

The Institutional Foundations of Science Education and Physics Research in Colonial India, 1757–1857

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Abstract- The century between the Battle of Plassey (1757) and the founding of the universities of Calcutta, Bombay and Madras (1857) is usually treated as a prehistory of modern science in India, a period of surveys and collections before the age of the laboratory. This paper argues that these years laid down institutional foundations that shaped how physics would later be taught and practised in the subcontinent. Drawing on published educational records and the historiography of colonial science, it examines three clusters of institutions: the state's instruments of measurement and communication (the observatory, the Great Trigonometrical Survey and the electric telegraph); the policy debates that decided whether, in what language and for whom natural philosophy would be taught; and the colleges and translation bodies through which Indian students first met mechanics, optics and higher mathematics. The analysis shows that the physical sciences entered colonial India chiefly as practice in the service of the state, in the form of precision measurement, geodesy, meteorology and telegraphy, while formal teaching of natural philosophy remained thin, uneven and dependent on Indian initiative. The examining universities of 1857 consolidated this pattern by rewarding the reproduction of knowledge rather than its creation. The paper concludes that the later struggle to build research-led physics in India was, in large part, a struggle against the institutional settlement of this first colonial century.

Keywords: colonial science; history of physics; science education; East India Company; natural philosophy; Great Trigonometrical Survey; Orientalist–Anglicist debate

I. INTRODUCTION

Histories of modern physics in India customarily begin in the late nineteenth century, with the founding of the Indian Association for the Cultivation of Science in 1876 or with the experiments of Jagadis Chandra Bose in the 1890s. What came before is often summarised in a sentence: a century of surveys, botanical gardens and learned societies run by and for Europeans. The summary is not wrong, but it leaves an important question unasked. When Indian physicists began to do original research around 1900, they did so inside colleges, universities, government departments and journals whose shape had been settled much earlier. Understanding the first colonial century is therefore a precondition for understanding why physics research in India developed as it did.

This paper is concerned with the period from 1757, when the East India Company's victory at Plassey opened the way to its control of Bengal, to 1857, when Company rule was shaken by the uprising and the first three Indian universities were incorporated. In these years there was no physics in the modern disciplinary sense. The relevant knowledge travelled under the headings of natural philosophy and mixed mathematics, and it reached India along several routes at once: through the instruments and routines of the colonial state, through missionary and private educational ventures, and through Indian intellectuals who sought out European

learning for purposes of their own [1], [2]. These routes did not add up to a single system. As Kumar has argued for the colonial period more generally, science and society in British India interacted on markedly unequal terms, and any account of scientific institutions has to reckon with that inequality [3].

Three questions organise the discussion. First, which institutions actually practised the physical sciences in Company India, and to what end? Second, how did the policy debates of the 1820s and 1830s decide what place natural philosophy would have in public instruction? Third, through which colleges and translation projects did Indians first study mechanics, optics and mathematics, and what did the universities of 1857 do with that inheritance? Section 2 sets out the historiographical frame. Sections 3 to 6 take up the three questions in turn, and Sections 7 and 8 draw the threads together.

II. HISTORIOGRAPHICAL FRAME AND SOURCES

For a long time the standard model of the spread of modern science beyond Europe was George Basalla's three-phase scheme. In the first phase a non-European territory serves as a source of specimens and data for European science; in the second, a dependent "colonial science" grows up, tied to metropolitan institutions; and in the third, an independent national scientific tradition emerges [4]. The model remains useful as a first map because it draws attention to the gap

between gathering data and building institutions. Its weaknesses are equally familiar. It treats the colony as a passive recipient, assumes a single direction of travel, and has little to say about local actors who adapted European knowledge to their own ends [5], [6].

Later scholarship has replaced diffusion with more interactive pictures. Kapil Raj has shown that much of what counted as European knowledge of South Asia was produced through encounters in which Indian skills of surveying, translation and classification were indispensable, so that the centre of knowledge production was itself relocated [7]. Zaheer Baber and David Arnold, from different starting points, have stressed the close fit between colonial science and the needs of the colonial state, while acknowledging the agency of Indian participants [2], [8]. Satpal Sangwan's work on precisely the period 1757–1857 is especially relevant here, because it documents a far more varied Indian response to European science than the older picture of indifference allowed [1], [9].

A note on terminology is also needed. To speak of “physics” before 1857 risks anachronism, since the discipline acquired its modern boundaries only in the second half of the nineteenth century. In this paper the term is used in a deliberately broad sense, to cover the kinds of knowledge that later fell within physics departments: mechanics, optics, heat, electricity and magnetism, astronomy as a science of measurement, and the mathematics on which these depended. The aim is not to find modern physics in the period, but to identify the places where such knowledge was taught, practised and institutionalised.

The sources used in this paper are of two kinds. The policy debates are followed through the published selections from the educational records of the Government of India and through the documentary collection on the Orientalist–Anglicist controversy [10], [11]. The institutional account rests on the secondary literature on the Asiatic Society, the survey, the telegraph and the colleges, cited in the relevant sections. The paper does not claim new archival findings. Its contribution is to read this literature with one question in mind: what the institutional arrangements of the first colonial century implied for the later development of physics in India.

III. SCIENCE IN THE SERVICE OF THE COMPANY

1. Observatory, Survey And Telegraph

The earliest sustained practice of the physical sciences in Company India took place not in classrooms but in the apparatus of rule. A private observatory established in Madras in 1786 passed into the Company's hands in the early 1790s and became a base for systematic astronomical and

meteorological observation in the south [2]. Its purpose was practical: accurate positions for navigation and for the maps the Company increasingly needed.

The Great Trigonometrical Survey, begun under William Lambton in 1802 and later directed by George Everest, carried this practical astronomy onto the land. The survey was among the most demanding exercises in precision measurement anywhere in the early nineteenth century. Its baselines had to be measured with chains and bars whose length varied with temperature; its angles had to be corrected for atmospheric refraction; and the figure of the earth itself, including the attraction of the Himalayan mass on the plumb line, entered its calculations [12].

In practice the survey was a school of applied physics, even though it was never described as one. Edney has shown that it was also a political project, whose rhetoric of exact measurement served to present British rule as rational and comprehensive [12]. Indians worked in it as instrument bearers, computers and assistants. Radhanath Sikdar, who served as a computer from the 1830s and became the survey's chief computer, is the best-known example [2]. Yet, as Kumar has shown for the scientific services more generally, the skills of Indian practitioners were recognised on terms set by their European superiors, and the higher posts remained effectively closed to them [13].

The Asiatic Society, founded in Calcutta in 1784, provided a forum in which such measurements could be reported alongside antiquarian and linguistic research [14]. Under James Prinsep, who took over the editorship of *Gleanings in Science*, a Calcutta monthly founded in 1829, and transformed it into the *Journal of the Asiatic Society of Bengal* in 1832, the Society's publications carried a steady stream of meteorological tables, geological notes and accounts of instruments [14], [15]. Prinsep himself was an assay master whose interests ran from weights and measures to the decipherment of ancient scripts. The breadth of his journal is a reminder that the physical sciences in this period were practised by generalists, for whom exact measurement was one tool among many.

The most striking application of physical knowledge before 1857 was the electric telegraph. William Brooke O'Shaughnessy, a medical officer who taught chemistry at the Calcutta Medical College, began experimental telegraph lines near Calcutta in 1839. In the early 1850s, with the backing of the Governor-General, Lord Dalhousie, he directed the construction of a network that by the eve of the 1857 uprising linked the principal cities of British India [16]. Lahiri Choudhury's study of the changing culture of science and experiment in India between about 1830 and 1856 places the telegraph within a wider transition, in which experimental work moved from individual trials towards large systems run by the state [17]. The telegraph also fits a pattern identified by Bayly, for whom the Company's power rested on the

collection, transmission and control of information [18]. Physics entered India, in other words, largely as a technology of government.

Two consequences follow. First, the most advanced physical work in the country was carried out inside departments whose priorities were administrative rather than scientific. Second, the Indian participants in that work acquired technical skill without acquiring the authority to direct research. Both features would persist long after 1857.

IV. DECIDING WHAT TO TEACH

1. Orientalists, Anglicists And Natural Philosophy

The Company's first educational foundations were Orientalist in character. The Calcutta Madrasa (1781) and the Benares Sanskrit College (1791) were established to cultivate Persian, Arabic and Sanskrit learning, partly to secure the confidence of Indian elites and partly to train law officers [11], [15]. The College of Fort William, opened in 1800, taught Indian languages to young British civil servants. None of these institutions placed natural philosophy at its centre.

The question of science teaching came to the fore after the Charter Act of 1813, which required the Company to set aside a modest annual sum for the revival of literature, the encouragement of learned Indians and the promotion of a knowledge of the sciences among the inhabitants of its territories [10]. How that clause should be read became a matter of dispute. The General Committee of Public Instruction, formed in 1823, at first favoured the support of classical Indian learning. In the same year Rammohun Roy wrote to the Governor-General objecting to the plan for a new Sanskrit college in Calcutta and asking instead for instruction in mathematics, natural philosophy, chemistry, anatomy and other useful sciences [10], [11]. His letter is often cited as evidence of Indian demand for European science. It is equally evidence that, in the view of a leading Indian reformer, the Company was not supplying it.

The controversy was settled, at least formally, in 1835. Thomas Babington Macaulay's Minute on Indian Education dismissed Oriental learning in notoriously contemptuous terms, and Lord William Bentinck's resolution of March 1835 directed that public funds be used to promote European literature and science through the medium of English [11]. Two features of this settlement matter for the history of physics. The first is that the Anglicist victory was won largely in the name of literature. The curriculum that followed emphasised English language and letters, and science remained a minor element in it [1], [19]. The second is that the choice of English as the medium narrowed the social base of science education to those who could afford an

English schooling, and for a time closed off the vernacular routes that some reformers had favoured [9].

Kopf's study of the Orientalist circle around Fort William complicates any simple contrast between the two camps. Orientalist scholars were not necessarily hostile to European science, and Anglicist officials were not consistently committed to it [15]. What the debate settled was less a programme of science teaching than a principle of language and patronage, and the place of natural philosophy within public instruction remained to be fought over in the colleges themselves.

V. COLLEGES, TRANSLATION AND THE VERNACULAR ROUTE

Whatever the policy debates decided, the first sustained teaching of natural philosophy to Indian students came from institutions of mixed sponsorship. The Hindu College in Calcutta, opened in 1817 with the support of Indian patrons and European sympathisers, offered mathematics and natural philosophy alongside English literature, and its students formed the core of the generation that would later demand more science [1], [15]. The Baptist missionaries at Serampore founded a college in 1818 and, through their press, issued textbooks in Bengali, while the Calcutta School-Book Society, established in 1817, commissioned and printed elementary texts, some of them in the sciences [9].

The Calcutta Medical College, founded early in 1835, the year of the Anglicist decision, was in some respects the most important channel. Medicine required chemistry, and chemistry in turn drew in heat, electricity and the handling of instruments; O'Shaughnessy himself taught chemistry there before turning to the telegraph [2], [16]. Engineering education developed along a parallel track. A survey school had existed at Madras since the late eighteenth century, and the college opened at Roorkee in 1847, later named after James Thomason, trained civil engineers and surveyors for the public works of the North-Western Provinces [2]. In these institutions physical science was taught for vocational ends, as preparation for medical or engineering service.

Developments outside Bengal followed a similar pattern. In Bombay, Elphinstone College, opened in the mid-1830s with funds raised in honour of the former governor Mountstuart Elphinstone, taught mathematics and natural philosophy, and Indian teachers such as Bal Gangadhar Shastri Jambhekar combined that teaching with the writing of educational texts in Marathi [9]. Such efforts show that the demand for scientific instruction was not confined to Calcutta, and that Indian teachers were already acting as translators and interpreters of European science in the regional languages.

The most interesting experiment in science education in this period took place in Delhi. The Delhi College, established in

1825, and the Vernacular Translation Society attached to it in the 1840s, produced Urdu versions of European works in mathematics and the natural sciences [20], [21]. Their best-known product was Master Ramchandra (1821–1880), a teacher of science at the College, who edited Urdu journals that popularised European science and wrote a treatise on problems of maxima and minima that sought to solve them by algebraic methods without the calculus [20]. The treatise came to the notice of Augustus De Morgan, who arranged for its publication in London in 1859 [22]. Raina and Habib have read Ramchandra's career as an attempt to introduce scientific rationality into north Indian intellectual culture on its own linguistic terms, and his treatise as a pedagogical

project that was aborted when the institutions supporting it were swept away in 1857 [20], [23]. The Delhi experiment shows that a vernacular route into the exact sciences was imaginable and, for a short time, workable.

Table 1 summarises the principal institutions discussed so far. Read together, they reveal a clear pattern. The institutions that did physics, namely the survey, the observatory and the telegraph, did not teach it; and the institutions that taught it did so at an elementary level, for professional or moral ends, with little expectation that students would add to knowledge.

Table 1. Selected institutions relevant to the physical sciences in India, 1757–1857

Year	Institution	Place	Relation to the physical sciences
1784	Asiatic Society	Calcutta	Learned society; its journal reported meteorological, geological and instrumental work
1786; Company control early 1790s	Madras Observatory	Madras	Astronomical and meteorological observation for navigation and mapping
1800	College of Fort William	Calcutta	Language training for civil servants; little science
1802	Great Trigonometrical Survey	Madras, later India-wide	Geodesy and precision measurement
1817	Hindu College	Calcutta	Mathematics and natural philosophy for Indian students
1818	Serampore College	Serampore	Missionary college; textbooks in Bengali
1825; 1840s	Delhi College; Vernacular Translation Society	Delhi	Teaching and Urdu translation of mathematics and natural science
1835	Calcutta Medical College	Calcutta	Chemistry and allied physical science within a medical curriculum
1839–1856	Telegraph experiments and network	Calcutta, then India-wide	Applied electricity under state direction
1847	College at Roorkee (later Thomason College)	Roorkee	Civil engineering and surveying
1857	Universities of Calcutta, Bombay and Madras	Presidency towns	Affiliating and examining bodies

Compiled from the sources cited in Sections 3–6.

VI. THE SETTLEMENT OF 1857

6.1 Universities And The Examining Model

The Education Despatch of 1854, associated with Sir Charles Wood, proposed a graded system of public instruction, grants-in-aid for private institutions and universities on the model of the University of London [2]. The universities of Calcutta, Bombay and Madras, incorporated in 1857,

followed that model closely. They were affiliating and examining bodies. They prescribed syllabuses, held examinations and conferred degrees, but they did not themselves teach or conduct research [2], [19].

The consequences for science were considerable. Teaching remained the business of affiliated colleges, many of which lacked laboratories. Examinations rewarded memorisation over experiment. The careers that a degree opened up lay chiefly in law and government service, not in science. Kumar's study of science in the decades after 1857 shows how slowly this changed, and how often Indians who aspired to scientific careers met with exclusion from the higher scientific services [13], [19].

The structural weakness was eventually acknowledged. The Indian Universities Act of 1904 gave the universities power to teach, and it was under this provision that the University of Calcutta later created postgraduate departments and endowed chairs in the physical sciences [24]. That development lies outside the period of this paper, but it makes sense only against the background of the examining university created in 1857.

VII. DISCUSSION

Three conclusions can be drawn. The first concerns the location of physical science. Between 1757 and 1857 the most sophisticated physical work in India was done inside the state's machinery of survey, observation and communication. This supports the view of Arnold and Baber that colonial science was closely bound to the requirements of rule [2], [8]. It also suggests a qualification. Precision geodesy and telegraphy were not simply applications of metropolitan theory. They were sites where new practical problems were met and solved locally, often with Indian labour and skill, as Raj's account of circulation would lead us to expect [7].

The second conclusion concerns education. The debates of 1823–1835 are often presented as a contest between tradition and modern science. In practice, as Sangwan and Kopf have shown in different ways, neither party made the teaching of natural philosophy its central aim, and the eventual settlement favoured English letters more than science [1], [15]. The most imaginative efforts, namely Rammohun Roy's petition, the Delhi translations and Ramchandra's mathematics, came from Indians or from Indian–European partnerships working at the margins of official policy [20], [22], [23].

The third conclusion concerns the legacy of the period. By 1857 India possessed scientific departments that did not train researchers, colleges that taught science largely without laboratories, and universities that examined but did not teach. Basalla's model would call this colonial science [4]. Raina's critique reminds us that the dependence was structural and institutional rather than intellectual [5], and Chakrabarti's account of metropolitan methods and colonial practices suggests that the gap between the two was itself a defining feature of science in British India [6]. Prakash has argued that, by the later nineteenth century, science had become for the Indian elite a central sign of modernity and of the capacity for self-rule [25]. If so, it was a sign that had to be appropriated from institutions designed for quite other purposes.

A fourth observation, about language, cuts across the other three. The decision of 1835 to teach European science through English tied the future of science education in India

to the spread of English schooling. The Delhi translations, the Bengali textbooks of Serampore and the Marathi writings of teachers in Bombay point to an alternative in which the exact sciences would have been taught, at least at the elementary level, in the languages of the students [9], [21]. That alternative was not pursued as state policy, and its eclipse helps to explain why scientific education in India remained the preserve of a narrow, English-educated stratum well into the twentieth century. The question of science in the Indian languages, which recurs in later debates about national education, therefore has its roots in this first colonial century.

VIII. CONCLUSION

The first colonial century did not produce Indian physicists, but it produced the institutional conditions in which Indian physicists would later have to work. Physics arrived as measurement and technique in the hands of the state. Science teaching occupied a marginal place in the policy settlement of 1835. The most promising vernacular experiment was cut short in 1857, and the universities created in that year were designed to examine rather than to discover. When Indian reformers began, later in the nineteenth century, to found institutions for the cultivation of science under their own management, and when Indian scientists began to undertake original research around 1900, they were responding to this inheritance. A fuller history of physics in India therefore needs to begin not in 1876 or 1900 but in 1757, with the institutions that made the later struggle necessary.

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