

Thakkura Pheru and the Popularisation of Science in India in the 14th Century

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[Sri Bhanwar Lal Nahata's services to the cause of learning are indeed manifold. Historians of Science will be ever indebted to him for the discovery and the publication of Thakkura Pheru's scientific works in Prakrit.]

1.0 Until the introduction of English in India, scientific texts as well as other scholarly works were written mainly in Sanskrit and that too in metrical form. Though Sanskrit had the advantage of being the pan-Indian medium of communication, its accessibility within any region of India was limited, and the writings in Sanskrit were naturally elitist in character, being

written chiefly by Brahmins for Brahmins. Moreover, the enormous respect for tradition and the urge to preserve it in all its purity resulted in a faithful following of the traditional frame-work in all intellectual endeavours, so much so that the chapter titles of almost all texts in a particular branch of science sound alike. If any innovations were made it was always within this framework. The lack of discrimination in the selection of ideas and the reluctance to discard outmoded concepts, coupled with a language of limited accessibility, resulted in the stagnation of Indian science in the middle ages. There is one more factor which contributed to this decline. This is the absence of communication, and therefore absence of any interaction, between science and technology. While the writers on scientific subjects were upper caste Brahmins, the practitioners of technology were artisans of low social standing. The techniques employed by the latter in their professions were rarely recorded in writing ; these were transmitted orally from father to son or from master craftsman to apprentice and remained in many cases guild or trade secrets.

0.2 The literature of the Jainas offers some sort of an exception to this general state of affairs. Though the Jainas respected Sanskrit as a vehicle of scholarly exposition, Prakrit also enjoyed religious sanction among them. Even while writing in Sanskrit, there was often a conscious attempt to simplify the language for the sake of wider under-

standing.¹ The Jaina monks played an active role in the affairs of the community and seem to have been responsible for the spread of learning to all strata of society, notably to the more numerous mercantile class of Vaisyas. In Gujarat where Jainism was influential, the Jainas of the merchant class played prominent role in the middle ages. A Jaina called Vira was the superintendent and minister of four successive rulers Mularaja, Camundaraya, Vallabharaya and Durlabharaya at the close of the tenth century and beginning of the eleventh.² His son Vimala was the commander-in-chief of Bhima I and built in 1031 the famous Vimala-vasahi temple with its exquisite marble carvings on Mt. Abu. In the thirteenth century, Vastupala served the Vaghela rulers as their Chief-minister and was a great patron of learning.³

0.3 Aside from these instances of political power, commerce was the exclusive forte of the Jainas, and much of the economic activity in the Gujarat-Rajasthan-Delhi region

was controlled by them. The members of the Srimala caste, in particular, specialised in minting and money-exchange. Even after the political domination of northern India by Muslims from the thirteenth century onwards, the expertise represented by this banker's caste was utilised by the Muslim rulers of Delhi in their minting operations,⁴ just as Hindu and Jaina masons and stone-carvers were employed in the construction of the Islamic monuments. The Kharatara chronicle mentions a number of wealthy Jainas from Delhi who enjoyed good relations with the rulers.

1.0 Notable among these members of the Srimala caste in the employment of the Sultans of Delhi is Thakkura Pheru who stands out as a writer on a wide range of scientific subjects in popular speech. He wrote six scientific works : Vastusara on architecture and iconography, Jyotisasara on astrology and astronomy, Ratnapariksa on gemmology, Ganitasara on arithmetic, Dhātutpatti on metallurgy and perfumery trade,

¹ For instance, Jinapala writing at Delhi in 1248, explains at the end of his Kharatara-gacchalamkara-yugapradhanacarya-gurvavali, a chronicle of the pontiffs of the Kharatara sect, how he simplified Sanskrit in this work in order that even children can understand it. Henceforth this chronicle will be referred to as the Kharatara chronicle. It was published in the Kharataragaccha-brhadgurvavali, ed. Jinavijaya Muni, Bombay 1966. Jina pala's statement occurs on p. 50.

² Cf. U. P. Shah, "Coinage of Early Chalukyas of Anhillavada-Patan", Journal of the Numismatic Society of India, XVI. 2 (1954), pp. 239-42.

³ Cf. B. J. Sadesera, Literary Circle of Mahamatya Vastupala, Bombay 1953.

⁴ Cf. John Scott Deyell, Living without Silver : The Monetary History of Early Medieval India (The University of Wisconsin-Madison Ph. D. Thesis, 1982. Xerography in 1983 by the University Microfilms International, Ann Arbor), Vol. I. p. 339.

and Dravyapariksa on assay and money-exchange.⁵

1.1 Pheru's biography can be pieced together from the personal references in his works. His first known work was written in 1291,⁶ hence his birth may have taken place around 1270. His native place was Kannana situated in the modern state of Haryana, and this place was not far from the then imperial capital Delhi. It was then a centre of pilgrimage for the Jains. Pheru was born in a prosperous banker's family belonging to the Kharatara sect of the Svetambara Jains. Pheru's grandfather, Kaliya or Kalasa, was a prominent banker of Kannana. It is not stated where Pheru's father Canda resided, but unlike his father, Canda had the title Thakkura. The Kharatara chronicle lists a number of prominent Jains by their names, castes and titles. A cursory survey of those enjoying the title of Thakkura shows that they are all from Delhi. This would suggest that Thakkura was a court title and that Canda may have been associated with the Sultan's treasury at Delhi.

1.2 Nothing is known about Pheru's early life and education, but it is likely that he was brought up and educated at his native

town Kannana. There in 1291, presumably at the conclusion of his formal education, he composed a eulogy of the pontiffs of his sect. Sometime later, but much before 1315, he joined the treasury of Alauddin Muhammad Khalji at Delhi and was apparently in charge of the jewellery. This job inspired him to write the Ratnapariksa, a manual on gemmology, for the instruction of his son Hemapala in 1315. In the same year he wrote two more works: the Jyotisa-sara on astrology and the Vastusara on architecture. In 1318 he must have been the assaymaster in the mint of Qutbuddin Mubarak Shah and produced his invaluable Dravyapariksa on assay and money-exchange. According to the Kharatara chronicle, he participated in that year in a pilgrimage to the holy places around Delhi. The chronicle reports further that in 1323 he joined the pilgrim congregation to Satrunjaya in Gujarat.⁷ It is not known if he was still employed at the court, but the very mention of his name among the Jaina prominence of Delhi suggests that he may have continued his services under Ghiyasuddin Tughluq as well. Thus, like Vira of Gujarat, Pheru also served four successive Sultans, Alauddin Muhammad Khalji (1296-1316),

⁵ All Pheru's works are published in the Thakkura-Pheru-viracita-Ratnapariksadi-saptagranthasamgraha, ed. Jinavijaya Muni, Jodhpur 1961. For other editions of the individual texts, see my Thakkura Pheru's Rayanaparikkha : A Medieval Prakrit Text on Gemmology, Aligarh 1984.

⁶ This is the Kharataragaccha-yugapradhana-catuhpadika, a eulogy of the pontiffs of his sect, written in Apabhramsa.

⁷ See Kharataragaccha-brhadgurvali, pp. 66-68, 72-77.

Shihabuddin Umar (1316), Qutbuddin Mubarak Shah (1316-1320) and Ghiyasuddin Tughluq (1320-1325).

1.3 It is noteworthy that Pheru's literary activity was not limited to his caste or professional interests only but extended beyond these to encompass astrology, architecture, metallurgy etc. Though well-read in Sanskrit, Pheru did not choose that language for his scientific writings nor did he choose the literary Prakrit of the Jaina clergy but wrote instead a mixture of Prakrit and Apabhramsa. Perhaps he was reluctant to abandon Prakrit altogether but at the same time wished to be understood by a wide strata of professionals like bankers, jewellers, traders, architects and masons. This way his language probably came very close to the spoken language of his day. Though he broke with the tradition of writing in Sanskrit, he still adopted the metrical form which is more suitable for memorising. However, in order to enhance the practical utility of his works, he included a large number of tables and occasional diagrams. With this background, we shall now discuss his scientific works individually in a chronological sequence as far as possible.

2.1 The Vastusara, completed on the auspicious festival of the Vijayadasami (ca. 19 September 1315) at Kannana, is divided

into three chapters. The first deals with astrological matters related to the selection of the site for house-building, auspicious moments for beginning the construction, for occupying the house etc. Normally these topics are dealt with in astrological works and not in those on architecture. But Pheru quite pragmatically includes them in his work on architecture and merely touches upon them in his book on astrology. The second chapter discusses the iconography of Jaina images and the third the architecture of various types of temples. V. S. Agrawala was of the opinion that this text "must have served as a practical hand book for architects of Jaina temples in the early Sultanate period."⁸ The Kharatara chronicle describes many instances of the construction of Jaina temples, installation of idols etc. in the Rajasthan-Delhi region in this period. It will be interesting to make a comparison of the theory expounded in this work with the extant examples of this period.

2.2 The Jyotisasara, also written in 1315, deals with the usual topics of astrology and the related areas of astronomy. This work contains many tables of computation and a detailed list of contents in Sanskrit at the end. The work is apparently meant for the use of the Jainas in the territory of Delhi, for at one place computations are given for Delhi and Hansi ; the latter was the first military outpost beyond Delhi.

⁸ "A Note on Medieval Temple Architecture", Journal of the United Provinces Historical Society, XVI. 1 (1943), p. 112.

At the beginning of the work, Pheru mentions the authorities consulted by him. I list them here to indicate his vast learning. These are Haribhadra, Naracandra, Padmaprabha, Jauna, Varahamihira, Lalla, Parasara and Garga. The first three are Jainas. The Jainas held jyotisa (i.e. astronomy, astrology and mathematics) in high esteem and wrote a large number of works on this subject. The influence of these Jaina writers on Pheru is considerable. Haribhadra (ninth century) wrote an astrological work called Lagnakundalika.⁹ Pheru apparently followed him in naming the chapters of his work dvaras (doorways). Padmaprabha Suri's Bhuvana-dipika or Grahabhavaprakasa, written in 1164, was an immensely popular text. There are several commentaries on it, and about three hundred manuscripts of this work are extant today.¹⁰ Naracandra Suri (d. ca. 24 August 1230) was a teacher of the famous Vastupala and the author of the Jyotisasara, also known as Naracandra or Naracandra-paddhati. This was also a very popular work, for there are some two hundred and odd manuscripts available today.¹¹ Pheru's aim seems to be to present the teachings of these Sanskrit works in simple Prakrit.

2.3 The Ratnapariksa on gemmology was also written in 1315. At the beginning of

this work, Pheru states that (i) he has studied the earlier Sanskrit texts on gemmology, (ii) seen the ocean-like vast collection of gems in Alauddin's treasury and (iii) observed the gem-testing by other experts. To put it differently, Pheru (i) acquired theoretical knowledge from the existing literature, (ii) had the practical experience of handling gems in the royal treasury, and (iii) underwent a period of apprenticeship under experts. One would call this a truly modern scientific approach. Pheru was indeed well placed to fulfil all the three conditions. His wide learning and good command of Sanskrit enabled him to read Sanskrit manuals on gemmology by Buddhabhatta, Agastya, Brhaspati and others. Secondly, Alauddin amassed enormous quantities of gems and precious metals during his campaigns, and his treasury must indeed have resembled an ocean full of gems. There can be no doubt that many of the gems were of a rare quality. An exquisite diamond said to have been acquired by Alauddin reached the hands of the Mughal emperor Babur in 1523. Babur states that "it is so valuable that a judge of diamonds valued it at half the daily expense of the whole world"¹² Thirdly, Alauddin's court boasted of Muslim experts also who were well versed

⁹ Cf. Ambalal P. Shah, *Jaina Sahitya ka Brhad Itihas*, Vol. V, Varanasi 1969, p. 168.

¹⁰ Cf. David Pingree, *Census of the Exact Science in Sanskrit*, Series A, Vol. 4, Philadelphia 1981, pp. 173-179.

¹¹ Ibid., Vol. 3, Philadelphia 1976, pp. 132-36.

¹² *Memoirs of Zehir-ed-Din Muhammad Babur*, tr. John Leyden and William Erskins, London 1921, Vol. II, pp. 191-92. Many historians and gemmologists thought this diamond to be identical with the famous Koh-i-Nur, but this view is no more favoured.

in Islamic gemmology. The quartermaster-general was such an expert, so was the court poet Amir Khusrau. Under these circumstances, one would expect that Pheru's treatise would (i) present Indian theories of gemmology, (ii) describe some of the rarest gems in the royal treasury, and (iii) display some acquaintance with Islamic gemmology, in particular with the Arab discoveries about the specific gravity of gems.

But Pheru's aim was modest, namely to provide his son with a practical handbook containing the contemporary tariff of prices along with some amount of the traditional theory and lore of gems. Therefore, he paraphrases the earlier writings—sometimes indiscriminately—on the mythology, properties and sources of gems. About the sources, he is most careless, repeating often the same lists of places enumerated by the earlier writers, sometimes even misunderstanding them. But unlike the earlier writers who mention the price of each gem separately along with its description, Pheru has an entire section where he quotes the prices very systematically, first in verses and then in tables for easy reference. Though the royal treasury might be overflowing with gems of large size, the prices quoted are only for gems weighing up to 18.35 metric

carats. Perhaps gems beyond this weight were not offered for sale in the market but were surrendered to the royal treasury.¹³

Besides this innovation of a separate section on the price tariff, there is another aspect where the *Ratnapariksa* distinguishes itself. It is the description of the gems imported from Persia (spinel, cornelian and turquoise). Pheru was the first Indian gemmologist to describe these gems, and his information is quite precise and accurate as can be seen from the contemporary Arabic works on gemmology.¹⁴

Though the *Ratnapariksa* cannot be counted among Pheru's best works, it exemplifies certain characteristics of Pheru as a writer. These characteristics are as follows : (i) Where there exists a corpus of traditional literature on a subject, he is content to follow the traditional framework and to present the material in Prakrit (as in the description of gems). (ii) However, he makes innovations in the traditional framework if practical considerations demand them (e.g. the price tariff; see also 2.4 below). (iii) But where there is no traditional literature to lean on, he writes from his practical knowledge, and is most original and precise (e.g. on the gems imported from Persia). The *Dhatutpatti* (see 2.5)

¹³ Fernao Nuniz reports in the sixteenth century that in the kingdom of Vijayanagara all diamonds exceeding 25 ct. were to be given to the king's treasury. See Robert Sewell, *A Forgotten Empire : Vijayanagara*, (reprint) Delhi 1962, p. 369.

¹⁴ Cf. Eilhard Wiedemann, *Aufsätze zur arabischen Wissenschaftsgeschichte*, hrsg. Wolf Dietrich Fischer, Hildesheim/New York, Vol. I, pp. 835-53.

and more particularly the Dravyapariksa (see 2.6) belong to this category of original works.

2.4 The Ganitasara or arithmetic is not dated but must have been written before 1318. Compared to the previous text, this one is more innovative, not so much in the theoretical portions but in the application of arithmetical rules to a wide range of areas. It is a common place to say that arithmetic is one of the most practical of sciences, its rules being employed by traders, masons, carpenters, tax-collectors and the like for the calculations connected with their professions. The units of measurement and the examples to illustrate arithmetical rules given by Pheru throw a flood of light on the economic and social conditions of this period. Here a few examples will suffice.

In the section on solid geometry, Pheru gives the rules for the volumes of domes (gonamta), square and circular towers with spiral stairways in the middle (payaseva), towers with fluted columns (munaraya), niches (taka), staircase (sopana), bridges (pulabamdha) and so on (III. 74-86). It should be noted that some of these are new architectural features being introduced by the Muslim rulers into India in this period. The purpose of such rules is to enable the chief mason to calculate the number of bricks or stones needed for these constructions. To do this calculation more exactly, Pheru informs us, one should first calculate the total volume of the wall space, subtract

from this the volume of the space occupied by the doors and windows, and then reduce the remainder by three-twentieths, the latter being the volume of the mortar (III. 70-71). The result when divided by the volume of a single brick yields the number of bricks.

Historically more significant is the following statement: "The munaraya is like a circular tower with a spiral stairway in the middle, as far as the inside is concerned. But the difference is this: the wall contains half triangles and half circles" (III. 80). The meaning of the cryptic last sentence is that in a horizontal cross-section of the munaraya, the outer circumference consists of alternate triangles and semicircles. It should be remembered that about a hundred years before this time, Qutbuddin Aibak built the Qutb Minar in Delhi and that Alauddin himself started constructing another tower twice as high. Now, the lower story of the Qutb Minar consists of alternately angular and circular columns, and it is clear that Pheru is referring here to such a tower with fluted columns.

In another section, dealing with cloth (IV. i. 18-37), Pheru mentions different kinds of silk, woollen and cotton materials, the rate of shrinkage or loss in washing, cutting and sewing, and the area of cloth needed to make various types of tents. There is a last section (IV. iii. 1-17) listing the average yields of grains, pulses, etc. per bigha, the average yield of molasses and brown sugar per maund of sugarcane, the amount of clarified butter that can be obta-

ined from cow's and buffalo's milk and so on. Mention must also be made of Pheru's rule for converting Vikrama dates into Hijri dates and vice versa (IV. i. 17) which is probably the first such rule to be formulated in India. It must be emphasized that all this is not germane to arithmetic as such, but Pheru is adapting arithmetic here to suit the needs of a variety of professions.

2.5 The Dhatutpatti, also not dated, deals with a heterogeneous mixture of topics, namely origin of metals, extraction of metals and perfumery articles. In the shape it has come down, the text does not seem to be complete or even continuous. Perhaps here are separate extracts from the lost Bhugarbhaprakasa said to have been written by Pheru. Even so, the present text offers valuable material. The section on the perfumery articles describes the properties, varieties, provenance and prices of camphor, aloe wood, sandalwood, musk, saffron etc. But more important is the section which discusses the techniques of extracting or preparing brass, copper, lead, tin, bronze, mercury, vermilion, red lead etc. This and the first part of the Dravyapariksa (to be discussed below) show Pheru's familiarity with metal technology, and are unique contributions to the history of metallurgy in medieval India.

2.6 The Dravyapariksa was written in 1318 during the reign of Outbuddin Muba-

rak Shah. Pheru states that he wrote this work on the basis of his direct experience of various types of coins while he was employed in the Delhi mint. The expression dravyapariksa denotes the examination of the metal content in coins or the assay. Since there was no official rate of exchange at that time for different currencies, the official or private money exchangers priced a coin on the basis of its metal content. For this purpose the coins had to be assayed either by melting some samples or, if the coins were few and of gold or silver, by rubbing them on the touchstone.¹⁵ Pheru states that he wrote this work for the sake of his son and brother who may have been embarking on the profession of money exchangers.

The Dravyapariksa can be divided into two parts. The first part (vv. 1-50) deals mainly with the techniques of refining gold and silver and of determining their fineness, and thus provides the necessary technical background for money exchange. The second part (vv. 51-149) can be termed a coin catalogue and is numismatically most valuable. Here are described the mullu tullu davvo namam thanam, the name, provenance, weight, average metal content and the exchange rate in terms of the Khalji currency. This data is given both in verses and in tables for some 260 types of coins belonging to the thirteenth and early fourteenth

¹⁵ See my paper, "Varnamalika System of Determining the Fineness of Gold in Ancient and Medieval India". Aruna-Bharati : Professor A. N. Jani Felicitation Volume, Baroda 1983, pp. 369-389.

centuries, issued by various kingdoms of northern India. Some of the coins described here are no more extant and the Dravya-pariksa remains the only testimony we have for the monetary history of several kingdoms.

Of the names listed by Pheru, some are based on the denomination, some on the king who issued them, some on the shape and some on the ornaments. The different kingdoms that issued these coins include Khurasan, Multan, Jalandhar, Banaras, Tahan-garh, Malwa, Canderi, Devagiri, Gujarat, Narwar and, of course, Delhi. It is worth noting that where a number of coins from a single kingdom are listed, these are arranged in the correct chronological sequence.

Now we turn to the most valuable data, the metal content. In the case of gold and silver coins, Pheru gives their degree of fineness. For coins made of alloy, the weight of each metal per 100 specimens is listed. Such information must have been obtained by Pheru, in most cases, by his own assay. Some of his assays, done through what would be considered primitive methods today, have been compared with modern assays and found to be quite accurate.¹⁶

The most interesting and comprehensive list is naturally of the coinage issued by the Sultans of Delhi, especially Alauddin and his successor Qutbuddin Mubarak. Pheru lists 12 types of coins issued by the former

and 63 types by the latter. It should be noted that Mubarak issued these 63 types during the brief span of his reign from 1316 to 1318. Apart from the large number of types, the quality of his coinage was far superior to that of his predecessors. Nelson Wright observes : "The coinage of Qutbuddin Mubarak stands out for its boldness of design and the variety of its inscriptions... There is perhaps no finer coin in the whole pre-Mughal series than the broad square gold tankah of high relief struck at Qutbabad Fort."¹⁷

Occupying a high position at the mint, Pheru must have had an active role in issuing these diverse types of coins and in the improvements in minting technology. It is indeed fortunate that he shared his master's enthusiasm for coins and, drawing upon his own experience and that of his caste, left us an excellent guide to the coinage of northern India.

3.0 It is now pertinent to ask whether Pheru's attempt at popularisation of science has had any impact or emulation. Perhaps a thorough survey of the Jain Mss. collections in Gujarat and Rajasthan may one day bring to light some scientific texts written in popular speech, but on the whole the tradition of writing in Sanskrit metres was so strong that Pheru's example was rarely followed. On gemmology, however, there

¹⁶ Cf. John Scott Deyell, op. cit., I, p. 344.

¹⁷ H. Nelson Wright, The Coinage and Metrology of the Sultans of Delhi, (reprint) New Delhi 1974, pp. 107-8.

are some texts written in old Hindi and old Rajasthani by jewellers and even by Jaina monks. But these are faithful renderings of the Sanskrit originals and do not exhibit any innovations.¹⁸ An old Gujarati text of the fifteenth or sixteenth century called Vividhavarṇaka enumerates tamkapaṛikṣa (i.e. examination of coins) as one of the sciences,¹⁹ but except the Dravyapaṛikṣa no

other text on this subject has been discovered so far.

Just as English is used today in India for the sake of pan-Indian or even world-wide communication, the Hindu and Jaina scientists wrote in the pan-Indian medium of Sanskrit until it was replaced by English. Thakkura Pheru, therefore, remains the only versatile scholar to have attempted to popularise science.

¹⁸ Cf. Agarchand Nahata and Bhanwar Lal Nahata, *Ratnaparikṣa*, Calcutta n. d.

¹⁹ See *Varnaka-Samuccaya*, ed. B. J. Sandesera, Pt 1, Baroda 1956, p. 48.