“Contribution to the early history of algorithmics in Tamil: the ஆறு தெளிவுகள் in the யாப்பருங்கல விருததி, the வீரசோழியம் and the வீரசோழியம் commentary.”

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With the advent of computers, the use of algorithmic techniques which require special training and concentration has potentially become the property of everyone, because we can often simply ask a computer to “do the job”, provided we are capable of “explaining” to it in details the procedures which are to be followed. As consequence, some ancient difficult technical texts are potentially available, for active reading, to a greater public than they were in earlier periods, when those technical texts were considered as closed books for most people. This can certainly heighten the interest of the general public in the domain called “History of Science” (and History of Scientific Literature).

The present paper is dedicated to an illustration of such a situation, being an attempt at a modernized short presentation of a topic traditionally known as ஆறு தெளிவுகள் (“the six clarifications”) which is dealt with in detail inside two ancient Tamil texts,[1] the யாப்பருங்கல விருத்தி (YV) and the வீரசோழியம் (VC) commentary, these six topics being called:

1. உறழ்ச்சி (alias பிரத்தாரம்)
2. கேடு (alias நட்டம்)
3. சுட்டு (alias உத்திட்டம்)
4. ஒன்றிரண்டுமூன்றென்னுமுறைமையானேறச்சொன்ன இலகு குருச் செய்கை
5. விருத்தத் தொகை

[1] It should be stated at the beginning of this article that Tamil is not the only language for which calculations of the type described here have been performed. The reader of Knuth [2006: 49-51] is already made partly aware of the importance of Indian sources for the history of combinatorics, but a reading of Alsdorf [1933] and of Van Nooten [1993], who both build on the seminal 1863 work of Albrecht Weber, makes one fully aware of the sophistication of some Sanskrit treatises. Alsdorf 1933 article (in German) about the “pratyaya-s” has appeared in English translation in 1991 in *the Indian Journal of History of Science*. It is therefore all the more important to also draw the attention of historians of Science on the mathematical elements buried inside ancient Tamil śāstric texts, since very few people are trying to read them nowadays.

The ancient scholars who made use of those technical devices were engaged in an attempt (inside a domain on the border of combinatorics and metrics [யாப்பு]) at mastering the complexity involved in describing the bewildering variety of the metres used by poets in certain types of stanzaic composition, with a fixed rigid pattern, where the four lines of a stanza are metrically totally similar, and which fall under what the YV calls அளவியற்சந்தம் (see YV_1998, p. 507-516) and the VC calls சந்தம்[2] (see VC_1942, p. 177 and VC_2005, p.477). Those meters[3] are different from the meters which were discussed in my INFITT 2009 presentation.[4]

A striking example of the use of those rigid meters is found inside the *Tēvāram* hymn (having twelve stanzas) which is referred to as வழிமொழித் திருவிராகம் (Tēv. 3-67)[5] and in which Campantar devotes one stanza to each of the twelve names of சீர்காழி, modelling each stanza on the particular phonic form of the name which it contains. More precisely, if we adopt, from earlier writers, the convention that "**L**" represents a "light" syllable and "**G**" a heavy syllable:

- Each line in stanza 1, which contains the first name, Pi-ra-ma-pu-ra(m), contains five groups **LLLLL** of five syllables in which the first four are almost always[6] unambiguously "light" (i.e. short): சுரருலகு நர(ர்)க(ள்)பயில் தரணிதல முறணழிய அரணமதில் முப் / புரமெரிய விரிவுவகை சரவிசைகொள் கரமுடைய ….. Those five groups are followed by a heavy syllable, as a coda.
- Each line in stanza 2, which contains the second name, Vē-ṇu-pu-ra(m), contains five groups **GLLL** of four syllables, plus a heavy coda. In each of the five groups, the first syllable is always "heavy" and the following three are

[2] For instance, the commentary to the VC announces, just before VC133: "iṉic **cantaṅkaḷukkup** pirattāramutal āṟuteḷivukaḷuñ collukiṉṟāṉ." It should however be noted that the 2011 "reprint" of VC_1942 has strangely changed the numbering of VC133 to VC131 (which is VERY surprising for a reprint!)

[3] The interested reader can gain more insight into the technicalities of that type of poetry by reading the second part (starting on p.242) of Pacupati[2010]. One episode in the history of the description of those meters is presented in Maṇikaṇṭaṉ[2014].

[4] More elements are discussed in Chevillard[2014].

[5] See pp. 345-346 in the edition cited in bibliography.

[6] The exceptions seem to caused only by the occasional presence of the liquids "r" and "l". One might postulate, as a working hypothesis, that those liquids are not sufficient for making those syllables (see for instance "nararkaḷpayil") heavy. The fifth syllable in each group is somehow less precisely specified and we might want to say, as a working hypothesis, that the line contains LLLLX LLLLX LLLLX LLLLX LLLLX G, where X is unspecified, because of a short pause.

"light": தாணுமிகு ஆணிசைகொ டாணுவியர் பேணுமது காணுமள வில் // கோணுநுதல் நீணயனி கோணி(ல்)பிடி மாணிமது நாணு(ம்)வகை[7] யே ….

- Etc.[8]

Space being limited, I shall now make the hypothesis that the reader has accepted the idea that rigid metrical patterns exist in some Tamil poetical compositions, and that we have three examples inside Tēvāram 3-67, which are:

- LLLLL LLLLL LLLLL LLLLL LLLLL G (in stanzas 1, 3, 7, 8 and 12)
- GLLL GLLL GLLL GLLL GLLL G (in stanzas 2, 4, 5, 9, 10 and 11)
- LGLL LGLL LGLL LGLL LGLL G (in stanza 6)

The first pattern contains 26 syllables and the other two patterns contain 21 syllables each. We are now in a position to make use of those examples for explaining that:

- The technical devices known as ஆறு தெளிவுகள் are useful for conceiving individual patterns as part of ordered sets, which would be in that case (A) the set of all patterns made of 26 syllables and (B) the set of all patterns made of 21 syllables.
- This is obtained by associating with each pattern a number, which is its RANK inside the ordered set.

More precisely, the application of the techniques referred to by the designation ஆறு தெளிவுகள், allow us:

1. to build step by step a (virtual) chart containing many lines, illustrating the உறழ்ச்சி, i.e. all the possible N-tuples, i.e. sequences of N symbols, each symbol being taken from {L,G}
2. to find out the unknown N-tuple which sits on a line of a given rank R inside that virtual chart (This is the second clarifying device, called கேடு[9], alias நட்டம்).

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[7] Concerning this apparent exception, one can note that ம் followed by வ is called மகரக்குறுக்கம் "reduced m" in grammars, which might in fact indicate a nasalized pronunciation of the preceding vowel.

[8] Space being limited, I shall here simply briefly indicate the patterns repeated five times in the other stanzas, and the names which they imitate. They are: 3. LLLLL (**pukalinaka_**rē); 4. GLLL (**veṅkuru-v-a**_tē); 5. GLLL (**tōṇipura**_mē); 6. LGLL (**tarāymoḻi**_….); 7. LLLLL (**cirapuram-a**_tē); 8. LLLLL (**puṟavam-atu**_vē); 9. GLLL (**caṇpainaka**_r-ē); 10. GLLL (**kāḻinaka**_r-ē); 11. GLLL (**koccainaka**_r-ē); 12. LLLLL (**kaḻumala-na**_kar)

3. to determine the unknown rank inside the chart of a given N-tuple.[10] (This is the third clarifying device, called சுட்டு, alias உத்திட்டம்)
4. to find out how many of the lines in the chart contain P times **G** and (N-P) times **L**, which amounts to a knowledge of Pascal's triangle.
5. to understand how many lines global charts contain
6. to calculate how much space it would take to explicitely write down the chart.

None of those tasks is easy to carry out by hand, and anyone who has tried to read the corresponding sections in the YV (see the 1998 edition of YV, pp. 535-547] or in the VC (see the 1942 edition, pp.177-194] will be aware of the complexity involved in understanding ancient scholars' explanations.

Luckily, a great Tamil scholar, the late T.V. Gopal Iyer (1926-2007), in his 2005 edition of the Vīracōḻiyam (see VC_2005) has provided us with very lucid explanations, which allow us to easily grasp the meaning of (slightly) cryptic veṇpā-s, such as:

> குருக்கீழ் இலகுவாம் ஏனைய தொக்குங்
> குருத்தொகையு மாதிக்கட் கூட்டு

Thanks to his help (see VC_2005, pp. 479-481), and thanks also to the explanations contained in Alsdorf[1933/1991] and Van Nooten[1993], it is however possible to a modern reader to understand how this veṇpā can be expanded into an algorithm generating the sequence of all N-tuples, because, after an initialisation phase, the algorithm explains how to go from line n to line n+1.

- START with line 1 containing N times the symbol G
- LOOP: look for the first G on line n {if it is found call "p" its position; if not go to END}
- place a L at position p on line (n+1)
- place a G at all positions before position p on line (n+1)

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[9] YV says **"இனைத்தாவது என்று அறிவதன் அலகு நிலை அறியேன்"** ("I do not know the disposition of the tokens for that of which I know the rank") (YV1998, p.536).

[10] YV says **"அலகிருக்கை அறிவேன்; எனைத்தாவது என்று அதன் எண் அறியேன்"** ("I know the disposition of tokens; but I do not know its number, which tells which rank the disposition has") (YV1998, p.536).

- for all positions after before position p on line (n+1), make them similar to what they were on line n
- go back to LOOP
- END: terminate.

There is of course much more to explain concerning the ஆறு தெளிவுகள் and we are just at the beginning. I hope nevertheless have given, through this short presentation, the desire to the young generations to explore the explanations hidden in ancient books, which they can rejuvenate with their young energies. They might thus become aware of the fact that, very often, as we say in French, "L'ancien est toujours neuf!"[11]

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[11] What is old can still be new/young/relevant !

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