vahvamiśām(41) purato nidhāyeti (verse 42ab)/
aatra kṣetraphalam/ tatra caturvimsāṅgulātmake madhyasūtre vahvamiśām(41)
aṣṭāṅgula(42)nī samyojya jāto lambāḥ 32/ caturasrapecialmabhuh 24 caturth-
āṃśadavayaṁ saṣṭāṅgulātmake samyojya jāta bhūḥ 36/
lamba(43)-32-guṇaṁ bhūmyardhaṁ <1>8
spaṣṭāṁ tribhuhu phalaṁ bhavattiti (L 166)
jātaṁ kṣetraphalam 576//

2. 5. vṛttakundam
atha vṛttakundam/
viśvāṁśaṁ svajināṁśakena sahitair iti (MKS 42cd)/
aatra caturvimsāṅtidhābhaktakṣetrasya trayodaśāṁśāḥ 13/ ete svajināṁśakenān-
kenāṅgulādyena(45) 0/4/2/5(346) sahitā jātaṁ vyāsārdham 13/4/2/5/3/ anena
vyāsārdhena sampātāt kṛte vṛtte vṛttakundam(45) bhavati/ darśanam (See Fig. 5)/
kṣetraphalam vyāsārdham driguṇaṁ 27/0/5/<35b>2/6/ vyāsasya varge
733/4/146) bhanavāgniṁighne 2880516 pañcasaahasrabhakte jātaṁ kṣetraphalam
576/0/6//

2. 6. 1. viśamaśādasrikundam
atha śādasrikundam/
bhakte kṣetre jināṁśair dhṛti(m)italavakaiḥ
svākṣiśailāṁsyayuktair iti (MKS43)/
aatra jināṁśakṣetrasya dhṛtyaṁśāḥ(47) 18/ ete svākṣiśailāṁśena 0/2 yutā jātaṁ
vyāsārdham 18/248)/ anena vyāsārdhena kṛte maṇḍala “indudiktāḥ”49)/
tenavia vyāsārdhamitakarkṣatenendudiktāḥ50) kṛtaṣṭcihnēṣv ekam ekam hitvā
sūtraṁ dadyāt/ madhyamgadosaṁ nāse “netraramyāṁ śaḍasaṁ” bhavati/
tathā kṛte sati darśanam patrapraṭhe (See Fig. 6.1)/

atra mahattrikonaḍavayaṁ nispānam/ tad yathā—ekam uttarāgram anyad
daksinaṁagram/ uttaradikto vahnidikparyantam(51) eko bhujāḥ/ evam cottar-
dikto nairṛtīṁ yāvad aparāḥ/ nairṛtīṁ ārabhyāṅgeyin(48) yāvat trītiyāḥ(52)/
uttarāgrād ārabhya trītiyabhujaparyantamadhyasūtraṁ lambāḥ/ evam eva
digvaiparytenāparam/

tatradāu53) vṛttāntastraḥbhujasya bhujajñānam/ vṛttavyāse 36/4 “tridvyān-k-
āṅginaḥsāndraṁ”54) hate 3793189/455) “khakhahāhārāsaṁbhakte”
(L 206–208) jātaṁ trayāṁśāḥ bhujāṇāṁ māṇām 31/4/7/ atra trītiyabhujāṁ

(41) vahvamiśām. 42) lambāḥ. 43) -āṅgulodīna. 44) 02 for 2. 45) vṛttam kundam.
46) I for 7. 47) dhṛtyaṁśāḥ. 48) 180/2/0. 49) -diksū, corrected in margin.
50) -mitarkaṇṭendudikṣū, corrected in margin. 51) vahir- for vahni-. 52) trītiyāḥ.
53) Here is mistakenly repeated a long passage, which actually belongs to the next section (2.6.2).
The repetition begins: ‘‘rekhādvayaṁ kuryāt’’; and ends: ‘‘phalāṁ tad eva’’. The words, “rekhā” and “phalāṁ tad eva”, have been encircled.
54) -āṅgir nabha-. 55) 1793/89/4.
bhūmiṃ prakalpīyānau bhujau bhujāv iti prakalpīyā lamba āniyate/ "tribhūje bhujayor yogāḥ 63/1/6 tadantaragūṇo 0/0 bhuvā 31/4/7 hṛtāḥ” (L 165) phalam 0/0/ labdhena65 bhūr dvīṣṭ(ḥ) aikatronā 31/4/7 ‘nyatra yutā 31/4/7 dalitā jāte67 āvādhe 15/6/3/4/ svāvādhiḥkṛt(ḥ) 249/6/2/3/ bhujā-31/4/7-kṛtiḥ 999/1/6/158/ antaram 749/2/7/3/159/ mūlam jāto lambā 27/3/0/ ayam catutṛṭhāṃśo vyāśa eva lamba iti siddham/ lambena 27/3/0 bhūmyardham 15/6/3/4 gunītaṃ jā[ta](4)bṃ uddīṣṭa triyābhuje kṣetre phalam 432/5/5/ athāsya mahattriyabhuṣya triṣṭv api bhūjeṣu tṛṇi tryasraṇi baihīṣaṅgrāṇy60 eva lagnāḥ santi/ ekam uttarato ‘gnidīggāṃbhujalagnāṃ dvitiyam uttarato nirṛtiddīggāṃbhujasaktam triyāṃ nairṛtiddikto ‘gnidīggāṃbhujasamālagnam/ tatraikasya tribhujasya phalam āniya triguṇam vidhāya pūrvapahale sāṃyojya kṣetraphalām syāt/ tatra triyābhuje mahattriyabhuṣyalambād bahirbhūtaṃ vyāsaturīyakahandha-ṃ lamparītam prayākṣato dṛṣṭaye ‘to vyāsacaturṭhāṃśo laghutribhūje lambāḥ 9/1/0/ bhūmis tu mahattriyabhusya triyāḥbhuratriyāṃśah/ yato mahattriyabhusya triyāḥbhūtāṃ yal laghutribhūjaṃ tasya da[kṣ]-[n]āṃ nirṛtāu bhujāvayaprāntau mahattriyabhusya tredhāvibhaktasya madhyākhaṇḍaprantalagnau prayākṣato dṛṣṭye a[tah] sa eva bhūmiḥ/ tanānāṃ 10/4/2/261/ atrāpi lambena 9/1/0 bhūmyardham 5/2/1/1 gunītaṃ jātam baih[rbh]jūṭatribhūje kṣetraphalam 48/0/4/262/ trayāṇāṃ tribhujānāṃ samatvāna63 idiṃ triguṇam 144/1/4/6/ (5a) idiṃ pūrvapahale ’smin 432/564) yojitaṃ 576/6/564/6) pūrṇaṃ phalam// 2. 6. 2. samāṣadāsrikūṇḍam atha prakārāntareṇa ṣaḍasrikūṇḍam ucyate/ athāvā jinabhaktakūṇḍamānād iti (MKS 44)/ jinabhaktakūṇḍamānasya tithiḥhāga(ḥ) 15 svā-15-khaḥūpa-160-bhāgena 0/0/6 hīnaḥ 14/7/2/ jātam vyāsārdhamān65 14/7/2/ anena kṛte ‘vṛtte vidhūdiktaḥ samaṣadbhūjah āṣaḍsram jātam darśanāṃ ca (See Fig. 6. 2)/ atra pūrvāparam parparsaṃlagṇāṃ viṣamacaturbhujadvayam dṛṣṭaye/ atra vyāsaturīyā bhūḥ 29/6/4/ mukham tu pūrvāpararūpam vyāsārdhatulyam 14/7/2/ yato yena vyāsārdhena vṛttam kṛtam tenaiva vyāsārdhena vidhūdiktaḥ samaṣadbhūjaḥ āṣaḍsram jātam āniya lambāṃ samāṣadāsrikūṇḍam ucyate/ atra vyāsaturīyā bhūḥ 29/6/4/ mukham tu pūrvāpararūpam vyāsārdhatulyam 14/7/2/ yato yena vyāsārdhena vṛttam kṛtam tenaiva vyāsārdhena vidhūdiktaḥ samaṣadbhūjaḥ āttāḥ saṇty ato vyāsārdhatulyamān66 mukham eko bhujā kalpitāḥ/ lambaḥ(ḥ) svamukhād67 yāmyottararekhhavādhiḥ/ athā68 mukhād bahir bhūtaṃ69 yad vyāśārdhahandhaḥ śarārūpam dhanuravadhi70 vartate tanānāṃ āniya vyāśārdhād apanīya lambāṃ samāṣadāsrikūṇdaṃ vṛttam lambaṃ āniya lambāṃ syāt/ tadānanaṃ vṛttam jāya-vyāśayogāntaretī (L 204)/ jyā-14/7/2-vyāśa71-29/6/4-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) -sāṭany. 61) 0/4/2/3. 62) 3 for 2. 63) samātvāṇa. 64) 3 for 2. 65) māsārdham. 66) vyāśārdhād tulyam. 67) sumukhād. 68) atatha, ta deleted. 69) varhir, first r deleted. 70) -āvadhīr. 71) vyāśa. 72) ntara.
6/4/ vyāsāḥ 29/6/4 tadūnaḥ 4/0/0 da(5b)litāḥ 2/0/0 śaraḥ syat/ anena śareṇa vyāsārdham 14/7/2 hīnaṃ jāto lambaḥ 12/7/2/ "caturbuḥhe 'nyatra smaṇala-mbe lambena 12/7/2 nighnam ku-29/6/473)-mukhai-14/7/2-kyya-44/5/6-

khaṇḍam" (L 173) 22/2/774) nighnam <2>88/4/5 jātam ekaviṣmacaturbuḥhajasya kṣetraphalam/ divigunam 577/1/1/ evam ekahasta ekāṅgula<m> 1 ekayaśa čantaraṃ patatti śthulam//

athavordh(v)asthabhujasampādatadvayād adha|h>sthabhujasampādatadvayāvadhi pūrvāparam rekhādvayam kuryāt/ evaṃ kṛte sati caturbhujasya yāmyottaram bhujādvayam parimṛtya vyāsasya catvāri khaṇḍāni smaṇanāntaraṇī jāyante/ tayo rekhayor yad yāmyottararekhāyā saha sampādatadvayam tasmād yad yāmyottarabhujasampādatadvayāvadhipad yad vyāsatoryakhāṇḍāmānaṃ sāvādhā 7/3/5/ yāmyottaragatavyāsāgrāniḥśrītam vyāsārdhāmānaṃ bhujādvayam karṇa-
rūpam bhūjaḥ 14/7/2/ tataḥ
svāvādābhujakṛtyor antaramūlaṃ praǰāyaṃ lamba (L 166)
ity anenāpi sa eva lambaḥ 12/7/2/ evaṃ lambam āṇiya
caturbuḥhe 'nyatra (L 173)
ityādinā phalāṃ tad eva 288/4/5//

2. 7.  padmakūṇḍam
atha padmakūṇḍam āha/

aṣṭāmśaṃ ca yata itī (MKS 45)/
kṣetrasyaśṭamāṃsā(6a)vrddhyā caturasrāntārāptavṛttacatuṣṭayamaṃ75) kuryāt/

paṇcamāvrṛtaṃ svasyāṣṭatri|m>śāṃśena76) 0/0/5 unitena pūrvavyaśārdhena77)
14/7/3 vṛttam kuryāt/ darsanāṃ ca pūrvapate78) (See Fig. 7)///

atha kṣetraphalānayanam/ tatra caturthavṛttavyāsāḥ 2479)/ asmad
vyāsasya varga (L 203)
ityādinā jātaṃ caturthavṛttiṃ kṣetraphalam 452/3/1/ paṇcamāvrṛtavyāsāḥ
29/6/6/ asmad api
vyāsasya varga (L 203)
ityādinā kṣetraphalam 699/4/1/ anayor antarārdham 123/4/4 pūrvakṣetraphale
yojitam athāvā paṇcamāvrṛtakṣetraphale hīnaṃ jātaṃ kṣetraphalam 575/7/5/
yūkāṭrayi namati na dosāya//

2. 8. 1.  viṣamāstārikūṇḍam
athaḥstārikūṇḍam āna/

kṣetre jīnāṃśa80) itī (MKS 46)/

jīnaṃṣakṣetrayāṣṭādasāṃśaiḥ81) 18 "svāṣṭadvidbhāgena82) 0/5/1/1 yutaiḥ”
18/5/1/1 anena vyāsārdhena krṭ(े) "vṛte vidigdisōr antarato 'ṣṭasūtras
trīyayuktaikaḥ" nāma cihnadvaṃ vijāhā trīyayuktair arthāc caturthayuktair

73) 2/9/6/4. 74) 22/7/2. 75) caturasramanyāpta-. 76) -śāṃśena, first na deleted.
77) kunitena 2/7/3 yutapūra- for unitena pūra-. 78) sūrya- for pūra-. 79) 14.
80) jīnaṃśa. 81) -dagaingati. 82) svastadvi- for svāṣṭadvi-.
Ritual Application of Mensuration Rules in India

ity artha/

atha kṣetraphalam/

tatra vyāsārdham 18/5/1/1 (6b) dvigunam jāto vyāṣāh 37/2/2/2/83) "dvidvi nandesuṣaṇāraḥ(84) 45922 vṛttavyāṣe 37/2/2/2/83) samāhate(85) 1712(2)>08/7/4/486) khakhakhābhūraṃ-120000-sambhakte(87) (L 207-208) labdhham aṣṭānāṃṣasaptābhradbhuhjāmanāṃ 14/2/1/1/ atra pūrvapara-

yāmyottararekhādvayacatūḥsāmpātān mahyhe bhṛdhbhujatūlyam samacaturbhuj-

ām nispannam/ tasya yāmyottaransanmukham(87) yat(88) pūrvvāsāṃcaibhuj-

dvayam tadagrā<d> vṛttasampātāvadhi yad rekhākhandam tadyojitam(89) daṃśinottarāyataṃ koṭidvayam jāyate/ tadrekhākhandānayanārtham upāya(h)/ aṣṭāsṛabhujah karṇah(90)/ tadagrān madhyacaturbhujasya koṇāvadhī niyāmānā rekhā koṭiḥ/ caturbhujakonāsaktotyagrāt karṇasāya dvitiyaprāntagāṃsīttrām bhujah/ bhujaktoyoḥ(91) (sa)māṇa(tva)m pratyakṣato drṣṭaye/ bhujaktoyora yo vargayogaḥ sa karnavarga iti ganite pratipāditam/ tasmāt karnavargād ekasya varge ’panite(92) ’nyataro ’vāṣiṣyate/ tasya mulaṃ bhujakotimānaṃ syat/ prakṛte bhujaktoyoḥ samānānātāṃ karnavargārdhamūlam eva bhujako(7a)tīmānaṃ syat/ tasmād aṣṭāsṛibhujatūlyasya karṇasya 14/2/1/1 vargo ’yam 203/4/4/ ardhham 101/6/2/ asmāt phalāṃ jātāṃ bhujakotimānaṃ 10/1/8/ etad eva pūrvodīṭaśkekḥkhandam/ idam uḍḍiṣṭamadhyāstacaturbhujasya yāmyottara-

dīnāmukhaḥpūrvvāśicibhujaprāntayor yojoṃ/ ato dviguṇaṃ vidhāya 20/2 madhyacaturbhujasyaśtāsṛibhujatūlyasya pūrvvāśicibhujayoyoḥ 14/2/1/1

yojitam jātataṃ daṃśinottaradīnāmukhaṃ koṭidvayam 34/4/1/1/ ubhayapārśve ’ṣṭaśrībhujah bhujah 14/2/1/1/ evaṃ jātāṃ yāmyottarāyataṃ ayatacaturbhujam/ asya bhujaktoyora hananām “tathāyate” (L 173) syād iti jātataṃ kṣetraphalam 492/3/6/7/ asmād ayatacaturbhujāntahpāṭidāṃśinottaraprāṇavadyavasthiibhuj-

dvayasya phalāṃ aṇiṃaḥ śodhyam/ tatra kṣetradāsanaṃ yathā (See Fig. 8. 1)/ mahābhujah bhujah 14/2/1/1/ pūrṇaḥdīṭaśkekḥkhandadvayam bhujadīvayam/ asya kṣetraphalānayanam/ “tribhūje bhujayor yogah 20/2 tadantaragun(ο) 0/0 bhuvā 14/2/1/1 hṛtaḥ” phalām 0/0/ labdhena(94) “dvīṣṭḥ(ḥ)ā bhūr unayuta
dalitā” (L 165) jātāvadhāḥ 7/1/0/4/89(7b) avādhaḥkriṭiḥ 50/7/0/1/ bhujakriṭiḥ 102/4/1/1/ etayor antaraṃ 51/5/0/7/ mulaṃ jāto lambah 7/1/6/4/ “lambagu-

naṃ bhūmyardham 7/1/0/4 spaśṭam tribhūje phalām” (L 166) 51/4/3/ etad
dvigunam jātataṃ ubhayātibhujaphalam 103/0/6/ evaṃ pūrvvaphalād asmāt 492/3/6/7 śodhitaṃ jātataṃ 389/3/0/7/ asmin pūrvvāśicimaktoyoḥ pratyekam
samāṅkonaḥdadvayasya(96) phalām aṇiṇa yojoṃ/ tatphalānayanam yathā/ mahābhujah bhujah/ pūrvvāśicimarekhākhandam koṭiḥ/ evaṃ evaṃ param

bhujakotiḥdvayam/ evaṃ militvā jātataṃ ayatacaturbhujam/ bhujaktoyora hananāṃ “tathāyate” (L 173) syād iti jātataṃ kṣetraphalam 144/3/5/3/ asmāt pūrvvātibhujaphalam etad 51/4/3 śodhitaṃ jātataṃ koṇadvayaphalam 92/7/2/3/ etāvad evaṃparakoṇam(97) ato dviguṇaṃ etat 185/6<6>/4/6/ idam pūrvvaphalē 83) 27 for 37. 84) dvigu- for dvidvi-. 85) samāhate. 86) 3/5/8 for 7/4/4. 87) -sasan- for -san-. 88) yataḥ for yat. 89) Inserts sa after tam. 90) karṇaḥ. 91) -koṭyor. 92) ‘paniye. 93) 10/1/0. 94) labdhā. 95) 6 for 0. 96) -dvayyoḥ. 97) konar.

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smin 389/3/0/7 yojitaṃ jātaṃ pūrṇaphalam\(^{98}\) 575/1/5/5//

2. 8. 2. samāṭṣārikunḍam

“athvāṣṭakonāṃ”

madhye ṣūṣṭe vedayamair iti \( (MKS 47) /\)

śākramāṣaḥ \( <14>/\) ete “nīṁṣaṝṣadvadhi-47-lavena”\(^{99}\) 0/2/3/0 yuktā jātaṃ
yāśārdham 14/2/3/ anena caturasramadhyāt krte vṛṭte yathoktadiśāstā(8a)sri
syāt/ darṣanaṃ pataṇprśṭhe (See Fig. 8. 2)\\

atra “dvīdvinandaṃsāgaraiḥ” “vṛttavyāṣe 28/4/6 samāhaṭe 1313082/1/4\(^{100}\)
khaṅkhāṅkhāṅhāṅrākisasambhakte” \( (L 207-208) jātaṃ aṣṭāsribhujamānaṃ 10/7/4/2/\)
atra yathāvatra\(^{101}\) teṣu bhujēṣv ekabhujasyōdbhayaprāntā\(^{102}\) sanmukhāparabhu-
jaṃprāntadvayāṃ yāvan niyāmānaṃ suṭradvayāṃ kuryāt/ evaṃ krta
āyatacaturbhujam pārśvayor viṣamacaturbhujayutam\(^{103}\) jāyate/ tattrayatac-
urhajam tu tribhujadvayakarnasāmyogajanyam\(^{104}\)/ prakṛta āyatacaturbh-
jasyā vṛttavyāṣaḥ\(^{105}\) karnaḥ 28/4/6/ aṣṭāsribhujō bhujāḥ 10/7/4/2/ tatra\(^{106}\)
dōkārnavargayo(r) vivarān mūlaṃ koṭiḥ \( (L 136) /\)

ity uktaṭvāt karnavargō ‘yaṃ 757/4/6 dorvargāḥ ca \( <1>/19/5/5/6/\) anayor antaram
637/7/0/2\(^{107}\)/ asmān mūlaṃ jātā koṭiḥ saivāyatacaturbhujē jīneyā 25/2/1/
tathāyate tadbhujakotīṣṭhāta \( (L 173) /\)

ity krte jātaṃ āyatacaturbhujapalām 276/3/4/ atha viṣamacaturbhujasyā/
tattrayatacaturbhujakoti(r) bhūḥ 25/2/1/ aṣṭāsribhujō mukham 10/7/4/2/
etattulyam evāparam/ bhujadvayāṃ bhūprāntadvayalagnāṃ/ evaṃ viṣama-
caturbhujāṃ/ tatra\(^{106}\) lambānayanāṃ

samānamālaṃsaya caturbhujasyā
mukhonabhumīṃ parikalpya\(^{108}\) bhūmīm/

bhujō bhujō tryasravad eva sādhye

tasyāvadhe\(^{109}\) lambamitis tataś ca// \( (L 184) /\)

uktavaj\(^{110}\) jāto lambāḥ 8/2/3/2/
lambena nighnaṃ kumukhaikyakahāṇḍam \( (L 173) /\)

ityādina jātaṃ kṣetrapalāṃ \( <1>/50/2/1/4/\) etad evāparaviṣamacaturbhujasyāto
dvighnam etat 300/4/3 pūrvāṇīyaṭacaturbhujaphalena yutam jātaṃ
kṣetrapalām 576/4/3/\]

ganaṃṣaḥ śīdharaṣuto nandigrāmanīvāsakaḥ/

subodhārtham kṣetravidām akarod ganitaṃ sṛṣṭāṃ Terrace to spṛṣṭaṃ//

saṃvat 1894 āśvinakṛṣṇā 14 maṅgalavāra// srī //

\(^{98}\) pūrvaphalam. \(^{99}\) laṃvena. \(^{100}\) 57 for 82. \(^{101}\) yathāvadat, da deleted.
\(^{102}\) ekamabhūja- for ekabhūja-. \(^{103}\) -bhujāṃ yutam. \(^{104}\) -jaṁnyaṃ.
\(^{105}\) vṛttayaḥ vyāśaḥ. \(^{106}\) 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 kunda 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 kundas prescribed by Viṣṭhaladikṣita (MKS 35). He also mentions others’ opinions (MKS 36).

<table>
<thead>
<tr>
<th>Number of oblations</th>
<th>Area of kunda</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>1 square aratni</td>
</tr>
<tr>
<td>$10^2$</td>
<td>1 square ratni</td>
</tr>
<tr>
<td>$10^3$</td>
<td>1 square hasta</td>
</tr>
<tr>
<td>$10^4$</td>
<td>2 square hastas</td>
</tr>
<tr>
<td>$10^5$</td>
<td>4 square hastas</td>
</tr>
<tr>
<td>$10^6$</td>
<td>6 square hastas</td>
</tr>
<tr>
<td>$10^7$</td>
<td>8 or 10 or 16 square hastas</td>
</tr>
</tbody>
</table>

The square-shaped kunda is the basis of the construction of kundas of other shapes; in other words, the rule for drawing a kunda, except for the square kunda, is given in terms of the side of the square kunda 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 kundas of any size, though Gaṇeśa only deals with ekahastakundas or kundas of one square hasta, except in one place (Sec. 2.2) where he makes an erroneous statement about yonikundas of other sizes (see Sec. 3.2, Remark 1).

Viṣṭhaladikṣita gives in advance the sides of the square kundas of one square hasta to ten square hastas (MKS 37).

<table>
<thead>
<tr>
<th>Area of square kunda</th>
<th>Side (a)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 square hasta</td>
<td>24 angulas 0 yava</td>
</tr>
<tr>
<td>2 square hastas</td>
<td>34 angulas 0 yava</td>
</tr>
<tr>
<td>3 square hastas</td>
<td>41 angulas 5 yavas</td>
</tr>
<tr>
<td>4 square hastas</td>
<td>48 angulas 0 yava</td>
</tr>
<tr>
<td>5 square hastas</td>
<td>53 angulas 5 yavas</td>
</tr>
<tr>
<td>6 square hastas</td>
<td>58 angulas 6 yavas</td>
</tr>
<tr>
<td>7 square hastas</td>
<td>63 angulas 4 yavas</td>
</tr>
<tr>
<td>8 square hastas</td>
<td>66 angulas 7 yavas</td>
</tr>
<tr>
<td>9 square hastas</td>
<td>72 angulas 0 yava</td>
</tr>
<tr>
<td>10 square hastas</td>
<td>75 angulas 7 yavas</td>
</tr>
</tbody>
</table>

3.1. Square kunda (MKS 39: Fig. 1)

\[ S = a^2 \ldots (1) \]
3.2. *Kunda* shaped like a vulva (*MKS* 40: Fig. 2)

\[
E_{P} = \left(\frac{5a}{24}\right) \cdot (1 + 1/32) \ldots (2)
\]

*a\=1 hasta\=24 a\n\g{\u{a}}ngulas: \ E_{P} = 5 + 5/32 = 5;1, 2 a\n\g{\u{a}}ngulas.

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

\[
O_{P} = 12 + 5;1,2 = 17;1, 2 a\n\g{\u{a}}ngulas.
\]

\[
S_{N} = 24 a\n\g{\u{a}}ngulas: \ S_{N} = \triangle PNS = (1/2) \cdot 24 \cdot 17;1, 2 \ (L 166)
\]

\[
=205;7 a\n\g{\u{a}}ngula^{2}.
\]

\[
O_{W} = 12 a\n\g{\u{a}}ngulas: \ S_{W} = \triangle WNS = (1/2) \cdot 24 \cdot 12 \ (L 166)
\]

\[
=144 a\n\g{\u{a}}ngula^{2}.
\]

\[
d = N_{W} = S_{W}
\]

\[
= \sqrt{O_{N}^{2} + O_{W}^{2}} = \sqrt{O_{S}^{2} + O_{W}^{2}} \ (L 136)
\]

\[
=\sqrt{12^{2} + 12^{2}} = \sqrt{288} = 16; 7, 6, 0, 7, \ldots \approx 16; 7, 6, 1 \ (L 22).
\]

\[
=3927 - d/1250 \ (L 199)
\]

\[
=3927; 16; 7, 6, 1/1250 = 66643; 7, 4, 7/1250
\]

\[
=53; 2, 4, 1, \ldots \approx 53; 2, 4, a\n\g{\u{a}}ngulas.
\]

\[
S_{3} = \text{sum of the areas of two semicircles } N_{A}W \text{ and } S_{B}W
\]

\[
= cd/4 \ (L 201)
\]

\[
=53; 2, 4;16; 7, 6, 1/4 = 904; 6, 0, 0, 2, 4/4
\]

\[
\approx 904; 6/4 = 226; 1, 4 a\n\g{\u{a}}ngula^{2}; \text{ or}
\]

\[
S_{3} = 3927d^{2}/5000 \ (L 203)
\]

\[
=3927; 16; 7, 6, 1^{2}/5000 = 3927; 288; 0, 0, 2, 3/5000
\]

\[
\approx 3927; 288; 0, 0, 2/5000 = 1130991; 2, 5, 6/5000
\]
Remarks.
1) Having obtained $EP=5;1,2$ for $a=1$ hasta, Gaṇeśa remarks: ayam eva
dvyādigunāṇaḥ san dvyādihaste bhavet/ evaṁ sarvatra/ “This (i.e. 5;1,2), when
multiplied by two etc., would be <the value of $EP$> in the cases of <kunda> of two
square hastas etc. So is it everywhere (i.e. for kunda of any shape).”
This statement is of course wrong because what are doubled, tripled, etc. in
two square hastas etc. are not their lines but their areas.
2) The excess 0;0,4 in the area $S$ is designated  “likhyacatustaya (=liksa-)” by
Gaṇeśa, but it should be  “yakacatustaya”. On the other hand, Viṭṭhaladikṣita, having obtained $S=576;0,4,5$ (83=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 yākās.
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 ganitānabhiṇjas tena caturasram kundam taṇḍulādinā pūrayitvā tān eva
taṇḍulān yonyādikunḍeṣu dattvā tatpārtuḥ toṣṭavam iti/ atrāṅgulayāvayū
kālikṣāḥ kṛtvā gomūtrikādirityā guṇayitvāṣṭabhir bhāge grhite phala upary
upari ca yojyamāne phalāny utpadyante111//

One who does not know mathematics should be satisfied when kunclas beginning with the one
shaped like a vulva are filled with exactly the same grains of unhusked rice and so on that
a square kuncla <of the same size> has been filled with. Here, when one has multiplied <the
numbers> arranged <in the places of> aṅgula, yava, yākā, and likṣā <severally> in the manner of
gomūtrikā (lit. urine of a cow) etc., divided <each product> by eight, and added each quotient
to the next higher place, the <true> results <for each place> are produced.
4) Requirement for the transformation. The transformation has to keep the
area unchanged:

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

Comparing this with (2), we have $\pi = 201/64 = 3927/1250 - 39/40000$.
5) The Śāradatilaka, 3.53cd–55ab, prescribes:

$$ EP = a/5. $$

3. 3. Semicircular kunḍa (MKS 41: Fig. 3)

$$ t = (a/5)(1 + 1/100) \quad \begin{cases} \ldots(3) \\ r = OP = OQ = a-t \end{cases} $$

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

111) phalādy utpadyate, in the text we have used (see Sec. 1.6 above).
\[ t = a/5 + (a/5)/100 \]
\[ = 4; 6, 3, 1, 5 + 4; 6, 3, 1, 5/100 \]
\[ \approx 4; 6, 3, 1, 5 + 0; 0, 3, 0, 4, 4, \ldots \]
\[ \approx 4; 6, 6, 2, 1. \]

\[ r = a - t \]
\[ = 24 - 4; 6, 6, 2, 1 \]
\[ = 19; 1, 1, 5, 7. \]
\[ d = 2r = 2; 19; 1, 1, 5, 7 \]
\[ = 38; 2, 3, 3, 6 \text{ angulas.} \]
\[ d^2 = 38; 2, 3, 3, 6^2 \]
\[ \approx 1467; 1, 5, 4, 3, 0, \ldots \]
\[ \approx 1467; 1, 5, 4, 3. \]

\[ S_1 = 3927d^2/5000 \quad (L \ 203) \]
\[ = 3927 \times 1467; 1, 5, 4, 3/5000 = 5761740; 1, 6, 4, 5/5000 \]
\[ = 1152; 2, 6, 2, 1, \ldots \approx 1152; 2, 6, 2 \text{ angula}^2. \]

\[ S = S_1/2 = 1152; 2, 6, 2/2 = 576; 1, 3, 1 \text{ angula}^2. \]

Remarks.
1) Viśṭhaladīkṣita mistakenly obtains \( S_1 = 1152; 2, 6, 4 \) and hence \( S = 576; 1, 3, 2. \)
2) Requirement for the transformation:
\[ a^2 = \pi^2/2. \]

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 kunḍa (MKS 42ab: Fig. 4)
\[ t = AQ = BR = a/4; \]
\[ u = EP = a/3. \]
\[ PW = a + u \]
\[ = 24 + 24/3 = 32 \text{ angulas.} \]
\[ QR = a + 2t \]
\[ = 24 + 2 \cdot (24/4) \]
\[ = 36 \text{ angulas.} \]
\[ S = \triangle PQR \]
\[ = (36/2) \cdot 32 \quad (L \ 166) \]
\[ = 576 \text{ angula}^2. \]

Remarks.
1) The triangle prescribed by Viśṭha-
ladıkṣita is not equilateral. If an equilateral triangle be required in this case, one has to satisfy the requirement,

\[ a^2 = (\sqrt{3}/4)(a + 2t)^2, \]

where \( t = AQ = BR, \) EP being consequently determined. This equation may be rewritten as:

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

2) Śāradātīlaka 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 Śāradātīlaka loc. cit. for several interpretations.

3.5. Circular kunda (MKS 42cd: Fig. 5)

\[ r = OP = (13a/24)(1 + 1/24) \quad (5) \]

\( a = 24 \) aṅgulas:

\[ r = (13a/24)(1 + 1/24) \]
\[ = 13 + 13/24 \]
\[ = 13 + 0;4,2,5,2,5,\ldots \]
\[ \approx 13;4,2,5,3 \text{ aṅgulas.} \]

\( d = 2r = 27;0,5,2,6 \) aṅgulas.

\[ d^2 = 27;0,5,2,6^2 \]
\[ = 733;4,1,0,0,4,3,4,4 \]
\[ \approx 733;4,1. \]

\( S = 3927d^2/5000 \) (L 203)

\[ = 3927 \cdot 733;4,1/5000 \]
\[ = 2880516/5000 \]
\[ = 576;0,6,4,6,6,\ldots \]
\[ \approx 576;0,6 \text{ aṅgula}^2. \]

Remarks.

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

2) Requirement for the transformation:

\[ a^2 = \pi r^2; \text{ hence } r = a/\sqrt{\pi} \quad (5a) \]

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

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

By comparing (5a) with (5), we have \( \pi = 329776/105625 = 3927/1250 = 2569375/13203125. \) The difference amounts to about 1/50. This is twenty times as large as those in the cases of the kundas shaped like a vulva and the semicircular kunda (see Sec. 3.2, Remark 4 and Sec. 3.3, Remark 2 above).

3) Śāradātīlaka 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]: \( t = (\sqrt{2} \cdot a/2 - a/2)/3 = \)
3.6.1. Irregular hexagonal kunḍa (MKS 43: Fig. 6.1).

\[ r = \frac{a}{2} \times (1 + 1/72) \]
\[ a = 24 \text{ aṅgulas}; \]
\[ r = 18 + 18/72 = 18 + 0.2; \]
\[ = 18.2 \text{ aṅgulas}. \]
\[ d = 2r = 36;4 \text{ aṅgulas}. \]

\[ \text{PR} = \frac{RU}{2} = \frac{103923d}{240000} \]
\[ = 103923 \times 36;4/120000 \]
\[ = 31;4,7,0,2,\ldots \]
\[ = 31;4,7 \text{ aṅgulas}. \]

\[ \text{RH} = \sqrt{\text{PR}^2 - \text{RU}^2} = \frac{12 \times \text{PR}^2 - \text{RU}^2}{2} \]
\[ = \frac{12(31;4,7)^2 - 31;4,7^2}{2} = 249;6,2,4,0 \approx 249;6,2,3. \]

\[ \text{RH}^2 = 15;6,3,4^2 = 249;6,2,3,4,2,0 = 249;6,2,3. \]
\[ \text{PR}^2 = 31;4,7^2 = 999;1,1,6,1. \]
\[ \text{PH} = \frac{(3/4) \times \text{PT} = \sqrt{\text{PR}^2 - \text{RH}^2}}{2} \]
\[ = 27;2,7,7,\ldots \approx 27;3,0 \text{ aṅgulas}. \]

\[ S_1 = \text{TRU} = \text{PH} \times \text{RH} \]
\[ = 27;3,0,15;6,3,4 = 432;5,1,6,4 \approx 432;5 \text{ aṅgula}^2. \]

\[ \text{TH} = \frac{\text{PT}^2}{4} = \frac{d}{4} = 9;1 \text{ aṅgulas}. \]
\[ \text{FG} = \frac{\text{RU}}{3} = 31;4,7/3 = 10;4,2,2,5,2,\ldots \approx 10;4,2,2 \text{ aṅgulas}. \]
\[ S_2 = \triangle \text{TFG} = (\text{FG}/2) \times \text{TH} = (10;4,2,2/2) \times 9;1,0 \]
\[ = 48;0,4,2,1 \approx 48;0,4,2 \text{ aṅgula}^2. \]

\[ S = S_1 + 3S_2 = 432;5 + 3 \times 48;0,4,2 = 432;5 + 144;1,4,6 = 576;6,4,6 \text{ aṅgula}^2. \]

Remarks.

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

2) Ganeśa says that the geometrical property, \( \text{PH} = \text{PT} - \text{PT}/4 \), “has been well established” (iti siddham). He also says that the property, \( \text{RF} = \text{FG} = \text{GU} \), is “observed by means of the direct perception” (pratyākṣato drṣyete). See also Section 3.8.1, Remark 2.

3) Requirement for the transformation:

\[ a^2 = \sqrt{3} \times r^2, \text{ or } r = \sqrt{\frac{3}{a}}. \]
4) The Śāradātilaka only prescribes for the regular hexagonal kuṇḍa. See the next section.

3.6.2. Regular hexagonal kuṇḍa (MKS 44: Fig. 6.2)

\[ r = OP = \left(15a/24\right)(1 - 1/160) \]

\[ a = 24 \text{ aṅgulas}; \]
\[ r = 15 - 15/160 = 15 - 0;0,6 = 14;7,2 \text{ aṅgulas}. \]
\[ d = 2r = 29;6,4 \text{ aṅgulas}. \]
\[ t = \text{GH} = \frac{\sqrt{(d+UV)(d-UV)}}{2} = \frac{[d-\sqrt{(d+r)(d-r)}]}{2}. \]

\[ (d+r)(d-r) = 44;5,6 \cdot 14;7,2 = 666;4,5. \]
\[ t = \frac{29;6,4 - 666;4,5}{2} = 4;0.0/2 = 2;0,0 \text{ aṅgulas}. \]

\[ h = \text{OH} = r - t = 14;7,2 - 2;0,0 = 12;7,2 \text{ aṅgulas}; \]
\[ h = \sqrt{PV^2 - PF^2} = \sqrt{r^2 - (d/4)^2} = \sqrt{14;7,2^2 - 7;3,5^2} \approx 12;7,2. \]
\[ S_1 = \text{area of trapezium PTUV} = h(d+r)/2 \text{ (L 173)} \]
\[ = 12;7,2 \cdot (44;5,6/2) = 12;7,2 \cdot 22;2,7 = 288;4,4,6,6 \approx 288;4,5 \text{ aṅgula}^2. \]
\[ S = 2\cdot S_1 = 577;1,2 \approx 577;1 \text{ aṅgula}^2. \]

Remarks.

1) Viṭṭhaladikṣita obtains:
\[ S_1 = 12;7,2 \cdot 22;2,7 \approx 288;3,1,5 \text{ (!)}; \]
\[ S = 2\cdot S_1 = 577;6,3 \text{ aṅgula}^2. \]

This is not a misprint, because he remarks: "idam likṣādvayam yūkātrayam yavaṇaṇkam adhikam..." In computing h, he uses the second method of Gaṇeśa’s.

2) Requirement for the transformation:
\[ a^2 = 3\sqrt{3} r^2/2, \quad \text{or } r = \sqrt{2/3} \frac{a}{3}. \]


3.7. Kuṇḍa shaped like a lotus (MKS 45: Fig. 7)

\[ r_i = (a/8)i, \text{ for } i = 1,2,3,4; \]
\[ r_5 = (a/8)(5-1/38). \]
\[ a = 24 \text{ aṅgulas}; \]
\[ r_4 = 12 \text{ aṅgulas}; \]
\[ r_5 = 15 - 3/38 = 15 - 0;0,5,0,\ldots \approx 15 - 0;0,5 = 14;7,3 \text{ aṅgulas}. \]
\[d_4 = 2 \cdot r_4 = 24 \text{ aṅgulas};\]
\[d_5 = 2 \cdot r_5 = 29;6,6 \text{ aṅgulas}.\]

\[S_4 = 3927d_4^2/5000 \quad (L \text{ 203})\]
\[= 3927 \cdot 24^2/5000\]
\[= 2261952/5000\]
\[= 452;3,0,7,7,\ldots\]
\[\approx 452;3,1 \text{ aṅgula}^2.\]

\[S_5 = 3927d_5^2/5000 \quad (L \text{ 203})\]
\[= 3927 \cdot 29;6,6^2/5000\]
\[= 3927 \cdot 890;5,1,4,4/5000\]
\[= 3497580;1,7,7,4/5000\]
\[= 699;4,1,0,\ldots\]
\[\approx 699;4,1 \text{ aṅgula}^2.\]

\[S = S_4 + (S_5 - S_4)/2\]
\[= 452;3,1 + 123;4,4\]
\[= 575;7,5 \text{ aṅgula}^2; \text{ or}\]

\[S = S_5 - (S_5 - S_4)/2 = 699;4,1 - 123;4,4 = 575;7,5 \text{ aṅgula}^2.\]

Remarks.

1) Viṭṭhaladiksita obtains \(S_5 = 699;4,5,0\) and hence \(S = 575;7,7 \text{ aṅgula}^2\).

2) Requirement for the transformation:

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

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

3) The Śāradātilaka, 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 kūṇḍa.

3.8.1. Irregular octagonal kūṇḍa

\((MKS 46: \text{Fig. 8.1}).\)

\[r = OP_1 = (18a/24)(1 + 1/28)\]

... (8.1)

\[a = 24 \text{ aṅgulas};\]
\[r = 18 + 18/28\]
\[= 18 + 0;5,1,1,1,\ldots\]
\[\approx 18;5,1,1 \text{ aṅgulas}.\]
\[d = 2 \cdot r = 37;2,2,2 \text{ aṅgulas}.\]
\[P_1P_2 = P_2P_3, \text{ etc.}\]

\[= 45922d/120000\]

\((L 207–208)\)

\[= 45922 \cdot 37;2,2,2/120000\]
\[= 1712208;7,4,4/120000\]
\[ P_1Q_2 = P_2Q_3, \text{ etc.} = \sqrt{P_1P_2^2/2} = \sqrt{14;2,1,1^2/2} \]
\[ = \sqrt{203;4,4,0,5,2,1/2} = \sqrt{203;4,4,4/2} \]
\[ = \sqrt{101;6,2} = 10;0,5,5,... \approx 10;1 \text{ angulas.} \]
\[ P_1P_4 = P_1Q_2 + Q_2Q_4 + Q_4P_4 = P_1P_2 + 2P_1Q_2 \]
\[ = 14;2,1,1 + 20;1 = 34;4,4,1,1 \text{ angulas.} \]

**Remarks.**

1. Vitthaladiksita computes, instead of \( S_2 \), \[ 2S_2 = P_1Q_1^2 = 102;4,0 \] (which should be \( 102;4,1 \)). His value of \( S \) is \( 576;2,0 \) angulas.  
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" (pratyakṣātā dvijāte). 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 \( kona \) occurs three times in this section in the sense of \( trikona \) or a triangle.  
4. Requirement for the transformation:
\[ a^2 = 4(\sqrt{2} - 1)r^2, \text{ or } r = \sqrt{\frac{2}{2} + 1 \cdot a/2}. \]
5. The Śāradāttīlaka does not prescribe for the \( kuṇḍa \) of this shape. See Remark 4 of the next section.
3.8.2. Regular octagonal kūnda (MKS 47: Fig. 8.2)

\[ r = \frac{OP_1}{a} = \frac{14a}{24} (1 + 1/47) \]

\[ a = 24 \text{ aṅgulas} \]

\[ r = 14 + 14/47 = 14;2,3,0,4,\ldots \approx 14;2,3 \text{ aṅgulas} \]

\[ d = 2r = 28;4,6 \text{ aṅgulas} \]

\[ P_1P_2 = P_2P_3, \text{ etc.} \]

\[ d = 2r = 28;4,6 \text{ aṅgulas} \]

\[ P_4P_8^2 = d^2 = 28;4,6^2 = 817;4,6,4,4 \text{ aṅgulas} \]

But Ganeśa obtains:

\[ P_4P_8^2 = 757;4,6 \text{ aṅgulas} \]

\[ P_1P_8^2 = 10;7,4,2^2 = 119;5,5,5,6,0,4 \approx 119;5,5,6. \]

\[ P_1P_4 = \sqrt{P_4P_8^2 - P_1P_8^2} \text{ (L 136)} \]

\[ = \sqrt{757;4,6 - 119;5,5,6} = \sqrt{637;7,0,2} \]

\[ = 25;2,0,3,1,\ldots \approx 25;2,1 \text{ aṅgulas} \] (Ganeśa’s value).

\[ S_1 = \text{area of rectangle } P_1P_4P_5P_8 = P_1P_4P_1P_8 \text{ (L 173)} \]

\[ = 25;2,1 - 10;7,4,2 = 276;3,4,2,0,2 \approx 276;3,4 \text{ aṅgula}^2. \]

\[ P_1Q = [(P_1P_4 - P_2P_3) + (P_1P_2 + P_3P_4)(P_1P_2 - P_3P_4)/(P_1P_4 - P_2P_3)]/2 \]

\[ = (P_1P_4 - P_2P_3)/2 = (25;2,1 - 10;7,4,2)/2 = 7;1,2,3 \text{ aṅgulas} \]

\[ P_2Q = \sqrt{P_1P_2^2 - P_1Q^2} = \sqrt{10;7,4,2^2 - 7;1,2,3^2} \]

\[ = \sqrt{68;3,2,6,2,3,3} = 8;2,1,3,0,\ldots \approx 8;2,3,2 \text{ aṅgulas} \] (Ganeśa).

\[ S_2 = \text{area of trapezium } P_1P_2P_3P_4 = P_2Q \cdot (P_1P_4 + P_2P_3)/2 \text{ (L 173)} \]

\[ = 8;2,3,2 \cdot (25;2,1 + 10;7,4,2)/2 = 8;2,3,2 - 18;0,6,5 \]

\[ = 150;2,1,3,7,4,2 \approx 150;2,1,4 \text{ aṅgula}^2. \]

\[ S = \text{area of the kūnda} = S_1 + 2 \cdot S_2 = 276;3,4 + 2 \cdot 150;2,1,4 \]

\[ = 276;3,4 + 300;4,3 = 576;7,7 \text{ aṅgula}^2; \text{ but the manuscript reads:} \]

\[ S = 576;4,3 \text{ aṅgula}^2. \]

Remarks.

1) If we use the correct value of \( P_4P_8^2 = 817;4,6,4,4 \) instead of Ganeśa’s erroneous one, we have \( S \approx 577;6,1 \text{ aṅgula}^2 \). Probably, Ganeśa deliberately manipulated the first two digits in the correct value of \( P_4P_8^2 \) (\( = d^2 \)) in order to
get a better result.

2) Vitthaladiksita's method (cf. Fig. 8.2). For the computation of $P_1P_2$, he cites a śloka from an unknown source:

\[
\text{candrartunādakṛtiḥḥṛtāḥ <ca> sāmāhate/ khakhaḥhāhṛagnisāṁbhakte//}
\]

$P_1P_2 \text{ etc.}=22961r/30000\approx10;7,4,2,3$ aṅgulas.

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

\[
t=UT=\left[d-\sqrt{(d+P_2P_3)(d-P_2P_3)}\right]/2 \quad (L \, 204)
\]

$\approx1,0,5,4$ aṅgulas.

$P_1P_4=d-2\cdot t=26;3,3$ aṅgulas.

$S_1=P_1P_4-P_1P_8=288;4,4$ aṅgula$^2$. 

$P_2Q=r-(P_1P_8/2+t)$

$=7;6$ aṅgulas.

$S_2=P_2Q:(P_2P_3+P_1P_4)/2$

$\approx144;5$ aṅgula$^2$.

$S=S_1+2\cdot S_2$

$=577;6,4$ aṅgula$^2$.

3) Requirement for the transformation:

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

4) The octagonal kuṇḍa prescribed in the Śāradātilaka, 3.64-66, is not a regular octagon. See Fig. 8.3, where:

$\quad EP=a/24$, and
$\quad RQ=RT=(\sqrt{2}/4)a$.

This will make the area,

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

**ACKNOWLEDGEMENTS**

We are deeply grateful to Mr R. Baskaran, curator of the Government Oriental Manuscripts Library, Madras, for his kindly permitting us to photograph and publish the manuscript (D 13403). Many thanks are due to Mr T. A. K. Venkatachari and Mrs Rajalakshmi (Sanskrit Paṇḍits) and other staffs of the Library for their kind help offered to us in researching the Sanskrit mathematical manuscripts of the Library. We are much indebted to the American Institute of Indian Studies, part of whose Junior Fellowship for the period October 1982 to September 1983 enabled Hayashi to visit the Library.

P.S.—The original draft of this article was first sent to Prof. Sri Rama Sinha of the Allahabad University, who was kind enough to propose to supervise my work in it and seek for a suitable means of its publication. His unfortunate death in April 1985, however, made the plan impossible. It is thanks to Mr S. Einoo of the National Museum of Ethnology, Osaka, that this article has found its way into the present journal.
4. Appendix

**Mandapakundasiddhi 31–47 (on Kunda)**

praçyäś catuśkoṇahlagendukhaṇḍatraikonaṇavṛttāngabhujāmbūjāṇī/  
aṣṭāṣrīṣakṛṣṇavarayos tu madhye vedaśri vṛttam uṣanti kūṇḍam//31//  
āśeṣaṇḍaṅgar iha paṇcākaṇḍaī caikaṃ yadā paścimasomasāśive/  
vedyāḥ sapādena kareṇa yad vā pādaṁtenaṇḍhilakundaṇḍasamsthā//32//  
viprāc churnyasram ca vṛttam ca vṛttādham tryasri syād vedakaṇḍāni vāpi/  
savāṇy āhur vṛttārūpāṇi cānaye yonyākārāny aṅganānāṃ tu tāṇi//33//  
siddhiḥ putrāḥ śubham śatrunāśaḥ śāntir mṛticchide/  
vṛṣṭīr ārogyam uktam hi phalaṃ pracyādikunḍake//34//  
śatārdhe 'ratniḥ syāc chataparimite ratnīvataṃ  
śahasre hastaṃ syād ayutahavane hastayugalam/  
caturhaṣṭam laṅke prayutahavane śatkaramitaṃ  
kakubbhīr vā koṭau nṛpakaṃram api prāhur apare//35//  
lakṣaṇaṅkavṛddhyā daśalakṣaṇāntaṃ karakavṛddhyā daśahastakaṃ ca/  
kotyārdaṅvigīvaṁśālaṅkaṣaṅkadaṇe munīśvartukṛṣānuhaṃ//36//  
vedākṣiṇī yugāngayah śaśiyugāy aṣṭābdhayaṃ triṣāvo  
śṭakṣa vahnirasaśa saṅgaṅkamadāśaṅBatmanoś vṛttasṛvarah/  
aṅgulyo 'mha yavāḥ kham abhram iṣavaḥ kham paṅca śat sāgarāḥ  
saptābhirṇaṃ munaṣṣa tva amī nigadita vedaśrake bāhavah//37//  
kunḍatrayai daṅkṣaṇyorin aṁdvṛṣī saumyāgrakā syād itaraṃ paṇca/  
paścābdhagāṁśadradigragrāṇi yonir na koṇe na ca yonikunḍe//38//  
dvighnavāsaṃ turyaḥcinnaṃ sapāśaṃ sūtraṃ śaṅkau paścime pūrvage 'pi/  
dattāva karṣet koṇayoḥ pāṣaturyā syād evam vṛttakaṇḍam saṃmaṇam//39//  
kṣetre jināṁśe puratāḥ sārāṃśaṃ sāṃvardhaṇa ca sviyaraṇāṃśayuktān/  
karaṇāṅgirhindānaṃ likhendukhaṇḍe pratyak puro 'nkād guṇata bhagābhāṃ//40//  
svaśatāṅgāṃṣayuteṣhābhaṅhinaṣvadharitāṁkarkaṭena madhyāt/  
kṛtvānṛtaḍale 'gratā ca jīvām vidadhaṅt induḍalasyā sādhusiddhayai//41//  
vahayāṃśaṃ purato nīḍhaya ca punaḥ śrṇyoś curthāṃsakaṃ  
chheṣu triṣu śūtraṇāna itaṃ syāt tryasri kaśtojhitam/  
viśvāṃśaḥ svajināṃśaṃkaha sahitaiḥ kṣetre jināṁśe kṛte  
vyaśārdhena mitena maṇḍalam itaṃ syād vṛttasamjñāṃ subham//42//  
bhakte kṣetre jināṁśair dhṛtimitalavakaiḥ śvākṣisailāṃśayuktaṁ  
vyaśārdhāṇa maṇḍale tanmitadṛṣṭaṇaṅke karkaṭe cendraṅkāṭaḥ/  
śaṭcīneṣu pradadyād rasamitadruṅkaṇāṃ ekam ekam tu hitvā  
nāśe sandhyartudoṣaḥ api ca vṛtikṛter netramyaṃ sādhasraṃ//43//  
athavā jinabhaṅkuraṇḍamānāt uttirhāgaḥi śvākhaḥbhāpahāghainaiḥ/  
mitakarkaṭakodhhave tu vṛtṛte dvihudiktaḥ sāmāḍdhuṅjaiḥ śādhasraṃ//44//  
aṣṭāṃśāc ca yataś ca vṛttasaraṅe tatrādimaṇaṃ karnikā  
yugme śoḍaṣakesaraṇi carame svāṣṭatribhāgonite/
bhakte śodāsadāḥ śarāntaradhṛte syuḥ karkaṭe 'ṣṭau chadāḥ sarvāṁ tāṁ khana karpikāṁ tyaja nījāyāmoccakāṁ syāt kajam //45// kṣetre jināṁṣe gajacandrabhāgaiḥ svāṣṭākṣībhāgena yutais tu vrṭte/ vidigdiśor antarato 'ṣṭasūtras triyayuktair idam aṣṭakonam //46// madhye gune vedayamair vibhakte śakrai nijāṣyābdhilavena yuktaiḥ/ vrṭte kṛte digvidiśo 'ntarāle gajair bhujaiḥ syād athavāṣṭakonam //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 Kundaśiddhyudārṣṭi「クンダ設営解説」は、ヴィッタラディークサ
作 Maṇḍkapuṇḍarasiddhi「マンダパとクンダの設営」(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）に不幸が起こるとといわれる。かくして数学的問題が生ずる。即ち、ローブ（śūtra）とコンパス（karkaṭa）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サは Maṇḍkapuṇḍarasiddhi 39–47 でその作図法
を与える。一方ガネーシャは、バースカラ II が Lilāvati (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サの作図
法の妥当性を例証する。

このように Kundaśiddhyudārṣṭi 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、若干の注を加えた。