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► **To cite this version:**

Jérôme Petit. Eugène Jacquet and his Pioneering Study of Indian Numerical Notations. *Ganita Bharati (Indian Mathematics): Journal of the Indian Society for History of Mathematics*, 2009, 31 (1-2), pp.23-33. hal-01112868

HAL Id: hal-01112868

<https://hal.science/hal-01112868>

Submitted on 3 Feb 2015

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Eugène Jacquet and his Pioneering Study of Indian Numerical Notations

JÉRÔME PETIT

ABSTRACT

Eugène Jacquet was one of the earliest European scholars who made a comprehensive study of all the systems of numerical notation which were prevalent in India. In a pioneering paper published in 1830 he put together the scattered pieces of information then available in Europe and built up a large corpus of symbolic words employed in Sanskrit astronomical texts to represent numbers. He was one of the first scholars to realise that this system of word numerals used in Sanskrit texts spread outside India and was to be found in Tibet and Java. Jacquet also discussed the two variants of alphabetic notation employed in astronomical texts, viz. the system designed and employed by Āryabhaṭa in his *Āryabhaṭīa* and the more widely used *Kaṭapayādi* alphabetic notation. The present article, after a brief outline of Jacquet's life, introduces Jacquet's paper on the numerical notations in India.

Keywords: Alphabetic notation, Āryabhaṭa, *Bhūtasamkhyā* system, *Kaṭapayādi* system, word numerals in Javanese, word numerals in Sanskrit, word numerals in Tibetan.

1. INTRODUCTION

Eugène Jacquet was one of the earliest European scholars to make a comprehensive study of the numerical notations in India, especially of the system known as the

“word numerals” or the *Bhūtasamkhya* system, where numbers are represented by certain symbolic words. Since he is not well known among historians of Indian mathematics or even among Indologists in general, a short account of his life and work is in order.¹

Eugène-Vincent-Stanislas Jacquet² was born in Brussels on 10 May 1811. His family moved to Paris when he was two years old. As he showed signs of precocious intelligence, his parents enrolled him at one of the best schools in Paris, the Collège Louis le Grand, where he made excellent progress. He studied “humanities”, learning Greek, Latin, and all monumental texts written in these ancient western languages. This classical education formed a solid basis on which he could build a fascinating career in eastern studies. The field of Oriental Studies was in its infancy then, and Jacquet learned several oriental languages with the pioneers of these studies in France. He learned Persian and Arabic under the guidance of Sylvestre de Sacy, Turkish under Amédée Jaubert, Chinese under Abel Rémusat, and Sanskrit under Eugène Burnouf. These were professors at the prestigious Collège de France and are regarded as the “fathers” of their fields. At that time, Paris was the centre of Oriental Studies, mainly because of the wonderful collection of oriental manuscripts kept at the Royal Library since the mid-18th century. In Indian studies, Eugène Burnouf impressed all European orientalists by his new philological approach. Jacquet diligently followed Burnouf, who gave him many tasks to do, papers to write, manuscripts to copy, etc. Jacquet’s knowledge of Chinese and Sanskrit led him to study Buddhism, and also the different south-eastern scripts from Java and the Malay Peninsula. He embarked on a furious pace of academic activity, without any pause or rest, until his untimely death at the young age of just 27. On 7 July 1838, he died of exhaustion, with a pencil and a notebook in his hands, amongst the coins sent to him by General Court because Jacquet was recognized as an authority in Indian epigraphy and numismatics.

Eugène Jacquet was introduced to the Asiatic Society of Paris on 7 September 1829 where he became soon one of the most active members. He gave lectures during the monthly sessions and published all his works in the organ of this society,

¹I would like to thank Prof. S. R. Sarma for his suggestion to prepare this note after an exchange we had on the fascinating persona of Eugène Jacquet.

²This account is based on a *Mémoire* written by Félix Nève (1816-1893), Professor of Oriental Studies at the Catholic University of Louvain, Belgium (see Bibliography).

the *Journal asiatique*, with more than forty papers³ on a wide range of topics like Nepalese literature (1829), Birth in Japan (1830), Singhalese manuscripts in Copenhagen (1830), Malay and Polynesian miscellanies (1831-1832), Jesuits processions in the East (1833), Bactrian medals collected by Général Allard (1836), and so on.

1.0 Jacquet's Paper on Indian Numerical Notations

A notable paper among his publications is on the “Mode of Symbolic Expression of Numbers employed by Indians, Tibetans, and Javanese”⁴ that we wish to introduce here. Eugène Jacquet is not the first to discuss the system of word numerals or the *Bhūtasamkhyā* system,⁵ which term, by the way, never appears in his paper. The German scholar A. W. Schlegel brought to light this system in a note entitled “Explication d’une Enigme” (Solution of an enigma) in his *Réflexions sur l’étude des langues asiatiques*. Jacquet writes that Schlegel’s note had attracted the attention of a Pandit who was teaching Indian astronomy in the Calcutta Sanskrit College. The Pandit⁶ prepared, for the benefit of European scholars, a list of Sanskrit word

³For a list of Jacquet’s articles, see *Journal asiatique*, serie 3, tome 14, July to December 1842, accessible on line [<http://gallica.bnf.fr/ark:/12148/bpt6k931402/f524>].

⁴Mode d’expression symbolique des nombres, employé par les Indiens, les Tibétains et les Javanais (see Bibliography).

⁵For a comprehensive discussion of the word numerals, see Datta & Singh, pp. 53-63.

⁶At the beginning of his paper, Jacquet praises the role played by Indian Pandits in the discovery of Sanskrit knowledge by European scholars. At the beginning of his paper, Jacquet saluted the role played by Indian Pandits in the discovery of Sanskrit knowledge by European scholars: “Un des signes évidents de l’intérêt quiattache chaque jour de plus en plus à l’étude des langues et des sciences de l’Inde, (...) c’est que les pandits les plus instruits ne restent déjà plus étrangers aux publications de textes et de mémoires relatifs à cette étude qui se font, soit en Angleterre, soit dans l’Europe continentale. Des brahmanes instruits ont formé, dans plusieurs parties de l’Inde, des sociétés littéraires liées à la Société asiatique de Londres par un sentiment de haute estime autant que par la communauté de direction scientifique. D’autres ont enrichi de dissertations et de notices les *transactions* des sociétés littéraires fondées dans l’Inde par les Anglais” (Jacquet, p. 5). “A clear evidence of the growing interest for the study of languages and sciences of India (...) is that the most educated Pandits are no more foreign to publications of texts and papers related to this study, either in England or in continental Europe. Educated Brahmins have formed, in several parts of India, literary societies connected with the Asiatic Society of London by a feeling of high regard and also by the community of scientific direction. Other Pandits have enriched with dissertations and records the *Transactions* of literary societies founded in India by the British.”

numerals and gave it to James Prinsep who was then the editor of the *Journal of the Asiatic Society of Bengal*. The list was seen by Sandor Csoma de Körös, the famous Hungarian father of Tibetology, who could recognize that the system was the same as the one used in Tibetan astronomy (Princep 1834). Jacquet found similar notation in the *History of Java* by Sir Thomas Stanford Raffles. In Javanese language, the notation was called *Candrasaṅkala*.⁷ Realising that the symbolic notation used in Tibetan astronomy and in Javanese *Candrasaṅkala* is the same one as the Indian system, he discusses these three parallel systems with copious examples.

1.1 Word Numerals in Sanskrit

Jacquet remarks that the main purpose of employing symbolic words for numbers was to prevent, by a kind of permanent control, any alteration of numbers. It is also to put all these numerical expressions in the limited space of a verse so that the meter provides a means to recognize the slightest disturbance in the series of numbers. Another advantage is to avoid an interruption of the poem, when mathematical rules are exposed by a prosaic enumeration or a list of numbers placed outside the main text, in a country where mathematical and astronomical treatises are always composed in poetical verses. On the other hand, “the disadvantages are certainly not in proportion to these advantages: they exist however, and we should make them known, so that they do not become the source for error” (Jacquet, p. 8). The disadvantage arises from the fact that many of the words used to represent numbers have multiple meanings and therefore can have different numerical values. Jacquet cites the example of the word *rasa*, which stands for 6 in the sense of “taste”, for 8 in the sense of “sentiment”, for 4 in the sense of “water” and for 1 in the sense of “earth” (*rasā*). He goes to say that the word *samudra* can change from 4 to 7; for Tibetan astronomers the word *graha* can mean 7 or 9, and *diś* 6 or 10. Difficulties increase when numeral expressions are in a compound: *bhūmidhara* (mountain) counts “seven”, but if each term is separated we have 71 (*bhūmi* = 1, *dhara* = mountain = 7) or 81 (*bhūmi* = 1, *dhara* = *vasu* = 8), or 11 (*bhūmi* = 1, *dhara* 1). However, Jacquet’s reservations in this regard are entirely misplaced; for *rasa* is used only in the sense of 6 and *dhara* has never been used in the sense of “mountain” or of *vasu*. It is rarely that any ambiguity arises in the numerical values represented by these symbolic words.

⁷ On the word numerals in Javanese, see Noorduyn 1993.

Jacquet wonders whether there are any general conditions for admitting a word in the list of symbolic words. He admits that he knows the rules “but exceptions still remain unknown” (Jacquet, p. 11: “Nous connaissons donc la règle ; les exceptions nous sont encore inconnues”). But he realises that the system is essentially a Brahmanic system and goes on to say that the Tibetan system is absolutely identical with the Brahmanic system. According to him, the Buddhists did not have any astronomical treatise suited to their religious beliefs and therefore borrowed all their scientific notions from the Brahmanic literature of middle ages (Jacquet, p. 12).

The most important aspect of Jacquet’s paper is the very large number of symbolic words from Sanskrit, Tibetan and Javanese. With regard to Sanskrit, Jacquet reproduces the list which was compiled by the Pandit of the Sanskrit College of Calcutta and which the Pandit put at Jacquet’s disposal. The list contains words to represent the numbers 0-27; 32-33; 49 (Jacquet, pp. 6-23). Jacquet reproduces each word first in Devanagari script, then in Roman transliteration, followed by the literal meaning of the word in French for the convenience of the French readers. The beginning of the list can be seen in Figure 1 below.

० ou 0.

ख *kha*, le vide; अनन्त *ananta*, l’espace; आकाश *ākāśa*,
l’éther, etc¹.

१ ou 1.

पृथ्वी *prithvī*, la terre, et ses synonymes²
चन्द्र *chandra*, la lune, et ses synonymes³.
रूप *roṭpa*, forme, etc.

Figure 1: *Journal asiatique*, Juillet 1835, p. 16. © BnF

Here the words for “zero” are *kha*, “empty space”, *ananta*, translated here as “space”, *ākāśa* “ether”. Words for number 1 are *prithvī*, “earth and its synonyms”, *candra*, “moon and its synonyms”, *rūpa* “shape”, etc. Jacquet also explains quite correctly the mythological, philosophical and other kinds of symbolism on the basis of which certain terms receive numerical values. In some cases, however, he is off the mark. For example, he thinks that the word *svara* which has the numerical

value of 7 refers to the vowels in the Sanskrit alphabet. But actually *svara* is given the numerical value of 7, not because it means “vowel”, but because it means the “musical note” of which there are seven in the Indian musical system.

Jacquet supplements the list of Sanskrit word numerals with several actual examples from the second chapter of the *Sūryasiddhānta*, a manuscript of which was lent to him by his teacher Eugène Burnouf (Jacquet, pp. 34-39) and some more examples of Sanskrit words which are employed to represent numbers (Jacquet, pp. 40-42).

1.2 Word Numerals in Tibetan

Jacquet continues the discussion with a list of Tibetan words with numerical association which was compiled by Csoma (Jacquet, pp. 26-34). This list presents words for numbers 0-16; 18; 24-25; 27; 32. Jacquet reproduces the words first in Tibetan script, then in Roman transliteration followed by the meaning in French and the Sanskrit equivalents (see Figure 2 for the beginning of the list). It is interesting to note that, while the system is basically borrowed from Sanskrit sources, the Tibetan texts made some additions of their own. For example, the Tibetan word *bse-ron* (rhinoceros) has the numerical value of 1, while the Sanskrit word *gaṇḍaka* with the same meaning has no such numerical association.

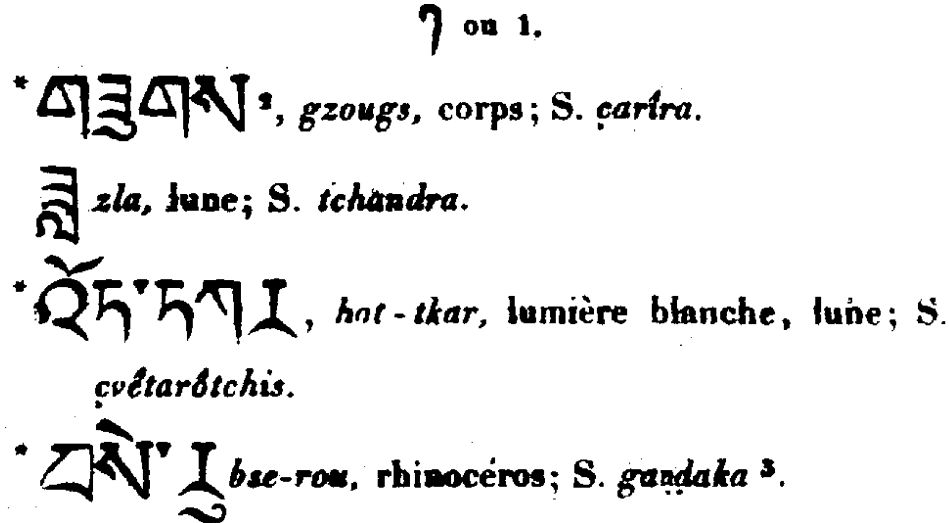


Figure 2: *Journal asiatique*, Juillet 1835, p. 26. © BnF

1.3 Word Numerals in Javanese (*candrasaṅkala*)

The largest list of word numerals is from the Javanese (Jacquet, pp. 97-116). Here Jacquet expands greatly the short list given by Thomas Stamford Raffles. For each number, Jacquet gives the Javanese word, a French translation, sometimes the equivalent of the word in Sanskrit, and the origin of the word in Kawi or Javanese. He also corrects the errors in the interpretation by Raffles. For example Raffles explains erroneously that the designation *Candrasaṅkala* means “Reflections of royal times”, which Jacquet corrects to “Names of numbers beginning with the word *candra* [which stands for 1]”. Figure 3 below shows the list for the number “two” in the Javanese system.

**DCI, deux (en sanscrit *doi*) : ce mot est kawi et javanais-
(*basa krama*).**
LORO, deux : ce mot est javanais.
LOTCHANA, deux (en sanscrit *lōtchana*) : ce mot est kawi

Figure 3: *Journal asiatique*, 1835, p. 100. © BnF

2.0 Alphabetic Notations

In order to make his paper comprehensive, Jacquet discusses also the system of alphabetic notation, where the letters of the Sanskrit alphabet are employed to represent numbers.⁸ This discussion is mainly based on Charles M. Whish’s paper “On the Alphabetical Notation of the Hindus” (see Bibliography), of which Jacquet gives an annotated summary.

2.1 Āryabhaṭa’s Notation

In his paper, Whish refers to the alphabetic notation employed by Āryabhaṭa in his *Āryabhaṭīy*. Jacquet regrets that Whish did not give a full translation of the verse where Āryabhaṭa defines his notation and proceeds to fill the lacuna with a French

⁸On this notation, see Datta & Singh, pp. 65-72.

translation.⁹ In this context, he prepares a huge synoptic table, presenting the numbers expressed by the twenty-five “classified letters” (from *ka* to *ma*) and eight “unclassified letters” (from *ya* to *ha*) in combination with the vowels (see

PARADIGME SYNOPTIQUE

DE LA NOTATION DES NOMBRES EMPLOYEE PAR ARYABHATTA.

क ०० का 1	कि ०० की 100	कु ०० कू 10000	कृ ०० कृ 1000000	कू ०० कू 100000000	के 1000000000	के 10000000000	को 100000000000	को 1000000000000
ख ०० खा 2	खि ०० खी 200	खु ०० खू 20000	खृ ०० खृ 2000000	खू ०० खू 200000000	खे 2000000000	खे 20000000000	खो 200000000000	खो 2000000000000
ग ०० गा 3	गि ०० गी 300	गु ०० गू 30000	गृ ०० गृ 3000000	गू ०० गू 300000000	गे 3000000000	गे 30000000000	गो 300000000000	गो 3000000000000
घ ०० घा 4	घि ०० घी 400	घु ०० घू 40000	घृ ०० घृ 4000000	घू ०० घू 400000000	घे 4000000000	घे 40000000000	घो 400000000000	घो 4000000000000
ङ ०० ङा 5	ङि ०० ङी 500	ङु ०० ङू 50000	ङृ ०० ङृ 5000000	ङू ०० ङू 500000000	ङे 5000000000	ङे 50000000000	ङो 500000000000	ङो 5000000000000
च ०० चा 6	चि ०० ची 600	चु ०० चू 60000	चृ ०० चृ 6000000	चू ०० चू 600000000	चे 6000000000	चे 60000000000	चो 600000000000	चो 6000000000000
छ ०० छा 7	छि ०० छी 700	छु ०० छू 70000	छृ ०० छृ 7000000	छू ०० छू 700000000	छे 7000000000	छे 70000000000	छो 700000000000	छो 7000000000000
ज ०० जा 8	जि ०० जी 800	जु ०० जू 80000	जृ ०० जृ 8000000	जू ०० जू 800000000	जे 8000000000	जे 80000000000	जो 800000000000	जो 8000000000000
क ०० का 9	कि ०० की 900	कु ०० कू 90000	कृ ०० कृ 9000000	कू ०० कू 900000000	के 9000000000	के 90000000000	को 900000000000	को 9000000000000
ञ ०० ञा 10	ञि ०० ञी 1000	ञु ०० ञू 10000	ञृ ०० ञृ 1000000	ञू ०० ञू 100000000	जे 1000000000	जे 10000000000	जो 100000000000	जो 1000000000000
ट ०० टा 11	टि ०० टी 1100	टु ०० टू 11000	टृ ०० टृ 1100000	टू ०० टू 110000000	टे 1100000000	टे 11000000000	टो 110000000000	टो 1100000000000
ठ ०० ठा 12	ठि ०० ठी 1200	ठु ०० ठू 12000	ठृ ०० ठृ 1200000	ठू ०० ठू 120000000	ठे 1200000000	ठे 12000000000	ठो 120000000000	ठो 1200000000000
ड ०० डा 13	डि ०० डी 1300	डु ०० डू 13000	डृ ०० डृ 1300000	डू ०० डू 130000000	डे 1300000000	डे 13000000000	डो 130000000000	डो 1300000000000
ढ ०० ढा 14	ढि ०० ढी 1400	ढु ०० ढू 14000	ढृ ०० ढृ 1400000	ढू ०० ढू 140000000	डे 1400000000	डे 14000000000	डो 140000000000	डो 1400000000000
या ०० या 15	यि ०० यी 1500	यु ०० यू 15000	यृ ०० यृ 1500000	यू ०० यू 150000000	ये 1500000000	ये 15000000000	यो 150000000000	यो 1500000000000

Figure 4: First part of the synoptic table presenting the alphabetic notation of numbers.

Journal asiatique, Juillet 1835, table. © BnF

⁹The verse in question is *Āryabhaṭṭya* 1.2:

vargākṣarāṇi varge 'varge 'vargārāṇi kāt n̄mau yah |

khadvīnavake svarā nava varge 'varge navāntyavarge vā ||

which Jacquet renders as “(étant rangées) dans leur ordre les lettres *classées*, dans leur ordre les lettres *non classées*, à partir de *ka*, *ya* (égale), *nga* (plus), *ma*; neuf voyelles se joignent à (cette série de consonnes qui peut ainsi être élevées jusqu’à la valeur) de dix-huit zéros (*kha*) ; neuf (voyelles) à chaque classe (de consonnes), voire même à la dernière de ces classes.” (Jacquet, p. 118).

Figure 4, for the beginning of the synoptic table). Jacquet deduces by some indications that this system does not belong to Indian antiquity, but seems to be related to the astronomy introduced into India in relatively recent times.¹⁰ A few years later, in a paper entitled “On the Use of the Letters of the Alphabet to represent Numbers by Indian Mathematicians,” Christian Lassen was giving to the German audience an elucidation of Whish’s paper, inviting readers to pay attention to the alphabetic notation of numbers *created* by Indian mathematicians.¹¹

2.2 Kaṭapayādi Alphabetic Notation

The second and more widely used system of alphabetic notation is the so-called *Kaṭapayādi* system. Jacquet cites a Sanskrit verse which defines this system and explains it in detail.¹² Unfortunately Jacquet did not have access to any of the astronomical texts of Kerala where this system was employed and therefore could not provide examples as he did for other systems, nor was he able to discuss the age of the system. The only text he knew which employed the system was the astrological work *Jamini-sūtra* from which gives some examples and a few other stray verses to illustrate the use of the *Kaṭapayādi* system.

3. CONCLUSION

Among the many fields of Indian studies that began at that time in Europe, Jacquet had seen the importance of mathematics and astronomy in the wide territory covered by Sanskrit knowledge. Despite some mistakes, his painstaking efforts to understand the Indian systems of numerical notation are laudable for their philological precision. Despite the very modest fortune of his parents, as his biographer Félix Nève remarks (p. 14), he had resolved to continue the enormous work he had imposed upon himself. Unlike some of his contemporaries¹³ who were

¹⁰See Nève, p. 84. Jacquet does not specify how recent it must be on his opinion.

¹¹Lassen 1839.

¹²Jacquet does not mention the source of the verse; it is actually from Śaṅkaravarman’s *Sadratnamāla* (3.3) which was composed in 1819. There are some errors in Jacquet’s reproduction of the verse, but his translation does not suffer from these errors.

¹³Jacquet is the opposite of his contemporary Victor Jacquemont (1801-1832), the French naturalist who died in Bombay during a mission for the Museum of Natural History of Paris. Both the men died young, both contributed much to the scientific world, but Jacquemont indulged in the many distractions that Paris offered at that time. He was a close friend of the French writers Stendhal and Mérimée and had an affair with the Italian singer La Schiassetti.

attracted by the many distractions of the literary circles of Paris, Jacquet led a retired life which he devoted entirely to the pursuit of science, and every work he did, he did with great meticulousness.

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