

Bījagaṇita of Bhāskara

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I	Introduction	
1	Text	4
2	Abbreviations	5
3	Notation	5
4	Publishing Information	6
II	Bījagaṇita	
1	Dhanarṇa-ṣaḍvidha	8
2	Kha-ṣaḍvidha	11
3	Avyakta-ṣaḍvidha	
1	Avyakta-ṣaḍvidha	12
2	Anekavarṇa-ṣaḍvidha	15
4	Karaṇī-ṣaḍvidha	16
5	Kuṭṭaka	25
6	Varga-prakṛti	
1	Varga-prakṛti	33
2	Cakravāla	35
7	Ekavarṇa-samīkaraṇa	40
8	Ekavarṇa-madhyamāharāṇa	57
9	Anekavarṇa-samīkaraṇa	73
10	Anekavarṇa-madhyamāharāṇa	86
11	Bhāvita	102
12	Grantha-samāpti	108
III	Appendices	
1	Rules and Examples of the <i>Bījagaṇita</i>	110
2	Classified List of Algebraic Problems in the <i>Bījagaṇita</i>	170
3	Glossary of Technical Terms in the <i>Bījagaṇita</i>	176
4	Bhūtasamkhyās and Weights and Measures in the <i>Bījagaṇita</i>	203
5	Index to Quarter Verses	205
6	Index to Words	227
7	Concordance of Verse Numbers	289

I Introduction

I.1 Text

This is a makeshift edition of Bhāskara's *Bījagaṇita* (hereafter BG). It consists of 102 Sanskrit verses for mathematical rules and 110 Sanskrit verses for examples and many of the former category and almost all of the latter are commented on by the author himself in Sanskrit prose. The work has been printed many times (see CESS, A4, 311b). The present edition is based on the latest seven printed books. They are as follows (in the alphabetical order of the abbreviations).

- A:** Acyutānanda Jhā's edition. Edited with Jīvanātha Jhā's Sanskrit commentary *Subodhinī* and the editor's own Sanskrit and Hindi commentaries. The manuscript(s) used is (are) not mentioned. Very close to Muralīdhara Jhā's edition (see 'M' below). Lacks Bhāskara's own commentary on the last example of Chapter 9 (BG E88p).
- F:** François Patte's critical edition of Sūryadāsa's commentary *Sūryaparakāśa* on the BG up to the kuṭṭaka section. Based on six manuscripts, but only two of them contain the BG itself (without the prose parts). Since the same two manuscripts are used also in Jain's edition (see 'J' below), I have not mentioned this edition in the critical apparatus except for one case (footnote for BG 32).
- G:** Girijāprasāda Dvivedī's edition of the BG together with the Sanskrit commentary *Vilāsi* and the Hindi Commentary *Mitākṣara* of his father Durgāprasāda Dvivedī. Several footnotes refer to variant readings of mūla- and ṭīkā-pustakas, although we cannot identify them.
- J:** Pushpa Kumari Jain's critical edition of Sūryadāsa's commentary *Sūryaparakāśa* on the BG up to the kuṭṭaka section. Based on twelve manuscripts (oldest of which is dated Saṃvat 1609 = AD 1552), but only three of them contain the BG itself (without the prose parts). See J(H), J(L) and J(S) in the 'Additional abbreviations' below.
- M:** Muralīdhara Jhā's re-edition of the text edited by Sudhākara Dvivedī (Benares 1888) with Sudhākara's and the editor's own mathematical comments in footnotes. Some of their comments refer to the text readings but all of them are meant for proposing better readings without documentation.
- P:** Poona edition of Kṛṣṇa's commentary *Bījapallava* (alias *Navāṅkra*) on the BG. Based on six manuscripts (oldest of which is dated Saṃvat 1761 = AD 1704) without critical apparatus. Does not contain the prose parts of the BG except for those quoted by Kṛṣṇa.
- T:** Tanjore edition of Kṛṣṇa's commentary *Bījapallava* (alias *Navāṅkra*) on the BG. Based on the oldest datable (11 April 1601 Julian) manuscript of the commentary. Only three footnotes (on pp. 2, 3, and 8) refer to the readings of the

manuscript. The corrigenda (śuddhāśuddha-patrikā), printed on the five pages that precede the text, may include corrections not only of printing errors but also of errors in the manuscript. Does not contain the prose parts of the BG except for those quoted by Kṛṣṇa.

Out of these, only A, G, and M contain both metrical and prose parts; the other four editions contain only the metrical parts.

I.2 Abbreviations

In addition to those defined in the previous section, I use the following abbreviations.

BSS: *Brāhmasphuṭasiddhānta* of Brahmagupta.

C: Colebrooke's English translation of the BG.

CV: Vṛddhacāṇakya, textus ornatior version.

GA: *Golādhyāya* of Bhāskara.

J(H): British Museum manuscript 447 used for J. 19th century.

J(L): Akhila Bhāratīya Saṃskṛta Pariṣad (Lucknow) manuscript, 4514, used for J (the BG verses are available up to BG 21). Dated Saṃvat 1745 = AD 1688.

J(S): British Museum manuscript 448 used for J. 19th century.

L: *Līlāvātī* of Bhāskara.

L(ASS): Ānandāśrama edition of the L.

L(VIS): Hoshiarpur edition of the L.

P(K): Prose part of the BG cited by Kṛṣṇa in P.

PPM(Wai): Prājña Pāṭhaśālā Maṇḍala, Wai.

SS: *Siddhāntaśiromaṇi* of Bhāskara.

SSe: *Siddhāntaśekhara* of Śrīpati.

T(cor): Corrigenda (śuddhāśuddhapatrikā) of T.

T(K): Prose part of the BG cited by Kṛṣṇa in T.

T(Ms): Tanjore manuscript D 11523 used for T.

I.3 Notation

BG n : the n -th verse for mathematical rules of the BG. I do not mention 'BG' when there is no fear of confusion, in this and the next three cases.

BG En : the n -th verse for examples of the BG.

BG Qn : the n -th quoted verse in the prose auto-commentary of the BG.

BG np/Enp : the prose commentary that occurs immediately after verse n/En . I divide it in paragraphs with serial numbers ($np1$, $np2$, etc.) when appropriate. $np0/Enp0$ denotes the introductory paragraph for verse n/En or for verses beginning with n/En .

\square : enclosure for displayed numerical expressions. It is commonly used in Sanskrit

mathematical manuscripts, especially when the numerical expressions have more than one line, although it is not used in AMG.

$\langle x \rangle$: x was added by me. This notation is not used for the chapter headings and the section headings, all of which were supplied by me.

x T1] y T2: the text T2 reads y for x of the text T1 which is accepted in the present edition.

\emptyset : non-existence.

I.4 Publishing Information

- A:** *The Bījagaṇita: Elements of Algebra of Śrī Bhāskarācārya*, edited and compiled with the *Subodhinī* Sanskrit Commentary of Jīvanātha Jhā and the *Vimalā* Exhaustive Sanskrit & Hindi commentaries, Notes, Exercices, Proofs, etc. by Acyuthānanda Jhā. Kashi Sanskrit Series 148. Benares: Chowkhamba Sanskrit Office, 1949.
- BSS:** *Brāhmasphuṭasiddhānta* of Brahmagupta, edited with the editor's own commentary in Sanskrit by Sudhākara Dvivedī. Benares: Medical Hall Press, 1902.
- C:** *Algebra with Arithmetic and Mensuration from the Sanscrit of Brahmagupta and Bha'scara*, by Henry Thomas Colebrooke. London: John Murray, 1817. Reprinted under the title, *Classics of Indian Mathematics*, with a foreword by S. R. Sarma. Delhi: Sharada Publishing House, 2005.
- CESS:** *Census of the Exact Sciences in Sanskrit*, by David Pingree. Ser. A, 5 vols. Memoire of the American Philosophical Society 81, 86, 111, 146, and 213. Philadelphia: American Philosophical Society, 1970, 71, 76, 81, and 94.
- CNTT:** *Cāṇakya-Nīti-Text-Tradition*, by Ludwik Sternbach, 2 vols. in 5 pts., Vishveshvaranand Indological Series 2 and 29, Hoshiarpur: Vishveshvaranand Vedic Research Institute, 1963–70.
- CV:** 'Vṛddha-Cāṇakya: Textus Ornatiore Version,' CNTT vol. 1, pt. 1, pp. 1–104.
- F:** *Le Siddhāntaśiromaṇi I-II: Édition, traduction et commentaire*, par François Patte avec une préface de Pierre-Sylvain Filliozat. Hautes Études Orientales 38. Volume I: Text et Volume II: Traduction. Genève: Librairie Droz, 2004.
- G:** *Bījagaṇitam*, edited with Durgāprasāda Dvivedī's Sanskrit and Hindi commentaries by Girijāprasāda Dvivedī. 3rd ed. Lakṣmaṇapura: Kesarīdās Seṭh, 1941.
- GA:** See 'SS' below.
- J:** *The Sūryaparakāśa of Sūryadāsa: A Commentary on Bhāskarācārya's Bījagaṇita, Volume 1: A Critical Edition, English Translation and Commentary for the Chapters, Upodghāta, Śaḍvidhaprakaraṇa and Kuṭṭakādhikāra*, by Pushpa Kumari Jain. Gaekwad's Oriental Series 182. Vadodara: Oriental Institute, 2001.
- L(ASS):** *Līlāvātī* of Bhāskara, edited with Gaṇeśa's *Buddhivilāsinī* and Mahīdhara's *Līlāvātīvivaraṇa* by Dattātreya Āpaṭe, et al. Ānandāśrama Sanskrit Series 107, 2 vols. Poona: Ānandāśrama Press, 1937.

- L(VIS):** *Līlavatī* of Bhāskara, edited with Śaṅkara and Nārāyaṇa's *Kriyākramakarī* by K. V. Sarma. Vishveshvaranand Indological Series 66, Hoshiarpur: Vishveshvaranand Vedic Research Institute, 1975.
- M:** *Bījagaṇita: Elements of Algebra of Śrī Bhāskarācārya, with Expository Notes and Illustrative Examples* by M. M. Pandit Śrī Sudhākara Dvivedī, ed. with further notes by Mahāmahopadhyāya Pandit Śrī Muralīdhara Jhā. Benares Sanskrit Series 159. Benares: Krishna Das Gupta, 1927.
- P:** *Bhāskrarīya-bījagaṇitam*, edited with Kṛṣṇa's *Navāṅkura* by Dattātreyā Āpaṭe, et al. Ānandāśrama Sanskrit Series 99. Poona: Ānandāśrama Press, 1930.
- SS:** *Siddhāntaśiromaṇi of Bhāskarācārya*, edited with the auto-commentary *Vāsanābhāṣya* and *Vārtika* of Nṛsiṃha Daivajña by Murali Dhara Chaturvedi. Library Rare Text Publication Series 5. Varanasi: Sampurnanand Sanskrit University, 1981.
- SSe:** *Siddhāntaśekhara* of Śrīpati, edited with Makkibhaṭṭa's *Gaṇitabhūṣana* and the editor's *vivarāṇa* by Babuāji Miśra. 2 parts. Calcutta: University of Calcutta, 1932/47.
- T:** *Bījapallavam: A Commentary on Bījagaṇita, the Algebra in Sanskrit*, edited with Preface by T. V. Radhakrishna Sastri. Madras Government Oriental Series 67 (Tanjore Saraswathi Mahal Series 78). Tanjore: TMSSM Library, 1958.

II Bījagaṇita

II.1 Dhanarṇa-ṣaḍvidha

utpādakam yat pravadanti buddher 1
adhiṣṭhitam satpuruṣeṇa sām̐khyāḥ/
vyaktasya kṛtsnasya tad ekabījam
avyaktam īśam gaṇitam ca vande//1//

pūrvam proktam vyaktam avyaktabījam 2
prāyaḥ praśnā no vināvyaktayuktyā/
jñātum śakyā mandadhībhir nitāntam
yasmāt tasmād vacmi bījakriyām ca//2//¹

dhanarṇasaṃkalane karaṇasūtram vṛttārdham/3abp0/

yoge yutiḥ syāt kṣayayoḥ svayor vā 3ab
dhanarṇayor antaram eva yogah/3ab/²

udāharaṇam/E1p0/

rūpatrayam rūpacatuṣṭayam ca 81
kṣayam dhanam vā sahitam vadāśu/
svarṇam kṣayasvam ca pṛthak pṛthak ced
dhanarṇayoḥ saṃkalanām avaiṣi//E1//³

atra rūpāṇām avyaktānām cādyākṣarāṇy upalakṣaṇārtham lekhyāni/ tathā yāny
ṛṇagatāni tāny ūrdhvaḥbindūni ca/ nyāsaḥ/ rū 3̣ rū 4̣/ yoge jātam rū 7̣/ nyāsaḥ/ rū
3̣ rū 4̣/ yoge jātam rū 7̣/ nyāsaḥ/ rū 3̣ rū 4̣/ yoge jātam rū 1̣/ nyāsaḥ/ rū 3̣ rū 4̣/
yoge jātam rū 1// evaṃ bhinneṣv api//E1p//⁴

dhanarṇavyavakalane karaṇasūtram vṛttārdham/3cdp0/

saṃśodhyamānam svam ṛṇatvam eti 3cd

¹vyaktam AMGTPJJ(HL)] vyaktām J(S); praśnā no AMGTPJJ(HS)] praśnānno J(L); śakyā
manda AMGTPJJ(HS)] śattyāmīda J(L).

²syāt kṣayayoḥ AMGTPJJ(LS)] tkṣayayoḥ J(H).

³kṣayasvam JJ(L)] kṣayam svam AMG, kṣayaḥ svam TPJ(HS); pṛthak ced J(HS)] pṛthāṇme
AGMTJJ(L), pṛthaktve P.

⁴nyāsaḥ/ (2nd, 3rd, 4th) G] ” AM; jātam (1st) G] jātam A, jāta M; rū 7̣ AM] rū 7 G; yoge jātam
(2nd, 3rd, 4th) G] ” AM; bhinneṣv api// AM] bhinneṣvapi iti dhanarṇasaṃkalanā/ G.

svatvaṃ kṣayas tadyutir uktavac ca//3cd//

udāharaṇam/E2abp0/

trayād dvayaṃ svāt svam ṛṇād ṛṇaṃ ca
vyastam ca saṃśodhya vadāśu śeṣam/E2ab/

E2ab

nyāsaḥ/ rū 3 rū 2/ antare jātam rū 1/ nyāsaḥ/ rū 3[•] rū 2[•]/ antare jātam rū
1[•]/ nyāsaḥ/ rū 3 rū 2[•]/ antare jātam rū 5/ nyāsaḥ/ rū 3[•] rū 2[•]/ antare jātam rū
5[•]//E2abp1//⁵

iti dhanarṇasaṃkalanavyavakalane//E2abp2//⁶
guṇane bhāgahāre ca karaṇasūtram vṛttārdham/4abp0/⁷

svayor asvayoh svam vadhaḥ svarṇaghāte
kṣayo bhāgahāre 'pi caivaṃ niruktam/4ab/⁸

4ab

udāharaṇam/E2cdp0/

dhanam dhanenarṇam ṛṇena nighnam
dvayaṃ trayeṇa svam ṛṇena kiṃ syāt//E2cd//⁹

E2cd

nyāsaḥ/ rū 2 rū 3/ dhanam dhanagham dhanam syād iti jātam rū 6/ nyāsaḥ/
rū 2 rū 3/ ṛṇam ṛṇagham dhanam syād iti jātam rū 6/ nyāsaḥ/ rū 2 rū 3/ dhanam
ṛṇagham ṛṇam syād iti jātam rū 6/ nyāsaḥ/ rū 2 rū 3/ ṛṇam dhanagham ṛṇam
syād iti jātam rū 6//E2cdp1//¹⁰

iti dhanarṇaguṇanam//E2cdp2//
udāharaṇam/E3p0/

rūpāṣṭakam rūpacatuṣṭayena
dhanam dhanenarṇam ṛṇena bhaktam/
ṛṇam dhanena svam ṛṇena kiṃ syād

E3

⁵nyāsaḥ/ (2nd, 3rd, 4th) G] ” AM; antare jātam (2nd, 3rd, 4th) G] ” AM.

⁶dhanarṇasaṃkalanavyavakalane AM] dhanarṇavyavakalanam G.

⁷bhāgahāre ca] ∅ AMGTPJ.

⁸vadhaḥ AMGTPJ(HLS)] vadhe J; GTP place 'bhāgahāre 'pi caivaṃ niruktam' after E2cdp2.

⁹dhanam AMGTPJJ(LS)] dhane J(H).

¹⁰nyāsaḥ/ (2nd, 3rd, 4th) G] ” AM; syād iti jātam (2nd, 3rd, 4th) G] ” AM; rū 2 (2nd) AG] rū
2 M.