Indian Journal of History of Science, **21**(1): 22—32 (1986)

THE GREAT TRIGONOMETRICAL SURVEY OF INDIA IN A HISTORICAL PERSPECTIVE

RAMA DEB ROY

Pre-Census Population Studies Unit
Indian Statistical Institute
203, Barrackpore Trunk Road
Calcutta-700 035

(Received 27 August 1984)

The British rulers in India came to understand that they should conduct extensive surveys of various types over the territories which they acquired either by conquer or by cession. It was essential for them to have a complete geographical knowledge of the country for their revenue and administrative purposes. Three main branches of land surveys conducted by the East India Company in India were (a) revenue surveys, (b) topographical surveys and (c) trigonometrical surveys which threw voluminous information about the land and the people of the country.

In the south of India, after the fall of Seringapatam in 1799 Lord Wellesley felt the necessity of exploring and collecting information of the newly conquered vast territories. Three streams of surveys started almost concurrently. Francis Buchanan started a general agricultural survey of Mysore and Malabar. Topographical and trigonometrical surveys were led respectively by Colin Mackenzie and William Lambton.

William Lambton, a geographer as well as a geodesist correctly understood that accurate maps of a large country could be obtained only through geodetic surveys. With this purpose in mind, William Lambton submitted his plan for a Geographical and Mathematical Survey in 1799 and started working in 1802. In the early years he had to face a lot of oppositions from the administrators as well as the scientists. But he was able to overcome all these barriers by his skill, and progressive achievements. His survey was officially named the Great Trigonometrical Survey from 1818, only a few years before his death.

During 1802 to 1815 Colonel Lambton measured a large number of base lines with a network of triangles covering the country upto 18° latitude. Triangulation also covered the territories from Goa to Masulipatam, from Cape Comorin to the southern boundary of the Nizam's and the Maharatta possessions. The total area covered was 165,342 square miles

George Everest joined the trigonometrical survey in 1818. After the death of Colonel Lambton in 1823 he became the Superintendent of the Great Trigonometrical Survey. Everest led the success further. He measured the Bedar base line to connect Bombay and the Great Arc from Cape Comorin to the Himalayan Mountains. He improved the methodology of surveying by introducing the use of luminous signals at night in stead of flags and beacons by day and also the gridiron system which replaced Lambton's labourious method of throwing a network of triangles. He became the Surveyor General in India in 1830 and was succeeded by Andrew Waugh in 1843.

Triangulation of a vast region between the Great Arc and Calcutta was completed by Waugh. He also measured the north-eastern Himalayan series and determined the heights of 79 Himalayan peaks and named the 15th peak as Mount Everest.

In 1861 the Offices of the Surveyor General and Superintendent of the Great Trigonometrical Surveys were separated and Colonel Thuillier and Colonel Walker took charge of the two offices respectively. By this time the work of principal triangulation of the country was completed. The main work awaiting for Walker was to determine the length and azimuth of the triangles and the latitudes and longitudes of different places. In 1877 Colonel Walker became the Surveyor General of India and the three branches of surveys—topographical, trigonometrical and revenue—were merged together to form the Survey of India which in later years continued the triangulation work in the rest of the areas to cover the whole of India.

It is therefore revealed that the ready materials which we get in the present days are the results of invaluable attempts of the British scholar administrators which they initiated to enrich their knowledge about an unknown country which came under their possession.

Introduction

India has now a high level sophisticated and integrated organisation known as the Survey of India. Almost the whole country has been covered by triangulation through a series of topographical and geographical maps on the basis of geodetic and topographical surveys. The topographical maps are sufficiently detailed to identify the individual features on the ground. The maps on scale one-inch to four miles and larger are called topographical maps. Those maps which are smaller than one-inch to four miles are called geographical maps. The Survey of India also makes available triangulation charts and pamphlets and related information as in other countries. This magnificent organisation was built up, brick by brick, from scrap to consolidate a growing territorial possession in a well-knit empire.

The English conquest of Bengal was followed by initiating a series of scientific surveys in the vast territory—land survey, marine survey, geographical survey including astronomical observations. Similar surveys were also undertaken in the Presidency of the Fort St. George leading to the establishment of an observatory and a surveying school. The fall of Seringapatam in 1799 induced the administrators to conduct a series of surveys—trigonometrical, topographical and revenue. Colin Mackenzie started the Mysore survey in 1799. Concurrently William Lambton submitted his plan for a geographical and mathematical survey and started working in 1802. This survey known as the Great Trigonometrical Survey from 1818, led successively by William Lambton, George Everest, Andrew Waugh and James Walker, extended almost to the whole of India. The survey occupied a place of pride by William Lambton's contribution to the science of geodesy and to the foundation of Indian geography on a granite base. This survey was also accepted as the basic frame of all other surveys. An account of this survey has been attempted in a historical context within a very brief outline.

State of the traditional knowledge and institutions in India and interface of the society with knowledge

The most essential principle underlying the importance of latitude for indicating geographical position was realised by the Greek geographer Ptolemy, the author of *Almagest,* a treatise on astronomy, in the second century A.D.[1] Scientists and technicians in Greece and Egypt are said to be pioneers in understanding the elementary principles of trigonometry. Elements of trigonometry were contained explicitly in a lost work of "a Greek Hipparchus of Nicaea (*c.* 140 B.C.) which has said to have comprised twelve books on chords of circles." The pyramid builders are said to have known of fixed ratios in similar triangles. Hindu astronomers of India and Muslim astronomers of Arabia and Persia were indebted to the works of the Greek. Indian astronomy was in glory during 400 to 1100 A.D. In India, in the writings of Aryabhatta (*c.* 500 A.D.) and Brahmagupta (*c.* 620 A.D.) chords were halved and something like modern *sines* was developed. The astronomical knowledge passed from India to the Arab world.[2]

Very little progress in Europe was made in astronomy after Ptolemy. They learned from the Greek through the Arabs. The royal astronomer of India, Raja Jai Singh who ruled from 1699 to 1743 is known for his keen interest for gathering European knowledge on the subject with some success. He founded observatories at Jaipur, Delhi, Mathura, Ujjayini and Varanasi.[3] In connection with revenue administration, there were definite procedures for measuring land and village boundary as illustrated by Kautilya.[4] In the Muslim period, surveys were prevalent as a measure for assessment. Records of surveys conducted in 1820's in the North-Western Provinces show that the Mughal rulers were aware of the necessity of accurate surveys.[5]

Introduction of European knowledge and the British system

Policies and strategies of the British : The English rulers of the East India Company were very much conscious about the necessity of accurate geographical knowledge for military and administrative purposes. As a matter of practice, surveyors preceded or accompanied or followed the army. For administrative purposes, the government of the East India Company initiated and executed a series of surveys in the newly acquired territories obtained by annexation, by war or by cession. The history of conquest and administration is therefore mingled with the history of surveys which constantly threw up voluminous scientific data about the country paving the way for a further development in the respective field.

The manner of introduction of the European knowledge : Even before the British conquest of Plassey, the knowledge of European sciences reached India. During 1728-1734, Raja Jai Singh obtained some current results of European scientific investigations to verify those of his own observations. Mariners and travellers published maps on Indian tracts from their own stations. Father Bouchet of French Jesuit Missionaries made a rough map of southern India with few observed latitudes and longitudes and several detailed

sketches in 1719. Bourgignon d Anville published his first map of Southern India in 1737 on the basis of these maps and sketches. Using all available materials compiled through several centuries on general geographical features as well as on astronomical observations by Jesuit Missionaries and also on the routes of European travellers, he published his *Carte de l' Inde* in 1752 at the instance of the French East India Company. In 1780, Father Monserrate, a Jesuit Missionary, recorded on his journey from Surat to Fatehpur Sikri a list of more than hundred positions. Francis Wilford (1750-51-1822) used his latitudes of Kalanaur and Attock and found them very accurate.

The Britishers suddenly came in virtual possession of a vast territory in Bengal after 1757 and no time was lost to initiate scientific surveys to assess the resources of the country for revenue and military purposes. Several categories of surveys were initiated sometimes concurrently such as (i) geographical survey, (ii) topographical survey, (iii) trigonometrical survey, (iv) revenue survey, (v) marine survey, (vi) route survey and (vii) military survey. As early as 1757, Lord Clive informed the Council at Fort William about the beginning of a survey of the lands, villages, districts, revenues from the Great Lake. Berthalomew Plaisted was deputed to start a coastal survey of Chittagong and the Sundarbans. Hugh Cameron started a survey in the new lands of the 24-Parganas. Rennell succeeded him in 1764 after his death and became the Surveyor General of Bengal in 1767. Rennell completed his provincial maps in 1774 and produced a uniform set of maps of Bengal and Bihar by 1786.[6]

The Court of Directors were seemingly very anxious since 1770's to obtain accurate geographical position of the territories where wars were fought and conflicts might errupt. Thomas Call (1749-88) made special efforts to complete his Atlas of India and discovered wide discrepancies in the geographical positions for many important places. He suggested a special astronomical survey. Reuben Burrow, a mathematician of eminence travelled widely in the Presidency of Bengal during 1787-89 and fixed a number of places by astronomical observations. He also tried to measure the length of a degree at the instance of General Roy, but this work remained incomplete due to his death. Michael Topping (1747-96), a skilled astronomical observer, realised that astronomical observations of longitude were not useful if not compared against corresponding observations at one or more stations. He was responsible for the permanent observatory in Madras in 1793. Only Topping was able to conceive the idea of a regular triangulation before Lambton.

The Mysore Survey is another illustration of motive behind the massive efforts for a scientific survey of the country. Immediately after the fall of Seringapatam on the 4th May 1799, a preliminary compilation of maps was done. The Governor General appointed Colin Mackenzie (1754-1821) to undertake "a survey on an extensive scale of the territories lately subjected to the Company." Mackenzie also rose to the occasion and submitted a *Plan of the Mysore Survey* on the 5th January 1800 which was intended to embrace two leading objects, mathematical and physical. The former included a

geographical and geometrical survey involving a series of primary stations to be obtained forming a series of triangles connected by bases to be carefully measured. The physical part aimed at collecting information on everything conducive to the improvement of natural history.[7] Mackenzie started his survey by 1800 and finished the field work and maps and memoirs by the middle of 1808. Six of his disciples completed the survey of the Ceded Districts between 1809 and 1814. Mackenzie followed the available scientific methods as accurately as possible: base lines were measured at suitable intervals and the whole country was covered with triangulation. Detail was filled in by theodolite bearings and traverses, and protracted on either the one-inch or half-inch scale, particular attention being paid to administrative boundaries and villages. Comprehensive statistical memoirs on the resources of the country were compiled for each district.[8]

There was little geographical knowledge in India upto the middle of the eighteenth century. Rennell's Atlas and some similar maps were prepared during the second half of the eighteenth century. There were some astronomical observations for specific purposes in selected areas. But the principle of geodetic surveying was first prepared in 1799 by Colonel William Lambton (1753-1823). Writing in 1850 A. S. Waugh, the Surveyor General of India said "This magnificent geodetic understanding, which at the present time extends from Cape Comorin to Tibet, and from the meridian of Calcutta to that of Cashmere, was commenced at the beginning of the present century by the celebrated Colonel Lambton."[9] After one hundred years another great surveyor, R. H. Phillimore remarked, "The debt that Indian geography owes to William Lambton can hardly be adequately expressed, for without him it is difficult to see how the boon of a great trigonometrical survey would have reached India..."[10]

Lambton correctly understood that geodetic survey was the only option for accurate maps of large areas and also to understand the correct size and form of the earth. The French and the Spanish collaborated in South America in the measurement of two bases connected by a series of triangles on the north and on the south of the equator on the meridian of Quito with a 180 miles long arc in the 1730's. After the Scottish upsurge of 1745 the trigonometrical survey was first conceived by General Watson and subsequently extended to the whole of Great Britain and Ireland. By the last quarter of the century, General Roy and Colonel Mudge took up the survey seriously in Great Britain.[11] The work of Lambton in India, in a historical context rightly has the honour of pioneership in the science of geodesy. William Lambton joined the 33rd Infantry Regiment in India in the year 1797. He participated in the Mysore war in 1799. Captain Lambton rose to fame by gallantry in the final assault of Seringapatam in May 1799. Lord Wellesley was very keen in obtaining accurate information of the conquered territory. Dr. Buchanan Hamilton assisted by a botanist, Benjamin Hyne, started a general agricultural survey of Mysore and Malabar. Colin Mackenzie submitted his plan of Mysore survey as mentioned earlier.

Lambton in his plan for a Mathematical and Geographical Survey submitted in November 1799 elaborated the advantage of this survey to general geography by determining the position of principal geographical points. He visualised that the country conquered by arms is connected from sea to sea, from the Malabar Coast to the Coast of Coromondel, by an uninterrupted series of triangles, and of continuing the series to an unlimited extent in every other direction. He emphasized the advantage of ascertaining the great geographical features upon correct mathematical principles and "after surveys of different districts have been made in the usual mode, they can be combined into one general map." Mackenzie also in his plan of Mysore Survey mentioned that "the position of the principal points ought at the same time to be corrected by Astronomical observations connected by a series of triangles.." He, therefore, very much welcomed Lambton's Plan and commented that his proposal merited every encouragement.

Lambton was a geographer as well as a geodesist. He was called upon, after sometime of the approval of his work in January 1800, to demonstrate the utility of his survey as against those on an astronomical basis. The latter were said to be equally accurate but more economic. He was successful to convince his fellow scientists in the authority about the importance and scientific usefulness of the survey. The trigonometrical survey was universally recognised by scientific men in Europe "as the only trustworthy basis for extensive national surveys." Lambton combined both the surveys and it was only in 1818 that his survey was officially named the Great Trigonometrical Survey of India. His work during this period was constantly interrupted by political disorders and wars. In 1800 Lambton measured a base line near Bangalore and thereafter carried out a preliminary triangulation of Mysore. In early 1802 Lambton measured a base line at St. Thomas Mount as a start both for his triangles north and south through the Carnatic and also for his east and west series across the peninsula—this base line carried out during April and May 1802 was the first operation of his general trigonometrical survey. The special scientific importance of this work was very ably stated by Markham, "The longitude of Madras is important, as that of the secondary meridian, or substitute for the prime meridian of Greenwich observatory, from which observations for longitude in the Indian survey are reckoned. Every station and place in that survey will be erroneous if the longitude of Madras is in error."[12] It was rightly pointed out that accuracy of the entire map of India would correspond to that of the geographical position of the Madras Observatory.

During May to July 1804 a base line was measured at Bangalore; Lambton measured base lines during March 1806 at Coimbatore, in July 1808 at Tanjore and in February-March 1809 at Palamcottah. During April 1811 and March 1812 he measured two base lines—one at Gooty and another at Guntur. Again during December 1814 and February 1815 two other base lines were measured respectively at Kumta and at Bedar. The total length of the base lines measured was 59.32 miles

yielding an average of 5.93 miles covered in 257 days.* Between 1802 and 1815 Colonel Lambton covered the country upto 18° latitude with a network of triangles. Territories from Goa to Masulipatam and from Cape Comorin to the southern boundaries of Nizam's and Maharatta possessions were covered by triangulation. The triangulation of Great Arc was extended to Takal Khera in 20°6′ latitude. Further work was done to cover the greater part of the eastern territories of the Nizams by meridional series and the work of longitudinal series from the Bedar base towards Bombay. The area covered by the trigonometrical operations during Colonel Lambton's time aggregated 165,342 square miles.

Like many scientists, Lambton had to make his way up in the face of adverse criticism, sometimes tantamount to opposition. Several times he had to demonstrate the scientific validity and utility of his work before both administrators and scientists. Equipped with an intimate knowledge of mathematics and geodesy he published perhaps his first scientific papers in the *Asiatick Researches* (Vol. VI, p. 93-101, 137-161) on statics and mechanics. On geographical survey and on trigonometrical operations including measurement of an arc on the meridian he wrote six papers between 1801 and 1820 in the same journal.[13] The full list of his manuscripts deposited with the geographical department of the India Office Library is available in their printed catalogue. An abstract of the measurement of the Great meridional arc was also published in the *Philosophical Transactions of the Royal Society* (Vol. VIII, 1818, p. 486-516). Lambton won academic distinction as a corresponding member of the French Institute in 1817. He was also elected as a Fellow of the Royal Society in 1818.

George Everest (1790-1866) joined the trigonometrical survey in December 1818 and started triangulation of the eastern part of the Nizam's dominion, but was unable to complete it due to illness. He was given an independent assignment in October 1822 on a longitudinal series of the great triangles originating from Bedar base line to connect Bombay. After the death of Lambton in January 1823 he became the Superintendent of the Great Trigonometrical Survey of India and continued the programme in carrying out the great arc northwards in difficult tracts; but Everest had to retire for rest after terminating the Sironj base line on 24° latitude. Everest sailed for England in November 1825. During his stay there, he was able to contact scientists, instrument makers and officers of the Ordnance Survey of Great Britain. In 1830 he published the results of his observations made between 1823 and 1825 under the title of *An account of the measurement of an arc of the meridian between the parallels of 20°3′ and 24°7′*. In the period of his absence in India, Joseph Olliver continued the work of longitudinal series from Sironj to Calcutta along parallel 24° under instructions from Everest and completed it by July 1832. Everest returned in India and took over as the Surveyor General in India in October 1830. He measured a base line of verification of the series completed by Olliver extending 6.5 miles along the Barrack-

*The base lines in Bangalore in 1805 was actually measured by Warren and that of Kumta by De Penning.

pore Trunk Road between November 1831 and January 1832. The work on the great arc series was resumed by Everest in 1832 after a gap of seven years and continued without any interruption upto December 1841 and "closed with the measurement of the Bedar base line; and the whole Indian arc from Cape Comorin to the Himalayan Mountains, forming the main axis of Indian geography was thus completed."[14] The area under the great arc operations, principal and secondary, aggregated 56,997 sq. miles with the measurement of three base lines. The rate of progress measured by time taken is one third of that of Lambton but it is still considered unsurpassed at the global level because of the superiority of quality.

In 1824, because of a high cost to the extent of £6,000 a year, the Court of Directors wanted to know precisely the specific and general purpose and the likely duration of the trigonometrical survey. The Surveyor General, Colonel Valentine Blacker having collected the views of Everest asserted that it would be "unworthy of the fame which the rulers of India have already acquired" in the promotion of the science to put any restriction on this survey, rather more resources should be made available. Blacker asserted that the scientific object was to collect data on the magnitude and the figure of the earth. He pointed out that the results of the survey had a bearing on a large portion of tables used by navigators and as such the East India Company should have a keen interest in this survey; moreover, the accuracy of all detailed surveys would not be dependable without a preceding trigonometrical survey.[15]

Among the technical achievements of Everest was the introduction of luminous signals, that is, the method "of observing to lights at night instead of to flags and beacons by day." Another achievement of Everest was the replacement of Lambton's system which was designed to throw a net work of triangles over the whole country. Everest thought that it was sufficient "to execute meridional series about a degree apart, tied together at their ends by longitudinal series. This is termed the gridiron system and is analogous to the French and Russian methods."[16] From the Calcutta longitudinal series, he accordingly planned to originate several meridional series to terminate at the foot of the Himalayas and eventually to be connected by another longitudinal series along the base of the mountains. Nine stations were selected on the Calcutta series as origins of as many meridional series. Two Indian associates of Everest deserve a special mention. Radhanath Sikdar, a high ranking mathematician contributed to the preparation of Auxiliary Tables. Sayed Mir Mohsin Hussain was appointed as a mathematical instrument maker in 1839 in place of Henry Barrow. Everest was able to build up a great organisation, altered and revolutionised the old system and made substantial contribution to the science and geographical knowledge of India.

Andrew Waugh succeeded Colonel Everest in 1843 and completed triangulation of the region between the Great Arc Series and Calcutta and also the north-eastern Himalayan series. Under his leadership heights of 79 Himalayan peaks were determined and the 15th one was named by him as Mount Everest. In 1861 Sir Andrew Waugh retired and the offices of the Surveyor General and that of the Superintendent of the

Great Trigonometrical Survey were again separated. Colonel Walker was appointed as the Superintendent of the Great Trigonometrical Survey and Colonel Thuillier, the Surveyor General. The task before Colonel Walker was to determine the procedure by which the final values for the lengths and azimuths of the sides of the triangles and also for the latitudes and longitudes of the stations might be ascertained as the principal triangulation of the country had already been completed. For this purpose the principal triangulation of India was divided into five sections as it was not possible to operate on the whole. The two longitudinal chains of triangles were the dividing lines of these sections—one from Karachi to Calcutta and the other from Vizagapatam to Bombay and the Great Arc lying between the parallels of 18° and 30°.

The Central Chain executed by Major Lambton and Colonel Everest from Cape Comorin to the Himalayas was converted into a geodetic arc by taking astronomical observations of the latitude on several points. The arc has been used in the searches of the earth's figure. Further accurate triangulation was done on the east and west of this channel forming several other meridional chains which, with the latitudes of certain of their stations being astronomically determined, could become variable meridional arcs for geodesy. Extension of telegraph lines facilitated determination of the differences between the stations telegraphically. With new instruments Colonel Walker succeeded in observing a large number of astronomical latitudes and differential longitudes. These data were used by the Ordnance Survey of Great Britain in the investigation of the earth's figure. Around 1877, after the retirement of General Thuillier, Colonel Walker became the Surveyor General of India and amalgamated the three main streams of survey—trigonometrical, topographical and revenue—into one, named as the Survey of India. Under the new organisation, the triangulation work continued mainly in areas still left out gradually to cover the whole of India.

Institutions created for education and research and dissemination of knowledge : Prior to the establishment of any institution for surveying, boys were recruited from Madras Military Asylum, the Bengal Upper Military School, Khidirpur, from the Quarter Master General's Office and from other similar channels. A stream of surveyors was available each year from the Madras Observatory and Survey School since its establishment in 1794. In the early nineteenth century Thomas Munro established a centre for training of revenue surveyors. The Madras Military Institution was founded at the end of 1804 and continued to train batches of professional surveyors for the field work till it closed down in 1816. The Colaba Observatory was set up in 1821. An engineering institution at Roorkie was established in 1847.

During the second half of the nineteenth century, after the establishment of three universities in three presidencies, a number of technical institutions came into existence. According to the educational report of the Bengal presidency for the year 1876-77 there were 124 pupils in the civil engineering department of the Presidency College. There were three Government technical schools located at Ranchi, Dacca and Dehri with a total of 116 students. Apart from that, there were four Government survey

vernacular schools situated at Hooghly, Dacca, Patna and Cuttuck with 159 students in all The Bengal Engineering College was also founded at that time.

Impact of new knowledge and the interaction between the old and the new

Apart from these institutions, the elements of trigonometry and surveying were also introduced in Indian languages in vernacular schools in Bengal, Bihar and Orissa and in all types of institutions in the North Western Provinces. The Calcutta School Book Society published a series of text books in Bengali, Hindi and Urdu since the second decade of the nineteenth century on several branches of science including mathematics, astronomy and geography. There were several journals in Bengali exclusively or partially devoted to scientific subjects since 1818. There were periodicals in Hindi and Urdu in the mid-nineteenth century for dissemination of scientific knowledge. The 8th volume of the Bengali Encyclopaedia under the title of *Vidyakalpadruma* published first in 1846 was devoted to geography and geometry. Rajendra Lal Mitra, a renowned Bengalee scholar who was responsible for publication of the first Bengali Atlas also wrote a text book on natural geography in 1854. The number of books on geography, geometry and astronomy in different Indian languages perhaps will be about one hundred by the end of the nineteenth century. Maps were published in all major Indian languages in the second half of the nineteenth century. These publications, as far as possible, contained the results of scientific investigations incorporated as teaching materials in England and elsewhere.

It is universally recognised that the British Surveyors in India contributed enormously in enriching the knowledge about the country. The Great Trigonometrical Survey was an unparallel adventure in the science of geodesy at that time both in quality and in magnitude. The geography of India was placed on a granite foundation. Though there was no direct link or communication between the survey and the Indian society, the results of the survey were published in the Indian journals, Government Gazettes and in official reports. These were made available to the enlightened public opinion and the intelligentsia of the country to some extent assimilated this knowledge and disseminated it through Indian languages in the channel of formal education and in a general way.

References

[1]Phillimore, R. H., *Historical Records of the Survey of India*, Vol. I, 1945, p. 148.
[2]*Encyclopaedia Britannica*, Vol. 22, 1932, p. 476.
[3]Please see 1, p. 150.
[4]Shamasastry, R., *Kautilya's Arthaśāstra*, Mysore, Shri Raghuveer Printing Press, 1951.
[5]Memorandum by Holt Mackenzie, dated the 19th October, 1826 and its unpublished appendices containing statistics of village surveys.
[6]Please see 1, p. 1-2.

[7]Mackenzie, Colin, Plan of the Mysore Survey and the manner in which it is proposed to be executed, *Military Consultation,* Vol. 265-A, p. 750-773, Fort St. George, 11th February, 1800 (MSS), objects were enumerated in An Outline Survey of Some Aspects of Technology in India 1750-1900 and its Legacy by the present author, *Indian Journal of History of Science,* Vol. 17, No. 1, p. 18-27.

[8]Mackenzie, Colin, Memoirs of a Geographical, Statistical and Historical Survey of Mysore dominions and containing South and North Canara, Vol. 142 (C)M of *Survey of India Records* transferred to the National Archives of India from Dehra Dun.

[9]Waugh, A. S., *Accounts and Papers, East India,* (House of Commons, Vol. XLI, 1851, p. 876).

[10]Phillimore, R. H., *Historical Records of the Survey of India,* Vol. II, 1950, p. 9.

[11]Markham, C. R., *A Memoir on the Indian Surveys,* 2nd edition, 1878, p. 59-60.

[12]Please see 11, p. 65.

[13]*Index to the Publications of the Asiatic Society,* 1788-1953, Vol. I, Part I, p. 180.

[14]Please see 9, p. 880.

[15]Phillimore, R. H., *Historical Records of the Survey of India,* Vol. III, 1954, p. 241.

[16]Please see 11, p. 102.