ABSTRACT

OF THE

REPORTS OF THE SURVEYS

AND OF OTHER

GEOGRAPHICAL OPERATIONS

IN

INDIA

FOR

1870-71.

PRINTED BY ORDER OF
HER MAJESTY'S SECRETARY OF STATE FOR INDIA IN COUNCIL.

LONDON:
SOLD BY W. H. ALLEN AND CO., 13, WATERLOO PLACE;
EDWARD STANFORD, 6, CHARING CROSS;
HENRY S. KING AND CO., 65, CORNHILL;
N. TRÜBNER, 60, PATERNOSTER ROW.

1872.

PREFACE.

The following Annual Abstract of the Survey and other Geographical Operations in India during the year 1870–71, is arranged on the plan of the "Memoir on the Indian Surveys" and of the Abstract for 1869–70, which give a history of these operations up to March 1870. The intention of these Annual Abstracts is to indicate the more important and interesting operations of the year, previous to an examination of the detailed Reports with their valuable Appendices. It is hoped that the Abstracts will continue to be useful for purposes of reference, and with this object constant foot notes are given, referring the reader to passages in the Memoir or in the Abstract of 1869–70, in which the previous history of each operation is described, and the previous services of each officer that is mentioned are given.

I take this opportunity of expressing my regret that more full justice was not done, in the Memoir, to the surveying services of Colonel Robinson. An account is given of his admirable survey of the Districts of Jhilam and Rawal Pindi, in the northern part of the Sind Ságar Doab,[1] but the failure to mention his other work was a serious omission. Colonel D. Robinson was a Surveyor for 19 years, from 1845 to 1865. He originated the present accurate style of delineating ground, and trained most of the best men now in charge of Topographical Survey Parties, and in the Surveyor General's Office. The paper on the use of the plane table in Sir A. Waugh's Instructions[2] is also by Colonel Robinson. He commenced the Topographical Survey of Central India, and was in charge of it from 1859 to 1863. In 1863 he officiated for Colonel Walker during his absence in Europe, and drew up the Report for

[1] See "Memoir," p. 104.

[2] See "Memoir," p. 103.

1863–4. In April 1865 he took charge of all the Revenue Surveys, during Colonel Thuillier's absence, but shortly afterwards he was invited to accept the Director Generalship of Telegraphs, a Department which he has now brought to a high state of efficiency.

Two important memoranda, by Colonel Walker, will be found at the end of the present Abstract, on the state of the arrangements for the publication of the sheets of the atlas of India in England, and on the projection of the Atlas.

At page 57 there is a brief history of the controversy on the spelling of Indian proper names, which has now been finally closed by the official adoption of the system of Dr. W. W. Hunter, LL.D., the Director General of Statistics to the Government of India.

CLEMENTS R. MARKHAM.

Geographical Department,
India Office, April 1872.

ANALYTICAL TABLE OF CONTENTS.

ABSTRACT

OF THE

REPORTS OF THE SURVEYS

AND OF OTHER

GEOGRAPHICAL OPERATIONS IN INDIA

FOR

1870-71.

I.—Indian Marine Surveys, 1870-71.

The question of Marine Surveys is still under the consideration of the Government of India, and the Secretary of State has not yet been furnished with their opinion and suggestions as to the best means of placing these Surveys on an efficient footing, which were called for in a despatch in the Geographical Department, dated March 30th (No. 7), 1871. But the importance of adopting effective measures for securing the due execution and continued revision of Marine Surveys and Charts is strongly felt both in India and in this country.

The Madras Government have reported[1] that several Surveys require to be made along the coast of that Presidency, and that others need periodical revision, thus showing the necessity for a permanent Hydrographer or Marine Surveyor General. These Surveys are as follows:—

1. A periodical examination of the river mouths of Mangalur and Cochin, and of the shifting mud banks off Paliport, Narakal, Alepy, &c.; places to which British vessels take cargoes in the S.W. monsoon.
2. A more thorough Survey, on a large scale, of the coast between Beypúr and Calicut is urgently required.
3. A large scale plan of Encian Islet, off the coast of Travancor, to show the soundings between it and the main; and a plan of Colachull, where troops are landed.

---

[1] Marine Despatch, dated February 17th (No. 5), 1872. Letter from H. D. E. Dalrymple, Esq., the Master Attendant at Madras, dated July 11th, 1871.

4. Deep-sea soundings in Palk Strait and the Gulf of Manar.[1]
5. A periodical examination of the shoals on the Coromandel coast, such as Armaghon, Palikat, and those between Calimere Point and Ceylon.
6. A Survey of the coast and river mouths from Nizampatam to Coconada is urgently required.
7. The coast from Santopillay to Point Palmyra has never been properly surveyed.

The Bombay Government have also shown their sense of the great importance of Marine Surveys by the measures they have recently adopted. In February 1871, Captain Robinson, the Superintendent of Marine at Bombay,[2] represented that a port on the Mekran coast called Khour Rapsh should be surveyed, and that afterwards the Bahrein reef channels in the Persian Gulf should be taken up, including the approaches to El Kateef and Deman, the N.E. approach to Bahrein, and the unsurveyed bay south of Bahrein.

Mr. Girdlestone, of the Topographical Survey, was lent by Colonel Thuillier to perform this work,[3] in an old sailing schooner of 180 tons, called the *Constance*, with no good boats, no steam launch, and an insufficient staff of officers. After leaving Bombay, two-thirds of the vessel's time were taken up in reaching the ground, running into ports for provisions and water, and at anchor for want of wind to enable her to prosecute the soundings. She was away from March 8th to June 20th, 1871, yet the actual work only occupied four weeks. In a steamer a surveyor could have done it all and returned to Bombay in five weeks, being a saving to Government of 650*l.* in pay and provisions. The inefficient equipment of a surveying vessel is, therefore, as wasteful as it is deplorable in other respects. Mr. Girdlestone, however, in the face of these difficulties, completed a chart of the large inlet of Khour Rapsh, on the Mekran coast, between Jask and Charbar, on a scale of three inches to the mile, and ascertained differences of longitude, by telegraph, between the Bombay Observatory and pillars which he erected at Gwadur, Charbar, and Jask. The chart, together with a memoir[4] and a

---

[1] See "Memoir," p. 16, and "Abstract" for 1869–70, p. 10.

[2] Letter from Captain Robinson to the Government of Bombay, dated February 17th, 1871.

[3] See "Abstract" for 1869–70, p. 10.

[4] Dated Muscat, June 30th, 1871, F. B. Girdlestone, Esq. (late I. N.), to Captain G. Robinson, Superintendent of Marine at Bombay.

synopsis of the computations of the triangles, has been sent home, and the chart will be engraved under the superintendence of the Hydrographer to the Admiralty.[1]

Mr. Girdlestone was obliged to come to England on sick leave in July 1871, and on his return to Bombay in the autumn he strongly represented the inadequacy of the means that were placed at his disposal to execute Marine Surveys. He urged that sketches or running surveys were useless in these days, and that good rigorous work, based on trigonometrical principles, in conjunction with the Great Trigonometrical Survey, was required. He pointed out that a steamer should be supplied, with a proper staff of officers, and a steam launch. In boats, it is seldom that more than 30 linear miles of soundings can be done in a day in such a climate as the Persian Gulf, while they cannot keep straight courses; but with a steam launch 70 or 80 miles a day can easily be completed.

As his suggestions were ignored, and it was impossible that he could turn out creditable work with the means that were provided, Mr. Girdlestone resigned the appointment in December 1871, and returned to the Topographical Survey, although he is enthusiastically fond of Marine Surveying, and would have gladly continued on that service if adequate means had been placed at his disposal. But he represented that the Survey of the Bahrein reefs, to be of any real use to navigators, must be executed in the most elaborate manner, on a very large scale, and on a trigonometrical basis. The *Constance* was, however, sent to Bahrein, in command of Mr. Chapman, who had served under Mr. Girdlestone, and he has since been carrying on the Survey of the reefs in the best manner he is able with the means at his disposal. But this method of doing the work is much to be deplored, as it cannot be satisfactory, and will require revision as soon as Marine Surveying in India is put on a proper footing.

The views of a young officer such as Mr. Girdlestone, who combines with some experience a love of the subject, deserve attention. He submitted them to the Government of Bombay on June 20th, 1871. He considers that there should be a Marine Surveyor General at Calcutta, on a salary of Rs. 1,200 a month, whose duty it would be to superintend and compile in a central office; and that under him there should be two executive officers,

[1] Marine Despatch from Bombay, September 10th (No. 62), 1871. The chart was sent to the Admiralty on November 16th, 1871.

with salaries of Rs. 1,000 a month each, in command of two composite screw steamers of 450 tons, with compound engines of 120 horse-power. The steamers should draw 8 to 10 feet, barque rigged, and carry 250 tons of coal and three months' provisions for a crew of 95 persons; and should have a poop 8 feet high and 30 feet long by 20, with ports, as a chart room. He calculates the cost of such a steamer at 16,750*l.* Each steamer should have two steam launches (cost 575*l.* at White's Yard). He calculates that with this equipment Marine Surveys could be made at the rate of 470 miles of coast a year, and 3,290 square miles of water examined and sounded, and that the cost would be at the rate of Rs. 40 the square mile. There cannot be a doubt that, in point of economy alone, a thoroughly efficient establishment of this kind will compare advantageously with the present haphazard method of conducting Marine Surveys, with its perfunctory work, and heavy losses by waste of time.

After Mr. Girdlestone's return to England on sick leave, in June 1871, his second in command, Mr. M. Chapman, assisted by Mr. A. P. Thomson, took a series of soundings in the gulf of Oman from Ras Jask to Ras-as-Shir, on board the surveying schooner *Constance*, during the months of August and September.[1] The lines of soundings were fixed by latitudes by meridian altitudes of the sun, and longitudes by observations of three chronometers, whose rates were determined by observations to stars on both sides of the meridian. Bearings were taken of well-known points on shore, when obtainable, and the courses were corrected by azimuths and amplitudes. Mr. Chapman reports, with reference to the position assigned to Tornates shoal on the Chart of the Persian Gulf, that he anchored on the spot in six fathoms, and was unable to find any indication of a patch of nine feet in the vicinity.[2] The chart, containing the soundings taken by Mr. Chapman, with drawings by Mr. Thomson, has been sent to England.

With reference to a remark in the Abstract of 1869–70,[3] to the effect that the Persian Gulf Charts are incomplete, and that they are

---

[1] Despatch from Bombay, No. 2. (Marine) January 9th, 1872.
Despatch from Bombay, No. 9. (Marine) January 25th, 1872.

[2] Letter from M. Chapman, First Officer of the *Constance*, and Assistant Surveyor, to Commander G. T. Robinson, Superintendent of Marine at Bombay.

[3] P. 10.

required to be on much larger scales, Captain Constable[1] and Lieutenant Stiffe,[2] who executed the last Survey of the Persian Gulf, between 1857 and 1860, have printed and circulated letters, with the object of defending their work. The value of that work, however, not only was never impugned, but was spoken of in the Memoir on Indian Surveys in terms of praise.[3] Captain Constable points out that the chart of the Persian Gulf is intended as a general chart, and that as such the scale is amply large enough. The scale was decided upon by Admiral Washington, and was reduced from a larger scale. But Captain Constable adds that separate charts of the coast, on a large scale, are wanted; that much of the Persian Gulf is imperfectly surveyed; and that much is not surveyed at all. He thus fully confirms the accuracy of the remark in the Abstract of 1869–70, to which his letter and that of Lieutenant Stiffe refer.

These officers further remark on the suggestion that the names in the Arabic character should be shown on the chart, and that Mr. Badger's revised nomenclature should be adopted.[4] Lieutenant Stiffe "protests against the chart being disfigured by names in the "Arabic character," as safety or destruction may hang on the clearness or confusion of a chart. He also insists upon the accuracy of the method of spelling adopted on the Persian Gulf chart. Captain Constable observes that to put the names on a chart in English and also in Arabic encumbers it.

Mr. Badger has replied to these officers in a letter, which he has also printed and circulated.[5] He affirms that two-thirds of the names, as given on the chart of the Persian Gulf, are spelt erroneously, and not according to the Arabic. He recommends that, if it is not desirable that Arabic should appear with the English on the same chart, two charts should be struck off until an English chart is published, with names that can be relied on. Writing on the same subject, Sir Arnold Kemball says that, "with reference to the large "amount of native craft navigating those seas, a resort to the use of

---

[1] From Captain C. G. Constable, I. N., to Clements R. Markham, Esq., C.B., London, January 1872.

[2] From Lieutenant Arthur W. Stiffe, I. N., to Clements R. Markham, Esq., C.B., Kurrachee, November 30th, 1871.

[3] P. 33.

[4] "Abstract" for 1869–70, p. 34.

[5] From the Reverend G. P. Badger, to Clements R. Markham, Esq., C.B., January 27th, 1872.

" the Arabic character is desirable."[1] Captain Felix Jones, one of the highest living authorities on such a subject, both as a surveyor and a draftsman, has also expressed his opinion on these points.[2] He says that it is desirable that the practice should be maintained of printing oriental names on the charts. If judiciously placed they will never lead to indistinctness or confusion; and he suggests that there might be three sets of a chart, one with the English, another with the native, and a third with both characters. He adds that Mr. Badger's system of spelling is critically the correct one. Mr. Palgrave, an Arabic scholar, who is acquainted with the Persian Gulf, is also of opinion that Mr. Badger's system of orthography is much more correct, and decidedly preferable to any other.[3] The Arabic names on the older chart of the Persian Gulf, by Captain Brucks,[4] are exceedingly accurate; and this is accounted for by their having been prepared by Colonel Taylor, formerly Resident at Baghdad, who was an accomplished Arabic scholar.

It is clear from this correspondence that the completion of the Survey of the Persian Gulf, and the publication of charts of portions of its coast on larger scales, are urgently needed, and that the transliteration of Arabic names on the present chart is open to very considerable improvement. Mr. Parkes, the Consulting Engineer of Kurrachee Harbour, examined the ports at the head of the Persian Gulf in October and November 1871,[5] on board the British India Steam Navigation Company's steamer *Cashmere*. His main object was to ascertain the practicability of establishing a port which would accommodate large steamers, and which could readily be connected with a Euphrates Valley Railway. The choice was between Bussorah, Core Abdullah, and Kowait or Grane. He found some obvious errors in the existing chart of Kowait; while he was unable to speak with confidence on the capabilities of Core Abdullah, in consequence of the absence of a systematic survey.

---

[1] From Sir Arnold Kemball, K.C.S.I., to Reverend G. P. Badger, January 26th, 1872.

[2] From Captain Felix Jones, I. N., to the Secretary of the Geographical Society, January 25th and February 3rd, 1872.

[3] From W. Gifford Palgrave, Esq., to Clements R. Markham, Esq., C.B., March 12th, 1872.

[4] See "Memoir," p. 10.

[5] Report on the Ports of the Persian Gulf, with Charts, addressed to W. P. Andrew, Esq., by William Parkes, Esq., Consulting Engineer to the Secretary of State for India in Council for Kurrachee Harbour. (Allen, 1872.)

The alterations which are taking place in the Gulf of Cambay, and the changes at the mouths of the Indus, necessitate periodical examination of those coasts; and there cannot be a doubt that Marine Surveys, executed on a systematic plan, are as urgently needed on the coasts of the Bombay as on those of the Madras Presidency, and the want is certainly not less felt on the Bengal side.

A survey on the Orissa coast was executed by Mr. H. A. Harris during 1868, 1869, and 1870 in the small steam vessel *Gemini*. Mr. Harris has had fifteen years' experience in river surveying, was Assistant Surveyor on the Hugli, and surveyed the Port of Calcutta. He commenced the Orissa Survey from two bases carefully measured on Dowdswell's Island, the angles of the coast portion being all taken with a theodolite, but the river survey angles were mostly observed by sextant, as the jungle interfered with the use of the theodolite. Check bases were measured wherever it was possible; and Mr. Harris mentions that, working for ten miles with a sextant through dense jungle, the difference between the calculated and measured check base was only 14 inches. Nine charts have been prepared from this Survey, of—

Bakud Creek (1 *sheet*),
Jumbu River (1 *sheet*),
Jumbu Canal Creek (1 *sheet*),
Mahánadi (2 *sheets*),
Noona Route (1 *sheet*),
Davi River (1 *sheet*),
False Point (1 *sheet*),
Dhamrah River (2 *sheets*),
Brahmanic River (5 *sheets*),

but it is only thought necessary, by the Master Attendant at Calcutta, that False Point anchorage should be engraved and published by the Hydrographer of the Admiralty, the rest of the survey being for local use. These desultory operations are undertaken by the different local Governments as the need arises, without any combined plan, with inadequate means, and with a view merely to satisfying local wants. In the present instance, the surveys should have been carried further along the coast, in order to make them useful to navigation; and there is a discrepancy, on two of the sheets, as regards the position of False Point light.

The adoption of effective measures for securing the due execution and continued revision of Marine Surveys and charts on a systematic Imperial plan is a question which yearly becomes more urgent. It

is, however, still under the consideration of the Government of India.

In the Abstract for 1869–70[1] it was stated that 264 manuscript charts and plans were handed over to the Admiralty in 1861, of which number 210 were obsolete; and that of the number that remained, 18 had since been utilized. There then remained 36 charts and plans of Indian coasts and anchorages at the Admiralty, which had not been published. During the last year the Hydrographer has published four of these, namely, Malwan Bay and Malundi Island,[2] Tudri, Tellicheri, and the correction of the old chart off Calicut.

In September 1870 Mr. George Robertson, C.E. was appointed to prosecute inquiries with a view to the improvement of some of the harbours on the Indian coast; and he has since published his report,[3] which gives detailed descriptions of the anchorages at Aden, Mangalur, Cananor, Calicut, Cochin, Narakal, Alepy, Paumben, Tutikorin, Negapatam, Madras, Blackwood's Harbour, and Cocanada, with suggestions for the improvement of some of them. His remarks on the encroachments of the sea at Cochin, on the alterations in the Gurpur gap at Mangalur, on the changes off Negapatam, and on the silting at Cocanada, place the necessity for periodical surveys in a very strong light. A Report by Captain A. D. Taylor, I. N., dated July 28th, 1871, on the proposed ship canal between Ceylon and India, has also been printed, with a lithographed copy of the Admiralty chart showing the soundings.[4]

In June 1871 the Council of the Asiatic Society of Bengal brought to the notice of the Government the desirability of undertaking deep-sea dredging in Indian waters. They represented that there were good grounds for anticipating very valuable results from such operations, for the progress of hydrography, the advancement of science, and the benefit of navigation. In former periods of our planet there prevailed a much more uniform distribution of temperature, and of animal and vegetable life. In the kainozoic epoch the climate in Europe was somewhat similar to that of our present Indian and

---

[1] P. 10.

[2] On Sheet 6.

[3] Reports to the Government of India on Indian Harbours, by George Robertson. Aden and the Harbours of the Madras Presidency. (Edinburgh, 1871.)

[4] On the proposed Ship Canal between Ceylon and India, by Commander A. Dundas Taylor, F.R.G.S., late Indian Navy. (London, July 28th, 1871, with a Postcript, February 1872, and an Extract from the Report on the Paumben Pass by Mr. George Robertson.)

Australian waters, and many of the then inhabitants of the seas show great affinities to those now living in the Indian seas. In order to trace the connexion of these faunas, dredging in Indian waters would supply most valuable materials. Again, no systematic observations have yet been made regarding the laws regulating the temperature of water in the Indian seas, the various currents, and the physical character of the sea bottom. The Asiatic Society suggested that three lines might be run across the Bay of Bengal, one from Jagannáth Black Temple to Cape Negrais, a second from Madras to the Andamans, and a third from Ceylon to Sumatra.

The Government cordially approved the proposal,[1] and, as they were still awaiting the opinions of authorities respecting Marine Surveys, they promised to consider whether a vessel might be made available for the joint purposes of marine surveying and of carrying out the deep-sea dredging operations. Meanwhile, they granted 200*l.* for procuring the necessary instruments and appliances; and the Council of the Royal Society has been requested to superintend their purchase and transmission to India.

II.—The Great Trigonometrical Survey of India, 1870–71.

During the season of 1870–71 the Great Trigonometrical Survey has been proceeded with on six series, and the completed work is represented by 11,203 square miles of principal, and 10,076 of secondary triangulation.

The Brahmaputra Meridian Series,[2] which was carried forward for 56 miles by Captain Thuillier in the previous season, has been continued by Mr. Beverley, whose operations, however, were necessarily confined to completing an approximate series, which has now been satisfactorily effected by a junction with the Assam Longitudinal Series.

The Assam Eastern Frontier Series,[3] under Mr. W. C. Rossenrode, has been taken up somewhat out of its turn, to supply points for the Revenue Survey operations. The series was advanced a distance of 86 miles, but the difficulties to be overcome were considerable. The

---

[1] Resolution, August 28th, 1871.

[2] See "Memoir," p. 114, and "Abstract" for 1869–70, p. 11.

[3] See "Memoir," p. 114, and "Abstract" for 1869–70, p. 11.

plains are covered with grass, 12 feet high, as far as the eye can reach, the hills are clothed with dense forest, and the rivers are lined with belts of trees. From January to April, when the grass is burnt, the smoke hangs for weeks over the valley like a pall, presenting a magnificent spectacle at night, when circles and walls of fire rise upon the hills and are canopied by dense black smoke. But the progress of the surveyors was retarded by the thickness of the atmosphere, caused by these fires, as much as by the difficulties of the ground. Wild elephants and tigers swarmed, and the former destroyed the huts of the party, and often drove them for refuge to the upper branches of the trees. The whole party also suffered from fever, and the progress made in the face of such obstacles is creditable to the perseverance and resource of Mr. Rossenrode and his fellow workers.

The Bidar Longitudinal Series,[1] was commenced by Mr. Shelverton, whose melancholy death was reported last year. Mr. H. Beverley succeeded him, and has advanced the main series 37 miles, while the preliminary operations, including the clearing of 10 hill-tops and of a hundred miles of pathways, cover a further distance of 144 miles.

The Biláspur Series,[2] under Mr. H. Keelan, has been extended 52 miles to the southward, through one of the wildest parts of India; while the northern and southern sections of the Bangalor Meridian Series,[3] under Lieutenant Rogers and Major Branfill respectively, have been advanced 227 miles. The northern section has been extended 160 miles to join the Bidar base line. The southern section has been taken across the Palni Hills, and the heights of some peaks, 5,000 to 7,550 feet above the sea, have been fixed, which are not even indicated on existing maps. Major Branfill has set up a self-registering tide guage at Tutikorin, to determine the mean sea-level for trigonometrical and levelling operations.

The topographical survey operations under the Superintendent of the Great Trigonometrical Survey, have been carried on in Gujrát, Katiwár,[4] and the Kosi valley. Lieut.-Colonel Nasmyth,[5] who had charge of the Gujrát Survey, was obliged to take sick leave, and died shortly afterwards in Australia. He was succeeded by Lieutenant

---

[1] See "Memoir," p. 115, and "Abstract" for 1869–70, p. 11.
[2] See "Abstract" for 1869–70, p. 12. [3] See "Abstract" for 1869–70, p. 12.
[4] See "Memoir," p. 118, and "Abstract" for 1869–70, p. 12.
[5] See "Memoir," p. 96 and p. 99, and "Abstract" for 1869–70, p. 13.

McCulloch, who continued the triangulation, and commenced a portion of the topography. An area of 534 square miles was surveyed and mapped on a scale of two inches to the mile. Lieutenant McCullagh gives a description of the face of the country, and remarks upon the evidence of recent encroachment by the sea, which will hereafter be carefully ascertained by tidal observations. A further attempt has been made to utilize the maps of the Bombay Revenue Survey, but the result has been as disappointing as it was in the previous season.[1] A further experiment will be made with these maps, as the acting Superintendent is exceedingly loath to think that no use can be made of them for topographical purposes.

The Katiwár Survey has made very satisfactory progress under the direction of Lieutenant Trotter.[2] 1,757 square miles have been surveyed on a scale of 2 inches to the mile, 301 on a scale of 1 inch, and 11 sheets of the final maps have been prepared on a scale of 2 inches to the mile. A few of these final maps will be printed in the Gujráti character for the use of the people, and if there is any demand a larger number will be printed off. Parts of Katiwár are very fertile and populous, while others are in such a wild state as to form the haunts of lions, Katiwár being one of the few places in India where the lion is still found. Colonel Walker considered it very desirable that the Topographical Surveys should combine the details of the maritime with those of the land surveys, by connecting the points along the coast which are common to both Surveys by actual measurement on the ground. The published charts of the coasts had been reduced from the original drawings, and are on a smaller scale than the land survey, so that no connexion by actual measurement has been possible. The original drawings of the charts of the Gulf of Cambay were deposited in the Hydrographer's Office at the Admiralty, and several copies have now been lithographed for the use of the Katiwár Survey.[3] The original drawings of the

---

[1] See "Abstract" for 1869–70, p. 13.

[2] See "Memoir," p. 118, and "Abstract" for 1869–70, p. 13.

[3] 1. Mandaire Roads, 2 in. to 1′.
2. Goorja Creek, 2 in. to 1′.
3. Isle of Din, 2 in. to 1′.
4. Kattywar Coast (Dwarka to Porebunder) in 2 sheets. Scale 1 inch to the mile.
5. Okha Coast, Kubeh to Dwarka, 1 in. to 1′.
6. Gulf of Cutch, $\frac{1}{2}$ in. to 1′.

charts of the Gulf of Kach were lost, but copies have been obtained from Captain Taylor (late R. I. N.), the Surveyor.

A very complete survey of the Kosi valley, under Lieutenant J. Hill, has been made to facilitate the investigation into the practicability of the construction of a railway up the valley. The survey is on a scale of 6 inches to the mile, and the triangulation covers 93,440 acres, with 735 points and 551 heights fixed. The levels are shown by contour lines, 300 feet apart. The slope of the valley was found to be well within the mean gradient of a railway, being less than 1 per 100 from Rámnagar (1,200 feet) to Bajar (2,885 feet) a distance of 46 miles. But the valley is bounded by lofty mountains, and the river passes through narrow gorges.

This work is not properly the business of the Survey, and the employment of one of its parties on it has of course retarded the progress of topographical surveying for geographical purposes. The expense ought to be deducted from the cost of the Survey and debited to the Railway Department.

Two parties have been at work on latitude observations, on the meridians of 78° and 75°, under Captain Herschel and Lieutenant Trotter respectively. Captain Herschel completed observations at 15 stations with the new zenith sector, and further experience has confirmed his first impressions as to the excellence of that instrument.[1] The observations of Lieutenant Trotter were suspended, pending the arrival of the second zenith sector, which has since arrived at Poona. From December 11th, 1870, to August 1871, Captain Campbell assisted Colonel Strange in the final testing and examination of this instrument, and of others with which he has since reached India; namely, a five-foot transit instrument, two chronographs, six relays with batteries, and three astronomical clocks.[2] The chronographs are for record, by electricity, of the observed transit of stars and of clock-signals. Another transit instrument will shortly be ready for shipment to India. It is considered a most important object to have the Russian and Indian geodetical operations in the same terms, and this has been effected, to some extent, by an interchange of instruments. Cape Comorin is already connected with two stations north of Changchemmo, and if the Russians bring their series to their outposts on the Tian-shan, the two Surveys will only be separated by a distance of 400 miles across a country presenting no physical difficulties.

[1] See "Memoir," p. 144.

[2] See "Memoir," p. 143.

Thus the connection of the Russian and Indian triangulations may be looked forward to as a great work to be achieved by the present generation.

In September 1871, Colonel Walker, who is now on leave in England, ascertained the longitude of Tehran by telegraph from London, and has given the following account of the operation:[1]—

"The approximate value of the longitude of Tehran was determined "by Colonel Walker, R.E., Superintendent of the Trigonometrical "Survey of India, and Major St. John, R.E., of the Persian "Telegraph Department, through the line of the Indo-European "Telegraph Company. Signals were sent from London by Colonel "Walker, and from Tehran by Major St. John, the Greenwich "times of the signals being ascertained from a clock in the Govern- "ment Central Telegraph Office, which was governed by a clock in "the Greenwich Observatory, while the Tehran times were deter- "mined by sextant observations taken on the spot by Major St. "John and his assistant, Captain Pierson, R.E."

"Considerable interest attaches to the operation, from the circum- "stance that though the distance from London to Tehran along the "telegraph line is 3,870 miles, and it was necessary to employ "automatic relays at five intermediate stations, the entire retardation "of the electric current in either direction was found to average less "than half a second. This shows that the line is in a very high "state of efficiency, which is most creditable to the Messrs. Siemens, "by whom all the working arrangements are carried out. Thus "there is much reason to hope that when the necessary instruments "are available in India, exact and final determinations of the differ- "ences of longitude of the Greenwich and Madras Observatories, and "the stations on the arcs of parallel of the Indian Survey, may be "obtained without any serious difficulty."

"The value now determined for the longitude of Tehran is "51° 24′ 5″ E. of Greenwich. It differs by less than half a minute, "or say half a mile, from the value which had been previously deduced "by Major St. John by combining a telegraphic determination of the "difference between Tehran and Karáchi[2] which was made by "himself and his assistants, with the trigonometrical difference between

---

[1] Monthly Notices of the Royal Astronomical Society, Vol. xxxii., No. 5, p. 222, (March 1872). See also the "Abstract" for 1869–70, p. 31.

[2] See "Abstract" for 1869–70, p. 31.

" Karáchi and the Madras Observatory, which is furnished by the " operations of the Great Trigonometrical Survey of India, and as- " suming for the Madras Observatory the latest and most exact value of " longitude, 80° 14′ 20″ E. of Greenwich, which has been adopted by " the Government Astronomer at Madras, and is quoted in all the " recent Nautical Almanacs, this close coincidence between two inde- " pendent results, though possibly to some extent fortuitous, may be " accepted as a sufficient proof that there can be no very material " error in the adopted value for the Madras Observatory, and this is a " matter of some importance, as all the most important determinations " of longitude in India have invariably been referred differentially to " that Observatory."

Captain Basevi, whose lamented death will cause a gap in the staff of the Great Trigonometrical Survey which it will be no easy matter to fill up, left Dehra on the 27th of March 1871, to complete his series of pendulum observations in Ladak and Tibet.[1] He ascended by the Takálung pass to the lofty plateau of Rukshu, 15,000 to 20,000 feet above the sea, and was for six days and nights observing for 22 hours out of the 24. He thence advanced to the north end of the Pangong Lake, and was wet through in a snow storm. Reaching the Lanak plain, 17,104 feet above the sea, he was attacked with a severe cough, and, overworked as he had been, with his constitution too severely tried by the previous strain, and nothing but a thin canvas tent to protect him, his strength at length gave way. He died on the 17th of July, while gallantly striving to get up and go on with the work. In reporting his death the Government of India expressed deep regret for the untimely loss of this talented officer, and the Secretary of State, in replying to their despatch, expressed his sense of the great loss which has been sustained by the public service and by science in the death of Captain Basevi. " The series " of observations," his Grace added, " which that accomplished and " devoted officer had so nearly completed, will form a lasting " memorial of his services to science, while his previous career had " already entitled him to rank among the foremost of the distinguished " scientific officers now serving in India."[2] The President and

---

[1] See " Memoir," p. 121, and " Abstract " for 1869–70, p. 13.

[2] From the Government of India, September 1st, 1871 (No. 12). From the Secretary of State, October 26th, 1871 (No. 26).

Council of the Royal Society also recorded "their deep sense of the "loss sustained by the lamented death of Captain Basevi."[1]

The levelling operations have been carried forward by Mr. Lane from Gorakhpur to Barbhanga, a distance of 308 miles; and five charts of levels have been published,[2] besides 13 triangulation charts. Mr. Hennessey has been engaged on calculations for the final reduction of the whole operations of the Survey, and has completed what is known as the "Reduction of the N. W. Quadrilateral," including the greater part of Upper and Western India. The principle of reduction adopted is due to Colonel Walker, and Mr. Hennessey has assisted his chief in those intricate and very extensive computations, with untiring energy and skill. Progress is thus being made with the preparation of the second volume of the History of the Great Trigonometrical Survey of India.

Meanwhile 200 copies of the first volume have been received in England,[3] and upwards of 90 have been distributed to various scientific institutions and men of learning at home and abroad. In a letter to Colonel Walker, dated December 1st, 1871, the Under Secretary of State for India acknowledged the receipt of the copies of this volume in the following words: "The Duke of Argyll desires me to convey "to you his congratulations on the completion of this first volume of "a great work which, as a record of accurate geodetical measure- "ment and of arduous services well performed, will yield to none "that has hitherto been published by any European nation, either in "interest or in scientific importance. His Grace is impressed with "the amount of labour and of concentrated thought which must "have been devoted to the preparation of this volume, and I am to "express to you his sense of the value of your services as its author. "In a despatch to the Governor General in Council, the Duke of "Argyll has requested that his Grace's appreciation of the assistance "afforded to you by Mr. Hennessey and other officers of the Survey "may be conveyed to those gentlemen."

The General Report for 1870–71, in Colonel Walker's absence,

---

[1] Resolution dated October 26th, 1871. See also an obituary notice of Captain Basevi, by Colonel Walker, in the "Times" of September 19th, 1871, and another in the Anniversary Address of the President of the Royal Geographical Society, for 1872, p. . For the previous services of Major Basevi, see "Memoir," pp. 100, 110, 111, 113, 121, and "Abstract" for 1869–70, p. 13.

[2] See "Memoir," pp. 97 and 119, and "Abstract" for 1869–70, p. 16.

[3] See "Memoir," p. 125.

has been prepared by Major Montgomerie. It contains an Index Chart of the Great Trigonometrical Survey of India, showing the chains of principal triangles, the base lines, the levelling operations, the pendulum stations, and the secondary triangulations to the peaks on the northern frontier. The Report also contains Index Charts of of the Gujrát Survey, of the Katiwár Survey, of the Kumáun and Garhwal Survey, of the Kosi Valley Survey, of the Levels in the North-West Provinces, a map of a route made by a Sapper Havildar in 1870 from the Punjab to Badakshan, and a sketch of Moré Plain by Captain Basevi.

III.—The Topographical Surveys of India, and Work in the Office of the Surveyor General, 1870–71.

The six Topographical Surveys, which have been at work under the direct superintendence of the Surveyor General during the year 1870–71 have completed the mapping of 14,592 square miles; and, including the Revenue Surveys, the work covers 31,530 square miles. The total area surveyed up to 1871 is 665,909 square miles, which is three times the area of France.[1] This does not include any of the topographical work of the Great Trigonometrical Survey, nor the work in Madras and Bombay. The cost is now at the rate of Rs. 22·4 per square mile.

Topographical Survey Parties have been working in Gwalior and Central India, in the Vizagapatam Agency, in the Central Provinces and Rewah, in Malwa and Bhopal, in Rájputána, and with the Looshai Expedition.

No. 1 Party, under Lieutenants Strahan and Holdich, completed 2,653 square miles of a difficult country, chiefly to the westward of the Betwa River. Near Deogurh the Betwa is overlooked by rocky cliffs on either bank; and the surrounding country is full of archæological remains of great interest. The ruins of numerous temples display the art of sculpture in the utmost profusion. Lieutenant Holdich mentions one temple of great magnificence, with a broad paved causeway leading from the foot of the hill on which it stands; and at Iran, on the banks of the Bina, a tributary of the Betwa, is the celebrated pillar supposed to represent the exact centre of the Empire of

---

[1] See "Memoir," p. 130, and "Abstract" for 1869–70, p. 17.

Hindustan,[1] on which is inscribed one of Asoka's famous edicts. Lieutenant Strahan describes the remarkable physical structure of the hill country in the native state of Ulwar. These hills by no means mark the water-parting of the country, for the drainage breaks through them in many places. The hills are in parallel ridges, and hence the drainage takes strange forms. A stream will often rise on one side of a ridge, flow along its base until it reaches the end, when it will pass completely round and flow along parallel to its former course, in the opposite direction, and within a mile of it. Precipices occur, 500 or 600 feet high, overhanging running streams of water, flowing through rich jungle intermixed with palm trees.[2] Lieutenant Strahan also gives an account of the city and fort of Ulwar; and the Assistant Surveyors Scanlan and Cornelius give a translation of the curious tradition of Budi or old Chanderi.[3]

Colonel Saxton,[4] in command of No. 3 Party, was engaged on the Survey of the Saora hills, which will fill up a long and unsightly gap on the Atlas, Sheets 107 and 108. This was completed, together with part of Jeypur and Panchipetta in the Vizagapatam Agency, the work covering 1,653 square miles of difficult and hitherto unexplored country. The Appendix to the Report is enriched by some very interesting notes on the Saora hills by Mr. Harper.[5] Colonel Saxton also completed the triangulation of the Nilgiri hills, and united it with the new series of the Great Trigonometrical Survey. This will enable a more correct delineation of the Nilgiris to be given on the old Atlas, Sheet No. 61.

No. 4 Party, under Major Depree,[6] completed 2,667 square miles in the north-east part of the Biláspur and Mandla districts of the Central Provinces, and in that of Sohagpúr belonging to Rewah. The latter region includes the famous plateau of Ummerkuntuck, where are the fountains of the Narbada and the Son; and Mr. McGill gives some notes on this interesting part of India, and on the religion and customs of the Gond and Baiga tribes who inhabit it.[7]

Captain Riddell,[8] with No. 5 Party, was at work in Malwa and Bhopal.

In Rájputána Captain Strahan[9] completed 3,551 square miles of very intricate ground, clothed for the most part with heavy forest, and intersected by numerous ravines. He also surveyed 20 square

---

[1] App., p. i. [2] App., p. ii. to. iv. [3] App.. p. viii.
[4] See "Memoir," pp. 103 and 128, and "Abstract" for 1869–70, p. 18.
[5] App., p. 11. [6] See "Memoir," pp. 103 and 128.
[7] App., p. xv. [8] See "Abstract" for 1869–70, p. 17.
[9] See "Abstract" for 1869–70, p. 18.

miles of Mount Abu, and furnishes a description of the hills, in the Appendix to the Report.[1]

Several accidents hindered the progress of the Khasia and Gáro Survey by No. 6 Party.[2] Captain Melville came out from England to take command of it in January 1871, but died suddenly at Thymensing, on his way, on the 15th of February. On May 8th, Captain Badgley took charge of the party, and was appointed, with Lieutenant Woodthorpe and Mr. Ogle and Mr. Robert, to accompany the Looshai Expedition, starting from Cachar. A most valuable contribution to the geography of the eastern frontier of India may be expected from their labours.

No. 2 Party, which was broken up in 1870, has again been constituted under Mr. Girdlestone,[3] to execute Surveys in Khandesh and the native States of the Bombay Presidency.

The usual activity has been displayed in the engraving, lithographing, and photozincographing branches of the Surveyor General's Office.[4] The number of new quarter plates of the Indian Atlas that has been engraved and published is 11,[5] making, with 2 finished in 1870, 13 engraved in India; and 21 more are in various stages of progress. The native engravers and apprentices have made fair progress, but the work of training in the difficult art of engraving is a very slow process. The European Engraving Staff urgently needs to be considerably enlarged. The lithographic branch, under Captain Murray, has prepared 526 lithographs of various kinds, and struck off 295,452 copies. The photozincographic branch, which provides for the early issue of maps for general use, has, under the able superintendence of Captain Waterhouse, produced 1,035 sheets. Several important general maps have either been published or are in course of production. New general maps of Oudh and Sind (16 *miles to the inch*) will soon be in the engraver's hands, and one of the Lower Provinces is under compilation. Another of the North-West Provinces (16 *miles to the inch*) has been lithographed, and a very useful general map of the eastern frontier, including part of China and

---

[1] App., p. xx. [2] See "Memoir," p. 128, and "Abstract" for 1869–70, p. 18.
[3] See "Abstract" for 1869–70, p. 18. [4] See "Memoir," p. 130.
[5] 3. S.E., 3. N.W., 10. N.E., 10. S.W., 10. S.E., 11. S.E. — Sind.
51. S.E. — Central India.
87. N.W., 87. S.W. — Oudh.
125. S.W., 131. S.W. — Bengal.

Burmah (32 *miles to one inch*). A new map of Orissa (12 *miles to one inch*) has also been engraved and published for the Statistical Survey of India, now in progress under the Director General of Statistics to the Government of India.[1] A number of sheets of Revenue Maps of Sind and other parts has been published, and progress has been made with the projection and compilation of Atlas sheets, and with several important general compilations, such as that of the Standard Map of India, which is to be engraved.

On June 6th, 1871, the Surveys were transferred from the Home to the new Department of Revenue, Agriculture, and Commerce; and on August 5th a committee was appointed by the Governor General, to consider and report upon a plan for the prosecution of the Surveys in India, and other questions connected with them. It was considered that a regular plan of operations for not less than five years should be sketched out, in order to give greater certainty to the progress of the work. Among other matters, the committee was instructed to direct its attention to the engraving establishment. Good maps, it was pointed out, are the interest which the State receives on the capital expended in surveying, and the material for them should be utilized at once, for otherwise the interest on the capital invested in the collection of those materials is virtually sacrificed. The committee was composed of the Honourable B. H. Ellis, as President, Mr. Chapman, Mr. Hume, Colonel Dickens, Colonel Thuillier, and Major Montgomerie, and they held their meetings at Simla. It was calculated that the remaining area to be surveyed, consisting of 462,599 square miles, might be executed within the next 20 years, and an increase of the engraving establishment was recommended. Colonel Thuillier, in order to furnish complete information respecting the Atlas of India, has drawn up two elaborate Reports,[2] showing the exact state of each sheet, and the materials for completion or correction.

IV.—The Revenue Surveys of India, 1870-71.

Revenue Surveys have been conducted on different principles in various parts of India. The ideal Survey, while furnishing complete

---

[1] This Map has now been published in Dr. W. W. Hunter's "Orissa," which forms the first result of the Statistical Survey. (*Smith, Elder, & Co.*, 1872.)

[2] 13th June 1871. No. 188 F. 28th October 1871. No. 803 F.

information for settlement purposes, should be executed throughout on accurate principles, and supply materials for compiling maps for general use. Such a system has always been advocated by Colonel Thuillier; but in the Madras Presidency alone has any approach to a compliance with all the demands been effected. The Madras Revenue Survey must therefore be considered as, on the whole, the best in India. The Bombay Survey is admirable, and perhaps the best for fiscal purposes; but it is of less use, so far as the supply of materials for general maps is concerned. In the Punjáb, although there is a professional Survey for the boundaries of villages and topographical features, a less accurate native system is in force for field measurements, which also unnecessarily goes over work done by the professional surveyor. A new Survey is now necessary for the fresh settlement of the North-West Provinces; and Colonel Thuillier has endeavoured to secure the adoption of an accurate system, to the exclusion of rough native work.

During the year 1870–71, 15 Revenue Survey Parties were at work in the Bengal Presidency, in the Chindwarra, Raepur, and Chanda districts of the Central Provinces; in Gonda, Moradabad, Bareilly, Kurnal, Dera Ghazi Khan, and Bhawalpur; in Assam, Hazáribágh, Hugli, Sibságar, and Cachar.

A new cadastral Survey in the Muttra and Moradabad districts has been commenced this year, on a scale of 16 inches to the mile, which is entirely under the Survey Department; and the re-introduction of the field or *khusrah* measurements by professional surveyors is certainly a very important step. At the time of the first Revenue Survey of the North-West Provinces, the whole was executed by professional surveyors, but this vital principle has since been set aside, the *khusrah*, or record of fields, being obtained without any reference to the professional Survey. The return to the old and more accurate system is quite in accordance with the views of Mr. Thomason, the administrator whose name is most closely connected with the settlement of the North-West Provinces, as well as with the principles laid down in Colonel Thuillier's Manual.

Four Revenue Survey Parties were employed in the Punjáb for the field season of 1870–71; two in Bhawalpur, one in Derajat, and one in the Delhi Division.[1] The Derajat Party, under Colonel

[1] Punjab Administration Report, 1870–71 (p. 20).

Johnstone,[1] completed 1,560 square miles of interior, and 2,330 of boundary Survey in the Dera Gházi Khán District, including the cantonment of Rejanpúr on a large scale. The Delhi Division Party, under Captain Macdonald, was ordered up from Sindh, but not having been able to leave Kotri until the end of November, it could not commence work until rather late in the season. Nevertheless, an area of 450 square miles was surveyed in Kurnál, and interior details over an area of 350 square miles. These professional Revenue Surveys are distinct from the measurement of fields. They fix the village boundaries and delineate interior details such as the limits of forest, waste or cultivated land, and all other features of the ground which can be shown in the scale of the Survey.

In my "Memoir on the Indian Surveys,"[2] I stated that the first *khusrah*, or native Survey of the Punjáb, proved a failure; that in 1856 it was reported that all the work done in this way was utterly useless, and that the system had broken down. In explanation of these remarks, I take this opportunity of adding that Colonel Meadows Taylor had informed me that he found it quite impossible to reconcile the Punjáb system with any scientific method of proceeding; that with the instruments and instructions sent from the Punjáb to the Assigned Districts in 1855 no Survey at all was possible; and that in January 1856 a letter was received by Mr. Bushby, then Resident at Haidarabad, in which it was stated that the system had broken down in the Punjáb, after having been tested. General Balmain also says that, in Berar, it was found difficult to get even approximately correct maps from the Pátwari Survey, according to the Punjab system.

In the Punjab the *hudbust* is the outline sketch of the village boundaries. The Pátwari, who in the Punjáb took the place of the Hindustani Amin, was in 1852 supplied with instruments with a view to his making a native *hudbust* map, which was to be nearly equal to that of the professional surveyors.[3] Mr. Barnes thus describes these instruments: The first and principal instrument was a horizontal board screwed to a shaft, shod with an iron point. The board was about 18 inches square, and over it was stretched a piece of paper, on which the village outlines were delineated. To this

---

[1] See "Abstract" for 1869–70, p. 15.

[2] P. 103–104.

[3] "Selections," Punjab, Vol. i., p. 128. Letter from George C. Barnes, Esq., 13th December 1852.

board was fixed a *quiblanumah*, or rough compass, used by the Mahommedans to denote the west, which would cost one rupee in the bazaars. The surface of the board was adjusted by this *quiblanumah*, and the entire periphery of the board was graduated like the card of a compass. This board and the *quiblanumah*, together with an iron ruler, formed the surveying equipment of the Pátwari. The ruler was graduated, each division representing 10 *kurrums*, or 50 feet, and it was fitted with a perpendicular sight at each end, through which the position of an object was observed.[1]

The Pátwari began work at a *trihudda*,[2] or triple junction pillar, by adjusting his board by the compass, "at some assumed and convenient portion of the paper." He then "takes the bearing of the next pillar, through the perpendicular sights attached to the ruler, and measuring the distance with the chain, reduces the measurement according to the graduated scale on the same ruler, and draws a straight line to correspond, both in distance and bearing, on the paper. In this manner he goes round the area of the whole village, correcting his measurements and angles by the scale and compass. Moreover, from each *trihudda* he takes the bearing and draws a line in the direction of the village site, and wherever these various lines intersect each other, the village site is duly marked upon the sketch. The total cost of the instruments is 1 rupee 12 annas."[3]

Such was the Pátwari system of surveying in the Punjáb. There was no actual measurement of bearings, as all directions were laid off by the ruler. The compass bearings were not corrected for variation, while the iron rulers must have made a farther large correction necessary, which was not applied. The compasses must really have been utterly useless. Moreover, no record of the distances appears to have been entered, so that it was impossible to check the work, by plotting the true bearings and distances independently. An error of 8 to 10 per cent. was allowed before any revision was ordered.[4] Such a Survey would furnish but a very rough and unreliable measurement for fiscal purposes. But the system never appears to have been abandoned, as was understood by the officers in the Assigned Dis-

---

[1] "Selections," Punjab, Vol. i., p. 129–130.

[2] Where the boundaries of three villages unite.

[3] "Selections," Punjab, Vol. i., p. 130.

[4] Ibid, p. 139. Letter from Mr. Temple to Mr. Barnes, September 25th, 1852.

tricts, whose information I quoted. On the contrary, it has been continued and improved upon.

A professional survey, working independently of the Pátwaris, fixed the boundaries of villages and inserted interior details, thus furnishing a partial check, but did not measure the fields.

Since the revised settlements were taken up in the Punjab in 1863, a great advance is reported to have been made in the native system of conducting a cadastral survey of fields, and more accurate results are said to have been attained, both in the measurements and in the maps. The *quiblanumah* is no longer used, but simply the plane table. Triangulation is often adopted to form the skeleton map, and within it small sections of country are marked off, and field by field measurement carried on, the work being tested as it proceeds. The positions of the chief physical features are fixed by running lines to the boundary, so as to form triangles, with which the fields are plotted. Dimensions of the fields are put on the map round each field, and are again checked by the chain and plane table. These are certainly great improvements. The assessment is based upon the aggregate areas, after checking each village with the results of the professional Survey.

The arguments for continuing the native survey in the Punjáb, side by side with the professional survey, instead of combining them in one accurate system, are, that "all the local aspects must be " brought to book, as well as the professional work; that the survey " must be based on a careful understanding of local requirements, " tenures, and modes of dividing land; and that physical features " must not only serve to indicate what is seen with the eye, but also " what the settlement officer knows to be wanted for administrative " purposes."

These considerations only show the necessity for the revenue and survey officers being in perfect accord and working together, but, this being the case, they supply no argument for a professional survey side by side with a native and less accurate system. If, for example, the village boundaries are accurately laid down by professional surveyors, there can be no good reason for the same work being also done inaccurately by ignorant natives. It is admitted that if professional officers supervised the field surveys they would make them more perfect, and that those surveys are not now as correct as they might be. It must, therefore, also be admitted that a system by which the survey and revenue officers work together, and which is

conducted on correct principles in every detail, in the field measurements as well as in the village boundaries, with a complete series of tests, is superior to a mixed native and professional system. The Madras Revenue Survey alone answers this description, and must consequently be considered as the best that has yet been established in India. Its work is adapted to reduction for geographical purposes, being carefully connected with the points of the Great Trigonometrical Survey, while its accuracy, as regards field measurements and village boundaries, is of a high order. Revision was not enforced in the Punjab Pátwaris system until the error had reached to 8 or 10 per cent.; now, an error of 5 per cent. is allowed. The Madras Revenue Survey tolerates no error greater than $1\frac{1}{2}$ per cent. This fact alone settles the question of superiority.

The Madras Revenue Survey,[1] executed on strictly accurate principles in every stage, is making regular progress. Up to March 31st, 1871, the number of square miles that had been surveyed was 41,043;[2] of which 35,643 were in fields on a scale of 16 inches to the mile, and 5,400 were topographically surveyed on a scale of 4 inches to the mile. There remain 77,601 square miles to be taken up before the Survey of the whole Presidency is completed. The Revenue Survey is complete in the Godavery, Kistna, Nellor, Trichinopoly, and Salem districts; and the Topographical Survey of the zemindary or rent-free lands[3] is in progress in Nellor and Salem. In Karnúl and Tinnevelly the Revenue Survey is approaching completion; and it is progressing in Cuddapah, Coimbator, Chengalpat, Ganjam, and the Nilgiris. In Wynaad 124 square miles of estates were surveyed before the party was transferred to Tinnevelli in 1862. There are five and a half parties now in the field, and they each get through the work at the rate of 760 square miles a year.[4]

The demarcation and Survey of the hill settlements in the Nilgiris[5] was ordered in February 1866, on a scale of 8 inches to the mile. Kunnur and Wellington have been completed in all respects; and Utakamand and Kotagiri are fast approaching completion. On these hills 168 waste land blocks, covering 79 square

---

[1] See "Memoir," p. 106 and p. 133.

[2] Up to March 31st, 1871, the average cost of the area surveyed has been Rs. 107, or Rs. 115 per square mile, inclusive of the share of the Central Office.

[3] See "Memoir," p. 133.

[4] The annual cost of a Madras surveying party is Rs. 77,988.

[5] See "Memoir," p. 108.

miles, have been surveyed and mapped. On the Shervaroy hills 41 square miles have been surveyed and mapped, and a combined map has been constructed.

The Madras Revenue Survey is based on true principles. The method of connecting it with the points of the Great Trigonometrical Survey has been described in the Memoir,[1] and it can thus be made available for geographical purposes. All the measurements are in triangles, of which the three sides are always measured, and the correctness of the measurements is also verified by measuring diagonals, while the aggregate of the fields must agree with the entire area as deduced by theodolite; thus errors are at once detected. The difference allowed between the area of the whole village as obtained by theodolite and traverse Survey, and the aggregate areas of the contained number of fields as laid down by subordinate measures, is $1\frac{1}{2}$ per cent., but the average difference does not exceed 0·3 per cent. The computation of fields is performed by the computing scale, as in the Ordnance Survey in England. As a check, 10 per cent. of the fields are tested, the fields being plotted by triangles within boundaries previously fixed, and the field surveyors not being allowed access to the plotted work.[2] Every village boundary is surveyed by theodolite, and proved by traverse, according to the rules laid down in Thuillier's Manual. The average size of a village is 2·7 square miles, and of a field 2 acres, the villages, for surveying purposes and to facilitate field plotting, being divided into *khandams* of from 50 to 150 acres. But this subdivision necessarily increases the work of boundary surveyors and computers, for unless the *khandam* boundaries are run by theodolites they lose their value as check lines.

Some progress has been made in combining the village maps, and 58 Talook maps, covering 22,614 square miles, have been brought out, on a scale of a mile to an inch, up to June 1870, while others are in progress; but only 21 are complete, the rest having unsurveyed blocks within their limits. No district map, reduced from the Talook maps, has yet been published, but that of Nellor is under compilation; and as the survey of the zemindary tracts is completed, the compilation of district maps will be taken in hand. Good progress is also being made in filling up the unsurveyed gaps.[3] The

[1] See "Memoir," p. 107.

[2] Answers to queries received from the Surveyor General, August 2nd, 1871.

[3] See "Memoir," p. 133.

scale of these intermediate Topographical Surveys is 4 inches to the mile, and they take note of roads, rivers, canals, tanks, channels, nullahs, swamps, village sites, hills, and other details. They also mark the divisions of wet and dry cultivation, and between cultivation and waste, and distinguish the heavy jungle from scrub or sandy waste.

Colonel Priestly has deposited a most interesting series of documents with the Geographical Department of the India Office, to illustrate all the different stages of the Madras Revenue Survey work. For this purpose one village is taken, that of Vellappakkam, in the Ponneri Talúk of the Chengalpat district, and the whole of its survey and demarcation records are given in regular order, from the original field books to the lithographed copy of the village map. Then follow a specimen of a Talúk map, of a topographical map, the demarcation and survey rules, and other documents. They are deposited in a separate case, so that anyone can obtain a clear idea of the system by one or two hours study.[1]

The Bombay Revenue Survey is, perhaps, the best and most perfect for revenue purposes, and it has undoubtedly conferred enormous benefits on the people. But it is useless for general purposes of mapping and geography, as the village maps are mere rough plans, and cannot be made use of in the compilation of maps on convenient scales. The careful elaboration of the original design of the Bombay system is due to Sir George Wingate, and his labours, extending from 1836 until he received the well-earned recognition of

---

[1] Village Map Records :—

- Land Register.
- Boundary and Khandam Circuit Field Book.
- Minor Circuit Field Book.
- Ameen's Sketches.
- Ameen's Field Book.
- Boundary Traverse.
- Khandam Traverses.
- Minor Circuit Traverses.
- Computation Papers.
- Area Lists.
- Manuscript Map showing process of plotting fields.
- Talook Maps.
- Maps of Madras Town.
- Specimen Plane Table Square.
- Topographical Maps.
- Demarcation Rules.
- Survey Rules.

Extract from Main and Village Traverses for Distances between G. T. Stations.

Comparative Statement of Distances between G. T. and Revenue Surveys.

Average Cost of survey measurements per square mile.

There is also an excellent Index Map of the Madras Revenue Survey, showing the areas completed, the areas in progress, the intermediate spaces topographically surveyed, and those not yet taken up.

his great services in 1866, resulted in the admirable system of administration which has proved so efficacious in promoting the revival of agriculture in the Presidency. The operations of the Survey form the basis of the revenue administration. The system is *ryotwar*, and the first object was to determine the size of the fields, and thus to form the unit or basis of the Survey, on which the cess should be placed. The smallest amount of stock with which cultivation can be carried on is one pair of bullocks, the *minimum* area to be measured separately and to be constituted a "*number*," as it is called, was therefore fixed at what two bullocks could plough. The *maximum* area to be measured and constituted a separate "*number*" must not exceed the means of the generality of ryots to cultivate, so that it may easily be made the subject of sale or transfer. The *maximum* area was fixed at what four bullocks can plough. Thus the Survey "*numbers*" were fixed at what one pair of bullocks could plough up to double that size. This varies from 20 to 40 acres for dry crops to from 4 to 8 acres for rice cultivation.

The first operation is for the settlement officer to settle disputes, and finally fix the village boundaries, which are marked by stone pillars. A series of detached earthen mounds are raised to demarcate the limits of "*numbers*," and these plots of land are defined on the map by continuous black lines. In order to facilitate the settlement of disputes, topographical features and permanent marks are noted, such as watersheds, nullahs, roads, temples, tanks, wells, fruit trees, and boundary pillars.

The field operations of the village Surveys are conducted by a European assistant and 20 native measurers. The European makes no original Survey himself, his duty being to supervise and test the work, which he does by going over 10 per cent. of it, the errors allowed being 1 per cent. for survey numbers of above 6 acres, 2 per cent. when they are under 6 acres, and 3 per cent. for small garden or rice numbers. The instruments of the native measurer consist of a chain 33 feet long, in 16 links, a square chain being called a *goonta*, 40 of which go to an acre. The areas are calculated in acres and *goontas*. He also has a pair of compasses, and a diagonal scale showing chains and links (called *avnas*). A base line is measured from the boundary on one side of a village to the opposite one, and all the first numbers are measured along this base. The plotting of the map on the base line is effected by the principle of the triangle, each number being broken up into internal triangles and trapezoids

by chaining, and the scale is 8 or 16 inches to the mile, according to the average size of the survey numbers. All the work in the field is finally entered and abstracted in a fair field book. As soon as the surveying work is finished, the registers and documents embodying the results are sent to the classing branch, in which the relative value of the soil and water in each number has to be determined, with a view to fixing the assessment.

The classing is a very complicated and elaborate system, and shows with what extreme care the true value of each field is ascertained. Numerous considerations are brought into account, which are classed under three heads, namely, the distance from the village site, natural productive capability, and the nature of the water supply. As regards productive capability, not only are the soils divided into black, brown, and gravelly, but the depth of the soils is also taken into consideration, and the land is thus divided into nine classes, from pure black deep soil to the poorest and thinnest gravelly soil. Moreover, the land is also rated with reference to eight other considerations called faults.[1] Thus the elements for settling the value of a Survey number are, 1, convenience of position; 2, colour of soil; 3, depth of soil; 4, faults; 5, water supply, which again is divided into six classes.[2] When the classing is completed the amount of the assessment is fixed, and it is another very complicated question to decide what can safely be taken by the State and still leave a sufficient surplus for the ryot, to render him capable of improving his circumstances and extending his cultivation. This is done by examining the averages of former settlements, but many other considerations

[1] The faults, which are noted by certain signs in the classer's field book, are—

1. Mixture of minute nodules of limestone.
2. Mixture of sand.
3. Sloping surface.
4. Want of cohesion in the soil.
5. Mixture impervious to water.
6. Liability to be swept over by running water.
7. Surface springs causing excess of water.
8. Large limestone nodules.

[2] The classes of water are—

1st. From a good tank or river, with supply until April.
2d. Similar to the above, but land more elevated.
3d. Dependent partly on rains.
4th. Still more elevated land irrigated from a canal.
5th. The same as the 4th, but on which no after-crop can be raised.
6th. Dependent wholly on rain.

come into the account, and the final result was generally a considerable reduction. A new era of prosperity and progress was inaugurated by this admirable Survey, which, so far as the administrative results are concerned, is the best in India. But the importance of making the Survey available for general use in the compilation of maps was entirely lost sight of, and the Topographical Surveyors in Gujrat have been unable to make any use of the revenue village maps.

This year a Revenue Survey has been organized for Násick, with a view to obviating this defect in the original arrangements. A Revenue Survey of village boundaries on rigorous principles is to be carried on by professional surveyors, in combination with a detailed measurement of fields (or "numbers") by the Revenue Settlement officers, the two staffs being distinct and independent of each other. But this plan is the same as that which prevails in the Punjáb, and falls short of a Revenue Survey on correct principles in every detail, such as is carried on in Madras, and in Madras alone.

The Survey and Settlement of the Haidarabad Assigned Districts, under Major Elphinstone, is conducted on the Bombay system of measuring and classing. Out of the 19 Taluks of which the Berars are composed, 14 have been entirely measured, three are far advanced in measurement, one has just been commenced, and one is still untouched. The latter is the large district of Wún, containing 633 villages. The classification of soils has been completed in 12 Taluks, and commenced in two others.[1]

It will have been seen that the work of surveyors and that of settlement officers are very closely connected. The first operation of all brings the settlement officer on the scene to arrange disputes and fix the village boundaries. Then the surveyors step in and measure the ground, and afterwards the settlement officers again take up the work and classify and assess the fields or villages, as the case may be. Hence it is essential that there should be complete agreement between the revenue and surveying officers, and that the latter should thoroughly understand the requirements of the settlement and all the details that should be recorded for fiscal purposes. But

[1] Of the 6,365 villages in the Assigned Districts, 2,792 have been settled, 3,622 classed, 4,561 measured. There remain 1,804 to be measured, 2,743 to be classed, 3,573 to be settled. The total cost of these Survey operations, since the commencement, amounts to Rs. 13,18,687, while the annual increase to the revenue from the settlement is Rs. 8,00,093.

there is no reason why this understanding should not exist, and why the excellent revenue system of classing and assessing, such as prevails in Bombay, should not co-exist with a Survey on rigorously exact principles, turning out village maps which would form materials for those geographical and general purposes, attention to which is also important and, indeed, essential to efficient administration.

Several questions respecting the re-settlement of the revenue demand in various districts will soon require decision, and the systems on which Revenue Surveys are conducted in different parts of the country are likely to be considered and discussed.

V.—The Geological Survey of India, 1871.

The strength of the working establishment of the Geological Survey was less weakened during 1871 by losses and sickness than it has been in previous years.[1]

Mr. Medlicott examined the Mohpani coal fields and the Puchmarri Hills in the southern part of the Narbada valley, using the maps of the Topographical Survey for recording his observations, and thus he got through a large amount of work. When this district was first visited in 1857, no maps of it existed, and the geologist was obliged to make the best shift he could, by constructing a sketch map. Mr. Medlicott had a severe attack of fever, and was obliged to come home, but he resumed work again in December 1871.[2] Mr. W. L. Willson[3] has been at work in the southern part of the Jhansi district and Tehri, where there is a remarkable series of trappean dykes and quartz reefs. Mr. Mallet, after reporting upon the water supply of Aden,[4] proceeded to the Mirzapur District; and is now examining the Kota coal field, extending into Rewa and Chota Nágpur. Mr. Hackett[5] completed the Jabalpur district, but was laid up with fever. He explored the Bijawur Series, extending N.E. and S.W.

---

[1] See "Memoir," p. 159, and "Abstract" for 1869–70, p. 20.

[2] "Records," Vol. iv., Pt. iii., p. 66. [3] See "Memoir," p. 156.

[4] Mr. Mallet found that there was abundance of water nearer to the foot of the hills a short distance from Aden, but that this became absorbed in the sands that intervened between these streams and the sea; in other words, that there was an abundance of good water, but that artificial means of conducting it into Aden would be necessary. There seemed nowhere such a structure as would justify the expectation of procuring water by wells sunk on the Artesian principle.

[5] See "Memoir," p. 159, and "Abstract" for 1869–70, p. 20.

across the central portion of the district, along the Bhitri range of hills. It consists of micaceous quartzites, limestones, ferruginous siliceous rocks, and micaceous schists; and contains valuable iron ores. Mr. Ball completed an extensive reconnaissance of a wide area to the south of Chota Nagpúr, in a very wild and roadless country.

Mr. W. T. Blanford mapped the coal-bearing rocks of the Godávari[1] during the season of 1871. A series of borings was undertaken, under the charge of Mr. Vanstavern, the executive engineer of the Godávari works, acting in accordance with Mr. Blanford's suggestions. There seems to be little prospect of any but a very limited supply of poor coal; the area of the coal-bearing rocks being small, and the beds thin and irregular. Mr. Blanford's estimate does not exceed 12,000 tons; and though this may perhaps be added to, in consequence of more recent borings, the supply will at best be limited.[2] But a thick bed of coal is reported in the valley of a nullah near Warungul, which is said to be well exposed and dipping at a high angle of 45°. The country is covered with jungle, but it could easily be opened out. Mr. Blanford afterwards carried on the general mapping of the extent of the sandstone area in the eastern part of the Nizam's Dominions, and southward into the Madras Presidency, towards Ellor.[3] These sandstones appear to belong to the true coal-bearing rocks. Mr. Hughes[4] was occupied in the examination of the Wurda coal fields; and in May he gave advice to Mr. Whyte, who is employed upon similar investigations in the Nizam's territory. The result has proved the existence, at Sastu, of coal more than 50 feet in thickness. But the conclusion has been reached that the central portion of the Wurda field is one in which the flooring of older rocks comes very near to the surface, and so irregularly, that coal, where found, will probably be only in small and discontinuous basins. Mr. Fedden[5] was examining the trappean rocks overlying the coal-bearing series to the westward; but he was attacked by fevers, to which the wild and unhealthy region in which his work lay necessarily exposed him.

Mr. Blanford, after completing his work in the valley of the Godávari, proceeded to Bombay, where he gave advice to the Municipal Commissioner with reference to a proposed plan of con-

---

[1] See "Abstract" for 1869–70, p. 20.

[2] "Records," Vol. iv., Pt. iii., p. 59.

[3] "Records," Vol. iv., Pt. ii., p. 49; Pt. iii., p. 82; Pt. iv., p. 107.

[4] See "Memoir," p. 156, and "Abstract" for 1869–70, p. 20.

[5] See "Memoir," p. 163, and "Abstract" for 1869–70, p. 21.

veying water to that city, through a tunnel in the solid rock, a plan which is believed to be more economical than laying down iron pipes. Mr. Blanford has since been deputed to accompany Sir Frederick Goldsmid to Seistan, a journey from which much valuable information may be anticipated, regarding a country almost entirely unknown.

On Mr. King's return from England he commenced his field examination from the Tungabudra river up to the boundary of the great area of Deccan trap rocks, as far as Gulburga.[1] The main object is to carry out an investigation of the several rocks which occur between the vast thickness of the overlying trappean rocks above, and the even more widely spread base of the underlying gneiss and other metamorphic rocks below. In the valley of the Bhima, overlying the gneiss, there is a series of limestones called provisionally the "Bhima Group." Their lie is generally quite flat, or with a gentle dip to the north-west. Mr. Bruce Foote continued the examination of similar rocks to the south-west, in the upper part of the Krishna valley, joining on to the limits of the exploration made in 1870. He made the very interesting and important discovery of the fossilized remains of a rhinoceros in the regur or black cotton soil.

Mr. Theobald has been engaged, during 1871, in re-examining the Arracan range of the Yoma. The peculiar relations of the altered rocks seen towards the centre of the range with the unaltered nummulitic rocks which occur in the flanks, were still, on many points, open to doubt and question. Mr. Theobald,[2] to determine these points, crossed the range in several places, from the low ground of the Irrawadi to the sea coast. He has satisfied himself that, notwithstanding the remarkable alterations to which the rocks occurring along the axis of the range have been subjected, they belong to the same series as the nummulitic rocks seen on their flanks. Mr. Theobald has also made a list of the brine springs in British Burmah.[3]

Mr. Wynne[4] completed the examination of the eastern portion of the Salt Range in 1870, and during 1871 he worked out the western part in considerable detail. He is now engaged upon the region north of the range, extending to Attock. Dr. Waagen[5] was sent to examine the relations and mode of occurrence of the fossils in the Salt

---

[1] See "Memoir," p. 162, and "Abstract" for 1869–70, p. 20.

[2] See "Memoir," p. 163.

[3] "Records," Vol. iv., Pt. ii., p. 33.

[4] See "Memoir," p. 163.

[5] Dr. Waagen joined the Geological Survey on December 13th, 1870.

Range;[1] while, in November, Dr. Stoliczka, the palæontologist of the Survey, visited Kuch for a similar purpose.[2]

The four numbers of the Records of the Geological Survey for 1871 contain several very interesting papers. In the first number there is a notice of the mineral statistics of Kumaon. In the second, Mr. Theobald discusses the geological features of the axial group in Western Prome, Mr. Wilkinson supplies a sketch of the geologieal structure of the Southern Konkan, and Mr. Blanford describes the plant-bearing sandstones of the Godávari valley, extending south to the neighbourhood of Ellor, which may possibly contain coal. He also, in the third number, gives a report on the results of the coal borings in the Godávari valley. The third number also contains a sketch of the geology of the Central Provinces by Dr. Oldham, and a note on the Narbada coal basin by Mr. Medlicott. The fourth number contains an account of the ammonite fauna of Kuch by Dr. Waagen, and a report on the Raigur and Hengir coal field by Mr. Ball. There is also a further description of the sandstone country between the Godávari and Ellor by Mr. Blanford.

The Geological Survey have been requested to furnish general outlines of the geology of different districts, for insertion in the Government Gazetteers, which are now in course of publication, and Dr. Oldham intends to have these sketches reprinted to the Records of the Survey. The sketch of the Geology of the Central Provinces has already been printed,[3] and others of Orissa, the North-west Provinces, and Bombay will follow.

The numbers of the PALÆONTOLOGIA complete the monograph of cretaceous bivalve fossils of Southern India, and two volumes of MEMOIRS are nearly ready. Thus the Geological Surveyors are gradually building up the materials which will enable a geological map of India to be prepared.

VI.—THE ARCHÆOLOGICAL SURVEY OF INDIA.

The First Report by General Cunningham has not yet been received in this country.[4] Yet there are tidings of activity in the field of research

---

[1] "Records," Vol. v., Pt. i.

[2] See "Memoir," pp. 151 and 164.

[3] "Records," Vol. iv., Pt. iii., p. 69.

[4] See "Memoir," p. 201, and "Abstract" for 1869-70, p. 22.

connected with archæology, in the past year, in various parts of India.

In Bengal, Mr. T. F. Peppé, of the Opium Department, has completed a set of 123 photographs of antiquities in the Patna division, including the Great Temple at Budh Gaya, the sculptured caves in the Barabar hills, the Son Bandar caves at Rajgurh, the pillars at Bakra and Lauriya, and the mounds and ruins at Baragon, which have been recognised as the remains of the great Buddhist Monastery of Nalanda.[1]

In Madras, Captain Lyon has been employed to execute a large series of photographs, and Dr. Hunter has been most successfully employing the pupils in his school of design to photograph temples, and to make casts of some of their sculptures.

Mr. Burgess, of Bombay, has presented the Government with plans of the Násick cave.[2] That accomplished archæologist has also commenced the publication of a periodical entitled "*The Indian Antiquary*," which will contain much valuable information on several branches of Oriental research.[3] There are two articles in the first number of special interest. One is on the identification of various places in the kingdom of Magadha visited by the Chinese pilgrim, Fa-hian (A.D. 400–15), by A. M. Broadley, Esq., C.S., Assistant Magistrate at Patna.[4] The other, by Professor Ramkrishna Gopal Bhandorkhar, M.A., is intended to show that the great Sanscrit grammarian, Panini, and his commentators often give very useful information in illustration of the ancient geography of India. The number of names of towns, villages, rivers, mountains, and warlike tribes occurring in Panini is said to be very great, and many can be identified. The Professor believes that some of them throw new light on doubtful points connected with the ancient geography of Afghanistan and the Punjab. Thus he finds the Malli of Arrian in the Mâlavâs of Panini.

Major Godwin Austen, of the Topographical Survey, has recently

---

[1] Bengal Administration Report, 1870–71, p. 268.

[2] Forwarded to this country with a letter from the Secretary to the Bombay Government, dated October 7th (Sec. Genl., No. 39), 1871.

[3] "*The Indian Antiquary*, a Journal of Oriental Research in Archæology, History, Literature, Languages, Philosophy, Religion, Folk Lore, &c." Edited by James Burgess, M.R.A.S. (Bombay, 1872, Nos. 1, 2, 3, 4, 5.)

[4] "Ruins of the Nalanda Monasteries at Burgia, by A. M. Broadley, Esq." (Calcutta, 1872.)

added a most interesting account of the stone monuments of the Khasi Hill tribes[1] to those already published by Colonel Yule and Dr. Hooker.[2] The most noteworthy fact connected with these stone monuments is that the people continue to erect them at the present day, and Major Godwin Austen actually saw the spars which had formed a sort of cradle on which the stones forming a monument were raised.

VII.—Meteorological and Tidal Observations, 1870–71.

The Report of the Meteorological Committee of the Royal Society, dated April 11th, 1871, on the organization of a Meteorological Department in India, was forwarded to the Government of India on the 18th of May, but the subject is still under consideration.[3] The Report of the Colaba Observatory for 1871, and those of the Meteorological Reporters in Bengal, the North-West Provinces, and in the Punjab, also for 1871, and one from the Astronomer at Madras, dated May 13th, 1871, have been received in England, as well as the Oudh Meteorological Report by Dr. Bonavia for 1870–71, and another in the Sanitary Report of the Central Provinces for 1869. Mr. H. F. Blanford has also drawn up a memorandum, dated April 1871, on a uniform Meteorological System for India, in which the different systems of making and recording meteorological observations that have been in operation for various periods in various parts of India is reviewed. Mr. Blanford also shows to what extent the data already collected have been utilised, and what steps are necessary to bring them together and to educe from them some useful knowledge of the meteorology of India during the past few years; and he goes on to define the most important object of a system of meteorological registration, and shows how the present system may be modified and consolidated so as to conduce to its attainment.

This review commences with Bombay. At Colaba observations are taken hourly throughout the year with great care and detail, and printed in an annual volume, under the supervision of Mr. Chambers.

---

[1] "On the stone monuments of the Khasi Hill tribes, and on some of the peculiar rites and customs of the people." By Major H. H. Godwin Austen, F.R.G.S. (Journal of the Anthropological Institute, May 1st, 1871, p. 122.)

[2] See "Memoir," p. 183.

[3] See "Abstract" for 1869–70, p. 24.

Complete sets of these volumes have been sent to England.[1] Systematic observations have also been taken at four other stations in the Bombay Presidency since 1854, namely at Púna, Belgaum, Dísa, and Karáchi. At these four stations the observations are registered at 9.30 a.m. and 3.30 p.m., and hourly observations are taken for 24 hours on the 21st of each month. The observers are selected from volunteers from European regiments who are trained at Colaba. They are under the direction of the senior medical officers. The monthly registers are sent to Colaba for tabulation and condensation. They have been regularly transmitted to England; but hitherto they have been handed over to the Army Medical Department, where they have not been utilized in any way. In future they will be sent to the Astronomer Royal. Weekly rainfall returns from revenue and political officers in the Bombay Presidency are sent to the Secretary of the Government Museum.

At the Madras Observatory the barometrical and thermometrical observations were regularly registered from 1796 to 1807, and the rainfall from 1803.[2] From 1807 to 1812 there was a break, in consequence of the absence of the Astronomer. Accurate observations were again taken from 1813 to 1821, when a fresh series was commenced, and conducted with great care from 1822 to 1843. An hourly series was commenced in March 1841, and continued until February 28th, 1861, when it was considered complete, and discontinued, as no longer necessary.[3] Since 1861 observations have been registered thrice daily, and published weekly in the "Fort St. George Gazette," but they have not been collected in a separate volume. A new anemometer was erected at the Madras Observatory in June 1864. Observations were taken at Cochin from July 1842 to December 1844, but they are still unreduced. The series taken at the observatory on Dodabetta Peak, in the Nilgiris, extends from December 1847 to April 1859,[4] and the observations are reduced to the end of 1855, but the rest are unreduced and still in manu-

[1] See "Memoir," p. 215 and p. 224, and "Abstract" for 1869–70, p. 23.

[2] See "Memoir," p. 299.

[3] The Publications of the Madras Observatory are :—

1. Goldingham's "Madras Observatory Papers," 1796–1821.
2. Taylor's "Madras Observatory Papers," 1822–1843.
3. "Hourly Observations, 1841–45." (Taylor.)
4. "Hourly Observations, 1846–50." (Jacob.)
5. "Hourly Observations, 1851–1855," nearly ready.

[4] See "Memoir," p. 210.

script. The Sikandrabad register dates from July 1863, that of Trichinápalli from July 1866. In 1867 the establishment of 14 meteorological stations was sanctioned for the Madras Presidency,[1] and 12 had commenced work up to April 1870:—

1. Salem (1st December 1867).
2. Bangalor (1st January 1868).
3. Ballári (1st February 1868).
4. Coimbator (1st February 1868).
5. Madura (6th February 1868).
6. Cochin (16th March 1868).
7. Karnúl (16th April 1868).
8. Trichinápalli (1st July 1868).
9. Negapatam (16th July 1868).
10. Masulipatam (17th August 1868).
11. Sikandrabad (1st July 1869).
12. Wellington (17th April 1870).

The stations are equipped with complete sets of meteorological instruments, and the observations are recorded by paid observers who have been trained in the Madras Observatory. Each station is under the superintendence of a medical officer, and copies of the register are forwarded half-monthly to Madras for reduction. The backward state of the meteorological publications of Madras arises entirely from the circumstance of the Astronomer having no European assistant; but a remedy was provided in 1871, and the arrears will now be duly worked up. Good progress has been made in tabulating the results of the observations of the last three years. The registers of rainfall at 216 stations are kept by the Sheristadars and forwarded to the Astronomer. They are now placed on a better footing, and more accurate gauges have been supplied.

In the Central Provinces sets of instruments have been distributed to nine stations; namely,—

Nágpur.	Hoshangabad.
Jabbalpur.	Chanda.
Raepúr.	Pachmarri.
Seoni.	Sambalpur.
Ságar.	

The first four date from 1868, and the other five were added in 1870. They are under the superintendence of the civil surgeons.

[1] See "Memoir," p. 224, and "Abstract" for 1869–70, p. 23.

The observations are taken at 10 a.m. and 4 p.m., and sent to the office of the Sanitary Commissioner; and there is a register of the rainfall at each Tehsil. The rainfall is also registered at each Tehsil in the Berars, and meteorological observations have been taken, but with uncompared instruments, at Akola since 1867, and at Amráwatí and Buldánah since 1870.

In the Punjáb a meteorological reporter was first appointed in April 1866.[1] There are now 14 stations with full set of instruments, where observations are recorded at 10 a.m. and 4 p.m. The registers are sent to the reporter, who publishes an abstract of the results. Five reports have been printed, for 1866, 1867, 1868, 1869, and 1870. The rainfall is registered at each Tehseel.

The Meteorological Reporter for the North-West Provinces was appointed in 1865.[2] In 1869 there were 24 stations, of which 14 were principal, with full registration of all instruments at 4 and 10 a.m. and p.m., and hourly observations are taken at Rúrkí for 24 hours, four times a year. The results have been printed in the Annual Reports for 1864, 1865, 1866, 1867, 1868, 1869, and 1870. Registers of rainfall are taken for the Board of Revenue at 203 stations, but they are not supervised by the reporter.

In Oudh there is an observatory at Lucknow, where observations are registered at 4 and 10 a.m. and p.m., and 2 p.m., with hourly observations for 24 hours on the 21st of each month. The returns are sent to the Reporter for the North-West Provinces.

In Bengal a committee for the establishment of storm warnings was appointed in 1865;[3] and the registration of observations at several telegraph stations was commenced. These are now reduced to four. The Meteorological Reporter for Bengal was appointed in 1867. There are 10 second-class stations under the civil surgeons, and the observations are taken both at the first and second-class stations four times a day, at 4 and 10 a.m. and p.m., and 6 p.m. The registers are reduced and the means calculated by the observers, and sent fortnightly to the reporter, who checks them and publishes a monthly abstract in the "Government Gazette." The telegraphic reports appear daily in the "Calcutta Gazette." The registers of rainfall are kept at the civil stations and sent to the reporter, who prepares a weekly summary for the Board of Revenue, which is

---

[1] See "Memoir," p. 220.

[2] See "Memoir," p. 221.

[3] See "Memoir," p. 222.

published in the Gazette. The reporter has issued two Annual Reports, for 1867 and 1868.[1] An hourly Meteorological Register has been regularly kept at the Surveyor General's Office at Calcutta since 1856.[2]

No regular system has yet been established in Burmah, but there is a register at Port Blair under the civil surgeon, and another at the telegraph station at Akyab.

Thus a very large mass of observations is in process of accumulation throughout India. But it is to be feared that much will be found to be of little value, because the data are not comparable, and because the instrumental errors of the barometers and their elevation above the sea are unrecorded. At Madras the great part of the observations is still in the crude form of unreduced readings of the instruments. In other parts the amount of computation required is moderate. The chief work to be done is to obtain the elevations of all the observing stations, and to have all the barometers compared for determination of errors. The diverse systems now in use ought to be superseded by a uniform system by which the results would be strictly comparable.

Mr. Blanford, in his Memorandum, observes that systematic observations should be directed to the special study of the normal law of the monsoons, and of their anomalies, with reference to the distribution of rainfall and its variation in different years. The leading known facts are that the rains of India may be distingushed according to the four seasons.

1st. The *spring* rains of Bengal, not felt west of Nagpore, which are due to the indrought of moist air from the Bay of Bengal towards the heated land of Central India.

2d. The *summer* or S.W. monsoon rains, felt nearly all over India, except in Sind and on the Coromandel Coast.

3d. The *autumn* rains of the Coromandel Coast, brought by E. and S.E. winds at the close of the S.W. monsoon.

4th. The *winter* rains felt in Northern India.

Thus the rains are dependent on the prevalence of the certain winds, the general direction of which is known. It is also known that they are caused, and their direction determined, by differences in

---

[1] The cost of the system is Rs. 18,094, of which the sum of Rs. 14,554 appears in the Budget.

[2] See "Memoir," p. 207.

barometric pressure. But very little is known of the actual distribution of that pressure in India. Pressure depends primarily on temperature, but the effects are complicated by variations in the humidity of the air, and by peculiarities of physical geography. Mr. Blanford considers that to trace out in detail the relations of these several elements, and to refer the variations to their physical causes, will be the proper course of inquiry; and that the method to follow would be to lay down the elements of mean temperature, pressure, and direction of wind, with the total of rainfall, month by month, on charts, which will then exhibit the leading characters of each period. The results, he recommends, should be collected in a central office, and the control of the whole system should be in the hands of one man. He estimates the total cost of such a system, for all India, at Rs. 61,620.

Major-General Richard Strachey, in a memorandum dated April 4th, 1871, recorded his general concurrence in the views of Mr. Blanford. He is of opinion that there should be a uniform system of registration, and a central office; but he thinks that the working should be on a provincial basis, and that it would not be advisable to make the provincial reporters subordinate to the central officer.

Mr. Chambers, of the Colaba Observatory, also recommends a uniform and centrally administered system of meteorological observations for the whole of India.

Dr. Forbes Watson, the reporter on the products of India to the Secretary of State, has prepared an elaborate paper on the conditions under which the wet and dry bulb thermometer should be employed, to give accurate results as an hygrometer. This paper represents a vast amount of laborious work and careful thought, and the tables of observations that accompany it tend to show that the results hitherto obtained by the use of the wet and dry bulbs are nearly worthless. After giving the evidence on which his conclusions are founded, Dr. Forbes Watson proceeds to suggest the steps that should be taken to ascertain the conditions under which it may be possible to obtain reliable results from the use of the wet and dry bulb thermometer. Mr. Buchan, the Secretary of the Scotch Meteorological Society, has expressed his sense of the great value of Dr. Watson's paper, and of the admirable manner in which the different points have been investigated and discussed; and he has pointed out the importance of the discussion to the practical working out of the problem of Indian meteorology. Dr. Watson's paper ought to be

in the hands of all observers in India. But it has not yet been printed.

Tidal Observations in India.[1]

Four years ago Colonel Walker, Superintendent of the Trigonometrical Survey of India, was requested to take steps for determining the mean sea level at various points on the Indian coasts, and more particularly on the coasts of Katiwár and the Gulf of Kach, where it was believed that changes were taking place in the relative levels of the land and sea, the rate and magnitude of which it was desirable to ascertain. Arrangements were made for the construction of self-registering tide guages, and for connecting the tidal stations by levelling operations; the guages were made in England and sent out to India two years ago, and by the present time the operations would probably have been in full swing, but for the financial difficulties of the Government of India and the consequent reductions of expenditure in all directions which led to the suspension of the proposed tidal and levelling operations.

Colonel Walker is now in England on furlough, and his attention having been drawn to the tidal investigations which are at present being carried on in England under the superintendence of a Committee of the British Association, presided over by Sir William Thomson, he has suggested that when the tidal operations are resumed in India their scope and object should be enlarged, and that they should be carried on in such a manner as to contribute towards the attainment of a better knowledge of the laws of the tides; he believes that with very little additional labour or cost, beyond what is required for the primary object of determining the existing relations of the level of land and sea, it will be possible to introduce similar methods of tidal observation, registration, and reduction to those which have been adopted by the British Association, and which are expected to lead—among other scientific results—to an evaluation of the mass of the moon, to definite information regarding the rigidity of the earth, an approximation to the depth of the sea from the observed velocities of tide waves, and to the retardation of the earth's rotation due to tidal friction; a variety of practical benefits arising from an accurate

---

[1] See "Memoir," p. 225.

knowledge of the height of the tide at any time would also be obtained.

In compliance with Colonel Walker's recommendations, Lieutenant Baird R.E.,—one of his officers who was at home on furlough—was deputed to study the practical details of the method of tidal registration and the harmonic analysis of the observations, as practised and recommended by the British Association. A new tide guage was constructed by Mr. Adie after the pattern of those which had been previously supplied by himself for the operations in India, but with a few modifications which appeared to be desirable, the most important of which was the substitution of a chronometer escapement instead of a pendulum or gravity escapement for the clock which drives the barrel of the tide guage, in order to permit of the instrument being set up on jetties or scaffoldings projecting into the sea, where they would be liable to concussions by the beating of the waves which would affect the rate of a pendulum clock and might even stop its action. The new tide guage was set up by Lieutenant Baird at Chatham, with the assistance of a few men of the Royal Engineers whose services were lent by the Colonel Commandant, and its performances were considered very satisfactory.

Lieutenant Baird has drawn up an account of the method of reducing tidal observations by an harmonic analysis, as conducted by the British Association. The reductions are exceedingly intricate, and, though perhaps not materially more laborious than previous methods of calculation, very full and precise explanations are required both of the mathematical formulæ on which they depend and of the practical application of these formulæ. These have been furnished to Colonel Walker by Lieutenant Baird, who, however, was obliged to return to India before his memorandum could be printed, but it is now being passed through the press by Mr. Roberts, of the Nautical Almanac Office, who has hitherto conducted the reductions of the tidal observations of the British Association, and has been most obliging in placing Lieutenant Baird in full possession of the details of his calculations.

In compliance with Colonel Walker's suggestions, a self-registering anemometer and self-registering aneroid barometer are under construction to accompany each tide guage, in order that the direction and velocity of the wind and the pressure of the atmosphere may be recorded *pari passu* with the tidal levels; and thus all the necessary instrumental appliances for the investigation of tidal phenomena will

shortly be available in India for simultaneous observations at six independent stations. It may therefore be hoped that the investigation of the laws of the tides of the Indian Ocean which has long been considered a desideratum, and the utility of which was originally pointed out by Dr. Whewell in 1832, and was recognised at the time by the Government of India, may at last receive the attention which it deserves, and be cordially supported by the Government. Hitherto, with the exception of Mr. Parkes' admirable analysis of the Karáchi tides, there has been little done that is entitled to be considered of scientific value.

J. T. W.

VIII.—The Madras Observatory, 1870–71.

The proceedings of the Madras Observatory are reported to have been regulated as strictly as possible by the *Code of Instructions*. In 1867, Colonel Walker reported, with reference to the Madras Observatory,[1] that the places of about 1,200 stars were required to be accurately known for the determination of astronomical latitudes in the Indian Survey, according to the present system of observations. At least 400 of these stars must be determined in an Indian observatory lying to the south; while the rest can be taken from the Greenwich catalogues.

In 1869, Sir George Airy, the Astronomer Royal, suggested that Colonel Walker should be called upon to draw up a document, to provide for the future administrative arrangements of the Madras Observatory, by prescribing certain definite duties for its future performance. Accordingly a "*Code of Instructions to define the future operations of the Madras Observatory*" was drawn up by Colonel Walker, with the assistance and concurrence of Mr. Pogson, the Astronomer, on February 26th, 1869.[2] The Code was amended on February 11th, 1870, and finally received the approval of the Government of India. It is in nine sections:—

1st. Meridian observations to be taken of a certain number of standard stars in the Northern and Southern Hemispheres, for the purpose of harmonizing and connecting together the positive determinations of the Greenwich, Madras, Cape of

[1] Colonel Walker to the Secretary to the Government of India, July 23rd, 1867.

[2] Colonel Walker to the Secretary to the Government of India, March 4th, 1869.

Good Hope, and Australian observations, with a view to the eventual preparation of an accurate catalogue of stars' places, from the combined operations of all these observatories:

2d. Meridian observations to be taken of all stars, down to the sixth magnitude, between North Polar Distance 60 and North Polar Distance 110:

3d. Meridian observations to be taken of all stars used for geodetical purposes in the course of the operations of the Great Trigonometrical Survey:

4th. Meridian observations to be taken of all minor planets within range of the instrument (10·5 magnitude), whenever they are in opposition south of the equator:

5th. Equatoreal observations to be taken of the planet Mars at every successive opposition, in continuation of the observations which have already been made by Mr. Pogson for the investigation of the constant of solar parallax:

6th. Magnetic and Meteorological observations to be continued on the system introduced by Mr. Pogson in 1861:

7th. Provision for time determinations for shipping, and for notices of approaching stormy weather, &c.:

8th. The publications should be issued in annual volumes, and annual Reports should be submitted to the Government of Madras, and sent to the Astronomer Royal, whose criticisms should be invited. Monthly tabular statements of arrears of reduction and publication should also be submitted:

9th. Special investigations may be undertaken by the Astronomer, but they should not interfere with the regular routine of the observations, nor retard the work of reduction and publication.

Up to February 1870 the Magnetic and Meteorological Observations from 1851 to 1855 had been reduced and printed, and were only awaiting an introduction by Mr. Pogson. The Magnetic Observations from 1841 to 1845, and from 1856 to 1860, and the Meteorological Observations from 1856 to 1860 had also been reduced, and were ready for the press. Colonel Walker recommended that Mr. Pogson's son should be appointed as European Assistant in the Observatory, on a salary of Rs. 150 a month, to be increased to Rs. 200 on the publication of the work ready for the press; and

to Rs. 250 on the publication of the other arrears.[1] This appointment has since been made. The Government of India ordered the *Code of Instructions* to be adopted without delay, and drew special attention to the clause providing for the regular publication of results;[2] and the Astronomer Royal subsequently expressed his opinion that the Code would meet every want.[3]

During the year 1870 the number of complete observations of fixed stars taken with the meridian circle was 1,662, of the moon 55, and of minor planets 33. The total number of unpublished observations with the new transit-circle is now 19,227. At the opposition of March 1871 the number of observations of Mars was 24. These constituted the fifth series of measurements made since 1862, for the purpose of correcting the constant of solar parallax, agreeably to the method suggested by the Astronomer Royal in 1857. For the accomplishment of this important work, the Madras Observatory is more favourably situated than any other in the world, on account of its proximity to the equator.

No information has yet been received with reference to the progress of the publication of arrears.

In October 1871 an important change was effected in the mode of communicating Madras mean time to the shipping in the roads. The invention of a new apparatus by Mr. G. K. Winter (the Telegraph Engineer to the Madras Railway) and the construction of a new line of telegraph between the Observatory and Fort St. George, enable the Astronomer to undertake the firing of both the noon and the 8 o'clock guns with strict accuracy; so that there are now two daily signals by which the error and rate of chronometers can be determined by the shipping in the Madras roads.[4]

IX.—Geographical Exploration and Publications.

During 1870 Major Montgomerie continued his plan for systematically exploring the countries beyond the British frontier, by despatching a man from Peshawur direct to Faizabad, the capital of

[1] From Colonel Walker, February 11th, 1870.

[2] Government of India to Government of Madras, March 21st, 1870.

[3] In a letter dated May 24th, 1870.

[4] Madras Administration Report for 1870–71 (p. 212).

Badakshan. The very interesting tract of mountain land between the Indus and the Kabul Rivers, and bounded to the north by the Hindu-Kush and Mustagh ranges had been sealed to all attempts at exploration. During the last season, however, this region was penetrated by a very intelligent Pathan Havildar of Sappers, under orders from Major Montgomerie, who had him regularly trained for the work. He crossed over from Yusufzsi into Swat, and went thence to Chitral. From Chitral he made his way by the lofty and difficult Nakshan pass to Zebak on the Upper Kokcha river, a tributary of the Oxus. Thence, descending the valley, he finally reached Faizabad, the capital of Badakshan. He returned to Chitral by the Dora pass, thus completing the Survey of the head waters of the Kokcha. The results of this journey are valuable. By fixing the positions of the Nukshan and Dora passes, the Havildar has supplied two more determinations of points in the ridge of the Hindu-Kush, between the Khawah pass determined by Wood, and the Pamir Lake of the Mirza, near which the Hindu-Kush range is joined by a comparatively low watershed to the Pamir Steppe. The Havildar took latitude observations at five points, and determined for heights. His route Survey is 286 miles in length, and has opened out the geography of 13,000 square miles of hitherto unknown country.[1]

During the autumn of 1871 another portion of the mountain region which bounds India on the north was examined by Mr. W. T. Blanford of[2] the Geological Survey; namely, the eastern and northern frontiers of British Sikkim, which he explored with Captain Elwes, during three months leave, their main object being to collect birds and study the zoology of the Alpine and Sub-Alpine regions, especially in the upper branches of the Tista valley, where Mr. Blanford expected to find a *fauna* resembling that of the dry Central Asian region. He reached the Donkia pass, 18,500 feet above the sea, thus obtaining a view over Tibet; he ascertained the position of another pass never previously laid down on any map; he met with three unmapped lakes, and made a good collection of birds.[3] Since Dr. Hooker and Dr. Campbell explored this region in 1849 only

---

[1] Report on the operations of the Great Trigonometrical Survey of India for 1870–71 (p. 23 and Appendix 1-6).

[2] See "Memoir," pp. 156, 163, 164, 166, and "Abstract" for 1869–70, p. 20.

[3] J.A.S.B., Vol. xl., Pt. ii., p. 367.

one European had penetrated to the Donkia pass previous to Mr. Blanford's visit.[1]

Considerable light has recently been thrown on the geography of Persia during the last year, and when the valuable results of the explorations under the auspices of Major-General Sir Frederick Goldsmid are available, the time will have come for the compilation of a new map of that country. Captain St. John, after co-operating with Colonel Walker in fixing the longitude of Tehran, has since fixed the latitudes of places between Shiraz and Tehran, correcting an error of ten miles in the position of Kashan, and has made a Survey of the Elbourz mountains. He is now on the eastern frontier with Sir Frederick Goldsmid. Meanwhile Major Beresford Lovett, who recently explored a portion of Mekran, has made an interesting journey from Shiraz to Kerman and Bam, and he submitted a report upon it with a map in December 1871. He has corrected the position formerly given to Niviz, an important place at the eastern extremity of the valley of Persepolis, which has some trade with Bunder Abbas. From Niviz the road traverses a pass, 18 miles long, over the range of Loivez hills, 5,640 feet above the sea; and Major Lovett remarks that a thorough exploration of this chain from its culminating point, Paderah, to where it terminates near the shores of the Persian Gulf, would be most interesting in a geographical and geological point of view. Beyond them is the desolate valley of Kotro, stretching away in a direction south of east, with no visible limit in that direction except the horizon, and the chief of the village of Kotro, repeating the popular tradition, stated that it extended to the confines of Sind. The valley is famous for its herds of wild asses. Major Lovett travelled thence to Khairabad at the foot of the Tung Chal, a granitic range which he considers to be the backbone of the mountain system of Iran. He crossed it at an elevation of 8,000 feet above the sea, and reached Kerman. He then made a journey to ascertain the true position of Khabis to the north-east of Kerman, the terminus for kafilahs proceedings across the deserts to and from Seistan or Meshed, a delightful place abounding in fruit, including eleven kinds of *Aurantiaceæ*. From Khabis, Major Lovett continued his journey to Bam. He has corrected the mistaken position of Khabis on Pottinger's

[1] This was Captain Chamer, who made a rapid journey in search of sport in the spring of 1870. See "Memoir," p. 252. Also papers by Major J. L. and Captain W. S. Sherwill, in J.A.S.B., xxii., 540, 611, and xxxi., 457.

map, and his descriptions of Niviz, Gok, Kotro, and other places are both new and interesting. In forwarding the Report, Sir Frederick Goldsmid observes that the Surveys of St. John and Lovett will furnish materials for turning out a new map of Persia of considerable value.

The officers of the Quartermaster-General's Department in India, under the superintendence of Lieutentant-Colonel MacGregor, have been actively engaged in collecting information relating to Central Asia. In 1870, Captain Chapman's translation of Meyendorf's journey to Bokhara was printed.[1] Captain W. S. A. Lockhart, an officer who has seen service in Bhutan and among the hill tribes beyond the Punjáb frontier, and who, like Chapman, has served in Abyssinia, where he was aide-de-camp to Sir William Merewether, has also done very useful work in adding to our stock of accessible Central Asia literature. His translation of Muraviev's journey to Khiva in 1819–20 was printed at Calcutta in 1871.[2] Several valuable memoirs on different districts have also been prepared by members of the Civil Service. Mr. Westland's Report on the district of Jessur contains an interesting description of the river system and its changes during the past century, and of the progress of the formation of the delta, and information respect the history and antiquities of the district, with identifications and descriptions of the chief ruins.[3] Dr. Oldham's first part of a memoir on the district of Gházípur, forming about a fourth part of the whole work, commences with an account of the physical characteristics of the district, with notes on the changes in the portion of the course of the Ganges which flows through Gházípur. The archæological notes are also very interesting, for Gházípur was the scene of at least two events in the life of Sakya Muni; it was visited by the two Chinese pilgrims, and the *lat* at Bhitri throws light upon the Gupta dynasty of Magadha. The other parts of the memoir will give accounts of the castes, religion, agriculture, and trade of the district.[4]

---

[1] See "Abstract" for 1869–70, p. 33.

[2] Muravier's Journey to Khivà through the Turcoman Country, 1819–20; translated from the Russian (1824) by Philipp Strahl, and from the German (1871) by Captain W. S. A. Lockhart, F.R.G.S. (Calcutta, 1871.)

[3] "A Report on the district of Jessore, its antiquities, its history, and its commerce, by James Westland, Esq., C.S." (Calcutta, 1871.)

[4] "An historical and statistical memoir of the Ghazeepoor District, Part I., by Mr. W. Oldham, B.C.S., L.L.D." (Allahabad, 1870.)

A uniform system of spelling native names has at last been authoritatively adopted by the Government of India. Thus a serious official attempt is to be made to finish the great battle of Indian orthography, which has now been raging for upwards of a hundred years.

There are two systems of exhibiting Asiatic words in our own letters, "founded," as Sir William Jones said, "on nearly opposite "principles, but each of them with advantages. The first proposes "to regard chiefly the pronunciation of the words intended to be "expressed, the second consists in scrupulously rendering letter for "letter, without any particular care to preserve the pronunciation." In after years the second has received the title of the "*scientific system*," and the first that of the "*phonetic system*." Each has had a succession of able and persistent advocates, and during the century that the battle has raged, there has existed a complete state of anarchy as regards the spelling of Indian names, the confusion and absurdities of which have every year become more intolerably inconvenient.

In the first years of English occupation of India, proper names were written down by ear, without any attempt at correctness; and according to the fancy of each writer. Thus we have "Sir Roger "Dowler" for Siráju'd-daulah, and "Isle of bats" for Allahabad. For the word Khán, the historian Orme has Cawn, while Dow adopts Chan. But the greatest variety of these barbarisms will be found in the speeches of Burke, a very fitting casket for such gems.[1]

The first advocate of any system at all was Major Davy, an officer who studied Persian in India just a century ago. He prided himself on his pronunciation, and was a strong supporter of the *phonetic system*. Major Davy instructed Professor White, the editor of the "Institutes of Timour," to use his plan of exhibiting the pronunciation of the Persian language in our characters; and the plan is retained, with minute care, throughout the work, which was published in 1784.

---

[1] Incorrect spelling is sometimes the cause of very serious errors. A striking instance is mentioned by Mr. Eastwick. The popular form of spelling *Cawnpore* led to the notion that it was a town founded by some Mohammedan Khán or *Cawn*. Hence it was supposed to be a place of no antiquity, and accordingly Thornton, in his "Gazetteer," says that it is quite modern. But the correct spelling is said to be Kánhpúr, the city of *Kanh* or Krishnah, and it is a place of primæval antiquity. Dr. Hunter, however, has adopted *Khanpur* as the correct form, to be spelt *Cawnpur*. He observes that Hindu Pandits give it *Kanhpur*, while Mohammedan Maulavis return it as *Khanpur*, and that local usage inclines to the latter form.

But Major Davy had a contemporary who advocated the *scientific system*, and was the first to give the Nagari and Bengali alphabets accurately in English characters. This was Mr. Halhed, whose method is given in the preface to his code of Hindu law, compiled under the orders of Warren Hastings in 1775. Mr. Halhed made no distinction between the hard and soft *d*, *dh*, *t*, and *th*; but every vowel in his system had its long or short mark above it.

Sir William Jones, not satisfied with the system of Mr. Halhed, devised the alphabet which bears his name.[1] He gives an analysis of each Nagari letter separately; and provides for all the sounds used in Sanscrit, Arabic, Persian, and Hindu. He discarded the *phonetic system*, by which the pronunciation of Asiatic names was to be shown by English letters; because there are no consistent rules of orthography in English, and every vowel may be used to articulate one and the same sound. Sir William gives the following sentence, as an example,—"*A mother bird flutters over her young*—" in which every vowel and the diphthong *ou* have the sound of *u* in *but*. He, therefore, used the Roman or Italian sounds of vowels. This great scholar thus identified himself with the *scientific*, which is hence also called the *Jonesian system*. It was scrupulously adhered to by Colebrooke and Wilkins. It prevails in the "Asiatic Researches," in the Journal of the Asiatic Society of Bengal, and in that of the Royal Asiatic Society; and it was adopted by Rottler in his Tamil dictionary, by Campbell in his dictionary of Telugu, and by Shakespear in his Hindustani dictionary.

Dr. John Borthwick Gilchrist soon afterwards became the great advocate and supporter of the *phonetic system*;[2] but the difference between his scheme, and that of Sir William Jones, lies entirely in the vowels. In the *Jonesian system* all distinct vowel sounds are represented by the same letters, and differences of length are shown by accents; while in the *Gilchristian system* one vowel sound, varying only in the accident of quantity, is represented by two distinct

---

[1] "A Dissertation on the Orthography of Asiatic words in Roman Letters," by the President, 1788. In the Researches of the Asiatic Society of Bengal, Vol. i. Also in the collected works of Sir William Jones, i., p. 176.

[2] "A Grammar of the Hindoostanee Language, or Part i. of Vol. i. of a System of Hindoostanee Philology," by John Gilchrist. (Calcutta, 1796).

"Hindoostanee Philology, comprising a Dictionary, English and Hindoostanee, with a grammatical introduction," by John Borthwick Gilchrist, LL.D., Hindoostanee Professor in the College of Fort William. (London, 1810. Again 1835.)

letters. The plan of Gilchrist became the more popular of the two. He used the short *u*, instead of *a*, for the silent unexpressed inherent letter of the languages of India; and substituted *oo* for the *u* of Jones. He also discarded the *au* of Jones (for *ow* in *how*) and substituted *ou* in its place. Dr. Gilchrist clearly states that his method of rendering Asiatic words is studiously founded on the orthoepy rather than on the orthography of their respective characters and languages; and he urges that, as the work is designed for British subjects only, there is no necessity for attending to general or continental pronunciation.[1]

Thus the names of Jones and Gilchrist became the watchwords of orthography and orthoepy, of the scientific and phonetic systems; and their disciples continued to argue, while absolute confusion and anarchy prevailed in the spelling of the general public. For 30 years they had a fair field and no favour; but, except among the learned, there was a decided leaning from the first in favour of Gilchrist's system. At last, in 1820, the Government ordered an accurate record to be made in English, of the land tenures, and uniformity became an important object. Dr. Gilchrist's scheme, in a simplified form, was then adopted, and the same system was used for maps and revenue survey records. The Record Committees succeeded in entirely reforming the orthography of names of places on this system,[2] and it continued to be that of all official correspondence for many years;[3] while the Asiatic Society and scholars were faithful to Sir William Jones.

This was only a lull. The battle began to rage again, in 1834, with renewed fury. Mr. Thompson, a missionary at Delhi, had

[1] Halhed.	Jones and Wilson.	Gilchirst.	English equivalents.
ĕ	a	u	As *a* in *above*, or *u* in *up*, *fun*.
ĕe	i	i	As *i* in *hill*, *in*, *bit*.
c̄c	ì	ee	As *i* in *police*, or *ee* in *heel*.
ŏo	u	oo	As *u* in *push*, or *oo* in *wool*.
ō̆o	ú	oo	As *u* in *rule*, or *oo* in *cool*.
ai	ai	ue	As *ai* in *aisle*, or *ue* in *guide*.
ou	au	ou	As *ow* in *owl*.
o	o	o	As *o* in *note*, *pole*.
	à		As *a* in *art*, *father*, *tartan*.
	e	e	As *e* in *there*, *a* in *mate*.

[2] Reports of Record Committee, Aug. 6th, 1820, and May 12th, 1821.

[3] Mr. H. Thoby Prinsep's Minute, June 1834.

written an English and Urdee dictionary in Roman characters, which Dr. Yates, another missionary, recommended to the Calcutta School Book Society. Mr. Prinsep protested against the innovation; while Dr. Duff, another missionary, declared for the Roman alphabet. Sir Charles Trevelyan, then a young civilian, vehemently supported the publication of vernacular books in the Roman character, and on the scientific system. He allied himself with four missionaries, Duff,[1] Yates, Pearce, and Thomas, for the purpose of printing and circulating such books, and 57 had been published by the end of 1836.[2]

Meanwhile a sharp controversy was carried on between Sir Charles Trevelyan, who upheld the scientific or Jonesian system, and Mr. Henry T. Prinsep, who maintained the superiority of the phonetic system of Dr. Gilchrist. Mr. Prinsep said that the system of Sir William Jones was a style of writing to be reverenced and respected, but not imitated, and that it should be reserved for recondite science.[3] Mr. Trevelyan replied that the phonetic system of Dr. Gilchrist was not a system of orthography, but of *kakography*, or of confusion, mystification, and absurdity. While such was, he maintained, the plan of Gilchrist, the system of Sir William Jones, after having completely stood the test of learned criticism, after having gone through a probationary period of sixty years, and approved itself to the great body of scientific men throughout the world, was at last claimed for general use. It was true, as Mr. Prinsep had urged, that it had long remained unused except by scholars. But that was no reason why it should continue to be so. "The jewel," he declared, "must no longer remain shut up in a casket, but must be brought "forth to shine in the face of day. The money must no longer "remain hoarded in the treasury, but must now pass into circu-"lation."[4]

Mr. Trevelyan returned to England in 1838, and published his work on the education of the people of India[5]; but his missionary

---

[1] "Dr. Duff's Modification of the Jonesian system, as finally approved by the Committee of the Calcutta Bible Society, with an alphabet," is given by Colonel Thuillier in his "Manual of Surveying for India," p. 631 (note).

[2] "Original Papers illustrating the History of the Application of the Roman Alphabet to the Languages of India," edited by Monier Williams. (London, 1859. 8vo. pp. 276).

[3] See Journal of the Asiatic Society of Bengal, iii., p. 281. "On the Adaptation of the Roman Alphabet to the orthography of Oriental Languages," by H. T. P.

[4] August 27th, 1834.

[5] Longman, 1838.

allies continued their labours, and in 1857, Mr Mather reported that the Roman character, with the Jonesian system, was universally used by the missionaries in the Upper Provinces.

In 1845 Mr. Crow, a deputy collector, published an ingenious treatise on the best mode of writing oriental words, in which he advocated the scientific system. But in the same year Sir Henry Elliot published a work in which he "conformed to the system of "Gilchrist, or rather to that modification of it in use in our Revenue "Survey, which certainly has the merit of enabling an Englishman "to pronounce a word in such a manner as to make it easily com- "prehended by the natives of Hindoostan; while Sir William Jones' "system is better suited to the learned."[1] Molesworth also adopted "the system of Dr. Gilchrist in his Marathi dictionary.

In the Directions for Revenue officers in the North-west Provinces,[2] they are instructed to convert Oordoo and Hindee words into English according to an alphabet which is given in the Appendix. This alphabet has the double *oo* and *ee*, and the initial *U* for the Jonesian A. It is, therefore, on the Gilchristian system, and is the same scheme as that adopted by the Record Committee in 1820. It is recommended as "that which an Englishman would naturally adopt, "without aiming at great refinement or accuracy."

In 1851 Colonel Thuillier published his "*Manual of Surveying for India*," in which he devotes a section to the question of orthograpby, observing that[3] surveyors of all persons must be most interested and concerned in such a question. The rules he lays down are that all vowels are to have the Italian sound, no others being used; all consonants to have the ordinary English sound, the C being excluded and K or S always substituted; the reduplication of consonants to be dispensed with as much as possible; superfluous letters of all kinds to be dropped; and old established orthography of historical places not to be interfered with. But he allows the double *oo* to stand for *u*, and the *ee* for *i*, as a compromise which will enable the generality of people to attain a better pronounciation.

Thus the phonetic system of Dr. Gilchrist was the one that was officially adopted in the Revenue and Survey Departments of the Bengal Presidency from 1820, certainly until 1850; and, indeed, it

[1] "Supplement to the Glossary of Indian Terms," by H. M. Elliot, B. C. S. Sudder Board of Revenue, Feb. 1844. (Agra, 1845).

[2] Published at Agra in 1849, para. 7. of sec. ii., p. 28, and App. No. 1., p. 89.

[3] p. 628.

appears to be the system which enjoyed official sanction up to the issue of the Government resolution last year. The new system will, therefore, be opposed to that used in all the official despatches and records during a long course of years, which will be one source of inconvenience.

When Professor H. H. Wilson published his "Glossary of Indian Terms," he adopted the scientific system of Sir William Jones throughout, discussing the whole question in his preface; and he gives equivalents in Roman characters for every letter in nine alphabets used in India. But a key is provided at the end of the book, in which the popular spelling is given, with a reference to the equivalent scientific form in the body of the work.[1]

These controversies prevented any uniform system of spelling from being introduced, and there was such hopeless confusion on the subject, that Mr. Thornton, when he compiled the "Gazetteer of India," gave it up in despair. He simply inserted the namcs as he happened to find them spelt in official documents.[2] Thus Amritsur and Ambála are the one in the first, the other in the fourth volume,[3] though their initial letters are identical in the vernacular (the *a* of Jones and *u* of Gilchrist). A town and district having the same name, are spelt quite differently. The word *fath* is spelt in eleven different ways, all wrong. Since the publication of this gazetteer the confusion has become worse and worse. Such uniformity as may have been secured by the Record Committees fifty years ago, when the phonetic system was in the ascendant, has long since disappeared; and has given place to the most perplexing and deplorable anarchy, than which any system would be preferable.

In 1858 the controversy broke out afresh, and was carried on with some spirit in the Times and other English newspapers, with Sir Charles Trevelyan, under the signature of Indophilus, and Mr. Monier Williams on one side, and Professor Garrett on the other. Sir Charles went out as Governor of Madras in the same year, and used his utmost influence to introduce the scientific system there in all official correspondence, but without any effect. That system also found an advocate in Mr. Eastwick, who edited Murray's handbooks for India in 1859; and Keith Johnston adopted it for the maps of India in his

---

[1] "Glossary of Indian Terms," compiled by H. H. Wilson (London, 1855).

[2] Thornton's "Gazetteer," Preface, p. iv. (1854).

[3] The one "Umballa," the other "Amritsir."

atlas published in 1861. It has been also adopted by Mr. Thomas in his system of transliteration and application of diacritic marks to English type, proposed for the forthcoming edition of Sir Henry Elliot's works; and it is explained in a pamphlet issued by the Philological Committee of the Asiatic Society of Bengal. It also forms the basis of the rules issued by Colonel Walker for the guidance of officers of the great Trigonometrical Survey, in spelling names of places.[1] The Syndicate of the University of Calcutta, in 1859, published a key to Professor H. H. Wilson's system of transliteration as modified by that body.[2] In this pamphlet it is observed that a general disregard of all fixed rules of spelling prevails; and it is hoped that the adoption of a fixed system by the Calcutta University and the Education Department in Bengal will have the effect of gradually securing a general uniformity of spelling throughout the country in public documents and in literary productions. This key gives a complete and an optional form of Roman equivalents to be used for the letters of the Sanscrit, Bengali, and Arabic alphabets. Every Indian letter must, in accordance with the rule of Sir William Jones, be represented by its fixed Roman equivalent. The vowels are to have powers as in Italian, but not as in English; diacritical marks attached to consonants may at option be omitted in writing proper names; but accents on long vowels must invariably be inserted.

But the phonetic system, first advocated by Gilchrist, in spite of this great weight of authority against it, still has powerful supporters: chief among whom are Mr. Marshman,[3] and Colonel Meadows Taylor. It is advocated by the latter very high authority on the ground that the English language possesses phonetic equivalents for all sounds in Indian proper names. But, in the phonetic system, the sound rather than the orthography of the Indian languages must be followed. Colonel Meadows Taylor has recently drawn up, and submitted to the Secretary of State, an excellent set of simple rules for the use of English equivalents for Indian phonetic sounds.[4]

---

[1] Dehra, Jan. 27th, 1865, Dept. Order, No. 33.

[2] "A key to Professor H. H. Wilson's system of transliteration as modified by the Syndicate of the Calcutta University, and ordered to be adopted in university proceedings and records." Calcutta, 1869, p. 71.

[3] "Observations on the establishment of a uniform orthography of Indian names and places." (London, 1870.) A pamphlet by J. C Marshman, Esq.

[4] With a letter dated Sept. 26th, 1870. He also discusses the question in the preface to his "Manual of Indian History."

The scientific system is essential to the scholar. The phonetic system is better suited for the use of travellers, and of the general public.

Mr. Barton deprecates the notion that the claims of linguistic science and the necessities of popular usage are so opposed to one another as to be altogether irreconcilable. He, therefore, proposes that in a gazetteer or other similar work, the scientific spelling should follow the popular one in each case, in brackets. He thinks that the requirements of popular utility might thus be reconciled with the claims of science.[1]

The present action of the Government of India originated with a proposal which was made by the Bombay Geographical Society in 1868, for the preparation of a vernacular and English index of Indian geographical names. On April 30th 1868, the Government of India invited aid from the local governments in the preparation of such an index, and suggested the adoption of a uniform system of transliteration, at the same time drawing attention to Professor Wilson's modification of the system of Sir William Jones. Mr. W. W. Hunter, of the Bengal Civil Service, was appointed to compile the Gazetteer of Bengal, and he was instructed to use his exertions to secure uniformity of spelling in the preparation of the other gazetteers throughout India, the system of Professor Wilson being again recommended as a model. Mr. Hunter submitted a plan, on November 6th 1869, in which he recommended a compromise. The "scientific system," though admirably adapted for scholars, was allowed to be too elaborate for general use. The diacritical marks are omitted in Mr. Hunter's plan, and a certain freedom is allowed in spelling names which have become familiar to the public, or have become historical, in an unscientific form. He divides such names into two classes. Some, such as Calcutta, Bombay, Lucknow, are to remain unaltered. Others are to be brought a little nearer to the pitch of scientific accuracy without losing their popular identity. Thus *Dinapore*, the correct form of which is said to be *Danapur*, is to be *Dinapur*. *Cawnpore*, which should be *Kanhpur*, is to be *Cawnpur*. *Oude*, which should be *Avadh*, is to be *Oudh*. The Government must, Mr. Hunter submits, consider, not what is best, but what is practicable. He endeavours to

---

[1] "Remarks on the Orthography of Indian geographical Names, with especial reference to the proposed new Indian Gazetteer," by the Rev. T. Barton, M.A., late Principal of the Cathedral Mission College, Calcutta. (Stanford, 1871).

get rid of accents as much as possible, but at the same time he attempts to show the true pronounciation at a glance. Mr. Hunter's plan may be described as the nearest approach to the "scientific system" that it is believed the general public, in the present state of education, are able to endure.[1]

The Government of India finally adopted Mr. Hunter's plan for the Gazetteers on February 28th, 1870; and it has now received authoritative sanction. A guide to the orthography of Indian proper names was prepared in 1871,[2] containing the spelling of 2,186 postal towns and villages of India according to Mr. Hunter's system; and on February 28th, 1872, this guide was ordered to be circulated to all the local authorities. The plan of Mr. Hunter, thus sanctioned by the Government, has now been adopted in legislation, in the gazetteers, by the Surveyor General, in the Post Office Guide, in the Railway Time Tables, in the Telegraph Department, by the East India Railway, by the Government offices, and by several newspapers. Thus the same name will be presented with the same spelling. Up to the present time the spelling of the same place has varied in the different local gazettes. The Postal Guide has spelt the name of a town in one way, the Railway Companies in another. Even two officials, dating their letters from the same place, often spelt it in a different way.

It is vain to hope that there will ever be a general agreement as to the best system of orthography for Indian proper names. At the same time uniformity has become essential, especially between maps and gazetteers; and the official introduction of one uniform system

---

[1] The following are the powers of the vowels in Mr. Hunter's plan. They are identical with those of Sir William Jones and Professor Wilson.

Short *a*	- - -	as *a* in the second syllable of tartan, and as *u* in but.
Long *a*	- - -	as *a* in the first syllable of tartan.
i	- - -	as *i* in ravine.
u	- - -	as *u* in rural.
e	- - -	as *a* in mate, dare.
o	- - -	as *o* in note.
ai	- - -	as *i* in ride, size.
au	- - -	as *ou* in cloud.

He omits *ì* and *ù* of Jones.

[2] "Guide to the Orthography of Indian proper Names, with a List showing the True Spelling of all post towns and villages in India," by W. W. Hunter, Esq., LL.D., Director-General of Statistics to the Government of India. (Calcutta, 1871). Folio., pp. xiii. and 146. Dated at Simla, Nov. 10th 1871.

if there is a fair chance of its being generally adopted and becoming permanent, is undoubtedly a very great advantage. A recension of all the names in the Postal Guide of India was a very formidable undertaking; and that Mr. Hunter should not only have completed it, but also have achieved so large a measure of success in his efforts to secure the adoption of the new system, are striking proofs of how much good service may be done by the judgment, tact, and perseverance of one man, within a comparatively short time.

The proceedings of the Government of India, with reference to the adoption of Mr. Hunter's system of orthography for the new Gazetteers, have received the approval and sanction of the Secretary of State in Council.

XI.—Geographical Department of the India Office, 1871.

The complete Catalogue of all the printed and manuscript maps, charts, memoirs, and other documents in the Geographical Department of the India Office is now passing through the press, and will shortly be published. Its execution was a laborious task, and was the work of several hands, but it was pushed steadily forward, and is at last completed. The lists of the memoirs, field books, miscellaneous papers, and atlases were made by the present writer. Mr. Saunders catalogued some of the Madras maps, and those of Mesopotamia, Afghanistan, Persia, and Central Asia. Mr. Girdlestone,[1] of the Topographical Survey, while on furlough, gave valuable assistance during August 1871, and finished the catalogue of the manuscript triangulation maps, and some of those of the River Surveys. But the great mass of the Catalogue has been executed by Captain H. Thuillier,[2] of the Great Trigonometrical Survey, who has worked at it zealously and constantly while at home on furlough from November 1871 to March 1872. Very great advantage was derived from the valuable services of this officer, for many of the old manuscript maps were without titles, others were vaguely described, and it required practical experience and a knowledge of the country to ensure correct entries. Captain Thuillier made several thousands of these entries, and finally completed this laborious but most useful work.

---

[1] See "Memoir," p. 34.

[2] See "Memoir," p. 113.

The Catalogue will convey a complete idea of the nature of the collection, and its publication is an opportune time for recording some observations on the value of the geographical documents in the India Office, and on the uses that their preservation and convenient arrangement are intended to serve.

The map collection of the India Office is intended to serve two purposes: I. The ready supply of information for official and general use. II. The record and preservation of original documents.

In order to ensure the first object, the Secretary of State for India in Council has ordered copies of every map of whatever kind that may be published in India to be forwarded to the Geographical Department.[1] The Surveyor General has accordingly arranged to send a box of maps to England every quarter. Thus there will be a complete set of all maps that are published in India conveniently arranged for reference. The great importance of making these maps easily accessible must be obvious, for no department of administration can work efficiently without maps and plans to illustrate the papers that come under consideration and to render various points intelligible. In the Public Works and Railway Departments scarcely a subject can be properly understood without illustration by means of maps and plans, and the documents relating to public works form an important section of the map collection. In the Political and Military Departments the use of maps is equally essential. In the various branches of the Revenue Department few questions of importance are clearly intelligible without map illustration. As regards the Judicial Department, the demand for maps comes not only from the India Office but also from that of the Privy Council, and in many appeal cases, such, for instance, as that of Dyce Sombre, a reference to old maps forms an essential part of the evidence. For the same reason the High Court at Calcutta is in daily communication with the Surveyor General's Office for geographical information.

For this first purpose the efficiency of the map collection at the India Office can only be attained by the provision of adequate space for its arrangement.

The second purpose, namely, the record and preservation of original documents, is of equal importance. After the millions of money spent on all the various Surveys of India it is of paramount

[1] Despatch to India, November 25th (No. 22), 1869. Despatch to Madras, July 22d (No. 1), 1869. Despatch to Bombay, July 29th (No. 2), 1869.

consequence that the results should be placed beyond the chance of loss, by keeping the originals or copies in England. The set remaining in India necessarily runs great risks, and is peculiarly liable to rapid deterioration and destruction. The loss of the old Survey Records of the North-West Provinces during the mutinies has proved a source of great inconvenience, which would have been entirely avoided if duplicates had been sent home. The loss or destruction by white ants of documents in India, of which no copies have been preserved in the India Office, has often caused great injury to the public service. Amongt many other instances may be mentioned the original charts of the Red Sea, which are now required at the Admiralty, and the loss of which will entail heavy additional expense in re-surveys; those of the Gulf of Kach, a copy of which has lately had to be purchased for 20*l.*; the sheets of the Mesopotamian Survey, which have been replaced by a mere chance and at a cost of 100*l.* The loss of some of these documents represents a waste of money amounting to thousands of pounds.

The preservation and convenient arrangement of these original documents is necessary, not only to avoid loss, but also for actual use. There are constant demands for copies of maps by every description of public officer, for old field books, and for the older Surveys of Rennell, as well as for the later works of Pemberton, Webb, Hodgson, Franklin, and others, for settlement, irrigation, and other purposes. The ancient maps showing the old drainage of the country and the subsequent changes are highly prized. All along the northern and eastern frontiers of India, questions constantly arise regarding encroachments on British territory. At this moment civil and engineer officers are engaged in tracing and adopting old boundaries along the Nepal frontier, and other questions, involving lakhs of rupees, have arisen between the perpetually settled estates in Mymensing, and the Khasia and Gáro hills. The Madras Revenue Survey is also seeking information as to the boundaries, as formerly existing, which could have been supplied from the India Office if the old maps had not been lost, owing to want of adequate space. Then, again, few persons connected with Indian administration can be ignorant of the constant and great changes which occur periodically in the beds of the rivers, and how largely the interests of the State, as well as of individuals, are annually affected by such fluctuations. The judicial and revenue cases which are perpetually arising, both as regards boundaries and the absolute existence of entire estates, are a

constant source of perplexity in the administration of justice, and cannot be settled without reference to old maps and records. Nor should the interest that must ever be attached to the manuscript work of such men as Rennell, Colin Mackenzie, Hodgson, Herbert, and other Indian worthies be entirely left out of account. The destruction of charts and maps, or the policy of consigning them to dark corners to rot, is not only an irreparable injury done to the public service and to all students and enquirers, but it also causes an enormous waste of public money.

The Secretary of State for India in Council has taken steps to repair some of the losses caused by former neglect, and to complete the collection of original records, by directing that if originals are retained in India, duplicates of all records that are worth preserving at all should be sent home.[1] His Grace has ordered duplicates of all the maps and records of the Geological Survey to be prepared and transmitted to the Geographical Department of the India Office;[2] and instructions have also been sent to the Madras Government[3] to arrange for the completion of the set of maps and memoirs executed in the beginning of this century under the auspices of the Madras Military Institution.[4]

The above considerations prove that it is of great importance to the public service that, for the two purposes which the maps in the India Office are intended to serve, the collection should be readily accessible, and should be provided with adequate space for its convenient arrangement. The requirements for attaining this end are very moderate, but they have not yet been met, though it is hoped that a satisfactory arrangement will soon be made. The subject is still under consideration. Meanwhile, steady progress is being made in mounting and repairing the older maps, and about 600 have now been put into a good state of repair. Many of them were in a most disgraceful condition, having been left for years to rot and perish in holes and corners. A complete set of sheets of the Atlas and other maps has been mounted and presented to the Royal Gardens at Kew.

A supplementary catalogue of the published maps which have been received in England up to the end of 1871, has been published, and a similar one will appear at the commencement of every succeeding year. That for 1871 contains all the maps issued between 1870 and

[1] Despatch to India, January 5th (No. 1), 1871.
[2] Ibid.
[3] Despatch to Madras, November 2d (No. 3), 1872.
[4] See "Memoir," p. 58.

the beginning of 1872, during which time 7,062 sheets were received from India, being 30 copies of each separate published sheet. The number of distinct sheets received is, therefore, 1,235. These catalogues, and any of the maps contained in them, may be obtained from the agents appointed for their sale by the Secretary of State.[1]

The lithographing of several of the maps of the Haidarabad Circars is in a fair way towards completion during the present year.[2] The maps of the Mullangur, Bidar, and Bhir Circars has been finished, and 270 copies forwarded to India. Proofs of the maps of the Darur and Eilguendal Circars have been taken, and are in course of revision, while those of the Medduck and Nandair Circars are progressing.

A copy of a map of the valley of Herirúd, including Herat, based on detailed Surveys, has been obtained through the kindness of M. Khanikoff, and forms a valuable addition to the collection. The only previously existing map of the neighbourhood of Herat was a very rough sketch compiled in India from Eldred Pottinger's notes. Several miscellaneous maps have been prepared in the Geographical Department during the year 1871, including a map of Mouraviev's route along the east coast of the sea of Aral, maps of the Chinese Empire, of part of Beluchistan from the surveys of Captain Beresford Lovett, of part of the Indor Agency, of Captain Euan Smith's route from Tehran to Gwadur, and of Seistan by Colonel Pollock, for the use of the Political Department; a railway map of India to illustrate Mr. Juland Danvers' Report, and another for the Material Progress Report. Large parcels of maps have been presented to the British Museum, the Library of the House of Commons, the Topographical Depôt of the War Office, the Royal Geographical Society, the Army Sanitary Commission, the Public Library of Melbourne, and the College of Engineers at Cooper's Hill. The appointment of agents for the sale of maps published by the Government of India, and the publication of catalogues, has already produced a demand for the maps, and the sanction which has lately been given to advertising, will no doubt increase the sale.

The completion of the sheet of the Mesopotamian Survey, including the Sea of Nejf and a portion of the course of the Euphrates, by Lieutenant Collingwood in 1870,[3] and the cessation of all further Surveys, showed that the time had come for the compilation of a general map

[1] Messrs. Allen (13, Waterloo Place); Mr. Stanford (6, Charing Cross); Messrs. King (65, Cornhill); Mr. Trübner (60, Paternoster Row).

[2] See "Memoir," p. 288.

[3] See "Memoir," p. 287.

of the Mesopotamian region on a convenient scale. Such a map will be the legitimate consequence of the publication of the large sheets of Felix Jones, Selby, and Bewsher; and without it very much of the utility of the Surveys would be lost. This was foreseen by Captain Felix Jones, who, in 1847, compiled a general map which was never published, but which, as regards the scale and general arrangement, would well form the basis of any future map. Sir Henry Rawlinson has pointed out that public attention is now specially directed to the country intervening between the Mediterranean and the Persian Gulf, with a view to the acceleration of the transit of mails between England and India; and that our information, which has accumulated ever since the original expedition of General Chesney in 1836, is at present distributed over a multitude of maps, plans, and charts, so as to be almost useless for general purposes of geography. The Secretary of State has resolved that all these separate surveys, routes, and observed positions, are to be embodied in one general map of the country intervening between the Mediterranean and the Persian Gulf. Besides the Mesopotamian Surveys, the materials consist of the elaborate frontier map between Turkey and Persia, delineated by the Anglo-Russian Commission, of maps and routes on the Syrian Coast and Palestine; and of sketch routes by Ross, Layard, Loftus, Hector, John Taylor, and the Lynches, which have intersected the country in all directions. The compilation of this important map has been entrusted to that accomplished surveyor and draftsman, Captain Felix Jones.

In consequence of the illness of Mr. Walker, the Geographer, it became necessary to make arrangements for the completion of the sheets of the Atlas which should have been engraved by him,[1] in accordance with the arrangements made by Colonel Thuillier when he was in England in 1868. Colonel J. T. Walker, the Superintendent of the Great Trigonometrical Survey, has therefore been appointed by the Secretary of State to examine the condition of the plates of the Indian Atlas remaining in England, and the amount and nature of material available for completing them; and also to decide the course to be adopted as regards each plate. Colonel Walker is actively engaged in forwarding the work and making all the necessary arrangements for engraving the sheets in England, and has investigated the principle on which the graticule of the Atlas was originally based.[2]

---

[1] See "Memoir," p. 284.

[2] See "Memoir," p. 281.

The following memoranda, drawn up by Colonel Walker, contain information on the present state of the arrangements for the publication of the sheets of the Atlas of India in England, and an interesting account of the projection of the Atlas.

MEMORANDUM ON THE PRESENT STATE OF THE ARRANGEMENTS FOR THE PUBLICATION OF THE SHEETS OF THE INDIAN ATLAS IN ENGLAND. BY COLONEL J. T. WALKER, SUPERINTENDENT GREAT TRIGONOMETRICAL SURVEY OF INDIA.

In Section XVII. of the Memoir on Indian Surveys, by Mr. Markham, the arrangements are described which were made in 1868, for having the remaining sheets of the atlas engraved at Calcutta, under the immediate superintendence of the Surveyor General.[1] An engraving office was to be organised in India by Colonel Thuillier, who had been given a staff of English engravers selected by himself in this country, to form the nucleus of the new office and train natives of India in the art of engraving and hill-etching on copper plate. To prevent any delay in the publication of the atlas while the new office was being organised at Calcutta, it was arranged that all the plates of the atlas which were actually in the hands of engravers in England, or for which geographical materials were available, should be finished in England. This work was necessarily to be performed under the superintendence of Mr. John Walker, the Geographer to the India Office, by whom the atlas had been commenced in the year 1826, and had been carried on ever since during a period of more than 40 years, in a highly satisfactory manner, but who had now attained a great age and wished to retire from business as soon as the engraving arrangements in Calcutta were sufficiently matured to permit of his services being dispensed with.

In fact it was the circumstance that Mr. Walker could not naturally be expected to be physically able to carry on his work much longer, which had shown the necessity for making some other provision for the completion of the atlas, and thus led to the formation of the engraving office in India. The new arrangements were not made a day too soon; Mr. Walker very shortly afterwards

---

[1] See "Memoir," p. 283.

became unable to attend to any further details of business, his communications to this office became more and more intermittent, and at last ceased altogether; very few of the atlas sheets, which in 1868, he had undertaken to complete, were rendered to this office, and nothing was known of the condition of the remainder, for latterly his medical attendants have not permitted him to be spoken to on the subject.

In January last I was asked to move in the matter, and to ascertain the state of affairs. I found that very little more had been done than what had already been rendered to this office, and that much the greater portion of the work had not yet been commenced. It soon became evident that the collapse had arisen mainly from the circumstance that Mr. John Walker had been in the habit of constructing the projections and compiling the materials of the atlas sheets with his own hands. He alone knew anything about the theoretical principles or the practical details of the system of projection on which the atlas had been constructed hitherto, and which necessarily would have to be adhered to in completing it. When his health broke down there was no one to take his place, consequently most of the new sheets had not yet been commenced, for he had not been able to construct the projections and put the materials together. On the other hand, the completion of the copper plates, which were actually in the hands of the engravers, was progressing very slowly for want of funds to pay the engravers. Mr. Walker had been in the habit of paying all the expenses of the engraving from his private means in the first instance, and sending in bills to this office after the completion of the work; but, for upwards of ten years, he had not taken any steps even to reimburse himself for the large advances which he must have made, and hence the operations languished for want of funds.

Thus it appeared, that a work which is of great national importance, though neither very difficult nor very costly, was almost at a standstill for want of some one to initiate the successive stages of the operations and to exercise a general supervision over the whole, and also for want of the moderate funds which were required to defray the current expenses.[1]

---

[1] In connexion with this subject the following paragraphs of a letter, dated 18th June 1828, from the Court of Directors to the Madras Government are of much interest. Noticing an announcement by the Surveyor-General of India (dated 29th

Out of deference and regard to the great family of geographers and engravers, by one of the members of which the atlas had hitherto been brought out so admirably, I proposed that an arrangement should be made with Mr. John Walker's younger brother, Charles, who had once been in partnership with him, but had long retired from business, for the completion of the plates actually in the hands of the engravers; but Mr. Charles Walker died very suddenly and unexpectedly, while the arrangement was under discussion; there was no other member of the family who was in a position to take his place, and thus the connexion of the Walker family with the great geographical work with which its name has been associated for a period of nearly half a century became dissolved.

On Mr. Charles Walker's death the copper plates and geographical materials were collected together and made over to this office.

I was then on the point of returning to India, but in consequence of Colonel Thuillier's earnest representations of the inadequacy of his engraving office in Calcutta to undertake all the arrears of work which had been accumulating in England, as well as to keep pace with the operations of the field surveys in India, I was detained in England for a few months in order to make arrangements for the completion in this country, not only of the copper plates which were in the hands of the engravers, but of several new plates for which geographical materials were available. For this purpose it was necessary that I should ascertain the principles on which the projections had hitherto been based, and this was not a very easy matter, for there was no one who could give me any information on the subject, excepting Mr. Walker, who was too ill to be spoken to. Eventually, I came across a manuscript memorandum book in

---

March 1823) that a map of the Peninsula was being constructed by his deputy at Madras, on the scale of Arrowsmith's large map, the Court writes:—

"We desire that such a work be not persisted in. To the attempts which have "been made at different times by the Surveyors-General at the several Indian Pre- "sidencies to construct maps embracing a large extent of country, and the consequent "retention of documents in India, we impute the little progress that has yet been "made in the formation of a general Indian atlas. All projects of that nature begun "in India have failed from the supervening sickness or death of the projectors, or "from other obstructions occurring in the progress of the work, whilst the requisite "documents having been retained in India, contrary to our reiterated orders, we "have been prevented from taking the necessary measures for the completion of a "general Indian atlas in this country."

Mr. Walker's office in Castle Street, Holborn, containing tables and other data on which the projections must have been based, as appears from internal evidence, though there is nowhere any statement to that effect. This book was lent to me for a short time, after which it had to be returned to Mr. Walker's family; but meanwhile all the most important portions had been transcribed, sufficient to permit of the projections of the remaining atlas sheets being constructed in such a manner as to be in exact correspondence with those of the sheets already completed, provided only that the scale or unit of length from which all the measurements had been hitherto laid off on the copper plates could be procured. After considerable difficulty and delay I succeeded in obtaining this scale from Mr. Walker's family, but only on loan, and under a promise that it should be soon returned. These difficulties, I am persuaded, merely arose from a natural feeling of hesitation on the part of the family to do anything which Mr. John Walker might—for aught that was known to the contrary—have disapproved; there can be no doubt they would not have occurred had he been well enough to be consulted, for it was afterwards ascertained that he had allowed Colonel Thuillier to take a copy of the manuscript memorandum book above specified, and had furnished him with an exact copy of the scale.

It is desirable that some more permanent record should be made than at present exists of the details of the construction of this great geographical work which has already been going on for nearly half a century and is still far from complete. I have, therefore, drawn up the following memoranda regarding the principles of the projection, the data on which it is based, and the practical details of its application, and also on the unit of the adopted scale of measurement.

The Projection.

This is one of the numerous modifications of the conical development; it represents the parallels of latitude by concentric arcs, but the meridians by arcs concave to the central meridian, and not by straight lines as in the true conical development. A cone is assumed to roll over the spheroid tangentially to an adopted central parallel of latitude, the distance from the vertex of the cone to this parallel (= normal $\times$ cotan latitude) is the radius of projection of the parallel, and may be considered as the fundamental radius of the projection, for the radii for

all other parallels are determined by adding to or subtracting from it the distances between those parallels and the central parallel.

The angle subtended at the vertex of the cone by a longitudinal arc of 1° in length is called the "angle of the projection" for the parallel of latitude to which the arc appertains; as this angle varies with the latitude, its value is computed for each parallel.

These data constitute the fundamental elements of the projection, and are given in the following table:—

TABLE OF THE ELEMENTS OF THE PROJECTION.

Parallel of Latitude.	Radii of Projection.		Angle of Projection for 1° of Longitude.	Length in Fathoms of 1° of Longitude.
	In Fathoms.	Logarithms.		
°			′ ″	
7	8723613	6·940696	23·48	60406
8	8663149	6·937675	23·55	60268
9	8602682	6·934630	24·1	60112
10	8542212	6·931570	24·7	59938
11	8481739	6·928468	24·13	59746
12	8421263	- - -	24·18	59535
13	8360779	6·922246	24·23	59307
14	8300286	6·919092	24·27	59060
15	8239793	- - -	- - -	58796
16	8179300	6·912700	24·35	58514
17	8118820	6·909493	24·39	58214
18	8058311	6·906243	24·41	57896
19	7997796	6·902970	24·44	57561
20	7937275	6·899671	24·46	57208
21	7876747	6·896347	24·48	56838
22	7816212	6·892997	24·50	56451
23	7755670	6·889640	24·51	56047
24	7695121	6·886215	24·51	55625
25	7634564	6·882786	24·51	55187
26	7574000	6·879325	24·51	54732
27	7513428	6·875837	24·49½	54260
28	7452847	6·872322	24·48	53772
29	7392258	6·868777	24·46	53267
30	7331660	6·865201	24·44	52746
31	7271053	6·861597	24·41	52210
32	7210437	6·857962	24·38	51657
33	7149812	6·854293	24·34	51088
34	7098117	6·851147	24·27	50504
35	7037473	6·847418	24·25	49905
36	6976819	6·843657	24·17	49290
37	6916155	6·839861	24·11	48660

The elements of the figure of the earth which are here employed are not stated, but there can be no doubt that they must have been those which were determined by Colonel Lambton from his measure-

ments on the great Indian Arc, and are given in vol. xiii. of the "Asiatic Researches." This will be seen by comparing the differences between the lengths of the radii of projection with the lengths of Colonel Lambton's meridional degrees, and also by comparing the lengths of the longitudinal degrees of the projection with those of Colonel Lambton, as in the following table:—

Parallel of Latitude.	Differences between Radii of Projection.	Lengths of Colonel Lambton's	
		Meridional Degrees.	Longitudinal Degrees.
° 7		60,467·5 fathoms.	60,406·4 fathoms.
8	60,464 fathoms.	60,470·1 „	60,268·6 „
9	60,467 „	60,473·2 „	60,112·6 „
10	60,470 „	60,476·5 „	59,938·4 „
11	60,473 „	60,480·3 „	59,746·1 „
12	60,476 „	60,484·3 „	59,535·6 „
13	60,484 „	60,488·7 „	59,307·1 „
14	60,493 „	60,493·4 „	59,060·6 „
15	60,493 „	60,498·4 „	58,796·3 „
16	60,493 „	60,503·8 „	58,514·1 „
17	60,480 „	60,509·4 „	58,214·2 „
18	60,509 „	60,515·4 „	57,896·6 „
19	60,515 „	60,521·6 „	57,561·4 „
20	60,521 „	60,528·2 „	57,208·8 „
21	60,528 „	60,535·0 „	56,838·9 „
22	60,535 „	60,542·0 „	56,451·6 „
23	60,542 „	60,549·4 „	56,047·2 „
24	60,549 „	60,557·0 „	55,625·8 „
25	60,557 „	60,564·8 „	55,187·5 „
26	60,564 „	60,572·9 „	54,732·4 „
27	60,572 „	60,581·2 „	54,260·6 „
28	60,581 „	60,589·7 „	53,772·4 „
	60,589 „		

Parallel of Latitude.	Differences between Radii of Projection.	Lengths of Colonel Lambton's	
		Meridional Degrees.	Longitudinal Degrees.
° 29		60,598·4 fathoms.	53,267·8 fathoms.
	60,598 fathoms.		
30		60,607·4 „	52,746·9 „
	60,607 „		
31		60,616·5 „	52,210·0 „
	60,616 „		
32		60,625·8 „	51,657·2 „
	60,625 „		
33		60,635·2 „	51,088·6 „
	51,695 „		
34		60,644·8 „	50,504·5 „
	60,644 „		
35		60,654·5 „	49,904·9 „
	60,654 „		
36		60,664·4 „	49,290·2 „
	60,664 „		
37		60,674·3 „	48,660·3 „

The accordance is sufficiently close to leave no doubt that Colonel Lambton's data must have been employed; the longitudinal degrees of the projection are all but identical with Colonel Lambton's, and the differences between the radii of projection practically correspond with his meridional degrees in every case, excepting between 33° and 34°, where there is a considerable error, which, however, has been allowed for in the practical construction of the projection, and has not very materially influenced the accuracy of this portion of the atlas.

With the data in the table of the elements of the projection, the rectangular co-ordinates of the points of intersection of the principal meridians with the principal parallels were computed with reference to an adopted central meridian, and the points of its intersection by the parallels. Putting θ for the "angle of projection" for 1° of longitude on any given parallel, and r for the corresponding radius of projection, then the co-ordinates of the extremity of an arc of n degrees on that parallel, as referred to the central meridian and the point at which it is intersected by the parallel, will be

$$r \text{ Sin } n\theta \text{ and } r \text{ versin } n\theta,$$

the former perpendicular and the latter parallel to the given meridian.

It is unnecessary to give in this place the values of the co-ordinates which were calculated for the projection they were found on examina-

tion to require to be checked by a recomputation which has been commenced but is not yet completed.

The meridian which has been adopted as the central meridian or axis of the projection is 76° 30′ east of Greenwich; this is not only stated to be the case in Mr. Walker's memorandum book, but can be deduced from the calculations of the co-ordinates. I have not been able to ascertain why a meridian which is so far from being central was selected as the central meridian.

What parallel was adopted as the central parallel of the projection is nowhere stated, and the data by which it might be ascertained are incomplete, but the value of the radii of projection clearly show that it must lie between 24° and 25°, and most probably is 24° 30′.

The sheets of the atlas are rectangular, their dimensions as taken between the marginal lines on the copper plates being 38 by 24·4 inches, representing a distance of 134,850 fathoms lengthways, on the perpendicular to the central meridian, and a distance equivalent to the length of a meridional arc of 1° 28′ breadthways.

The sheets are situated unsymmetrically with reference to the central meridian, for it passes over the central sheets at a distance corresponding to 37,100 fathoms from the west, and 97,750 fathoms from the east margin. This is exceedingly inconvenient, entailing separate computations for the projection of the sheets east and west of the central meridian, which would have been avoided if a symmetrical arrangement had been adopted.

The origin of co-ordinates is at the intersection of the parallel of 5° with the central meridian; but each of the points at successive intervals of 1° 26′ on the central meridian, from lat. 5° upwards, may be said to be origins of co-ordinates, and employed as such in the calculations for the corresponding belts of sheets, right and left, and this is a very convenient arrangement which lessens the labour of the calculations.

The following table gives the distinguishing numbers of the central sheets, and the parallels of latitude whose intersections with the central meridian are the points through which the perpendiculars are drawn, which are the top and bottom marginal lines of the sheets in each belt.

Sheet.	Intersecting Parallels.	Sheet.	Intersecting Parallels.
	° ′		° ′
	5		20 46
None		54	
	6 26		22 12
None		53	
	7 52		23 38
63		52	
	9 18		25 4
62		51	
	10 44		26 30
61		50	
	12 10		27 56
60		49	
	13 36		29 22
59		48	
	15 2		30 48
58		47	
	16 28		32 14
57		46	
	17 54		33 40
56		45	
	19 20		35 6
55		44 (A)	
	20 46		36 32

The dimensions of the sheets from top to bottom have been made to correspond with lengths of 86,716 fathoms to the south of the parallel of 21°, and 86,788 fathoms to the north of that parallel; the corresponding values of the meridional degrees are 60,500 fathoms to the south and 60,550 to the north, which differ appreciably from those on which the calculations for the projection are founded, though not to any material extent.

None of the documents to which I have hitherto had access give any information as to who was the originator of the projection of the Indian Atlas. There is a lithographed pamphlet in this office entitled "Construction of the graticule for a General Atlas of India" which is believed to have been written by Col. Blacker, who was Surveyor General of India, but it does not give either the name of the author or the date at which it was written. It proposes a method of projection which in principle is identical with the one actually adopted, and is based on the same geodetic elements, but differs in all other details, the central parallel—the adopted value of which influences the whole of the calculations—being lat. 20° instead of 24°½, and the central meridian being that of 80° instead of 76°½. The size of the sheets

was intended to be 38·38 by 27·53 inches; the origin of co-ordinates was placed in the centre of the atlas, at the point corresponding to lat. 20°, long. 80°, the intersection of the central parallel with the central meridian.

Tables are added, giving the natural lengths of the co-ordinates, and their lengths on the scale of the map. This scale was in the first instance intended to have been $\frac{1}{250000}$th part of nature, but afterwards was altered to $\frac{1}{253440}$ which is the same as that of 1 inch = 4 miles; the tables give the values of the co-ordinates for both scales. All the calculations seem to have been carefully made out and verified, and the results are tabulated in a convenient form for use, which is very far from being the case with the calculations for the actual projection.

The design of the atlas is believed to have been influenced to some extent by Mr. Aaron Arrowsmith's Atlas of Southern India, from Cape Comorin to the river Kistnah, which was published in the year 1822, and was evidently designed by its author as the commencement of an Atlas of all India; for it is accompanied by a sketch map showing "how many sheets of this size would be required for a map "of India on a scale of 4 English miles to one inch, any one of "which may be engraved independent of another when materials "offer, and may be united to the rest by keeping correctly to the "lines as drawn on this map; the sheets as far as N. 16 are already "engraved on the above scale."

But on a close examination it will be found that this atlas has little or nothing in common with the Atlas of all India, the publication of which commenced five years afterwards; the lengths of the sheets may have been intended to correspond and there is an agreement between the limiting meridians of some of the southern sheets which can scarcely have been fortuitous; but there are no other points of similarity. Mr. Arrowsmith's central meridian appears to have been not 76½° but 78°, and the elements of the earth's figure which were adopted for his projection cannot have been those which resulted from Major Lambton's operations and were used as the basis for the calculations of the second atlas, for they appertain to a figure of which the polar axis is materially longer than the equatoreal, the diminution of the length of the longitudinal degree between lat. 8½° and 14½° being only 1·07 instead of 1·44 of a mile, a circumstance which may very possibly have caused the subsequent abandonment of this atlas. In both atlases the dimensions of the sheets appear

to have been regulated by the size of the double elephant sheet of drawing paper; in the earlier one the details are carried so close up to the edges of the paper as to leave no room for borders with the degrees and minutes of latitude and longitude, which are therefore only given on certain exterior sheets; in the subsequent atlas the extent of the details is less and permits of a border being placed round each sheet.

The whole of the sheets of the Atlas of India have been engraved by Mr. John Walker; the 24 sheets first issued comprise portions of Northern India and Eastern Bengal, as well as a reproduction of Mr. Arrowsmith's Southern India; they were published between February 1827 and November 1833, under the name of James Horsburgh, Hydrographer to the Honourable East India Company. The next sheet was published in September 1836, under the name of John Walker, Geographer to the Honourable East India Company. Mr. Horsburgh died in that year, and Mr. Walker was appointed to succeed him in his duties, retaining the engraving of the atlas.

The Scale of the Indian Atlas.

The working scales which have been used by Mr. Walker are engraved on a thin brass bar, about 17 inches in length by $1\frac{1}{2}$ in breadth, with a scale of fathoms on one edge and a scale of minutes of latitude on the other. There can be little doubt—though it is nowhere stated in words on the atlas sheets—that the scale of the atlas must originally have been intended to be that of 1 inch to 4 miles, or the $\frac{1}{253440}$th part of nature; for this, the entire length of the fathom scale, from 0 to 60,000, should be 17·045 English inches, but on comparing it with a standard yard by Troughton and Simms, which appertains to the Observatory at the India Store Department, Lambeth, I find that it is only 16·904 inches; the scale of the atlas is therefore the $\frac{1}{255561}$th part of nature, or somewhat less than 1 inch to 4 miles, as has hitherto been supposed. The value of the meridional degree on Mr. Walker's scale is taken at 60,500 fathoms, and the actual length of this degree on the scale is equal to 17·055 inches of Troughton and Simms' standard yard, or very nearly what the length of the fathom scale should have been. On the other hand, the fathom scale has been prolonged to a point, beyond the 60,000 fathom division, at a distance from the zero of that scale which is almost exactly equal to what the length of the meridional degree should

have been. Hence it seems probable that the lengths of the scales were laid off with all desirable accuracy in the first instance, but by some mistake the fathom scale length was mistaken for that of the meridional degree and subdivided accordingly, and vice versâ.

In consequence of this error the dimensions of the copper plates, which should have been 38·31 by 24·65 inches within the border lines, are only 38·00 by 24·45 inches. The error necessitates a reduction of scale of all geographical materials which are drawn on the quarter-inch scale, before they can be correctly inserted on the copper plates, but otherwise it is of little importance; in the printed sheets of the atlas larger errors arise from the shrinkage of the paper, which, unfortunately, is unequal, being invariably greater lengthways, in the direction passed over by the roller during the process of printing, than breadthways, at right angles to that direction; the dimensions of several sheets which I have measured vary from 37·06 to 37·50 inches in length, and from 24·12 to 24·22 inches in breadth, the greatest contraction having probably occurred when the paper was most moistened before being passed through the press. To facilitate accurate measurements from the atlas sheets for certain specific purposes—as for instance for compiling geographical materials for new maps—it would be a great advantage if a second scale of miles were given in either of the side margins, at right angles to the one at present given at the bottom of each sheet.