GENERAL REPORT

ON THE

Operations of the Survey of India,

COMPRISING

GREAT TRIGONOMETRICAL, THE TOPOGRAPHICAL, AND THE REVENUE SURVEYS UNDER THE GOVERNMENT OF INDIA,

DURING

1879-80.

PREPARED UNDER THE SUPERINTENDENCE

OF

MAJOR-GENERAL J. T. WALKER, C.B., R.E., F.R.S., &c.,

SURVEYOR-GENERAL OF INDIA.

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GENERAL REPORT

ON THE

Operations of the Survey of India,

FOR SEASON

1879-80.

INTRODUCTORY.

THE general direction of the Department and the immediate supervision of the Trigonometrical and Topographical Branches, have been performed by Major-General J. T. Walker, C.B., R.E., Surveyor General. The immediate supervision of the Revenue Branch has been performed by Lieutenant-Colonel J. Sconce, S.C., Deputy Surveyor General.

2. The principal operations which have been carried out during the survey year under review, *viz.*, from 1st October 1879 to 30th September 1880, are as follows:—

Statement of Survey Operations and Parties.

Number in this Report.	Nature and Locale of Operation.	Name of Executive Officer.	Designation of Survey Party.	Remarks.
	Triangulation.			
I	Madras	Lieut.-Col. B. R. Branfill	Madras Party.	Principal Triangulation.
II	Eastern Sind	Capt. M. W. Rogers, R.E.	Bombay Party.	
III	,, Frontier	Capt. J. Hill, R.E.	Eastern Frontier Party	
IV	Burma	Mr. W. G. Beverley	Burma Party.	Secondary ,,
	Topography.			
V	Central India	Major E. H. Stoel, S.C.	No. 1 Topographical Survey.	Topography on 1-inch scale, for reproduction on same scale.
VI	Khandesh	Capt. W. J. Heaviside, R.E.	No. 2 Topographical Survey.	
VII	Malwa	Major J. R. Wilmer, S.C.	No. 5 Topographical Survey.	
VIII	Sylhet	Major W. F. Badgley	No. 6 Topographical Survey.	
IX	Rajputana	Lieut.-Col. G. C. Depree, S.C.	No. 7 Topographical Survey.	
X	Mysore	Capt. G. Strahan, R.E.	No. 8 Topographical Survey.	
XI	Guzerat	Lieut.-Col. C. T. Haig, R.E.	Guzerat Survey.	2-inch scale for reproduction on same scale and reduction to 1-inch scale.
XII	Meerut Du., N.-W. P.	Major W. H. Wilkins, S.C.	3rd Revenue Survey.	
XIII	Kattywar and Cutch	Major A. Pullan, S.C.	Kattywar and Cutch Survey.	2-inch scale, for reduction to 1-inch scale.
XIV	North Deccan and Konkan	Col. J. Macdonald, S.C.	10th Revenue Survey.	
XV	South Deccan	Major H. S. Hutchinson, S.C.	11th do. do.	
	Mauzawar or Village Survey.			
XVI	Rawalpindi and Dera Ismail Khan.	Lieut.-Col. D. Macdonald	1st Revenue Survey.	4-inch scale.
XVII	Khorda Estate, Bengal	Mr. J. Campbell	7th do. do.	
	Cadastral or Field Survey.			
XVIII	Banda and Mirzapore, N.-W.P.	Col. F. C. Anderson, S.C.	5th Revenue Survey.	16-inch scale, and Forest Survey on 4-inch scale.
XIX	Jaunpur, N.-W. P.	Mr. E. T. S. Johnson	6th do. do.	16-inch scale.
XX	Ghazipur, do.	Major W. Barron, S.C.	4th do. do.	
XXI	Hanthawaddy, Burma	Capt. J. E. Sandeman, S.C.	2nd do. do.	
XXII	Bassein, Burma	Major D. C. Andrew, S.C.	8th do. do.	

Statement of Survey Operations and Parties,—concluded.

Number in this Report.	Nature and Locale of Operation.	Name of Executive Officer.	Designation of Survey Party.	Remarks.
	Miscellaneous.			
XXIII	Darjeeling and Sikkim .	Lieut. H. J. Harman, R.E.	Darjeeling Survey.	Various scales.
	Geographical.			
XXIV 1	Northern Afghanistan .			
,, 2	Southern do. . .			
,, 3	Beluchistan . . .			
XXV	Trans-Frontier Explorations.			
XXVI	Surveys around Gilgit .	Lieut.-Col. H. C. B. Tanner.		
	Tidal Operations.			
XXVII	Indian Coasts . . .	Capt. A. W. Baird, R.E.		
	Leveling Operations.			
XXVIII	Bombay and Madras .	Ditto ditto.		
	Geodetic.			
XXIX	Southern India . . .			

3. The principal triangulation of all India, as originally designed by Colonel Everest—about the year 1832—with the approval of the Court of Directors of the Honourable East India Company, was intended to consist of a system of meridional chains of triangles at intervals of about 1° apart, tied together by longitudinal chains at about 6° apart, the whole being enclosed within a periphery formed by chains of triangles carried along the frontier and coast lines. The operations have been carried on in general accordance with this design. But the distance between the principal meridional chains which have been executed within the last 20 years has been materially increased; for it was found that chains at intervals of 2° to 3° apart would suffice as a basis for the general topography of the country. For similar reasons a chain of principal triangles on the west coast of the Peninsula, from Cape Comorin to Mangalore, which is now all that is wanted to complete the periphery of frontier and coast-line triangulation, may be dispensed with; it would extend from the southern extremity of the well-known Great Arc of Colonels Lambton and Everest—as recently revised and modernised—and close on the Mangalore longitudinal series, and thus it would nowhere be as much as 100 miles, nor more on an average than 50 miles, distant from the principal triangulations which have already been completed; moreover, it would cover a hill tract through the whole of which good secondary triangulations have already been carried—being in this respect unlike the twin series on the east coast which passes over forest-clad plains, very difficult to triangulate and never before operated in. Moreover, its completion is not necessary for geodetic purposes, as for them the present first class chains of triangles in its neighbourhood will amply suffice. It is solely desirable from considerations of regard for the general symmetry of the principal triangulation; but as it would employ a survey party for fully three or four years, its cost would altogether outweigh those considerations. Consequently, as the chain of triangles along the east coast, between Cape Comorin and Madras, which has been some years in progress, was completed during the present year, the principal triangulation may now be considered to be wholly finished in Southern India. In Northern India, only a small portion of a single (meridional) chain of triangles remains for execution, which will probably be completed within the next few months, and then the whole of the principal triangulation of the regions between Afghanistan and Burma, the Himalayan Mountains and the Indian Ocean, will be finished as regards the linear and angular measurements and the field operations generally; the reduction of the observations is well advanced, but about one-half still remains for completion.

4. The general outturn of the triangulation was as follows: Three chains of principal triangles of an aggregate length of 165 miles, furnishing 26 new stations—at three of which verificatory astronomical determinations of azimuth have been made—and embracing an area of 3,949 square miles; also various

chains of secondary triangles of an aggregate length of 150 miles, furnishing 33 new stations and 172 points, in an area of about 5,000 square miles, exclusive of a large amount of secondary triangulation in Siam and Sikkim, of which complete details have not yet been received.

5. The regular topographical operations—mostly on the standard scale of one inch to the mile and on the half-inch and two-inch scales—were carried on in continuation of the operations of the preceding year, in the same provinces and by the same parties. The general outturn of the topography was as follows:—

220	square miles surveyed	on the	¼-inch scale.
7,138	ditto	ditto	½ ,,
4,794	ditto	ditto	1 ,,
9,664	ditto	ditto	2 ,,
117	ditto	ditto	4 ,,

Two towns of an aggregate area of 20 square miles were surveyed, one on the 6-inch, the other on the 12-inch scale.

6. The Mauzawar or Village survey of the Murree and Kahuta Tahsils of the Rawalpindi District for the Forest Department has been completed; and the survey of another tract, the "Kala Chitta" range, also in the Rawalpindi District, for the same department, has been commenced. The village survey operations in the Dera Ismail Khan District have been continued. The forest survey, on the 4-inch scale, in the Banda District, has been completed. The Khorda Estate Survey Party—reduced in strength after completion of its cadastral survey operations—has surveyed a hilly portion of the estate on the 4-inch scale, where a cadastral survey was not required; and at the same time has completed the survey of the village boundaries in the area left for the measurement of fields by the settlement survey. This party has also surveyed, on the 32-inch scale, several detached hills within the settlement survey area.

No. 3 Revenue Party, which has been engaged chiefly on topographical survey, has also carried on a village survey of the alluvial lands in the bed of the Jumna River.

The total areas of these several operations are—

2,118 square miles surveyed in detail on the scale of 4 inches = 1 mile, but including 40 square miles of 32-inch survey in Khorda.
1,973 square miles of preliminary traversing.

7. A small area rejected from the forest reserves has been surveyed cadastrally in Banda, and the survey of the district has been completed. The cadastral surveys of Districts Jaunpur, Ghazipur and Mirzapur have been continued, as during the previous season, on the 16-inch scale. The cadastral survey of District Hanthawaddy in Burma has been continued on the 16-inch scale, but having the field as the unit of survey in place of the holding. A new party has been raised for the cadastral survey of the Bassein District, for which the 16-inch scale and the unit of the field have been adopted, as for Hanthawaddy.

The total areas surveyed by the Cadastral parties are—

2,692 square miles surveyed in detail on the scale of 16 inches = 1 mile.
1,581 square miles of preliminary traversing.

8. In Northern Afghanistan the advance of the British forces to Kabul and the occupation of the country up to August 1880 offered fresh opportunities for the extension of our geographical knowledge, which during the previous year had been limited to the western extremity of the Kuram and Jellalabad Valleys. In continuation of this work the survey has been extended westwards up to the Pughman range, and now embraces the Koh-i-daman, Logar, Hissarak, Wardak, Maidan and Lughman Valleys; several points have been trigonometrically fixed on the Hindu-Kush which will be of much assistance towards the rectification of existing maps.

9. In Southern Afghanistan the operations were somewhat restricted; but a rough reconnaissance was made of a portion of the country between the Khakrez Valley and Girishk, and the surveys of the country around Kandahar were added to and improved as far as possible. A very useful and important route through the Khushk-i-Rud and northern portion of the Tarnak Valleys on northwards through the Ghazni Valley over the Shere-i-darra Pass, and into Wardak, was completed; and as this establishes a connection between the

surveys in Northern and Southern Afghanistan, and furnishes the positions of several important places, it will afford material aid in rectifying the old maps of the country between Kandahar and Kabul.

10. In Beluchistan a rough reconnaissance was effected of the country situated within the triangle formed by Quetta, Thal-Chotiali and Sibi; it is more or less incomplete, as the country was in an unsettled state, and the surveyors could only pass along the routes traversed by troops; but around Sibi, Dadar and a portion of the Lower Bolan, a fair amount of good topography has been obtained.

11. The combined operations in Northern and Southern Afghanistan and in Beluchistan furnish a total area of about 16,000 square miles of new geography, of which about two-thirds appertain to Northern Afghanistan.

PART I

THE OPERATIONS OF THE SEVERAL SURVEY PARTIES APPERTAINING TO THE THREE BRANCHES OF THE DEPARTMENT.

TRIANGULATION.

I.—THE MADRAS COAST SERIES.

12. The primary object of this chain of triangles was the completion of the principal triangulation in Southern India by a regular series between Madras and Cape Comorin, with a branch series from Rámnád *viâ* Rameswaram and the adjacent islands of Palks' Straits for the connection of the Ceylon Survey with that of India. Triangulation had been commenced in the southern portions of the Peninsula, by Colonel Lambton, at the beginning of the present century, and it had been carried down the coast from Madras to Negapatam; but it simply consisted of a narrow chain, following the coast line and avoiding the interior, which is flat and covered with trees, and was found to be altogether too difficult to be touched during those early days of the trigonometrical survey, when as yet no method of taking the operations through tracts of forest had been devised; thus, a great blank in the triangulation has waited for the better part of a century to be filled in, and this work, which was commenced a few years ago near Cape Comorin, has now been completed.

Personnel

Lieutenant-Colonel B. R. Branfill, Deputy Superintendent 2nd grade.
Mr. C. D. Potter, Assistant Surveyor 1st grade.
„ A. H. Bryson, „ „ 3rd „

13. The principal operations of the present year consisted in the measurement of the angles of three polygonal figures, covering the space between the terminal side of the triangles of last year, which is situated a little to the north of the parallel of Pondicherry, and a side of the triangles near Madras which are situated at the eastern extremity of the Madras longitudinal series. Observations were taken at 15 principal stations, of which 11 were newly fixed; the direct distance spanned was 68 miles; 82 secondary stations and points were fixed; and an area of 2,001 square miles was covered by the principal and secondary triangulation. Astronomical observations were taken at two of the principal stations, partly for the verification of the azimuth, and partly in order to throw light on the probable amount of the local attraction in the direction of the prime vertical on the coast line; for this is a matter of much interest in connection with the question of the relations between the density of the strata of the earth's crust under continents and the density under the bed of the ocean.

14. Secondary chains of triangles were carried from the main chain to fix the positions of the light-houses at Pondicherry and Negapatam, and various other points which were too far away from the principal stations to be observed from them. These secondary chains passed over a thickly-wooded country, and could not have been executed at a moderate cost had it not been that there were lofty temples—commonly called Gopurams—in some of the intermediate villages, from the summits of which mutual observations could be taken; thus, the delay and expense of cutting lines to open out the rays between the stations, were avoided. To reach the summits of the temples was, however, in all cases a more or less difficult matter, as there were no staircases leading

up to them; ladders had invariably to be lashed outside,—in one case to a height of 103 feet—the climbing over which was very perilous; and as the roofs were always so ricketty that the movement of an observer round his theodolite would cause much vibration and deteriorate the observations, a platform resting on the walls had to be erected for the observer in each instance.*

15. The principal triangulation was finished unusually early in the field season, as the country was generally very favourable for the operations. After its conclusion Colonel Branfill proceeded to the west coast to connect the secondary triangulation which Colonel Lambton had brought up from Cape Comorin, over the hills of Travancore and Cochin to Ponâni, early in the present century, with the secondary triangulation—known as the Malabar Minor Series—which was brought down from the Mangalore Longitudinal Series in the year 1873-74. The connection was satisfactorily accomplished, rendering any further triangulation in this quarter unnecessary, for the reasons which have been already stated at paragraph 3 of this Report.

16. Colonel Branfill's operations of the present year closed with sundry observations for effecting a better connection of the triangulation on which the topography of the Nilgiri Hills is based, with his principal triangulation. This has completed the modern operations in Southern India, the greater portion of which have fallen to his share, and have been accomplished with much skill, energy and perseverance. His future work will be to complete what remains to be performed of the principal triangulation in Northern India, and to supervise the measurement of a base line in Tenasserim at the southern extremity of the Eastern Frontier Series of principal triangles.

II.—THE EASTERN SIND SERIES.

Personnel.

Captain M. W. Rogers, R.E., Officiating Deputy Superintendent 3rd grade.
Mr. W. C. Price, Surveyor 4th grade.
„ C. P. Torrens, Assistant Surveyor 2nd grade.

17. Having completed the operations on which he had been engaged in Southern Afghanistan in connection with the recent military movements, and which included the execution of a chain of triangles between Quetta and Kandahar, Captain Rogers returned to Sind to resume the principal and secondary triangulations which had been suspended in 1878, when war with Afghanistan was declared. While returning he was much delayed for want of transport, all available animals being required for the army; and when he arrived at Hyderabad, where his principal instruments had been left in store, he was further delayed, because none of those useful men called 'hammals' or 'bearers' were to be obtained for the carriage of his large theodolite, all persons of this calling having either joined the army, or deserted the country through fear of being required to do so. Thus, it was necessary to wait until bearers could be brought up from Poona before the operations could be commenced.

18. The amount of work remaining to be completed on the principal series of triangles was what it might have been just possible to accomplish in a long field season and under a very favourable combination of circumstances, by a survey party fresh and in full vigour after some months' residence in recess quarters. Under existing circumstances Captain Rogers and his party, who had just returned from field operations extending over a year in Afghanistan, could not be expected to accomplish more than half of what remained to be done; but as this would secure the completion of the whole by the end of the following year, the duty was a very appropriate one for him to take up on his return from Afghanistan. He took final observations at 14 principal stations, forming two double (or two-centered) polygons; the area covered by the principal triangulation was 1,278 square miles, and the direct distance spanned was 64 miles. An azimuth of verification was also determined by star observations. The chain of secondary triangles connecting Khelat with Quetta was completed, and is serving as a very valuable basis for such topographical operations as are being carried on from time to time in this region.

19. Captain Rogers went to Europe in April, making over charge of his party to Mr. Hennessey, who has supervised the reduction of the observations and the preparation of the charts of triangulation, in addition to his regular

* This work fell principally to Mr. Potter, whom Colonel Branfill highly commends for his skilful performances and his good management in dealing with the Temple authorities.

duties in connection with the Computing Office at the Head-Quarters in Dehra-dun. This work has been taken up in the order which was most desirable to furnish final data for the survey operations in Southern Afghanistan and Beluchistan; *viz.*, *1st*, the series from Jacobabad to Quetta; *2nd*, the series from Quetta to Khelat; *3rd*, the series from Quetta to Kandahar; *4th*, the triangulations around Kandahar and in the Khakrez Valley. The three first have been finally disposed of, but the fourth will probably be largely supplemented by observations taken subsequently by Major Leach, V.C., R.E., and by Lieutenants Talbot and Longe, R.E.*

III.—EASTERN FRONTIER SERIES.

20. The party employed in the Eastern Frontier had been chiefly engaged during the previous year on the chain of secondary triangles which was intended to connect Bangkok, the capital of Siam, with the Indian triangulation. The programme of the operations for the present field season was for Captain Hill to complete the triangulation in Siam, while Mr. Beverley extended the chain of principal triangles which is known as the Eastern Frontier Series, down into Lower Tenasserim, and selected a suitable site for the measurement of a base line there at the southern extremity of the British territories in the Malayan Peninsula.

Personnel.
Captain J. Hill, R.E., Officiating Deputy Superintendent 3rd grade.
Mr. H. Beverley, Surveyor 1st grade.
„ J. Low, Surveyor 2nd grade.
„ J. F. McCarthy, Assistant Surveyor 3rd grade.

21. The ill-health, both of Captain Hill and Mr. H. Beverley, on whose presence the successful prosecution of the operations mainly depended, has materially interfered with the progress of the operations. Captain Hill was obliged to go to England in the summer of 1879, and this prevented him from reaching Bangkok in time to commence the field operations before the end of January, when the most favourable time of the year for observing distant objects was nearly over. The triangulation had been carried eastwards in the preceding year to the edge of the alluvial plains in which Bangkok is situated, and which are so thickly covered with trees that it seemed almost impossible to extend it over them without much line cutting, which, for obvious reasons, would have been very undesirable, both from a political point of view, and because very costly. Fortunately, a careful reconnaissance of the ground enabled Captain Hill to discover certain lofty temples and the chimney of a deserted sugar factory, the summits of which were mutually visible over the tops of the trees, though only in very clear weather, as the distances were considerable. No observations could be taken until the rains began to fall, and then they were speedily completed. A large number of observations have been taken from the stations of the triangulation, fixing several hill peaks on both sides of the Gulf of Siam, all the chief pagodas and flagstaffs in Bangkok, and various objects in the towns of Pechbooree, Tachin and Paknam. Captain Hill cordially acknowledges the valuable assistance he received from the Siamese Government, and from Mr. Palgrave, the British Consul at Bangkok, and his assistants, Messrs Newman and Gould.

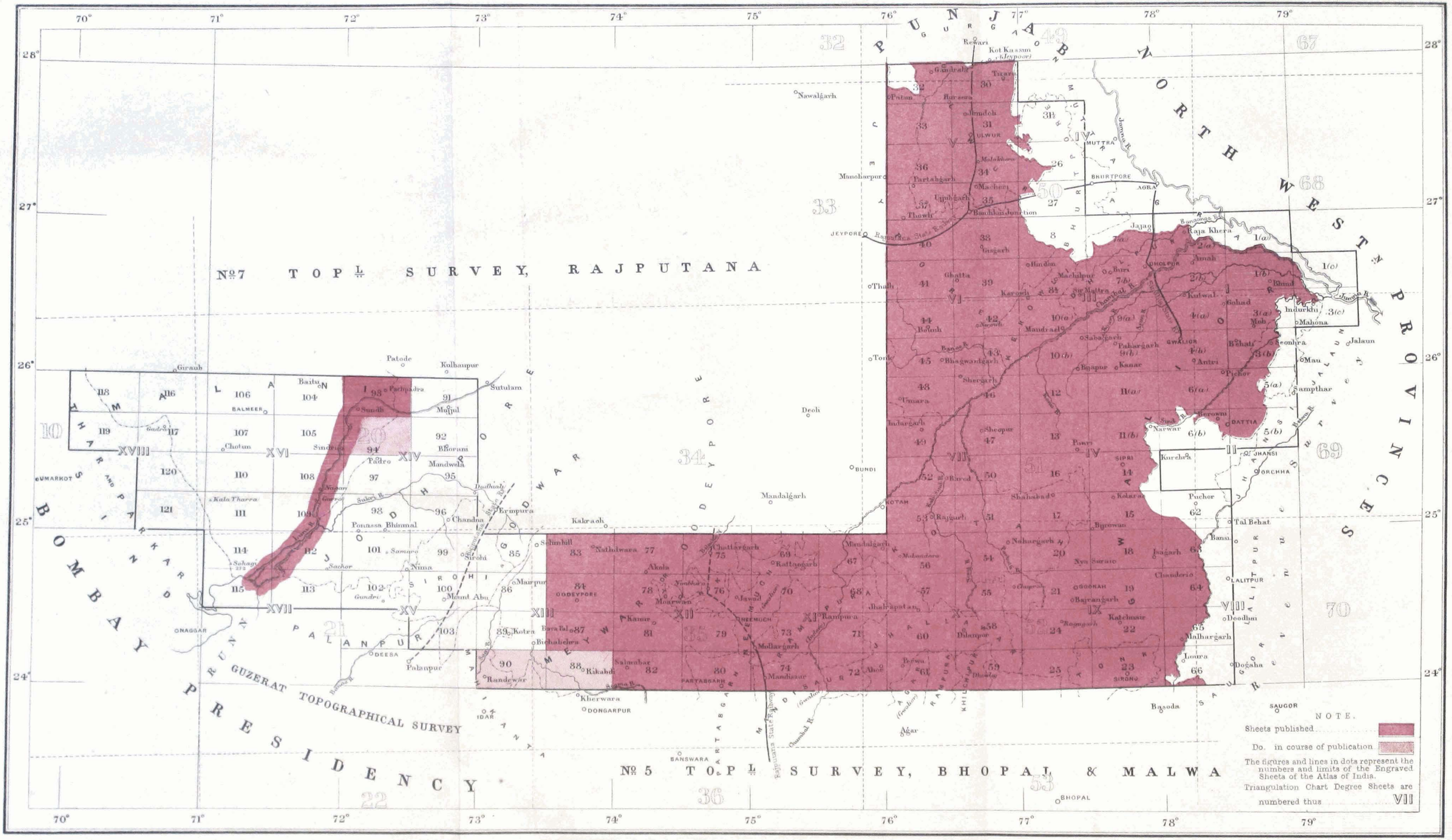
22. Mr. Henry Beverley commenced his field operations in November. But after a few weeks spent on the measurement of the principal angles, his health broke down, and he had to proceed to Mergui for medical advice. He had taken observations at five principal stations, and tried hard to get to the sixth station in order to take the few observations which were remaining to complete two quadrilateral figures; but his strength failed him, and, greatly to his sorrow, he had to give up work with his last figure still incomplete. He had been stricken with a serious illness, which from the first was pronounced by the doctors to be fatal, and, through having a naturally very strong constitution, he rallied occasionally and lived on until the 22nd June, when his working days were over and he was never again able to put hand to an instrument. He entered the Great Trigonometrical Survey in the year 1855, had served 25 years, and was one of the most hard-working and valuable men in the Department; for his heart was

* Captain Rogers reports that Mr. Price has proved himself, as of old, a good and trustworthy assistant, who does his work cheerfully and well; also that Mr. Torrens did good work in the Kelat Series, under exceptionally trying circumstances.

No. 1 PARTY.

INDEX TO THE SHEETS OF THE GWALIOR & CENTRAL INDIA TOPOGRAPHICAL SURVEY,

On the Scale of 1 Inch = 1 Mile.



Published under the direction of Major General J. T. Walker, C.B., R.E., F.R.S., Surveyor General of India,
at the Surveyor General's Office, Calcutta, October 1880.

always in his work, at which he laboured with unflinching assiduity and perseverance, and almost invariably with much success, though his operations were often carried on in malarious tracts, under great disadvantages, and with much detriment to his health. His loss is much to be regretted.*

IV.—THE SECONDARY TRIANGULATION IN BURMA.

23. The triangulation which was being carried from Rangoon to the two beacons that were constructed on the main land opposite the Krishna Shoal, after the disappearance of the Krishna Lighthouse, had progressed very slowly in the preceding year. Mr. Hughes, the Surveyor who was employed on it, expressed his inability to complete it in another season, owing to the difficulties to be encountered; the country was quite uninhabited, and was covered with dense forest and jungle through which lines had to be cut in all cases to open out the rays between the trigonometrical stations. The triangulation was therefore abandoned, and a traverse was carried up to the beacons along any footpaths and openings which presented themselves in the forest. This being a much easier matter to perform, was accomplished in a few weeks; and though it is not as accurate as a triangulation, it may be considered sufficiently accurate for the purpose in view. The traverse was so executed as to form part of one of the main circuits on which the cadastral and revenue surveys now being made in the Hanthawaddy District of Rangoon, by the survey party under Captain Sandeman, will be based; for this purpose it was executed conjointly by Mr. Hughes, and an Assistant Surveyor, Mr. G. E. Parker, of Captain Sandeman's party, both going over the same line independently and comparing results, station by station.

Personnel.

Mr. W. G. Beverley, Officiating Assistant Superintendent 2nd grade.
„ J. O. Hughes, Assistant Surveyor 2nd Grade.

24. Mr. W. G. Beverley was employed throughout the field season on the secondary triangulation around and to the north of Bassein; the outturn of work was small and the triangulation was left incomplete, because, under the supposition that it was finished, Mr. Beverley had been directed to proceed to Mergui to take charge and supervise the field operations of the Eastern Frontier Party, which had lost its executive officer through illness. This he did not succeed in doing, merely joining the party after it had returned to recess quarters; thus, he would have been better occupied had he remained to complete his work in Bassein.

TOPOGRAPHY.

V.—GWALIOR AND CENTRAL INDIA SURVEY (No. 1 TOPOGRAPHICAL PARTY).

25. The operations of this party were almost entirely confined to the area between the parallels of 24° 0′ and 24° 30″ north latitude, and between the meridians 73° and 74° east longitude, the exception being a small tract in the vicinity of the Luni River, east of Sindri. The results of the season's work are represented by 1,287·4 square miles of detail survey on the scale of 1 inch = 1 mile, and by 270 square miles of triangulation, the latter being required to cover a gap in the triangulation of previous years in the vicinity of the small cantonment of Kotra.

Personnel.

Major E. H. Steel, S.C., Officiating Assistant Superintendent 1st grade, in charge.
Mr. W. J. Cornelius, Assistant Surveyor 1st grade.
„ P. J. W. Doran, „ „ „ „
„ C. T. Templeton, „ „ 2nd „
„ A. Kitchen „ „ 3rd „
„ G. P. Tate „ „ 4th „
Sub-Surveyor J. R. Harris,
„ Abdul Guffar (transferred to Kandahar in April)
and 4 others.

26. This outturn of area is exceptionally small; but as the greater portion of the work lay in exceedingly intricate ground, the lower features of which have been described by Major Steel, as resembling a petrified stormy sea, a

* Captain Hill intimates that the site for the proposed base-line in Southern Tenasserim which was selected by Mr. Low is very unpromising, and that further reconnoissance will probably lead to the discovery of a better site. He reports most favourably of Mr. McCarthy's operations in Siam, and states that the local officials are so pleased with Mr. McCarthy that they have offered him an appointment under the Siamese Government, which he will take up as soon as his services can be spared from this Department.

larger outturn could not well have been expected. The work has been very carefully executed and examined in the field by Major Steel.

27. The fair mapping of standard sheets Nos. 88, 90, and 94 has been completed, and the maps are now in course of publication.

28. Captain C. Strahan, R.E., having returned from furlough, was posted to this party in time to commence the field operations of the current working season. The party will be engaged on the detail survey of sheets Nos. 86 and 89, on the scale of 1 inch = 1 mile, and on a survey of the cantonment of Kotra on the scale of 8 inches = 1 mile. The work on the smaller scale will again fall in very intricate ground.*

VI.—KHANDESH AND BOMBAY NATIVE STATES SURVEY (No. 2 TOPOGRAPHICAL PARTY).

29. This party has been engaged in topographical work solely on the scale of 2 inches to the mile in the Khandesh District; the mapping on the 1-inch scale of the country north of Khandesh, including the Satpura Range and the Nerbudda Valley, having been completed last year. With a view to assist the settlement officers, the positions of the trijunction pillars of all the villages are fixed, generally by traversing; and are shown on the fair maps together with the village boundaries.

Personnel.

Captain W. J. Heaviside, R.E., Deputy Superintendent in charge.
Mr. A. G. Wyatt, Surveyor, 4th grade.
„ J. A. Barker, Assistant Surveyor, 1st grade.
„ F. E. Warde „ „ 2nd „
„ G. Vander Beck „ „ 3rd „
„ E. Graham „ „ 3rd „
„ C. George „ „ 4th „
Shek Omar, Sub-Surveyor,
Mr. F. Rosario „
Hyder Ally, „
and four others.

30. The triangulation this year was carried on by Mr. Wyatt in the southern portion of the District in the Talukas of Erandole, Páchora, Jámner and Nasirábád, and covered an area of 1,281 square miles, most of which is under cultivation.

31. Traversing was extended over the area triangulated last year in the south-east portion of Khandesh, including the Talukas of Bhusawal and Jámner, and also in the Pimpalner and Nandurbár Talukas, west and north-west of Dhulia. Altogether 1,151 linear miles of traversing were executed, by which 753 trijunction pillars were fixed; affording the means of determining the heights of 184 traverse stations by the simple and comparatively accurate method of observing from traverse stations to trigonometrical stations, the heights of which were known, the distances between the trigonometrical and the traverse stations being worked out from the difference of the horizontal co-ordinates.

32. The detail survey was carried on in the Pimpalner and Nandurbár Talukas, lying west and north-west of Dhulia. Sheet 38 was completed with an overlap to the south and west, of 1 mile; portions of sheets 37 and 34 were likewise surveyed. The total area of detail survey executed is 827·4 miles.

33. The country in sheet 38 embraces the upper basin of the Pánjhra Valley; the uplands are about 2,000 feet above sea-level with scattered groups of Bheel huts and but few villages. In the northern portion of the sheet a good deal of the country is very hilly and but sparsely inhabited: to the south a narrow rugged range, a spur of the Sáhyádri hills separates Khandesh from Násik with peaks of columnar basalt standing up 2,000 feet above the Pánjhra Valley; on the west the Sáhyádri hills covered with tree forest run northwards sloping away westwards to the Dangs. In sheet 37 the country is more level and more open. In sheet 34 the north-east portion of the country near the banks of the Tapti River is a flat open plain of black soil, on which a great deal of wheat is grown: further west the country is covered with low dhák jungle, which, however, is being gradually cleared off, and in some places with heavy tree forest. The southern portion of this sheet is in strange contrast to the north-east portion, the prevailing characteristics being low hills covered with grass and tree forest with but little cultivation.

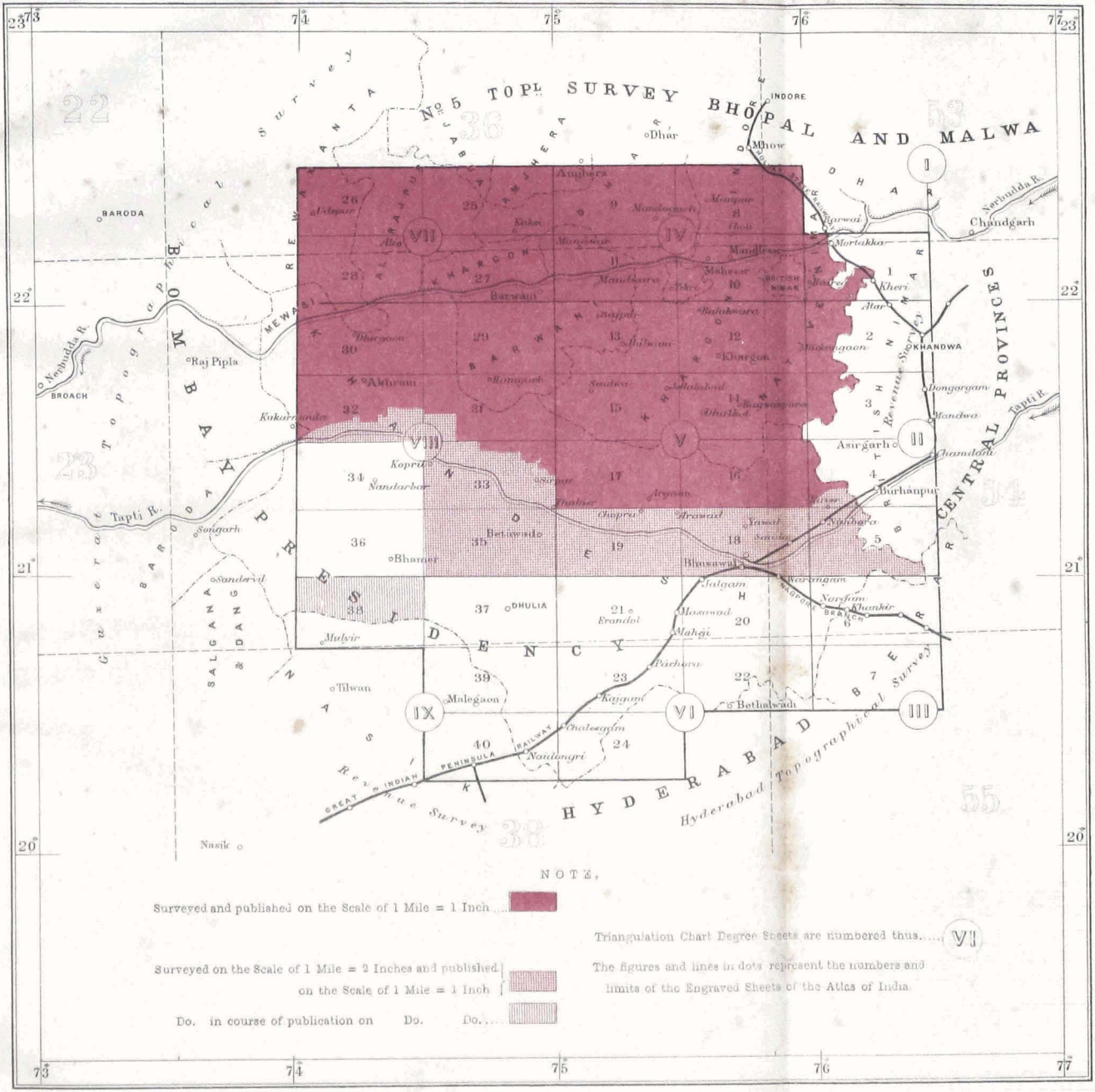
34. The survey is carried on under great disadvantages in sheets 34 and 36, as that part of the country is deemed very unhealthy until the month of February, and by that time water has become scarce: the heat is very great in

* Major Steel mentions Mr. Cornelius as specially worthy of praise; reports favourably of the other European assistants; and commends Sub-Surveyors Abdul Guffar, James Nathaniel, and Abdul Aziz.

No. 2 PARTY.

INDEX TO THE SHEETS OF THE KHANDESH & BOMBAY NATIVE STATES SURVEY,

On the Scales of 1 Inch = 1 Mile and 2 Inches = 1 Mile.



NOTE.

Surveyed and published on the Scale of 1 Mile = 1 Inch

Surveyed on the Scale of 1 Mile = 2 Inches and published on the Scale of 1 Mile = 1 Inch

Do. in course of publication on Do. Do.

Triangulation Chart Degree Sheets are numbered thus..... VI

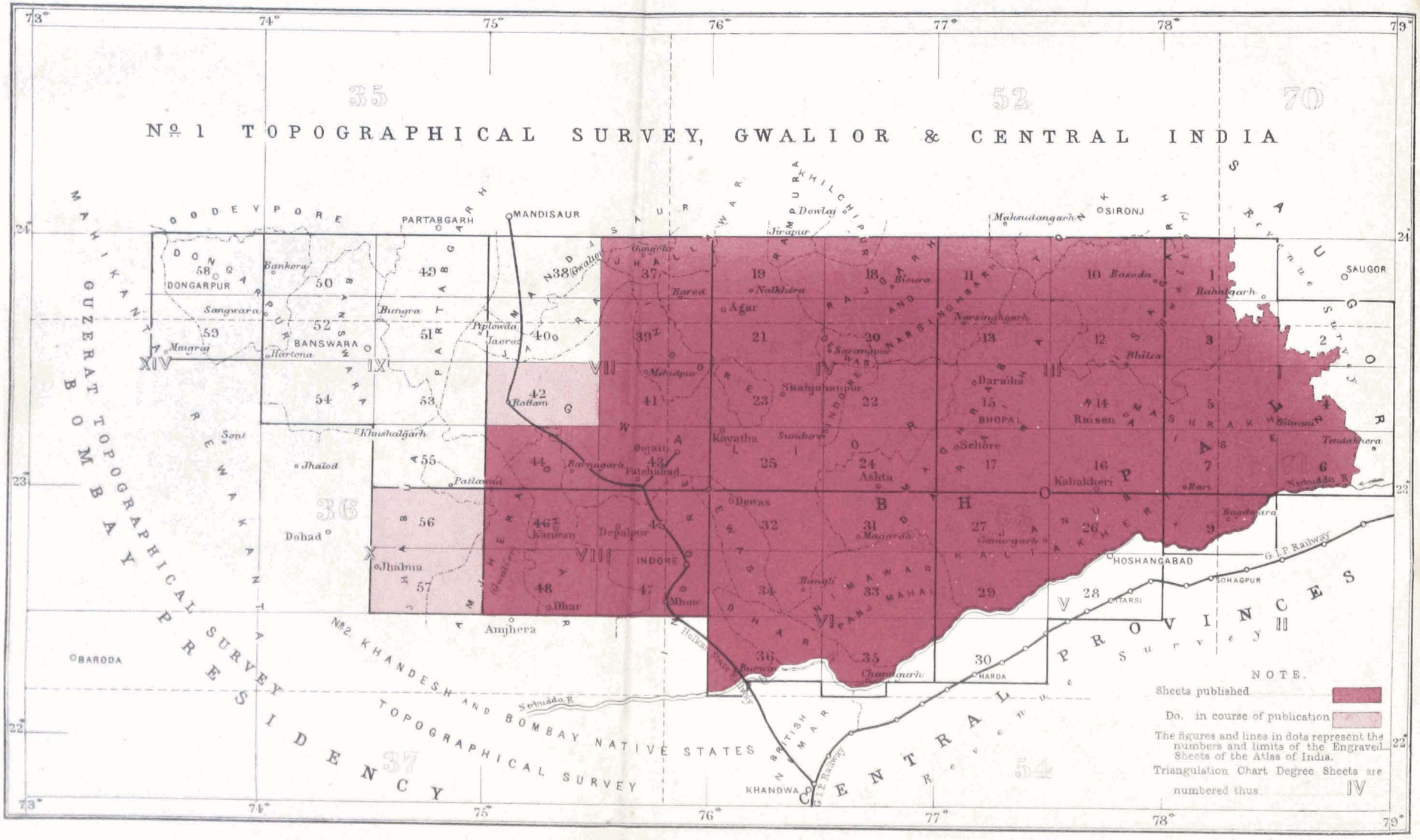
The figures and lines in dots represent the numbers and limits of the Engraved Sheets of the Atlas of India.

Published under the direction of Major General J. T. Walker, C.B., R.E., F.R.S., Surveyor General of India, at the Surveyor General's Office, Calcutta, October 1880.

No. 5 PARTY.

INDEX TO THE SHEETS OF THE BHOPAL & MALWA TOPOGRAPHICAL SURVEY,

On the Scale of 1 Inch = 1 Mile.

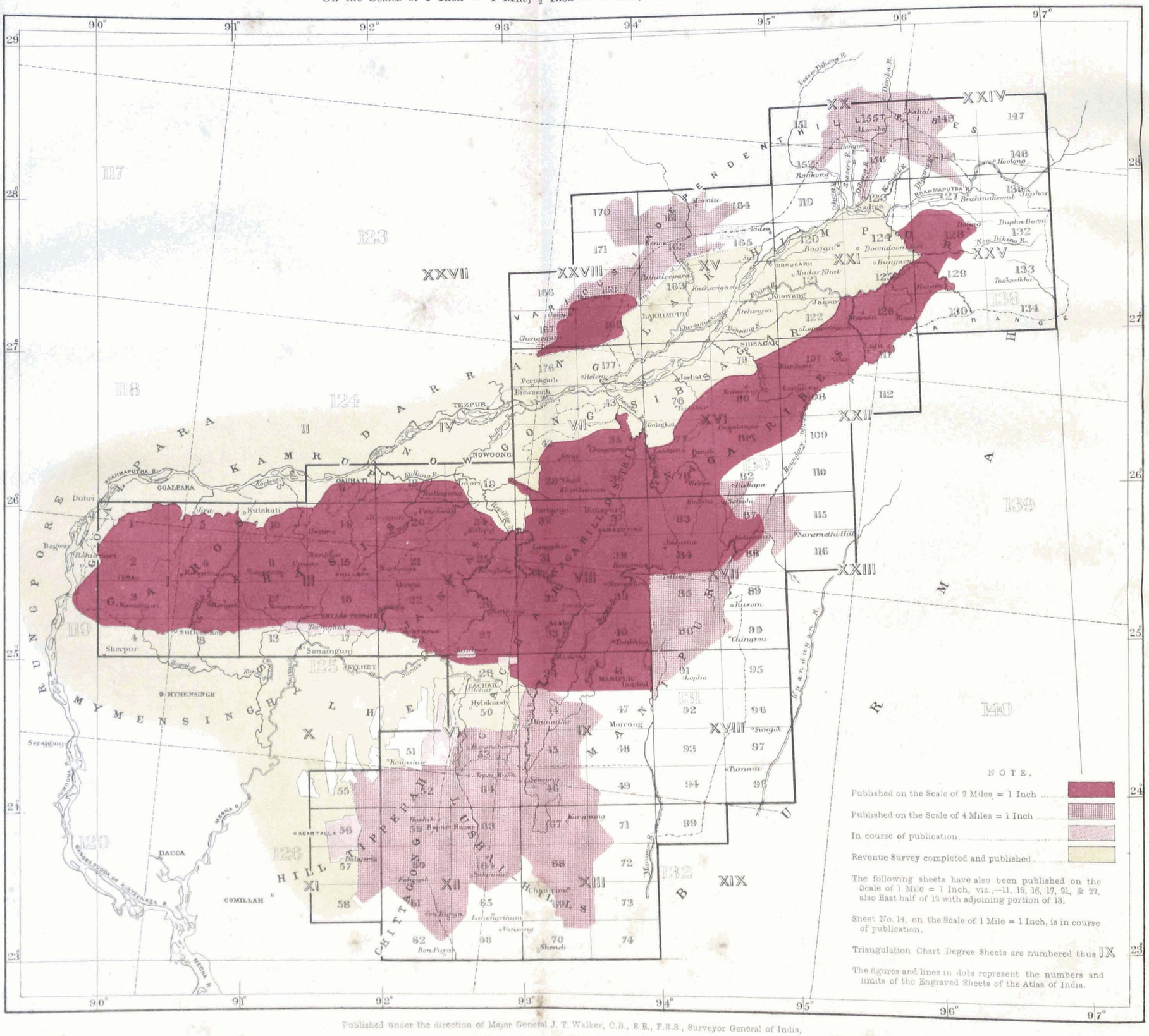


Published under the direction of Major General J. T. Walker, C.B., R.E., F.R.S., Surveyor General of India,
at the Surveyor General's Office, Calcutta, October 1880.

No. 6 PARTY.

INDEX TO THE SHEETS OF THE GARO, KHASI, AND NAGA HILLS TOPOGRAPHICAL SURVEY,

On the Scales of 1 Inch = 1 Mile, ½ Inch = 1 Mile, and ¼ Inch = 1 Mile.



such low-lying ground as the hot weather advances, the low hills and forest shutting out all breeze.

35. Standard sheet 38 has been mapped during the recess, and is now in course of publication.

36. The following is now the state of progress of this survey :—

Area surveyed up to date, 13,663 square miles.
Area remaining for detail survey, 4,017 square miles.

37. During the current field season the triangulation will be carried over the south-western portion of the Khandesh District, extending over an area of a little more than 1,200 square miles, and the detail survey on the scale of 2 inches = 1 mile will be continued in the eastern part of the Khandesh District, in portions of standard sheets 6, 7, 20 and 22, and in portions of sheets 34, 36 and 37 on the north-western part of the District.

VII.—BHOPAL AND MALWA SURVEY (No. 5 TOPOGRAPHICAL PARTY).

38. As stated in paragraph 48 of last year's report, this party was to have been employed on the triangulation of the ground falling between Latitude 23°—24° and Longitude 74°—75°, and on the detail survey on the scale of 1 inch=1 mile of the tract shewn on the index maps by standard sheets 55, 56 and 57, and on the survey on the scale of 6 inches=1 mile of the City of Dhar. The party was late in taking the field, and it was found that the difficulties of the ground to be surveyed in detail were too great to admit of the programme being carried out in the manner anticipated; the area designed for triangulation was consequently very considerably reduced, in order that more time might be made available for the detail survey; notwithstanding this, the area surveyed in detail fell short of the expectations entertained at the commencement of the field season.

Personnel.

Major J. R. Wilmer, S.C., Officiating Assistant Superintendent 1st grade, in charge.
Mr. D. Atkinson, Surveyor 2nd grade.
„ C. F. Hamer „ 4th „
„ E. A. Wainwright, Assistant Surveyor, 1st grade.
„ H. T. Kitchen „ „ 2nd „
„ W. H. Lilley „ „ 2nd „
„ G. R. Copping „ „ 3rd „
Sub-Surveyor Prem Raj
„ Harlall Sing
and three others.

39. The triangulation was extended over an area of 1,019 square miles by Major Wilmer, and the detail survey of sheets 56 and 57 and portions of sheets 42 and 55, in all embracing an area of 1,408 square miles, consisting almost entirely of intricate hilly country covered with jungle, was completed on the scale of 1 inch = 1 mile. The city and environs of "Dhar" covering an area of 8·34 square miles, were surveyed on the scale of 6 inches to the mile, and the plan is now in course of publication. The results of the 1-inch work will admit of sheets 42, 56, and 57 being published.

40. The state of the work of this party up to date is as follows, *viz.*:—

Area actually surveyed, 22,842 square miles,
„ remaining for survey, about 5,700 sqaure miles,

of which about 2,800 square miles have been prepared by triangulation in advance for future detail survey.

41. During the current field season, the triangulation being well in advance of the detail survey, will only be extended over small portions of the tracts falling in sheets 49 and 51. The detail survey on the 1-inch scale will be continued over the remaining portion of sheet 55, and over sheets 38 and 40; and surveys on the scale of 6 inches = 1 mile will be made of the Cities of Ujjain, Rutlam, and Jhabua.

VIII.—KHASI AND GARO HILLS SURVEY (No. 6 TOPOGRAPHICAL PARTY).

42. This party was delayed somewhat in taking the field, by the difficulty of collecting coolies among the Khasias, on whom the party entirely depends for carriage. So many of them had been taken for service with the troops on the expedition to the Naga Hills, that Major Badgley had to search far and wide before he could collect a sufficient number for his requirements. The party was obliged

Personnel.

Major W. F. Badgley, Officiating Deputy Superintendent, 3rd grade, in charge.
Mr. A. W. Chennell, Surveyor 4th grade.
„ J. McCay, Assistant Surveyor, 3rd grade.
„ A. W. Smart, „ „ 3rd „
„ D. Campbell, „ „ 4th „
Sub-Surveyors, Munshi Shah Nasirudin,
and four others.

to leave the field earlier than usual, on account of the heavy rains and floods which occurred at the latter end of March. These circumstances tended to reduce the outturn of work below the usual quantity.

43. The objects of the year's work were,—the continuation of the survey of waste lands, which have been, or may be, taken up for tea cultivation, and of the forest reserve lands in the south-east corner of the Sylhet District,—and the survey of a portion of Hill Tipperah to the east of Agartollah.

44. The triangulation of these tracts having been almost completed in previous seasons, scarcely anything more than the detail survey remained to be done; 102 square miles of waste land were surveyed on the scale of 2 inches to the mile; 210 square miles of forest reserve were surveyed on the scale of $\frac{1}{2}$ inch to the mile; and 220 square miles were surveyed on the scale of $\frac{1}{4}$ inch to the mile in Hill Tipperah. The whole of the work was in country of a very difficult character, covered in some parts with dense forest and thick undergrowth, and in others consisting of swamps covered by high reeds. A great portion of the work had to be done from a succession of platforms in trees, sometimes nearly 100 feet above the ground, and by chain measurements along the beds of streams. The season was unhealthy, cholera broke out in several parts of the tracts under survey, and Major Badgley reports the death of 12 of his menials from that and other diseases.

45. During the current field season Major Badgley will be engaged on the survey on the scale of $\frac{1}{2}$ inch to the mile of a portion* of Hill Tipperah between the Lungai Valley on the east, and "Koilashar and Hudgajeeah" on the west, an area of about 230 square miles, and will continue the survey on the scale of 2 inches to the mile of the six portions referred to in paragraph 56 of last year's report.

* Said by mistake in last year's report to be required on the $\frac{1}{4}$-inch scale.

IX.—THE RAJPUTANA SURVEY (No. 7 TOPOGRAPHICAL PARTY).

46. This party assembled at Delhi on the 10th October, and in accordance with the programme laid down in paragraph 61 of last year's report, proceeded to extend the triangulation over the northern portions of the tracts falling in degree sheets XV and XVI, embracing an area of 690 square miles. The area previously prepared for detail survey was so large that no farther triangulation for the work on the $\frac{1}{2}$-inch scale was necessary; the only other triangulation required was that in connection with the survey of the city of Bickaneer.

Personnel.

Lieutenant-Colonel G. C. Depree, S.C., Deputy Superintendent 1st grade, in charge.
Mr. G. A. McGill, Surveyor 2nd grade.
„ E. S. P. Atkinson, Surveyor 4th grade.
„ J. H. Wilson, Assistant Surveyor 2nd grade.
„ W. C. G. Barkley, Assistant Surveyor 3rd grade.
„ R. W. Senior, Assistant Surveyor 4th grade.
Sub-Surveyors, Baboo Modhusudun Dutt, Munshi Esuf Sharif, and six others.

47. The detail survey on the scale of 1 inch = 2 miles was extended over an area of 6,928 square miles in degree sheets marked XIII, XIV and XV on the index map. The country thus surveyed is described by Colonel Depree as almost entirely an uninteresting desert, the only variety being found in the salt works at Sar, and in the sandstone quarries of Khari. In the former, a coarse salt is produced by solar evaporation, and in the latter a stone of good colour and of compact texture, of which the stratum is horizontal and close to the surface.

48. The city of Bickaneer was also surveyed and mapped on the scale of 12 inches = 1 mile. The results of the season's work will admit of the publication of four maps on the scale of $\frac{1}{2}$ inch to the mile, *viz.*, the northern half of degree sheet XIII, the northern and southern halves of degree sheet XIV, and the southern half of degree sheet XV.

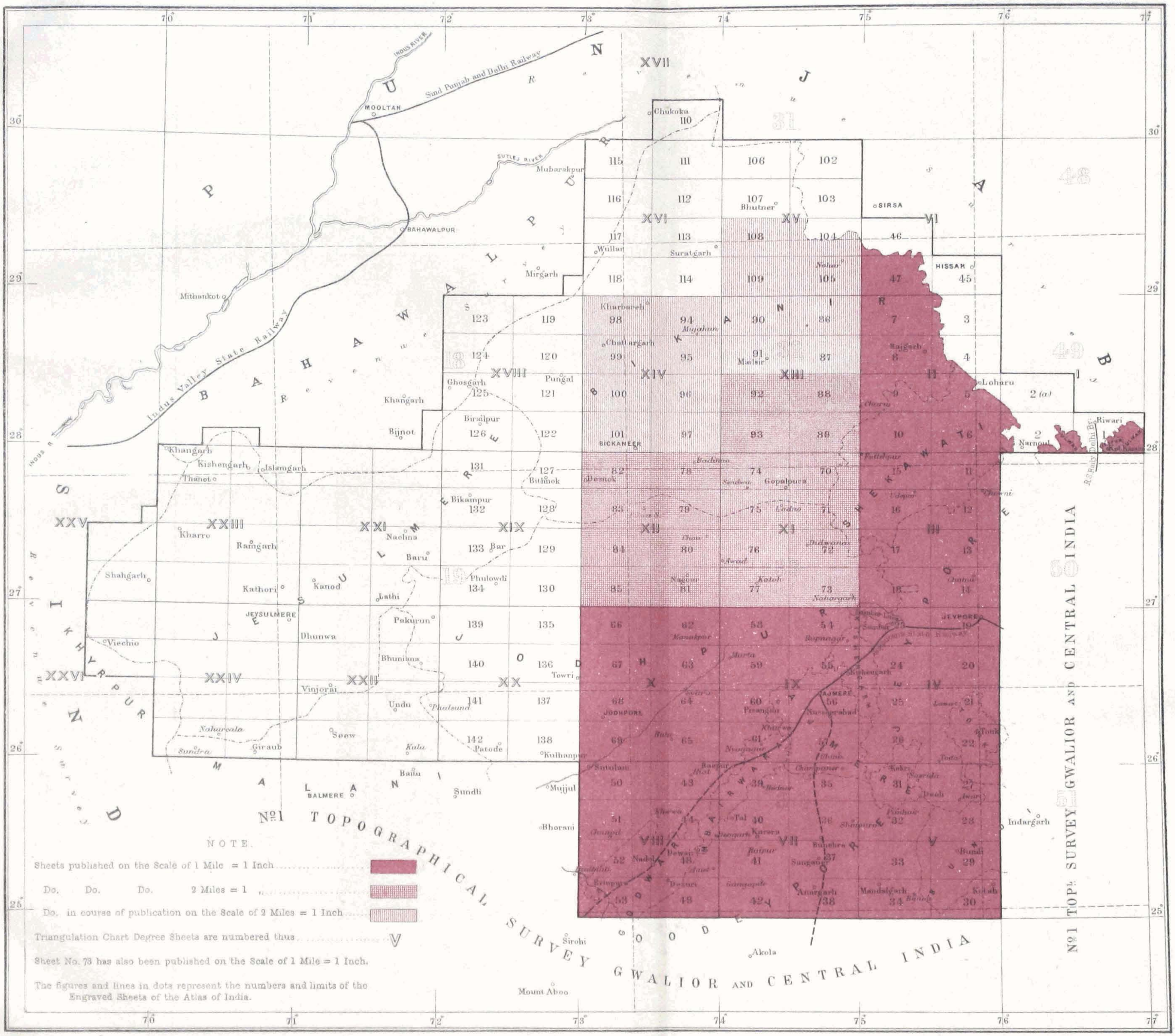
49. During the current season, part of this party will be employed in Rajputana and the remainder in completing the surveys of the cantonments of Dagshai and Solon, as already sanctioned by the Government of India.

50. In Rajputana, a large area, about 8,000 square miles, having been prepared for detail survey, a comparatively small amount of work of this nature will be required, and in consequence the triangulation will only be continued in the western portion of degree sheet XX, and perhaps in the southern portion of degree sheet XIX. The detail survey on the scale of $\frac{1}{2}$ inch = 1 mile will be carried on in degree sheets XV and XVI. The survey of the cantonments

No. 7 PARTY.

INDEX TO THE SHEETS OF THE RAJPUTANA TOPOGRAPHICAL SURVEY,

On the Scales of 1 Inch = 1 Mile and ½ Inch = 1 Mile.

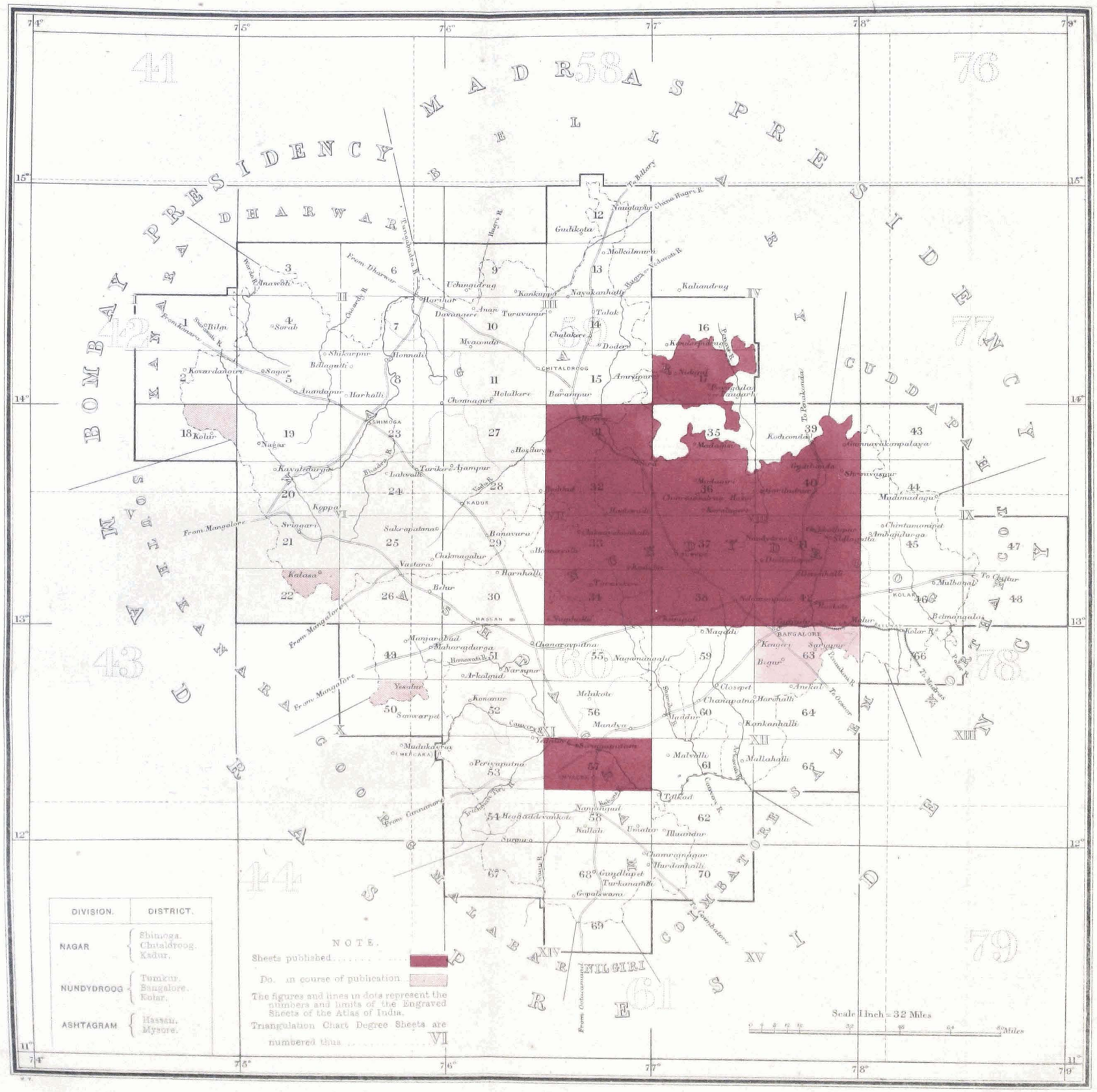


Published under the direction of Major General J. T. Walker, C.B., R.E., F.R.S., Surveyor General of India, at the Surveyor General's Office, Calcutta, October 1880.

Nos. 8 & 9 PARTIES.

INDEX TO THE SHEETS OF THE MYSORE TOPOGRAPHICAL SURVEY,

On the Scale of 1 Inch = 1 Mile.



DIVISION.	DISTRICT.
NAGAR	Shimoga. Chitaldroog. Kadur.
NUNDYDROOG	Tumkur. Bangalore. Kolar.
ASHTAGRAM	Hassan. Mysore.

NOTE.

Sheets published.

Do. in course of publication.

The figures and lines in dots represent the numbers and limits of the Engraved Sheets of the Atlas of India.

Triangulation Chart Degree Sheets are numbered thus VI

Published under the direction of Major General J. T. Walker, C.B., R.E., F.R.S., Surveyor General of India, at the Surveyor General's Office, Calcutta, October 1860.

of Solon and Dagshai will be continued on the scale of 24 inches = 1 mile.*

X.—THE MYSORE SURVEY (No. 8 TOPOGRAPHICAL PARTY).

51. The area of triangulation in the province of Mysore previously prepared by this party was so large as to render it unnecessary to make any farther extension of it during the season under review, the whole strength of the party was, therefore, employed on the topographical delineation of the Mysore-Kanara frontier with a view to having the maps of that rugged and difficult country ready for the use of the Boundary Commission in the ensuing season.

Personnel.

Captain G. Strahan, Deputy Superintendent, in charge.
Captain J. R. McCullagh, R.E., Assistant Superintendent.
Mr. R. W. Chew, Surveyor 2nd grade.
" L. Pocock, " 4th "
" A. James, Assistant Surveyor 1st grade.
" C. Tapsell, " " 1st "
" F. Kitchen, " " 1st "
" W. Stotesbury, " " 1st "
" H. Todd, " " 1st "
" G. Flemming, " " 4th "
" J. Kennedy, " " 4th "
Sub-Surveyor Rugavayangar,
" Tiruvenkatasami,
and three others.

52. The programme had been so arranged, that, no unforeseen circumstances intervening, the whole of this frontier would be surveyed in detail. Unfortunately, owing to sickness and the exceeding difficulty of surveying in such country as the Malnád of Mysore, this plan became impossible, and two small gaps aggregating about 25 miles in length have been unavoidably left in the frontier survey. It is hoped that arrangements may be made early in the season to supply the Boundary Commission with some sort of a map of these missing parts, so as not unduly to extend the time they will employ on this settlement work. The total outturn of detailed topographical survey during the season was as follows:—

	Square miles.	
In the Malnád forests . . .	1,911	
In the vicinity of Bangalore . .	188	
Total .	2,099	All on the scale of 1 mile = 1 inch.

53. A large part of this area was examined in the field according to departmental practice by competent officers and was found accurate. During the progress of this topography, many of the Ghât roads, whose courses are very intricate, were surveyed independently by theodolite and chain; 251 linear miles, entailing 4,410 theodolite stations, were thus measured.

54. The survey operations during the season under review were carried on under great and numerous difficulties, the ruggedness of the Western Ghâts combined with the tangled luxuriance of the forest, the absence of communications, difficulties of obtaining supplies and apathy of native officials, all conspired to retard progress, as well as the repeated attacks of fever to which many members of the party were exposed.†

55. The ordinary methods of working with the plane-table were in many places utterly impracticable, and resort was had to special methods, particularly that known in the department as plane-table traversing, in which the plane-table supplies the place of an angular instrument, and the measurements are made by chain. This is at all times slow; but where the chain lines have, as in this case, to be cleared through dense forest, the progress of the work becomes small indeed. All the mapping of the country surveyed during the field season was incorporated in the fair sheets drawn during the recess, and those which were complete, *viz.*, sheets 18, 22, 50 and 63, are now in course of publication; the remainder, *viz.*, standard sheets 20, 21, 25, 26 and 49, have been retained in the office of the party at Mysore for completion during the ensuing season.

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* Colonel Depree reports favourably of all the members of his party, and specially mentions Mr. McGill, the senior Surveyor.

† The Deputy Superintendent is happy to be able to report very favourably on the assistance rendered, both in field work and recess, by the Assistant Superintendent, Captain McCullagh, R.E., whose previous experience in the Malnád proved very valuable in forestalling some of the difficulties to be met with in that district.

The services of the undermentioned Surveyors and Assistant Surveyors also deserve prominent mention:
Messrs. Chew, Pocock, Kitchen, Stotesbury and Flemming.

The two undermentioned Assistants, *viz.*, Messrs. James and Todd, were much incapacitated by illness, or they would doubtless have been entitled to equal credit with the others.

56. The present state of the work of this party is as follows:—

	Square miles.
Area surveyed up to the end of last field season	9,316
Area remaining for survey, about	18,000
„ triangulated in advance of detail survey	16,900

XI.—THE GUZERAT TOPOGRAPHICAL SURVEY.

57. Three descriptions of work are being carried on by this survey, as follows:—

Personnel.

Lieutenant-Colonel C. T. Haig, R.E., Deputy Superintendent, officiating 1st grade.
Mr. T. A. LeMesurier, Assistant Superintendent, Guzerat Revenue Survey.
„ A. D'Souza, Surveyor 1st grade.
„ A. D. L. Christie, Surveyor 4th grade.
„ C. H. McA'Fee, „ 4th „
„ J. Bond, Assistant „ 1st „
„ S. F. Norman, „ 4th „
„ C. A. Norman, „ 4th „
„ R. F. Warwick, „ 4th „
„ A. George, „ 4th „
Gopal Vishnu, Sub-Surveyor.
Lakshuman Gharparé, Sub-Surveyor.
Bhau Govind, „
and 18 Native Sub-Surveyors and Apprentices.

1*st*.—The ordinary topographical survey executed on the 2-inch scale, but published on the 1-inch scale:

2*nd*.—The publication of a series of maps on the 2-inch scale comprising British territory in detail and foreign in skeleton: and

3*rd*.—The survey of the Dangs forests on the 4-inch scale.

58. The ordinary topographical work was carried on over an area of 1,052 square miles, sub-divided between British and Foreign territory as under—

		Square miles.
British	Ahmedabad Collectorate	43
	Broach „	52½
	Surat „	332½
Foreign	Baroda Territory	369
	Mahi Kanta States	176
	Rewa Kanta States	72½
	Sachim States	6½

and situated in four "sheets" (½ a degree longitude by ¼ degree latitude), of which only two can be immediately published (as the third and fourth are not yet complete), and of these the British territory will be published in three maps on the 2-inch scale.

59. An area of 110 square miles in the Dangs forests has been surveyed on the 4-inch scale, admitting of the addition of four more maps to the series of that survey which join on to the south of the area previously surveyed, completing a very compact block of this wild, hilly country.

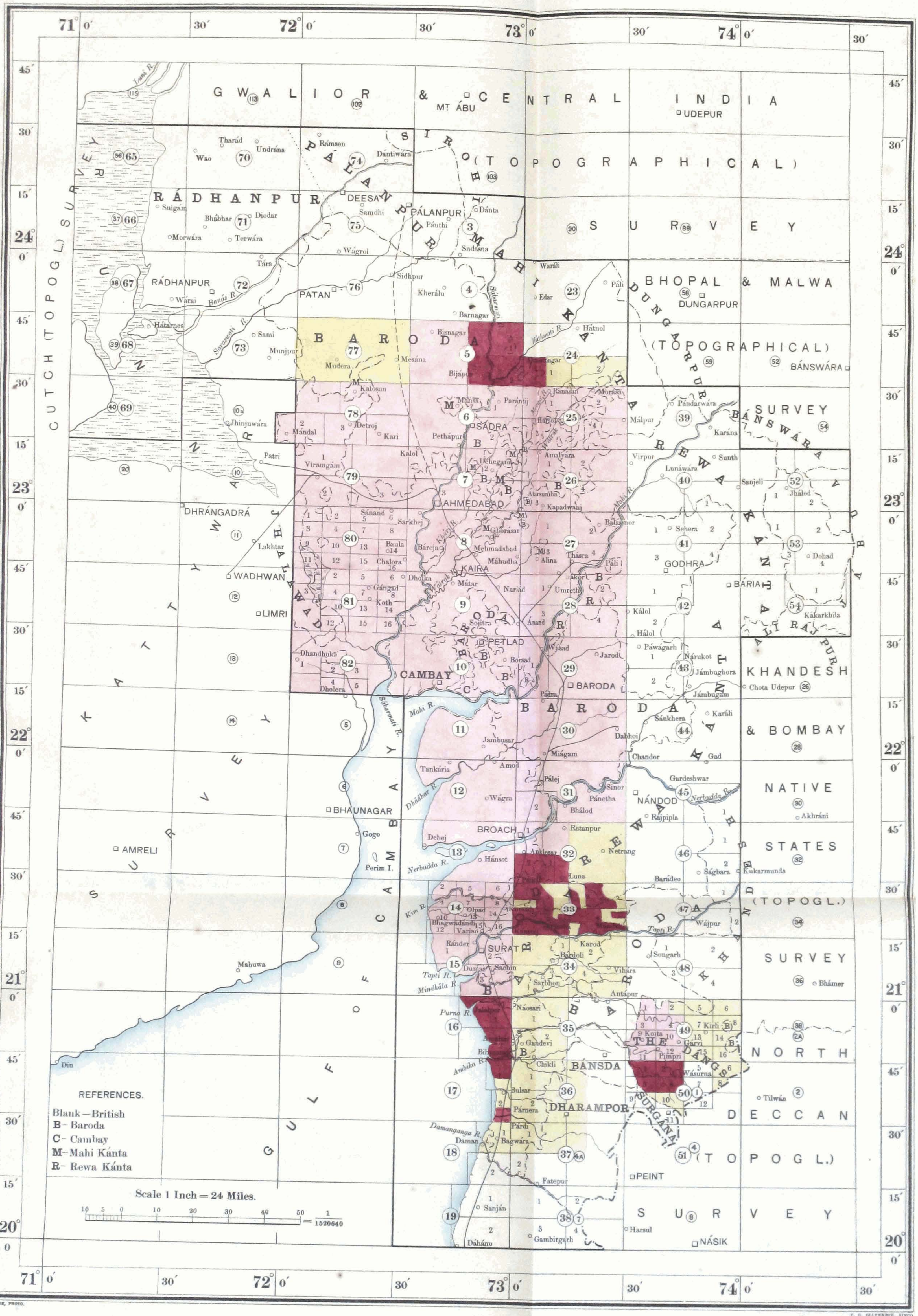
60. The operations of the past season bring the total area topographically surveyed in Guzerat up to about 12,660 square miles, and leave about 18,340 square miles to be done hereafter. In the Dangs about 300 square miles have been completed, and about 550 square miles remain.

61. The outturn of topography on the 2-inch scale has been less by 151 square miles, and that on the 4-inch scale by about 35 square miles, than in the preceding year. This is owing partly to the party taking the field somewhat later than usual on account of the unusual amount of mapping on hand at the close of the recess as mentioned in paragraph 70, page 14, of last year's report, partly to many casualties caused by sickness, but chiefly to the very intricate nature of the ground surveyed.

62. A large area has been triangulated in advance for future topography, that executed during the past season having been carried chiefly over the British territory in the southern portion of the province. An area of 750 square miles is now ready for final survey in the north of the province, and about 2,400 square miles in the southern portion, including about 650 square miles in the Dangs, and the traversing connecting the work of the Guzerat Revenue Survey with the triangulation has been carried over the whole of the British territory in Guzerat, with the exception of a small area of about 60 square miles at the extreme south of the Surat Collectorate, and also with the exception of the Panch Mahals, which have been surveyed more recently by the Guzerat Revenue Survey on a principle different from the rest of the province, which

SURVEY OF INDIA.

INDEX CHART of the GUZERAT SURVEY.



C. DYSON, PHOTO.

C. G. OLLENBACH, ZINCO.

Note.—Sheets 1 and 2, 20 to 22 and 55 to 64 are wanting, because of transfers to other Surveys and a revision of the numbering, which have been made since the last edition of this Index was prepared.

The numerals (3) (4) &c., indicate the sheets of the Survey on the scale of 1 inch to the mile.

The small numerals thus (5) indicate the sheets of adjoining surveys.

The originals of the 1-inch sheets are drawn on the 2-inch scale and are divided into 4 sections, known as N.E., N.W., S.E., and S.W.

Numbered sections in sheets 14, 49, 50, 80, 81 and 82 indicate publications on scale of 4 inches to the mile.

Ditto 2 in other sheets indicate 2-inch scale publications of British Territory.

Denotes country Topographically Surveyed up to 1878-79.

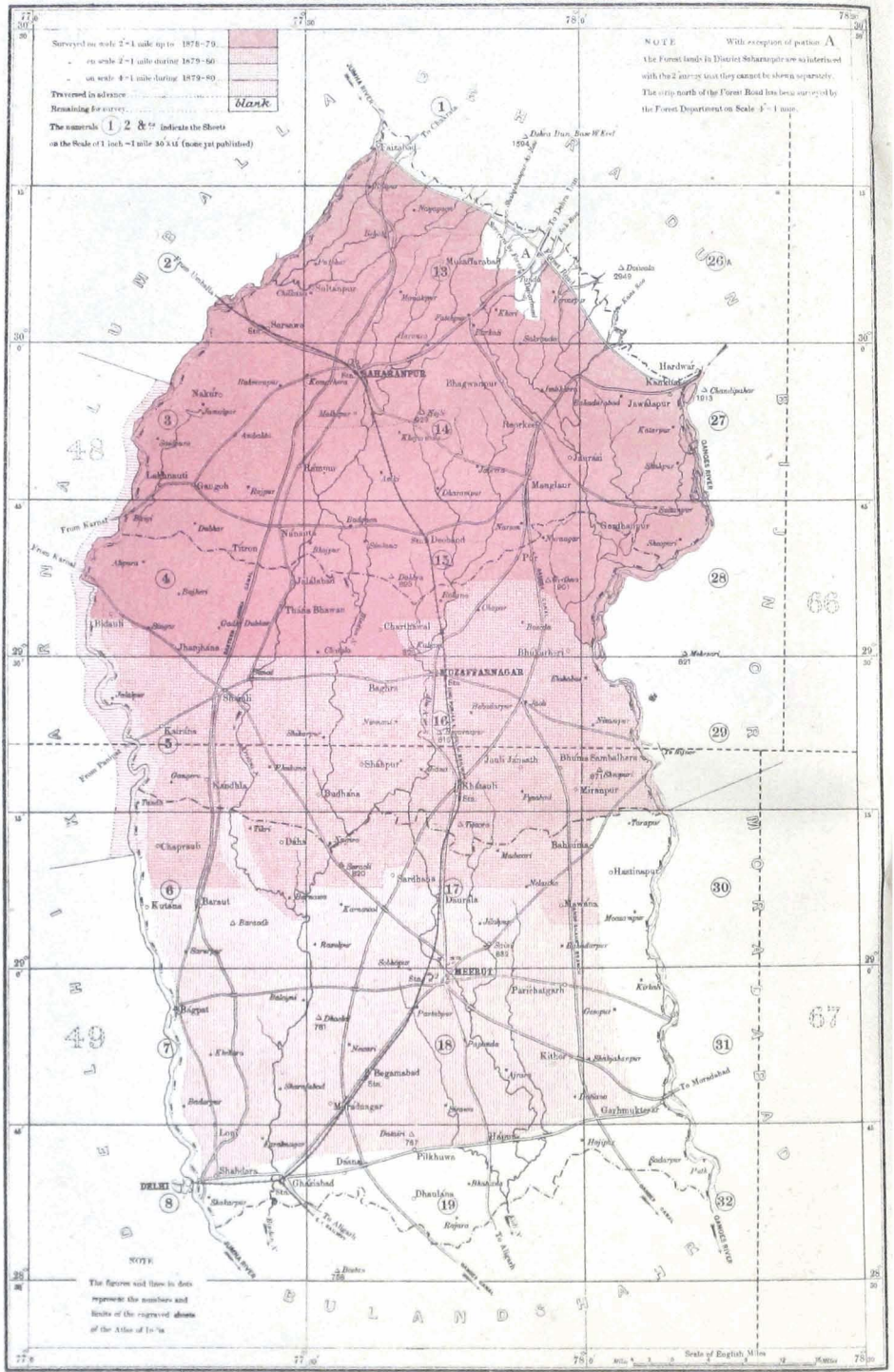
Do. do. do. do. in 1879-80.

Do. do. Triangulated in advance.

Photozincographed at the Office of the Trigonometrical Branch, Survey of India, Dehra Dún, November 1879

N.W. PROVINCES SURVEY

INDEX MAP OF DISTRICTS SAHARANPUR, MUZAFFARNAGAR & MEERUT



SOTE

The figures and lines in dots represent the numbers and limits of the engraved sheets of the Atlas of India

Photozincographed at the Surveyor General's Office, Calcutta.

Published under the direction of Major-General J.T.Walker, C.B.R.E.-F.R.S., *Surveyor General of India.*

Surveyor General's Office, Calcutta, November

1880

will render the work of the Revenue Surveyors much more easy of incorporation with that of this department.

63. The area triangulated in advance for future topography was 844 square miles, in which 504 stations and points were fixed, 80 having their heights determined also; the aggregate length of the lines traversed was 795 miles as a basis for the topography, and 590 of check lines on the topography after completion. Ten sections of the 2-inch maps, and one of the 4-inch maps have been sent in to the Head-Quarters office for publication, and eight more are nearly ready to be sent in. Reductions of sheets 6, 7, 28, 29 and 31 have been prepared for incorporation into the Indian Atlas.*

XII.—MUZAFFARNAGAR AND MEERUT SURVEY (No. 3 PARTY, REVENUE BRANCH).

64. This party, of the strength noted in the margin, and under the charge of Major W. H. Wilkins, resumed field operations in the Muzaffarnagar District on the 18th October.

Personnel.

Major W. H. Wilkins, Deputy Superintendent 3rd grade, in charge.
Mr. E. C. Ryall, Officiating Assistant Superintendent 2nd grade.
" J. Todd, Surveyor 3rd grade.
" R. C. D. Ewing, Assistant Surveyor 1st grade.
" C. W. Wilson, " " 2nd "
" C. W. F. Seyers, " " 2nd "
and 34 Sub-Surveyors, &c.

65. The regular work of the party is the topographical survey, on the 2-inch scale, of the districts in the North-Western Provinces lying between the Ganges and the Jumna, and this survey has been continued southwards from the work of the previous season as far as the parallel of Latitude N. 29° 08′; but in addition to the 2-inch survey, the party has also extended the special 4-inch survey, described in paragraph 80 of last report, of the villages subject to fluvial action on both banks of the Jumna, and has advanced southwards, as far as the river forms the common boundary of District Karnal of the Punjab with District Meerut of the North-Western Provinces. The areas of the two descriptions of survey are as follows:—

Districts.	Scale of survey.	Area surveyed in square miles.	Remarks.
Muzaffarnagar . . .	2″ = 1 mile	1,139·99	
	4″ "	53·50	Mauzawar.
Meerut	2″ "	381·21	
	4″ "	23·59	Do.
Karnal	4″ "	80·00	Do.
Total .	.....	1,678·29	

The survey of District Muzaffarnagar has been completed during the season. In addition to the area of which the topography has been surveyed in the Meerut District, the preliminary traverse work has also been done of 1,256 square miles in readiness for topographical survey during next season.

66. Regarding the nature of the 2-inch topographical survey, Major Wilkins reports:—

"The survey has been as minute as the scale would allow. All cart tracks and roads, masonry wells, topes of trees, temples and other prominent objects, as well as village sites, are shown. Limits of jungle and grass lands, except unimportant patches, have been surveyed. Great attention has been given to all drainage lines, and low ground has been carefully defined."

The village boundaries have been introduced on the final 2-inch maps, as in former seasons, by transfer from the settlement field maps, with the exception of the villages in the alluvial lands of the Ganges, where some of the boundaries had to be obtained by actual survey, a reliable connection with the settlement survey not being possible on account of the want of trijunction platforms in those lands; the field maps of the low-lying villages were also not so good as in the uplands.

* Messrs. D'Souza, McA'Fee, Christie, Bond and Norman have each done good work as usual. Of the native plane-tablers, Gopal Vishnu and Bhau Ghosal are stated by Colonel Haig to be prominently at the top of the list.

67. The success of the system of transferring the village boundaries from the settlement field maps to the survey maps entirely depends on the accurate identification of the points adopted as trijunctions of village boundaries by the settlement survey. Most of these points in the Saharanpur and Muzaffarnagar Districts had originally been marked by low platforms, and in those Districts these marks were repaired, or newly constructed, prior to survey, so that in Saharanpur and Muzaffarnagar the identification of the trijunction points has been satisfactory. The repair of these platforms has given a permanent value to the traverses of the topographical survey; and should it ever be required to repeat the settlement survey, skeleton plots of the trijunctions could be furnished which would form the basis of a new set of settlement maps. It is to be regretted that the repair or construction of these platforms is not being carried out in the Meerut District; the Government of the North-Western Provinces have refused to sanction the necessary expenditure, on the grounds that the survey operations are regarded as being purely topographical, the present necessity of restoring the platforms as boundary marks, or the prospective advantage of obtaining a skeleton basis for a settlement survey, not being recognised.

68. The 4-inch survey of the villages on the Jumna has been carried out as explained in paragraph 80 of last report, to obtain accurate maps of the boundaries of villages, regarding which there had hitherto been much uncertainty, as well as to obtain a true definition of the District boundaries on the river, which also forms a part of the boundary between the North-West Provinces and the Punjab. The survey has been extended as far as the southern limit of the Karnal District; and the boundaries have been surveyed as pointed out by the people, without previous demarcation by the civil authorities. The disputed boundaries between Districts Ambala and Saharanpur, which had come to notice during the previous season, have been settled by representatives deputed by the respective Governments of the North-West and Punjab, with whom a surveyor was associated as a referee on the matter of old boundary lines, and to provide for the immediate survey of the adjusted boundaries. Regarding the adjustment of the disputed boundaries, Major Wilkins reports:—

"In nearly every case arbitration by a *panchayet* was adopted, this being approved by the people themselves. The advice of Mr. Todd (the Surveyor) was eagerly sought for by the people regarding their boundaries; and the presence of an European Surveyor undoubtedly enabled the disputes to be settled, and without him no decision could have been come to. The zemindars told Mr. Todd plainly that they were agreeable to whatever boundaries he laid down; but he informed them that it was impossible in most cases to lay them down accurately, as the *thakbusts* were worthless, and for this reason arbitration had to be employed."

Regarding the *thakbust* maps of the river villages, Major Wilkins further reports:—

"They are so distorted in shape that they cannot be depended on for laying down any boundary."

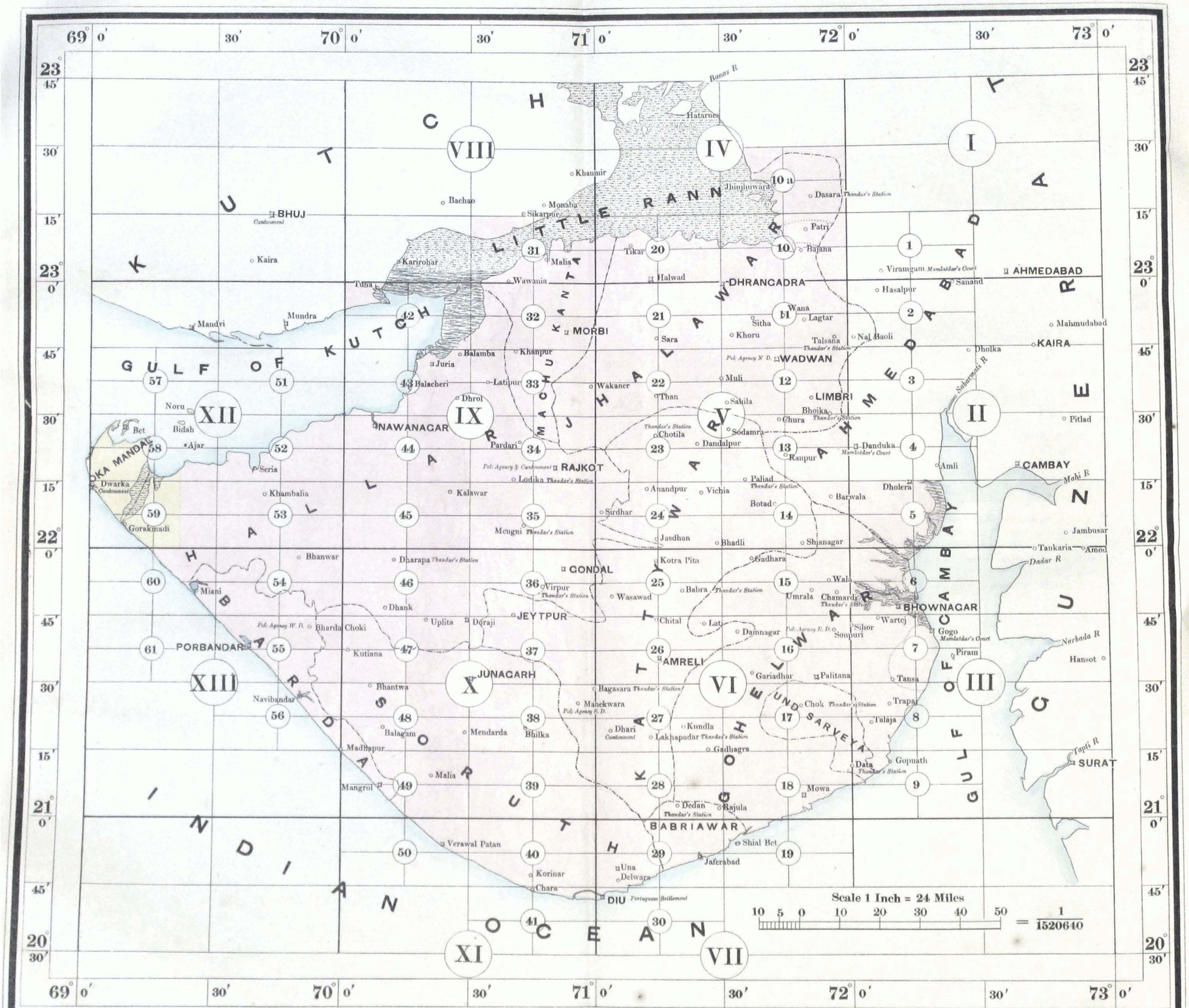
The disputes on the boundary between Karnal and the Districts of the North-Western Provinces are not so numerous as those which were found on the Ambala boundary; and it is hoped the Provincial Governments may consent to the deputation of Civil Officers to settle these disputes, the same as was done for those of Ambala last year.

69. During the season's operations, four principal stations of the Great Trigonometrical Survey have been connected with the measured traverses, and their co-ordinate values have been used to correct the errors of the chaining, in which the average error was found to be 2 links per 100 chains, or about 1 foot per mile. Check lines aggregating 274 miles in length have been measured through the topographical board plans by Major Wilkins and his assistants; and observations for azimuth to check the angular work of the traverses have been taken at 69 stations.

70. The mapping is still somewhat in arrears, the sheets having only been completed southwards to the parallel of 29° 30′. The drawing of the Sewalik Hills in the Saharanpur District by transfer from the Forest Survey maps has however, been completed; and in all, 43 standard sheets for reproduction on the 2-inch scale, and 47 "exaggerated" copies for reduction to the 1-inch scale are now ready.

GREAT TRIGONOMETRICAL SURVEY OF INDIA.

INDEX CHART OF THE KATTYWAR TOPOGRAPHICAL SURVEY.



C. F. OUTHRIE, PHOTO.

C. G. OLLENBACH, Engr.

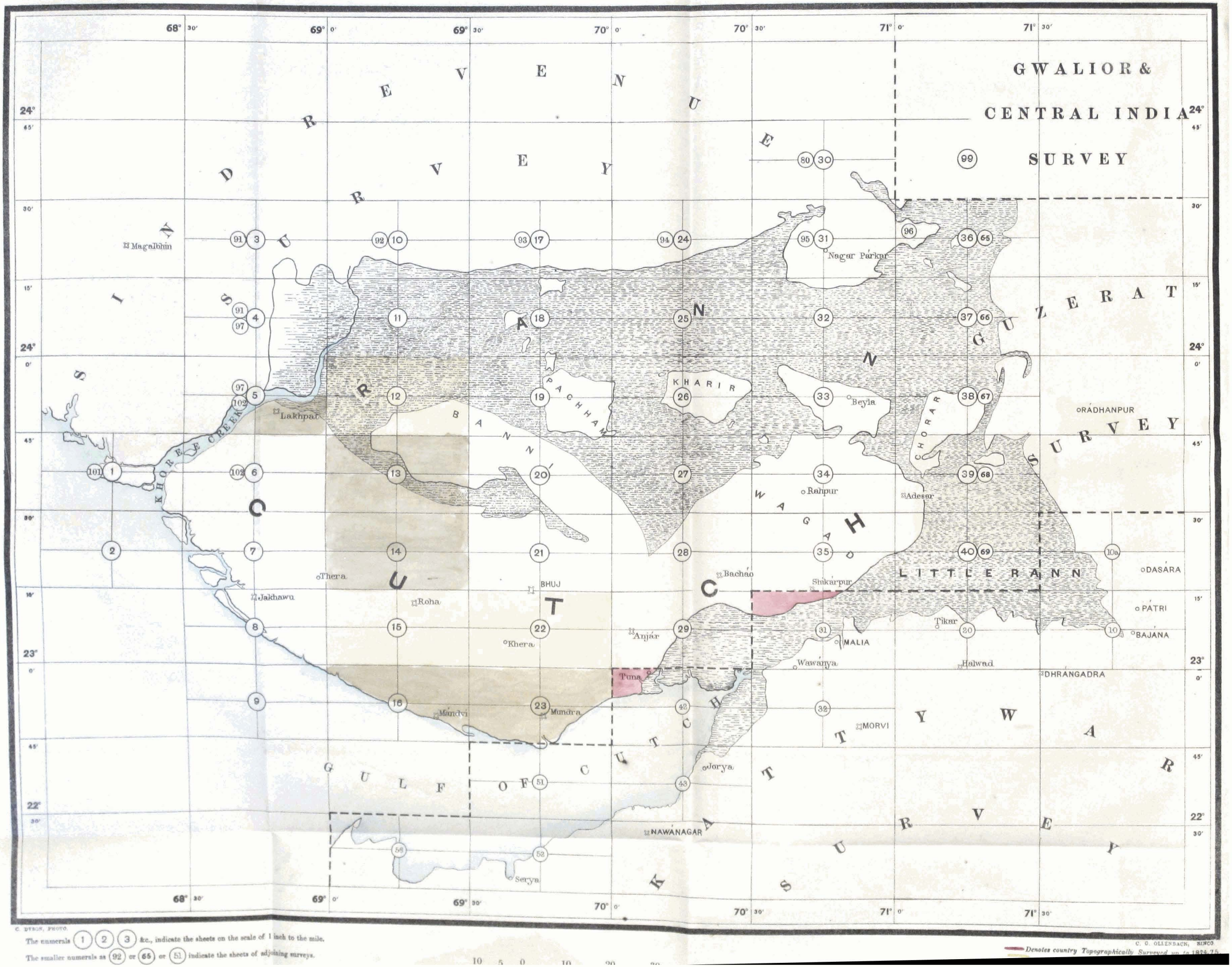
The numerals 1, 2, 3 &c., indicate the sheets on the scale of one inch to the mile. The numerals I, II, III &c., indicate the degree sheets, on the Scale of ½ inch to the mile. The one inch sheets are divided into 4 sections known as the N. E., N. W., S. E., & S. W., sections of the sheet, of those a few copies will be published on the Scale of the original Survey, *viz.*, 2 inches to the mile for the use of local officials.

Denotes country Topographically Surveyed up to 1878-79.
" " " " *in* 1879-80.
" " ~~*Triangulated in advance*~~

Photozincographed at the Office of the Trigonometrical Branch, Survey of India, Dehra Dún, November 1880.

TRIGONOMETRICAL BRANCH, SURVEY OF INDIA.

INDEX CHART OF THE CUTCH TOPOGRAPHICAL SURVEY.



C. DYSON, PHOTO.

The numerals (1) (2) (3) &c., indicate the sheets on the scale of 1 inch to the mile.

The smaller numerals as (92) or (65) or (51) indicate the sheets of adjoining surveys.

C. O. OLLENBACH, SINCO

Denotes country Topographically Surveyed up to 1874-75.

71. The office of the party was inspected at Mussoorie during October; the records were found to be in order, and the office duties were being carried on systematically.*

XIII.—THE SURVEY OF KATTYWAR (KATHIAWAR) AND CUTCH.

72. At the commencement of the field season the topography of the district of Okhamandal, which is situated at the western corner of the peninsula, remained for execution in Kattywar; this has now been completed, and with it the general survey of Kattywar. In a few places the boundary lines between the talooks appertaining to the several Native States have not been surveyed, and are still shown in the maps as "approximate," because they were disputed and had not been demarcated when the survey was being made. Major Pullan thinks that the survey of the province may now be considered finished, and that it is not worth while going to the expense of sending a traverse party to pick up the few scattered breaks which remain for survey to complete these boundaries; and if the Political authorities, to whom this question has been referred, are of the same opinion, nothing more will be done.

Personnel.

Major A. Pullan, S.C., Deputy Superintendent 3rd grade.
Mr. N. C. Gwynne, Surveyor 4th grade.
" W. A. Fielding, Assistant Surveyor 2nd grade.
" G. T. Hall, " " 3rd "
" P. F. Prunty, " " 4th "
" J. Keating, " " 4th "
Visaji Raghunath Godboli, Head Sub-Surveyor, and 11 other Sub-Surveyors.

73. The area finally surveyed on the 2-inch scale for reduction to the 1-inch scale amounted to 2,133 square miles, of which 494 were in Kattywar and 1,639 in the sister province of Cutch; the average number of plane-table stations was 12·6 per square mile of topography. The triangulation in advance covered an area of 1,450 square miles, fixing 56 stations and 462 points and giving the heights of 119 points. Of traversing, 1,224 linear miles were executed, and test lines of an aggregate length of 296 miles were carried over the topography.

74. During the recess season fair maps of sheets 57, 58, 58*a*, 59, and 59*a* of Kattywar, and 15 and 22 of Cutch, each in four large sections on the 2-inch scale, were completed and sent to the Head-Quarters office for publication. The whole of the current computations were duly brought up. Twelve of the standard sheets were reduced from the 1-inch to the ¼-inch scale for incorporation in the engraved Indian Atlas. Two of the general reports for square degrees, Nos. v and vi, have been completed and sent in, and a third, No. ix, was nearly ready.†

XIV.—AHMEDNAGAR, POONA, AND COLABA SURVEY (No. 10 PARTY, REVENUE BRANCH).

75. This party, of the strength noted in the margin, took the field in two sections and resumed field operations on 15th November. One section has been engaged in completing the survey of the portion of the Deccan which had been allotted to this party for survey, with which also has been included the survey of the Ashti Taluka of the Nizam's Dominions, as it is surrounded by Deccan country. The second section has commenced the topographical survey of the Konkan, where preliminary triangulation had been done last season. The 2-inch scale of the Deccan surveys has been continued in the survey of the Konkan,

Personnel.

Colonel J. Macdonald, Deputy Superintendent 2nd grade, in charge.
Mr. G. H. Cooke, Assistant Superintendent, Officiating 2nd grade, on furlough for 1 year, from 22nd May 1880.
" A. M. Lawson, Surveyor, 3rd grade.
" J. Newland, Assistant Surveyor, 1st grade.
" W. M. Kelly, " " 3rd grade, transferred from No. 5 Party, 11th November 1879.
" R. R. Dickinson, Assistant Surveyor, 3rd grade.
" H. Corkery, Assistant Surveyor, 4th grade, proceeded to Afghanistan on field service, 18th October 1879;
and 18 Sub-Surveyors, &c.

* Major Wilkins has reported on his Assistants as follows:—

Mr. E. C. Hyall has done very well in the field.
Messrs. Todd, Ewing and Wilson have given uniform satisfaction both in field and office.
Mr. Seyers has done well in office, but some of his field work was indifferent.

The following Sub-Surveyors and others of the Native Establishment are selected for favourable mention: *viz.*, Nundlall Chatterjee, Kedar Nath, Bhugobutty Chuckurbutty, Surfaraz Khan, Mahomed Zakaria, Hidayatulla, Boitbram, Alladad Khan, Sharafdin, and Ali Hosan.

† Major Pullan reports favourably of all his European Assistants, and commends Sub-Surveyors V. R. Godboli, Narsu Dinkar, K. Govind, Ganesh Ramchundra, K. Vital, and Tukaram Chowdry.

but the village boundaries have been obtained by direct survey, as it was found that the transfer of the boundaries in such hilly country from the Bombay Revenue Survey maps would not be satisfactory. A comparison, however, has afterwards been made in office between the boundaries according to the two surveys.

76. The area surveyed topographically in the Deccan is 1,150 square miles, and in the Konkan 845 square miles. The total area of 1,995 square miles is less than the outturn of the previous year by 220 square miles, but the decrease is stated by Colonel Macdonald to be due to the nature of the work in the Konkan, where the country itself is very intricate, being hilly and largely covered with jungle, and where also the smaller villages necessitated a great increase in the boundary traversing beyond what had hitherto been required in the Deccan. Colonel Macdonald anticipates that there will be a still further reduction in the out-turn when the work is entirely confined to the Konkan.

77. The preliminary triangulation for future work in the Konkan has been extended over an additional area of 2,520 square miles; and the boundary traversing in advance has been completed of 475 square miles. The triangulation is comprised within 71 secondary triangles and 271 tertiary triangles, besides which there are 124 points fixed by intersections. In these triangles, the average differences found on comparison of common sides are, 4·87 inches per mile for the secondaries, 6·29 inches for the tertiaries, and 12·1 inches for the intersected points. The heights of 126 points have been determined by means of vertical angles; these determinations of height have been verified by independent observations to the same points, resulting in an average difference of 3·72 feet. Mr. G. H. Cooke, Assistant Superintendent, who carried on the triangulation, experienced the same difficulties as last season from the hazy state of the atmosphere, and his progress was also much hindered by the attacks of guineaworm amongst the signallers, not one of whom is said to have been free from the malady. Check surveys aggregating 323 linear miles were measured in the open parts of the country; in hilly parts, the work of the topographers was checked *in situ*. Colonel Macdonald himself visited and inspected every Surveyor's section.

78. The geographical limits of 4 sheets of the Deccan series of standard maps, extending over detached portions of Deccan Districts, embrace a considerable area included within the old topographical survey of the Nizam's Dominions; these sheets have been filled up to margin by transferring the details from the old maps. An area of 1,260 square miles has thus been added to the mapping of the season, and the total area which has been drawn is 3,255 square miles. In Colonel Macdonald's office, a "Reduction" to the scale of the Atlas of India has also been drawn, covering an area of 7,650 square miles of present and past seasons' work, to be used as a guide to the engravers of the Atlas, but this map is still somewhat incomplete.

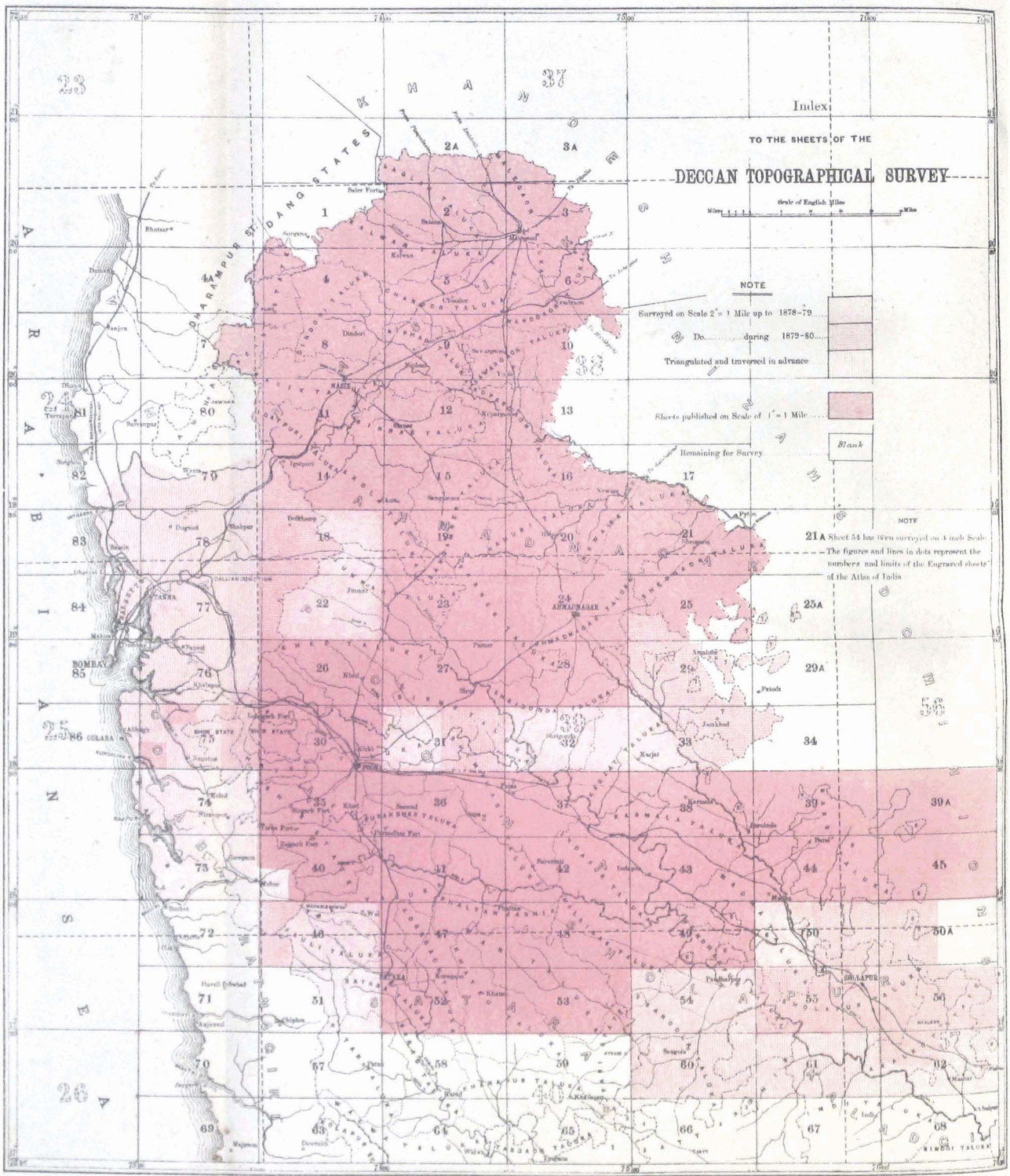
79. During the coming season, the triangulation will be extended northwards to Latitude 20°, which is the limit of the area allotted for survey to this party. The topographical survey will be confined within sheets 75, 77, 78, 79, 83 and 84.

80. The office of the party was inspected at Poona in July. The field sections were found to have been surveyed with care, and the final maps were being drawn in good taste.

A descriptive report of part of the country surveyed, submitted by Colonel Macdonald, is given in the Appendix.*

* Colonel Macdonald reports most favourably on the good services of Mr. G. H. Cooke, Assistant Superintendent, and of Messrs. Lawson and Newland. Mr. Dickinson is praised for his faithful hill-sketching; and amongst the Native establishment, who were reported to have all worked well, special mention is made of Lingoji Potana, Govind-Janardhan, Fyzulah Khan, Nathu Lall, Inayutullah Khan, and Ramrao Yadbo.

DECCAN TOPOGRAPHICAL SURVEY



Photozincographed at the Surveyor General's Office, Calcutta

Published under the direction of Major-General J.T.Walker, C.B.-R.E.-F.R.S., *Surveyor General of India.*

Surveyor General's Office, Calcutta, November

1880

XV.—SHOLAPUR AND RATNAGIRI SURVEY (No. 11 PARTY, REVENUE BRANCH).

81. This party left recess quarters at Poona on the 10th November 1879, and proceeded by rail to Sholapur, in the neighbourhood of which town field operations were immediately resumed. Field work was continued up to 6th May 1880. Major Hutchinson held charge of the party during the whole of the field season, but for three months of the recess, while Major Hutchinson was absent on privilege leave, Mr. J. McGill held charge. The topographical outturn is 2,028 square miles, part of which area had to be triangulated, as well as surveyed in detail; and the area of preliminary triangulation and traversing done in advance for next season is 1,584 square miles. The completed area is included in sheets 50, 50A, 55 and 56; and the western portion of sheet No. 46, which had been done in 1876-77 up to the limits of the Deccan, has now been completed taking in a portion of the Konkan. The system of survey has been the same as before, and the 2-inch scale has been continued. Village boundaries, however, have been obtained by direct survey, and not by transfer from the Bombay Revenue Survey maps, as in former years. The survey of the city of Sholapur, on the scale of 80 inches = 1 mile, at the expense of the Municipality has been commenced, and about one-third is completed. The map on the 80-inch scale will be in several sections, but a general map of the city, having the cantonment added to it, on the scale of 8 inches = 1 mile, is also being prepared.

Personnel.

Mr. J. McGill, Officiating Assistant Superintendent 1st grade, held temporary charge of the Party from 16th July to 13th October 1880.
Major H. S. Hutchinson, Officiating Assistant Superintendent 1st grade, in charge, proceeded on 3 months' privilege leave on 16th July 1880, re-joined 14th October 1880.
Mr. S. M. Smylie, Surveyor 3rd grade.
„ J. T. U. Coxen, Assistant Surveyor 2nd grade, proceeded to Afghanistan on field service on 22nd October 1879.
„ J. Hickie, Assistant Surveyor 2nd grade, transferred from late 2nd Division from 1st November 1879.
„ G. C. Swiney, Assistant Surveyor, 2nd grade.
„ W. H. Penrose, „ „ 2nd „
„ G. A Knight, „ „ 3rd „
and 21 Sub-Surveyors, &c.

82. The final mapping of sheets Nos. 46, 50, 50A, 54, 55 and 56 has been completed on the 2-inch scale suitable for reduction by photography to the 1-inch scale for publication on sheets of the standard size. Sheet No. 50A, of which a portion only has been surveyed, has been drawn up to marginal limits by transfer from the maps of the old topographical survey of the Nizam's dominions. In addition to the ordinary computations of the season, the heights of all the previously published sheets have been revised in accordance with the results of the recent operations of the Bombay Tidal and Leveling Party. The drawing has been completed of the sections of the survey of Satara City, scale 80 inches = 1 mile, executed during the previous year; and the sections, 23 in number, have been published at the Government Photographic Press at Poona. A general map of the city and cantonment of Satara on the scale of 8 inches = 1 mile has also been published.

83. The triangulation is subordinate to several of the triangles of the Bombay Longitudinal Series of the Great Trigonometrical Survey, and a comparison has been made between the direct distances of two Trigonometrical Survey Stations and the computed distances by minor triangulation, showing that the average error of the latter is 2·9 inches per mile. Check surveys have been measured to the total extent of 181 linear miles, whereby the work of each of the topographers has been carefully tested; the result in most cases was very satisfactory. Sheet No. 46, as it includes a very difficult hilly country, was examined on the ground by Major Hutchinson personally.

84. During the ensuing season, the topographical survey will be continued into sheets Nos. 60, 61, 62, 67 and 68, sheets Nos. 60 and 61 having been already triangulated, and the village boundaries partially traversed.

85. The recess office of the party was inspected at Poona in July. Good progress had been made with the final maps, and the drawing was being done carefully.*

* Both Mr. McGill and Major Hutchinson report favourably of all the assistants; Messrs Smylie, Hickie, Swiney and Knight being specially commended by Mr. McGill. Of the native establishment, Toolsee Ram, Anant Narain, Malloo Sayer, and Chandoo Meean are mentioned by name for their good services.

MAUZAWAR OR VILLAGE SURVEY.

XVI.—DERA ISMAIL KHAN AND RAWALPINDI DISTRICTS (No. 1 PARTY, REVENUE BRANCH).

86. The field operations of this party were resumed under the superintendence of Captain H. L. Smith, Assistant Superintendent; but in the meantime Lieutenant Colonel D. Macdonald has been posted to the party on the breaking up of his late party, which had been employed in the Sirsa District, and he relieved Captain Smith on the 6th December 1879. The party, of which the strength is noted on the margin, took the field in two sections; one section moved out from recess quarters at Murree during October to continue their work in the Murree and Kahuta Tehsils of the Rawalpindi District; the second section marched down to the Dera Ismail Khan District, and resumed work there on 15th November. Some of the Surveyors continued at work in the Murree and Kahuta Hills until the end of May; in Dera Ismail Khan, field work was closed on 1st April.

Personnel.

Lieutenant-Colonel D. Macdonald, Deputy Superintendent 2nd grade, in charge from 6th December 1879.
Captain H. L. Smith, Assistant Superintendent 1st grade (in charge from 1st October to 5th December 1879).
Mr. G. Housden, Surveyor 1st grade, retired on pension from 1st November 1879.
" G. B. Scott, Surveyor 3rd grade, joined from 14th June 1880.
" W. S. Buttress, Surveyor 3rd grade.
" A. J. Gibson, " 4th "
" R. Todd, Assistant " 1st "
" P. A. Peters " " 3rd "
" J. C. Kelly, Probationary Assistant Surveyor 4th grade, and 22 sub-surveyors, &c.

87. The survey of the Murree and Kahuta Tehsils, which has been done for the Forest Department, has now been completed; and, at the request of the Conservator of Forests at Murree, the survey has been extended so as to include two small Forest Reserves in Tehsils Rawalpindi and Gujar Khan. For the Forest Department, the "Kala Chitta" Range of hills in the Rawalpindi District still remains to be surveyed, but the preliminary triangulation of the tract has nearly been finished.

The following statement shows the outturn of completed survey, during the season, both in the Rawalpindi and Dera Ismail Khan Districts:—

District.	Sub-divisions.	Scale 4" = 1 mile.
		Square miles.
Dera Ismail Khan . . .	Pargana Bhakkar	1,334·7
Rawalpindi	Tehsil Kahuta ...	386·4
	" Rawalpindi	12·3
	" Gujar Khan	11·0
Total . .	...	1,744·4

In addition to the above, the preliminary boundary traversing of 1,934·3 square miles in Pargana Bhakkar of Dera Ismail Khan has been done, besides the preliminary triangulation of 450 square miles of the Kala Chitta Range in Rawalpindi.

88. Respecting the country surveyed in Dera Ismail Khan, Colonel Macdonald reports:—

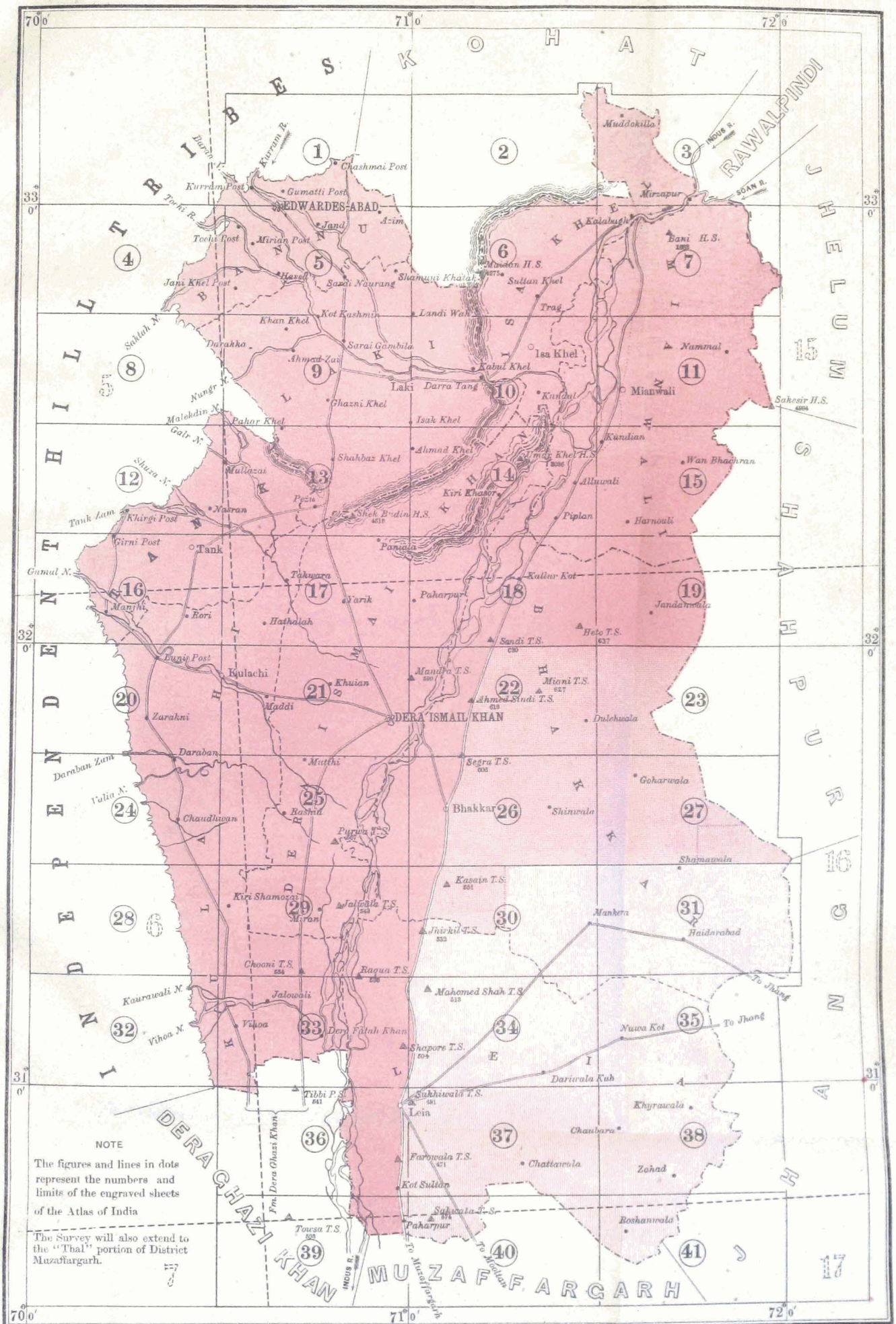
"It is a portion of what is termed the '*Thal*' (or sandy region). The country, as the name indicates, is sandy and barren, covered with sand-hills more or less permanent. Hamlets are few and far between, with a well or two surrounded by a few fields. Small tanks are scattered about over the face of the country, where flocks are occasionally watered after a rainfall. Melons are largely cultivated as might be expected from the nature of the soil."

* * * * * *

"There is no such item separately recorded on the maps as 'fit for cultivation;' the whole area almost might be included in this item, if water could be made available. The distance in feet between the surface of the ground and the surface of water in wells at the time of survey has been indicated on the maps in the usual manner."

PUNJAB SURVEY

INDEX MAP OF DERA ISMAIL KHAN & BANNU DISTRICTS



NOTE

The figures and lines in dots represent the numbers and limits of the engraved sheets of the Atlas of India

The Survey will also extend to the "Thal" portion of District Muzaffargarh.

Surveyed on Scale 4″=1 mile up to 1878-79....

during.....1879-80....

Triangulated and Traversed up to 1879-80....

Scale of English Miles

Miles 0 5 10 15 20 25 Miles

The numerals (1) (2) &c. indicate the Sheets 30′ X 15′ on the Scale of 1 inch = 1 mile (none yet published)

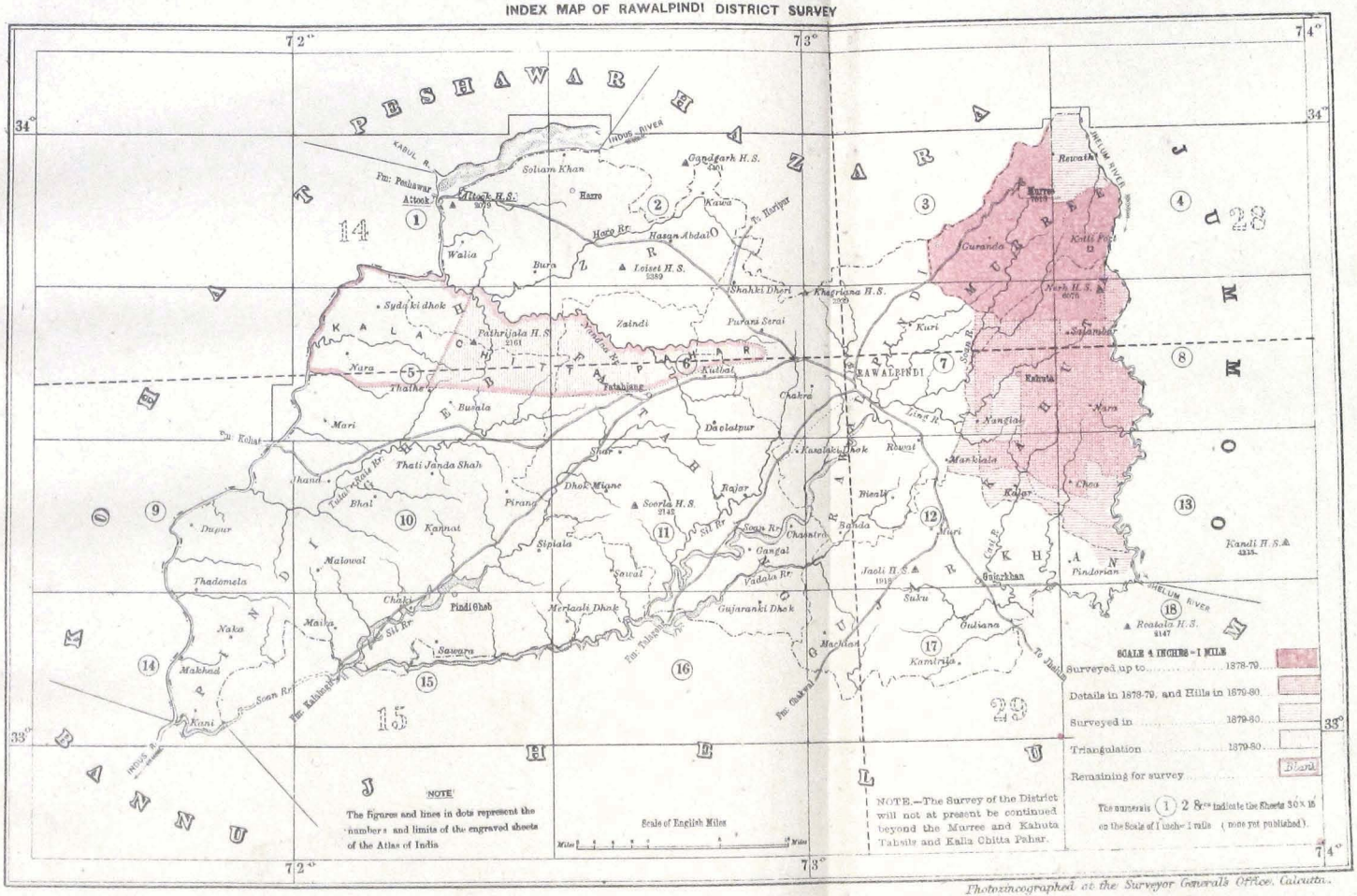
Photozincographed at the Surveyor General's Office, Calcutta.

Published under the direction of Major-General J.T.Walker, C.B.-R.E.-F.R.S., *Surveyor General of India.*

Surveyor General's Office, Calcutta, November 1880

PUNJAB SURVEY

INDEX MAP OF RAWALPINDI DISTRICT SURVEY



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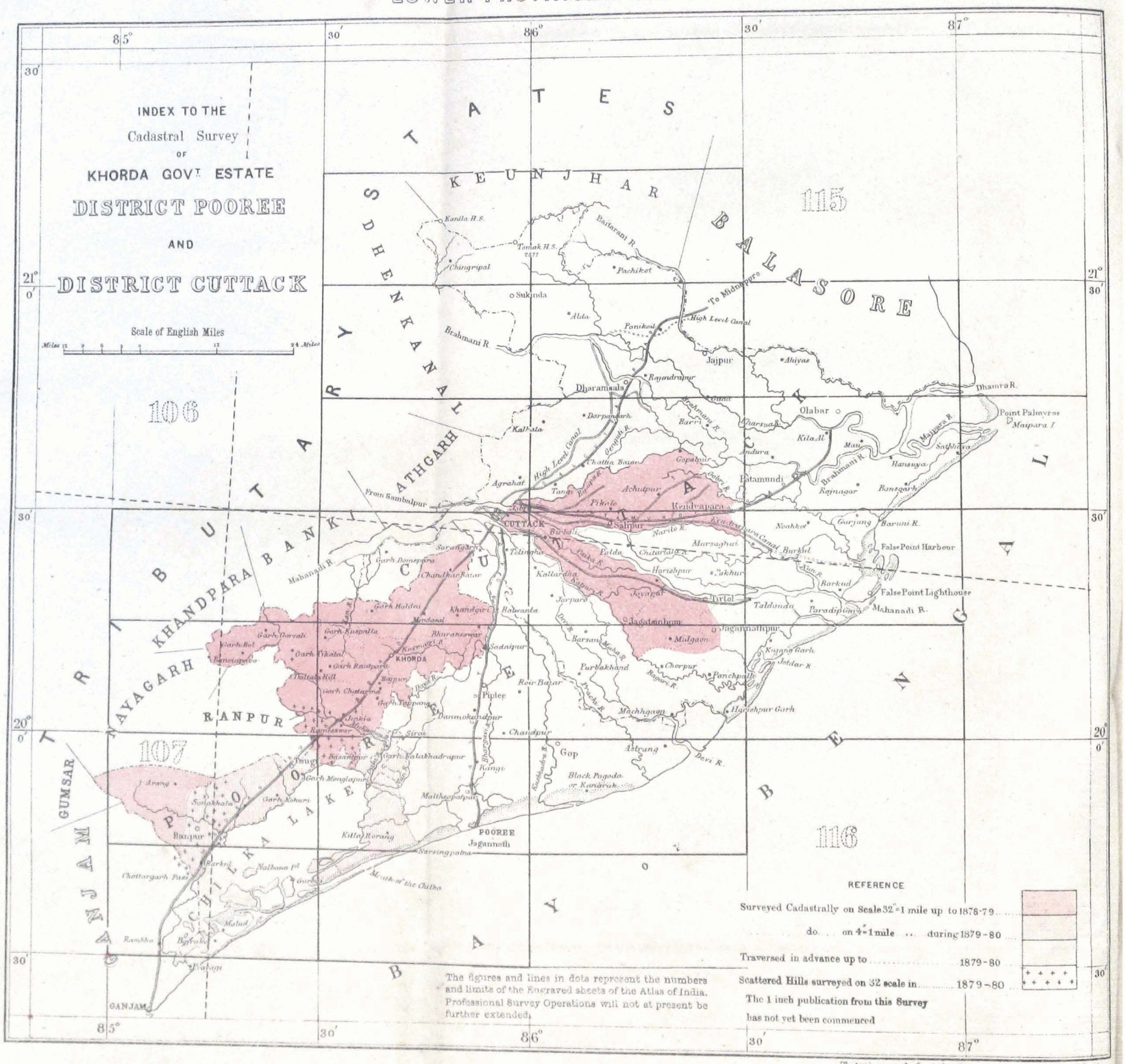
Surveyor General's Office, Calcutta, November

1880

LOWER PROVINCES SURVEY



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Surveyor Generals Office, Calcutta, November

1880

Photozincographed at the Surveyor Generals Office, Calcutta.

The topography in Dera Ismail Khan has been tested by 85 linear miles of check surveys. As a check on the angular work of the preliminary traversing, 22 azimuths were observed showing that an average correction was required of one minute in every 16 angles. Connections were made with 6 stations of the Great Trigonometrical Survey, and the direct distances by triangulation have been used to correct the errors of the chain measurements. The average error in the chaining was found, on comparison with 6 triangulation rays, to be $\pm$·785 foot per mile. All the mapping on the 4-inch scale has been brought up to date; and copies of the maps have been prepared in the usual manner for record with the District Officer.

89. In the Rawalpindi District, the country in the Kahuta Tehsil, where the operations chiefly were carried on, is described as being very difficult to survey on a large scale, though it is less mountainous than the Murree Tehsil where the surveyors were employed last year. The number of stations of which the heights had been determined during the previous season was insufficient; and observations for height were taken last season to 250 points. There is now an average of one height to every 2 square miles in the Kahuta Tehsil, but the heights in the Murree Tehsil are still deficient and a few more observations will be taken at the commencement of next season. The final maps of these Tehsils on the 4-inch scale will be prepared on graticule sheets in size $3\frac{3}{4}'$ latitude $\times$ $7\frac{1}{2}'$ longitude, but the maps will not be completed until the boundaries of the Forest Reserves have been adjusted; and in the meantime, the Forest Department has been supplied with photozincograph copies of the field sections. These field sections are of uniform size, $3\frac{3}{4}'$ latitude $\times$ $3\frac{3}{4}'$ longitude, and each includes an area of about 15 square miles.

90. The following areas remain for survey:—

About 2,800 square miles in the Thal portion of the Dera Ismail Khan District, of which one-half will probably be surveyed next season.

The *Thal* portion of the Muzaffargarh District, in area about 1,000 square miles, to be taken up after the completion of Dera Ismail Khan.

The Kala Chitta Range in the Rawalpindi District, which contains an estimated area of 600 square miles, and of which about 450 square miles will probably be surveyed.

91. The office of the party was inspected by the Deputy Surveyor General at Murree during September. The drawing of the maps was being carefully executed and the numerical records systematically prepared. The favourable results are largely due to the close supervision which Lieutenant-Colonel Macdonald exercises over his establishment.*

XVII.—KHORDA GOVERNMENT ESTATE, DISTRICT POOREE (No. 7 PARTY, REVENUE BRANCH).

92. Mr. R. B. Smart, Deputy Superintendent 2nd grade, who had hitherto been in charge of this party, having obtained leave of absence, was relieved on the 10th October 1879 by Mr. J. Campbell, Assistant Superintendent, who has since conducted the operations. The change in procedure, referred to in paragraphs 167 to 171 of last report, has been introduced; and of the area remaining for

Personnel.

Mr. R. B. Smart, Deputy Superintendent 2nd grade, proceeded on privilege leave for 3 months from forenoon of 11th October 1879, and on furlough for 2 years from 10th January 1880.
" J. Campbell, Assistant Superintendent 1st grade, in charge from 11th October 1879.
" A. D. Smart, Surveyor 3rd grade, placed on the half pay list from 1st January 1880.
" C. David, " " retired on pension from 1st January 1880.
" W. R. Vyall, " 4th grade.
" H. Dowman, " " transferred to No. 2 party Hanthawaddy District, British Burma, from 1st November 1879.
" T. H. Dunne, Assistant Surveyor 1st grade.
" G. W. Jarbo, " " " transferred from late No. 9 party, Cuttack Irrigation Survey, from 1st April 1880.
" J. R. Scott, Assistant Surveyor 2nd grade, transferred from late No. 9 party, Cuttack Irrigation Survey, from 1st April 1880.
" G. Campbell, Assistant Surveyor, 3rd grade, transferred to No. 8 party, Bassein District Survey, British Burma, from 1st November 1879, and 16 Sub-Surveyors, &c.

Temporary Establishment.

94 draftsmen and area calculators.

* Lieutenant-Colonel Macdonald has expressed himself satisfied with the manner in which the establishments, both European and Native, have worked during the field and recess seasons.

cadastral survey, the field measurements have been left to be carried out under the orders of the Settlement Officer of Khorda. For the rest of the work, which still remained for the professional party as noted in paragraph 165, field operations were resumed on 6th January 1880, with an establishment of the strength which is given in the margin on the preceding page.

93. It was known that the chief tract for survey—the *máls* or forest lands of Banpur—was at all times unhealthy, but especially so in the early part of the cold season, and the local officers recommended that nothing should be done there until the beginning of January. Mr. Campbell reports as follows on the extreme unhealthiness of the tract:—

"Our greatest foe was the climate; without a single exception, every one who entered the *mál* jungles was sooner or later struck down with fever. Entire parties fell together on the same day, and sick men deserted by dozens at a time; the work of forming new parties and pushing them on to work was incessant."

As to other difficulties met with during his survey, Mr. Campbell further reports:—

"The Banpur máls had never before been demarcated; the people, occupying the hamlets scattered in the valleys, had hitherto escaped all taxation: they cultivated the open patches of land without let or hindrance. It is not surprising, therefore, that they looked upon the survey as an innovation, and, as far as possible, evaded giving any help. It was with extreme difficulty that coolies were got for clearing the lines, and there was constant trouble and difficulty as regards supplies."

Mr. Campbell acknowledges, in the following hearty manner, the great assistance he received from the Officiating Collector of Pooree:—

"I desire to mention the deep obligation I am under to Mr. F. F. Handley, late Officiating Collector of Pooree, for the great help he gave the survey at a very critical time. His timely visit to Banpur, and the steps he there took to ensure help being given to the survey by the headmen of villages, at once removed all anxiety about the work. But for Mr. Handley's help, the Banpur máls could not have been all surveyed this year."

Owing to the sickness among the establishment, and to the difficult nature of the country, it was found desirable in March to strengthen the party by attaching to it Messrs. Jarbo and Scott, whose work had come to an end with the Cuttack Irrigation Survey, and by transferring three Sub-Surveyors from parties in the North-Western Provinces.

94. When field operations commenced, great uncertainty existed with the Settlement Establishment as to the extent of country appertaining to the Banpur máls of the Khorda Estate, and the first line of demarcation excluded a tract of hilly country believed to belong to Goomsur of Madras. This tract has been surveyed as an overlap beyond Khorda so as to form a connection with the Madras Survey and with the Topographical Survey of the Tributary States of Orissa, but it is now stated that the tract will be incorporated with the Banpur máls of Khorda. In the meantime, the boundary of the Estate in that direction is incomplete. The area surveyed in the Banpur máls is 125 square miles, the scale of survey being 4 inches = 1 mile.

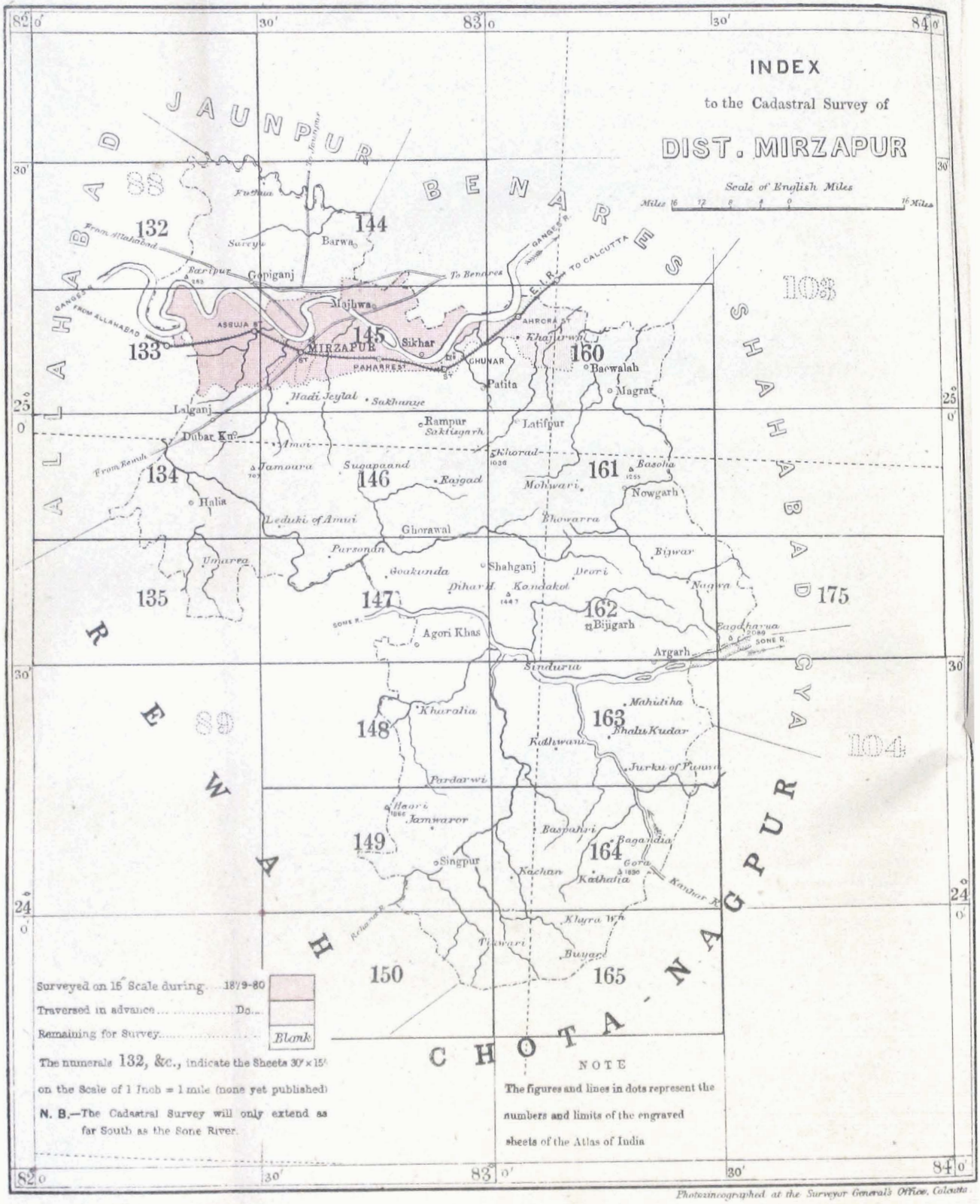
Simultaneously with the 4-inch survey of the Banpur máls, the boundary survey of the detached villages of Parganas Balbhadrapur and Tapang was carried on; and skeleton plots of the boundaries, on the 32-inch scale, have been supplied for the use of the Settlement Survey Establishment. The detached villages are 68 in number and cover an area of about 39 square miles, but a very much larger area had to be included in the traversing in order to connect the surveys of the detached villages.

The final work of the field season was the survey of the hills, in the area of which the field measurements were being carried on by the Settlement Establishment. These hills have been surveyed on the full scale of 32 inches on the original settlement sheets, instead of on the scale of 4 inches as had at first been intended. The hills are scattered over many villages and cover an area of 40 square miles.

The angular measurements were checked by 12 observations for azimuth. The topography in the Banpur máls was tested by 10 linear miles of check survey carried through the principal valleys; the Assistant Surveyors also frequently visited the topographers working in the hills and tested the surveys. The field work was completed on 30th June.

95. During the recess season, the completion of a large number of records, that have been accumulating for the past four years, has been attended to in

N. W. PROVINCES SURVEY



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addition to the regular mapping of the past season. On the 1st January 1880, 2,608 cadastral maps remained to be completed after the results of the settlement examinations had been communicated; it is expected that all these will be lodged in Calcutta by the 31st January 1881.

When the drawing is completed, the whole of the Khorda Estate will be mapped in 65 general maps on the 4-inch scale; of these, 48 containing the area surveyed by this Department are finished; the remaining 19 have been plotted in skeleton, but they will stand over until the cadastral survey now in the hands of the Settlement Establishment is completed.*

CADASTRAL or FIELD SURVEY.

XVIII.—BANDA AND MIRZAPUR DISTRICTS (NO. 5 PARTY, REVENUE BRANCH).

96. This party, of the strength noted in the margin, returned from recess quarters at Naini Tal and resumed work, partly in the Banda District, and partly in the Mirzapur District, on 1st November.

Personnel.

Colonel F. C. Anderson, Deputy Superintendent 1st grade, in charge.
Mr. E. J. Jackson, Assistant Superintendent 2nd grade, on furlough to Europe from 1st May 1880.
" C. W. Campbell, Surveyor 1st grade.
" E. G. Little, " 4th "
" R. B. Smart, Assistant Surveyor 1st grade.
" T. F. Freeman, Ditto 2nd " on furlough from 1st May 1880.
" W. M. Kelly, Ditto 3rd " transferred to No. 10 party from 1st November 1879.
" E. P. S. Hill, Ditto 3rd "
" P. C. H. Smart, Ditto 4th "
and 24 Sub-Surveyors, &c.

Temporary Establishment.

233 field surveyors and others.

In the Banda District, the work has chiefly consisted of the survey of the Forest Reserves on the scale of 4 inches = 1 mile. An area of 50·77 square miles was surveyed, and the total area of these Reserves, including the survey of the previous season, is now found to be 137·87 square miles. To complete the cadastral survey of the Banda District, there still remained 19·22 square miles for survey on the 16-inch scale; this area has been surveyed, and the District is now finished. In District Mirzapur, the following statement shows the extent of the completed survey :—

Names of Parganas.	No. of villages.	Area in square miles.
Kantit	775	401·73
Haveli Chunar . .	30	19·95
Total . .	805	421·68

In addition to the above, the preliminary boundary traverse survey of 117 square miles has been done in advance for next season.

97. Regarding the discontinuance of the field books of cadastral measurements, Colonel Anderson reports as follows :—

"No field sketch books have been compiled for final record. It was believed that the abolition of the field sketch book would save much time and expense both in the field and recess. In order therefore to reduce the rates, the compilation of these valuable records was done away with; but after the trial of a whole field season, I can confidently express my opinion that the saving has been effected only during the recess, and that there it is limited to the operations connected with paging and indexing. For, whether compulsory or not, the

* Mr Campbell reports of his assistants.
Mr. Vyall thoroughly understands his duties and is a deserving officer.
Mr. Dunne " rendered excellent service in the field."
Messrs Jarbo and Scott " who joined the party in April have been of great help to me."
Amongst the Native Establishment, Venket Swamy is said to stand conspicuous as an excellent Sub-Surveyor.
Joona Lall, Sumeyr Sing, Bepin Behari Bose and Ishanchunder are said to be deserving men.

experienced field surveyor, having once become familiar with the field book system, will always make his own field book in the cool of the day for personal convenience, so as to utilise the hotter hours by plotting from it on to his plane table sheets; as, therefore, the money saved by the discontinuance of the field book is insignificant, and we lose thereby a permanent record of our measurements, I hope we may be allowed to revert to the old system, in which, however, a change could easily be introduced, which would save the expense of an elaborate index."

98. Stone pillars have been placed by the Settlement authorities at the trijunctions of village boundaries, and smaller slabs at the intermediate bends in place of the usual earthen mounds. Other special marks have been fixed by the Survey Department at all the theodolite stations on the boundary, but the expense of these is recovered from the landowners, as the marks serve also as part of the boundary demarcation. Many fields were met with in villages close to the Ganges which had no ridges to define their limits, the extent of which could only be ascertained with the aid of the *putwaris*, who took measurements from certain recognised marks in other fields. After the limits of these fields had been determined, the Collector of the District, at Colonel Anderson's suggestion, tried to get the owners of the fields to demarcate the boundaries with stone slabs. The attempt to get the landowners to move in the matter was not successful; but in the villages, under the management of the Court of Wards, the field demarcation has been carried out at a very small cost.

99. For the maps of the Banda District, the boundary along the southern border touching on Foreign States was in the first instance carefully compared with the maps prepared by Mr. Spedding, who had been deputed to adjust the boundary in 1870-71. In a few instances, the boundary line was found to be wrongly interpreted by the demarcating Officer associated with the survey, owing to the very small scale (2 miles = 1 inch) of Mr. Spedding's maps; these errors were brought to the notice of Mr. McConaghey, the Collector of the District, who personally visited the boundary and rectified the errors.

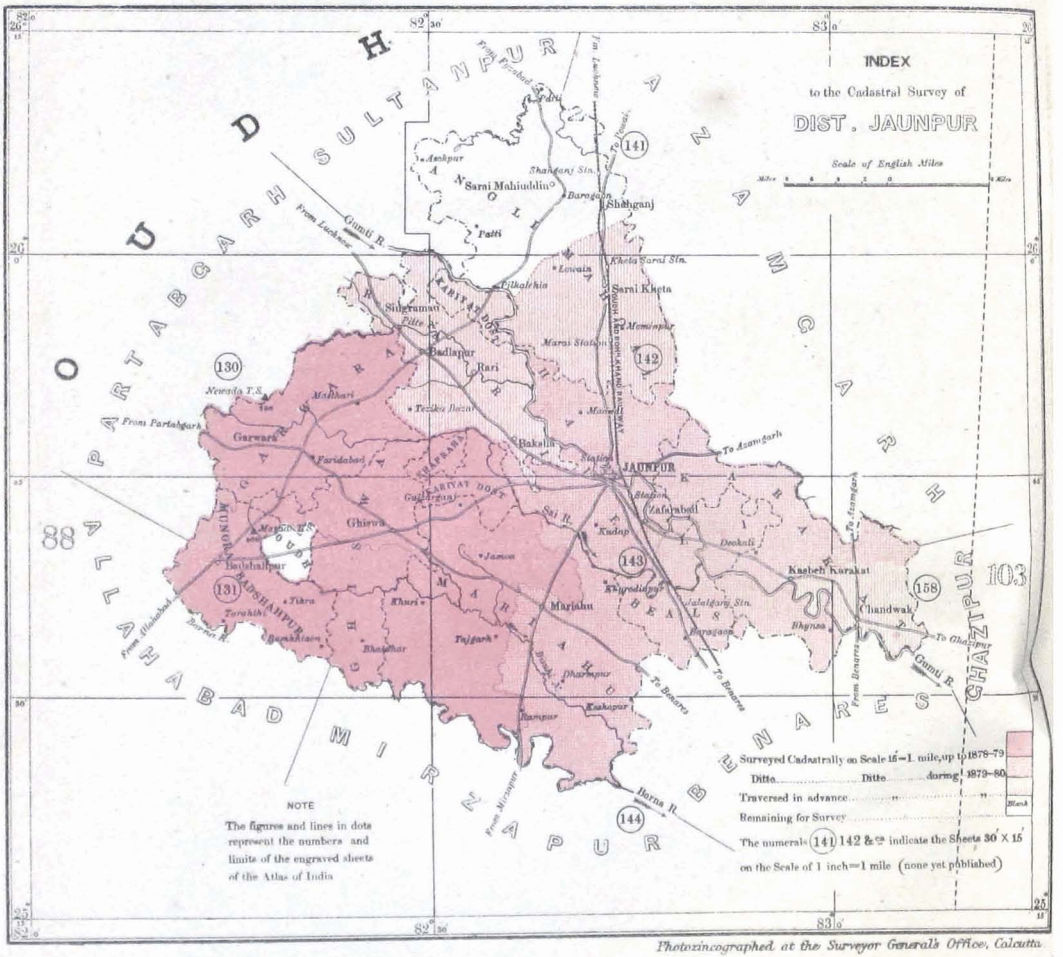
100. The field survey has been tested by 167 linear miles of checks measured by Surveyors and Assistants, and by 814 miles measured by Native Inspectors. As checks on the angular work of the boundary traversing, 20 observations for azimuth were taken, requiring average corrections to be applied to the traverses of about 2½ minutes on every 100 angles. Connections have been made with 17 stations of the Great Trigonometrical Survey, and the coordinates of the measured traverses have been made to agree with the values obtained from the direct distances of the triangulation. The average error of the chaining on the comparisons of 12 direct distances is 1·9 foot per mile. Colonel Anderson has adopted a novel method for instructing his Sub-Surveyors in hill sketching; his description of it is given in the Appendix.

101. In the Banda District, the small area surveyed cadastrally has added ten 16-inch sections, bringing the total number of sections for the District up to 3,364. Of these, the drawing of 1,097 has been completed during the season, and in all 2,788 sections have now been lodged in Calcutta. The remaining 576 sections are retained, partly for completion of the drawing, but chiefly for reduction to the 4-inch scale. Of the 95 general maps of Banda, noted in paragraph 132 of last report as remaining to be completed, 29 have been lodged. The season's outturn in the Mirzapur District has been mapped on 747 original sections, but this number will be increased by the separation into maps of single villages of the sheets on which the villages had been congregated, this is explained in paragraph 115 regarding the increase to the number of the Ghazipur sheets. Of these sections, 601 have been lodged in Calcutta; the remaining 146 are still somewhat incomplete. The general maps of District Mirzapur, which are to be prepared on the scale of 2 inches = 1 mile, have not yet been commenced.

102. The office of this party was inspected by the Deputy Surveyor General at Naini Tal during October. The check surveys on being compared with the maps showed the cadastral survey to have been done very accurately; and great pains were being taken to ensure accuracy in the computations of area. Colonel Anderson, as usual, has taken upon himself a very large share of the examination of the maps.*

* Colonel Anderson reports favourably on Messrs. Campbell, Little, R. B. Smart, Freeman, and Hill.

N.W. PROVINCES SURVEY



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XIX.—JAUNPUR DISTRICT (No. 6 PARTY, REVENUE BRANCH).

103. This party, in strength as noted on the margin, returned from recess quarters at Hazaribagh to resume work in the Jaunpur District on the 22nd October. Field work was closed on the 15th April, when the office establishment returned to Hazaribagh.

Personnel.

Mr. E. T. S. Johnson, Deputy Superintendent 3rd grade, in charge.
" P. A. G. Cowley, Surveyor 2nd grade.
" J. S. Pemberton, " 3rd grade, transferred from No. 2 party, Hanthawaddy District Survey, British Burma, from 15th October 1879.
" J. H. O'Donel, Surveyor 4th grade, transferred to No. 8 Party, Bassein District Survey, British Burma, from 1st July 1880.
" J. S. Swincy, Assistant Surveyor, 2nd grade.
" E. J. Martin, " " " "
" A. W. Smart, " " 3rd grade, transferred to Naga Hills Topographical Survey from 1st December 1879.
" E. H. S. Gasper, Assistant Surveyor 3rd grade.
" C. S. Kraul, " " 4th grade, transferred from Kamrup Lakhiraj Survey from 1st November 1879.
and 28 Sub-Surveyors, &c.

Temporary Establishment.

237 field surveyors and others.

104. The outturn of cadastral survey during the season is given in the following table:—

Names of Parganas.	Number of villages.	Number of fields.	Area in acres.	Area in square miles.	Average size of fields.
Parganas Haveli, Zafarabad, Chandwak and portions of Parganas Mariahu, Saremu, Bialsi, Duriyapar, Pisara, and Guzara	1,371	9,25,928	3,36,220·85	525·35	0·36

In addition to the above, 315·56 square miles of village boundary traversing have been done in preparation for next season's cadastral operations.

The city of Jaunpur has fallen within the area which has been cadastrally surveyed, and has been surveyed on the scale of 16 inches = 1 mile; the boundaries of the 46 *mohullas*, or sub-divisions of the city, as well as the fields and blocks of buildings within the *mohullas*, have been surveyed in accordance with old Settlement maps.

105. Regarding the doing away with the field book of cadastral measurements, Mr. Johnson reports:—

"The *Amins* surveyed much faster on this system, and the *purtalling* proved the work to be equally good as before; but it has not been so satisfactory as when we had the field books, which used to be of great assistance to draftsmen when inking in the maps; for in many instances, where the ground is intricate, considerable difficulty is experienced in making out the items, and portions of the 16-inch sheets of this intricate nature have had to be sent out several times for re-survey." * * * * * *

106. Considerable difficulty had been experienced during the previous season in ascertaining the boundaries of fields in rice lands, as a "field" in such lands often consists of several plots or terraces prepared for the purpose of rice cultivation; it was, therefore, arranged that the "field," boundaries should be marked with low mounds of earth by their proprietors to guide the *Amins* as to how the terraces should be grouped into fields. The demarcation of village boundaries by the Settlement Staff is reported to have been very backward; and in Parganas Ungli and Mahaul, the Surveyors are said to have been several times obliged to stop work, owing to there being no marks along the village boundaries. The stone pillars at the trijunctions were not fixed prior to survey, and considerable inconvenience and delay were caused thereby.

107. Owing to the abolition of the field-book system of survey, it was thought necessary by the Executive Officer to increase the usual amount of *purtal* or check survey. The total length of these check surveys run by Assistant Surveyors is 215 miles, and by Native Inspectors 1,814 miles; it is reported that the quality of the work was found to be very good. As checks on the angular measurements of traverses, 28 observations for azimuth were taken, showing an average correction to be required of one minute per 100 angles.

108. The season's outturn has been mapped on 1,069 sixteen-inch sections; many of these consist of several villages congregated on one sheet, but the number of sections will be increased when the villages are separated during publication. The sections have been sent down to Calcutta for publication at various times during the season; now (31st December 1880) all, except 16 kept back on account of disputed boundaries, have been lodged, and 825 sections have been published.

The general maps, on the scale of 2 inches = 1 mile, have been brought up as far as the maps of the cadastral survey have been available for reduction. None of the sheets are as yet entirely filled up to margin.

109. To complete the cadastral survey of the Jaunpur District, there remains an area of 472 square miles, which will be finished next season.

After completing Jaunpur, this party might have been suitably employed on the survey of the Benares District; and it is to be regretted that the Government of the North-Western Provinces should have ordered the survey of the Benares District to be deferred for the present. The party has been brought to a high state of efficiency under the superintendence of Mr. Johnson; and should the cadastral survey of any District in any other Province be in contemplation, it is very desirable that the services of this party should now be utilised, as it has been found from experience that a new cadastral party when required is not readily organised; it is hoped, therefore, the party may be saved from dispersion.

110. The recess office of the party was inspected by the Deputy Surveyor General at Hazaribagh during September. An examination of the checks showed the surveys to have been carefully executed, and the state of the maps and other records reflects great credit on Mr. Johnson's watchful supervision.*

XX.—GHAZIPUR DISTRICT (NO. 4 PARTY, REVENUE BRANCH).

111. This party, of which the strength is given in the margin, returned from recess quarters at Naini Tal to resume field work in the Ghazipur District on the 26th October 1879. Field operations were continued until the 30th April 1880, and the recess office was again opened at Naini Tal on the 9th May.

Personnel.

Major W. Barron, Deputy Superintendent 3rd grade, returned from privilege leave and resumed charge on the afternoon of 3rd November 1879.
Mr. E. C. Barrett, Assistant Superintendent 2nd grade, in charge up to the 3rd November 1879, transferred to No. 8 Party, Bassein District Survey, which he joined on the 11th November 1879.
" W. A. Wilson, Surveyor 3rd grade.
" H. T. Hanby, " 4th "
" S. O. Madrus, Assistant Surveyor 2nd grade.
" W. D. Corbett, Ditto 2nd "
" J. Murphy, " 3rd " transferred to No. 2 Party, Hanthawaddy District Survey from 1st December 1879.
" L. F. Berkeley, Assistant Surveyor 4th grade.
" W. H. D. Ewing, " 4th " went on leave (m. c.) for 2 months from 2nd July, and was transferred to No. 8 Party, Bassein District Survey.
" C. B. Taylor, Office Assistant,
and 31 Sub-Surveyors, &c.

Temporary Establishment.

173 field surveyors and others.

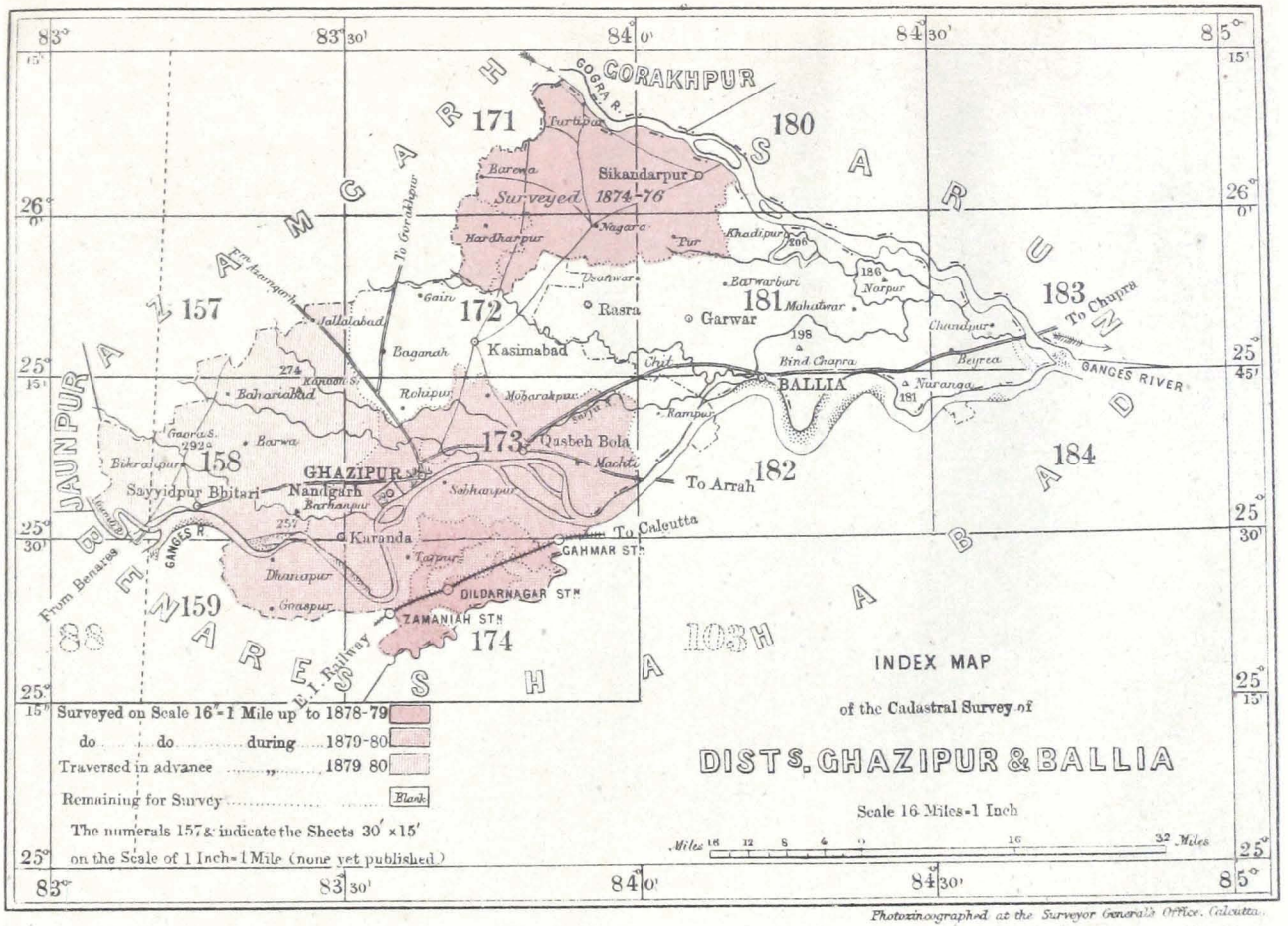
112. The outturn of completed survey has been as follows:—

Parganas.	No. of Villages.	Area in square miles.
Zamaniah	181	171·91
Mahaich	133	87·52
Karanda	88	43·11
Ghazipur	299	98·58
Muhammadabad . . .	721	177·78
Sayyidpur Bhilari . . .	102	37·85
Total . .	1,524	616·75

An overlap of 69·69 square miles on the scale of 2 inches = 1 mile has also been surveyed in Districts Benares and Shahabad; and the boundary traverse survey of 1,131 villages, area 399·23 square miles, has been prepared in advance

* Mr. Johnson reports very highly of his senior assistants, Messrs. Cowley, Pemberton, O'Donel and Swiney.
He also expresses great satisfaction at the manner in which Messrs. Martin, Smart and Kraal have performed their duties.
Mr. C. Rivett, Sub-Surveyor, is well reported on, and also the following individuals of the Native establishment, viz.:—
Baboo Guru Pershad Chuckerbutty, Shimbhu Nath, Kanhia Lall, and Kedar Nath, Computers; and Ghulam Hyder Khan, Draftsman.
The Native Doctor Russick Lall Mookerjee is said to have been attentive to his duties.

N. W. PROVINCES SURVEY.



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NOTE

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for the field measurements of next season. The City and Cantonments of Ghazipur have been surveyed, on the scale 16 inches = 1 mile, as part of the cadastral operations.

113. Regarding the system of cadastral survey and the change in the manner of recording the field areas, referred to in paragraph 155 of last report, Major Barron reports as follows :—

"No field books of field measurements were prepared. The measurements were plotted on the original plans at once in the field. This gave opportunity of testing the accuracy of the work on the spot, and is a far quicker method than the system of recording in a field book and plotting afterwards. There were no *khasras* prepared for the Settlement Officer, as formerly used to be done; instead of these, he is supplied with copies of the field area calculation books having a column added for remarks, which require no additional labour in their preparation. It is calculated that from these two simplifications, *viz.*, doing away with the field books of measurements, and the *khasras*, about 100 square miles additional area have been surveyed, and the work has cost less by Rupees 30 per square mile than it otherwise would have done."

114. The field survey has been tested by 497 linear miles of check surveys measured by the Deputy Superintendent and his European Assistants, and by 1,081 miles of checks measured by Native Inspectors. Connections have been made with four stations of the Great Trigonometrical Survey, and the values of the direct triangulation rays have been made use of for correcting the chain measurements of the traverses; the average of the corrections required, in two cases where *plus*, is ·5 foot per mile, and in six cases where *minus*, 1·43 foot per mile. To check the angular work, 88 observations for azimuth were taken.

115. The season's outturn of 1,524 villages was originally mapped on 861 sheets, scale 16 inches = 1 mile, having in many instances several villages congregated on one sheet. This system, which was introduced with the double object of reducing the labour of preparing the sheets in executive offices and of lessening the cost of publication, has not been approved by the Government of the North-Western Provinces, who require that each village should be shown singly; the villages are now, therefore, being separated, so that the number of sheets will be increased considerably. The sheets, as they have been completed, have been sent down to Calcutta for reproduction by photozincography; and, up to 1st October, 510 sheets had been forwarded comprising an area of 352 square miles. Besides providing for the speedy publication of the sheets, Major Barron also supplied the Settlement Officer with 111 tracings of the maps of villages in the low-lying lands of the Ganges River, so as to enable the Record of Rights in these villages to be prepared during the year of survey.

The general maps, on the scale of 2 inches = 1 mile, are being prepared by reduction from the 16-inch plans, as the cadastral survey progresses; but none of the maps have yet been completed.

116. The demarcation of trijunctions, which is carried out under orders of the Settlement Officer, is very backward in some parganas, and a good deal of the boundary traverse survey had to be carried on before the trijunction stones had been imbedded, which is always an objectionable procedure. There are several disputes still unsettled, and several discrepant boundaries caused by defective demarcation; from both causes, the maps of 88 villages remain incomplete.

Baked clay cylinders have been imbedded at all theodolite stations on the village boundaries.

117. Referring to paragraph 151 of last report, in which it is stated that, by reason of the ruling of the Government of the North-Western Provinces requiring the boundary of districts Budaun and Bareilly,—where falling on the Ramganga,—to be the main stream of the river, a difficulty had arisen as to how the gaps and overlaps between the surveys of Budaun and Bareilly should be accounted for on the maps of the recent survey of Budaun, the difficulty has been disposed of in the following manner: It had previously been overlooked that a special survey of the village boundaries in alluvial lands of the Ramganga River, "to facilitate the annual settlement of the alluvial lands," had been carried out in 1852-53 by Lieutenant T. J. Burgess, at which time a set of 4-inch maps had been prepared showing continuously the villages of both the adjoining Districts on one projection. It was found, on the maps being referred to, that the special survey had been extended beyond the action of the river, and that the points, which had been fixed as the trijunctions of the village boundaries on the high lands, had been identified and adopted as the village

trijunctions during the recent survey of the Budaun District; it was thus practicable to make a combination of the two surveys, and Major Barron has introduced the boundaries of Lieutenant Burgess' survey on the village maps of Budaun, thus showing the limits to which the village lands may be extended, should it be desired to uphold the settlement of 1852, while he has retained the course of the main stream of the Ramgunga as it flowed during season 1878-79, the year of survey, as the present record of the District boundary.

118. An opportune illustration of the advantage of possessing a record of the boundaries of villages bordering on a shifting river,—in the manner of the survey under Lieutenant Burgess,—occurred during last season with respect to a disputed boundary in the valley of this very Ramgunga River, and on the same portion where the boundaries of the old survey have been introduced on the Budaun maps. The boundary in question, which entirely falls on land liable to submersion, had long been under dispute; and an attempted restoration of an old line by the Civil Authorities in 1873 having failed to give satisfaction, the Collector of Bareilly reported through the Board of Revenue that a proper adjustment could only be made with the aid of the Survey Department. The Government of the North-Western Provinces consequently requested that a Surveyor might be deputed to do the work, and the boundary has been restored in accordance with Lieutenant Burgess' map by a Sub-Surveyor deputed from Major Barron's party.

119. The recess office of this party was inspected by the Deputy Surveyor General at Naini Tal during October. The same state of high efficiency is being maintained as has frequently been reported of the Establishments under Major Barron's supervision.*

XXI.—HANTHAWADDY DISTRICT, BRITISH BURMA (No. 2 PARTY, REVENUE BRANCH).

120. This party, which had been of half strength during the previous year, was raised to full strength at the beginning of the field season, and, with the establishment as noted on the margin, resumed operations in the Syriam Township of the Hanthawaddy District early in December 1879.

Personnel.

Captain J. E. Sandeman, Deputy Superintendent 3rd grade, in charge.
Mr. F. Grant, Surveyor 2nd grade, transferred from late 2nd division, Jhelum and Sirsa Survey, from the 1st November 1879.
" H. Dowman, Surveyor 4th grade, transferred from No. 7 party, Khorda Estate Survey, from the 1st November 1879.
" C. A. R. Scanlan, Surveyor 4th grade, transferred from Surveyor General's Office from the 1st November 1879. On sick leave from 9th June 1880. Resigned from 1st October 1880.
" D. A. King, Assistant Surveyor 1st grade.
" J. McHatton, Assistant Surveyor 2nd grade, transferred from Head-Quarters Office, Calcutta, from the 1st January 1880.
" G. E Parker, Assistant Surveyor 3rd grade.
" J. Murphy, " " " transferred from No. 4 party Ghazipur Survey, from the 1st December 1879, temporarily attached to Leveling party from the 1st February to the 31st May 1880.
" B. M. Wilson, Assistant Surveyor 3rd grade, transferred from No. 9 party, Cuttack Irrigation Survey, from the 1st December 1879, and 21 Sub-Surveyors, &c.

Temporary Establishment.

166 field surveyors and others.

Leveling.

Mr. J. Murphy, Assistant Surveyor 3rd grade, Leveler from the 1st February to the 31st May 1880.

Hindustanis and Burmans have been employed in about equal numbers as Field Surveyors. The Burmans, who had been trained by Captain Sandeman during the recess of 1879, fully justified the trouble that had been taken with them; and after instruction during another month in the field, the majority turned out fair Surveyors, realising even more than might have been expected from men in their first year of service. Burmans have been very largely employed in office as computers of area, and as draftsmen. All the measurers and flagmen were taken down from India, the experience of the previous season having proved that these men could not be hired in sufficient numbers in Burma. No village labour of any kind was obtained. A good deal of rain in April obstructed the operations, but the party did not return to recess quarters until the middle of May, when the monsoon rains had fairly set in.

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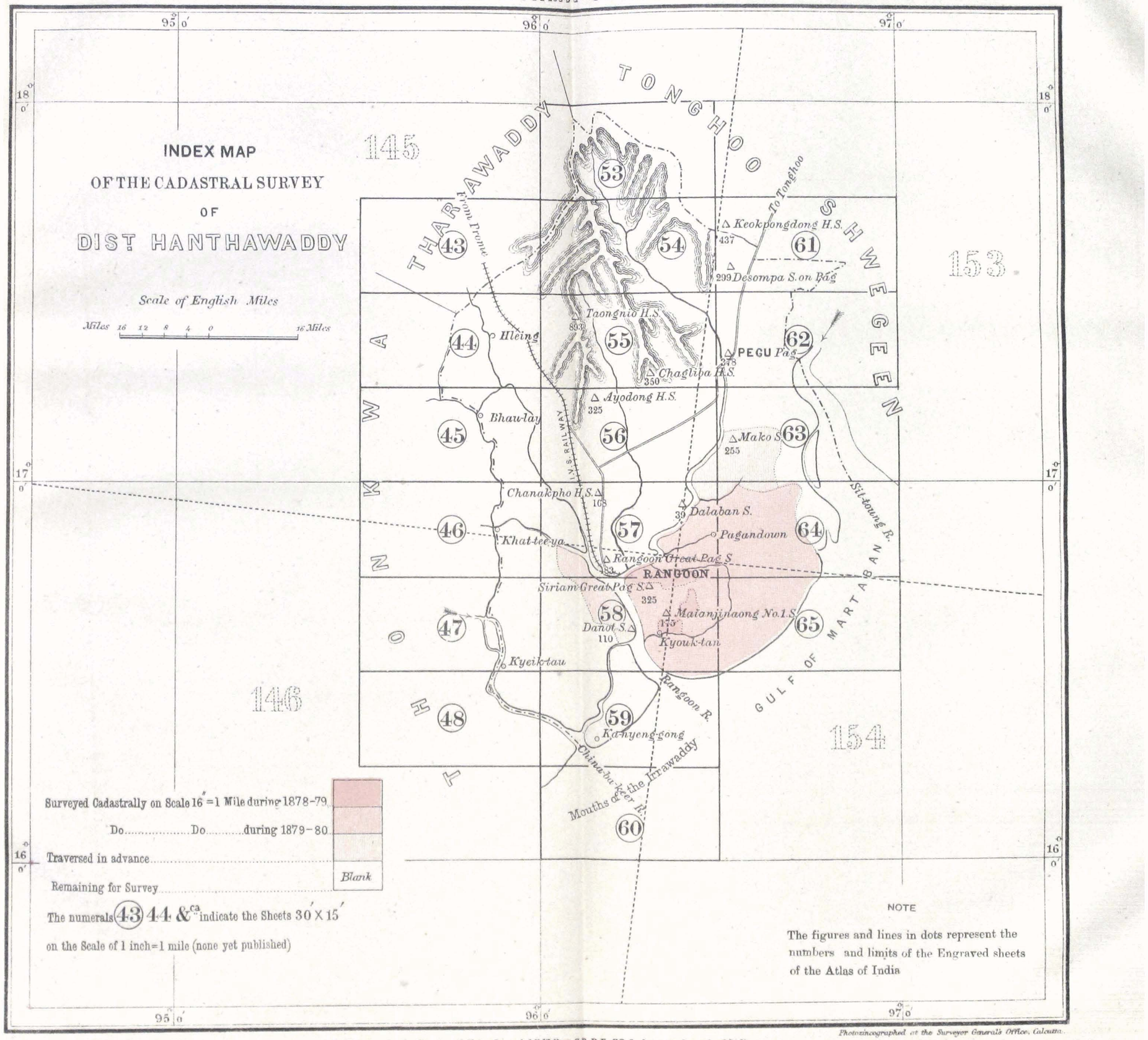
* Major Barron commends Messrs. Wilson, Hanby and Madras for the way in which they supervised the work of their respective sections of the establishment, and Messrs. Corbett and Berkeley for the ability and energy with which they performed the duties entrusted to them.
Mr. C. B. Taylor, Sub-Surveyor, is also commended, and the Native Staff are said to have all worked well.

BRITISH BURMA SURVEY



Surveyed Cadastrally on Scale 16″ = 1 Mile during 1878-79

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Traversed in advance .....

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The numerals (43) 44 &ca indicate the Sheets 30′ X 15′ on the Scale of 1 inch = 1 mile (none yet published)

NOTE

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Surveyor Generals Office, Calcutta, November 1880

Photozincographed at the Surveyor Generals Office, Calcutta.

121. The unit of survey has been the field; and the scale of survey has been that of 16-inches = 1 mile. The "holding" survey of the first season (paragraph 214 of last report) has been revised, and the area has been again included in the "field" survey of the present season. The total area of field survey is 762·6 square miles, which embraces the whole of the Syriam Township, excepting 31 square miles surveyed last year, and about 65 square miles of jungle land at the north-east extremity of the township, which is liable to be flooded by the sea and where there are no villages. Preparatory boundary traversing has also been done in 130 square miles in the Pegu Township and 115 square miles in the Angyee Township At the request of the Chief Commissioner, the preparatory traversing has also been done for 60 square miles in the Tharawaddy District in anticipation of the sanction of the Government of India to the cadastral survey of that district, which had been recommended. The Tharawaddy District survey has since been ordered; and the traversing which has been done will enable the field measurements to be commenced without delay by the new party which has been raised for the Tharawaddy District. A small section of this party has been employed on leveling, and their work is reported on with the other leveling operations of the Department.

122. In the completed area of 763 square miles,—after rejecting the large patches of jungle and waste, but including minor details of waste, &c., mixed with the cultivation,—there are found to be 576 square miles of cultivated country with fields numbering 4,16,402, which gives an average size for the fields of ·9 acre.

The completed area includes 20 Waste Land Grants, having a total area of 13,457 acres.

The field survey measurements were plotted direct on the 16-inch sheets, no field books having been kept.

Check surveys have been measured aggregating 465 linear miles. These have proved the general work to be good, but they also brought to light some errors, and several resurveys were necessary. Azimuths were observed at 31 stations as checks on the angular measurements of the traverses. The linear measurements have been tested by comparison with 10 rays of the Great Trigonometrical Survey, showing in them an average error of—9·25 feet per mile.

No permanent demarcation of boundaries has been done previous to survey; but during the course of the boundary traversing, baked clay cylinders have been imbedded at selected theodolite stations, and these cylinders are intended to take the place of all other permanent marks.

123. At the commencement of the field season, a Settlement Establishment took up the examination of the 31 square miles of field survey, which had been completed during the previous season, using tracings of the maps which had been got ready during the recess; and it was desired by the Chief Commissioner that continuous work should be supplied to this Establishment in order that the Settlement of six Circles might be carried out during the season, *pari passu* with the Survey. Tracings of the maps of these Circles, with field area statements, were therefore furnished as soon after survey as the drawing of the maps and computation of areas could be done; and, subsequent to the settlement examination, the maps have been corrected by remeasurement, where errors or omissions were discovered; so that in these six Circles, which include an area of 432 square miles, the successive operations of Survey, Settlement investigation, and the final rendering of the maps ready for publication have all been done in one season. The Settlement investigation includes the grouping of the fields into cultivators' holdings; but the boundaries of the holdings are not distinguished on the maps, as the holding boundaries are liable to change; and it is intended that a Settlement investigation regarding these boundaries should be made annually. The annual changes will be noted on fresh copies of the maps, of which 30 copies of each are being printed. There is no cognizance of the holdings in any of the survey records, but the average area of the holdings in the Circles which are settled is given by the Settlement as being 43 acres in rice lands, and about 3 acres in garden lands. The average area of the kwins has been ascertained by the survey computations to be 1,722 acres.

124. In the six Circles, of which the Settlement examination has been completed, there are 193 kwins, which are mapped on 649 sheets. These sheets have been received in Calcutta and are now being published by photo-zincography. In the five Circles not examined there are 101 kwins, which are mapped on 456 sheets. Manuscript tracings of these sheets have been supplied, on which the Settlement examination will be carried out; and the sheets will not be forwarded for publication, until all errors or omissions that may be discovered have been rectified.

In addition to the 16-inch cadastral sheets, the preparation of the general maps on the 2-inch scale has been proceeded with, as far as the cadastral area has extended. This area falls on eleven of the standard sized sheets, but of these only three could be completed up to margin.

125. One of the Assistant Surveyors of this party has been employed, in conjunction with an Assistant Surveyor from the Trigonometrical Branch, in measuring a traverse from a Trigonometrical Survey station for about 60 miles along the sea-coast for the purpose of determining the latitudes and longitudes of two marine beacons recently placed opposite the Krishna Shoal. The measured traverse was substituted for a series of triangles to determine the positions of these beacons, as from the nature of the country triangulation would have been very tedious and expensive. Accuracy in the traverse has been provided for by the independent measurements of the two Assistants.

126. Captain Sandeman's camp in the Hanthawaddy District was visited by the Deputy Surveyor General during March. The completion of the maps and area statements to meet the requirements of the Settlement Officer was then being prosecuted most vigorously, and great credit is due to Captain Sandeman for his arrangements, which allowed of the results of his survey being so speedily utilised for Settlement purposes. The pains which Captain Sandeman had bestowed on the training of Burman field Surveyors, was abundantly evident in the large share of the season's outturn which had been done by these men.*

XXII.—BASSEIN DISTRICT, BRITISH BURMA (No. 8 PARTY, REVENUE BRANCH).

127. The orders of the Government of India having been received for the despatch of a party for the cadastral survey of the Bassein District, British Burma, (conveyed in letter No. 366, dated 12th August 1879), Major Andrew who had been temporarily employed in the Head Quarters Office was nominated to the charge; and the party was formed partly of Surveyors and others of the late Cuttack Irrigation Survey, and partly of those withdrawn from Cachar. Before the final constitution of the party was determined on, Major Andrew was directed in September 1879 to proceed to Bassein, that he might judge whether the nature of the country required any special organization in his Establishment, and also that he might make all needful preliminary arrangements. On Major Andrew's return to Calcutta in October, the members of the different classes were collected, and the party numbering (with measurers and line cutters, all of whom had to be taken from India) about 840 men embarked for Bassein early in November. Field operations were commenced soon after the 16th November, the date on which the party reached Bassein.

Personnel.

Major D. C. Andrew, Deputy Superintendent 3rd grade, assumed charge on the 11th November 1879.
Mr. E. C. Barrett, Assistant Superintendent 2nd grade, joined on the 11th November 1879, proceeded on furlough on the 22nd July 1880.
„ H. R. Littlewood, Surveyor 3rd grade, joined on the 8th November 1879.
„ J. H. O'Donel, Surveyor 4th grade, joined on the 26th July.
„ P. Ford, Surveyor 4th grade, joined on the 5th November 1879; died in Calcutta, 21st November 1880.
„ G. Campbell, Assistant Surveyor 3rd grade, joined on the 11th November 1879.
„ C. W. J. Ford, Assistant Surveyor 3rd grade, joined on the 11th November 1879.
„ W. H. D. Ewing, Assistant Surveyor 4th grade, joined on the 9th August 1880.
and 29 Sub-Surveyors, &c.

Temporary Establishment.

144 field surveyors and others.

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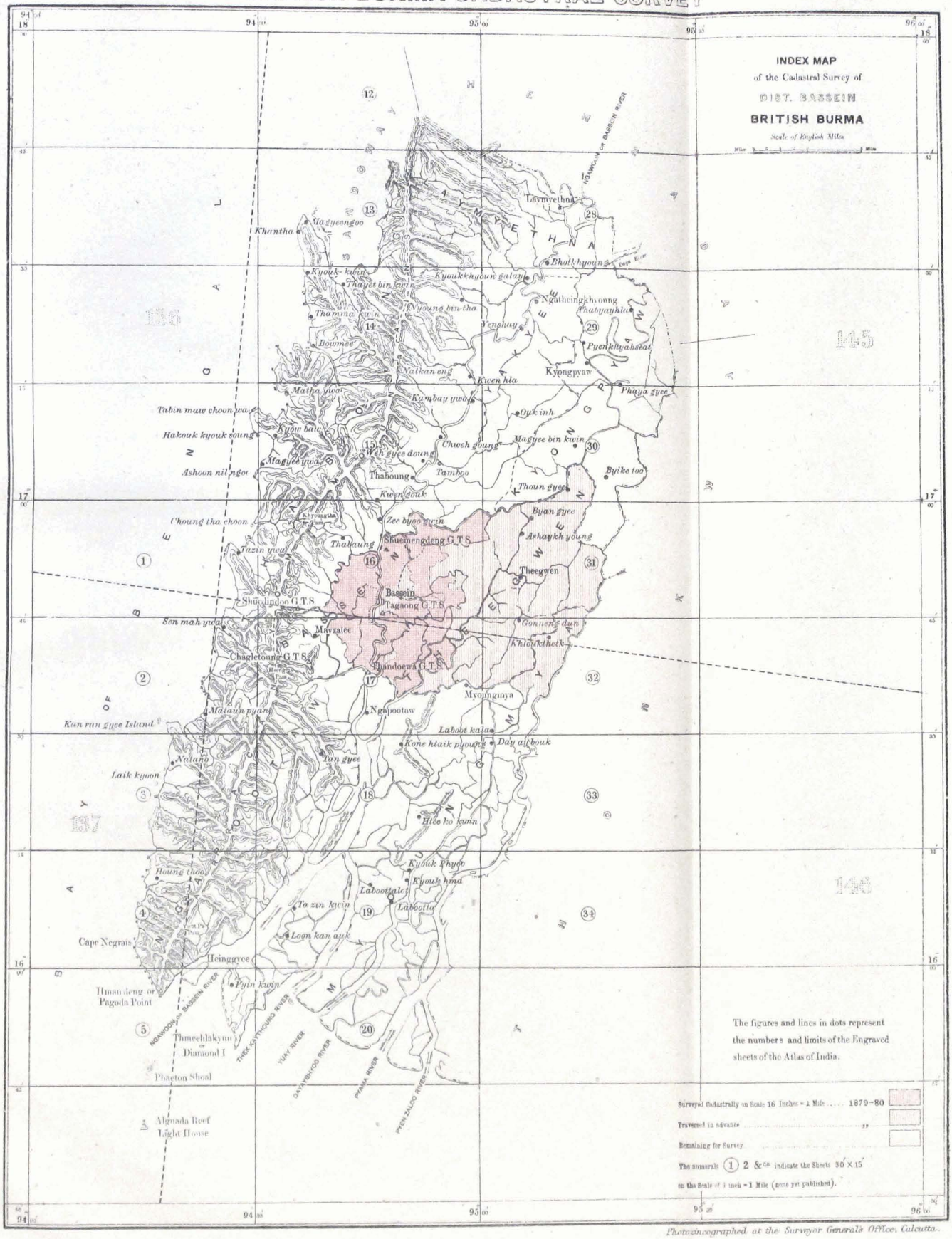
* Captain Sandeman reports of his Assistants as follows:—

"To the senior Officers, Messrs. Grant, Dowman, and King, I am indebted for the zeal with which they have worked. Messrs. M'Hatton, Parker, Murphy and Wilson have ably aided the senior Officers. Mr. M'Hatton especially has shown great industry"—also:—"as a rule the Sub-Surveyors have worked well; I may particularly mention Ungamothoo and Ifillaluddin."

BRITISH BURMA CADASTRAL SURVEY



Photozincographed at the Surveyor Generals Office, Calcutta.

Published under the direction of Major-General J.T.Walker. C.B.R.E.-F.R.S., *Surveyor General of India.*

Surveyor Generals Office, Calcutta, November

1880

128. The survey was commenced in the Bassein Township, where the boundaries of kwins had been demarcated, and an area of 346 square miles, comprised in 10 Circles, has been completed. Field measurements have also been taken over an additional area of 55 square miles; but in this area the survey has still to be tested. The preliminary traversing for the work of next season has been carried out over a further area of 449 square miles.

The country brought under survey is much intersected by tidal creeks, and the jungle land which fringes the creeks is, as a rule, liable to be submerged, while cultivation has been extended over nearly all the land beyond tidal influence. In the completed area, about 200 square miles are cultivated and the remaining 146 square miles consist either of waste land or of water. The average size of the fields is ·75 acre.

The field measurements have been recorded on field books, as in the absence of preliminary traversing there were no boundary maps ready on which the fields could be directly plotted. The survey has been tested by 400 linear miles of check surveys, of which 16 miles were measured by Assistant Surveyors and 384 by Native Inspectors. There are about 2 miles of these checks in each of the 188 kwins that have been surveyed. Check azimuths have been observed at stations on the main traverses averaging about 6 miles apart. One station of the Great Trigonometrical Survey has been incorporated with the traverses.

129. The demarcation done by the Civil Officers in advance of the Survey, consisted of light posts intended only to be temporary, and a commencement was made during the season to carry out a permanent demarcation, by replacing the posts at the trijunctions of kwins by others of a larger size; but this description of mark was afterwards abandoned in favour of a burnt-clay cylinder, which will be imbedded at all tri-junction theodolite stations, and at other selected stations on the kwin boundaries not more than half a mile apart.

130. The Chief Commissioner was very desirous that a commencement of the Settlement should be made during the first season of survey; and to enable this to be done, it was necessary that tracings of the kwin maps and statements of the areas of fields should be furnished to the Settlement Officer as early as possible. These tracings and statements were supplied for three Circles, in area = 76·6 square miles; the Settlement investigations were then carried out, and finally the maps were corrected by remeasurements where errors or omissions were discovered during the investigation.

131. Major Andrew reports the following to have caused delay in the progress of his operations:—

1st.—Difficulty of communication.—The country being so largely intersected with creeks, all communication is necessarily carried on by water; but boats were available for hire only in small numbers, and could with difficulty be procured even for the temporary convenience of ferrying the survey squads over creeks in the course of their daily work.

2nd.—The heavy line-clearing.—Fringes of dense jungle are invariably found on the banks of the numerous creeks, and, as the latter usually form the kwin boundaries, a very large number of the boundary lines had to be cleared through jungle. For the future, the lines will not be taken so close to the creeks, but will be kept, as far as possible, clear of the jungle.

3rd.—Defective demarcation.—A large amount of extra work was caused owing to a misunderstanding regarding kwin boundaries; many boundaries intended to follow the edges of fields were first taken straight on account of the insufficient number of posts that had been erected.

4th.—The early setting in of the rains.—Rain commenced to fall about 1st April and greatly retarded the field work, which on this account had to be continued until June, or at least a month longer than had been expected.

5th.—The sickness of the establishment.—The disease most prevalent was dysentery, which is believed to have been caused in a great measure by inferior and adulterated food. There were 23 deaths during the season.

132. The head-quarters of the party at Bassein were visited by the Deputy Surveyor General during March. The work was then being prosecuted energetically, in face of difficulties which all the members of the party had to contend with, in the exceptional features and circumstances of a new country.

133. The party has to regret the loss by death of one of its members, Mr. P. Ford, Surveyor 4th grade, who manfully remained at his post after being attacked by severe illness, but who succumbed to the disease he had contracted, shortly after reaching Calcutta where he had come on medical leave.*

MISCELLANEOUS.

XXIII.—SURVEYS IN THE DARJEELING DISTRICT, AND IN SIKKIM.

134. On the termination—at the end of the field season of 1877-78—of the triangulation and geographical operations in Assam on which Lieutenant Harman and his party had been employed for some years, the party was sent to recess at Darjeeling in order to be available for the prosecution of similar operations in Sikkim, to those on which they had been engaged in Assam. It happened, however, that a variety of survey operations were urgently wanted in the Darjeeling District for the demarcation of new boundaries and the settlement of disputes regarding old boundaries and for various other local requirements. The Government of Bengal urged that these surveys were of far more immediate importance than a geographical survey of Sikkim, and recommended that Lieutenant Harman and his party should at once be employed on them. The Surveyor General readily assented to this proposal as no other survey party was available for the purpose at the time, and the amount of work to be done was believed to be small; moreover, the recent amalgamation of the three branches of the Survey Department rendered it desirable that this party, which originally belonged to the Trigonometrical Branch, should have an opportunity of acquiring practical experience in large-scale surveys of lands and boundaries which had hitherto been the special province of the Surveyors in the Revenue Branch of the Department.

Personnel.

Lieut. H. J. Harman, R.E., Assistant Superintendent in charge.
Mr. W. O'Sullivan, Surveyor 4th grade.
„ W. Robert, Assistant Surveyor 2nd grade.
„ D. J Collins, „ 3rd „
Mohibulla Khan, Sub-Surveyor.
Bhawani Din, „ and 4 others.

135. The general programme of the operations in the Darjeeling District and the details of the operations completed up to the end of 1878-79, are given in paragraphs 236 to 239 of the report for last year. In July 1879 it was believed that so little work remained to be done within the limits of the District itself that the survey of Sikkim might be commenced in the following field season. Arrangements were made accordingly, and early in October Lieutenant Harman started for Northern Sikkim and sent Mr. Robert into Western Sikkim, leaving the remaining surveyors, European and Native, to complete the field work in the Darjeeling District.

136. The result has been unfortunate in various respects. Little more than a month had elapsed after his departure from Darjeeling, when Lieutenant Harman was so badly frost-bitten at the Donkia Pass, on the frontier of Thibet, that he lost eventually four and a half of his toes, and had to return, leaving his work in Sikkim incomplete. Moreover, as regards the work to be done in the Darjeeling District, not only was it found to be much more laborious and extensive than Lieutenant Harman had supposed in July, but it was materially

* Major Andrew reports o Mr. J. H. O'Donel, that he has given entire satisfaction in all he has undertaken since he joined the party, on 30th July.

added to afterwards, because the local officers in all departments and the tea-planters, finding a survey party available on the spot, applied for its services on every occasion when surveyors were wanted to relay old boundaries or demarcate new ones, or to perform any of the varied duties which they are liable to be called on to undertake. Under the circumstances, Lieutenant Harman's absence in Sikkim, though only for half the field season, is to be regretted, as his presence on the spot and direct supervision were required to enable the District work to be completed, and the survey party transferred to other duties as speedily as had been desired by the Government of Bengal.

137. The operations in the Darjeeling District having already formed the subject of special reports to the Government of India, it is unnecessary to say more here than that the surveyors have been very fully occupied and a large amount of work has been performed, in the station of Darjeeling, in the Hope Town estates, in the Government Khas lands, in the lands east of the Teesta River which are required for tea cultivation, in the tracts which are reserved for native cultivation in the hills of the Daling Sub-Division, and on a number of boundary lines of which the longest and most important is the boundary between the Darjeeling and the Jalpaiguri Districts. The blocks of land newly taken up for cinchona plantations in Sittong have been surveyed. The congregation of the 16-inch settlement survey maps of the jotes in the Terai on the 4-inch scale into a frame-work of triangulation and traverses specially constructed for the purpose by the professional survey, is well advanced; and much data have been collected for the preparation of a new edition of the general map of the District, on the 2-inch scale, corrected up to date.

138. For the survey of Sikkim, Lieutenant Harman had arranged to undertake in person the whole of the country lying to the east of the range running south-east from Kanchinjinga, and assigned the country to the west to Mr. Robert. He proceeded in the first instance, to the snowy ranges on the frontier between Sikkim and Tibet hoping to survey them during the brief interval between the cessation of the rains and the setting-in of the winter with its heavy snow-falls. Going up the main valley to the point of junction of the Lasing and the Lachung Rivers, he ascended the Lachung Valley and reached the Donkia Pass on the boundary. Here his feet were badly frost-bitten as already stated; but with most commendable persistence and energy, he bravely continued his work under great difficulties, going about as best he could, on coolies, or ponies, or crutches. On returning to the junction of the two rivers he ascended the Lasing Valley and reached the Kangra Lama Pass, also on the boundary. He subsequently ascended the summits of Kinyong, Nochego and other mountains, and penetrated into parts of Sikkim which no European had before visited. He was in Sikkim for about $3\frac{1}{2}$ months, during which he surveyed an area of over 1,000 square miles on the scale of $\frac{1}{4}$ inch to the mile, determined the heights of about 300 positions of more or less importance by barometric and boiling-point observations, and executed a large amount of triangulation.

139. Mr. Robert succeeded in making a survey on the $\frac{1}{2}$-inch scale of an area of about 600 square miles in Western Sikkim, including the line of boundary with Nepal. From the numerous commanding points on this mountain frontier line he could see most of that part of Nepal which lies to the east of the southern spurs of Mount Everest, and was able to sketch an area of about 900 square miles, besides fixing a large number of points on the surrounding hill ranges and in Sikkim. Lieutenant Harman finds that Dr. Hooker's work in Nepal will combine well with Mr. Robert's, which is very satisfactory.*

* Lieutenant Harman reports that the steady, persistent manner in which Mr. Robert achieved all that he attempted, and all that could possibly have been expected of him, is most praiseworthy.

GEOGRAPHICAL.

XXIV.—GEOGRAPHICAL OPERATIONS IN AFGHANISTAN AND BELUCHISTAN.

140. The Officers who had operated with the army in Northern Afghanistan, during the first year of the war, were withdrawn from the field when the army retired on the conclusion of the Treaty of Gundamak, and were occupied in bringing up their calculations and completing their maps at the Mussoorie Head-Quarters, when intelligence was received in September 1879 that an army would at once be sent to Kabul in consequence of the massacre of the British Embassy. Immediate measures were, therefore, taken to organize two field parties, one under Major R. G. Woodthorpe, R.E., to proceed *viâ* Kuram and the Shutargardan to join the column under General Sir F. Roberts; the other under Captain Holdich, R.E., to proceed *viâ* Peshawar and Jellalabad to join the column under General Bright. The formation of these two parties was deemed expedient so as to secure as much topography as possible along the two lines of advance. Eventually both parties met at Kabul, where they were employed in making the most of every opportunity which was presented by the movements of the forces to add as much as possible to the geography of the surrounding country; in continuation of the preceding surveys, they operated westwards and southwards, up to the Pughman Range and over almost all the country which is drained by the Logar, Shiniz, and other affluents of the Kabul River.

141. Some additional geography was obtained in Southern Afghanistan, between Kandahar and Girishk, and along the valleys to the west and north-west of Kandahar. A connection with the operations in Northern Afghanistan was also made by the survey of the route from Kandahar to Ghazni, through the Khushk-i-rud, Tarnak and Ghazni Valleys. In Beluchistan a rough reconnaissance was made of a considerable portion of the country north of Sibi inhabited by the Marri tribes, and detailed surveys were commenced in the plains around Sibi and Dadur.

142. These operations will now be described in the following order: 1st, Northern Afghanistan; 2nd, Southern Afghanistan; and, 3rd, Beluchistan; to be followed by, 4th, a report on the general organization of survey operations with an army in the field.

1.—THE OPERATIONS IN NORTHERN AFGHANISTAN.

143. On the re-occupation of Gundamak, in November 1879, by the advanced brigade of General Bright's division under Brigadier General C. Gough, the survey party under Captain Holdich, R.E., joined the brigade. Captain C. Strahan, R.E., had previously executed a triangulation in the Jellalabad Valley and beyond as far as Gundamak, and had fixed points on the Karkacha Range to the west, which were of much use in extending the topography into the plains of Kabul. Additional triangulation was required to connect the operations in this quarter with those of Major Woodthorpe in the Kuram Valley and around the Shuturgardan Pass, and to complete the general system of triangulation in Northern Afghanistan. This was effected in due course as opportunities offered on the advance of the troops.

Personnel.

Captain T. H. Holdich, R.E., Officiating Deputy Superintendent 3rd grade.
Mr T. E. M. Claudius, Surveyor 4th grade.
„ W. W. McNair, Assistant Surveyor 1st grade.
Two sub-surveyors (The Munshi and Bozdar).

144. Major R. G. Woodthorpe's party, which had proceeded *viâ* the Kuram Valley, reached Ali-Kheyl on the 4th October, a few days after the force under General Sir F. Roberts had advanced on Kabul. Here it was detained until nearly the end of October, when General Hugh Gough arrived at the Shuturgardan Pass with orders to withdraw the garrisons from the posts there and at Ali-Kheyl, and take them on to Kabul. A day's halt at the Shuturgardan enabled Major Woodthorpe to ascend a hill in the neighbourhood from which a good view was obtained, enabling much work

Personnel.

Captain (Brevet Major) R. G. Woodthorpe, R.E., Assistant Superintendent, 2nd grade.
Captain G. W. Martin, Assistant Superintendent, 3rd grade.
Mr. M. J. Ogle, Surveyor.
Sub-surveyor Hira Singh.

MAP
ILLUSTRATING THE
SURVEY OPERATIONS
IN
AFGHANISTAN
up to date, 1880.

Scale 1 Inch = 32 Miles.

10 5 0 10 50 100

NOTE. *Survey in detail shewn in Pink tint.*
Geographical Reconnaissance supplemented by native information in Pink Lines.

Extract from the Map of Turkestan, 4th Edition; Dehra Dún, 1879.

Photozincographed under the orders of the Surveyor General of India, Dehra Dun and Calcutta, December 1880.

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to be done, both with the theodolite and plane-table, but for which Major Woodthorpe would not have been able to connect the triangulation of the Kuram Valley with that of the Logar and Kabul Valleys, which now together form a continuous series from Thull round *viâ* Kabul to Jellalabad.

145. At first, however, little could be done in the way of triangulation, and it was found necessary to base the topography on a traverse with a subtense theodolite from the Shuturgardan Pass *viâ* Kushi to Kabul, and even this was executed with considerable difficulty, owing to the length of the marches with the troops. Points determined by this traverse were every night plotted on a plane-table, and, with the aid of these, Captain Martin was enabled to make a fairly accurate preliminary reconnaissance of most of the Logar Valley on the scale of 1 inch to 4 miles.

146. The party arrived at Kabul on the 4th November 1879, and Captain T. H. Holdich, R.E., as the senior departmental officer, assumed charge of all further survey operations in Northern Afghanistan.

147. Mr. Ogle, of Major Woodthorpe's party, was detained in the Kuram Valley and accompanied General Tytler's column into the Zaimukht country, west of Kohat, where he secured topography to the extent of 880 square miles in country which was very little known. On completion of this work he proceeded to Kabul and took part in the survey under Captain Holdich.

148. On the occupation of Kabul and partial investment of Sherpur by Mahomed Jan's forces in December, the officers of the survey were temporarily transferred to the Field Engineer Department, and either assisted in the construction of defensive works, under Colonel Perkins, the Chief Engineer, or were placed on the personal staff of the Brigadiers and Generals Commanding. After the defeat of Mahomed Jan, Captain Holdich and Major Woodthorpe accompanied a brigade to the Koh Daman and succeeded in mapping a portion of the country on the $\frac{1}{4}$-inch scale and establishing two trigonometrical stations there.

149. Captain Holdich then joined General Bright's division in the Lughman Valley. Afterwards he accompanied General Sir F. Roberts on his march through the Logar Valley, taking advantage of this opportunity to make a leisurely re-survey of the valley on the $\frac{1}{2}$-inch scale. Major Woodthorpe at the same time considerably improved and extended the triangulation in this valley and fixed a number of points on the Altimor, Pughman, Deh-i-Sabz, and Karkatcha Ranges.

150. In April General Ross proceeded with a division through Maidan towards Ghazni to meet Sir Donald Stewart, then advancing from Kandahar. Major Woodthorpe accompanied this force, and was able to extend the triangulation and topography towards the head of the Logar River, the sources of which he states, have now been approximately fixed. He also ascended two points on the Pughman Range at elevations of 14,400 and 15,000 feet; but, unfortunately, the weather at this time had become hazy and he was unable to take observations to the distant peaks on the Hindu-Kush.

151. In June and July Captain Martin accompanied General C. Gough's brigade into the Koh-i-Daman and Kohistan, where he mapped 700 square miles on the $\frac{1}{2}$-inch scale and was successful in obtaining information regarding the courses of some of the rivers issuing from the Hindu-Kush and flowing through the Kabul Valley.

152. Mr. Claudius completed the topography of the country from Gundamak to Kabul on the $\frac{1}{2}$-inch scale, and under the escort and guidance of a friendly Khan of Tezin he mapped the important bit of country which borders the route across Lataband and the Haft-kotal Passes. This part of his work was executed at considerable personal risk, and he was badly frost-bitten in carrying it through.

153. Mr. W. W. McNair completed the survey of portions of the Asphan and Hisarak Valleys, west of Gundamak and of the Lughman Valley, both on the 1-inch scale, and subsequently he executed a large amount of excellent topography in the Logar Valley, on the $\frac{1}{2}$-inch scale.

154. In April two officers of the Royal Engineers, Lieutenant the Honourable M. G. Talbot and Lieutenant F. B. Longe, were attached to the Survey for duty, and did excellent work both as plane-tablers and in taking a share in the calculations for the general reduction of the observations.

155. The Native Sub-Surveyors were found particularly useful throughout the campaign from the fact of their being able to move about the country without much personal risk, even in disturbed portions of the country; their services were also largely utilised in pushing forward the Military Survey of the country around Kabul and Sherpur on the 4-inch scale.*

156. The total area mapped in Northern Afghanistan during the season is roughly estimated by Captain Holdich at 10,300 square miles, to which should be added 880 square miles in the Zaimukht country,—making in all 11,180 square miles, of which 64 square miles were done on the 4-inch scale, 1,276 on the 1-inch, and the remainder on the $\frac{1}{2}$-inch and $\frac{1}{4}$-inch scales, in about equal proportions.

Notes by Captain Holdich on "the route to Kabul through the Lughman Valley," and an extract from Major Woodthorpe's report regarding the triangulation from the Shuturgardan Pass to Kabul, are given in the appendix attached to this report.

2.—The Operations in Southern Afghanistan.

157. On completing the survey of Pishin which is mentioned in paragraph 251 of the last report, Lieutenant Gore, R.E., received instructions from Lieutenant General Sir D. Stewart, K.C.B., to proceed to Kandahar *viâ* the Barghana route, which had not been previously surveyed. Accordingly he made a sketch of the route and the surrounding country, and amalgamated it with the previous surveys on the more direct routes to Kandahar. On arrival at Kandahar he was employed in making surveys of the surrounding country, including an area of 160 square miles in the fertile and well-cultivated country along the banks of the Argandab and Dori Rivers to their junction, which he mapped on the 1-inch scale. He also extended the triangulation towards Giriskh.

Personnel.

Lieutenant St. G. C. Gore, R.E., Assistant Superintendent, 3rd grade.
Sub-surveyors Atma Sing and Saidulla Khan.

158. Subsequently he accompained an expedition into the Argastan Valley which proceeded as far as the village of Badozai, about 8 miles between the point where the river issues from the hills; the Sundarzai villages were also visited, and the Tagak Kotal, through which an excellent road passes into the Tarnak Valley, was explored. This road was afterwards used by the 1st Brigade of the Ghazni column on their march towards Kabul. Lieutenant Gore states that

"*of the three rivers forming the Argastan basin the Kushk-i-Rud is the smallest; its* total length is about 50 miles. A fair body of water, however, comes down it, but it is very brackish and nasty to drink. Of the remaining two the Argastan has probably the larger basin, as a good deal of the drainage, which on old maps was shown as running into the Kadanai is now known to flow into the Argastan. The Lora River is said to take the overflow drainage of Lake Ab-i-Istada, and when the lake overflows the river water comes down very salt."

159. From Badozai the expedition turned to the south and marched skirting the main range of hills through the Kadanai plain until it reached Dabrai on the road from Quetta to Kandahar; a good reconnoissance of all this country was made and was based on trigonometrically fixed points. Subsequently, when General Stewart's force advanced from Kandahar on Kabul, *viâ* Ghazni, Lieutenant Gore accompanied it and was attached to the 1st Brigade, which commenced its march on the 30th March. The route taken led for two days up the Tarnak Valley, thence across the Tagak Pass, on the water-shed between the Tarnak and Argastan Rivers into the Khushk-i-Rud Valley, at the head of which it crossed an almost imperceptible water-shed and re-entered the Tarnak Valley, opposite to, but about 10 miles to the east of, Kalat-i-Ghilzai. From

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* Captain Holdich reports as follows of the services of these men:—

"The Munshi carried on the mapping (on the large scale of four inches to the mile) of the Sherpur cantonments, and of the country immediately round it, during the actual progress of the investment, and thus really executed some most useful military work. He continued to work through the city and surrounding districts immediately the siege was raised, and before it would have been possible for any European to have been so employed. From a purely military point of view this part of his work was most important. He also undertook an exploration *viâ* the Kunar River into Kafiristan, travelling as a Native Doctor; there is every reason to suppose he could have succeeded in reaching *Kafiristan* (for he was never suspected at any time) but for an unfortunate rise of the Safis and Deligans, which took place most unexpectedly. Returning to Kabul he was next employed in mapping a part of the district adjoining Kabul (stretching through the Chardeh plain to the district of Pughman) which had been entirely closed to European Officers, and which it appeared likely would altogether remain a blank. Here he succeeded perfectly, and finished a valuable bit of one inch topography extending to the main crest of the Pughman Range.

"Saidulla was further occupied *for some time previous to the evacuation* of Kabul in completing a portion of topography near the line at Jellalabad, where it was advisable to employ Native rather than European agency."

this point onwards the route followed the foot of the Surgarh hills, which form the eastern flank of the Tarnak Valley, up to within a short distance of Shahjui, in latitude 32° 31′, where the 1st Brigade joined the main body of the army. The whole force then advanced into the valley of the Ghazni River, fought the battle of Ahmed-Khel on the 19th April and reached Ghazni two days afterwards.

160. Up to Shahjui Lieutenant Gore's work was based on trigonometrically fixed points, but beyond he had to rely on plane-table fixings and traversing until he reached the Wardak Valley above Ghazni and was able to effect a junction with the survey brought down by Major Woodthorpe from Kabul. While halting at Ghazni Lieutenant Gore made a large-scale sketch of the ground in the vicinity of the city, in which he was assisted by several officers of the force. He accompanied a small force sent to reconnoitre the Altamur Pass, and had hoped to reach the summit of the Pass and obtain a good view of the Zurmut Valley beyond, but this was found impracticable, as the hills were occupied in considerable force by the enemy. On reaching Kabul Lieutenant Gore was permitted by Sir Donald Stewart to return to India in order to complete his mapping.

161. Major E. P. Leach, V.C., had proceeded to Europe on sick leave in consequence of a wound received during the first campaign. On his return he was sent to Kandahar to be available—in communication with Colonel St. John, R.E., the Political Officer—for any survey work which might be wanted. Few opportunities were presented for survey operations, but Major Leach succeeded in reconnoitering a portion of the Argandab Valley, and in extending the previous year's survey of the Khakrez Valley eastwards for some distance; he also fixed a number of the peaks on the water-shed between the Argandab and the upper waters of the Tirin Valley, and obtained some valuable information concerning the passes into and across the Hazara country. Unfortunately—

"The whole of this material, together with a series of valuable notes concerning the Hazara tribes and country, was lost during the retreat from Maiwand and during the subsequent evacuation of the Kandahar cantonment."

The survey portion has, however, since been replaced during an exploration made by Lieutenant the Honourable M. G. Talbot, R.E., and Lieutenant F. B. Longe, R.E., and Major Leach has drawn up from recollection and some brief notes which he had saved, a *résumé* of the information which he had collected of the Hazara country and people, and has embodied the results on a sketch map which, he says,

"is so far valuable that it gives an idea of the general lie of a country which is at present a perfect blank and the relative positions *inter se* of the more important tribal divisions."

162. At the beginning of June, Major Leach sketched a portion of the Maiwand District, which lies at the foot of the Shah Maksúd Range and is intermediate between the Garmao and Khakrez Valleys, in continuation of the previous survey of the Khakrez Valley. He subsequently accompanied General Burrows' force to Girisúk and did good service on the staff during the disastrous battle of Maiwand and retreat to Kandahar. He was then appointed Brigade Major of Engineers and served in that capacity throughout the defence of Kandahar and in the subsequent battle of Kandahar, when the enemy under Ayúb Khan were defeated by the British troops under General Sir F. Roberts. For some time after these events further survey operations at a distance from Kandahar were impracticable; meanwhile a survey of the city and its environs was commenced on the scale of 6 inches to the mile.

163. Lieutenant the Honourable M. G. Talbot, R.E., and Lieutenant Longe, R.E., accompanied General Sir F. Roberts in his memorable march from Kabul to Kandahar; they were present at the battle of Kandahar, and have since been employed in such survey operations as the movements of the troops enabled them to undertake.

3.—The Operations in Beluchistan.

164. In September 1879, as there was no immediate prospect of more survey being undertaken in Southern Afghanistan, Major Bewan was directed to proceed from Kandahar to Quetta to survey the country between and around

Personnel.

Major R. Bewan, S.C., Assistant Superintendent.
Mr. J. T. U. Coxen, Assistant Surveyor 1st grade.
„ H. Corkery „ „ 3rd „

Quetta and Sibi as opportunities offered. On arrival at Quetta he found that an expedition was about to start under the Political Officer, Captain Showers, to explore the route to Sibi, *viâ* the Hamra Pass. Furnished with the approximate positions of several prominent peaks which had been fixed by previous triangulation, he proceeded *viâ* Astangi through the Tiri defile to Sangan, whence he accompanied Sir R. Sandeman to Sibi *viâ* Harnai, leaving Captain Showers to explore the country to the north for a direct road to Sharigh and Dargi.

165. While at Harnai he was able to visit the hill of Torgarh, about six miles to the south, from which a good view was obtained of all the country towards Sangan and Nari.

Afterwards he went to Khost in the Dargi Valley, where he met Sir R. Temple, Governor of Bombay, and accompanied him to Thal, from which place he subsequently accompanied military expeditions towards Chotiali and to Baghao and Smalan on the north-east.

166. Major Beavan had considerable difficulties to contend against, as the disturbed state of the country prevented him from deviating to any distance from the routes followed by the troops; but he succeeded in making a rough reconnaissance, on the scale of 1 inch = 4 miles, of about 2,500 square miles between the parallels of 29° 15′ and 30° 20′ and the meridians of 67° 10′ and 68° 50′ extending from Quetta to Thal-Chotiali and down to Sibi, which was of much use afterwards to the engineers employed in laying out the new line of railway. He also completed some triangulation near Sibi and Dadur.

167. The assistant surveyors (Messrs. Coxen and Corkery*) completed a survey of 1,500 square miles around Sibi, Mitri and Dadur, in detail, on the scale of 1 inch = 2 miles.

168. Major Beavan proceeded in April to the Head-Quarters at Mussoorie, with his field maps and original records and observations, with a view to completing the calculations and preparing the fair maps. This work done, he returned to Sibi in July, to resume field operations whenever and wherever it might be found practicable to operate in the hill tracts of Beluchistan lying on the northern frontier of the Province of Sind.

4.—On the general organization of Survey Operations with an Army in the Field.

169. In the General Report for last year, a special report on the experience gained regarding the sufficiency of the general organization of the survey operations during the campaign in Afghanistan was made, under the instructions from the Secretary of State for India prescribing that all experience on the work and organization of the several departments engaged, directly or indirectly, on the conduct of the campaign, should be reported on and recorded for future guidance.

170. During the present year a committee was assembled at Kabul, under the orders of General Sir Donald Stewart, G.C.B., for the purpose of considering the equipment necessary for a survey party in the field. The committee was composed of Lieutenant Colonel Stewart, of the Guide Corps, as president, and Major Woodthorpe and Captain Holdich, of the Survey Department, as members. Their recommendations were as follows:—

1. A survey party should consist of one officer (who should be both accustomed to triangulate and to use the plane-table) and of two assistants (one of whom should be competent to triangulate) as topographers for each column operating on an independent line in a country where no survey has hitherto been made.

The native establishment for a party of this size should be as follows:—

For 1 officer 7 followers
„ 2 officers 10 „
} inclusive of interpreters and permanent guides.

The addition of native sub-surveyors must depend entirely on the nature of the country under survey, but when they are employed, extra public followers, at the rate of at least one per sub-surveyor, will be necessary.

* Major Beavan reports that "both Messrs. Coxen and Corkery have undergone a great amount of very hard work and had difficulties and privations to encounter. The work they have turned out has been carefully done, and they have succeeded in dealing with the Pathan and Beluchi inhabitants of the country without raising opposition or provoking complaints, which I consider highly creditable to them."

2. The instruments for the equipment of such a party will be as follows:—

1 six-inch subtense theodolite with full vertical circle and tripod stand.
5 plane-tables, *viz.*, one for the officer in charge and two for each assistant.

The two for each assistant should be interchangeable on one stand and should be of different sizes and portability. The committee are of opinion that the plain deal table, 30″ × 26″, has, on the whole, been found to be of the greatest use on account of its superior size and stability. It can be slung with its stand on a mule or pony without difficulty and can be used with cavalry. But each assistant should also be provided with a lighter, smaller, and more portable table, which can be conveniently slung on a man's back; a really portable table of this sort has yet to be devised, as also the best kind of stand.

Each officer or assistant should also be provided with the following minor instruments and books, *viz.*:—

2 trough needles, 1 sight-rule, 1 telescope or binocular, 1 aneroid barometer, 1 prismatic compass and stand, 3 thermometers for determining the boiling point of water, ordinary air thermometer, 1 Gunter scale, 1 beam compass, 1 small box instruments, 1 Shortrede's log tables, 1 Chambers's log tables, 1 auxiliary tables for facilitating the computations of the Great Trigonometrical Survey.

The Officer in charge should carry in addition—

1 Abney's level, 1 set scales, 1 maximum and minimum thermometer, 1 nautical almanac, 1 prismatic subtense instrument, 1 parallel ruler, 1 pantagraph, 1 manual of surveying, 2 sets measuring tapes (steel), 1 perambulator, lamps for observing, 1-6″ heliotrope, 1 chronometer watch, 1 portable sun-dial, spare compass and drawing pens.

3. *Stationery.*—The ordinary forms in use should be indented for before starting, in quantities suited to the nature of the work likely to be undertaken, but not more than three months' supply either of forms or stationery need ever be carried.

4. Office tentage and baggage allowance should be on the same scale as that of the senior Quarter Master General with the division.

5. In addition to the usual personal baggage scale, the following will be required for the Head-Quarters camp—

Office tent	150 lbs.
„ table	20 „
Stationery and small instrument . .	160 „
Maps and Data	50 „

For public followers 1 sepoy's pâl, holding 17 persons, or its equivalent in smaller tents.

171. These recommendations were made on the following assumptions regarding the nature and extent of the work to be undertaken by the Survey officers:—

A.—That a large extent of country, embracing several thousand square miles, may be either actually visited or sketched from a distance, during the course of a campaign.

B.—That every surveyor should be equipped to act independently, if necessary.

C.—That there may be no opportunities of visiting any portion of the ground twice, and therefore that all surveying must be done *pari passu* with the more or less rapid movements of troops along the main lines of communication.

D.—That maps are to be compiled and traced in the field, so that all the work of the Survey can be put into the hands of the Generals concerned as speedily as possible.

E.—That the topographical operations are not to consist merely of surveys of the lines of route, but are to embrace as much as possible of the surrounding country, and must therefore be executed on a trigonometrical basis; consequently, that the surveyors must always work together in pairs, one doing the triangulation, the other the topographical sketching; for, when the troops are marching rapidly, it is impossible for any single man to do both, and each is required to supplement the other.

F.—That the Survey office with the Army will be the general depôt for all maps of the country which may be published by the Surveyor General's Department and be supplied for distribution as required.

G.—That the sanctioned allowance of baggage and equipment for every officer in the field who is employed in transport, commissariat or any other duties which oblige him to carry his own camp equipage and make it impossible for him to join a mess, is 400 lbs.

172. The recommendations were obviously much influenced by the circumstance that the military occupation of Afghanistan was long protracted, so that the whole of the equipment specified by the committee had been found to be necessary. It will be obvious, however, that much valuable work of military survey and reconnaissance may be done by officers who are equipped more lightly, with instruments fewer in number and of a smaller size; and indeed that when a force has to march with great rapidity through an enemy's country, as in General Sir F. Roberts's march from Kabul to Kandahar, it would be absolutely necessary to restrict the equipment of each Survey officer to what might be readily carried about by himself and one or two attendants.

173. It will be obvious that the nature of the equipment must be materially influenced by the nature of the duty which the officer has to perform,—that is to say, by the consideration whether he is expected to make a general geographical survey of as much as can be seen of the country, or a detailed topographical survey of the principal military roads and lines of communication and the ground in their immediate neighbourhood. Both surveys may be invaluable to the officers commanding the forces, but it is scarcely possible for both to be performed satisfactorily by the same individuals and the same processes of operation. The general geographical survey of the country is not required to give much minute detail, but it must be conducted with some precision in order that what it does give may be accurate; on the other hand, the topographical sketches and reconnaissances are required to give full details of the configuration of the ground on both sides of the principal military lines of communication, and more particularly to show all the hills by which the roads are commanded; for them, however, fullness of detail is of infinitely greater importance than precision of execution. The geographical survey is mostly of value for rapid strategical movements over a large area of country, while the topographical is mostly of value to aid a general officer in determining the best disposition of his troops in action or wherever liable to be attacked by an enemy. The geographical survey must, necessarily, be made on a much smaller scale than the military topographical sketches, and it would be of very little use wherever minute detail is required; but, on the other hand, the topographical sketches would by no means suffice of themselves for the construction of a reasonably accurate map of the country.

174. In the first Afghan War a large amount of route surveying was executed: it was mostly done on the scale of 1 inch = 1 mile, and some of it appears to have been of very good quality; but few, if any, attempts were made to carry on a general geographical survey of the country *pari passu* with the military route surveys. Thus, when the latter came to be combined together, large gaps were found to exist in our knowledge of the country; sufficient data were not even forthcoming for an accurate combination of the work which had been done, the result being that in the maps of Afghanistan, which were executed on the basis of the route surveys, the cities of Kabul and Kandahar are shown respectively as 7 and 15 miles west of their true positions relatively to places in the same parallels of latitude on the British frontier.

175. It was the chief duty of the Officers of the Survey Department who served in the last Afghan War to endeavour to obtain as much information as possible of the country at large, and not merely to operate on the military lines of communication. For this purpose they were directed to make general maps of the country—on scales of $\frac{1}{2}$ an inch or $\frac{1}{4}$ of an inch to the mile, as might be most suitable in each case—by the method of plane-tabling on a trigonometrical basis; also to carry route surveys, on the 1-inch scale, with the most suitable instruments available, over the principal roads traversed by the troops. They were, of course, expected to make themselves generally useful whenever occasions might arise for their employment on other duties; but it was contemplated that whatever work of military reconnaissance and sketching on scales larger than that of 1-inch to the mile might be required, would be done by some of the numerous field engineers and staff officers attached to the army, who were more or less skilled in the performance of such duties. Thus, it has resulted that the bulk of their work is on the $\frac{1}{4}$ and $\frac{1}{2}$-inch scales; their route-surveying on the 1-inch scale became generally merged into their smaller scale maps; they surveyed Kandahar and the surrounding country within a radius of ten miles on the 1-inch scale, and Kabul and its environs on the 4-inch scale; but the bulk of the work of military reconnaissance was done chiefly on the 6-inch scale, by field engineers and staff officers who were attached to the several divisions of the army; regimental officers were also largely employed in making field sketches and reports.

176. The Surveyor General is of opinion that this separation of the work of precise military survey from that of approximate military reconnaissance, the former being allotted to the professional military surveyor, the latter to the staff officer or field engineer, is a judicious arrangement which deserves official recognition and should be laid down as a rule for future guidance. It was found to work well on the whole during the late campaign, though it was not formally introduced, but merely came to be adopted in course of time as the

most appropriate way of employing the several officers whose services were available for the various kinds of work to be performed. Had the principle been generally adopted from the outset, even better results might have been obtained, and there are many excellent reasons for its adoption in future campaigns in India. The survey of a large extent of country, more particularly during hurried movements of troops, is one which is obviously more likely to be performed satisfactorily by a military officer who had been constantly practising the duties of a professional surveyor, than by a field engineer or staff officer, who has been as constantly employed on other duties. On the other hand, in the work of military reconnaissance, the professional surveyor may, from want of military training, be often at a disadvantage as compared with the staff officer, and may not succeed as well in obtaining local information on various points affecting the movements of the troops, which is usually of great value to a general officer, and may even be of more importance than the topographical sketches; this work should, therefore, be performed whenever possible by staff or regimental officers, rather than professional surveyors. Such division of labour has the further advantage of employing each officer on that work in the success of which he is most immediately interested.

177. The recent publication of the report of the Committee appointed by the Secretary of State for War to report on the System of Instruction for Military Sketching and Surveying, in the British Army, affords the Surveyor General an opportunity of offering suggestions on the recommendations of the Committee on two points of importance which may well receive further consideration. *First*, the "re-introduction of the plane-table in its simplest form" as an instrument of survey; and, *secondly*, the "substitution of the system of showing hill features by shading in mezzotint, with stump and powdered chalk, or lead from a pencil, for the one now in force of indicating them by horizontal hachures."

178. The Committee recommend the re-introduction of the plane-table on the following grounds: that it is "the principal instrument used in India for surveying;" that it "can be now made as light as the sketching case, which every man working with a prismatic compass usually carries;" and that it may be employed in countries, such as Southern Africa, "where the prismatic compass was very unreliable, and in some cases almost useless, owing to the powerful local attraction in the ground." Now, it is impossible that plane-tables of the same form and design can be made to subserve the two conditions of portability and independency of the magnetic compass. This may be readily inferred from the following description of the plane-table which is used in the Indian Survey Department.

179. The plane-table is ordinarily 30 inches long by 24 broad and $\frac{3}{4}$ of an inch thick, and is made of the lightest wood procurable, well seasoned and not liable to warp to an extent that will sensibly distort the plane of the table. It is usually supplied with a strong and well-braced tripod stand, on which it can be set up and clamped very firmly; folding tripods with tightening screws are also used occasionally and are about two-thirds of the weight, 12 lbs., of the braced tripod. The plane-table is also supplied with an ebony sight-rule, which is usually about 27 inches in length by 2 inches in breadth, and carries brass sight vanes about 4 inches high at each end, by means of which the rule can be truly directed on any surrounding object. The lower surface of the rule and the upper surface of the table being both truly planed—so that the rule will rest evenly on all parts of the table over which it may be brought—the two together constitute a surveying instrument which may be employed independently of any instrument for measuring angles, such as a theodolite, sextant, or magnetic compass, provided that the table when set up is firmly clamped to its stand, and is not liable to be thrown out of position by the lightness or weakness of its supports. But if the plane-table is to take the place of all other instruments, and be employed in localities where local magnetic attraction renders the prismatic compass useless, it must be true in surface and free from shake: thus, it cannot be made materially lighter than the ordinary Indian plane-table, which weighs about 25 lbs. with stand and sight-rule complete, and cannot well be carried about by less than two persons, and is certainly a very awkward instrument to take about on horseback.

180. It would appear, therefore, that the officers who have reported to the

Committee in commendation of the plane-table on the grounds that "the table itself can be now made as light as the sketching case which every man working with a prismatic compass usually carries; and the legs, which are separate, can be made so as not to be much more inconvenient to carry than a large stick," must have been thinking, not of a plane-table forming a complete survey instrument in itself as above described, but of one requiring to be used in combination with a magnetic needle to govern the setting-up of the table, and, therefore, as useless as the prismatic compass would be in localities influenced by local attraction. Still, such an instrument would be very serviceable in furnishing a small table, on which the topographer can work in much greater comfort and ease, and therefore with greater rapidity, than on the ordinary sketching block.

181. The magnetic needle is usually of so great assistance in enabling a plane-table to be speedily adjusted to the true meridian that a long trough needle is invariably supplied to every plane-tabler on the Indian Survey; the table is first brought into position with the aid of the needle, and finally adjusted by the sight-rule on surrounding fixed objects, as the magnetic position cannot be relied on. But firmness and trueness of table, and accuracy of sight-rule, are essentially necessary to obtain good results when the plane-table is employed, as usual, independently of all other angle-measuring instruments, after once it has been brought into position.

182. On the other hand, a much smaller table than the Indian plane-table, mounted on a folding tripod stand, such as is usually supplied for the support of a prismatic compass, may be used in combination with a small theodolite, with entire satisfaction as regards accuracy of results, though with somewhat more of labour than in the case of the plane-table pure and simple; for the angles must be measured with the theodolite and laid off with a protractor. But the operations would be independent of the magnetic needle, and unaffected by any accidental displacement of the table. Probably the best and most convenient of theodolites to employ for extended operations in which more or less precision is necessary would be Casella's little altazimuths, with 3-inch horizontal and vertical circles divided to read minutes, telescopic power $5\frac{1}{2}$, weight in box $4\frac{1}{2}$ lbs., weight of stand $3\frac{1}{2}$ lbs. For ordinary topographical reconnaissance it would suffice to employ a prismatic compass, which might be rested on the table itself; then the extra weight to be carried about, as compared with that of a hand-held prismatic compass and sketching block, would be merely the excess of the weight of the table over that of the block, *plus* the weight of the folding tripod stand, all which need not be more than 5 lbs.

183. The question of the propriety of employing the plane-table, pure and simple, is much influenced by the scale on which the survey or reconnaissance is to be made. The instrument is specially valuable for determining the positions of all surrounding points which are visible at two or more fixed stations, or for determining the position of a station at which the table is set up, by interpolation from surrounding points which have already been fixed by triangulation. The plane-tabling in Northern Afghanistan was at the outset entirely based on points which had been fixed on the summits of the great mountain ranges in previous years, by observations from the frontier stations of the Indian triangulation, and of which the positions are given in Synoptical Volume I of the results of the operations of the Great Trigonometrical Survey of India. Many of these points were 30 to 60 miles distant from the plane-tabler: thus, as the size of the tables was 30 by 24 inches, a larger scale than $\frac{1}{4}$ of an inch to the mile could not be used without discarding several of the more distant points, which might often be of much service to the plane-tabler in interpolating his position.

184. The scales recommended by the War Office Committee are 1 to 2 inches to the mile for roads and rivers, and 6 inches for positions and camps. The largest of these scales was adopted in Afghanistan for the Kuram Valley and the road from thence to Kabul *viâ* the Shutargardan Pass, for the road through the passes between Kabul and Jellalabad, and for the Khyber Pass. Obviously, where so large a scale is used, the work must necessarily be of the nature of reconnaissance rather than exact survey. When done on a sketching block, a large number of sheets of paper must be used, and this is very troublesome at the time and afterwards in joining the sheets together. For reconnaissance on

a large scale, regular plane-tabling is not suited, as a sufficiency of well-marked points for the plane-tabler to work on would probably not fall within the limits of the paper. But when working with a small table and a prismatic compass, in the manner indicated in paragraph 182, paper mounted on cloth in sheets extending considerably beyond the limits of the table, may be used with advantage, with the aid of a few drawing brads to pin down the sheet on the board at the part which is wanted. This method was practised during the last three years of the Trans-Indus Survey of 1849-54, and was found most convenient; the paper, mounted on brown holland, was obtained in rolls a yard wide, from which any desired length, usually $1\frac{1}{2}$ yards, might be cut; the table was only 1 foot square, and was mounted on the stand of a prismatic compass; the angles were measured with a 5-inch theodolite, the smallest available at the time, and were plotted with a protractor and marquoise scales; the scale of the survey was 1 inch to the mile; the paper was pinned down to the board with brads when in use, and rolled up and kept in a wax-cloth case when not in use. The whole of the instruments might be carried about by two persons, whether on foot or horseback, without difficulty. For ordinary military reconnaissance a roll of paper mounted on cloth, 12 to 18 inches wide and 24 to 30 inches long, would probably suffice, and a wax-cloth cover would be ample protection for it while being carried about; the corresponding instrumental equipment would be a light table, 10 to 12 inches square, mounted on a folding tripod stand; a prismatic compass, a protractor, and a scale with folding sights which might be used on occasion as a sight-rule.

185. As regards the substitution of shading in mezzotint for the present system of horizontal hachures, in order to show hill features, there can be no question but that maps so produced could be drawn with greater rapidity and would, as a rule, be clearer and better understood. When only a single copy of a sketch or map is wanted, nothing better can be desired. But if several copies are wanted as speedily as possible, as frequently happens, then the map should be drawn with a view to adapting it for the only process which is at present known for obtaining speedy reproduction and multiplication, *viz.*, photographic transfer to stone or zinc. This process enables pen and ink drawing, however elaborate and complicated, to be reproduced and multiplied satisfactorily and with great rapidity; but it cannot reproduce mezzotint. Thus an original drawing in mezzotint must always be redrawn by hand, on transfer paper or stone, before it can be multiplied, and this is usually a slow and laborious process, requiring much more time than direct reproduction by photography; consequently, all maps and sketches which are required to be speedily multiplied should be drawn in pen and ink. As regards reproduction it is immaterial whether the hachuring of the hill features is drawn vertically or horizontally; but for clearness and general legibility vertical hachures are usually preferable in small-scale maps, and horizontal in large-scale ones.

186. The speedy reproduction and multiplication by this Department of the maps and sketches which were received from Afghanistan, directly or through the Quarter Master General's, the Foreign and other offices, constitutes a feature of much importance as regards the connection of the Survey Department with the general business of the campaign. Up to the end of 1880 over 400 maps and sketches, in sections of various sizes ranging from "double elephant" down to "foolscap," obtained from all quarters, were reproduced by photozincography; upwards of 50,000 prints were taken, giving an average of about 125 copies for each subject: the average time which elapsed between the receipt of an original map or sketch in the photozincographic office and the issue of the requisite number of copies from that to the despatch office, was 5 days for each subject, including Sundays and holidays and the time spent in examining the proofs and correcting the zinc plates; ordinarily when the original was clearly drawn, so that the plates did not require correction, 200 copies could be supplied without much difficulty on the third day after its receipt in the photographic office; and in not a few cases copies were despatched to the Generals and Staff Officers in Afghanistan by the third day.

187. In some instances the prints were rough and coarse, but this was because the originals were in the same condition. Photozincography cannot do more than produce a facsimile of any subject; it cannot improve on, and

indeed is liable to produce something slightly less good than, the original. But a map, however rough and coarse, may, if supplied *instanter*, be often of far more value than an elaborately finished map supplied some time afterwards. Thus the general principle was followed, of furnishing the Government Offices, the Army Head Quarters and the Officers commanding the troops in Afghanistan, with facsimiles of all maps and sketches precisely as received, so that the persons most interested might be placed as speedily as possible in possession of all the latest information available. New maps were compiled in the Surveyor General's Offices as soon as possible after any new information was received; and new editions of previous maps were published from time to time as rapidly as was practicable. But the labour of re-drawing and compiling was great; and a long period was consequently liable to elapse between the publication of the facsimiles of the primary materials, and the publication of the maps into which these materials were incorporated. Thus, the speedy publication of the originals was a desideratum of great importance, and the Survey Department may claim credit for the manner in which that want has been supplied.

188. It may be here stated that most of the maps supplied for the use of the officers in Afghanistan were printed on calico instead of paper. Prints on calico are nearly as sharp and clear as on the best paper; the cloth is lighter, more readily folded, much more convenient to carry about, and far less liable to be torn and injured, than any of the various kinds of paper on which maps are usually printed. On the other hand, they are not so well suited for the insertion of correction and additional matter. Thus, a few prints on paper were also furnished to supplement the prints on cloth.

XXV.—TRANS-FRONTIER EXPLORATIONS.

Irrawaddy River Exploration.

189. In the early part of 1879, Captain J. E. Sandeman, Deputy Superintendent, in charge of the Cadastral Survey in the Hanthawaddy District, British Burma, was requested, with the sanction of the Chief Commissioner, to train a native of Burma, with a view to his being employed in exploring the upper course of the Irrawaddy River, beyond Bamo. Towards the end of the year, this man had acquired a sufficient knowledge of his duties to be started on a preliminary exploration.

190. A full account of his journey and adventures will be found in Captain Sandeman's report in the appendix. Here, therefore, it is unnecessary to say more than that he started by steamer from Rangoon with two companions of his own selection, and arrived at Bamo early in November 1879. Thence the party went up the river in boats, first to the village of Haw-ka in latitude 25° 6′, and then to Ka-cho, once an important city, in latitude 25° 20′ at an elevation of about 1,000 feet above the sea. Thence he proceeded by land, pacing distances and taking bearings, up to Mogoung-poon Maing-koung in latitude 26° 8′, at which place the exploration terminated.

191. At the village of Maingna, about 16 miles north of Ka-cho, the Burmese frontier was reached. The country beyond is inhabited by Kachins or Kansa-Kachins, among whom no Shans reside, and the people pay no tribute to Burma. Two days afterwards the village of Pouk-san-poon was reached, whence a view was obtained of the junction of the eastern and western branches of the Irrawaddy River, about 5 miles to the north-west. The western branch (called the Malee-ka) had previously been noticed to be considerably swollen and about 500 paces wide, while the eastern branch (called Meh-ka), which was now reached, was found to be low and flowing in a stream about 100 paces wide, down rapids and over large rocks. The people of the country stated that the great increase in the waters of the western branch was due to the melting of the snow at its sources, and there can be little doubt that the western branch is the larger of the two and rises in higher ranges.

192. Such information as could be obtained from the natives of the country was to the effect that the eastern branch has two principal affluents, one flowing from the east, which is believed to have its source in the Naungsa Lake, and the other from the north, which is said to rise in the hills at six days'

journey from Mo-goung-poon, the days' journey being reckoned at eight to ten miles. Of the western branch it was stated that its sources are in the "Kantee country," at a distance of about 23 days' journey from Ka-cho. Thus it is highly probable that this is the branch of the river reached by Wilcox in his journey from Assam in 1827, which is described in Volume XVII of the Researches of the Asiatic Society of Bengal, Calcutta, 1832. The explorers' "Kantee" is obviously identical with Wilcox's "Khanti."

193. In the accompanying map of Some Sources of the River Irrawaddy above Bamo, the country below the parallel of 26° 30' is taken from a map by Captain Sandeman, which was compiled solely from the explorers' field books, and in which the adopted origin is the position of Bamo—latitude 24° 16', longitude 96° 53' 47"—which was determined in 1868 by Captain Bowers and first employed in the map illustrating Dr. Anderson's report on the expedition to Western Yunan (Calcutta, 1871). The country north of the parallel of 27° is taken from Wilcox's map of his surveys and routes in Upper Assam and Burma during 1825 to 1828. A portion of a smaller-scale map by Father Desgodins to illustrate a paper on the eastern frontier of Thibet, which he has recently presented to the Asiatic Society of Bengal, is also given for comparison. It will be seen that the information obtained from these three independent sources is fairly accordant, though greater exactitude is still a desideratum of importance for correct geography. The adopted longitude of Bamo, on which the lower portion of the map is based, is about 4 miles to the west of that employed by Colonel Yule in the map published in his "Narrative of the Mission to the Court of Ava in 1855," and 10 miles to the west of that assigned by Wilcox in 1828, not from actual survey but from such information of itineraries as was then available. The new value was determined by Captain Bowers, of the mercantile Marine Service, when he visited Bamo as one of the members of the Yunan expedition; Dr. Anderson states that Captain Bowers had much previous experience in astronomical observations, was a very careful observer, and devoted many a night to the object of determining the positions of Bamo. Wilcox's longitudes in Assam, on which the upper portion of the map is based, have been very closely corroborated by recent operations of the Great Trigonometrical Survey; but Wilcox does not appear to have been able to take any observations for longitude when he reached the Irrawaddy River; thus his map of the country between Assam and the Irrawaddy rests on a route survey, which was executed under considerable difficulties and was checked only by observations for latitude. There may possibly be a little too much easting in the upper and too much westing in the lower portion of the accompanying map; but under existing circumstances it is preferable to show the results of each survey independently of the other, and to postpone any attempt to combine the two until a survey has been made of the as yet unknown course of the main branch of the Irrawaddy, between Wilcox's Moong-Khanti and the explorers' junction of the Malec-ka and Meh-ka Rivers.

XXVI.—SURVEYS AROUND GILGIT.

194. Colonel Tanner was returning to recess quarters to bring up his mapping and calculations of work done during the summer of 1880, and had reached Lahore, when he was ordered back to Sirinagar and placed in command of a body of troops in the service of the Maharajah of Kashmir, under instructions to proceed to Gilgit for the relief of Major Biddulph, the Political Officer, whose safety had been imperilled by a general rising of the surrounding tribes with the avowed intention of subverting the authority of the Maharajah in those regions. This has prevented him from completing his mapping or doing more than submit a brief report of his survey operations. He has, however, intimated that, with the assistance of his native Surveyor, Ahmed Ali, he made a small-scale geographical survey of an area of about 2,000 square miles during the last field season, and that the limits of the Gilgit map now extended as far south-east as Astor, northwards to the great range which separates little Guhjal from Gilgit, southwards to Chilas, and westwards to the mouth of the Wurshigum River at the entrance to the Yasin Valley. Several of the spurs which run

down from the range west of the Khagan Valley to the Indus have been fixed, but the names of the valleys between them have not been ascertained. The positions of several far distant peaks on the Hindu-Kush range have been fixed, and among them the summit of the notable Tirich Mir mountain, first brought to notice by Major Biddulph, which lies to the north of Chitral, and rises to a height of between 24,000 and 25,000 feet as approximately deduced by Colonel Tanner from his preliminary calculations.

XXVII.—THE TIDAL OPERATIONS.

195. These operations are progressing very satisfactorily, in accordance with the programme prescribed by the Government of India, for obtaining a systematic record of tidal phenomena on Indian coasts, which is given in section XI of the General Report on the Operations of the Great Trigonometrical Survey for 1876-77. When the last annual report was submitted, self-registering tidal instruments had been set up and were in operation at eight ports,—*viz.*, Aden, Kurrachee, Bombay, Karwar, Beypore, Paumben, Madras and Vizagapatam; these instruments have been in operation throughout the year now under review; similar instruments have also been set up and are now operating at six additional places,—*viz.*, False Point, Rangoon, Elephant Point, Amherst, Moulmein and Port Blair; self-registering anemometers and aneroid barometers and verificatory mercurial barometers have been erected at all the tidal stations with the exception of Kurrachee, Bombay and Madras, at the first of which they shortly will be erected, but not at the two last, where there are meteorological observatories from which all necessary information for the reduction of the tidal observations may be readily obtained.

Personnel.
Captain A. W. Baird, R.E., Assistant Superintendent 1st grade.
Mr. W. G. Beverley, Officiating Assistant Superintendent 2nd grade.
Mr. T. H. Rendell, Assistant Surveyor 1st grade.
Mr. E. J. Connor, Assistant Surveyor 1st grade.
Dhondu Vinayek, Sub-Surveyor.

196. At Aden the new tide-gauge of the standard pattern which was erected in March 1879, in place of the small one previously set up by the port authorities, has been working very satisfactorily, and there has been no interruption whatever in the registration of the tidal curves. The anemometer and aneroid barometer have also been working satisfactorily. Daily reports have been received in weekly batches by the mail steamers, and an inspection was made by Mr. Rendell in January 1880. The Port Officer, Mr. Thynne, has rendered constant and valuable assistance. Two years' observations have been reduced by Captain Baird, and they form the basis of the Tide Tables for 1881, which are now being published.

197. At Kurrachee the old small-scale tide-gauge, set up many years ago for Mr. Parker, has been employed throughout the year, because a press of work, caused by the war in Afghanistan, prevented the port officers from setting up the new instruments, though a complete set had been supplied by the middle of the year. An inspection was made by Captain Baird in November 1879; some six years' observations with the old gauge then remained unreduced and were handed over to Captain Baird, by whom they have now been finally brought up and analysed: the results are given in the appendix.

198. At Bombay the tide-gauge on the Apollo Bunder has continued to work most satisfactorily: it has been inspected on two occasions by Captain Baird and Mr. Rendell. Another tide-gauge is in readiness to be set up near the entrance to the Prince's Dock.

199. At Karwar the action of the tide-gauge was satisfactory, being continuous with a few trifling exceptions. The anemometer also worked well throughout, but not the aneroid barometer. Inspections were made on three separate occasions, on the last of which the whole of the instruments were taken to pieces and cleaned, and the driving-clocks were also cleaned.

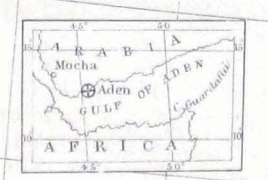
200. At Beypore the observations have been registered very satisfactorily, the aneroid being the only instrument which has given trouble. Inspections were made on three separate occasions during the course of the year. The arrangements for connecting the well of the tide-gauge with the sea had to be modified on one occasion in order to prevent the piping from becoming choked

OUTLINE MAP OF INDIA

shewing the positions of the

TIDAL STATIONS

Scale of English Miles



Kurrachee
Gulf of Cutch
Nowanar
Okha
Hansiat
Bhownagar
Bombay
Carwar
Madras
Beypore
Negapatam
Paumben
Tuticorin
Vizagapatam
False Point
Calcutta
Diamond Harbour
Saugor
Akyab
Kyouk Phyoo
Bassein
Rangoon
Elephant Point
Moulmein
Amherst
Diamond Island
Mergui
Port Blair

REFERENCES.

- ⊕ Tidal Stations where observations are in progress.
- ○ Tidal Stations to be established during season 1880-81.
- ● Tidal Stations where observations have been completed.
- \+ Places where sites have been selected for Tidal Stations, and where observations will be taken when instruments are available.
- ✳ Places where Tidal observations have been taken with inferior instruments, by Irrigation and other Departments.

Lithographed at the Surveyor General's Office, Calcutta, November 1880.

by mud; but this was accomplished without any sensible interruption in the continuity of the register.

201. At Paumben continuous results have been obtained from the tide-gauge, though an accident happened which might have destroyed the value of the register but for the timely and judicious assistance rendered by the Port Officer, Mr. Baker. The band connecting the float with the registering apparatus parted, just above the float; a re-connection was immediately made, but the relation of the pencil on the barrel to the zero of the gauge was necessarily altered in so doing; and the new registration would have been worthless without a determination of the amount of the alteration. Mr. Baker promptly came to the rescue and made the necessary measurements, on being telegraphed to by Captain Baird to do so. The aneroid barometer has worked well, but not so the anemometer, the clock of which has stopped several times. Paumben is difficult of access, but Mr. Baker being resident on the spot, it has not been necessary to make more than one inspection of the observatory during the year.

202. At Madras the communication between the tidal observatory at the shore end of the pier and the sea was destroyed by a cyclone in May 1879; an attempt to restore the communication, by means of a syphon tube laid under the roadway of the pier above the action surf, failed because of the difficulty of expelling the air out of the great length, nearly 600 feet of horizontal tubing. It was obvious that no permanent observatory could be erected until the completion of the breakwater which is now under construction. Meanwhile, a temporary station has been erected at the head of the pier, with the special sanction of His Grace the Duke of Buckingham, on the condition that the space occupied should be the minimum possible and that the observatory should not interfere with the traffic. The action of the surf is so violent that it was necessary to employ a small cylinder, 7 inches in diameter, instead of one of the usual size, 22 inches in diameter, for the float of the tide-gauge to work in. The cylinder is held in position vertically by three stout iron bars driven to a depth of about 9 feet into the ground, and the whole is attached by a system of chain lashings to the contiguous piles of the pier. The sea-water enters the bottom of the cylinder through a rose, which is intended to keep out the sea-weed; it then ascends through a perforation about an inch in diameter in the centre of a block of wood two feet long, which serves as a plug to the cylinder, and is capped by a metal plate, with a perforation $\frac{1}{8}$ of an inch in diameter. Thus the momentary undulations of the surface are not transmitted into the cylinder, the water in which rises and falls exactly with the tide, as has been shown by an independent verificatory gauge. The change in the cylinder necessitated the employment of a float specially constructed for these observations, and various modifications of the general arrangements and procedure, all of which have been carefully thought out, and are acting satisfactorily. In consequence of the vibrations to which the flooring of the observatory was subjected not only by the action of the sea but by the bumping of the cargo-boats against the pier and the rolling of the landing trucks, it was necessary to substitute a clock with a spring escapement for the ordinary pendulum clock by which the barrel of the gauge is usually driven.

203. The observatory and the cylinder were entirely put up under the superintendence of Captain Taylor, the Master Attendant for the Madras Presidency, to whom Captain Baird expresses himself as much indebted for the trouble he has taken to ensure success in every particular. The work was completed in January 1880, when the registrations were resumed, and they have been continued without any interruption up to the present time.

204. At Vizagapatam the tidal observations have proceeded satisfactorily; the anemometer has worked very well, but the aneroid barometer has given much trouble, necessitating constant reference to the mercurial barometer. The observatory was twice inspected, and on one occasion the clerk in charge was found to have been very negligent in rating his clocks; this work is now done under the immediate superintendence of the Port Officer.

205. At False Point considerable difficulty has been met with in obtaining a suitable site for a tidal station. The site first proposed was at Reddie Point, the extreme north end of Dowdeswell Island; but Captain Baird found it would not answer because of the varying configuration of the foreshore, the

difficulty of access and distance from the only inhabited locality in the island, the length of piping which would have been necessary to effect a connection between the sea and the observatory, and finally the general doubt of the safety of any structure erected on a moving sand-spit. He decided on erecting the observatory on a staging of piles in the harbour opposite the place called Hookey Tolah; here a few feet of piping suffices for connection with as deep water as is essentially necessary for the observations. The staging is well secured by a mass of stone rubble, and may be regarded as fairly permanent; the observatory is only accessible by boat, which is an objection, but the distance from the shore is not more than 300 yards, and the clerk in charge can readily cross at pleasure. The staging and observatory were reported complete by the Department of Public Works in September 1880, and the regular registration of observations was commenced immediately afterwards; a recent inspection has shown that the staging is not sufficiently firm to resist a strong gale of wind, and arrangements are being made for it to be materially strengthened.

206. At Rangoon a site for the observatory was selected in February 1880 by Captain Baird, in concert with the Port authorities, on the Latter Street wharf. All necessary preliminaries having been completed, the instruments were set up and registration was commenced in the same month, and has gone on satisfactorily ever since. An inspection was made by Mr. Rendell in August. As there is sometimes an interval of nearly half an hour between the turn of the tidal current and the times of high and low water, the clerk in charge has orders to note the time of the turn—as indicated by the swing of vessels at anchor in the river—and enter it in the observatory records, as often as he can conveniently do so.

207. At Elephant Point the observatory is about 50 yards from the telegraph office. It was completed and the instruments were at work by the middle of May 1880, and when inspected in August all was going on satisfactorily; shortly afterwards the piping connected with the sea was carried away by the tide, and a break of ten days on the registration was caused thereby. It is feared that a similar accident may again occur, as the bank is being constantly undercut by the very strong current which rushes past Elephant Point. The water is here highly charged with mud, which is liable to be deposited in the cylinder and piping; special arrangements have therefore been made to flush them out from time to time whenever desirable. The clerk in charge is one of the assistants in the telegraph office, who was authorized by Colonel Murray, the Director General of the Telegraph Department, to undertake the work in addition to his regular duties.

208. At Amherst the observatory is 20 feet to the north of the water pagoda, and is built, like it, on posts let into the rock. A well had to be sunk in the rock for the cylinder and a groove cut for the reception of the piping. Observations were commenced on the 30th July 1880, but it appears that the well was not sunk to a sufficient depth, as some low tides have since occurred which the instrument could not register. This must be rectified at an early opportunity. The observatory is only accessible at the times between mid-tide and low water, and by the causeway between the water pagoda and the mainland. The clerk in charge is a Telegraph Assistant; the anemometer and barometers have therefore been set up in the telegraph office for convenience.

209. At Moulmein an observatory has been set up on the main wharf opposite the Master Attendant's office, in which the anemometer and barometers are kept. Registrations were fairly commenced in April, and the work, up to the present time, has been satisfactory, but with a few breaks, owing to the occasional stoppage of the pendulum clocks, by the vibrations of the wharf, which is far from being as rigid as is to be desired. Here, too, the turns of the tidal current are observed and noted as at Rangoon.

210. Captain Bean, the Master Attendant, exercises general supervision over the observatories at Amherst and Moulmein, and Captain Baird states that he is much indebted to him for his valuable assistance and hearty co-operation.

211. At Port Blair an observatory has been set up close to the pier on Ross Island. It rests partly on the stone wharf and partly on piles, and is opposite to the Port Officer's house. Registrations were commenced in March 1880, and have been continuous up to the present time, excepting as regards the anemometer. The clerk in charge is a licensed European convict, who is also

the Port Signaller. Daily reports are sent to Captain Baird in two batches monthly by the mail steamers.

212. The barrels of all the tide-gauges are 5 feet in length, and are capable of producing diagrams of the curves of all tides of an amplitude not exceeding 5 feet between extreme high and low water on a natural scale. A gear of wheels is supplied with each instrument to enable tides of the largest amplitude to be delineated within the limits of the paper; for this purpose the scales can be changed to $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$, $\frac{1}{6}$, and $\frac{1}{8}$ of the natural scale. In all cases the largest scale that can be employed is the one adopted. The order of scale at the several ports is the following: *Natural scale*, Madras and Paumben; *one-half*, Aden, Karwar, Beypore, Vizagapatam, and Port Blair; *one-third*, False Point; *one-fourth*, Bombay and Moulmein; *one-sixth*, Rangoon, Amherst, and Elephant Point.

213. The measure of success to be obtained in the accuracy of the tidal registrations depends very greatly on the accuracy of the adjustment of the instrument both to true time and to a definitely fixed level, so that when the pencil in traversing the paper on the barrel crosses an hour-line, the time should be exactly that of the hour indicated; and when it crosses a height-line, the height indicated should be exactly that of the momentary height of the sea-level with reference to the bed plate of the instrument or any fixed bench-mark in its neighbourhood. The several adjustments and settings are, of course, made with great accuracy before the registrations are commenced, but this would be of little use if the instruments were not maintained uniformly in exact adjustment throughout the entire period of registration. Happily there is a telegraph office at every place where a tidal observatory has been established, with the exception of Port Blair, to which time-signals are sent daily from the Madras observatory; arrangements have therefore been made to correct the clocks of the several self-registering instruments to local time, whenever necessary, by communicating with the adjoining telegraph office. For the general examination of the instruments, Captain Baird has introduced a system of periodical inspections, which results in every station being inspected once or twice in the course of the year, or more frequently if necessary, either by himself or one of his assistants. He has also drawn up a programme of instructions as to the matters to be particularly attended to during these inspections, which cannot fail to bring to light any alteration in the adjustment of the tide-gauge or imperfections in the working of the instruments generally. Sometimes a native watchmaker accompanies the inspecting officer for the purpose of repairing and cleaning the clocks. On these occasions any instrument which is found out of order is thoroughly cleaned and repaired, or replaced by another in better condition.

214. The original supply of instruments was calculated to equip six tidal stations for investigations of secular variations in the relations between the land and sea levels, such as those which have already been commenced in the Gulf of Cutch and are described in previous reports. These operations have now been suspended until a sufficient interval elapses for changes of level to take place, of a magnitude exceeding the probable errors of the determinations of mean sea-level. Meanwhile, the instruments have been lent to the minor Indian ports, which cannot afford to purchase new ones; all the principal ports have, however, been required to pay for their own instrumental equipment. In all cases the instruments have been constructed, as formerly, by Mr. Adie of London; but with various modifications and improvements, which Captain Baird's long experience in their practical manipulation has enabled him to suggest.

215. The clerk in charge of each observatory is required to send Captain Baird a daily report, which gives the hourly readings of the tidal diagrams and various items of information regarding the performances of the several instruments, which indicate whether everything has been going on properly. This report is very useful as a check on the vigilance of the observer, and a precaution against the loss of the diagrams in transmission to Captain Baird's office. The paper on the barrels of the tide-gauges is usually taken off once a week; the curves are inked in daily by the clerk in charge whenever he visits the observatory; ink of different colours is used for different days, to enable the curve of each day to be readily identified, whenever there is any overlapping, as not unfrequently happens.

216. When the whole of the diagrams for any port have been received in Captain Baird's office, whatever corrections may be necessary to the hour-lines for clock error, and to the height-lines for changes of zero or contraction of paper, are carefully made, and marked on the diagrams; then, the momentary heights corresponding to the hours are measured and tabulated. These values furnish the basis of all the subsequent calculations, by the method of harmonic analysis, as described in the Annual Report for the Great Trigonometrical Survey for 1876-77.

217. The calculations are very laborious, but fortunately they can mostly be put into a form for mechanical computation by any intelligent natives who know a little arithmetic and the use of logarithm and multiplication tables. Captain Baird has succeeded in doing this in a most satisfactory manner: by apportioning the different stages of the calculations among different computors and introducing a careful system of checks, an enormous amount of work, in the calculation of the constants for the several tidal stations, has been performed, which is highly creditable to the office.

218. The values of the constants are forwarded by Captain Baird without delay to Mr. Roberts, of the *Nautical Almanac*, to be employed in the preparation of tide-tables for each of the ports with the aid of the tide-calculating machine which he constructed for the Indian Government, as previously reported. Tide-tables for 1881 have already been computed and printed for Aden, Karachi, Okha (Gulf of Cutch), Bombay, Karwar, Beypore, Paumben, and Vizagapatam, on the basis of Captain Baird's constants. When it is remembered that up to the present time such tables have been published for no ports in India but Bombay and Karachi, the services which Captain Baird has already rendered to the Marine Authorities and navigation generally will be readily understood. I have every reason to be well satisfied with his assiduous devotion to his work, and the skill with which it is performed.*

XXVIII.—THE SPIRIT-LEVELING OPERATIONS.

1.—The Spirit-Leveling Operations in connection with the Tidal Observations.

219. These operations have been conducted under the direction of Captain Baird by Mr. Belcham, with a view to connecting the several tidal stations at different points on the Indian coasts by lines of spirit-levels, and while so doing to connect all the collateral bench-marks of the Irrigation and other Departments and reduce them to a common datum. The line from Bombay along the Great Indian Peninsula Railway, which had been carried last year to the station of Kem, was extended this year a distance of 223 miles *vid* Gulburga to Raichur, where it was connected with the line of levels from Bangalore to Kárwár, which had been executed in 1873-75. From Gulburga a branch line of levels, 75 miles long, was carried to the Bider Base Line, one of the fundamental bases on which the principal triangulation of India depends for its linear elements. Another branch line was carried from Sholapur to Bijapur, a distance of 93 miles; smaller branches, of an aggregate length of 44 miles, were carried to connect the collateral bench-marks. In all 435 miles were leveled, in accordance with the prescribed rigorous system of operation and by two observers working independently over the same line and comparing results; 28 stone bench-marks were set up, and 337 permanent points, of which 28 were bench-marks of the Irrigation Department, were connected for future reference. The whole constitutes a very good outturn of work for the field season.†

Personnel.

Captain A. W. Baird, R.E., Assistant Superintendent 1st grade.
Mr. G. Belcham, Surveyor 4th grade.
Sub-Surveyor Narsing Dass, and two Recorders.

* Mr. Beverley joined the Tidal Office in July 1880, and was taken, with Mr. Belcham, on a tour of observatory inspection by Captain Baird in the following September, in order to acquire a knowledge of the instruments and general arrangements. Mr. Rendell has been employed almost entirely in the erection of the new observatories, and has worked well. Mr. Connor has been solely employed on the calculations: he is most painstaking and diligent, and his services have been very valuable. Dhondu Vinayek, Sub-Surveyor, is one of the few educated Brahmins who is ready to travel anywhere by land or sea at a moment's notice, without demur; he has been chiefly employed in teaching the observatory clerks their duties, which he does very well.

† Captain Baird reports that both Mr. Belcham and Narsing Dass have done work which is very good and to his entire satisfaction.

2.—THE SPIRIT-LEVELING OPERATIONS IN CONNECTION WITH REVENUE SURVEYS.

220. The Chief Commissioner of British Burma having sanctioned the taking of levels in connection with the cadastral surveys in that Province, operations have been commenced in the Hanthawaddy District, where a small leveling party has been employed under the orders of Captain Sandeman, the executive officer in charge of the cadastral survey. Two Assistant Surveyors were successively detached for the leveling, but unfortunately both in turn fell sick, and only 30½ linear miles were accomplished. The plan of operations in the part of the District where the cadastral survey is now progressing is for lines to be run at distances of about 10 miles apart, and laid down on the maps of the Survey.

XXIX.—GEODETIC.

221. The electro-telegraphic operations, for the determination of differences of longitude, have had to remain in abeyance for another year, no officers being available to carry them on. Lieutenant-Colonel Maxwell Campbell, R.E., who was associated with Captain Heaviside, R.E., in the operations described in Section XII of the Report of the Great Trigonometrical Survey for 1876-77, returned from Afghanistan at the end of the field season and has been employed since then in preparing the volume of the Account of the Great Trigonometrical Survey which will give the details of the longitude operations of previous years. Arrangements were made for the work of observing to be resumed in the following field season, and it is now being proceeded with by Lieutenant-Colonel Campbell and Captain Heaviside, on the telegraph lines connecting Kurrachee with Calcutta.

PART II.

THE OPERATIONS AT THE SEVERAL HEAD-QUARTERS' OFFICES.

222. These offices comprise—

(1) The Surveyor General's Office.
(2) The Revenue Survey Office.
(3) The Lithographic Office.
(4) The Photographic Office.
(5) The Mathematical Instrument Office. } All in Calcutta.
(6) The Trigonometrical Survey Office, at Dehra Dun.

The five offices in Calcutta are still located as formerly in different buildings, the Revenue Survey Office, which is that also of the Deputy Surveyor General, being at a considerable distance from all the others. Very deficient in accommodation when last reported on, they are still more so now, as they are incapable of expansion to meet the growing requirements of the Department, and to provide space for the annual increasing stock of maps for general issue. At last, however, the construction of a new set of buildings to contain the several offices has been commenced, and a building is now being erected which is intended to hold the whole of the Surveyor General's Offices, and the Revenue Survey Office, under one roof. There is sufficient space on the premises for the construction of buildings for the Lithographic, Photographic and Mathematical Instrument Offices also, as soon as funds can be assigned for the purpose by the Department of Public Works.

1.—THE SURVEYOR GENERAL'S OFFICE.

223. The superintendence of the work in this office devolves on Captain Riddell and Mr. J. O. N. James. Captain Riddell has the general charge of the accounts of the three branches of the Department and the immediate supervision of the expenditure and much else in the Topographical Branch in addition to his duties as Superintendent of the Lithographic and the Mathematical Instrument Offices. Mr. James, who returned from furlough and relieved Major Steel in October 1879, has the general charge of the Drawing, Engraving and Despatch Offices. The duties of both offices are most responsible and laborious, and the Surveyor General has much reason to be satisfied with the manner in which those duties have been performed.*

Personnel.

Captain R. V. Riddell, R.E., } Dy.-Supdts.,
J. O. N. James, Esq., } 3rd Grade.
H. Duhan, Esq., Personal Assistant.

DRAWING BRANCH.

Drawing and Compiling Section.

Mr. J. F. Baness, Chief Draftsman.
Mr. J. Peyton, Surveyor 1st Grade.
" F. Adams, " 3rd "
" W. Green, Draftsman.
" J. R. Adels, ditto.
" F. Volkers, ditto.
Munshee Sonaullah, ditto.
" Nabbi Baksh, ditto.
Mr. J. A. Higgs, Apprentice.
" A. J. Musgrove, ditto.
" W. P. Smith, ditto.
" R. C. Sinclair, ditto.
and 14 Native Draftsmen.

Geographical Examining Section.

Mr. A. Chamarette, Surveyor 1st grade.
" H. E. T. Keelan, ditto 2nd "
" A. J. Wilson, ditto 2nd "
" R. D. Farrell, ditto 3rd "
Baboo Mohesh Chunder Shaw,
and 3 others.

ENGRAVING BRANCH.

Mr. C. W. Coard, Superintendent.
" W. Donaldson.
" G. G. Palmer.
" D. L. Mitchell.
Mr. J. Fulford.
" A. G. Palmer.
" T. B. Rodger.
" S. M. Coard.
" A. W. N. James.
" A. R. Coard.
" A. D. M. Chamarette.
" E. A. Ollenbach.
22 Native engravers and 1 clerk.

Copperplate-printing Section.

Mr. W. T. Collins.
11 native printers and pressmen, &c.

CORRESPONDENCE BRANCH.

Mr. T. W. Babonau, Registrar.
" M. Francis.
" F. A. D'Rozario.
" T. E. Ware.
Baboo Bani Madhab Banerjee.
Mr. J. A. Vallis.
Baboo Bheeeum Sing,
and 6 others.

Accounts and Miscellaneous Section.

Mr. N. A. Belletty, Surveyor, 1st grade.
" E. D. Algar.
and 2 Native clerks.

Map, Record and Issue Section.

Mr. R. A. Gibson, Map Curator.
" H. R. Vallis.
" W. P. Abro.
and 1 Native clerk.

* Mr. T. W. Babonau and Messrs. Francis, D'Rozario, and Babooo Bani Madhab Banerjee and Bheeeum Sing, in the Correspondence Branch, have discharged their duties satisfactorily.

224. The work performed in the Drawing Branch during the past year was of the usual kind, *viz.*, compilations on various scales, and from various materials, for maps of the British Provinces, Native States and Afghanistan; maps to illustrate special reports; drawings for the sheets of the Indian Atlas reduced from departmental surveys; drawings for photozincography, of new editions of some of the standard sheets of old topographical surveys; copies of maps, plans, charts, &c., for various departments; and colouring of maps and plans for issue.

225. During the past year the demand for maps of Afghanistan has been great and very urgent; the compilation of new maps from time to time to embody all the latest geographical information as soon as possible after it reached the office has engrossed much of the working power of the office, and retarded the completion of various maps which were in hand and which, though of much importance, had to give way to more pressing requirements. The extensive survey operations in Afghanistan produced from time to time a large quantity of new materials which it was necessary to utilise speedily; thus, in the interval between October 1879 and August 1880, five editions of the large map issued under the successive titles of the two routes to Kabul and the Seat of War in Northern Afghanistan were compiled on the scale of 1 inch = 4 miles and published. Two editions of the map of Quetta to Kelat-i-Ghilzai and Girishk, and a first edition of the map of Sibi to Quetta and Thal-Chotiali to the Pishin Valley, have also been published on the same scale to provide for immediate requirements; as regards Southern Afghanistan and Beluchistan, a new map of these regions is under compilation and should be published shortly.

226. Additions have been made, as opportunity permitted, to the maps of India on the scales of 1 inch to 32 and 64 miles, and also to the provincial maps on the scale of 1 inch to 16 miles. The map of Bengal was ready for transfer to stone in outline when it became necessary to make numerous corrections to the boundaries of districts because of territorial alterations which had recently taken place under the orders of the Bengal Government; the hill-drawing for the western half of this map is nearly ready for the lithographer. The map of Assam, scale 1 inch = 16 miles, has been revised and completed to date in outline; a new compilation of Berar, scale 1 inch = 8 miles, has been commenced. Considerable additions have been made from recent survey materials to fifteen sheets of the Indian Atlas, and fourteen new sheets have been commenced. Four sheets of the old Ganjam and Orissa Topographical Survey, scale 1 inch = 2 miles; twelve sheets of the Hyderabad and three sheets of the Central Provinces Topographical Surveys, scale 1 inch = 1 mile, have been re-drawn and others are in hand; and a considerable amount of miscellaneous mapping has been completed. The details of all this work will be found in the usual tabular statement given in the appendix.

227. The employment of the pantograph for the reduction of survey results on the sheets of the Indian Atlas having been found both tedious and unsatisfactory, photographic reductions to the required scale are now employed instead; with careful manipulation in setting the reduced photographs on the points fixed by triangulation and the intersections of the lines of latitude and longitude, all desirable accuracy is obtained and the draftsman is less embarrassed in deciding what details should be omitted to suit the reduced scale of his drawing.*

228. The *Examining Branch* has worked very satisfactorily in the careful examination and scrutiny of all the mapping and field work received from the several survey parties, also of the work performed in the drawing office, and of the proofs from the lithographic, photozincographic and engraving offices; 40 of the standard sheets of the topographical surveys, 34 original compilations and drawings of various kinds and 254 proofs of engravings, lithographs and zincographs have been examined. In addition to this a large amount of miscellaneous work, including the projection of lines of latitude and longitude, and

* Mr. James reports as follows:—
Considerable improvement appears in the hill-shading by brush-work since Mr. Peyton joined the office; his excellent specimens of hill-drawing not only serve as models for the guidance of less experienced draftsmen, but are highly appreciated by the hill-etchers in the Engraving Office. Efforts are being made to introduce hill-shading by vertical hachures on the original maps prepared for the lithographers and engravers, and also for photozincographic reproduction, but the draft men are new to this style of hill-drawing, and time is necessary to perfect them in it. This measure, it is expected, will, if it can be satisfactorily carried out, enable the hill-etchers and lithographers to work with greater facility and accuracy from originals prepared in the style in which they express hills on copper and stone, than in transposing brush-shading into vertical hachure-shading.

trigonometrically fixed points and calculations of area, &c., for statistical reports has been performed.*

229. *Engraving Office.*—This office was primarily formed for engraving the sheets of the Indian Atlas on the scale of 1 inch = 4 miles. But, as there is a much larger demand for the several smaller-scale maps of India, and the various Provinces, and these maps require to be at least as highly finished as the Indian Atlas, new editions of those maps have either been already put into the hands of the engravers or are in progress with that object. Now, it so happens that there are still very large areas within and on the frontier of India which have not been surveyed at all, or only very roughly, so that the materials for filling in these areas on the maps are far less accurate and satisfactory than those for the areas which have actually been surveyed. In such cases the work of the engraver is restricted within the limits of exact survey, as it is not desirable that anything should be engraved on the copper-plate which may soon require to be erased. When the engraving is completed so far, a transfer is made from the plate to a lithographic stone, and the remaining details are drawn on the stone, which is a much quicker and less expensive process than engraving on metal. The map is then ready for publication as a preliminary edition. Even when the whole of the materials are exact, it is sometimes necessary to make a transfer from the copper to the stone, for maps containing much hill work, as soon as the engraving of the names and outlines is completed and before the etching of the hills is commenced; for etching on copper is a slow and laborious process; so a preliminary edition of the map with the hills drawn on stone is occasionally required as a make-shift until the more beautiful and highly finished etching on copper can be completed.

230. Of the map of India, scale 1 inch = 32 miles, sheet 1 of the Punjab and the North-West Frontier has been transferred to stone, but it requires large corrections for Afghanistan. Sheet 2 has been drawn on stone, as it contains incomplete geography relating to the northern portions of Nepal, Bhotan, and the course of the Sanpu River; sheets 3, 4, 5 and 6 are also ready for transfers to stone in outline. The blanks on these sheets for the unsurveyed portions within and beyond India will be drawn on stone from the best available maps of routes and explorations; the hills will also be completed on stone for a first edition. Large additions from surveys in progress have been made to the map of India, scale 1 inch = 64 miles, to complete it up to date, and a fresh transfer to stone has been taken. The maps of Bengal and Assam, scale 1 inch = 16 miles, have been completed in outline; the map of the Central Provinces, on the same scale, is nearly ready, and the maps of the Rajputana and Central India Agencies are near completion up to the limits surveyed. Twelve new quarter plates, which were in various stages of progress last year, have been completed and published, and twenty-six others have been fairly advanced either in outline and writing, or in hill-etching. Additions and corrections from surveys in progress and new lines of roads and railways have been inserted on nineteen plates, and repairs to outline, writing and hills have been well advanced on nine plates.

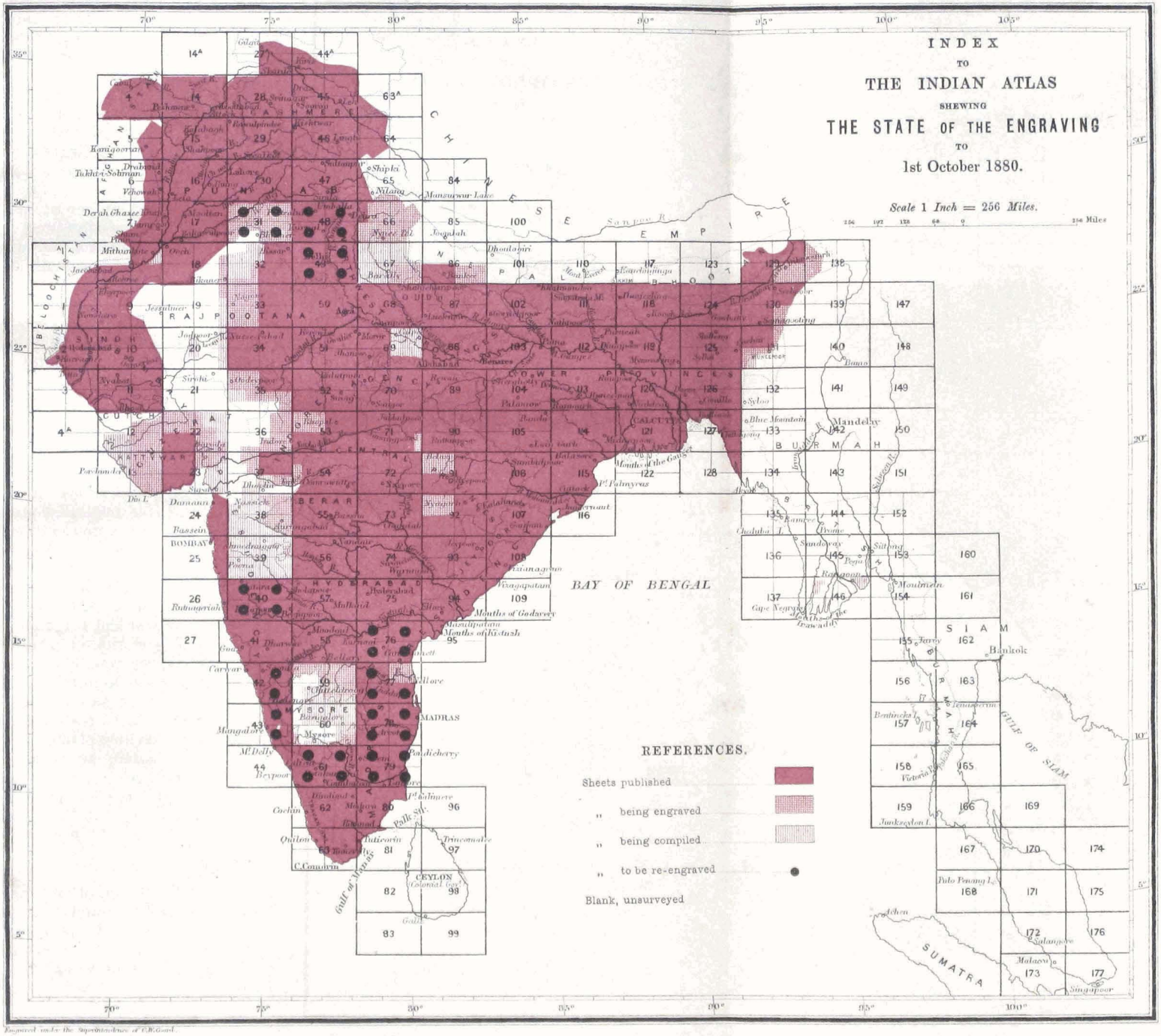
231. The total outturn, reckoned as it was last year, in square inches, is as follows:—

	Square inches.
New work, outline and writing	4,106
Do. hill-etching and sand-dotting	1,630
Repairs of old work { outline and writing	731
Repairs of old work { hills and sand	1,336

Owing to the intricacies of the work in its various stages of outline, lettering of different kinds and sizes, ornamentation, hill-etching, sand-dotting and corrections, and the number of hands through which each plate passes in various stages, it is very difficult to arrive at any satisfactory method of classifying and calculating with fair accuracy the actual outturn of work; but efforts are being made to arrive at some fairly accurate system of estimating the outturn and checking the cost.

232. In addition to the above, much useful miscellaneous work has been completed, a variety of scales have been engraved, a drawing of an idiometer

* Mr. A. Chamarette, Surveyor and Head Examiner, deserves much credit for the zeal and ability with which he performs his duties; his assistant, Mr. A. J. Wilson, has worked well and shows much aptitude as an examiner. Baboo Purna Chundra Sen has given satisfaction.



Published under the direction of Major General J. T. Walker, C.B., R.E., F.R.S., Surveyor General of India.

Surveyor General's Office, Calcutta, December 1880.

to illustrate one of the forthcoming volumes of the Account of the Operations of the Great Trigonometrical Survey has been very skilfully etched on copper, and a chart of the Indian ocean showing the localities of all wrecks has been commenced for the Marine Survey Department.

233. The process of steel facing continues to be performed on the copper-plates successfully, and without any detriment to the plates, such as happened when it was originally commenced in this office. Twenty-two of the new quarter plates of the Indian Atlas and seventeen of the old full plates (double elephant size) have been thus treated and printed from; none of the plates show the least sign of wear or of suffering from rust or other effects of climate. To preserve the steel facing it is sufficient to apply coatings of Brunswick black at stated intervals. The steel surface preserves the most delicate portions of the work on the copper plates from wear or deterioration in the press; thus it is no longer necessary to make transfers from the copper-plate to stone, that prints may be taken from the stone in order to preserve the plate, but prints are taken directly from the plate, and with the satisfactory result of being sharper and clearer than those from the stone. Full details of all the work completed and in progress in the Engraving Branch are given in the appendix.*

234. The Map Record and Issue Section has continued to work under considerable pressure caused by the large demand for maps of Afghanistan and the North-West Frontier; the issue of maps to agents for sale to the public has also been greater than usual. The applications received for maps by letters, indents and telegraph messages numbered 2,228; the letters issued either in reply or as advice were 1,290; the invoices and map receipts issued numbered 3,282. The total number of packets and parcels despatched were 5,774.

The map issues have been as follows:—

	Maps.	Value. Rs.	A.	P.
To Government officials	26,597	42,806	4	9
„ India Office, London	3,225	6,104	6	0
„ Agents for sale	3,974	8,095	1	0
Total . .	33,796	57,005	11	9

In this branch of the office 22,662 sheets of maps and plans were coloured by contract.† The amount realized by the sale of maps and placed to the credit of Government by this office, is Rs. 9,621.

235. The re-arrangement, classification under distinct heads in accordance with the present territorial divisions of India, and cataloguing of the original maps in the office have been gone on with as opportunity permitted. Section III, which comprises the river, canal and railway maps, has been completed; and Section IV, which comprises maps of civil divisions in the three Presidencies and Native States, is in hand. In these two sections, 1,734 maps in 4,071 sheets have been examined, grouped according to their respective divisions, labelled or ticketed, and numbered and catalogued. Formerly the maps were kept in rolls, but they are now folded suitably and laid flat, a form in which the maps are more easily accessible and less liable to injury. This work, which is likely to take more than a year to complete, was not commenced a day too soon, as the numerous changes which have taken place in the limits, both external and internal, of the several jurisdictions, provinces, districts and Native States in India had much impaired the value of the old registers of maps, and made most of them almost useless, so that much time was liable to be lost in searching for old records under different heads.

* Mr. C. W. Conrd, Superintendent of Engravers, has performed his duties satisfactorily and has paid good attention to the training of the native staff. Mr. W. Donaldson and Mr. J. Fulford, Outline and Writing Engravers, have rendered very efficient aid in various ways. Mr. G. Palmer's style and out-turn of hill-etching has been most satisfactory. Messrs. D. Mitchell and A. Palmer, hill-etchers, have worked well. Mr. S. Conrd has been very successful in steel-facing the engraved plates of the Indian Atlas and has shown considerable skill in mechanical engraving. The European apprentices under Messrs. Donaldson and G. Palmer have made good progress in hill-etching and are able now to take a share in regular work. Several of the native engravers have made good progress and are now employed both in hill-etching and writing on various plates.

† Early in the year Mr. T. W. Habonau was appointed registrar in this office and was succeeded in the post he previously held of Map Curator by Mr. R. A. Gibson.

2.—The Revenue Survey Office.

236. A summary of the results and cost of the field work of the several parties of the Revenue Branch is given at page 64. A statement of the principal records prepared in the executive offices is given in table A at page 62 of the appendix; a detailed statement of the work done by the Drawing Branch of the Head Office is given in table B at page 63 of the appendix; and table C, at page 67 of the appendix, shows the state of the publication of the cadastral maps.

PERSONNEL.

Lieutenant-Colonel J. Sconce, Deputy Surveyor General, and Superintendent, Revenue Branch.
Major F. Coddington, Deputy Superintendent, 2nd grade.

DRAWING BRANCH.

Mr. F. W. Kelly, Surveyor and Head Draftsman.
„ J. Connor, Assistant Surveyor and Draftsman.
Sheikh Mehir Ally, Draftsman.
„ Golam Mohamed, „
„ Abdul Aziz, „
„ Rohim Bux, „
and 5 other draftsmen and 7 colorists.

Map Examining.

Mr. J. A. May, Surveyor and Draftsman.
„ T. W. Reilly, „ „
Sheikh Abdur Razak, Draftsman.
„ Wahed Bux „

Computing and record examining.

Baboo Haribur Sen, Head Computer.
„ Tincowry Sen, Computer, and two others.

Cadastral map examining.

Mr. W. Sinclair, Surveyor and Draftsman.
Sheikh Kodrut Alli, Draftsman, and 5 other draftsmen and one clerk.

Records and map issue.

Mr. W. J. Lane, Assistant Surveyor.
Baboo Ashootosh Kur, and 1 other.

CORRESPONDENCE AND ACCOUNTS BRANCH.

Correspondence.

Mr. A. E. Byrn, Registrar.
„ A. C. Cunningham, Head Clerk.
Baboo Kallypudo Banerjee, Clerk.
„ Doorgaparain Ghose „
„ Ramkisto Chunder „
and 5 other clerks and copyists.

Accounts.

Mr. Gopal Chunder Lahn, Head Accountant.
Baboo Bama Churn Chuckerbutty, Accountant, and two others.

Despatcher.

Baboo Judo Nath Mookerjee.

237. The summary of the field work shows there has been an increase of 1,018 square miles in the cadastral area over the return of the previous year, while the general rate of 5 annas 8½ pie per acre is very similar to the general rate of the 16-inch surveys of last year, though all the old parties show a considerable reduction in their rates. The village survey area, on the 4-inch scale, is 2,373 square miles less than last year, chiefly owing to the abolition of one of the parties. The Topographical Survey area on the 2-inch scale by revenue survey parties is 378 square miles more than last year.

238. The following original maps received from Executive Officers have been examined and published during the year, *viz.*:—

Sirsa District	16	sheets on 1-inch scale.
Deccan Topographical Surveys (drawn in 24 sections on 2-inch scale)	6	„ „ „

The following maps drawn in the Head Office have also been published, *viz.*:—

Bannu and Dera Ismail Khan Districts (drawn in 36 sections on 2-inch scale)	9	sheets on 1-inch scale.
Midnapore District (drawn in 56 sections on 2-inch scale)	14	„ „
Muttra District (drawn in 28 sections on 2-inch scale)	7	„ „

The disposal of the cadastral maps has continued to occupy the attention of a large section of the office; 2,985 maps and the proof copies of 2,926 have been examined between 1st January and the 30th September, up to which date the return has been prepared to agree with the other returns of the department. All the maps have this year been published at the Photographic Branch of the Surveyor General's Office.

239. The records received from field parties during the year have all been carefully examined, and a percentage of the computations of 4 districts has been checked. Revised area statements of districts Midnapore, Hooghly, Muttra, and Jhung have been made according to revised limits. The preparation of the new register of the records in the Head Office has been continued. A large part of the correspondence section of the office continues to be employed in checking the bills of the field parties and in keeping the accounts of the Revenue Branch generally.

240. The Deputy Surveyor General again acknowledges the very valuable aid which Major F. Coddington, on duty in his office, has rendered to him.*

3.—Lithographic Branch.

241. The total number of maps, plans, diagrams, &c., printed during the year, amounts to 160,346 copies; of these 119,100 copies, or nearly three-fourths, were done for other departments and were very varied in character; the remainder were printed for the requirements of this Office.

Personnel.

Captain R. V. Riddell, R. E., in charge.
Mr. E. Jevezy, Head Assistant and Chief Draftsman (on furlough).
„ H. L. Lepage, Officiating ditto.
Mr. H. Ferns . . . .
Baboo Buloram Nath . .
Munshee Muhomed Azim . . } Draftsmen.
„ Sobhan Buksh . .
and 21 others . .
Mr. H. Niven, Chromo-Printer.
„ E. D'Pyrah, Printer.
1 Press Assistant and 17 others.
3 Native Clerks.

242. The map of the District of Maldah, on the scale of 1 inch = 1 mile, has been lithographed. The 1-inch = 1 mile maps of the Districts of Jalpaiguri and Noacolly have been taken in hand during the year, the former in 13 sheets and the latter in 12 sheets. The stock of several of the sheets of the Oudh map on the scale of 1 inch = 1 mile having become nearly exhausted, a second edition has been commenced; 3 sheets have been drawn, and the modern spelling has been adopted.

243. Maps of the Districts noted in the margin have been transferred to stone from the copper-plates of the sheets of the Atlas of India and published during the year. Similar maps are under preparation of six other Districts, *viz.*, Mymensing, Dacca, Furreedpoor, Backergunge, Noacolly and Sylhet. Copies of the sheets of the Atlas of India specified in the margin have been transferred to stone from the engraved plates, corrected up to date on the stone and printed to meet immediate demands, the original stock having become exhausted.

District Rungpore.
„ Dinagepore.
„ Shahabad.
„ Jalpaiguri.
„ Gya.

Quarter sheet, No. 66 S. W.
„ „ „ 71 N. E.
Full sheet, No. 68.
„ „ „ 111.
„ „ „ 103.
„ „ „ 104.

244. A preliminary edition of the map of India, scale 1 inch = 64 miles, with the outlines transferred from the copper-plate and the hills drawn on the stone in chalk, has been completed and published to meet immediate requirements pending the completion of the hill-etching on the copper, as the demand for this map is very great.†

4.—The Photographic Office.

Personnel.

Major J. Waterhouse, B.S.C., Assistant Surveyor General, on furlough from 11th December 1879.
„ S. H. Cowan, B.S.C., Officiating Assistant Surveyor General, in charge.

Negative Branch.

Mr. J. Mackenzie, Photographer.
„ C. Marshall, ditto.
„ L. Lagnier, ditto.
„ G. G. Dempster, ditto.
„ T. Lloyd, ditto.
and 10 assistants.

Silver Printing Branch.

Umbica Churn Bhattacharjee, Assistant Photographer, and 1 native assistant.

Zinc Printing Branch.

Mr. B. Mackenzie, Zincographer.
„ J. Watson, ditto.
„ E. A. LeFranc ditto.
12 zinc correctors, 12 printers, 7 grainers and 36 pressmen.

245. The tabular statements in the appendix give full details of the account and value of the work executed in this office on account of the Survey Department, and a summary of the work done in compliance with the

* Mr. F. W. Kelly, Surveyor 1st grade, has continued to do excellent work as Head Assistant in the drawing branch. Mr. Sinclair's duties in connection with the publication of the cadastral maps have been very laborious, and he has given entire satisfaction.

Messrs. J. A. May, T. W. Reilly, J. Connor and W. J. Lane, Surveyors and Draftsmen, have all worked well in their own branches of the office.

Mr. A. E. Byrn, Mr. A. C. Cunningham, Mr. Gopal Chunder Laha, Baboos Harrihar Sen, Kallypudo Banerjie, Doorgamurain Ghose and Judo Nath Mookerjee, together with the rest of the establishment, have all given satisfaction.

† In June last, Mr. Jevezy, who had been Head Assistant for 10 years, obtained furlough to Europe, and his duties have since been performed by Mr. Lepage.

Captain Riddell states that the following Draftsmen are worthy of special mention, on account of their skill and assiduity:—

Boloram Nath, Mahomed Azim, Dino Nath, Umbica Churn Mookerjee, Abdool Hamid, Abdool Moojid, Mahomed Yeasin and Deno Nath Dass.

Photographic Transfer Branch.

Mr. J. Harrold, Photographer.
„ R. George, ditto.
and 2 native assistants.

Office and Store Branch.

Mr. A. E. Caddy, Store-keeper and General Assistant.
Syud Ishmail, Head Clerk and Accountant, and 4 native clerks.

requirements of all other departments; also an abstract of the cost of the office.

246. The details of the work executed during the year are shown in the following table:—

Abstract of work performed in the Photographic Office, from 1st October 1879 to 30th September 1880.

	Original Section or Sheets.	Negative plates.	Photographic transfer prints.	Transfer to zinc or stone.	Number of pulls.	Number of printed sheets of each subject.		Silver and other prints.	Remarks.
Topographical maps	72	224	189	58	7,527	7,527	7,527	...	
Revenue Survey „	288	383	469	56	10,658	10,678	10,570	...	
District maps	...	...	...	2	310	310	310	...	
General „	13	2	...	38	5,980	4,350	4,350	...	
City and Cantonments. Plans	12	55	55	14½	2,680	39,664	685	...	
Miscellaneous Department	502	637	573	409½	31,342	2,685	31,471	...	
Ditto extra-departmental	542	628	649	390	64,058	1,91,431	1,85,371	...	
Transfers and proofs	...	...	...	...	2,595	...	...	...	
Pigment prints	...	...	...	...	...	...	...	29	
Platinum „	...	...	...	...	...	...	...	56	
Silver „	...	...	...	...	...	..	...	932	
Total	1,429	1,929	1,935	968	125,150	256,670	140,309	1,017	
Cadastral, North-Western Provinces	...	...	...	...	...	...	...	...	
Photozincographs	2,000	2,000	2,105	2,160	58,307	58,307	41,578	...	
Zincographs	408	...	...	367	9,369	9,369	8,544	...	
Total	2,408	2,000	2,105	2,527	67,676	67,676	50,122	...	
Cadastral, Lower Provinces	...	...	...	...	...	...	...	...	
Photozincographs	941	909	910	941	39,689	39,689	11,739	...	
Zincographs	73	...	...	73	3,913	3.913	2,050	...	
Total	1,014	909	910	1,014	43,602	43,602	13,789	...	
Cadastral, British Burma, Photozincographs	5	5	1	1	120	120	120	...	
Transfers and proofs for cadastral maps	...	...	...	...	7,006	...	...	...	
Grand Total	4,856	4,843	4,951	4,510	243,554	368,068	204,340	1,017	

247. The number of cadastral maps of the North-Western Provinces published during the year is 2,527, of which 2,160 were photozincographed, 113 were printed from re-transfers and 254 from transfers traced by hand. It is satisfactory to note that a large proportion of these were the results of field work of the cold season of 1879-80. Of the Government estate of Khorda in District Pooree 1,014 maps were published, of which 941 were photozincographed.

The work done for other departments forms a very large proportion of the total outturn of the office, amounting to upwards of $\frac{2}{3}$ of the whole, excluding cadastral maps.*

5.—THE MATHEMATICAL INSTRUMENT DEPARTMENT.

248. During the year 1879-80 the receipts of instruments in the depôt were as follows: about 250, in value Rs. 8,200, were obtained from England; nearly 1,300 were purchased in the local market, at a cost of a little more than Rs. 6,900; about 4,500 were manufactured on the premises, at a cost of Rs. 13,300; over 7,700 instruments, in value about

Personnel.

Captain R. V. Riddell, R.E., Superintendent.

Workshop Branch.

Mr. R. Wehlisch, Mathematical Instrument Maker (on furlough).
Mr. T. Bolton, Officiating Mathematical Instrument Maker.
Mr. J. Keymer, Officiating Assistant Mathematical Instrument Maker, from 1st April to 8th September 1879.
Mr. B. J. Cardozo, Officiating Assistant Mathematical Instrument Maker, from 1st December 1879 to 31st March 1880.
66 Permanent artificers and on an average 77 temporary artificers.

Store Branch.

Mr. G. R. Alderman, Store-keeper
Baboo Womesh Chunder Chowdry, Packing Sircar.

Office Establishment.

Mr. M. O'Brien, Head Clerk.
„ J. W. Collins, 2nd „
6 other Permanent Clerks and 2 Extra Clerks.

* Major Cowan speaks very favourably of Messrs. J. Mackenzie, B. Mackenzie, J. Harrold, and Caddy; he also commends Messrs. Marshall, Lagnier, and LeFranc.

Rs. 67,000, were received by inter-departmental exchange; of which about 290 were serviceable, and 4,800 were repairable. The serviceable stock was further increased by more than 4,300 instruments which had been repaired and rendered fit for future issue, at a cost of a little over Rs. 13,300, and after repair were valued at nearly Rs. 45,600. Over 1,600 instruments were repaired for various departments at a cost of Rs. 11,522.

249. More than 14,000 instruments, in value over Rs. 1,07,200, were issued during the year, *viz.* :—

	Approximate Number.	Approximate Value.
To the Survey Department	5,450	37,600
„ Marine „	25	980
„ Telegraph „	13	460
„ Military „	390	9,770
„ Public Works „	2,740	32,500
„ Educational „	480	2,210
„ Miscellaneous „	4,680	20,630
„ Road Cess Committees, District Engineers, &c., entitled to receive instruments on payment	185	2,200
„ Workshop to complete repairs of instruments	140	880
	14,103	1,07,230

The principal instruments issued were of the same class, for the several departments concerned, as those enumerated in paragraph 355, page 70 of the General Report for the year 1878-79.

250. The following statement shows the detail of the principal instruments locally purchased, their cost, and, as far as comparison can be made, the excess of the Calcutta prices over the values at which they would have been issued had they been procured from England.

Names of Instruments.	No. of instruments purchased.	Amount paid in Calcutta.	Issue value of corresponding instruments obtained from England.	Excess of Calcutta prices over issue value.
		Rs. A. P.	Rs. A. P.	Rs. A. P.
Barometers, aneroid, pocket	16	965 8 0	750 0 0	215 8 0
Compasses, Napier's, and pillar	5	128 0 0	99 0 0	29 0 0
Lenses, reading	24	70 4 0	52 0 0	18 4 0
Levels, reflecting	7	271 0 0	230 0 0	41 0 0
Protractors	46	558 0 0	408 0 0	150 0 0
Scales, plotting, &c.	90	540 0 0	452 0 0	88 0 0
Sextants, pocket	4	360 0 0	260 0 0	100 0 0
Tapes, measuring	475	3,470 0 0	2,893 0 0	577 0 0
Total	667	6,362 12 0	5,144 0 0	1,218 12 0

It is not easy to form an exact estimate in all cases of the values at which instruments locally purchased might have been procured from England, for so much depends on the quality of the instruments; but, as far as a comparison can be made, the result shows that the rates paid here were about 25 per cent. in excess of the rates at which the several instruments might have been issued had they been procured from England. The purchase of instruments to the value of at least Rs. 2,000 was due to sudden demands to meet the requirements of the Afghanistan Expedition.

251. The principal instruments manufactured in the workshop are detailed below:—

Names of Instruments.	No. manufactured.	Cost of manufacture.
		Rs. A. P.
Boards, drawing	13	125 6 0
Chains of various sizes	316	2,226 11 0
Plane-tables	208	2,337 14 0
Rules, electrum, on rollers	72	1,536 7 0
,, sight, for plane-tables	78	496 14 0
Scales, offsets, metal	36	153 10 0
Squares, optical	100	647 10 0
,, set, wooden	144	122 6 0
Stands for plane-tables	115	1,156 6 0

The savings effected by departmental manufacture have been calculated at about Rs. 2,000, or very nearly the same as in the previous year.

252. Besides the ordinary instruments above referred to, an idiometer designed by Lieutenant-Colonel W. M. Campbell, R.E., which has for some time past been under construction, under his own supervision, has been completed. The object of this instrument is to afford means of measuring the absolute personal equations in observations of star transits recorded on a chronograph. The general arrangement is that of a moveable frame, carrying vertical wires, in imitation of the wires of a telescope, which passes in front of a fixed imitation star; a small observing telescope is attached to the wire frame, so as to follow its movements, and thus the appearance of fixed wires and a moveable star is obtained. As each wire passes the star two signals are recorded on the chronograph, one by the observer and the other automatically by the instrument.

253. The total number of instruments repaired in the workshop was about 6,000, and the value of the repairs has been calculated at Rs. 25,065. The principal instruments repaired were as follows:—

	Number repaired.		Number repaired.
Chains	582	Scales	729
Drawing instruments of sorts	1,025	Sextants	31
Compasses, prismatic	106	Squares, optical	312
,, surveying	176	Stands for various instruments	438
Levels, dumpy	79	Staves, levelling	65
Plane-tables	246	T squares	101
Rules, flat, and parallel	445	Theodolites	113
Rules, sight, for plane-tables	259		

254. The receipts from England were exceptionally small, the greater proportion of the stores due during the year having arrived after its termination.

255. The aggregate cost of the portion of the establishment which was employed in the construction and repair of instruments, the cost of the material expended, the share of office accommodation, the estimated loss of wear and tear of block, and other petty contingencies, amounted in all to about Rs. 41,750; this sum is almost exactly balanced by the value of work done as estimated in the case of instruments manufactured, by the value at which they are issued; and in the case of instruments repaired, by the difference between the value at which they are issued or placed in store for future issue and that at which they were rated previous to repair. The cost of the remaining portion of the establishment, including supervision, office accommodation, packing expenses, &c., was about Rs. 18,300. This may be considered to have been expended on the receipt and issue of over 32,400 instruments valued at about Rs. 2,16,000.

256. Towards the end of the year stock was taken, and, as the rating was found to be generally at too low values, the occasion was taken to make a re-valuation. The serviceable and repairable instruments taken together, exclusive of material, machinery, and plant, were found to be over 42,000 in number, and in value about Rs. 3,18,000.*

* On the 7th November 1879 Mr. Wehlisch, Mathematical Instrument Maker, returned from furlough, but in a few days was invalided to Europe as unfit for further service in India. Thus the duties of Instrument Maker again devolved on Mr. Bolton, by whom they have been carried out very satisfactorily. Arrangements have been made to secure the services of a trained Assistant Mathematical Instrument Maker from England.

6.—The Trigonometrical Survey Office.

257. The principal work of this office is the final reduction and publication of the triangulation of all parts of India, and the reproduction of the Surveys executed in the Trigonometrical Branch of the Department. The office being located at Dehra-Dún, at a considerable distance from Calcutta, has a Drawing Branch, a Photozincographic Branch, and a Printing Branch of its own; it is thus independent of all extraneous assistance in the matter of publication, excepting as regards the binding of its productions, which has to be done elsewhere—usually at Calcutta. The office has also a depôt of instruments and stores attached to it, chiefly containing the higher class of instruments appertaining to the Trigonometrical Survey, of which it has long been the Head-Quarters Office. It is now, and has for many years, been under the immediate and able superintendence of Mr. Hennessey, M.A.,F.R.S., who is well aided by Mr. Cole, M.A.

Personnel.

J. B. N. Hennessey, Esq., M.A.,F.R.S., Deputy Superintendent 1st Grade, in charge.
W. H. Cole, Esq., M.A., Assistant Superintendent 1st Grade.

Computing Branch.

Mr. C. Wood, Surveyor 2nd Grade.
„ H. W. Peychers, „ 4th „
Babu Gunga Persad, Computer.
„ Cally Mohun Ghose, „
„ Kally Coomar Chatterjee „
and 10 other Computers, &c.

Printing Branch.

Mr. M. J. O'Connor, Printer,
and 15 Compositors and Apprentices.

Correspondence and Stores.

Mr. L. H. Clarke, Surveyor 2nd Grade, from 1st October 1879 to 7th December 1879.
Mr. W. Todd, Surveyor 2nd Grade, from 8th December 1879 to 31st July 1880.
Mr. H. E. T. Keelan, Surveyor 2nd Grade, from 1st August 1880, and 2 Native Writers.

Solar Photography.

Mr. L. H. Clarke, Surveyor 2nd Grade, from 8th December 1879.

Photozincographic Branch.

Mr. C. G. Ollenbach, Zincographer.
„ C. Dyson, Photographer.
1 Native Apprentice Photographer.
2 „ Draftsmen.
1 „ Apprentice Draftsman, and 1 Map-keeper.

Drawing Branch.

Mr. W. Todd, Surveyor 2nd Grade, from 1st October 1879 to 15th November 1879.
Mr. G. W. E. Atkinson, Surveyor 3rd Grade, from 16th November 1879.
Jafir Khan, and 6 other Draftsmen.
1 Assistant Draftsman, and 14 Apprentices and Map Colourists.

258. The great work of the final reduction of the observations and measurements, both linear and angular, of the Great Trigonometrical Survey, and the publication of the results, has been making good progress.

259. The final reduction of the astronomical observations for determinations of latitude had long remained in abeyance, pending the publication by the principal observatories in Europe and other parts of the globe of star catalogues, giving the places of the stars to which observations have been taken with sufficient exactitude for geodetic investigations. The place-values which are given in different catalogues often differ materially, when reduced to a common epoch, and it is no easy matter to determine the exact position of a star at any time when it may happen to have been observed, during the period of 80 years which has elapsed since geodetic operations were commenced in India. This work, which is a necessary preliminary to the final reductions, has been taken in hand by Mr. Hennessey during the present year, and is being proceeded with very satisfactorily; it is now so far advanced that the printing of Volume IX of the Account of the Operations of the Great Trigonometrical Survey, which is intended to contain the latitude observations, has been commenced.

260. The longitude observations are of comparatively modern origin, having been commenced in 1872, by electro-telegraphic determinations of differences of longitude. Operations had been carried on through three field seasons, when they were put a stop to as no officers were available to go on with them. The return this year from Afghanistan of Lieutenant-Colonel Campbell, who had been employed in the whole of the operations already completed, has enabled the final reductions to be taken in hand. Thus the printing of Volume X, which is to be devoted to the electro-telegraphic observations and their results, has been commenced and is now well advanced.

261. The final reductions of triangulation have been principally those connected with the adjustment of various secondary chains of triangles, which depend on the already reduced principal chains that appertain to the three great sections of the principal triangulation known as, *first*, the North-West Quadrilateral, of which the results are published in Volumes II, III, and IV of the Account of the Operations of the Great Trigonometrical Survey; *secondly*, the South-East Quadrilateral, now being published in Volume VI;

and, *thirdly*, the North-East Quadrilateral, forming the subject of Volumes VII and VIII, not yet published. The final reduction of the two great sections of the principal triangulation which are still unreduced, *viz.*, the South-West Quadrilateral and the Southern Trigon, was initiated as soon as possible after the completion of the triangulation in the Madras Presidency,—see paragraphs 3 and 12.

262. Each of the volumes above mentioned requires much explanatory matter, descriptive of the general progress of the operations, and of the general principles on which the final calculations have been carried out in order to obtain the most probable results of the observations. This work has been completed for Volume VI during the present year, and commenced for Volumes VII and VIII, and has been mainly performed by Mr. Cole.

263. Volume V, giving the account of the Pendulum Operations, which was stated in the last report to be in the hands of the bookbinder, has been published, and presentation copies have been supplied to all leading scientific societies, libraries, and geodesists in all quarters of the globe. The printing of Volume VI was completed, and the sheets were ready to be sent to the bookbinders. It is expected that Volumes VII and VIII will be published by the end of 1881. Portions of the four following volumes have also been printed.

264. Of the Synoptical Volumes—which give a précis of the results of the triangulation, both principal and secondary, for the requirements of topographers and geographers—volumes 7 to 9 were published during the year, 10 to 13 were ready for the binder, and 14 more were well advanced towards completion.

265. The Auxiliary Tables for facilitating the calculations of the Indian Survey Department have been supplemented by a table of "mile-equivalents in feet and links," and a table for readily determining the so-called "subtended angle" for observations of unreciprocated vertical angles.

266. A pamphlet, giving the results of the spirit-leveling operations in portions of the Bombay Presidency, has been printed. A large amount of data of spirit-levels, taken by officers of the Irrigation Department in various parts of India, but chiefly in the Punjab, has been collected and is being embodied into the departmental charts of spirit-levels.

267. In the Drawing Office considerable progress has been made towards the completion of a fifth edition of the Turkestan Map; but the advent of new materials from various quarters, including Russia as well as Afghanistan, has much retarded publication, in some cases necessitating the re-drawing of large portions of the map.

268. Various charts of triangulation, with full numerical details, have been published, including the triangulations to Quetta, Khelat, and Kandahar. Ten charts have been prepared and photozincographed to illustrate the principal and synoptical volumes. All the maps of the current year's work of the Guzerat and Kattywar Topographical Surveys, and of the Forest Survey Department, have been published in this office, and also various maps of portions of Afghanistan, which were drawn at the Mussoorie Head-Quarters by Captain Holdich, Major Beavan, and Lieutenant Gore.

269. The taking of daily photographs of the sun,* which had been suspended since the death of Mr. Meins on the 31st March 1879, was resumed on the 17th December by Mr. L. H. Clarke, acting under Mr. Hennessey's supervision, and with occasional assistance from the Photographic Office. During the 289 days from 17th December 1879 to 30th September 1880, solar phenomena were visible on 191 days; no phenomena were visible on 47 days, and there were 51 days of bad weather when the sun was hidden by clouds and remained invisible throughout the day.*

* Mr. Hennessey acknowledges the valuable assistance he has received from Mr. Cole in general co-operation and supervision.

He also reports very favourably of the services rendered by Mr. Wood, and Baboos Gunga Persad and Cally Mohan Ghose in the Computing Office; and commends Messrs. Atkinson, Peychers, Ollenbach and Dyson.

Northern Section. Fourth Edition

TRIGONOMETRICAL BRANCH, SURVEY OF INDIA

INDEX TO LEVEL CHARTS OF THE G. T. SURVEY, PUBLISHED AND UNDER COMPILATION.

Sheet No. 1.

NOTE.—Great Trigonometrical Survey Main Series of levels thus

Charts published are colored Red

Do. under compilation „ Green

Data in hand for compilation „ Yellow

Each rectangle drawn on this Index. represents the area included in a single sheet (or chart) of levels.

Fourth Edition with corrections and additions up to October 1880.

COMPILED UNDER THE INSTRUCTIONS OF MAJOR T. G. MONTGOMERIE, R.E., F.R.S., &C., OFFICIATING SUPERINTENDENT, G. T. SURVEY OF INDIA, 1879.

Orthography is in accordance with the orders of Government.

Scale 1 Inch = 80 Miles or $\frac{1}{5068800}$

Miles

Photozincographed at the Office of the Trigonometrical Branch, Survey of India, Dehra Dún, January 1881.

C. G. OLLENBACH, Engr.

Abstract of the Outturn of Work executed by the TRIGONOMETRICAL PARTIES during the Survey year 1879-80.

Description of Details.	Madras Const series 24-inch theodolite.	Eastern Sind 24-inch theodolite.	Eastern Frontier 24-inch theodolite.	Totals.
Number of principal stations newly fixed	11	12	3	26
Do. do. triangles completed	16	16	4	36
Lengths of principal series in miles	68	64	33	165
Area of principal triangulation in square miles	2,001	1,278	670	3,949
Average triangular error in seconds	0″·26	0·34	·43	...
Do. probable error of angles in seconds ±	0·13	...	·37	...
Astronomical azimuths of verification observed	2	1	0	3
Number of principal stations selected in advance	...	...	...	...
Lengths of principal approximate series in advance	...	...	...	...
Number of towers, pillars and platforms constructed for principal stations	7	...	...	...
Number of scaffolds erected for principal stations	1	...	...	...
Do. principal stations placed under official protection	13	15	5	...
Do. do. do. protected and closed	...	13	...	...
Do. do. do. the elements of which have been computed	13	...	...	...
Do. secondary stations fixed	17	16	...	33
Do. do. triangles, of which all three angles have been observed	20	20	...	...
Do. do. do. of which only two angles have been observed	73	18	...	...
Lengths of secondary series in miles	90	60	...	150
Area of secondary triangulation in square miles	1,099	619	...	1,718
Do. embraced by triangulation to prominent points exterior to principal triangulation and in square miles	296	3,035	...	3,331
Number of points fixed by intersection, but not visited	65	107	...	172
Do. stations and points, the heights of which have been determined	57	121	...	...
Do. pillars, platforms, or posts for secondary stations, constructed or repaired	2	11	...	...
Do. miles of rays cleared	...	...	...	...
Do. do. pathway cleared	...	...	...	...
Do. hill tops cleared of forest and jungle	3	...	...	...
Do. Secondary stations, the elements of which have been computed	65	21	...	...
Do. points fixed by traverse, the elements of which have been computed	1	...	...	...
Do. miles leveled over, see para. 219	...	...	...	...
Do. permanent bench-marks fixed, see para. 219	...	...	...	...
Do. preliminary charts of triangulation	1	1	...	2

Summary of results of the work of the TOPOGRAPHICAL PARTIES between 1st October 1879 and 30th September 1880.

Scale of Survey.	Topographical Survey.	TRIANGULATION. Area triangulated in square miles.	Number of stations at which observations were taken.	Number of square miles to each point trigonometrically fixed.	Number of square miles to each height.	1st class, or those in which each angle is usually observed on four zeros, or more. Number of stations fixed.	Number of triangles.	Triangular error in seconds.	Error per mile in feet.	Number of heights.	2nd class, or those in which each angle is usually observed on two zeros. Number of stations fixed.	Number of triangles.	Triangular error in seconds.	Error per mile in feet.	Number of heights.	3rd class, Tertiary, or those in which two angles only of each triangle are observed. Number of intersected points fixed.	Number of triangles.	Error per mile in feet.	Number of heights.	Number of extra heights determined by Barometrical observations or otherwise.	TRAVERSE. Instruments used.	Number of Stations at which the Theodolite was set up.	Linear miles simple traversing.	Linear miles Boundary Survey.	Average angular error per Station in seconds.	Average error per 1,000 links in links.	Number of village trijunctions fixed.	Number of plane-table points fixed.	TOPOGRAPHY. Final Topography completed during the season in square miles.	Average number of plane-table fixings per square mile.	Number of linear miles of test line run.	Names of districts, &c., through which the seasons' operations have been carried.	Area of Triangulation in advance of Topography.
1 inch = 1 mile.	No. 6 Topographical Party, Khasi and Garo Hills	160	3	...	...	...	...	...	...	...	30	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	220	0·7	...	Hill Tipperah.	
																						...	...	...	...	...	...	...	...	210	0·3	...	Sylhet District and Hill Tipperah.	259
¼ inch = 1 mile.	No. 7 Topographical Party, Rajputana	690	37	5·8	10·7	...	...	...	...	...	38	202	0·7	0·03	34	80	130	1·93	30	...		...	...	...	...	...	...	...	...	6,928	2·1	...	Bickaneer	8,000
																														7,138				
1 inch = 1 mile.	No. 1 Topographical Party, Gwalior and Central India	270	7	4·2	8·4	...	...	...	...	...	2	20	3·5	0·00	1	63	112	0·5	81	...		...	...	...	...	...	...	...	...	1,287·4	13·4	3	Idar, Oodeypore, Mahi Kanta, Jodhpore	,913
	No. 5 Topographical Party, Bhopal and Malwa	1,019	33	4·0	7·0	...	...	...	...	...	28	50	3·0	0·31	28	177	354	1·0	116	...		...	...	...	...	...	...	...	...	1,408	11·0	43·7	Dori, Gwalior, Indore, Jhabua, Johat, Rajpur Ali, Lutlam, Saibana	2,811
	No. 8 Topographical Party, Mysore	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	209		...	4,410	250	...	...	...	...	...	2,000	7·0	...	Shimoga, Hassan, Kadur	16,000
																														4,704·4				
2 inch = 1 mile.	No. 2 Topographical Party, Khandesh and Bombay Native States	1,281	74	2·8	6·7	...	...	...	...	...	56	142	12·4	0·50	56	307	606	1·3	193	184		0″ and 5″ Theodolite	2,050	1,151	...	5″	0·49	753	285	827·4	33	131·8	Khandesh	2,030
	No. 6 Topographical Party, Khasi and Garo Hills																					...	...	200	...	...	...	...	...	102	6	...	Sylhet District	277
	Guzerat Party	644	60	1·9	0·1	...	...	...	...	...	73	110	8·2	0·3	80	345	531	0·3	...	...		6″	3,258	794·0	217·6	17″	1·6	...	395	1,057·7	25·0	598	Ahmedabad, Broach, Surat, Baroda, Maha Kanta, Rewa Kanta	1,030
	Kattywar Party	1,360	63	2·8	12·2	...	...	...	...	...	56	107	12·4	0·0	41	402	813	0·7	78	...		5′	2,741	797	428·8	16″·9	1·7	...	...	2,133	12·6	200	Okamandal (Baroda), Cutch	1,450
																														4,120·1				
¼ inch = 1 mile.																																		
	Guzerat Party																					6″ and 5″	...	...	...	...	...	...	...	...	117·17	54	4·5	Dang Forests (Khandesh).	
6 inch = 1 mile.	No. 8 Topographical Party, Bhopal and Malwa																					...	...	...	...	...	...	...	...	...	6·34	...	5·1	Dhar City.	
12 inch = 1 mile.	No. 7 Topographical Party, Rajputana																					5″ omnimeter.	6	7·02	...	...	·25	...	...	...	7·6	...	...	Bickaneer City.	

Summary of the results of the field work of the REVENUE BRANCH

Designation of survey party.	Scale of survey.	Where employed.		No. of villages.	Area completed.		
		Province.	District.		Topography and Detail.	Traversing In advance.	Triangulation In advance.
					CADASTRAL SURVEYS.		
					Sq. miles.	Sq. miles.	Sq. miles.
No. 4 Party	16 inches = 1 mile	North-Western Provinces	Ghazipur	1,524	617	399	...
„ 5 „	Ditto	Ditto ditto	Banda	4	19	...	...
„ 6 „	Ditto	Ditto ditto	Mirzapur	805	422	117	...
„ 2 „	Ditto	British Burma	Jaunpur	1,371	525	316	...
„ 8 „	Ditto	British Burma	Hanthawaddy	294	763	245	...
		British Burma	Bassein	188	346	504	...
		TOTAL OF CADASTRAL SURVEYS		4,186	2,692	1,581	...
					MAUZAWAR SURVEYS.		
No. 1 Party	4 inches = 1 mile	Punjab	Dera Ismail Khan	51	1,335	1,934	...
			Rawalpindi	187	410	...	450
„ 3 „	Ditto	Ditto	Karnal	...	80(g)	...	...
	Ditto	North-Western Provinces	Muzaffarnagar	...	53	...	...
			Meerut	...	24	...	...
„ 5 „	Ditto	Ditto ditto	Banda	15	51	...	...
„ 7 „	Ditto	Bengal	Pooree	...	125	...	...
	32 inches = 1 mile		Ditto	...	40(f)	39	...
		TOTAL OF MAUZAWAR SURVEYS		253	2,118	1,973	450
					TOPOGRAPHICAL SURVEYS.		
No. 3 Party	2 inches = 1 mile	North-Western Provinces	Muzaffarnagar	...	1,140	...	...
			Meerut	...	381	1,256	...
			Ahmednagar	...			
„ 10 „	Ditto	Bombay Presidency	Poona	...	1,995	475	2,520
			Tanna	...			
			Colaba	...			
„ 11 „	Ditto	Ditto ditto	Sholapur	...	2,028	576	1,008
			Akalkot State	...			
		TOTAL OF TOPOGRAPHICAL SURVEYS		...	5,544	2,307	3,528
			GRAND TOTAL	...	10,354	5,861	3,978

ABSTRACT ACCORDING TO JURISDICTIONS.

Province.	Scale of Survey.	Area surveyed in square miles.	Cost inclusive of contingent expenses.	Average rate per square mile.	Remarks.
			Rs. A. P.	Rs. A. P.	
North-Western Provinces	2-in. = 1 mile	1,521	47,646 9 9	31 5 2	
	4-in. = 1 mile	128	4,235 0 0(j)	...	(j) Exclusive of cost of 51 square miles of 4" survey in district Banda.
	16-in. = 1 mile	1,583	2,93,408 15 10	185 5 7 (k)	(k) The rate is inclusive of cost of Banda mapping.
Punjab	4-in. = 1 mile	1,825	60,262 6 0	37 2 8 (l)	(l) The rate is exclusive of cost of 80 square miles of river survey in district Karnal for which no separate rate is available.
Bengal	4-in. = 1 mile	125	55,666 6 9(m)	...	(m) Expenditure includes the cost incurred in bringing up records of previous season's cadastral survey.
	32-in. = 1 mile	40			
Bombay	2 in. = 1 mile	4,023	1,07,425 11 4	26 11 3	
Burma	16-in. = 1 mile	1,109	3,21,789 5 0	290 2 7 (n)	(n) The rate is enhanced owing to this being the first season of operations in Bassein district.
TOTAL	.....	10,354	8,99,434 6 8	...	

DEPUTY SURVEYOR GENERAL'S OFFICE,
Calcutta, 1st October 1880.

PARTIES between 1st October 1879 and 30th September 1880.

Designation of survey party.	Total cost.	Rate.	No of fields.	Average size of fields.	Remarks and References.
	Rs. A. P.	Per acre.		Acre.	
No. 4 Party	97,742 7 5	0 3 11	610,000	0·65	(a) Expenditure is inclusive of cost of completion of records of previously surveyed parganas.
„ 5 „	23,561 3 11 (a)	...	4,953(i)	(i)	(b) These averages are exclusive of hill, jungle and river tracts.
	77,856 12 10	0 4 7	355,140	0·70 (b)	
„ 6 „	94,248 7 8	0 4 6	925,928	0·36	(c) First season's operations with a new establishment in a new district; the rate is consequently high.
„ 2 „	159.061 6 1	0 5 2	416,402	0·90 (b)	
„ 8 „	162,727 14 11	0 11 9(c)	194,421	0·75 (b)	(d) An assumed cost of Rs. 55 per square mile has been adopted for the 4" survey.
	615,198 4 10	0 5 8½(h)	2,506,844	0·68	(e) Expenditure included under head Cadastral Surveys.
		Per sqr. mile.			(f) Detached hills, surveyed in area under cadastral survey by Settlement Department.
No. 1 Party	64,862 6 0	37 2 8			(g) Area surveyed along the Jumna River.
	4,400 0 0	(d)			(h) The average rate exclusive of Banda and Bassein would be 4 annas 7 pies per acre.—*vide* notes (*a*) and (*c*).
„ 3 „	2,915 0 0	(d)			
	1,320 0 0	(d)			(i) Chiefly hills, consequently excluded from average.
„ 5 „	(e)	...			
„ 7 „	55,666 6 9(a)	...			
	129,163 12 9	37 2 8			
No. 3 Party	47,646 9 9	31 5 2			
„ 10 „	67,872 15 11	29 0 1			
„ 11 „	49,552 11 5	24 6 11			
	155,072 5 1	27 15 6			
	899,434 6 8	...			

DISTRICTS COMPLETED SINCE LAST REPORT.

District.	Scale of survey.	Area in square miles.	Cost inclusive of contingent expenses.	Final rate Per sq. mile.	By whom and when surveyed.	Remarks.
BENGAL.			Rs.	Rs. As. P.		
Cuttack (Irrigation Tract).	32-in. = 1 mile	364	1,75,857	483 1 11 (o)	By Captain D. C. Andrew and Messrs. E. C. Barrett and H. B. Talbot in 1877 to 1879.	(o) Rate enhanced owing to small size of fields and limited area surveyed. The rate per acre is Rs. 0-12-1.
N.-W. PROVINCES.						
Saharanpur	2-in. = 1 mile	1,952 (p)	1,36,329	37 9 5	By Major W. H. Wilkins in 1877 to 1880.	(p) Inclusive of 32 square miles on 4-in. and 13 square miles on 8-in. scale. The area of Saharanpur District here given is exclusive of the area surveyed by the Forest Department.
Muzaffarnagar	2-in. = 1 mile	1,675 (q)				(q) Inclusive of 53 square miles on 4" scale.

J. SCONCE, *Lieut.-Colonel,*
Deputy Surveyor General.

APPENDIX.

EXTRACTS

FROM

THE NARRATIVE REPORTS OF THE EXECUTIVE OFFICERS

IN CHARGE OF

THE SURVEY PARTIES AND OPERATIONS.

Extract from the Narrative Report, dated 24th September 1880, *of* LIEUTENANT-COLONEL B. R. BRANFILL, R.C., *Deputy Superintendent, Survey of India, in charge Madras Party.*

ON the cessation of the autumnal rains, the Madras Party proceeded to take the field, leaving Bangalore early in November, and reached the scene of operations by the end of the month.

I directed Mr. Potter to complete the remaining portion of the approximate series near Madras—selecting two of the final stations with special reference to their suitability for circumpolar azimuth observations, as near to the Madras observatory and to the sea as possible—and to build the necessary stations. At the same time Mr. Bryson was to devote himself to building the stations and clearing the rays immediately in advance of the observing party until he should meet Mr. Potter, and the whole be completed.

I myself undertook the final observations with the 24-inch theodolite and commenced the observing at Kaniyanúr H. S. on the 5th December, and continued without interruption, except from the long round-about marches, obliged by want of roads, and two or three bouts of rainy weather, until the work was finished at St. Thomas' Mount S. (the 15th station visited) on the 26th February, having fixed 13 new principal stations and closed upon two other previously fixed stations, common to the Madras Meridional and Longitudinal Series, Mâvandûr-Malaipêdu, by 16 triangles forming a hexagon and two pentagons, covering 2,001 square miles, and advancing the series from S.-S.-W. to N.-N.-E., a distance of 68 miles to its terminus at Madras.

1. Kaniyanúr H. S.	(north-west station of Polygon)			6th Dec.	1879.
2. Narasingapuram H. S.	(west " ")	Ponúr Hexagon.		11th "	"
3 Chenji Rock S.	(south-west " ")			20th "	"
4. Perumukkal Rock H. T.	(south-east " ")			25th "	"
5. Ponnúr H. S.	(centre " ")			31st "	"
6. Mâvandûr H. S.	(north " ")			6th Jan.	1880.
7. Avirimédu H. S.	(north-east " ")			12th "	"
8. Tirumani H. S.	(centre " ")	Tirumani Pentagon.		17th "	"
9. Manamai-Kunnatúr S.	(east flank " ")			21st "	"
10. Pudupákam Mount S.	(north-east " ")			28th "	"
11. Malaipêdu H. S.	(north-west " ")			4th Feb.	"
12. Mángád Mound S.	(north-west " ")	Nannangalam Pentagon.		8th "	"
13. Nannangalam Mt. S.	(centre " ")			13th "	"
14. Injambákam sandhill S., azimuth station	(east flank " ")			20th "	"
15. St. Thomas' Mt. S., azimuth station	(north " ")			20th "	"

Two sets of observations for azimuth were taken—at Injambâkam sand-hill on the coast line, 10 miles south, and at St. Thomas' Mount, 5·6 miles S.-S.-W. of the Madras observatory. Mr. Pogson, the Government Astronomer, was unwilling that an azimuth should be observed at the observatory, by which he thought his own pressing work would be retarded; and, notwithstanding Mr. Potter's earnest endeavours, no other suitable point could be found nearer than St. Thomas' Mount for an azimuth station, without incurring a heavier outlay in money and time than the object seemed to justify, the whole of the ground in and around the City of Madras being covered by lofty trees and private houses.

As soon as Mr. Potter had completed the approximate series, about the middle of January, I directed him to proceed with all speed to examine the ground between Pondicherry and the east flank of the series, as he was already well acquainted with the latter, having selected the east flank stations himself the year before last. He very soon submitted what appeared the most simple and feasible project for connecting Pondicherry with the principal triangulations. He then moved on without delay to the larger and more important work of connecting Negapatam with the main series near Kumbakônam.

In this task he succeeded to my satisfaction, taking advantage of the lofty towers of the temples, by which alone the task could have been accomplished during the season.

The spires or gateway towers of South Indian temples, commonly called *gópurams*, are tall, ricketty brick structures, consisting of an oblong basement, usually of stone, pierced for the gateway, surmounted by a pyramidal spire of many storeys, tapering up to a narrow ridge, and profusely covered with stucco ornaments. They are seldom or never used except by bats and vermin, and the many floors or stages within them have been allowed to fall in, so that access to the summit is dangerous, and, when attained, it is quite unsuited to observe from with a theodolite. Mr. Potter displayed much ingenuity in overcoming these difficulties by means of temporary staging, long ladders, and a portable striding platform, which he devised and carried with him, and by means of which he was able to set up the 8″ theodolite on seven *gópurams*, and thus complete the series.

On completion of the final observations at Madras, I hastened by your directions to the west coast of the Peninsula, to effect a connection between Colonel Lambton's triangulation, brought up from Cape Comorin, through Travancore and Cochin to Ponâni, with the Malabar minor series, brought down from Mangalore to the same neighbourhood.

I had directed Mr. Mitchell to effect this connection when he was engaged on the latter series, but he failed to find Colonel Lambton's old station marks at Kurnád ("Koornaud") and Anangamala ("Annangamalli"). The station of Anangamala, however is identical with Colonel Lambton's point, and I believe that Colonel Lambton's station of "Koornaud" was at a point on the Kurnád hill, marked by a mound of earth, with which I have made a secondary connection. A more thorough connection has been now made by my finding station ⊙ marks at Ponmala ("Punmalli") and Alattúr ("Allatoor"),

as also an old station platform on Machât (" Muchaut ") hill, the centre of which I occupied. All three of the latter are probably nearly identical, if not quite so, with Colonel Lambton's stations, thus completing a satisfactory connection. It was now the end of March and the air so hazy as to be quite unfit for observing, but I determined to take the opportunity to effect a further connection with the tranigulation of the Nîlgiri hills.

When in charge of the Great Arc Series (in 1869-70), at the instance of the Surveyor-General, I was requested to determine points on the Nîlgiri hills to form a base for Colonel Saxton's minor triangulation, which I accordingly did; but, owing to the length of the rays and the hindrance from cloudy weather, I was not satisfied with the results, though they were the best obtainable under the circumstances.

I am sorry to say that, although I spent about a month upon this work, in very trying weather, I was not very successful, chiefly owing to the sickness and consequent absence of my signalmen; still a connection has been made, and I think, from the approximate reduction that has been computed, it tends to show that my fears about the points laid down in 1869-70 were excessive.

After a circuit of some 700 miles, from Madras to Bangalore, thence by the Great Arc to Cape Comorin, and back by the East Coast Series *viâ* Râmnâd to Madras, the series has closed with a small cumulative error in latitude and distance, but with a larger one in longitude, azimuth, and height.

The mean closing error in		latitude	is	0″·008 or about one foot.
,,	,,	longitude	is	0·262
,,	,,	azimuth	is	9·212
,,	,,	height	is	17·3′
,,	,,	distance	is	0·72′

the latter being equivalent to 0·027 feet, or one-third of an inch per mile.

This amount of closing error is perhaps no greater than might have been expected. Indeed, considering the extent of unfavourable country traversed, I anticipated a much larger.

Extract from the Narrative Report dated 5th November 1880, *of* CAPTAIN J. HILL, R.E., *Officiating Deputy Superintendent, 1st grade, in charge of the Eastern Frontier Series.*

I LEFT Bangkok on the 29th January, and next morning reached the small town of Phrapatom, where I had arranged to meet Mr. McCarthy, who was working in its neighbourhood.

He arrived about noon, and I had the satisfaction of learning that he had pressed on the work well during my absence. I may here remark that the Siamese, although they wish for telegraphic communication with British Burma, do not seem to care about rapid postal communication in Siam. For example, although Phrapatom (which is distant, as the crow flies, 30 miles from Bangkok) can be reached through the creeks in 12 hours, a letter I wrote to Mr. McCarthy from Bangkok on the 15th January (the day after my arrival), and which the authorities professed to send by express messenger, only reached him on the 30th, as he came into the town of Phrapatom to join me. After a few instances of such delays, I employed my own men as letter-carriers The Siamese appear to have no conception of the value of time, and our chief difficulty consisted in overcoming their dilatoriness. They thought (and indeed appeared to hope) we should find it impossible to extend our triangulation into Bangkok across the 30 miles of flat, wooded, and swampy country lying to the west of the city, and they were languid, to say the least, in their operations to assist us. I am glad to say there were exceptions to the rule; and, as in my report on the previous season's work I had the pleasure of expressing my acknowledgments to the Governor of Kanbooree, so now I beg to acknowledge the assistance given by the Governors of Nakonchasee, Tacheen, and Paknand. Our thanks are due to those gentlemen for their help and their hospitality. If the Assistant Governors and other minor executive officials with whom we came in contact had been equally attentive to our requirements, the work would have progressed all the more rapidly.

During my short stay in Bangkok the weather had once or twice been clear enough to enable me to get a good view of the surrounding country from an artificial eminence called Phookhow Thong, which is ascended by external winding flights of stone steps and is surmounted by a small pagoda, and which is the highest point of vantage in or near Bangkok. From this raised position I was able to obtain the magnetic bearing of the Great Pagoda of Phrapatom (the largest in all Siam), upon which I had placed a station the previous season; and I also, while searching the western horizon with the telescope, noticed, in a fortunate break in the far distant jungles, an object which appeared to me too thick to be the trunk of a palm tree, and which seemed to be more like a pillar or factory chimney. I accordingly noted its bearing, &c. It appeared to be from 15 to 20 miles distant, and to lie in a south-easterly direction with respect to Phrapatom. I had heard there was a tall chimney belonging to a ruined sugar factory near Nakonchasee, but it was supposed to lie more to the north. On going to Phrapatom I was fortunate enough, after some time, to identify the object I had seen through the telescope at Bangkok, and which could only be distinguished at Phrapatom when the sun

fell upon it in one direction. It turned out to be the old sugar factory chimney after all, the height of which from the ground I afterwards measured and found to be 83 feet. The problem of how to carry the triangulation into Bangkok was thus solved. I caused a huge bamboo scaffolding to be erected round the chimney, and a timber platform with an arrangement for insulating and centreing the theodolite to be constructed and placed on the top, and our observations were duly taken there. The height above the ground of the stations forming the last triangle of the Bangkok Series are all considerable. The height of the chimney has just been given. The height of the Bangkok mark stone at Phookhow Thong is 110 feet according to aneroid observations of mine, and 115 feet by Mr. McCarthy's measurement of the steps leading up to it. The station I placed the previous season on the Phrapatom Pagoda was exactly 100 feet above the ground, while a station Mr. McCarthy subsequently caused to be placed at a higher level, in order to avoid ray clearing (which with local labour would be an endless undertaking in Siam) is only 32 feet below the top of the spire, the altitude of which I carefully measured the previous season, and found to be no less than 347 feet above the mean level of the ground at the base of the pagoda. The height of 347 feet is that of the top of the masonry, and excludes the large metal ornament which surmounts the spire. Mr. McCarthy describes it as being nervous work climbing up the bamboo ladders to this lofty observatory. A pagoda being composed of one solid mass of masonry cannot be ascended from within. The ascent has to be made by means of bamboo ladders placed against it externally, and secured in position to iron pegs driven into the masonry. While the scaffolding round the chimney of the old sugar factory was being prepared, the ordinary observations of the lines were being carried on elsewhere by myself and Mr. McCarthy. It will be recollected that I reached Phrapatom from Bangkok on the 30th January. Throughout February and March there was a great deal of thick haze, much aggravated by jungle fires, which obstructed the observations considerably. The people also were in some instances inclined to be obstructive. In one instance they went so far as to stake with sharpened bamboos the path by which one of the signallers was accustomed to go for water from his station, and the man was badly wounded in the foot. In another they secreted some large timber posts I had ordered from Bangkok for the construction of a station near the village of Po Hak. This station, which was on flat, low, ground, had to be raised in order that observations might be taken between it and the chimney station. Mr. McCarthy was consequently obliged to make use of the trunks of some small palm trees which grew near; but after spending much time and trouble on the station, and clearing a quantity of trees and bamboos in the direction of the chimney, he was unable to open the ray. I was determined, however, that the chimney and Po Hak stations should be joined; and after a great deal of trouble, and the loss to us of much valuable time, the villagers, fearing they were about to get into serious trouble at Bangkok, suddenly gave up the missing posts to Mr. McCarthy, who quickly raised his station to the requisite height, and obtained his observations. Such occurrences as these, together with the dilatoriness of the officials and people, and the uncertainty as to the fate of any letter or message entrusted to a Siamese, constituted our chief difficulties.

Extract from the Narrative Report of MAJOR E. H. STEEL, R.E., *in charge No.* 1, *Topographical Party, Gwalior and Central India Survey, season* 1879-80.

Remarks on country triangulated.

THE triangulation only extended over 270 square miles; it was all very heavy ground, and mostly covered with dense jungle. Long parallel ridges running north-east and south-west are the principal features; there are one or two fine, though very narrow, valleys. The undergrowth and tree jungle to the west will give the plane-tablers much trouble.

Country plane-tabled.

The country plane-tabled was, with little exception, of a very difficult nature. Mr. Cornelius had in plane-table 186 a few square miles of flat ground near the Dhebar Lake bund, and Sub-Surveyor Abdul Aziz had to the south and west of his board a small portion of level country; but it was nearly all covered with scrub jungle and high grass. I should not omit to mention that the 120 square miles surveyed by Mr. Tate in standard sheet 94 were in fairly open country, with one high range of hills called "Saora" and a few isolated ridges dotted about.

A good deal of the country in standard sheets 88 and 90 is comprised of high mountain ridges with very steep slopes, and where the features die down into the lower ground, the drainage is exceedingly intricate. When I looked down from Sisa hill in March on the lower ground, the leaves were off the trees, and the under-features were visible; the land then looked like a petrified stormy sea.

The long ridges of precipitous hills are crossed at very rare intervals by passable passes; for instance, the Sam Ghata or pass is the only road passing from east to west in a run of 28 miles along the great ridge or backbone of the mountains which terminates on the Kulalia hill overlooking the village of Pol.

There were no forts, towns, or cities comprised in this season's work. The cantonment of Kherwara falls into the overlap of one mile, and will be surveyed and described by No. 5 party. The largest villages met with in standard sheet 88, were Madri, Juwass, Chawand, Babalwarra, and Rakhabdoo. This last contains a well-known Hindu shrine. The villages of Shodadur and Khed Brahma, of the Mahi Kanta agency, fall in sheet No. 90; the former is the property of a petty Rao.

Passes.

The Som pass is on the road from Kherwara to Kotra; the ascent from the Som valley is 700 feet, and the descent into the Manpore valley to the west is fully 1,000 feet. This pass is just practicable for lightly-laden animals; there is no other well-known pass.

Roads.

The main road from Oodeypore to Kherwara and thence to Ahmedabad runs through standard sheet No. 88; it is a fairly metailed road, is well bridged, kept in good order, and is quite practicable for all arms. A road has been traced from the village of Pershad, on the above-mentioned main road, to the Dhebar Lake bund, above which there is an old palace, now just repaired. A fair road has been made from Kherwara to Pola, and thence to Idar. This road is, however, fast falling out of repair. A good riding track, practicable for baggage animals, has been traced from Madri to Kherwara by the Madri Rao; it is six to eight feet wide. Lastly, the track from Kherwara to Kotra is called a road; it passes, as I have said some few lines back, over the Som pass.

Rivers.

The Sábarmati drains the country comprised in the western half of standard sheet No. 90; it forms many deep pools, but is fordable every mile or so during the cold weather, and in the rains, forms a stream 250 to 300 yards wide from bank to bank. The Som and Gomti, drain the country shown in standard sheet No. 88; the last-named stream receives the outfall of the Dhebar Lake. These two rivers join just south of the margin in the south-east corner of sheet 88.

Inhabitants.

The Bhils and Grassias have been described already; one point, however, struck me, which I do not think has been noticed before, namely the large size and fine look of the Bhil women relatively with the men. This point has, I believe, been noticed before in connection with some other predatory tribes.

Extract from the Narrative Report of Captain W. J. Heaviside, R.E., *in Charge No. 2 Topographical Party, Khandesh and Bombay Native States Survey, season* 1879-80.

The physical features of Khandesh are most pleasantly varied when compared with the dull monotony of the scenery in most Indian districts.

Khandesh cannot boast of snowy peaks or of the luxuriant vegetation of Lower Bengal; but the Satpura Hills are scarcely inferior, in point of scenery, to the lower ranges of the Himalayas. North of the Tapti River one meets with forests which, though not extensive, hold trees worthy to rank as timber with those of the Terai, while hard by, on the edge of these forests, the banks of the Tapti in the month of January are plains of waving wheat.

Khandesh has in addition all the best points of the Deccan: plateaux 1,500 feet above sea-level, not wanting in shady trees, where tent life is pleasant up to the end of April; ghâts of grand black precipices surmounted by columnar basalt in fantastic forms rising to a height of 4,000 feet; well-irrigated valleys of black soil growing magnificent crops of wheat and sugar-cane; uplands near the sources of the Pánjhra River, where there is pleasing woodland scenery, and the river, shadowed by fine old trees, flows over the rocks in rapids and pools where an occasional small *mahsir* may be tempted with a fly in the evening. As a contrast, there is the low-lying malarious country of the *Dángs*, with low hills almost concealed by grass jungle and tree forest—a country which is considered deadly to the European until February, and which, by that time, is so dried up that it is difficult to obtain decently good water; a country where an occasional clearing and a few Bheel huts are the only signs of habitation, but where the frequent call of the painted partridge somewhat compensates for all these disadvantages.

Such are the diversities of country lying west and north-west of Dhulia, that have been met with in the country plane tabled this season, within a few days march of each other, and within an area of 30 miles of longitude by 70 of latitude; but the chief portion of the work executed embraced the whole upper portion of the Pánjhra Valley.

The Pánjhra Valley.—The Pánjhra River rises in the Sáhyádri Hills, about—

Latitude	...	...	...	...	...	20° 45′
Longitude	...	...	..	...	...	74° 0′

and for the first 15 miles of its course flows eastwards through an upland country nearly 2,000 feet above sea-level. The fine old mohwa and mango trees grouped about the borders of the river and its tributaries—the large, undulating expanses of grass, broken here and there by patches of wheat round a group of Bheel huts, or by low hills clothed with tree jungle—make up a pleasant sylvan scene, which is green and refreshing to the eye even in April, and is rendered all the more striking because in such marked contrast to the severe black basaltic precipices and peaks which form a background to the south.

The uplands are but sparsely inhabited; there are no large villages; Bheel huts are scattered about here and there near the patches of cultivation, or near water, as the latter becomes rather scarce towards the end of March, except in the main stream.

The bed of the river in these upper reaches alternates between sand and rock, with a considerable fall averaging 30 feet a mile, the water here and there cascading over the rocks.

Pimpalner, the taluka town, is the first place of any importance on the river, and although out of the upland country, is nearly 1,700 feet above sea-level. It is a poor looking place of about 2,500 inhabitants, but there is a considerable expanse of well-irrigated black soil round about it, and from a few miles above Pimpalner the flow of the river is perennial.

From Pimpalner to Dhulia (50 miles) the river still flows eastwards; its bed is of rock throughout, with the considerable fall of 830 feet in this distance, or about 17 feet a mile. The river is thus eminently suited for irrigation purposes, and, from some distance above Pimpalner, masonry dams, often having the appearance of being 100 years old, stand across the river at every three or four miles, the water being led off in wide channels to irrigate large tracts of black soil, in which magnificent crops of sugar cane and wheat are grown. This ground appears never to be left fallow: no sooner is one crop off the ground, than the land is ploughed and a new crop sown, wheat and sugar-cane generally alternating; and in a good year, such as this has been, the sugar-cane mills are in constant work, day and night, for some six weeks, in all the villages on the banks of the river.

The chief tributary of the Pánjhra is the Kán, which joins the river about 28 miles west of Dhulia. The basins of these rivers extend from the narrow, lofty range of hills on the south, dividing Khandesh from Násik in about latitude 20°-45′, to the high table land to the north, on which the Kundabáiri Ghát and Bhámergarh are situated, in about latitude 21°-7′, and is bounded to the west by the Sáhyádri Hills, which overhang the Dáng country near the meridian of 74°.

The Mangya Tungya Hills.—This narrow rocky range, which runs east and west near latitude 20°-45′, separating Khandesh from Násik, is a spur of the Sáhyádri Hills, and has all the marked characteristics of the trap formation, such as fine black precipices, three and four hundred feet in height, while the peaks of the hills rise from three to four thousand feet above sea-level, in masses of columnar basalt which frequently takes the most fantastic shapes, resembling buildings and monuments on a Titanic scale.

The two most remarkable hills of the range are known as Mangya Tungya, and are about three-quarters of a mile apart. Rising some 2,500 feet above the Pánjhra Valley, they are visible from very long distances, and a near approach to them impresses one with their massive grandeur.

From the south, or Násik side, these two hills rise in quadrangular pyramidal forms, with rocky precipitous sides, stepped at intervals to a height of 1,500 feet above the plains. They are here connected by a narrow saddle, the southern face of which is a precipice having the appearance from below of a wall of black rock some 400 feet high. At either end of the saddle the hills still rise some 550 feet higher, the pyramidal forms being more strongly marked than they were below, and more frequently stepped, till each culminates in a column of basalt 200 feet in height. It is difficult to imagine anything in nature more typical of the monolith rising from a pyramidal base, with which architects have made us familiar. But here the scale is colossal, and so much the more magnificently grand.

The basaltic columns which form the summits of these hills are quite inaccessible. A terrace, partly natural, partly artificial, has been formed round the western one, which on the south side is only just wide enough for a single man to pass along, but on the north side is about 10 or 12 feet wide and 330 feet long. On this side five temples, or rather *chatris*, have been built in the shadow of the rock. There are also on this side three temples and two water-tanks, all excavated in the rock. These three rock temples appear considerably older then the *chatris*, and may originally have been commenced by Buddhists; but the inscriptions, as well as the character of the figures and ornament, show that they were finished or converted by Maráthás.

The face of the rock above the terrace is studded with figures of gods and goddesses of various sizes—altogether, within and without the temples, 400 figures were counted.

There are two ways up the hill, on both of which a number of steps are cut at intervals, where the rocks are most precipitous, and without these steps, or the use of ropes, an ascent to the temples would be impracticable. I ascended by one route and descended by the other. I did not count the steps going up, but in coming down there were 570; most of them were cut out of the solid rock, and some were built up, with here and there a low parapet wall, and at the corners, where the steps zigzagged, one rather failed to appreciate the grandeur of the precipice below. Near the bottom of the hill there are two small, rock temples, evidently Buddhist, in fair preservation. Altogether a vast amount of labour has been expended on this hill, which appears to be worth the notice of the Archæological Survey.

Pisul Hill.—Pisul is another hill in the same range, with a history. Standing 1,500 feet above the surrounding country, its sides are as precipitous as those of Mangya Tungya, but its summit is a plateau about half a mile long by a quarter in width, and is a natural fortress.

Such a combination in nature seems seldom to have escaped the eye of the predatory Maráthá. He would be as safe there from any ordinary attack as the eagle in his eyrie, and could swoop down at pleasure on the dove-cots below.

The only approach to Pisul is by a narrow gorge on the south side of the hill. This was protected by several cross-walls, the ruins of which still remain. In the rocky sides of this gorge, store-rooms and water-tanks are excavated. Water is still deposited in considerable quantities in the latter, but is much fouled by bats. There are also catchment basins for water in suitable spots on the top of the plateau.

Notwithstanding the precipitous nature of the hill sides, it appears that the edge of the plateau was still further strengthened by walls here and there. There is but one

building remaining—a small house which is still in fair order. The Mahomedans have left their mark of supremacy in a fine gothic archway, standing erect amidst the debris of old walls and houses.

Towns.—Mr. Horst, in last year's report, described most of the *taluka* towns in this season's work; and in referring again to some of these I shall be careful to avoid repetitions.

Nandurbár—latitude 21°-22′, longitude 74°-17′, population 7,000—is situated between two low ranges of hills, which nearly surround it. The position from a sanitary point of view is about as bad as it could be. The site was probably selected with a view to protection from incursions, as the numerous old remains of walls along the hill-tops tend to prove; but as water is very scarce within these limits, the site could hardly have answered this purpose well. Fifteen *per cent.* of the inhabitants are Mahomedans—a decaying remnant of the descendants of the Mogul dynasty. Their principal mosque—the shrine of Sayat Sháhádawa Alladin, who was killed in a battle near Nundurbár—stands on the western extremity of a low range just outside of, and about 70 feet above, the town, and forms an admirable landmark for miles around. It is of good proportions, and overlooks a fine tank, on the embankment of which there are thick groups of large *banyan*, *semel*, and tamarind trees, while in the cold-weather the waters are well covered with fowl, and under certain aspects this combination is eminently picturesque. The mullas of the mosque, who state they are very poor, instead of whitewashing the mosque with brushes in the ordinary way, have adopted the cheaper plan of dashing the whitewash in pailsful over the building. The result is that the arched recesses, the cornices, and the general tracery of the mosque, are fringed with stalactites producing a most pleasing and artistic effect, suggestive, even in the warm sunshine, of snow and icicles.

A considerable quantity of teak timber passes through Nandurbár, about 4,500 cart-loads paying octroi duty annually. On one market day I saw as many as 400 cart-loads, but this is an unusual number. A cart-load sells at about Rs. 7 to Rs. 15; thin poles cost 4 annas each; those about 15 feet long and 6 to 8 inches in diameter, Rs. 2-8 each; and timber from which beams 9 or 12 inches square could be cut, cost about Re. 1 a cubic foot. This timber comes chiefly from the Ságbára estate, north of the Tapti.

A good deal of timber is employed in the construction of the houses in Nandurbár, many of which are substantially built of two stories, with tiled roofs. The woodwork is generally carved, sometimes elaborately, and nearly always with very good taste, by men from Guzerat.

A large trade in wheat has been done this year by *Banjáras* between Nandurbár and Surat, the harvest having been very plentiful throughout Khandesh. The married *Banjára* women adopt a fashion hereabouts, which I have never seen elsewhere: the *sári* is worn hanging down over a piece of bamboo about 18 inches long, projecting from the back of the head, thus having rather the appearance of a fool's cap, and resembling the steeple cap worn by ladies in England towards the end of the 15th century.

The taluka town of Pimpalner and the petta town of Nizámpore are insignificant in size, and with nothing remarkable about them.

Balsána Temples.—At the small village of Balsána, about ten miles north-east of Nizámpore, there are several small temples of a style known as hemádpáthi, built during the dynasty of the Gouli kings, which appear to have escaped the vandalism of sects and conquerors. Unfortunately they were built of stone (trap), not thoroughly crystalline, so the weather has played sad havoc with the external figures and ornament.

The figures in niches placed in a belt round the walls of one of these temples are 2½ feet in height, which is larger than I have seen before on a temple of this style, and many of these figures are in fair preservation. The interior of this building is small, the height from the floor to the top of the dome being only 15½ feet, but it is in excellent preservation. The figures are unmutilated, and, blackened as they are by the action of time and of colonies of bats, harmonise well with the simplicity of the ornament on pillars, cornices, lintels, and jambs, which, again, are in such perfect keeping with the straight lines of the massive pillars and corbelled stonework, as to remind one strongly of Greek art. This little temple is quite a gem, well worthy of the attention of the Archæological Survey. It is at present devoted to the popular Hindu god *Lingum*, but has escaped the desecration of red paint.

Manufacture of Catechu.—Small encampments of Bheels are not unfrequently met with in the forests, engaged in the manufacture of catechu, which is chiefly sold to chew with the pán-leaf by natives. The superintendent of the manufacture was generally a *bunya* who paid a small royalty to Government. The process is simple. Chips are cut from the heart of the *khair* tree, and stewed in small pipkins for several hours; a turbid, orange-colored fluid is thus produced, depositing a substance the color and consistency of thick strawberry cream. This is subsequently dried in the sun, and breaks up into pieces much like nodules of dark red earth. In this form it is sold in the bazars

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General description of the country triangulated by Mr. A. G. Wyatt, *Surveyor, Fourth Grade, Khandesh and Bombay Native State Survey, season* 1879-80.

The triangulation of the past season comprises a portion of Khandesh lying between the meridian $\frac{75°15'}{74°45'}$ and south of latitude 21°-0′ and up to Hydrabád boundary. Starting from the side Sátmála to Walwári, a series of secondary triangles was run westwards, closing

on the side Danwar to Sirsúla, both of the Khanpisura series of the Great Trigonometrical Survey.

The triangulation embraces portions of the following talukas:—Pachora, Erandole, Jamner, and Nasirábád of the Khandesh district. Of this tract three-fourths may be said to consist of well-cultivated country, and about one quarter of low, undulating hills. That to the south of Nasirábád and on the right bank of the Girna river consists of low hills rather thinly covered with babul and brushwood. The table-land of Dhanor, on which is situated the Great Trigonometrical Station of Danwar, lies about ten miles south of Nasirábád village. It is about 12 to 14 miles in extent. The fall to the north and east is very gradual; that to the south and west abrupt, the fall measuring about 700 feet. The portion to the west of the Girna, and between that river and longitude 74° 15′, with the exception of a small range of hills lying three miles south-east of the town of Erandole, called the Powarthála plateau, is well cultivated, and consists of numerous, large and well-inhabited villages. The country south of Pachora and along the Waghur valley is also well-cultivated. To the north of Bhargáon and east of Argaon villages is a low range of hills running north and south, on which is situated the Great Trigonometrical Station of Walwári.

The chief rivers passing through the portion triangulated are the Girna, Waghur, Anjni, Titur, and Hiura. The Girna, the largest of these, flows eastwards by the large village of Bhargáon; it then turns northwards and flows through the low country and plain into the Tapti in $\frac{\text{Lat. } 21°\text{-}8'\text{-}30''}{\text{Long. } 75\text{-}21\text{-}30}$. The Titur and Waghur, Anjni and Hiura, take their rise from the high range of hills separating Khandesh from the Nizam's dominion. The Waghur flows northward by the villages of Páldhi and Pohar, and is a running stream throughout the year. It is a tributary of the Tapti. The Titur and Hiura join the Girna—the former about two miles east of Bhargáon village and the latter north of Bholeswar and east of Utran villages. The village of Bholeswar is situated at the junction of the two streams.

Erandole and Pachora are the chief towns of the talukas of those names. The former is situated on both banks of the Anjni and on the high road between Málegaon and Bhusáwal; the latter is a smaller village, but is well known on account of the railway passing through it. It is situated on the left bank of the Hiura.

Bhargáon village is situated on an island in the Girna river. It is about six miles west of Pachora. A good metalled road connects the two villages. Bhargáon is a peta or sub-division of Pachora taluka.

The products of the country triangulated are of various kinds. The soil in the plain is extremely fertile. It is a rich, black clay. On the hill tract every available spot is cleared and brought under cultivation.

From Dhulia, the capital of Khandesh, there is a high road going east to Jamner, and passing by the villages of Parola, Erandole, and Musáwad. Another road from Dharangáon meets this one a few miles east of Erandole. Both these roads are bridged the whole way.

Starting from Nasirábád there is another metalled road going south to Jamner, which passes over the Dhanor plateau and descends two miles north of the village of Neri. The road from Dhulia to Jamner, already described, meets this one half a mile west of Neri village.

Extract from the Narrative Report, dated 3rd November 1880, *of* Lieutenant-Colonel C. T. Haig, R.E., *Officiating Deputy Superintendent, 1st grade, in charge Guzerat Party.*

On reference to the accompanying index chart it will be seen that the Sábarmati crosses sheet 5 from north to south, and that the Háthmati joins the Sábarmati in this sheet. All west of the Sábarmati is Baroda territory, and with the exception of one British village, all in the fork of the two rivers is Máhi Kanta territory; and, excepting one Máhi Kanta village, all south of the Háthmati is British territory. The greater portion of the adjoining plane table of sheet 24 is British; the remainder is Máhi Kanta.

The banks of the Sábarmati and Háthmati rivers were great obstructions owing to their being broken up, sometimes to a distance of a mile from the river into a reticule of precipitous, tortuous ravines. The watershed west of the Sábarmati lies very close to the river, from less than one mile up to three miles from it; and west of the watershed the country falls very very gently down to the Runn of Cutch. The Sábarmati flows between steep banks, nearly 100 feet high, and the general run of the watershed is only a few feet higher than the top of the banks; and so, although the drainage slope is so narrow, it has but a gentle declivity. West of the watershed the country is in many parts very undulating; but the features are without any regular formation, and could only be properly shown by rigorous contours. The drainage is so precarious that there are large areas which are really not drained at all; but in a copious monsoon the tanks are enlarged into lakes, called "Bharits." On account of this lack of drainage the drinking-water is bad, and in the hot weather it becomes so impregnated with saline matter that it is deleterious to health.

The country of sheet 5 is fairly populous and well cultivated, parts of it are woody; but the trees, though no hindrance to the cultivation, are to surveying; and there is an area of about 200 square miles over which there is no triangulation, but which had to be prepared for final survey by traversing; and therefore over this area there are no heights, but as the country is very flat their absence is not a very serious matter.

The principal towns in sheet 5 are Visnagar, the head quarters of a taluka, or, as it is styled in Baroda territory, a máhal and a post town where there is a Wainatdar or Mamletdar. It has a population of nearly 21,000, and in the same máhal, Walan and Wasai with populations respectively of 5,940 and 5,125: the post town of Vijapur, the head quarters of another máhal, with a population of 8,880, and in this máhal Ládol, with a population of 4,632. Besides these there are in these two máhals 20 towns with populations ranging between 1,500 and 3,000.

On the banks of the Háthmati is the post town of Ahmednagar, once a fine city but now a town, with a population of 4,461. The walls are still in a sound state, though considerably out of repair. It was built by Ahmed Shaw in A. D. 1426, and is a place of considerable historical interest. It now is part of Edar, the principal of the Máhi Kanta States. There is a broad straight road from Edar (in sheet 23) to Ahmednagar, and thence through Paránty to Ahmedabad. Just above the city of Ahmednagar there is a fine masonry bund built in 1875 by the Irrigation Department. It is 1,016 feet long and 64 feet high in the centre, and converts the river above it into a magnificent lake, several miles long, which supplies a canal that irrigates the country round Paránty.

In the fork between the Háthmati and the Sábarmati is the town of Ilol, with a population of nearly 4,000, the chief town of one of the Máhi Kanta States; and near the north-east corner of sheet 5 is a large Edar village, named Jádar, with a population of 1,600; but excepting these two and Ahmednagar, all the villages east of the Sábarmati in sheet 5, and in the one plane table of sheet 24, have populations under 1,500.

The country in sheet 33 and the south-west quarter of sheet 32 is mostly difficult ground to survey. It is very much cut up with watercourses, the most tortuous that I have ever seen; and as their banks are thickly wooded, their sinuosities could not be laid down by intersection, but compelled the plane tabler to follow them along their entire course, causing great delay. The average number of plane table stations per square mile of the respective plane tablers in sheet 33, ranges from 22 by Mr. D'Souza to 53 by Lakshuman Shitaram. In easy country I have had to insist on the plane tablers not having less than six per square mile, so that it will be gathered from this how intricate the ground was.

The drainage of sheet 33 is from east to west. The river Tapti, with its tributary, the Virakhári, the Kim, and the Amráwati, a tributary of the Narbada, are the chief watercourses. I have stated them in their order from south to north. The watershed between the Amráwati and the Kim is a well-marked elevation from almost any point of which a fine view of the country on either side is obtainable, but south of the Kim the country is hilly and jungly affording cover for tigers, of which one or two are generally killed there annually. The eastern half of sheet 33 is very unhealthy in the cold-weather, malaria being very prevalent, and it was therefore not commenced till the hot-weather; but there was also a good deal of fever among the native establishment working in the western half during the cold-weather.

The taluka town of Mándvi is in sheet 33, but as the sheet is not completed, I will give the details of the towns and their population in my next report The south-west quarter of sheet 32 contains portion of the Ankleswar taluka of the Broach collectorate, a portion of Baroda territory, and part of the Rajpipla territory, one of the Rewa Kanta States. This will be published on the 2-inch scale, showing the British territory in detail and the Foreign territory in skeleton. The Bombay, Baroda, and Central India Railway crosses this section, the station of Ankleswar being on the northern margin, and Pánoli station near the southern and western margins. There are no large towns or villages in this section, the largest being Jitáli, with a population of 1,345, situated close to the northern margin, about the middle of the section.

Sheet 16 was also a very laborious piece of work. It is a small area, but it is important from its containing the large Gaekwári taluka town of Navsári, population 14,218, and the British taluka town of Jalálpor, population 2,188, which are close together on either side of the Bombay, Baroda, and Central Indian Railway. It also contains the railway station of Amalsád, and the Gaekwari town of Mora, population 3,528, with its adjoining village Bili, which together give the name to Bilimora railway station. Besides these there are the towns of Matwád, population 4,392; Abrama, population 3,566; Bigri, population 3,141; and seven villages with populations between 1,500 and 2,000, and, of course, many smaller ones.

Navsári is on the estuary of the Purna river, which admits of the largest native craft coming right up under the town. Into this estuary flow numerous creeks, and these and the muddy expanses through which they flow caused great trouble to the surveyors; but not more than the rest of the ground in the sheet, which was so broken and woody that it admitted of little sketching, but obliged the plane-tablers to put up their plane-tables as often as the ground in sheet 33. This will not appear to be exactly the case from the tabular statement of the detail of topography, where the average number of plane table stations per square mile ranges from 22 by Nilkunt Vithal to 35 by Wasadeo Gonesh, but these averages include the work on the mud, in which the number was less, than on the *terra firma*, though it was none the less tedious.

The country surveyed in the Dangs lies immediately south of that previously surveyed. It is as rough and wild as to its features as any yet surveyed, but it seemed more healthy and was more thickly populated than the country to the north. Malarious fever seems to vary in prevalance with the bamboo, and in this southern area there was less bamboo jungle than we have yet encountered. The surveyed area contains Wásurna, the chief

village in the Dangs of that name, but otherwise an insignificant place. The southern portion of the Dangs is much more capable of cultivation than the northern portion. In the northern portion forest clearances are scattered about the country, but in the portion surveyed this year there are many large areas which have been cultivated, though not nearly all the culturable land is taken up in any one year. The population may, I suppose, be taken as a measure of the actual cultivation, and the area under survey this year was much more thickly populated than the parts we have yet surveyed in previous seasons; but population seems such a very precarious item of Dang statistics, that I abstain from any definite statements. A village may be largely inhabited one year. One hundred and fifty is a large population for a village in the Dangs, and nearly or quite deserted next. There is a greater abundance of bamboo jungle in the northern than in the southern Dangs, and the bamboo seems to hinder cultivation. In comparing between north and south I refer only to the western half of the Dangs. In the eastern Dangs there are large open tracts more populated and cultivated than any we have yet met with in the topographically surveyed area.

The season's work in the Dangs is mostly confined to the valley of the Ambika (which, however, in the Dangs goes by the name of "Ibla") and its tributaries, the Deoldár and Pánetha. The Khápri valley also enters into the north-east portion. The Khápri flows into the Ambika, but outside the Dangs. The greatest height on the watershed between the Ibla and the Khápri in this season's work is Humbália Hill, 2,210 feet above the sea.

Extract from Annual Report on the operations of the No. 10 *Revenue Party, Deccan Topographical Survey, for season* 1879-80, *by* COLONEL J. MACDONALD, *Deputy Superintendent.*

THE country surveyed to complete sheets 14, 18, and 22 is under the western aspect of the Ghâts, whose supporting spurs are built up in a series of plateaux cut up by innumerable deep ravines. The slopes are almost universally forest grown. Around "Kasgaon" there are a few square miles of open country. The hills bristle with the old hill forts, among which "Tungi" and "Rajmachi" are most noticeable.

Amongst the streams which drain this western fall of the Ghâts, the "Kalu," which rises at "Harrichanderghur" and flows almost due west, is the greatest. The "Shai," which rises at "Ajuba," flows south and falls into the Kalu at Khapri. The "Khandeshi" and the "Chilar" rise on "Bhimashanker," near the village of "Tembri." On the banks of the "Chilar" is an ancient cave excavation; the open face entrance, 40 feet in width, is supported on two massive pillars with carved capitals cut out of the rock. The depth of the cave is about 21 feet. No trace of inscription exists.

The "Thul Ghât" incline of the Great Indian Peninsular Railway has been surveyed in sheet 14; also the old Agra road from Bombay which crosses the railway at several points. This is the only first class metalled road in that portion of the district. There is no available road for wheel traffic along the Ghâts between the "Thul" and the "Bhore Ghât" inclines of the Great Indian Peninsular Railway. A road over the "Malsej Ghât" is in course of construction; commencing at Callian it passes through "Murbad," following the old "Brinjari" track, and enters the rich valley of "Junnar" above the "Ghâts" in the Poona district. The "Nana Ghât" road, a few miles south of the new "Malsej Ghât" road in process of construction, is the next in importance; it is only adapted to pack-carrying animals. When the Mahomedan army that entered the "Deccan" arrived before Deoghur in 1294, they found outside the walls a vast number of bags of salt which had just been brought from the "Konkan" over the "Nana Ghât." At the top of the Ghât there is cut on the rock the oldest inscription which has yet been discovered in this part of India.

Salt was evidently then, as now, the chief article carried from the Konkan to the upper lands. There is also a pack bullock track over "Bhimasanker," but it is very little used as it is long and difficult. Coolies carrying head loads can scramble up and down the Ghâts here and there. The best foot track is up the hill side at "Kapoli."

The area surveyed in sheet 75 comprises talukas "Penn" and "Alibaugh" of the Colaba Collectorate, and a detached portion of the "Bhor State." The Ghâts here approach within thirty miles of the sea board. The intervening country is very rugged, crossed with ranges of hills, which in many cases are of considerable height, ranging from 1,000 to 2,500 feet. The slopes and intervening valleys are mostly covered with a strong growth, chiefly of teak. With the exception of the "Kharapet" lands around "Washi," and a narrow strip along the seaboard, the country is forest clad. The wild mango trees are especially grand as trees.

The facility for transport afforded by the numerous tidal creeks, which permeate these valleys very numerously, is taken full advantage of in supplying the markets of Bombay with wood and jungle-produce, amongst which the fruit of the "Hirda," known in trade as "Myrobolam," is chief. Rice is grown in vast quantities along the "Kharapet" lands, and full advantage is taken of every spot of cultivable land, in all the "Konkan" valleys and plateaux. Along the seaboard there is a dense vegetation in cocoanut, betelnut, and plantain cultivation. Fruit and vegetable gardens, also a great system of fish-drying, complete the industry of these thickly inhabited villages.

The "Amba" river rises under "Khandala Ghât," passes "Nagotna," where it is crossed by an ancient Mahomedan bridge below which it is navigable for vessels of 30 to 40 tons burthen. It extends as a tidal channel entering the Bombay harbour. On the banks of this

river, near the village of "Unheri," are situated two hot springs frequented by sufferers from paralysis and rheumatic affections. The temperature of the water is about 130° Fahrenheit. The water has a sulphurous taste. The flow is great and constant, there is never any palpable difference in the volume of water.

The "Bhagwati" rises at "Bondia Donger;" it passes the large town of "Penn;" and is navigable to a point about a mile and a half from "Penn" at the village of Antora, that is to say, it is navigable when it merges into a tidal creek.

General Description of the Konkan.

The Konkan may be described as the tract between the Ghâts and the sea, from latitude 20° 25′ north to the border of the Portuguese territory of Goa, a distance of more than 300 miles, and its average width is about 45 miles. Its area may be roughly estimated at 14,500 square miles.

The North Konkan is well wooded. It is intersected by many rivers and arms of the sea. Where there is arable land it is highly cultivated and very populous, but much of it is rocky and rugged.

North of Bombay and Salsette the general character of the coast is sandy and shallow. South of Bombay the coast is precipitous. Behind the rocky islands are deep tidal rivers which form commodious harbours. All along the coast the rocky eminences are crowned with forts, which of old played an important part in the long succession of wars which for centuries were continued between the Mahomedans, Portuguese, Marathas, and, during the early part of last century, the piratical hordes led by Angria.

It is only within the last few years that roads fit for wheeled vehicles, have been made in many of the districts south of Bombay. Only eight roads (one under construction) cross the great Ghât wall between the "Konkan" and the "Deccan" plateau. The Tanna Collectorate has roads through most of its talukas, and it benefits by the lines of railway which, commencing at Calcutta and Madras, meet at Callian.

The numerous rock excavations so common in the "Konkan" show that the Budhists had an influencial following here. In the island of Salsette they abound especially. The caves at Kanheri form so large a cluster, that they could afford shelter to many hundreds of people. The excavations amount to 102, but these do not represent all the immense labour expended on these rock-cuttings. Each group of caves has its separate reservoir outside; couches and benches are cut out of the rock. Across the slopes of the hills, steps are carved out for the convenience of intercommunication between the different halls and temples. Though greatly disappointed in the beauty of the caves, still I think they are worth visiting. It is supposed that their construction dates from about nineteen centuries ago.

Near "Kanheri" are the caves of "Mandapeshwar" and "Magathan;" these are "Brahmanical." The caves at "Mandapeshwar" were utilized by the Portuguese, who set up an alter in the large cave and used it as the crypt of a church built over the cave.

The caves at "Kuda" and "Mhar" are Budhist. Numerous small caves are found here and there. In these, as at Elephanta, the soulptures and inscriptions were destroyed and defaced by the Portuguese in the sixteenth century, when as partial iconoclasts they routed out the hordes of *jogees* who inhabited the caves.

There are but few remains of fine buildings showing the traces of Mussalman occupation. At Callian, where there is still a large Mussalman population, there is a fine mosque; and if its dome was in proportion to the rest of the building, it would be architecturally remarkable. It is situated on the edge of a splendid tank, round which are many tombs. In a rather large building is the tomb of Mortabha Khan, which dates from 1695 A.D. The fine old bridge at Nagotna, built in 1582, deserves notice; but as it is barely ten feet in width between the parapets, two carts cannot pass each other on it, and it would be almost useless for heavy traffic. It is strange that there are not more traces of a governing race which built like giants and finished like jewellers, considering that they attached considerable importance to the trade with Egypt, Persia, and Arabia, and that they were supreme in power from an early date in the fourteenth century to the close of the sixteenth.

Of the Maratha rule, dating from the middle of the seventeenth century, the great hill forts are left as their heaviest marks. Though some show traces of Mahomedan building, it is evident the Mussalman thought less of fortresses than the Marathas. All are constructed on the same principle. The top of the fortified hill is surrounded by a bastioned wall. If any outwork is necessary, it is connected by a carved passage with the body of the work. The gateway is always in the part most difficult of access. Some of these forts show results of stupendous labour in rock-cuttings. In all a small shrine dedicated to "Hanuman" is found inside the main gate.

Some notice should be given to the masonry built fort at "Khardeh" in the "Jamkhed" taluka. A square, enclosing about ten acres of ground, surrounded by lofty bastioned walls and a deep ditch with walled counterscarp. The walls are eight or nine feet in thickness at the top, and sufficiently thick at the base to admit of casements being built in them as shelter for the garrison. Inside the fort is a mosque built by "Sirdar Jehan Khan," killadar. The fort was erected, as announced on an inscription, on the outer doorway of the sally post: "In good time and in good days this building has been erected by Rajah Sultanji Nimbalkar, the Deshpandias, the Patels, and the Saukars of Kasba Sheopatan, pergunnah Jamkhed, Sirkar Ahmednagar, tributary to the Bádáshá Takte Buniyad (the Badshah of Aurangabad), and was completed on the 25th of Saban 1156, Hijiri," (1740 A.D.)

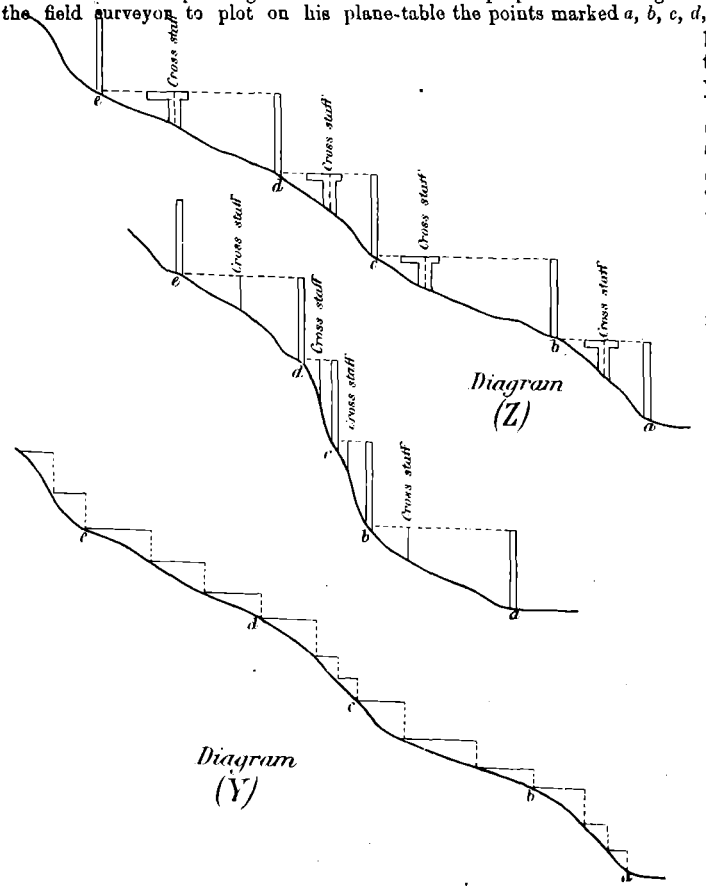
Khardeh itself is a town which was once the seat of a very important grain and salt trade, now deteriorated to one-fourth of its former value; and it is also noticeable as having been the scene of a great battle between the troops of the Nizam and the Peshwa in 1796, in which the latter were victorious and ever after maintained their supremacy in the eastern districts of Ahmednagar, until their authority passed into the British power after the battles of Poona and Kirki.

All this country shows denudation of its forest trees. Every effort is being made to promote jungle growth; but centuries must elapse ere the injury to the country caused by the folly and greed of one unthinking generation can be quite forgiven by nature. It is my opinion that the future of the eastern districts, as far as their agricultural prospects are concerned, is most gloomy; and it is certain that the rainfall in the upper basins of the Godavery and Krishna rivers will be most precarious for many years to come.

Extract from Annual Report on the operations of the No. 5 Revenue Party, Banda and Mirzapur Districts Survey, for season 1879-80, *by* Colonel F. C. Anderson, *Deputy Superintendent.*

It was impossible to employ European agency alone on the 93 square miles of hills surveyed on the 16″ and 4″ scales during the past field season; and as it is a work of time to train even the best native surveyors to judge degrees of slopes to ordinary accuracy, I devised the following plan by which to carry out, as far as practicable, the instructions contained in the Surveyor-General's circular No. 21 of 24th January 1879.

Along a line taken from the base to the top of the hill, contour lines at vertical intervals of ten feet were measured by means of a 10-foot rod and cross staff, to which a plumb was attached. The plumb gave to the cross staff the properties of a rough level, and enabled the field surveyor to plot on his plane-table the points marked *a*, *b*, *c*, *d*, *e* in diagram Z, between which the distances were determined by chain measurements, as shown in diagram Y. The object of the cross staff and rod was not so much to attain unnecessarily extreme accuracy, as to train the field surveyor by giving him his first few contours accurately ploted on his plain-table, and by this means to obtain a more correct idea of the number of contours required for the scale in use for the particular hill on the survey of which he was engaged. At first the field surveyor was directed to measure up lines from the base to the crown of the hill, as shown in diagram Z, ten chains apart, and to fill in his eye contours between each pair of measured lines. As practice engendered confidence, the distances from measured line to measured line, between which the eye contours were filled in, were increased to 20 and 40 chains.



Statistical and Geographical description of Syriam Township, District Hanthawaddy, British Burma. *By* CAPTAIN J. E. SANDEMAN, *Deputy Superintendent.*

THE Syriam Township is situated approximately between $\frac{16°30'}{17°\ 0'}$ north latitude and $\frac{96°18'}{96°83'}$ east longitude, and covers an area of about 850 square miles, of which 793 square miles have been surveyed up to date. It is bounded on the north by the Pegu Township; on the south by the Gulf of Martaban; on the east by the same Gulf and the Sittoung river; and on the west by the Rangoon and Pegu rivers.

Geographical position and extent. Division into circles and kwins.

It is divided into the following Circles or "Tikes":—

Name of circles.	Number of kwins.	Total area. (Acres.)
Pagoo	11	19,729·50
Poo-gan-doung	41	71,846·84
A-goon	26	73,665·64
Than-hlyeng-myoma	21	25,078·48
Kyouk-tain-byin	25	34,524·20
Kyouk-tan	44	46,506·94
Yoon	18	32,907·76
Hmaw-woon	44	66,028·73
Met-ka-than	25	45,348·48
Kadoon-baw	9	37,154·01
Tada	31	54,603·75

A circle is a revenue division, and has its own "Tike thoogyee" or Officer to collect the revenue. As some of the circles are rather large, it is possible they may be still further divided ere long.

The circles are sub divided into "kwins." A "kwin" literally means a plain. It used to be the unit of assessment in the old days, all land in one kwin having been assessed at the same rate; but the Settlement now in progress divides a "kwin" into four classes of soils, the assessment on which varies from Rs. 3-8 to.12 annas an acre. A "kwin" is therefore only a convenient division of the circle, and corresponds to the Indian "mouzah" or village. The "kwin" is still further divided into fields, generally of a regular shape, where the contours of the land do not interfere. The field forms the "survey unit," and a group of these is held by each cultivator direct from the State.

The aspect of the Township is a vast alluvial plain, with hardly a tree in most parts, the only land-marks being the monasteries at the different villages, which are lofty buildings and are generally surrounded with clumps of tall bamboo and plantain. The creeks which intersect the plain are fringed with low mangrove jungle, which is fast disappearing as cultivation spreads. To the east of the Township along the sea coast, the jungle is still a few miles wide in parts, owing to the tract being inundated by the sea at high tides and being unculturable; but the silt yearly deposited is raising the land even here.

Aspect. The Kon-dan soil.

The one break in the general aspect is the low laterite ridge, in its highest part not more than 200 or 300 feet above the sea, which first appears at Thanhlyeng-myo, and, running parallel with the Rangoon river through the Than-hlyeng-myoma and Kyouk-tan circles, disappears at the village of Kyouk-tan, the last seen of it being the rocky bars in the Hmaw-woon creek, which appear high and dry at low water, and which cause the navigation of this important channel to be very precarious. It would help to develope trade, were a passage to be formed through these reefs by blasting the rocks. This "konedan," or high land, is evidently the last eastern spur of the Pegu-yoma. It is curious that the eastern slope is abrupt, whereas the western slopes are gradual, and disappear in the plain almost imperceptibly. Along the sea coast on the south of the Hmaw-woon circle, is a "dune" or sandy ridge, a few feet higher than the country inland, formed by deposits of silt. It is covered with jungle and is hardly perceptible

The soil of the Township consists of clays chiefly, and of sands, varying from rich black clays to laterite sand and gravel.

Almost the sole product of the Township is rice, or what is locally termed by all Europeans "paddy" or unhusked rice. Captain Parrott, the Settlement Officer, in his report mentions the Burmese saying that there are 102 varieties of paddy; and as he collected 16 kinds in two villages, he thinks there may be some truth in the saying. He divides paddy into two descriptions—(1) ordinary, (2) glutinous paddy. The latter will not stand boiling, but has to be cooked by steam or in a bamboo, in which it is sold; it is very satisfying, and eaten before the cultivator goes to his labour in the morning. Of ordinary paddy, the Burman considers "meedone" the best, and "bawgoot" second best. For export purposes, "nga seing" is the only paddy grown in the township; this is a hardy kind, and preferred by the purchasers. Where cultivated, the entire plain is a paddy plain; but there are a few other products. Many edible plants are found in the fields, which the Burmese eat.

Products.

"Thekkeh," or thatching-grass, is obtained and sold chiefly by the "Shans."

The "danee" palm, which grows along the creeks, yields leaves used for roofing houses which are sold at from Rs. 2 to Rs. 5 per 100 leaves. The fruit and the juice of this palm are also sold.

The products of the "Kone-dan" vary from those of the plain. Much of the land is taken up as so-called "garden" land. Some of these gardens consist of nothing but jungle, with a few jack and mango-trees, but others are cultivated and yield pineapples, plantains, guavas, &c. They are all valuable, however, and are assessed at Rs. 3 an acre. The land on the lower slopes and foot of the Kone-dan produces a variety of crops, the chief being pawn, or, as locally called, "betel;" the others, potatoes, roselle, pumpkins, onions, and chillies, &c. The pawn gardens here are not covered in as they are in Bengal, and the plant grows to a much greater height.

The Shans are great gardeners; but I noted that Madrassees are taking up much land at the foot of the Kone-dan, and it was in one of their gardens that I noticed potatoes.

Modes of cultivation. Prices.

The mode of paddy cultivation is by sowing. The plough, which is like a huge rake in appearance, is first used after the early showers of the rains; and after several ploughings have taken place, the seed, which is not carefully chosen being very often mixed, is thrown broad-cast over the field. No weeding is done, the seed being left to take care of itself. No manure is ever used; but I have noticed that where manure has by chance fallen, a clump of paddy strong and high will grow, and sometimes a field will be dotted over with these clumps, which are readily seen. Only the ears of the paddy are reaped. The Burman does not stack the straw, which is burnt down afterwards, and forms the only manure the land gets. It is said the Burman reaps only the ears of the paddy, because he is afraid of snake-bites! The threshing-floor is generally in some convenient field, the oxen that tread out the corn being left unmuzzled. The winnowing sieves are made of bamboo, and are hung from tripods of bamboos and swung backwards and forwards, the wind blowing away the chaff.

For the last few years, very high rates have ruled for paddy in the Rangoon market, and the average price this year is about 100 baskets or bushels for Rs. 90.

The prices of some of the other products are given by Captain Parrott. Bamboos, which are of three kinds, are sold from Rs. 3 per 100 to Re. 1 each; pineapples are two pice each. A jack-fruit is sold from four annas to twelve annas. Mangoes from Re. 1 to Rs. 6 per 100.

Sometimes, when the rains are very heavy, some of the fields become flooded, and the yield is small; but as a rule there is not much loss by floods in this township.

Tenure. Waste land grants.

The land is held direct from Government, and except in grants made under the Waste Land Rules of 1839-41 and 1863-65, there is no middleman. In the former case the cultivator enjoys fixity of tenure, in the latter he is merely a tenant-at-will of the grantee. Of these grants there are fortunately only 20 in the Syriam township, and it is possible that one or two of these may be resumed. The total area of these grants is 13,457 acres, or 21 square miles.

Modes and rates of assessment.

The new Settlement in progress classifies the land into four classes, on which the rates are as follow:—

	Average rates. Rs.	A.	P.
Class I	3	6	0
„ II	2	5	0
„ III	1	3	0
„ IV	0	12	0

The rate for the class varies slightly according to the "Settlement tract" it is in. Garden land is classed high, about Rs. 3. The yield of first-class paddy land is about 40 bushels per acre, and it diminishes to 10 bushels for the poorest land; with careful cultivation, the yield might be doubled.

Increase in revenue owing to settlement and survey.

The new Settlement will raise the revenue considerably, owing to the rates being enhanced, and because the Survey has revealed that the area on which revenue was formerly paid was greatly in defect. In the six circles which have come under Settlement, the Survey has shewn the increase in cultivation to be 23·91 per cent., and the increase in revenue will be 36·22 per cent.

Other taxes.

Besides the assessment on the land, the cultivator pays a 10 per cent. cess by the new Act, and a capitation tax of Rs. 2-8 a year if a bachelor, and Rs. 5 if a married man. "Tari" and cocoanut palms are assessed at four annas each. Next year, all fruit-bearing trees are to be assessed at six annas a tree.

Labour and its remuneration.

The holdings in the township being large, averaging, as far as has yet been ascertained, about 43 acres, and the assessment light, the cultivators are well off, and seldom cultivate their own fields, but largely employ foreign labour, either Burmans from Upper Burma, or

gangs of coolies from Madras. Coolies for ploughing are paid about Rs. 30, and reapers about Rs. 24 a month.

The Burman generally does his own carting. The paddy is either stored in granaries in the village to be sold hereafter, or is sold to the owners of paddy boats in the nearest creeks.

Agricultural implements and stock.

The agricultural implements are the plough, the harrow, reaping hook, and winnowing sieves.

The cattle are very fine. The average price of a buffalo is Rs. 100, and of a bullock Rs. 70 or 80; they come from up-country; the mortality among them is great, owing to the Burmans taking no care of them.

There are no rules regarding grazing, and no tracts have hitherto been set apart for the purpose. The custom has been to send the cattle to graze under a cowherd, who receives payment in paddy. It is a strange sight in the rains to see a very small Burman boy astride on a large buffalo out in the "kwins," his sole clothing being a large bamboo hat to protect him from the rain; he has generally a large cheroot in his month, and thus he sits the live-long day, while the buffalo quietly grazes. A boy is mounted on every buffalo to prevent the animal from injuring the crops; and he seems quite happy to spend his day thus.

Grazing.
Grazing lands.

The new Settlement Department is setting aside grazing tracts in every "kwin," wherever land is available, in which no one will be able to take up land for cultivation.

The Rangoon and Pegu rivers, which border the township, are navigable for sea-going vessels as far as Than-hlyeng, and the latter for very large craft as far as it borders on the township. The Hmaw-woon creek is 670 yards wide at its mouth, and is navigable for 30 miles for large paddy boats; during the rains, paddy boats can go right through the creek to the sea, or to the Sittong river.

Principal rivers and creeks.
Yos.
Swamps.

The other large creeks are the Baw-choung, navigable to Thatay-kwin, Kama-ka-loke-choung, navigable as far as Kama-ka-loke, Pada-choung, Khanoung-choung, Mayaw-choung, Adoon-choung, Poogandoung-choung, and Kawet-choung, which are all navigable for distances depending on the state of the tides. During the rains, boats can go right through from one to the other.

All the creeks in the township are tidal, many of them overflowing their banks at very high tides. Besides those mentioned by name, the country is intersected with numbers of smaller creeks, many of which are silting up gradually. The banks of most of the large creeks are very high, and it is only at high water that any view of the country can be seen when sailing along.

When creeks have silted up and are no longer navigable, they are termed "Yo's," and appear as mere depressions without high banks, some of them being after a time cultivated.

In the Met-ka-than and A-goon circles there are considerable swamps.

The only road in the township is a very indifferent one along the crest of the "Kone-dan," and runs from Syriam to Kyouk-tan. It has been partly metalled, but is in a very neglected state.

Roads.

The creeks therefore are the highways of commerce. It is true, in the dry weather, after the paddy is all reaped, fair-weather cart tracks are made from village to village; but these are only used to a limited extent, and parts of the township are not fully tapped for paddy till the rains set in and fill the smaller creeks.

There are no wells except at the villages at the foot of the "Kone-dan," because in the plain, the water, which is a few feet below the surface, is brackish and unfit to drink. Drinking-water is therefore stored in tanks. There is everywhere a scarcity in March and April, some of the villages in A-goon being deserted till the rains for want of drinking water.

Wells and water-supply.

The rainfall is about 100 inches, as far as I can ascertain; but there has never been a rain-gauge regularly kept until lately. Showers begin in April, and the regular monsoon bursts about the middle of May. There is hardly a shower from early in November till April. The temperature is very equable. In the dry weather it ranges from 60° to 94°, and in the rains from 75° to 90°, the mean in the dry weather being about 80° and in the rains about 82.° A cold weather is unknown; the nights are slightly chilly in January. Thick fogs prevail in the early mornings in the dry season.

The rainfall.
Climate.

There are various descriptions of boats to be seen on the creeks. There is the large Burman paddy boat with a carrying capacity of from 800 to 2,000 bushels of rice. There is the smaller Burman boat, in which are carried plantains, vegetables, and fruits of kinds for sale. There are Chittagonian or "kalah" boats, manned by the natives of Chittagong; these chiefly carry passengers. There are Burman canoes; and, lastly, the gaily-coloured Chinese sampans. Except the latter, of which the construction is different, the others, from the paddy boat to the tiny canoe, are flat-bottomed, the lower part being hollowed out of a single log, the lines of the boats being very fine. They all carry one square sail.

Boats.

The larger boats have beautifully carved chairs on the high stern, on which the steersman sits; at the bow there are grotesque figureheads of birds and animals, and the same also sometimes at the stern. Owing to their flat bottoms the boats can make no way against the tide; therefore it is that a fleet of every description of boat daily collects in the paddy season at the mouth of the Hmaw-woon and other creeks, and as the tide begins to make,

all weigh anchor together. If there is no wind, the simultaneous creeking of the oars and chaunt of the boatman are heard; but the most picturesque sight is when there is a breeze, and they all set sail together. Some of the sails of the smaller boats are made of discarded silk garments, and the bright colors look pretty.

Towns and principal villages.

The capital of the township may be said to be Than-hlyeng-myo, commonly known as Syriam. It is merely a long straggling village with few good houses in it, and is a very dirty place. It is situated on the left bank of the Pegu river, at the foot of, and at the northern extremity of the Kone-dan, and is the site of an old Portuguese and Dutch settlement, the remains of an old fort and of a Christian monastery being still in existence. It has a population of about 2,000 souls.

The other principal villages are Kyouk-tan, on the Hmaw-woon creek; Kama-ka-loke, on the Kama-ka-loke creek; Khanoung, on the Khanoung creek; Pyin-magan, on the Pyin-magan creek; Tada, on the Tseng-ma-kan creek; Thone-gwa, on the Hmaw-woon creek; Thatay-kwin, on the Baw creek; Poogandoung, on the Poogandoung creek; Pagoo, on the Pegu river; Kayin, on the Kayin creek; Pada, on the Pada creek; Ok-kan, on the Ok-kan creek. In these villages many of the principal houses are built of teak. Pada is the site of an ancient town, and there are traces of ruins. Kyouk-tan is not a large place, but it derives its importance from the head-quarters of the Assistant Commissioner in charge of the Sub-division.

Kyouk-tan and Thone-gwa are laid out in squares, but most of the villages straggle along the creeks, one or two rows of houses on each bank. The houses are never built on the ground, but are raised on piles of wood or stout bamboos, the sleeping room being higher than the front veranda, which is the family sitting and dining room. Under the house the pigs and poultry live.

In villages built on creeks liable to inundation at high-water or in the rains, the principal roads are made of a single plank raised on cross sticks, or of bricks laid on edge or earthenware jars sunk in rows touching one another. Every village has its "Phoongyee Khyoung" or monastery; these are often picturesquely built like pagodas, or having three roofs superposed.

Classes of inhabitants.

The principal classes of the inhabitants are Talaings, Burmese, Shans, and Karens; the two former are in by far the greatest numbers, and they constitute respectively 43 and 41 per cent. of the total population.

The following table gives the numbers by circles, the total population of the township being 66,866, or about 79 per square mile:—

Circles.	Talaings.	Burmans.	Karens.	Shans.	Chinese.	Mahomedans.	Hindoos.	English.	Total.
Than-hlyeng-myoma	2,573	1,959	.....	606	4	251	.....	.....	5,392
Kyouk-taing-byin	1,968	1,671	238	1,088	2	37	.....	.....	5,004
Toda	3,090	2,502	.....	356	10	.....	2	.....	5,960
A-goon	1,727	6,400	433	442	39	12	106	.....	9,220
Yoon	1,790	2,114	.....	2,718	35	.....	28	.....	6,695
Kyouk-tan	459	4,406	625	1,634	15	35	50	2	7,226
Hmaw-woon	4,076	3,411	.....	883	47	.....	225	.....	8,591
Poo-zan-doung	8,263	1,010	693	.....	26	.....	41	.....	10,044
Met-ka-thon	2,150	1,170	0	14	2	.....	12	.....	3,366
Pagoo	2,604	2,632	.....	99	16	3	9	.....	5,363
Kadoon-baw	.....	.....	.....	.....	.....	.....	.....	.....	.....
Total ...	28,719	27,316	1,995	7,797	196	338	473	2	66,866

Manners and customs.

The population is almost entirely agricultural. Living so near Rangoon, the people are adopting many English customs. They use kerosine lamps and matches; English beds and mattresses; chairs with long arms, sprawling in which, the Burman, in very little clothing, his legs tatooed black from the waist to the knee, his body tatooed red, and with a large cheroot in his mouth, is a quaint sight. Near him may be seen his gaily-dressed wife, literally "his better-half," engaged in helping to husk the paddy for the day's consumption or in other domestic duties, but generally busy when not engaged at her toilet.

Here, as elsewhere in Burma, rice and dried fish (ngapee) and chillies, or a little vegetable, form the diet of the people.

The large villages have one or two shops in them, generally kept by Chinamen, in which are sold biscuits in tins, sardines, pickles, matches, twine, artificial flowers, umbrellas, and so forth. Soda-water and lemonade are sold at stalls in the streets. There is also generally one liquor shop and an opium farm, kept also by Chinamen; at the former, beer brewed in Rangoon is sold, as well as infamous brandy.

All the people smoke, men and women, and even very small children. Their cheroots are six inches long, and are made of chopped wood and tobacco rolled up in a leaf; but they also smoke the cigar made in the ordinary manner. They chew betel to a great extent.

They eat out of lacquered trays and bowls, but also use China cups and plates, bed-room crockery sometimes being used at the meals of a large family. No such thing as "caste" is known in the country. On one occasion, when one of the Surveyors asked for a light, a Burman standing by hastened to the fire of an Oudh classie cooking

close by to get it, and when he saw the man indignantly throw away his food, he was surprised indeed.

There are many quaint customs amongst the people which we noticed, but most of these will be found well described in Forbes' "Burma." I may mention that at Kyouk-tan, when small-pox was prevalent, the entire population used to turn out in the evening at dusk with gongs and sticks; with the latter, they began to beat the thatch of their houses; the gongs sounded, guns were fired, crackers were let off, and the din was so great that at first, the cause not being known, it was most alarming. We ascertained that the "nats," or evil spirits, were being frightened away!

Funeral ceremonies.

Funeral ceremonies were pretty sights at Kyouk-tan. One would have hardly thought it was a time of mourning. The bier is of bamboos gaily decorated with flags. In front are young men dancing and singing, and playing on musical instruments. The villagers, chiefly women, in their bright colors, walk behind. A phoongyee heads the procession, a member of

"That noble order of the yellow robe,
"Which to this day standeth to help the world."

Village bazars.

In every village all the inhabitants seem to have something to sell in a corner of their front verandahs, and in the evening a little bazar is formed in the main street. A few cheroots, plantains, ngapee, chillies, &c., form the stock in trade. Some stalls have also a table, laid out with cups and saucers and tea. The buyers are the boatmen and passengers going up and down the creek on which the village is situated; the young women and children of the house are the vendors, the men apparently being content to lie on their backs smoking all day, and only turning out in the evening to talk and flirt with the village belles.

In the whole township there is very little to be got to supply the wants of a European. There are no sheep or goats, there is no bread, nor vegetables worthy the name, no milk or butter, as Burmans do not use either; and the poultry the people will not sell, as they rear them to exchange for cloths with traders who come from Rangoon and go up all the small creeks in boats. The fowls are very fine, and are re-sold by these men in the Rangoon market at Re. 1 each.

Mahomedan colony.

At Than-hlyeng there is a colony of Mahomedans, who have a ziarat on the Kone-dan, and a mosque. They are descendants of the families who came from India with the Portuguese, but they cannot talk anything but Burmese; and, except in dress and religion, are quite Burmanised.

Education.

The education of the boys is chiefly carried on by the Phoongyee schools. Females are taught to some extent by nuns and old men.

Forests.

The forests consist of mangrove and willow on the creeks and along the sea coast, Pyeimma (*Lagerstroemia regina*), Thitsie, Danyeng,

Edible caterpillar.

Pyeng-kado (*Xylia-dolabri-formis*), jack-trees, mangoes, and bamboos of several varieties.

A caterpillar is found in the jungle which, when cooked on toast, is excellent, and tastes like marrow toast.

Remarkable buildings—Kyoungs. Pagodas.

Some of the "Phoongyee kyoungs," or monasteries, at Syriam, and those at some of the villages up the Hmaw-woon and other creeks, are worthy of note. They are generally large buildings on very stout piles, situated in a clump of fruit-trees or bamboos; the ground around is kept beautifully clean, and very often there are "zaiats," or rest-houses, around the kyoung for the weary traveller.

The principal pagoda is Kyaik-khouk, the one on the Kone-dan, four miles south of Thanhlyeng. There are pagodas worthy of mention also at Than-hlyeng itself and at Kyouk-tan. At the latter, on the reef of rocks about the centre of the Hmaw-woon creek, is a small pagoda, which is a conspicuous feature in the landscape. On the right bank of the creek is also a pagoda of great antiquity, although not of any beauty or size.

The golden pagoda of Kyaik-khouk is very handsome, being 130 feet in height and built of blocks of laterite. It is 1,200 feet in circumference. It is said to have been built before Christ, and that there are some relics of Gaudama buried under it. It is in charge of a Committee of Elders. The view from it is extensive, and it can be seen from every part of the township.

There are several small pagodas along the crest of the Kone-dan, and the ruins of many more, some of which must have been very large.

Burman officials.

For each circle (or *tike*) there is a revenue officer called the "tike thoogyee;" he is solely responsible for the revenue due to Government.

The "kyee-dan-gyee" is the head man of the village; he pays no capitation tax for which he performs various minor duties; he is also the village police officer. The "goung" is the circle police officer, who receives a salary of Rs. 10 a month.

Health.

The health of the people is good. In a few villages small-pox is prevalent generally from March till the rains break; but there is little fever or any other sickness, and the people may be said to be very healthy.

Litigation and crime.

There is a certain amount both of litigation and crime, but not excessive. The people are inveterate gamblers.

Religion.

The religion of the people here, as elsewhere in Burma, is Bhudhism. Monier Williams says:—"It cannot be said to be a religion at all, but a system of duty—morality and benevolence—without a real deity, prayer, or priest." There is no system of caste, and all men are considered equal. They believe in transmigration; they attach importance to charity, self-denial, and meditation. A daily occurrence in every village is the string of yellow-robed "phoongyees" or priests, who pass through the streets with bent head, begging their daily bread.

Arnold describes this scene thus—

"A yellow cloth over his shoulder cast
"Girt as the hermits are, and in his hand
"An earthen bowl, shaped melonwise, the which
"Meekly at each hut door he held a space
"Taking the granted dole with gentle thanks
"And all as gently passing where none gave."

Manufactures.

The manufactures of the township may be said to be almost *nil*. A little salt is manufactured at Theelwah, a village in the Myoma circle on the Rangoon river, by evaporation, and at a few other places. Some "thamaines" (women's costumes) are manufactured and sold by the Shans.

At Thone-gwa, on the Hmaw-woon creek, there are a number of sawpits. The timber comes through from the Sittong during the rains.

Weights and measures.

The ordinary Burmese weights are in use, one viss being equal to 3·65lbs. The English land measure is adopted, the acre being divided into 16 annas, and the anna into 12 pie.

Obstructions in creeks.

It has been mentioned that the creeks are the highways of commerce. The most important, and by far the largest of these, is the Hmaw-woon-choung. But unfortunately at Kyouk-tan, the reefs of laterite rocks, which have been already mentioned, greatly impede the navigation. The Government would confer a great benefit on the people if these rocks were blasted and a channel opened out. Kyouk-tan can now only be passed even by small passenger boats at high-water, and even then the navigation is difficult.

Ferries.
Bridges.

There are regular ferries at Syriam, Kyouk-tan, Thonegwa, Weh-gyee, Nyoung-lay-bin, Dayzat; the leases of the ferries for the year being sold by auction.

The creeks, if not very wide, are bridged at all the larger villages by wooden bridges for foot passengers. These, after the manner of the Burmese, are never repaired, and many of them are in a very rickety condition, being generally unsafe for ponies.

At the villages where there are no ferries or bridges, small canoes, often in a leaky condition, are kept by the village authorities for the convenience of travellers. I crossed in one at Pa-da-wah, which filled as we crossed, and we just landed in time, for in another moment it must have sunk.

Fisheries.

Many of the creeks and "yo's" used to be fisheries let out by Government, the lease being yearly sold by auction; but they have recently been all abolished, as when the creeks were banked up, the country became flooded, and a great deal of harm to cultivation occurred.

Postal arrangements.

There are no postal arrangements in the township, worthy of the name. There is a post-office at Kyouk-tan under the charge of the Assistant Commissioner; but as Burmans are employed as runners, the delivery of the daily post from Rangoon is very irregular.

Fairs and markets.

Cattle markets are held at Kyouk-tan and Nyaung-bin. Captain Parrott mentions that the largest transactions in paddy take place at Thatay-kwin, Tha-koot-kone (Ywathit), Nyaung-thoone-bin, and Joung-joung-ja, these being the termini of the land routes from the in-lying kwins.

Syriam Pagoda Feast.

The only large fair held annually in the township is the religious festival at the Kyaik-khouk pagoda. This fine golden pagoda, situated on the Kone-dan about four miles south of Syriam, has already been mentioned. The yearly festival takes place at the end of January, or early in February at full moon. It lasts for four or five days. I could get no estimate of the numbers assembled, but there must have been, I suppose, ten or fifteen thousand people at least. Many of the Rangoon traders send out representatives, and the inhabitants of the township make this the occasion of their yearly purchases of such articles as cannot be got in their villages. As our camp was in the vicinity, I was able to visit the fair, and found it one of the most strange and amusing sights I have ever seen. Amidst the trees and bamboo jungle at the base of the pagoda, and on three sides of it, was laid out a miniature town, with narrow but regular streets, lined with booths made of a frame work of light bamboos, and covered with coloured cloths. Behind the main streets were regular

encampments of the pilgrims and holiday-makers. The stalls were occupied by Chinese sellers of various sweets and jellies, Burman eating-shops, Chinese boot-makers, Madrassis and Hindustanis selling every kind of miscellaneous article; various peep-shows, in which photographs of London were being passed off as those of Mandalay. In the forenoon there were boxing matches. A ring being formed of the surging mass of human beings, two equally matched boxers came to the front, having their loins tightly girt; they first made their prostrations to the Assistant Commissioner and to the "nat," or evil spirit of the place; they then stood up, and, having made a few defiant antics, proceeded to business. Low music accompanied their movements, and as they warmed to their work and blows came thick and fast, the drums got louder, till finally the noise was deafening. It generally ended in the combatants being locked in each other's arms, and thus coming together to the ground, when they were separated by the umpires. Whenever blood was drawn, the match was at an end, and more prostrations having been made, the boxers were each presented with silk cloths. Then two more would stand up, and the fun lasted for some hours.

In the afternoon we visited the pagoda platform. Here was a most picturesque sight. The long rows of steps and the platform were crowded, with women chiefly, gaily and most tastefully dressed. The tightest of silk dresses, the colors of which are beautifully blended—a white linen jacket with a delicately colored silk handkerchief thrown over the shoulders, the shining black locks gathered up behind, with one or two bright artificial or real flowers stuck in at one side, the face done up with a white cosmetic or powder—is a description of the fair devotees. They would kneel down in rows and make their devotions in an earnest manner, then light a taper and place it as an offering, or else their good action would consist in sticking some gold-leaf on the pagoda, or they would offer a few flowers, oranges, and rice. Then they would pass on to listen to a singing minstrel, or blind fidler with a monkey, who had been all this time performing close by on the platform of the pagoda. Under the full moon, the picturesque crowd, with the golden pagoda towering above, was a sight not to be easily forgotten. The evening was devoted to visits to the Burmese plays or "pooeys." There were several going on, as well as some puppet pooeys, or marionettes. The posturing of the women was extraordinary, and the puppets move most naturally; but the thing that struck us most was the enjoyment of the Burmese crowd, and the hearty bursts of laughter at every joke.

History and antiquities.

Than-hlyeng is the site of an old Portuguese settlement. Here can still be traced the ramparts and bastions of a fort, which includes within it an area of over 20 acres; the walls were built of laterite and earth.

The *Gazetteer* says, according to Burmese tradition, the town was founded in 587 B.C. At the beginning of the 17th century, the king of Arracan took possession of Pegu, aided by the Portuguese, and to them he gave the town of Than-hlyeng, which they fortified; but they were driven out again a few years later.

In 1631, the Dutch were allowed to establish a factory at Than-hlyeng, which they retained till 1677. Then an English factory was established, but the date of this is unknown.

In 1740, the Peguans expelled the Burmese, but did not molest the Europeans.

In 1743, the Burmese re-took the town, but were driven out again immediately by the Talaings, who burnt the factory, this time to the ground.

Ruins.

Nothing now remains of these English and Dutch settlements, except the remains of an old church (which must have been a grand building), the foundations of the fort, and walls of a few monastery buildings.

The *Gazetteer* says:—"The church was erected in 1749-50 by Father Nerini. In plan it consisted of a single nave ornamented with arches and columns both inside and out."

Hardly was the labour of constructing the church ended, when Father Nerini took in hand the building of a roomy house as a residence for the bishops and the missionaries. This old ruin is very substantially built with thick walls of small but well-burnt bricks; but trees are growing out of the walls and breaking them down, and it is a great pity that nothing has been done to preserve this ruin, which is such a grand monument of the earliest Christian enterprise in Burma.

Cultivation extending.

Cultivation is extending very rapidly in the Township. Mr. King, Assistant Surveyor, mentions that when out surveying in Met-ka-than Circle, he met armed parties of Burmans exploring for land to make clearances; the men had come chiefly from the Pegu direction. A-goon is all cultivated except the belt of jungle bordering the sea, and in this Mr. King saw trees being felled, and the Burmans extending their cultivation.

Traces of former cultivation.

The parts of Met-ka-than and A-goon, which are now a swamp, were evidently once inhabited by the Talaings before they were expelled by the Burmese, for there are the remains of tanks to this day.

Notes by CAPTAIN T. H. HOLDICH, R.E., *Officiating Deputy Superintendent of Survey, on the route to* KABUL *through the* LUGHMAN *Valley.*

THE course of the river Kabul, which, from its general directness, would form the natural highway between Jelalabad and Kabul, is unfortunately confined for some miles of its

length between precipitous walls of rock which offer little or no chance of successful road-making along its banks. There are four of these defiles (locally called *tangis*) between Kabul and Jelalabad, and hitherto their existence has been sufficient to divert the greater portion of the traffic of the country into the Gandamak-Jagdalak route, involving the passage of the Jagdalak pass which forms the connecting link between the Karkacha range, which is in itself a spur of the Safed Koh and the Seah Koh, which is really an extension of the Karkacha eastwards. Any route from Jelalabad to Kabul, running south of the Seah Koh, must either pass over the Jagdalak kotal (6,200 feet above sea level) or over some other pass of the Karkacha or Seah Koh, higher than that of Jagdalak. The disadvantages of this route, both politically and strategically, are matters of history; its disadvantage as a traffic route lies mainly in its gradients, which must either be excessively steep, or else the route must be lengthened until the rise of the Jagdalak kotal is spread over a sufficiently long line of ascent.

But it happens that only one of these defiles or *tangis* interferes with the adoption of the river route for a considerable distance (about 30 miles) beyond Jelalabad, and this gorge, which is known as the Deronta defile, is hardly two miles in length.

The Deronta gorge leads into a direct road to Kabul, which runs nearly due west along the northern base of the Seah Koh range, south of the river, for about 20 miles through the Lughman valley, and thence over an easy pass (called the Adrak Badrak) to Kata Sang and the Tezin valley. The whole of the Gandamak-Jagdalak route is thus turned, and with it all the difficulties involved in the ascent of the pass, the dangerous nature (strategically) of the pass itself, and its disadvantageous position as regards the neighbouring Ghilzai tribes. The Lughman route, too, is shorter and flatter, involving much less wear and tear on any transport system which may be worked along it.

About the end of January a working party of Madras Sappers and Miners, supplemented by cooly labour, was employed in making a practicable road over the Deronta hill, west of the river (which takes a southerly bend through the gorge), so as to avoid the double passage of the river across two awkward fords. The hills east of the river trend down to its banks in low spurs of soft sandstone rock, much mixed with water-worn boulders, which offer very little difficulty to the passage along its banks of laden baggage animals of all descriptions; so that it has been usual to cross the river to the left bank, and then re-cross in order to enter the Lughman valley. On the western bank the Seah Koh range comes to an abrupt conclusion, breaking up into rocky limestone spurs which terminate in precipitous cliffs right over the river bed. It is over these cliffs that the road was made. The crystalline limestone rock of which they are composed proved superficially soft and friable, and the three and a half days labour bestowed on the road resulted in a pass which was practicable for lightly laden baggage animals of all sorts, except perhaps that class of camels taken from the plains of India, which have been collected for transport in the hills of Afghanistan. This pass, as first laid out, rose to a height of about 650 feet above the plain; but an alternative road has been surveyed and is in course of construction, rising only 300 feet, and another even is contemplated, which will pass almost at the river level round the base of the cliffs, and be suitable for any sort of traffic.

From the top of the Deronta pass the Lughman valley, backed by the rugged hills and snowy peaks of Kafiristan, is spread out in a grand panorama to the north and west, and appears at the first view to be a well-irrigated, highly cultivated plain, full of flourishing villages, protected by the usual square-built bastioned mud forts. This is the nature of all the districts called Kuj, in which are situated the forts of Asmatulla Khan, and it is also the case with that part of Lughman, north of the Kabul river, which is watered by the Alishang below its junction with the Alingar; but by far the greater part of the Lughman district, from the immediate neighbourhood of the Alishang westwards to the Bad Pakht hills, consists of a dry, sandy plateau, covered with boulders and patches of coarse grass, deeply intersected by ravines and nullahs, and utterly unproductive. About a mile and a half from the northern foot of the Deronta pass is the village of Futteh Mahomed or Fatiabad, and a little beyond it is a small garden of cypresses and palms, laid out with much care and taste, near the fort of Bahram Khan. These are all some distance north of the foot of the Seah Koh, and in the midst of well-cultivated ground, apparently open and traversable, but in reality so deeply intersected by water-cuts for irrigation as to be almost impracticable for cavalry. The high road to Kabul passes between this cultivation and the hills, and for the first 10 or 11 miles runs nearly level, and is already a well-defined open road, owing to the amount of *Kuchi* traffic which has lately passed along it. For about 300 yards it skirts the banks of the Kabul river so closely as to require some additional width to make it practicable for wheeled traffic.

The first village on the road is Sakh Khan, almost exactly 10 miles from Asmatulla's fort, a small unimportant little hamlet built at the end of a sandstone spur, which extends from the Seah Koh down to the river bed. About a mile further, after crossing this spur by a low kotal about 100 feet above the river, is the village of Khair Khel, containing about 300 houses, with some cultivation reaching down the banks of the river. From this point cultivation only exists in small, unimportant little patches on either side the river, and the villages are insignificant. The road from Khair Khel passes over a low, stony plateau, only a few feet above the river level, much of the same nature as that existing between Jagdalak and Kata Sang, only without the deep, intersecting water-courses which render that road so full of steep gradients. Nine miles from Sakh Khan is the village of Kuch Mahomed Ali, the last four miles of the road being fairly free from stones and easily

traversable. Two other villages are passed *en route*, viz. Kaghar Kuch and Urmur. The former possesses about 100 houses and a small, square, mud fort, measuring about 40 yards each way, the road running through the middle of the village and under the fort walls. There are a couple of small villages on the left or opposite bank of the river, about opposite to Kaghar Kuch, inhabited by marauding bands of Utman Khels, one of the numerous sections of the Ghilzai tribe. The villages of Sakh Khan and Khair Khel are peopled by Nasars, another section of Ghilzais, who are said to be occupied entirely in agricultural pursuits and not to share the marauding proclivities of their neighbours. There are, however, several villages not far from the road, but quite out of sight, hidden among the low spurs at the foot of the Seah Koh range, inhabited by Ahdamzies, who are well-known robbers. These villages between them could probably muster 600 or 700 armed men if necessary. The left bank of the river at the eastern end of the valley, and the valleys of the Alingar and Alishang contain many important villages, of which the principal appear to be occupied by Tajiks; Charbagh and Mandrowar are Tajik villages. Alishang itself, too, is Tajik. Mingled with the Tajiks are various sections of Ghilzais, Dehgans, and Safis, both of which latter people are allied by language and race to the Kafirs of Kafiristan. The Safis occupy a considerable extent of country fringing Kafiristan. They spread from the north of the Lughman valley and the southern slopes of the Kafiristan hills across the Bad Pakht range over the Ushin and Tagao valleys, probably into the valley of the Panj Shir, north of that part of the Kabul river which flows through the Doaba.

The village of Kuch Mahomed Ali may be said to terminate the Lughman valley. Opposite to it rise the rugged peaks of the Bad Pakht, themselves an offshoot from the great Chardi mountains which are piled up between the Alingar and Alishang. The Bad Pakht form the western boundary of Lughman, and over them runs a well-known Kuchi route from Mandrowar to Nagulu opposite Sarobi in the Doaba. About a mile west of Kuch Mahomed Ali the river emerges from the gorge known as the Dabeli, along which no track whatever exists. At this point, where it is about 2,200 feet above sea level, it is necessary to leave the river and rise gradually over the Adrak Badrak (so named from two peaks overlooking it) to a height of about 4,000 feet over a rough, but very practicable, ascent to the villages of Chota and Barra Durgai. Chota Durgai is about four miles from Kuch Mahomed Ali; Barra Durgai being about two miles further on at the foot of a descent of about 500 feet from the highest point of the pass. From Durgai the route runs nearly level across the stony plateau which forms the north-western base of the Seah Koh and Karkacha, and which reaches down from the mountain masses northward in long slopes to the Kabul river, forming a curious geographical feature, common both to Northern and Southern Afghanistan. This rough, uneven, plateau, through which the Kabul river runs, after emerging from the Kabul plain through the extraordinary defile known as the Tangi Garhu, gathering the waters of the Panj Shir, the Tagao and Usbin, and passing in succession through the Gogomand and Doaba valleys to the Dabeli defile, extends westwards to the Deh-i-sabz range (overlooking the Kabul plain), and northwards to the base of the Nijrao and Kafiristan hills. The only cultivated parts of it are those bordering the rivers mentioned, which here and there (as in Tagao and Sarobi) open out into valleys which, if they are narrow, yet show extraordinary richness and fertility, being filled with thriving villages surrounded by orchards, meadows, and corn-fields.

The Adrak Badrak route finally joins that of the Jagdalak pass at the northern end of the Parri-darra, or Jagdalak defile, thus turning that defile completely. But before its junction with the main route, it rises over the Dabeli kotal to a height of about 5,000 feet above sea level, falling again to 4,000 feet, which about represents the level of the Parri-darra. This descent forms the steepest incline in the whole route, and has required some special attention to make it thoroughly practicable. So that the whole difficulty of the Lughman valley route to Kabul from Jelalabad may be said to be distributed between its two ends—the Deronta defile and the Dabeli pass. Between these two points the road, as it exists in its unmade condition, offers very unusual facilities to a marching force from its contiguity to a large river and its easy gradients. The total distance saved by the adoption of this route from Jelalabad to Kata Sang would be about 12 to 15 miles; but there would be a saving in the gradient represented by the rise and fall over successive kotals and ridges, which would be much under-estimated by a mere comparison of the highest point passed over on this route with the known height of the Jagdalak pass.

The Lughman valley offers many points of great interest to the historian or archæologist. It is on the summit of the great white peak of Kund, overlooking Lughman from the region of Kafiristan, that Noah's Ark is said to have rested after the floods, and the valley of Dara-i-Nur, which lies on the border land of Kafiristan territory, leading into that land of romance and conjecture, still bears his name.

The famous zearat of Mehtar Lam (Lamech) is in the Alishang valley, and annually numbers of pilgrims repair from Jelalabad on a pilgrimage to the shrine.

Within the limits of Lughman no topes (or stupas) are observable, although they exist in numbers in the district of Jelalabad, and one of the best preserved of them is at Deronta, near the entrance to the valley; but there are other evidences of a former occupation by a Buddhist population in the caves bordering the river, both at Deronta and opposite Kuch Mahomed Ali. The Lughmanis too have ever been the connecting link between Kafiristan and the southern world in the matter of trade. Kafir slave girls brought down from the mountains to the Dara-i-Nur were introduced by Lughmanis through the markets at Jelalabad and Kabul to the harems of the wealthy classes of those cities. Kafir beauty is

famous; but it is probable that, as a matter for export, its value has been lately considerably depreciated. A list of marches from Jelalabad to Kata Sang is appended:—

Jelalabad to Asmatulla's fort	11	miles.
Asmatulla's fort to Khair Khel	10	,,
Khair Khel to Kuch Mahomed Ali	9	,,
Kuch Mahomed Ali to Parri Darra	13	,,
Parri Darra to Kata Sang	4	,,
Total ...	47	miles.

Notes on the LOGAR *Valley by* CAPTAIN T. H. HOLDICH, R.E.

FROM the western extremity of the Safed Koh range, about the position of the Shutargardan pass, there reaches out in a south-westerly direction a long watershed composed principally of bare, rocky hills, called the Michelga and the Shari Koh, till it reaches a point about fifty miles east of Ghazni. From here it bends suddenly to the north-west, almost at right angles to its original course, and under a new name (the Uluk Koh) it passes a little to the north of Ghazni, and becomes finally merged into the rough and crumpled mountain masses which originate the four great rivers of Afghanistan—the Helmund, the Surkh Rud, the Panj Shir, and the Kabul—and bind together such mountain chains as the Koh-i-Baba, the Hindu Kush, and the Paghman. This is perhaps the centre of the great web of Afghanistan geography. Over this watershed lie the principal passes from Northern into Southern Afghanistan, leading from Kohistan and the plains of Kabul, or yet more remotely from Afghan-Turkistan to the great Ghazni-Kandahar road, or to other routes less known to trade traffic; or travel in the direction of the Waziri country and the valley of the Gomul. Northward from this watershed the drainage is all carried into the Kabul river by the Logar and its principal affluent—the Shiniz. The valley of Shiniz and of the Logar, starting from the Sher-i-Dana pass, over that same watershed, close to Ghazni, would give the natural and most level line of communication between Ghazni and Kabul, but for the fact that after its junction with the Shiniz, the Logar still continues its easterly course till it rounds the corner of what may be called an accidental range. This would lengthen the line of route considerably, so that the Ghazni-Kabul road, after following the Shiniz to its junction with the Logar river, runs straight away northwards by the most direct line, rising and falling over a series of low kotals formed by successive spurs from the mountains on its left to Maidan and to Argundeh, and so through the historical Chardeh valley into Kabul city. Meanwhile the Logar, after an eastward course for 20 miles or so, receives an occasional tribute from the water-courses and streamlets draining the northern slopes of the Michelga, and then turns sharply to the northward, winding through a series of open plains connected by narrow tangis or gorges, after the fashion of most Afghan rivers, till it finally runs out in the Kabul plain, where it carries after all but a very insignificant tribute of water to swell the volume of the Kabul river. The reason of its insignificance will be presently explained.

The Logar valley throughout consists of a series of broad open plains bounded by rugged hills, from the foot of which long, low, sandstone spurs stretch down with gentle gradients towards the river, presenting generally an appearance of arid waste, which limits the cultivated strip along the river banks to a few miles of width; so that its general appearance from commanding hills and peaks is that of a broad, green ribbon of cultivation, lying extended along an open, sandy plain, with a few outlying patches of green here and there. The exception to this general appearance is where the river makes its way from one plain to another through a gorge or tangi closed in by rocky hills on either side. There are three such tangis in the course of the Logar. The Tangi Wardak, shortly after its junction with the Shiniz, conducts it to the Hisarak plain. From the Hisarak it passes by the Tangi Wagjan into the Charasia plain, and thence again by the Tangi Navishta into the plain of Kabul. It is difficult to estimate the volume of the Logar because of the drain on it for purposes of irrigation. Narrow as the cultivated strip may appear, it is sufficient to support a great number of very large villages, and its high state of cultivation is very remarkable. The river, in many places during the dry month of May, is run to a narrow thread by the amount of water carried from it to the surrounding crops. Large areas are flooded for rice, and the irrigation system is so complete as to appear even complex in some parts of the valley. The villages are connected by narrow watered roads, no more ground space being taken up by the roads than is absolutely necessary for communications which are never subject to wheeled traffic of any sort. In order to move troops with facility about the valley, it is as well to avoid the cultivation as much as possible, and to make use of the flat sandy waste that borders it. And yet the pleasure of the green shady lanes, over-shadowed by the sweet-scented trees which border each canal or cutting, surrounded by a waving sea of luxuriant crops, is such that a few extra miles, and perchance many extra hours of such marching, is barely inducement enough towards forsaking these cool, sweet paths for the hot, fierce glare of the unsheltered hill sides. And without wheeled artillery, there is no real difficulty in moving by these village roads. It is almost impossible to exaggerate the occasional beauty of the Logar valley, viewed from the river banks. The white-walled, square-towered villages (each with its bastioned fort) are literally buried in the groves of dark-green mulberries and palm-trees. Poplar avenues are by no means an unusual feature in the scene, while the wide fields of clover (in which one may wander knee-deep) and of wheat

are fenced off either with low mud walls, or with hedges of the wild yellow rose carefully banked and tended. Occasionally broad stretches of soft smooth turf flank the river; but there is not, as a rule, much grass in the country. There is always the enchantment, too, which distance lends to the hot, rough-sided hills which are ever the back-ground of the picture: but the final charm of the distant snows is wanting in the Logar valley, and, in this particular, Kashmir scenery surpasses that of the Logar. The river gorges or *tangis* are always beautiful, without the grandeur and impressiveness of the Kabul *tangis*, but with a picturesqueness due to the wealth of vegetation which they enclose, which does not belong to the Kabul rifts. The Kabul gorges are so stupendous that it is impossible for the eye to measure them fairly, and some of them have never yet been explored by living soul; but the Logar passes, on the contrary, all admit of the passage of troops after some attention has been bestowed on the roads, and usually enclose a good strip of cultivation on either side the river.

It is curious that south of Charasia the Logar valley should apparently be destitute of objects of antiquarian interest. There was at any rate, with one exception, nothing that formed a prominent feature in the landscape. At Hisarak there are ruins on a low hill overlooking the river, which were said to be Bhuddist. I cannot quite agree to this theory of their origin. They appeared to be far more like the remains of an old fort, of no great size, but in a fairly strong position, with a good command of the surrounding country; and as they form the solitary point of interest that marks the exception to the general rule, I should be inclined to suggest (in the absence of any authoritative description of them) that this is the fort that gives its name (Hisarak—small fort) to the adjoining district. From Charasia the Logar flows through a "*tangi*," called "Sangnavishta" ("or written stone") into the Kabul plain. The name refers to a stone which once existed in the gorge on which was an inscription. This stone is at present in Sherpur, and photographs have been taken of it, which will no doubt prove of great interest. Another stone with an inscription is said to be at Safed Sang, near Zahidabad, in the Logar country; but this I have never seen. I should think it possible that, wherever the word 'Sang' (or stone) is applied to denote a locality in North Afghanistan, there may have existed originally similar inscriptions on rocks in the immediate neighbourhood of that place. Near Kabul, where the Logar and the Kabul rivers are near to their junction, there are evidences of the former existence of a great deal of Buddhist architecture. The Takht-i-Shah or the summit of these hills south-west of the city, which were held so resolutely by the enemy in December until the assault of the 92nd Highlanders and 5th Goorkhas placed them in our possession, to be again transferred to Mahammed Jan on our retirement into Sherpur, is nothing but the remains of a Buddhist tope, partially excavated (and therefore affording most excellent bomb-proof cover) with caves below it on the western side of the hill. The Siah Sang hills are perforated with caves, some of which were unearthed by Lieutenant the Hon'ble Talbot, R.E., while constructing a road on the western face of the hill, but which he had not time to explore; while near the village of Chakri, about ten miles south of Kabul, are many specimens of Buddhist architecture in an unusually good state of preservation. A small map, on the scale of one inch to the mile, will best show the position of the minars and tope that have been observed there. No doubt there are many more evidences of Buddhist occupation, which have never yet come to light. The minar, which is perhaps in the best condition, and which has attracted most attention from its conspicuous position, is on the ridge overlooking the Kabul and the Kurd Kabul plains, and marks about the most convenient pass from one district to the other. It is 95 feet high, and about 62 feet in girth at the base; a picture of it appeared in the Illustrated News of January 24th, 1880, but its relative proportions have not been very well preserved; another sketch will be appended to this report. The early centuries of the Christian era, after the disappearance of the Greek and Scythian invaders, must mark about the epoch in the spread of Buddhism, when all these *minars* and *topes* were built. The masonry is peculiar (similar to that of the *topes* of the Jelalabad district), the small flat bricks or tiles which form the mass of the building being interspersed with rough natural boulders, which give it a curious spotted appearance.

The present inhabitants of the Logar valley are Ghilzais and Tajaks, the latter predominating. Previous to our occupation of Kabul, I believe the Logaris did not bear the character of being a particularly turbulent or troublesome people to deal with; but our experiences during the winter of 1879-80 prove that the Logari can equal the Kohistani in his fighting capacity, and fully justified Shere Ali's judgment in detecting the Logaris to form with the men of Wardak, the flower of his regular forces. At the same time the Logaris are most advanced cultivators. The Logar valley embraces quite as much cultivated soil as any district of similar physical and geographical conditions that I am acquainted with in India, and the cultivation is of a very much higher order. For the explanation of this apparently contradictory state of affairs, we must look to the division of races occupying the soil; and we probably find that the Ghilzai is, as usual, the fighting man, and the Tajak the ryot of the land.

Additions to Notes on the Logar Valley by CAPTAIN T. H. HOLDICH, R.E.

THE name of the small village near the tope, marked in the sketch map which accompanied the notes on the Logar valley, is Kanzada Kila, not Chakri. Chakri, which gives its name to the monuments generally, is in the Kurd Kabul valley (called Chakari in Mr. Claudius' map); there is no other village of the same name. The larger village, about a mile north north-west of Kamjada, is called Usman.

In the accompanying sketches the upper plate represents what appears to be the base of an unfinished *minar*, close to the *minar* which is marked on the map south-west of Usman (about a mile and a half). It is built of a mixture of brick masonry with stones interspersed exactly like the other *minars*, nor is there any appearance of the rounded top which is characterestic of topes. The ornament which runs round it is shown in figures 1 and 2, and slightly differ from that on the tope near Kanzada in the construction of the arches which are centered in the latter, but not in the former. All these ruins have been excavated, and I was told by an old man who remembered the excavations being made, that a silver casket, containing coins and relics, was taken out of the tope, but nothing out of the *minar*, except small earthenware saucers like those used for *charaghs*. The tope evidently is of a more recent construction than the *minars*. The dome is entirely brick, and there was originally a coating of plaster over it. It is about 40 feet in diameter.

Extract from a Report by MAJOR R. G. WOODTHORPE, R.E., *Season* 1879-80.

A FEW remarks on the triangulation may be of some value. It is founded on two Great Trigonometrical peaks known as Kadimakht Ghar, a point a few miles north of Thul, and No. 187, or "Dingsar" (its local name), the base being computed from the latitudes and longitudes given in the Synopsis of the Indus Valley Series. This base was chosen of necessity instead of taking one nearer Kohat, and working down from two absolutely fixed stations (instead of merely intersected peaks) as at first intended, as the state of the country between Kohat and Thul did not allow of the survey party leaving the main road very far on the south, and any attempt to visit the prominent peaks to the north was absolutely forbidden by the political officers at Kohat. A very good series of triangles was carried up to the Shutargardan in season 1878-79. A base in the Kuram valley was measured to commence work from, and when the triangulation was afterwards brought up from that, it was found that the difference in the values obtained by measurement with a subtense theodolite and by triangulation was only three feet, the total length being 4·03 miles. Of course it was impossible, under the circumstances of hasty marches and hostile people, to carry on the triangulation as carefully as it ought to be done; in many cases time did not allow of any mark, such as a cairn of stones, &c., being erected over the stations; and in other instances, where marks had been put up, the inhabitants destroyed them, and it was often very difficult, when the hills, as they so often are, are broad and flat-topped, to make out the exact spot over which the theodolite had been placed when observing back to these hills. The results are fairly satisfactory notwithstanding these drawbacks. The triangles are a little attenuated at the Shutargardan, any ascent of the Machalgu hills and the Surkhas range being forbidden. However, points on both these ranges had been well fixed, and by making use of them with supplemental angles, the triangulation has tided over that part and opens out again in the Logar Valley, and so on to Kabul. In November, having left all triangulation behind, a fresh base was measured in Sherpur cantonment, and from this base points on the Bemara ridge, Sher Darwaza, Khurd Kabul, and Karogh ranges were fixed, and as opportunity offered each of these points was visited, and from them many peaks on the Pagman, Hindu Kush, and Deh-i-Sabz ranges were fixed, which formed the basis of all the topography obtained around Kabul. Later on, this triangulation round Kabul was connected with that in the Kuram Valley, as I have explained, but the values thus obtained for intersected points do not differ materially from those previously worked out. The results of the triangulation* have not been finally worked out yet, but at present the values of a point common to the Kuram and Khyber triangulation differ by about 3′ in latitude and 9′ or 10′ in longitude. This difference may become less when the final results are worked out.†

The height of Kabul will probably alter slightly with the final computations, as better vertical angles have been observed in the later Logar triangulation than was possible before, but there is no reason to suppose that the result will be very different. The heights are of the Kuram and Kabul triangulation points, obtained from Mirkwaili Sir and Tog as the initial points, though unfortunately reciprocal angles have not been observed at Mirkwaili. The value as at present assigned by the Kuram triangulation to Sikaram is 40 feet greater than that assigned to it by the Indus Valley series. This may be due partly to the fact that a house has been built on Mirkwaili Sir, immediately over the Great Trigonometrical station, the level of which it is now impossible to discover; and secondly, it is highly probable that the highest point of Sikaram was not observed to from the Indus Series, as a point a few feet lower looks the most prominent from all places east or south-east of Sikaram. It is only from the south that the real shape of the hill-top is discernible. The supposition is strengthened by the fact that the latitude and longitude of the Kuram Valley hill station of Sikaram differ from those of the Great Trigonometrical peak by about the distance that this lower point is from the hill station.

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* Since this was written, I have computed all the triangulations and intersected points, and worked out all the longitudes and latitudes of the secondary stations and of all the intersected points that are proved.

(Sd.) G. W. MARTIN, *Captain.*

† By my fresh computation I have only obtained a difference of 0·7 of a second in latitude, and 5·2 seconds in longitude from our old values.

(Sd.) G. W. MARTIN, *Captain.*

Report on the operations in Southern Afghanistan, by Lieutenant ST. G. C. GORE, R.E., *Assistant Superintendent, Survey of India, season* 1879-80.

I HAVE the honor to submit herewith my report on the work executed by me in Afghanistan during 1879-80 in continuation of last year's report.

On completion of my work in Pishin in October 1879, I received orders from Lieutenant-General Sir D. Stewart, K.C.B., to proceed to Kandahar to take charge of the work there.

Having met Captain Rogers, R.E., at Quetta, I took over from him such computations, &c., of the work about Kandahar as he had to give me.

I left Quetta on the 25th October, taking with me sub-surveyor Saidulla Khan, and took advantage of my passage across Pishin to fill in a few additional details on my map.

On arrival at Chaman, I received instructions from Kandahar to take an escort of men who were about to return and to proceed to Kandahar by the Barghana route, which lies north-east of the ordinary road. This I did, making a sketch of the route traversed and the surrounding country on the scale of 1 inch=4 miles, amalgamating my work with that previously done by Lieutenant Hobday on the Kandahar-Chaman road. This work is based on points trigonometrically fixed by Captain Heaviside, Captain Rogers, and Lieutenant Hobday.

I reached Kandahar on the 13th November. On arriving there I found that there was no immediate prospect of any field-work, and so devoted my time to putting my Pishin work in order. It was at last arranged that as some troops were going out of Kandahar towards south-west I might take advantage of their presence to extend the survey of the country round Kandahar on the scale of 1 inch=1 mile down towards the south-west, thus mapping the fertile country lying along the banks of the Argandáb and Dori rivers, down as far as their junction, or further if possible. I started on the 12th December from Kandahar taking with me my two sub-surveyors, Atma Sing and Saidullah Khan, and an escort of 12 Goorkhas. My orders were to keep open communication with the troops who were to be despatched to the neighbourhood and to stay as near them as possible. A native official, the Sháhgassi, was also sent with me by the Wali to aid me as far as possible.

I extended the triangulation about Kandahar as far as I could towards Girishk, so as to give the sub-surveyors fixed points to work on, and then started the detail survey. We continued the plane-tabling thus till the end of December, when I started with the intention of pushing down the Argandáb as far as I could, to try and extend our knowledge of the country in that direction. Unfortunately when I had gone three marches and reached Kila Shah Mir, just beyond Atakarez, I was peremptorily recalled by orders from headquarters as rumours had got about that the country was in an uneasy state. The people however were very fairly civil to us, and my sub-surveyors had no difficulty in prosecuting their work, although their camps were at some distance from mine and almost unprotected. For this security I have to thank the Sartip (who has since deserted and joined Ayub Khan), who used all his influence to further the work. I was fortunately enabled to complete the survey of the country which was most essential, *i.e.* all the fertile and well-cultivated parts from which supplies were to be drawn to Kandahar. The area completed was about 160 square miles.

After waiting at Kandahar for about a fortnight, it was arranged to send out a reconnaissance up the Arghastan Valley for the double purpose of collecting supplies of bhoosa and grain and of enabling me to sketch the country. We started on the 22nd January 1880, Major Clifford, 2nd P. C., being in charge. We marched by Mandi Hissár, striking the Arghastan river during our third march. Our fourth march was to Amin Kila, where we were detained several days by rain and snow, the weather being bitterly cold. Hence we marched on up the Arghastan, passing its junction with the Khushk-i-Rud and camping amongst the Sundarzai villages.

Hearing that there was a good direct road from here to Kandahar, we rode out to explore it. The road led over a low watershed, the Tagak kotal, into the Tarnak valley, and was an excellent one though it had a bad reputation from being greatly infested by thieves. This road was afterwards used by the 1st Brigade of the Ghazni column on their march towards Kabul.

We continued our march up the Arghastan, passing the junction of the Lora and Arghastan rivers until we reached the village of Badozai, about eight miles from where the Arghastan issues from the hills. We were unfortunately unable to approach nearer Maruf than this point. Of the three rivers forming the Arghastan basin the Khushk-i-Rud is the smallest. Its total length is about fifty miles. A fair body of water, however, comes down it, but it is very brackish and nasty to drink. Of the remaining two the Arghastan has probably the larger basin, as a good deal of the drainage, which on old maps was shown as running into the Kadanai, is now known to flow into the Arghastan. The Lora river, we were told by several people, takes the overflow drainage of Lake Ab-i-Istada, and they said that when the lake overflowed the river-water came down very salt.

From this point on the Arghastan we turned southwards and marched down parallel to the main range of hills through the Kadanai plain, striking the Quetta-Kandahar road at Dabrai, whence we proceeded to Kandahar. The whole of the survey done during this trip has been based on trigonometrically fixed points.

I remained at Kandahar during the remainder of February and March preparing for the march to Ghazni. On the 27th March Major Leach, R.E., V.C., arrived at Kandahar from India. I at once made over to him all documents, &c., which were to remain at Kandahar.

Hearing that the first brigade of General Stewart's force were to move towards Ghazni *viâ* the Khushk-i-Rud, I decided to move with them as their march would take me over a large extent of unknown ground. We left Kandahar on the 30th March, and marched for two days up the Tarnak Valley. Thence we struck across the watershed between the Tarnak and Arghastan rivers, crossing by the Tágak pass, which we had explored in our previous reconnaissance. We marched up the Khushk-i-Rud for four days, the country consisting of a tolerably level valley, much broken up in the neighbourhood of the river by hillocks and scarps of red earth and conglomerate. These attain a height of from 50 to 100 feet.

Thence we passed over an almost imperceptible watershed into the valley of the Tarnak, camping at Pamba, about 10 miles south-east of Kálat-i-Gilzai. We then marched along parallel to the Tarnak along the foot of the Surgarh hills, which form the watershed between the Tarnak and Lora rivers.

As far as Shahjui my survey depended on points trigonometrically fixed, but from that point onward I had to fall back on plane table triangulation and traversing as a basis for the detail sketching.

From the time we left Shahjui until we reached Ghazni the country was entirely deserted, and as the only guides who could be got did not belong to that part of the country, it was almost impossible to obtain any information whatever. In many places indeed I was quite unable to ascertain the village names. On the 19th April, the day of the battle of Ahmed Khel, I had with great difficulty obtained a hazara guide. After the fight commenced he several times tried to make off so as to get his share of the plunder, but was with difficulty restrained. At last a well caparisoned, riderless horse, passing near proved too much for him and he disappeared. I never heard any more of him.

After the battle was over we marched 7 miles in a thick dust-storm, when it was almost impossible even to tell in what direction we were going. This is a type of the many difficulties which a surveyor accompanying troops through an enemy's country has to cope with.

On the 21st we reached Ghazni, and as we stayed there a few days, I was enabled to make a sketch of the vicinity on a large scale, in which I was assisted by several Officers told off by the Assistant Quarter-Master-General.

On the 28th April we reached Saidabad and were in communication with General Ross's brigade from Kabul, and I was enabled to join on my work to that brought down from Kabul by Major Woodthorpe.

From here we turned into the Logar Valley, where we remained for about a fortnight.

We made a reconnaissance up the Altimor pass with the hope of getting a good view of the Zurmat Valley, but before I had been five minutes on the top of the pass the enemy appeared and I was recalled. A few shots were fired in among us as we retired, but no damage was done. I remained in the Logar Valley until all work possible there was completed. I then proceeded to Kabul and thence to Mussoorie, which I reached on the 19th June.

List of Heights along the road from Kandahar to Kabul traversed by the 1st Brigade.

They are all determined by barometrical observations.

		Height in feet.
Camp Marsinzai	...	3,697
Tagak Pass ...	...	4,718
Camp Kánat-i-Mir Alam,	Khushk-i-Rud Valley	4,474
,, Sarioba,		4,457
,, Mir Afzal,		4,666
,, Salam Kila,		4,952
,, Sheru,		5,577
,, Near Kuram,	Tarnak Valley	6,302
,, Khaka,		6,176
,, Opposite Shajui,		6,057
,, Jafir,		6,652
,, Martaza,		6,369

		Height in feet.
Camp Mukur,	Tarnac Valley	6,561
,, Karez-i-Oba,		6,986
,, Jamrad,	Ghazni Valley	6,974
,, Mashaki,		6,900
,, Ispandi,		7,252
,, Ghazni,		7,279
Sher-i-Dana Pass	...	8,373
Camp Shashgao,	Logar Drainage	8,184
,, Haftasia,		7,896
,, Haidar khel,		7,204
Zamburak Pass ...	...	7,872

Notes on the Valleys of Mastung, Mungchar and Kelát, by MR. C. P. TORRENS, *Assistant Surveyor, season* 1879-80.

THE Kelát series emanates from the stations of Dhik and Landi, near Quetta, of the Beluchistan series, and is carried down south to the city and fort of Kelát. The stations of the series are on the high hills east and west of the valleys of Mastung and Mungchar, through which the high road from Quetta to Kelát passes. The nature of the hills is the same as those of the Bolán and about Quetta, with this difference that instead of a confused

mass, they run in parallel ranges from north to south and have wide fertile valleys between. Some of the ranges rise up in small steppes, notably the Avagul hills, towards the south-east of the valley. These steppes are generally well supplied with water from wells and are cultivated by the inhabitants. A remarkably fine steppe or plateau exists below the survey station on the Avagul range, its height is 8,000 feet above sea level, and the steppe would make a good sanitarium for the troops at Quetta; it has four or five wells and a number of fields. The heights of the hills used as stations on the series, vary from 7,000 to 10,750 feet above sea level, the latter being the height of Koimarán (literally the mountain of serpents), a well known hill and the favourite resort of the shepherds of the country during summer.

The valley of Mastung, 28 miles in length from north to south, and having a mean breadth of 8 miles, narrow and very stony at the south, and widening to 16 miles at the north, is one of the most important in the northern portion of Beluchistan. It is watered by numerous hill streams, of which the chief is the Durisuna, which takes its rise in the southern hills and flows north almost the entire length of the valley. The Pashakuran Nalla is the second in importance; it rises in the Zairigat hills north-east of the valley, and flowing west, unites with the Durisuna, and then falls into the Sirinap river which flows north towards Shorawak. The valley is very fertile; cultivation commences along the banks of the Durisuna, where the river reaches the low lands about the centre of its course, and fields continue increasing in number as the volume of the water is augmented by additional streams from the hills, till the northern portion of the valley is reached, where the country may be termed an immense garden; fields abound and are thickly interspersed with orchards of apricot, mulberry, and other trees. The chief passes leading into the valley are as follows:—at the north, the Nishpa, from the Shál or Quetta valley, passable for wheeled artillery; at the north-east, the Mastung-i-lak from Darwáza (the Bolán), and the Dasht-i-be-daulat, passable for laden camels; at the east, the Avagul or Rambak, from the Ghor road, connecting the Dasht-i-be-daulat with the Robdar pass, passable for lightly laden camels and mules; at the south, the high road from Kelát, passable for wheeled artillery; at the west, the Chotak, from the Sirinap valley, passable for lightly laden camels; and at the north-west, an easy pass from the Kanak valley. The chief town is Mastung, from which the valley takes its name. It contains about 3,000 inhabitants, chiefly Brahuis, and boasts of a fort, admittance to which was refused, so I am not able to give a very minute description. The fort is square, and has mud walls about 25 feet high, loop-holed; at the corners are bastions, capable of mounting guns; it has one gate facing the town towards the east and two or three sallyports, and is garrisoned by a few of the Khan of Kelát's regulars, armed with the old Brown Bess. Tiri, a great mart for grain, is about six miles north of Mastung, and is the second town of importance in the valley. Besides Mastung and Tiri, there are many other villages and hamlets scattered about the northern portion of the valley.

South of the Mastung valley lies that of Mungchar; it is much smaller than that of Mastung, but very fertile. Its length from east to west is about 16 miles, and its breadth about 6 miles. It is watered by a branch of the Sirinap, which takes its rise in the Koimarán and Melabi hills to the east. Besides this stream there are a number of curious, underground canals termed Karez, described in previous reports by survey officers in Afghanistan. The valley is thickly inhabited and has a number of small hamlets, but no village of any magnitude, with the exception of perhaps the village called Hindu-ke-shahr, assigned to the Hindus, situated near the road to Kelát, which contains from 50 to 80 houses. From the valley there is a direct road to Darwázo (the Bolán) passing by the hill of Koimarán; it is however, seldom used, as water is scarce and villages few *en route*. Another road through the Shekh Háji pass to the east leads to the Robdar pass, and is much used during the migration to and from the Katchi plain. The road to Kelát by the Marján pass is very good and is passable for wheeled artillery.

The valley of Kelát is very small in comparison with Mastung and Mungchar, but is quite as fertile; the town and citadel of Kelát are situated towards its southern portion. The town is enclosed by a high wall once capable of having guns mounted, but now in a dilapidated condition; it has three gates. The streets are dark, narrow and crooked, and the town is kept in a filthy state; its reported number of inhabitants are 4,000; besides these the environs contain a very large number. The citadel is towards the south-western portion of the town and contains His Highness the Khán's residence. The approach to the palace is very strongly guarded; four or five gates and sentry posts, besides a long dark tunnel have to be passed before it is gained. The palace audiance hall or council chamber overlooks the town and surrounding country for some distance, and it is here that the Khán passes most of his time.

The country through which the series passes is inhabited by Brahuis. Two or more slaves are to be found in each family; they are generally brought from Sehistan and the western country, and are worth,—a woman Rs. 100, and a man about Rs. 200; they are generally well treated by their masters. Slaves of the African type are preferred to any other, as they are considered more faithful. A Hindu village, as already mentioned, was met in the Mungchar valley; it is inhabited by Banias (Karads) originally from Shikarpur in Sind. Some of them no doubt are well-to-do, but all openly profess to be poor; they dare not wear jewels for fear of being robbed. Avariciousness being the ruling passion of the Brahuis, they were rather glad than otherwise at a survey party being in their country, as they could make a little money. Their demeanour was that of indifference to what I did

so long as they got paid. No escort was thought necessary for me when working on this series, and so I had none ; happily no mishap of any kind occurred during the work.

From a surveyor's point of view, the country triangulated is all that could be wished for, but it must be done during the summer. Circumstances necessitated that the series should be done late in the season,—November and December,—and consequently the hardships and exposure endured by the party were very great. The minimum thermometer on occasions registered 5° below zero, *i.e.* 37° below freezing point, and when it is remembered that hills, in some instances, of over 11,000 feet had to be ascended, sometimes without guides and lived upon for two or three days with an insufficiency of clothing and food, and no tent, the hardships can better be imagined than described. The native establishment underwent the exposure cheerfully, and gave up many caste prejudices.

Report by MAJOR R. BEAVAN, B.S.C., *Assistant Superintendent, Survey of India, on Survey Operations in Southern Afghanistan and Beluchistan, season* 1879-80.

IN September 1879 I received instructions from Kandahar, through Major Campbell, R.E., to investigate the geography of the country between Sibi and Quetta. I was then at the Khojak Pass, and, taking advantage of the first convoy, I marched to Quetta, arriving there on the 23rd September.

Captain Beavan's movements.

I here found that a portion of the escort of the Governor-General's Agent, with Captain Showers, Political Officer, and Lieutenant-Colonel Bergman, in command, was about to start to explore the route to Sibi, *vid* the Hanna or Hamra Pass. Making hasty arrangements, I left Quetta with them, early the following morning. Mr. Price of the Bombay party, who was at Quetta at that time, furnished me with the approximate positions of several prominent mountain peaks on which my subsequent work was based. The values given me were not very accurate, but I had to make the best of them, and succeeded eventually in getting a sketch of the whole country between Quetta, Thul-Chotiali and Sibi, which I have been told has proved of great value to the Engineers employed in laying out the new line of railway—rough though it is.

We marched *vid* Astangi through the Tiri defile to Saugan, which we reached on the 6th October 1879. From Quetta to Astangi the road is good and the country open, but below Astangi the only route is along the bed of the river, flowing between lofty hills, which close in at several points, leaving only a narrow gorge for the passage of the water. In many places the troops had to work for hours before a practicable path could be made for the camels to pass, and at a short distance from the end of the Pass many days were expended in clearing a road.

Altogether it was found that the idea of making a railway, or even a cart-road, along this route, would have to be given up.

At Saugan we remained a fortnight, pending the arrival of Sir R. Sandeman, and the setling for our further progress with the Marri chiefs, who came to Saugan to meet us.

On October 19th, Captain Showers and Lieutenant Jennings, R.E., started from Saugan to explore a direct road to Sharigh and Dargi. I accompanied Sir R. Sandeman's party, and on the 21st we marched to Bahdra, on the 22nd to Mian Kach, and on the 23rd to Harnai, not without some threats of opposition, which however were not carried out.

The road from Saugan to Harnai is good throughout, but in one or two places along the Gandakin river it passes through narrow defiles, commanded on both sides by steep and rugged hills, where it would be exceedingly difficult to force a passage against a determined enemy. Again, a couple of miles on this side of Harnai, the road passes over a low kotal, affording a very strong position for defence. This kotal, we were told, was occupied by Pathans, but on approaching it we found this was not the case. The road *vid* Mian Kach can be avoided by turning north at Spintangi through a rift in the limestone ridge, but at the time we went up, this was not practicable for camels. Captain Showers rejoined us at Harnai, having explored as far as the Chapa defile. From Harnai we marched to Sibi, arriving there on the 30th October, in order to meet His Excellency the Governor of Bombay, who proceeded thence with Sir R. Sandeman up the route we had opened out *vid* Saugan to Quetta; meanwhile I remained at Sibi and Dadur, and on the 9th November I was joined by Messrs. J. T. U. Coxen and H. Corkery, Assistant Surveyors, who were placed under my orders.

Having made arrangements for these two assistants to take up the topography of the low country near Sibi, I returned with Sir R. Sandeman's escort to Harnai, and on to Khost, where we met the Governor of Bombay and the Agent to the Governor-General on the 23rd November 1879. During a day's halt at Harnai I visited Torgarh or Tongarh Hill, about six miles south, and erected a station on the summit, from whence a good view was obtained over the whole country towards Saugan and Nari. I observed some angles hurriedly, but had not much time to spare in order to reach camp again by nightfall. Returning from Khost the whole camp marched *vid* Harnai to Thul-Chotiali; the road between these places is now fairly good, but at that time there was nothing but a mere track: it has since been much improved. The drawback is the scarcity of water, which at one halting place (Sambar) is quite salt and unfit for use.

At the request of His Excellency I prepared a sketch map of the country to illustrate his report, which has since been published.

On the 6th December Sir R. Sandeman started for India *vid* Vitakri, leaving his escort to garrison Thul. I was therefore obliged to remain at Thul till an opportunity should occur of returning to Sibi. I employed my time in preparing a tracing of my survey for the Assistant Quarter-Master-General at Kandahar, and on other office work. We also made expeditions with some of the troops towards Chotiali, and to Baghao and Smalen or Smaber, where we spent Christmas day.

On the 3rd January I finally left Thul with a detachment of the 19th Bombay Native Infantry, who were sent to repair the road between Thul and Spintangi. I arrived at Sibi on the 12th, in time to witness the arrival of the first railway train and the opening of this portion of the Kandahar railway. During the remainder of the field season—*i.e.*, till the end of March—I was employed at Sibi and Dadur, laying out triangulation and observing, superintending the detail work which was being executed by Messrs Coxen and Corkery, and doing office work—computations, accounts, preparing annual report of previous year's work, &c. By permission of the Surveyor-General, and with the sanction of Sir R. Sandeman, I left Sibi on the 1st April in order to take the records which I had with me, of 18 months' work in Afghanistan, to the head office at Mussoorie, and complete them there. I was also anxious to procure any data that might be available for my future work, the Beluchistan and Kelát series of triangulation not having been calculated out up to that time.

On my return to Sibi on July 27th, I was anxious to proceed at once to Quetta, and to push on with the detail survey that was being executed by Messrs. Coxen and Corkery. I found, however, that the resources of the Transport Department were being taxed to the utmost by the despatch of troops to the front, and no carriage was procurable in the country on hire.

Shortly after this the news of the defeat at Maiwand arrived, and all survey parties were recalled from the field. I was thus detained at Sibi until the 4th September, when I succeeded in getting carriage and started for Quetta. I subsequently accompanied the force proceeding into the Marri Hills; this work, however, falls within the operations of the field season of 1880-81.

Mr. Coxen's work.

Mr. J. T. U. Coxen, Assistant Surveyor, joined this party on the 9th November 1879. He was employed triangulating and plane-tabling during the winter near Sibi and Dadur and the Bolan Pass. During the month of April he was on leave, and in May he proceeded to Quetta with the office, and made arrangements for commencing plane-tabling work in the vicinity. Escorts and carriage had to be arranged for, and advantage taken of the movements of troops, as the temper of the Pathan tribes was very changeable and uncertain. During June and July Mr. Coxen was working in the hilly country east of Quetta, until he was recalled into Quetta on the 29th July 1880, on account of the disturbed state of the country.

Mr. Corkery's work.

Mr. Corkery also joined me on the 9th November 1879. He was employed plane-tabling near Dadur during the winter months. In April he left Sibi with General Burrows, and marched up the Harnai route to Quetta. He was not able to do much on the way, but succeeded in sketching some bits of country that had not previously been explored. The tribes along this route were then in a very disturbed state. He was afterwards employed plane-tabling west of Quetta, until the survey work was stopped at the end of July.

Both Messrs. Coxen and Corkery have undergone a great amount of very hard work, and had difficulties and privations to encounter.

The work they have turned out has been carefully done, and they have succeeded in dealing with the Pathan and Beluchi inhabitants of the country without raising opposition or provoking complaints, which I consider highly creditable to them. They have been disappointed at not having had opportunities of sharing in any of the greater military operations towards the front, or of exploring countries hitherto unknown. Their labours, however, have not been unprofitable, although they may not have had equal opportunities of earning distinction as fell to the lot of surveyors employed in Northern Afghanistan.

Out-turn of work.

The amount of work done during the year may be summarised as follows:—

Tringulation.—Four new hill stations selected and cairns erected. Preliminary angles observed at five stations.

	Square miles.
Topography.—Reconnaisance more or less complete on the scale of 1 inch=4 miles	2,500
Survey in detail on the scale of 1 inch=2 miles	1,500
Total ...	4,000

Carriage.

Difficulties encountered.—The principal drawback to survey operations in this part of the country is want of carriage. I have tried, unsuccessfully, to hire camels by the month from the Dera Ghazi Khan district. The owners, however, refuse to come here on any terms.

The local Brahin carriage is entirely monopolized for the service of the troops, and camel-owners realize such enormous profits by carrying Government stores up the Pass at so much a maund, that they refuse to take service by the month. We have thus been entirely dependent on the Transport Department, and generally find difficulty in getting camels or carts at the times and places that we require them. This of course created great delay.

Atmosphere.

The next difficulty arises from the uncertainty of the climate, and especially from the dust and haze which loads the atmosphere at certain seasons, and prevents survey work being carried on at all. Last year thick haze filled the air in the middle of November. In December it was clearer, and in January, February, and March 1880 there were a succession of furious dust-storms which for days together hid every hill from view.

Water.

The scarcity of water is also a cause of delay. Many parts, both in the hill and plain country are quite destitute of water, and in other places where water exists it is salt and unfit for drinking purposes. Hence special arrangements have to be made for bringing water to the camp from a distance, and half the day is frequently lost in going to and returning from work when the camp cannot be pitched near at hand.

Health.

A natural result of bad water, and an unequable climate, presenting great extremes of heat and cold, and, of coarse, food, is a considerable amount of sickness both among Europeans and Natives of India. The country is not adapted by nature for hard work, and it cannot be carried through without distress and much strain on the constitution.

Guards.

In an unsettled and hostile country it is of course necessary to make due arrangements for the protection of the survey parties. Advantage has to be taken of the movements of troops, and the surveyor is constantly kept idle on this account. He is moreover often unable to visit some prominent hill, or to explore a confined tract of country which is essential in order to fill up a gap in the map.

The Military authorities will usually render every assistance in their power, but are not always in a position to send guards where the survey requirements would demand.

For instance, on applying for a guard to accompany Mr. Coxen into the hills between Sibi and Bahdra, I was told that the guard could be given, but that they could not be provided with carriage for themselves and the necessary supplies. For these reasons it is advisable to trust as much as possible to protection from the inhabitants of the country, but great watchfulness is requisite against thieving. Several cases have occurred of camels, &c., being stolen at night, and not much redress is to be had from the Civil authorities on these occasions.

It will be seen, therefore, that survey work in Beluchistan is liable to serious difficulties and hindrances, and it is not to be expected that the out-turn will be equal to that which might be obtainable under more favourable conditions.

By Topographical Branch order No. 48, dated 12th July 1880, the party under my orders was organised as a regular party for the survey of Southern Afghanistan, Beluchistan, and the adjacent country, under the designation of the "Beluchistan Topographical Party." During the present and following seasons I trust we shall be able to complete a considerable area of country in a systematic manner, on the scale of 1 inch=2 miles. The existing maps of Beluchistan are very valuable, but not having been based on geographical data, the positions of the various towns, &c., are naturally incorrect in latitude and longitude. There are also many blanks to be filled up between the various routes that have been laid down by travellers. These deficiencies I hope we shall be able to remedy in due course.

Extract from a Report by Captain J. E. Sandeman, *Deputy Superintendent, Survey of India, on the* Irrawaddy River *Exploration, season* 1879-80.

Many conjectures have been formed from time to time as to the source of this great river, D'Anvilles' theory and that of others being that it is identical with the Tibetan river, the Sanpo. This theory has been recently warmly advocated by Mr. R. Gordon, C.E. On the other hand, Captain Harman of the Survey Department has, by personal observation and by the aid of explorers, all but proved that the Sanpo falls into the Brahmaputra.

Former attempts to explore this river have been limited to the following:—

Wilcox in 1825 visited the source of the western branch. Mr. Strettell, of the Forest Department, in 1874 went a few hours' journey above Maing-na, although he believed himself to be in latitude 26°. How he saw the junction of the two branches of the river is strange, for it does not take place for nearly 30 miles beyond Maing-na, the spot from which the people told the explorer he turned back. At page 170 of his narrative he says:—"*4th February* 1874.—At 8 A.M. we left Maing-na ..... The river increases in impetuosity ..... We found ourselves passing up a noble gorge ..... The hills echoed forth the wild cries of my boatmen, cheering one another on as they endeavoured to stem the current .... Our progress was slow and the pace continued to decrease, until the crew found it was hopeless depending any longer on their poles .... They jumped overboard with their towing ropes and renewed the struggle, and straining every nerve, it was as much as they could do to creep along;" and then he describes how in a couple of hours

more their troubles were at an end, for he says: "Here the river divides into two great arms, that to the east being considerably the larger." On the 5th Mr. Strettell describes his return in fifteen minutes! Mr. Strettell's description of the rivers does not agree with that of the explorer, and I can hardly believe he could have got from Maing-na to the confluence of the two streams against such a current as he describes, in one day, and return in fifteen minutes! I think he must have taken a hasty glance from some distance and come to the conclusion he did: or else more probably he was deceived by the river being divided into two by an island. This actually occurs at Shanta-yoke-ywa above Maing-na, which I cannot but think is the spot reached by Mr. Strettell.

Dr. Anderson in his report on the expedition to Western Yunan, devotes a chapter to discussing the probable sources of the Irrawaddy. He is no advocate of the theory that the Sanpo is the Irrawaddy. He himself visited the first defile above Bhamo, and he gives the opinions of Hannay, Bayfield, and Griffith, who had been as far as latitude 25°.

Early in 1879 the Surveyor-General asked me if I would train a man to explore the Irrawaddy. I need hardly say I was only too glad to undertake the interesting task. Through the exertions of Mr. Burgess, the Secretary to the local Government, a man named A—a was obtained, who had volunteered, and with the sanction of the Chief Commissioner his training was proceeded with.

I soon saw that he was an intelligent man. He knew the use of the compass already. I trained him to pace and observe double altitudes of stars with the sextant. The latitude of Rangoon being too low, the sun could not be observed on the meridian, but he was taught to observe it off the meridian. I instructed him, as best I could, how in higher latitudes he would be able to get it at noon. On the 17th October 1879 he started with one A—e M—e, an elderly man, and M—o, a nephew of his own, as companions. The former had been trading in timber up and beyond Bhamo for years, and, although an elderly man, was in many ways fitted to make a good assistant to the explorer. The party took with them about Rs. 300, in gold principally, and the following instrumental equipment,—a 6-inch sextant and a supply of quicksilver, a small prismatic compass and pocket compass, two boiling point thermometers, a common thermometer, and a bull's-eye lantern. As A—a speaks Hindustani imperfectly, Messrs. Burgess and Pilcher, the Chief Commissioner's Secretaries, very kindly, and with great patience, explained to him all my instructions. A note was made of the index error of the sextant and variation of the needle, and of the reading of the thermometer when water boiled at Rangoon.

After an absence of less than six months, the explorers have returned, and although they have not been able to visit the exact source of the river, they have not been very far from it, and have done a vast deal to silence conjecture for the future.

The following is taken from A—a's journal:—

October 17th, 1879.—The party left Rangoon.

November 2nd.—The travellers reached Bhamo. There they remained till the 7th November. During their stay they looked about for a way of getting up the river, and at last found some Shan Kadoos starting for Haw-ka with salt, who agreed to take them for Rs. 5 each.

November 7th.—A start was made, and Maing-ka was reached by the evening.

November 8th.—The boat reached Tha-pan-bin. From hereabouts the river begins to narrow, and the rocky gorge continues to below Myintha. The current is tremendous, and the water forms into whirlpools between the large rocks that stand up as islands in the narrow channel. The explorer heard that in the rains no boat can row up, but that they had to be towed up with strong ropes from the banks; that some are yearly lost and people drowned. He says that the gorge is 200 yards broad at its narrowest. The people speak of it as "Kyouk-twin" or rocky gorge.

The inhabitants on both banks are chiefly Poons, living in about a dozen villages from Tha-pan-bin to Pagan.

November 11th.—On this date Pagan was reached, and on the 12th the island of Hnote-cho, a large village on an island inhabited by Shan Kadoos. The country on the banks along here is described as being a fine plain, parts of which were once cultivated. At this village limes are very plentiful. The people carry on *kaing* cultivation on the banks of the river and have gardens. The average breadth of the river about here is over a mile.

November 13th.—Poot-tay stream, south of Shway In, was reached. Here was obtained the first opportunity the explorer had of taking observations for determining the latitude.

November 15th.—Ayeing-dama was reached. From Poot-tay stream bearings of every turn of the river had been taken. The distances were also noted by time. The mouth of the Mo-goung river was passed. The explorer heard that up its course it widens out, that it is a large river, and that it takes its rise in a lake. From Ayeing-dama upward on every sand bank that is formed, the people wash for gold with great success. The river here is described as 2,000 paces wide: the eastern bank as 18 feet above the water.

Ayeing-dama is an old and once populous city, and is called after a King who lived here. There are the remains of a fort. The place was of importance till the reign of the Burmese King Alompra.

A large trade used to be carried on with China, and large tracts of paddy-land lie fallow. At present there are 20 houses of Shan-Kadoos and five of Kachins: the former pay revenue to Burma; the latter do not do so here or anywhere.

November 16th.—Haw-ka was reached. Here fresh arrangements had to be made for the party proceeding on. During their four days' stay they slept in the boat they had come

in. The travellers here remark that the teak forests ever since they left Tha-pan-bin have been very fine, and they saw other useful timber also. The inhabitants since leaving the island of Hnote-cho have been chiefly Kadoos.

November 20th.—The explorers were able to continue their journey through the good offices of their former boatman, who got a friend of his own to take them on in his boat to Ka-cho. They passed the Shan-Kadoo villages of Koung-boo and Ta-law. They heard that lately some Kan loung Kachins had made a raid on this village, killed the sawbwa, and taken possession of the village.

The people of Ta-law and Koung-boo wash for gold. Above Ta-law were met two tributaries of the river,—Nam-malee and Nam-tabet streams. Up these, Kadoos, and also Chinese-Shans, live. They are subjects of the Kan-loung King. The former pay taxes also to Burma. They grow opium. The Kachins about here obtain lead ore from the hills, and they were seen "to burn the rocks in a kiln" by the explorer. They take the lead to Bamo. There is a road to China from Nam-tabet, by which merchants bring cloth and iron cooking-pots. Above Nam-tabet there is a plain occupied by Kantees (Shans). They are emigrants from near the western source of the river. Further on was passed the village of Maing-maw, a Kadoo village. It is said to have been an important city; old paddy clearings still remain; also the ruins of a fort. At the present time there are 20 houses of Kadoos and five of Kachins. Pa-law on the right bank has 20 houses of Chinese-Shans. Pinpa and Sanka are Kachin villages.

November 23rd.—Ka-cho was at last reached. This is a large village of about 80 houses of Shan-Kadoos. It was built in olden days by a Shan governor called "Hawpyin." It was a very important city. It now pays tribute to Burma in the shape of a yearly present. It pays nothing to the Kachins. From Ka-cho also there was formerly a good deal of trade with China, but the depredations of the Kachins have closed the road.

There is a large village called "Zee-gyoon" on an island in the river opposite to Ka-cho. It has about 50 houses. The travellers were destined to make a long stay at Ka-cho. In the boat they had last travelled by they had heard that a saya (doctor) was the head man and much respected, and they had made up their minds to arrive as guests at his house. He received them hospitably, and as their stay continued the friendship warmed, and they received a lot of information from him about the people and country further on.

He told them that when the Panthays were at war with the Chinese that the latter came to Ka-cho and had there enlisted many men by offering Rs. 50 or Rs. 100, and that he had gone with about 80 or 100 men and had fought on the side of the Chinese; that after the war was over he remained in that country many months and had been up to the Noungsa lake, which was so wide that one could not see across it. He described that there were lots of people there, Shan-Chinese and Kachins too; that a river flowed out of the lake to the westwards, which could be no other than the eastern branch of the Irrawaddy. He said he was sure of this on account of the direction the water took.

On account of all they heard about the Kachins, the travellers during their stay at Ka-cho became convinced that it was useless their trying to proceed without a guide and interpreter, who at least could tell the Kachins what their object was in coming amongst them.

One day the Kachin sawbwa of a neighbouring village (Paroo) came to the house. They made freinds with this man and accompanied him to his village on the 18th December in the hope that he might consent to be their guide; but they had no success at Paroo, and returned on the 23rd to Ka-cho.

The explorers took observations for latitude at Ka-cho. Owing to the constant dread of the Kachins in which the villagers live, the houses are all shut up at 8 o'clock, sentries being posted, every man taking his turn. Tigers also enter the village and carry off cattle and pigs. There was a little courtyard behind the house where the explorer slept. He was there able to take some very good observations. He also boiled the thermometer here on two days, and in the day-time he went to the jungle twice, as he says, "with a *da* and his sextent" to observe the sun at noon; but these observations were not successful owing to his want of practice with the sun. The explorers one day applied to the Saya if he would not go with them, and when a reward was offered, terms were come to. He would not go however without a Kachin companion, and sent for one Makan-too, sawbwa of Pinpa village bellow Ka-cho. This man agreed to go as far as Sinpoung-poon, where the sawbwa, Laboo-shoung, lives. From the map it will be seen that this hill is a little further than the point from which the travellers had to turn back.

January 15th.—A start onwards was made. Mee-thoo-ma-hee was left behind with directions to return to Rangoon if the travellers did not come back in a month.

The party consisted of the explorer and his elderly companion, the saya, the Shan, Nga Kan-too, the Kachin, and a little Kachin boy whom the latter took with him.

January 16th.—Maing-na was reached. Waing-maw, Ywadaw, and other Shan villages were passed, each containing from 20 to 40 houses. Maing-na has 30 houses. Paddy clearing of former days lie fallow. The land is very fertile.* Many of the people of these villages and of Ka-cho live by acting as interpreters and brokers between the merchants from Burma and the Kachins. Above Maing-na there is no tribute paid to Burma, that being the frontier town. Shans also ceased, and hereafter our travellers found themselves entirely among Kachins, what are called the Kansa-Kachins.

* The river here is over a mile wide, full of sand banks and small channels. The bank is steep, in two steps, the lower twelve feet in height, the upper eight or nine feet.

January 17th.—On this date their camp was in the jungle near Kway-too choung.

January 18th.—Yesterday the travellers noticed the river considerably swollen, and on enquiry were told that it was caused by the first melting of the snows. They heard also that the western branch of the Irrawaddy was called Malee-ka and the eastern branch Meh-ka. In the evening they reached Pouk-san-poon. They describe the hills as covered with the *Ficus elastica* from Maing-na as far as they went. From Ka-cho the distance had been paced steadily and the bearings recorded. The stars could not be observed; it was very cloudy and a good deal of rain fell. From here they had a view of the junction of the two branches of the Irrawaddy and saw some miles up the western branch. They thought it about 500 paces wide. They lived in the sawbwa's house.

January 23rd—They went along measuring as before and recording, and reached Moo-koung-poon, where they put up with the sawbwa.

January 24th.—To-day they crossed the eastern branch of the river. They saw it was smaller than the western branch, and that there was no flood whatever as they had expected, for it will be remembered as they passed Maing-na they had noticed the river swollen. The river was some 300 or 350 paces wide, but at this season had in places a narrow channel of running water of 100 paces, and in other places deep and stagnant pools; as they saw up the river reach it was coming down in rapids over and round large rocks.

They had to cross in a ferry-boat, and they questioned the ferry-man why the river was not flooded. He said it was not so till April. In the evening they reached Pone-ka.

January 26th.—Reached Mara-poon hill. Went to the sawbwa's house.

January 27th.—To-day they crossed the boundary between the Kansa and the Kan-loung Kachins: these latter seem to be under what the explorer calls a "Badshah" who lives at Nga-kone-lapoon. They reached Mo-goung-poon Maing-koung. It will be seen hereafter that this was destined to be the termination of the route, and unfortunately no opportunity occurred of observing the stars. However, twice the sun was observed on the meridian on 31st January and 1st February, and although the difference is 6′ (instead of the mean), the last observation has been adopted, which the observer declares to be the best, and which tallies with the position of the place as obtained by the route so nearly that I have left it as plotted.

February 2nd.—The party moved to Tone-poon-poon, Pouk-lee-shoung, Akyee-wa's house. They began to make friends and to ask the road. They slept there one night.

February 3rd.—Returned to Mo-goung-poon.

The explorers were told of the custom of the Kan-loung Kachins, that if a Shan or Burman wanted to come to their villages, he must make friends with the sawbwa and come as an invited guest, and that no one was allowed to come and go as they were doing.

February 15th.—They were allowed to depart. I have asked the explorers why they did not try the Tazoopoon route by which the saya had once gone eastward. Their reply is that the whole country had heard of the black men, who were popularly supposed to be *Nats*, being in the country, and that they could not have gone a mile without being seized. As it was, on their return journey they avoided the villages as much as possible, and when they saw one, turned off into the jungle and took a roundabout road.

February 17th.—They put up at Pone-ka.

February 18th.—Crossed the river once more and saw that it had receded about three feet from a stone on which they sat on their former visit. They arrived at Pouk-san.

February 20th.—As they came in sight of the main stream they noticed that it was more flooded than ever; it had risen considerably since they had last seen it. This is a strange coincidence, that one branch should be falling when the main stream was rising, and points I think clearly to the nature of the two sources.

This observation of the explorer is quite an independent one, and was mentioned casually by him. He had no hint that he should watch the rise or fall of the river.

February 21st.—Ka-cho was reached.

March 6th.—They reached Bamo.

March 7th.—They found a Poongyee's boat proceeding down, by which they were allowed to travel.

March 24th.—The party arrived at Mandalay, and went straight on board the steamer, reaching Rangoon on the 2nd April.

The following are the explorer's notes on the people among whom he travelled:—

After leaving Bamo, the people first met with are Poons, whose dwellings are on the banks of the river. These people cultivate very little rice, and live chiefly on the produce of hill cultivation or *toungya*. They grow yams, potatoes, oil-seeds and cotton. Fish forms their principal food. They talk a dialect of their own. The women are dressed like Shans, the men like Burmans.

The Burmese extort from them as much as they can, there being no fixed rate of revenue.

The Kachins who inhabit the hills overlooking them also extort pigs, cattle, fowls, &c., from them, especially when there is a funeral or marriage and sacrifices have to be made. One Kachin sawbwa rules two or three villages; that is, he considers these as his legitimate prey, and no one but himself is allowed to extort from them. Whenever a Kachin dies, the Poons have to attend the funeral, each taking with him a spade, a *da*, a basket of rice and four annas in pice. The Poons are Buddhists. They build pagodas and reverence poongyees.

Above Pagan, the Shan-Kadoos inhabit the river banks. They dress like Shans or Burmans. They wear silver ornaments. Their houses are like those of Shans, and they speak both languages. They are Buddhists. They plant gardens; also *toungya* or hill cultivation and *kaing* cultivation on the river banks, the latter consisting of tobacco, brinjals, cucumbers and pumpkins. On an island above is the Kadoo village of Hnote-cho-kyoon. The Burmans appointed a thoogyee there, who levies as much revenue as he can.

This village and another on the island refuse to acknowledge the authority of the Kachins, which they can do with impunity, being on an island.

The Shan-Kadoos also cultivate rice. They trade with the Kachins and with Bamo. They import salt, clothes, betel boxes, &c. Some live by washing for gold.

The villages along the river bank pay revenue to Burma, a thoogyee being stationed in each village; they also pay to the Kachins, who indent on them whenever sacrifices have to be made.

Below Ka-cho there is a plain inhabited by Kantees,—emigrants from the country at the western source of the river. On their first arrival they asked permission from the King of Burma to settle. Their dialect is different from Shans. Their houses are like those of Shans. The women dress in black and blue. They have a short jacket and a petticoat with a high waist. They tie their hair in a knot on their heads a little to one side. They are Buddhists.

The reason of the emigration was that there were two powerful sawbwas, Lone-kyeing and Loke-koon, who had a dispute. The former being defeated came down here and is now a subject of Burma.

The Loke-kyeing sawbwa sends a yearly present to the King of Burma of an elephant or something else to show his respect, but pays no revenue.

Above Ta-law, up the Nam-malee and Nam-tabet streams, some Shan-Tarokes (Chinese-Shans) live. They are also scattered about along the river bank. They grow opium and cultivate the low lands. Men and women wear black clothes and pig tails. They speak Shan and Chinese, and, although Buddhists, men, women and children drink spirits. They have two kinds of priests, one like a poongyee, and the other eats at any time and drinks spirits and smokes opium, and, except for the priestly garment, is undistinguishable from the people. These Shans build their houses on the ground like *Kalas* (Natives of India). The Kachins not only inhabit all the high lands, but they have homesteads also on the river bank.

In Tasaing are ten Kachin houses. They only go in for hill cultivation. They manufacture opium. Men and women wear very little clothing. The women's jackets have no sleeves. They wear cowries as ornaments round their waists and beads round their necks, and bangles, made of cane dyed black, round their ankles. They use leaves for plates. They are not cleanly, but eat and live like pigs. They have no cups or plates or knives or spoons. They have nothing in their houses. Their cooking-pot is either a large iron vessel brought from China or else of stone. Sometimes they boil their food in bamboos, and they use these solely for water.

Their marriage customs are peculiar. A rich man has four or five wives. When a man's father dies, the son has to take all his wives, except his own mother. When a son dies the father has to give a substitute, his second son or some relative, or else has to take his daughter-in-law to wife. The custom is that a woman once in a family must not quit it.

Every family has slaves, between whom and their masters and mistresses there is no difference made; they do the same work, and all eat together the same food.

They smoke opium every day. Men, women, and children drink fermented spirits every day, made from rice in their own houses, just as Chinamen drink tea. The spirit is called *Koung* and *Chet*.

If any one gets ill they say that the *Nats* have caused it, and they sacrifice extensively on these occasions. They wear very dirty clothes. Pinpa and Sanka and other villages along the river bank are occupied by Kachins, who know a litte Burmese and Shan. About 20 or 25 people live in a long house, which has a number of rooms in a line. There is a fireplace in each room at which they cook, and in the common passage outside the room, there are some fireplaces round which they sit and smoke opium.

When Maing-na is passed, the country is peopled entirely by Kachins. First come the Kansa Kachins, and after them the Kan-loung Kachins. The latter have very little communication with strangers, and their custom apparently is for no one to visit the hill who is not a friend of the sawbwa, or whom the sawbwa does not meet and lead in himself; hence their suspicion of the travellers. To the east are the Maroos, a tribe of Kachins. These extend northwards to the water-shed of the Irrawaddy. To the east of them again are more Kachins. A village is always called by the name of the hill (poon) on which it is situated. Evey hill has its own sawbwa. To him presents are given whenever the people sacrifice, which they do on every occasion. Any relation of a sawbwa can order the people about. They are obedient. Whenever there is a dispute with a neighbouring hill, the sawbwa gives the order before fighting takes place.

A custom is that every boy after reaching ten years of age carries with him a bag and a *da*. People carrying more than one bag are thought to have something secret with them, or money, and are apt to be robbed.

Their *pa-soes* (kilts) are five hands in length and very narrow. The turban is red or white; the jacket black or white; these they procure from the Shans in exchange for rubber, oil-seed and cotton. They can't weave jackets.

Some have a hair-knot. Some cut the hair short like *Kalas*. The women dress in the same short petticoat as the males, dyed black, and tied tightly with a string round the waist. Their jacket is ornamented with shells; also strings of cowries are tied round the waist. Some rich men's wives are tattooed in bands from the ancle to the knee. They wear red and white beads round the neck. They never trade. If they are in want of salt or ngapee or anything, they go to a Shan village and exchange oil-seed, or rubber, or yams, or cotton for whatever they want.

In the hot season sometimes 30 or 40 men will make an excursion to a distance of nine or ten days' journey to some village, from whence, having killed or driven off the men, they carry off all the children and sell them as slaves, exchanging them for opium or cattle. They have no compassion and act as brutes, and when they have a dispute the stronger kills the weaker, seizes the wife and children, and sells them. A rich man, a sawbwa, has 40 or 50 slaves; a poor man, four or five only. The Burmese style this Kan-loung race "robbers." When a big man goes to make a raid, he does not require money to enlist his soldiers, but they get as pay four or five ticals (weight of over five rupees) of opium each. If they take captives they never torture them or ill-treat them, but feed them well until the time comes for killing them, when they cut off their heads with a *da*. Among the Kansas the sawbwas receive presents or bribes. Among the Kan-loungs there is no such custom as for the subject to give anything to the governor or sawbwa. The King of the Kan-loungs lives in Nga-kone-lapoon. He is young, and is apparently acknowledged as supreme, and without consulting him nothing of importance is undertaken.

The hills are described as devoid of large trees, and the population is so dense that the same fields have to be cultivated three or four years in succession. They cannot grow enough rice for themselves, and have to eat Indian-corn and yams and arums in the rains. They grow a little tea too. The hills are covered with cultivation and *Ficus elastica*.

The explorer speaks with admiration of their roads, which they make in zigzags up steep hills. The land is very moist and fertile, and they evidently have a perfect system of terracing, for he says they grow rice all up an almost perpendicular cliff. Snow falls, the climate is cold, and water is found on all the hills at the top. I am telling the story just as the explorer relates it.

When a marriage takes place, the bride has to give presents to the parents of the bridegroom. The explorer says that in the morning all the food for the household was cooked in a large vessel, and then each man's share wrapped up in leaves and made over to him. The explorers got their shares with the rest.

Whenever they sacrifice animals, they always hang up the horns on the steps or at the door. When a Kachin dies, four or five days' revelling takes place and cattle are sacrificed. He is buried under a mound. A ditch seven or eight feet deep is dug round, a tree planted on his grave, and a pole stuck into the ground with the horns of the beasts sacrificed, hung up on it. Their music consists of a very long drum beaten slowly, to the sound of which the young men and women dance.

One sawbwa was met with long hair (four feet long) tied in two plaits and wound round his head like a turban, in the middle being a hair-knot formed with some more of his hair.

One Sa-goo-noung, a leader of soldiers, showed them a snake's head, with two horns, one inch long, pointing backwards.

The sawbwa who governs the Mo-goung-maing-koung-poon, by name Sanouglee, has a black stone of a flat shape, something like a hand. It is always moist, and whenever put on one side turns on the other of itself. It is said that when he first got this stone it was about 40 tolahs in weight. Now it has increased to 80 tolahs; it has also got bigger. If it is kept in a cloth, the latter in time becomes full of holes, and it is supposed it eats it! The explorer was taken into a room and shown this wonderful stone, which is supposed to have life.

The Kansa and Kan-loung tribes of Kachins are divided into the following sub-classes: Lapake, Lasee, Lakoon, Lathoung, Sadan, Kara, Kakoo and Yoyin. The above all speak the same language.

The Maroo tribe are divided into the following:—Lamna, Malan, Lawin, Lapouk and Kalan. These speak a different dialect from the Kansa and Kan-loung sections, and are said to be a simpler, quieter, race, and do not commit the same barbarities as the latter.

The following materials were available for the compilation of the map:—

The river has been actually reconnoitred to about 60 miles up its eastern branch when it was last seen. The latitude of Mo-goung-poon, the termination of the explorer's route, is 26° 08′ as obtained by a double altitude of the sun when on the meridian.

The latitude and longitude of Bamo have been taken as 24° 16′N., and 96° 53′ 47″E. The latitudes of Poot-tay stream, Haw-ka village, and village Ka-cho have been determined by observations to four or more stars.

On a graticule on the scale of eight miles to one inch, Bamo was projected; also the other three points, whose latitudes are determined in longitudes adopted from the published maps of the river in the given latitudes.

From Bamo to Poot-tay stream the map has been compiled simply from notes made by the explorer.

From Poot-tay stream to Haw-ka and from Haw-ka to Ka-cho bearings and distances by time were recorded, and the plots of the route agree wonderfully between fixed points, and with the aid of the explorer are fitted in with considerable accuracy.

From Ka-cho the route has been plotted by bearings and paced distances. 3° 30′ has been deducted from every observation for the variation of the explorer's needle; the latitude of the termination of the route is checked by the observed latitude of Mo-goung-poon, and it agrees so nearly (within a mile) that the plot is left unaltered.

The height of Ka-cho above sea-level has been obtained by two boilings of the thermometer on the 2nd and 9th December. The final height is 1,020 feet, the temperature of the air on the two occasions being 65° at 9 A.M., and 71° at noon.

No opportunity occurred for ascertaining the temperature of the boiling point again.

At Mo-goung-poon at the end of January, at 9 A.M., the temperature of the air in the shade was 66°.

The following is an abstract of latitudes :—

Locality.	Star observed.	Resulting latitude.	Final latitude.	Remarks.
		Deg. m. s.	Deg. m. s.	
Poot-tay stream	*α* Piscis Aus.	24 53 37	.....	
	β Ceti	24 53 45	.....	
	α Ursæ min.	24 50 43	.....	
	α Persei	24 55 15	24 53 20	
Haw-ka village	*α* Piscis Aus.	25 5 32	.....	
	α Canis maj.	25 5 19	.....	
	β Ceti	25 5 24	.....	16th November 1879.
	β Ceti	25 6 14	25 5 37	17th ditto.
	β Orionis	25 9 53	.....	Observation rejected.
Ka-cho village	*β* Orionis	25 19 31	.....	2nd December 1879
	Ditto	25 19 66	.....	3rd ditto.
	α Canis maj	25 19 51	.....	
	β Ceti	25 18 37	25 19 29	
Pouk-san hill	⊙	.....	.....	An observation of the sun was taken, but it is rejected because it was interrupted.
Mo-goung-poon hill	⊙ Upper limb	20 14 17	.....	
	Ditto	20 8 3	20 8 3	This observation is adopted instead of the mean, because the observer states he has more confidence in it. The difference of over 6 is the result of want of practice in observing the sun which could not be obtained in Rangoon.

In the Kachin country, in addition to the names of the villages or hills, I have given the governors' or sawbwas' names, as they appear to be as much known by the one as the other. It will be seen that the eastern branch of the river splits up again into two branches. The sources of these have been placed on the maps as they are for the following reasons :—

At Mo-goung-poon Maing-koung, the sawbwa said that six days' journey from that place the river ceased. A 'Kachin' day's journey is taken at eight or ten miles, as according to the explorer that is what these people travel. The sawbwa pointed in the direction the river flowed. He said he had been there. When the saya, who was present, mentioned the lake, he said he had not been in that direction.

He said the Maroos extended as far as the river. After them and beyond the river came a people wearing white clothes and speaking an unknown language.

At Main-goung-poon the sawbwa, of the same name, said he formerly lived at Sakee-poon, and had been to where the river ended at five or six days' journey from his former house.

The saya of Ka-cho village, who accompanied the explorer onwards from there, stated that when the Panthays and Chinese ('China-gyee' as he called them) were at war, he went with a hundred men to take part with the latter.

When the war was over he remained several months among the Chinese, and had been up to the lake called "Noungsa," which he said was so large he could not see across it. He stated that a river flowed out of it to the west; that he was sure it was the Irrawaddy on account of the direction of the flow of the water.* The explorer first heard the Saya talk of the eastern branch of the Irrawaddy as the In-myit, meaning 'Lake river,' which made him enquire why he called it so. He said there were no hills near the lake, so it would appear to be on an elevated plain. He described the country about there to be well peopled with Shans and Kachins. The longitude of the lake is approximately obtained by the distance to the Chinese territory being invariably given as about six marches from the Irrawaddy. I may have put it too close. There is a snowy peak on the map, but this has snow on it only in the coldest weather I conclude. The eastern branch of the Irrawaddy is styled by the Shans 'Myit-ngeh' or 'Little river,' the western branch 'Myit-gyee' or 'Big river.' The Kachins call the two branches Meh-ka and Malee-ka.

* This information was confirmed by a man of Zee-gyoon who also had been there, but whose name he has forgotten.

At Ka-cho the explorer heard that it was from 22 to 24 days' journey to Kantee, near the sources of the western branch. At Mo-goung-poon he heard that it was from eight to ten days' journey to the same place. At Mo-goung-poon Maing-koung he heard from the sawbwa that northwards from where they were the distance across from one branch of the Irrawaddy to the other was only one day's journey.

An important fact was observed by the explorer, from which some conclusions can be arrived at. One perhaps is that the eastern branch has not its source in the snows, or if so only a small branch of it. One thing is evident, that the first melting of the snows flooded the river from its western source, whereas the other smaller branch was not affected but was daily drying up.

On the 16th January near Maing-na the explorers noticed the river unusually flooded, and heard their companions say this was owing to the melting of the snows.

They then gradually struck off from the river, as will be seen from their route on the map. On reaching the eastern branch, where they had to cross it, there was no sign of a flood. They re-crossed at the same place on their return journey on the 18th February, and they noticed that the water had receded about a yard from the stone on which they had rested at its edge on their former visit. On the 21st February, when they came in sight of the main stream again, they were surprised to see that the river was not only in flood but double the height that it was the first time.

These observations show the intelligence of the explorer, and I think if all he heard and saw is put together, it may be concluded that the main branch of the Irrawaddy is the western, and that Wilcox's proud boast that he had discovered its source in 1825 has after all turned out to be true, and that all theories about the Sanpo being the Irrawaddy may be for ever abandoned. It is possible the Noungsa lake, said to be of great size, may account for the enormous rise of the Irrawaddy in the rains. Also it is possible that Wilcox though he thought himself near the source was not so in reality, and that the river takes its rise higher up in Thibet, but that it is the Sanpo is more than improbable.

NOTE.—Since writing this report I have received from Mr. Burgess a copy of the gauge register of the Irrawaddy river kept at Myanoung main gauge during January, February and March 1880.

I see by it that the river was falling steadily till the 20th February, on which date it began to rise, the readings being on 19th February 1·58 feet, 20th February 2·17 feet; it fell again from the 3rd March to the 22nd, when it began to rise and continued to do so till the end of the month.

The gauge reads 40 feet at the high flood mark of 1875. I asked for this information out of curiosity, to see if the flood noticed by the explorer in latitude 25° 30′ was appreciable down here. I hardly expected it would be, but it is satisfactory to find that the river did begin to rise on the 20th February and on 22nd March, and continued to do so.

Translation of the Explorer's notes, appendix to CAPTAIN J. E. SANDEMAN'S *report on the* IRRAWADDY RIVER *Exploration.*

ABOUT eight miles above Bamo there is a place called Kyouk-twin because of the high floods there during the rains. There are great mountains on either side, and in the middle of the river there are many large rocks which bar the passage. Between these rocks there are most violent whirlpools. During the rains boats going up and down cannot use their oars. They must go by means of tow-ropes. Many people perish here every year through the destruction of their boats.

The people who live on the right and left banks along the whole course of this Kyouk-myoung are called Poons. From Tha-pan-bin to the village of Pagan there are nine villages, containing altogether some 150 houses. The inhabitants live by cultivating *toungyas* and cutting bamboos. There are no tillers of rice-fields. These people have a tongue unlike the Shan, Kachin, or Chinese language. The men dress as Burmans and the women as Shans. Their houses are like cow-sheds; and they are in the habit of wearing very filthy garments. The Burmese authorities take from them what revenue they think proper. Various Kachin sawbwas rule over them. When a Kachin sawbwa wants to make offerings of cattle, pigs, or poultry to *Nats*, he makes demands on these people, who have to furnish what he requires. When a Kachin under the ruling sawbwa dies, each house must assist by furnishing a man with a *pyee* of rice, a quarter rupee, a spade, and a *da*. These Poons are Buddhists. They study Burmese and Shan literature. After the manner of the Burmese, they build monasteries and worship the sacred clergy and images.

Above the village of Pagan Kyouk-twin there is an island called Hnote-cho-kyoon. Shan-Kadoos live on this island. The men dress as Burmans and the women as Shans. The women wear silver bracelets and gold earrings. These people build houses like the Shans and Burmans. They speak Shan and Burmese, and are Buddhists. They cultivate orchards, *kaings*, and *toungyas*, and live by trade. There is an upper and a lower village. The Burmese have appointed a Thoogyee, and levy what taxes they think proper. The islands do not submit to the authority of the Kachins, for the Kachins cannot attack them, since they are surrounded by water.

Above the island of Hnote-cho, Shan-Kadoos live in Shway-in, Tahaw-na, Kone-tha, and Hantha villages up to the city of Ayeing-dama. They cultivate rice-fields, *kaings* and *toungyas* and trade. The men dress as Burmese and the women as Shans. They speak Shan and Burmese. The Burmese have placed a Thoogyee in each village, and they levy what they think proper in the way of revenue. They are ruled by various Kachin sawbwas, to whom, when asked for cattle, pigs, poultry, or rice for offerings to the *Nats*, they must furnish what is required. When a Kachin dies, each household must send a man to assist with a *pyee* of rice, a spade, and a *da*. These Shan-Kadoos are Buddhists, and like the Burmese they build monasteries and worship the sacred clergy and images.

Ayeing-dama is an ancient capital city, and there is something still left of the walls and ditch. Up to the reign of King Bodaw Paya, a road between it and China was open and traders dwelt there, carrying on constant traffic and trade by means of pack bullocks and mules.

There is an extensive plain here where existed rice-fields formerly. Timber does not grow here even now. The plain is in its former state. Were industry established here afresh, a great and most flourishing city would spring up. There are now some 20 Shan-Kadoo and some five Kachin households, governed by one Done-ngoo, a Kachin sawbwa. The Shan-Kadoos pay revenue to the Burmese Government; but the Kachins do not. Kachins do not pay revenue to the Burmese on whatever part of the river they may dwell; they are called savages and are let alone.

Above Ayeing-dama are the villages of Ka-yone, Haw-ka, Koung-hoo, and Ta-law, inhabited by Shan-Kadoos, who live by tilling the soil. There are extensive rice-fields. The men dress as Burmans, the women as Shans. The women wear silver bracelets and earrings. Like the Burmese, they build monasteries and worship the clergy and sacred images. These villages are governed by various Kachin sawbwas. The Burmese Government also have appointed a Thoogyee to each village. The Burmese levy such imposts as they think proper. When we arrived at Ta-law, the sawbwa of that village had been seized and killed by a Kan-loung sawbwa. The village is governed by Kan-loungs. Some of the inhabitants of Ta-law and Koung-boo live by washing for gold.

Above these villages there are two streams, named the Nam-malee and Nam-tabet streams. Shan-Tarokes and Shan-Kadoos live there. The villages are governed by Kan-loung Kachin sawbwas. The Burmese Government take revenue from the Shan-Kadoos. The Shan-Tarokes and Kachins grow poppies and make opium. They cultivate rice-fields and *toungyas*. The Kachins smelt lead. Lead comes abundantly from the streams. There is a road open to China, and Chinese merchants constantly traffic and trade in this metal. The lead is exported to Burma also.

A Kantee chief left his country, with the intention of not returning, to become the vassal of the King of Burma. He said that he was a hereditary sawbwa; and asking permission of the Burmese King to establish towns and villages, obtained a Royal Order This chief has now established himself above the Nam-tabet stream in a large plain. The Kantees speak a language of their own. Their houses are like those of the Shans. The dress of the men is like the Burmans. The women wear garments dyed blue and black, sewn up in front like lonegyees, and silver bracelets and earrings; and their hair-knots are worn over the middle of their crowns, flattened out and twisted round. These people are Buddhists, and like the Burmese worship the clergy and images. In the native country of these Kantees the sawbwas of the Lone-kyeing and Loke-koon tribes being at enmity with each other went to war, and the Lone-kyeing sawbwa fleeing on defeat, the Loke-koon sawbwa at present governs in the Kantee country; while the Lone-kyeing sawbwa, becoming a vassal of the Burmese King, has now established villages and towns. The Loke-koon sawbwa must present yearly gold and silver flowers to the Burmese King. He does not pay revenue, and he levies what dues he chooses from his people.

Above this Kantee village is the village of Ta-saing, consisting of about 10 Kachin households. The inhabitants cultivate *toungyas*. They grow poppies and make opium. The men wear waist-cloths (*nan-ngeh*). The women also wear waist-cloths, which they tie around them with waist-bands. Above they wear loose jackets with short sleeves. At the waist they wear girdles made of cowries threaded with rattan. On the neck they wear white and red *lake-taw* beads. Above the calf up to the knee they wear hoops of rattan dyed black. On the head they wear coarse cotton cloth, some four cubits long, as a turban. They wrap up their rice in green leaves, and eat it on leaves. Their curry is also eaten on leaves. They are dirty in their eating and drinking. They have no such things in their houses as bowls, plates, spoons, cups, *okes*, and *dounglans*. They drink water out of bamboo tubes. With regard to their customs: if a father dies the son takes possession of his father's wives, except his own mother, and makes them his wives. If the son dies, a substitute must be given to the son's wife. Should there be no relation to give as a substitute, the father takes possession of the daughter-in-law and makes her his wife. If the elder brother dies, the younger brother takes possession of his wives and makes them his own; and if the younger brother dies, the elder brother does likewise. The unmarried young men and women, so long as they are not brothers and sisters, act like the brutes. The people smoke opium daily. *Kazaw* and *koung* liquors are prepared at home by the women, and drunk by old and young, men and women. If any sickness befals them, they say they are *Nat*-seized; and having killed cattle, or pigs, or poultry, and saying that they are offering to the *Nats*, old and young, men and women, assemble and eat and drink. They are very filthy in their dress.

Above this place is the old town of Maing-maw, which contains some 20 or more Shan-Kadoo houses and five Kachin houses. The Shan-Kadoos cultivate rice; and the Kachins cut *toungyas*. The Shan-Kadoo men dress as Burmans and the women as Shans. Like the Burmese they are Buddhists, building monasteries and worshipping the clergy and images The Shan-Kadoos pay revenue to the Burmese. Maing-maw was formerly established by a great Shan sawbwa who lived there in great state. The plains where formerly there was rice and other cultivation are still unwooded. There are some remains of the city walls and ditch. If a city be established here, it is likely to become great and flourishing.

Above Maing-maw is the village of Pa-law, containing some 20 or more householders of Shan-Tarokes, who live by rice cultivation. The men wear trousers like Chinese. Some wear their hair in a tuft, and some do not. They wear black jackets and black turbans. The women wear black cloths like *lonegyees*. They have, like the men, turbans on their heads. They wear bracelets and ear ornaments of silver. They build their houses like *Ponena* (Hindu) houses by raising up the ground. The men and women, young and old, drink liquor. They speak Shan and Chinese, and are Buddhists. They have two sects of clergy; one, calling themselves the "forest church," behave like the Burmese clergy; the other, calling themselves the "*Pweh* (feast or assembly) church," eat their rice morning and evening and drink spirits and smoke opium. These last act like the people, differing from them only in their dress.

Above Pa-law are the villages of Pin-pa and Sanka, inhabited by Kachins. They live by cultivating *kaings* and *toungyas*. They grow poppies and make opium. These Kachins, because they live on the banks of the river, know a little Shan and Burmese. The Kachins, according to Kachin custom, build houses, and roof them as if they were roofing imaginary boats, the roofs being of the same form as those placed on large boats. The men and women, young and old, drink liquor. The men also smoke opium daily. If they are attacked by sickness, they make offerings to the *Nats* by the sacrifice of cattle, pigs, or poultry.

Above these villages, on a large plain, Kantees have established themselves in towns and villages. In Kantee, the native country of these people, the hereditary sawbwa of some 5,000 odd households died, and his sons being unable to support themselves left their native place, and presented the late Burmese King with a live musk-deer, gold and silver flowers and other gifts, and prayed to be allowed to become vassals without prejudice to the succession of the Loke-koon sawbwaship. Having obtained a Royal Order to establish towns and villages, and live on the confines of Burmese territory, they established themselves some 10 houses with 50 odd houses of Shan-Tarokes in a village which they called Lweh-zaw on the Nam-yin stream. In 1239 (B.E.) the Kachins having made an invasion killed the Kantee sawbwa, and the remaining sons unable to stay there went and dwelt temporarily above Ka-cho. There, however, the elder brother of the dead sawbwa killed the man who acted as Prime Minister. The son of the dead sawbwa accordingly presented his sister to the present Burmese King as a "Virgin daughter," and obtained a Royal Order to succeed and establish himself, under the order previously given to his father, below Ka-cho. These Kantees dress—the men as Burmese and the women in cloths, like longyees, dyed blue and black. Their jackets also are dyed black. They wear their hair-knots over the middle of their head and twist their hair round.

The city of Ka-cho was formerly established by a great Shan sawbwa, Haw-peing, who came from Theing-nee city. This city of Ka-cho was a great city, and had to present yearly gold and silver flowers. A road was opend to China, and there was incessant traffic and trade of merchants of great and small degree by means of baggage animals. A sawbwa of these Shans established another city above Ka-cho, which was called Waing-maw. Another city, Maing-na, was established by another of these sawbwas above Waing-maw. Another Shan sawbwa established another city, Maing-maw, below Ka-cho. Ka-cho being made the principal city, there were four cities on the eastern bank of the Irrawaddy, Maing-maw, Ka-cho, Waing-maw, and Maing-na, established by four sawbwas living in great state after the Shan custom in places called by them "Haws," and building walls and ditches. They thus dwelt for a long time, submitting yearly gifts of gold and silver flowers, but not revenue. Subsequently, during the reign of Aloung-paya-gyee, when the Talaing and Yodaya (Siamese) kingdoms were attacked and taken possession of, they followed as Shan generals with a contingent of a thousand men. When victory was obtained they asked leave of the Burmese King and went back. While trading and trafficking in their own cities, they sent during Bodaw Paya's reign, a Burman as their messenger with the usual gold and silver flowers for submission to the King and expenses for the journey. But this Burman took away the offerings and went elsewhere, wherefore the Burmese King gave orders for an expedition against them, saying that the four Shan sawbaws were rebels in that they had not presented the usual tribute. Accordingly the Burmese King's generals set out with men, arms and ammunition, simultaneously captured the four cities, arrested the sawbwas, and captured and killed many, old and young, men and women. Thus the towns and villages were destroyed; and although there are people living here now, there are not so many as before: there are but few. The city of Maing-maw contains 20 odd households, Ka-cho city 80 odd, Zee-gyoon 50 odd, Moke-lway village 20 odd, Thagara 30 odd, Waing-maw 40 odd, Ywadaw 20 odd, Thayagone 20 odd, Myitkyee-na 30 odd, Noungtalaw 20 odd, and Maing-na 30 odd. Their inhabitants are Shan-Kadoos; and old and young, men and women, are able to speak Shan, Burmese and Kachin. The Burmese

Government has appointed a Thoogyee at each of these places, and over these Thoogyees a Myo-oke, called the Lay-myo-oke (Four-city Myo-oke).

The inhabitants are Buddhists, building monasteries and worshipping the clergy and images. The Burmese take what revenue they think proper. They are governed also by different Kachin sawbwas. When a Kachin sawbwa makes demands for offerings to the *Nats*, they must give cattle, pigs, or poultry. When a Kachin dies also, each house has to furnish a man with a *pyee* of rice, a *da*, and a spade.

Of the above villages, the inhabitants of Ka-cho refuse to subject themselves to the authority of Kachin sawbwas: they pay revenue only to the Burmese Government. They till rice-fields extensively. The inhabitants of the villages above Ka-cho are some of them rice cultivators. Some associate themselves with merchants, interpret and carry on negotiations, and act as brokers. There are extensive plains here where formerly cultivation was carried on. If the city be again established, there is a likelihood of its being great and flourishing. The soil here is exceedingly good.

To the east of Waing-ma, on the Nam-yin stream, some 30 odd households of Shan-Tarokes live by cultivation. They are governed by Kachin sawbwas, who levy an impost on the paddy cultivated. They have not to give any revenue to the Burmese Government. There are traces up to the present time of extensive paddy cultivation along the right and left banks of this stream.

Above Kyouk-twain on the Irrawaddy, from Ayeing-dama up to the sources of the stream, the Kachin mountains, gold is to be had by washing wherever a sandbank appears. Above Bamo from Tha-pan-bin to Haw-ka is wooded plentifully with teak trees. There is much excellent timber here along the course of the river up to the sources of the stream where the Kachins dwell. India-rubber is very abundant. It is still more so where the Kachins are.

On the Irrawaddy river Shans live as far as Maing-na village. They pay revenue to the Burmese Government. Above Maing-na there are no Shans or Burmans. The Burmese territory ends at Maing-na.

Above Maing-na the Burmese do not own territory. The Kachins severally dwell with hill-chiefs of their own. Going up the main stream of the Irrawaddy to the North-East, boats, eight fathoms in length, can proceed about three miles, but beyond this they cannot. At this last boat-station there are no Shans or Burmans: there are only Kachins. Those only who understand Kachin can go, and they can only do so when the Kachin headmen come and meet and invite them. If they are not accompanied by Kachins, they cannot go. When the Kachins wish to come down, they construct bamboo rafts and come down. The river has two branches,—a right and a left. The left branch is called the Malee river, which means the 'Big river.' The right branch is called the Meh-ka, which means the 'Little river.' Above this Meh-ka or 'Little river' there are a great many boulders, rocks and reefs. Regarding the rise of the water: when I was going up, the waters had risen on the 6th waxing Tabodweh; but when I had crossed over to the "Little river" on the 13th there were no indications of its rise. I also questioned the ferry-man at the ferry, and he stated that the waters did not then rise. When I was returning I did not see any rise. The rise was in the Ma-lee ('Big river'). The reason of the rise is this. At the sources of the 'Big' and 'Little' rivers there are snowy mountains. The snow on these mountains melting becomes water, and the Burmese call the phenomenon *yay-myoo-to* (water-vapour-rise).

Above Maing-na dwell Kachins. First, sawbwa Souk-lee of the Ka-chaing mountains, then Laing-yan-moo, sawbwa of Laing-yan-moo-poon, Nga Kan-too of Laing-pouk-poon, Patone-wa, sawbwa of Pouk-san-poon, Souk-kan, sawbwa of Moon-koung-poon, Souk-moon, sawbwa of Mara hill, Marekka-tantoo-naw, sawbwa of Kate-tway-poon, Touk-lone-ka, akyeewa of Pone-ga hill, Wa-win-wa, Sawbwa of Nan-seing-yin-poon, Maing-doung-too, sawbwa of Marapoon. These people, who call themselves Kansa Kachins, have one governing sawbwa for each hill according to Kachin custom. As for their customs: followers, when they offer cattle, pigs, or poultry to *Nats*, must present a leg of each to their sawbwa. If the sawbwa be hereditary, young and old, women and men, attend to all his behests. When there arises any complication or quarrel between two hills, action is taken only when the sawbwa gives his commands. Young men from 10 years old always go about provided with a *da* and a wallet. They wear waist-cloths some four or five cubits long, and for turbans they wear *sha-ban-dee* cloths, red or white. They get their jackets by going to the Shans, and exchanging for them sessamum, India-rubber, or cotton. Some wear hair-knots. Some cut their hair as low as their ears. The women also wear cloths dyed black, four cubits long and two cubits wide, folded around their waists and tied with waist bands. The jackets are close fitting and over them they have a looser one with set cowries. On their waists they have perforated cowries threaded on hoops of rattan, some wearing three, some four, hoops. From their knees down to their calves they wear hoops of rattan. Some women, the wives of the principal men, tattoo their legs from the knee to the ankle. They wear also red or white *lake-taie* beads. The men daily smoke opium. *Koung* and *kazaw* liquors are made by the women at home, and drunk by men and women, old and young, daily. The men do not understand trade. If they have no salt or *ngapee* to eat they go to the places of the Shans and Burmese and get them by bartering with sessamum, cotton, India-rubber, arums, or yams. During the summer some of these Kachins collect together in bands of 30, 40, or 50 and go to some Shan, Burmese, or Kachin village which they can overpower, which is distant some eight

nine, or ten days' journey, and besiege and set fire to it; and when the inhabitants come out, the grown up men are cut down and killed, and boys and girls from two to 11 years old are captured and exchanged for silver, opium, cattle, or any other thing they require. They have no compassion for human beings: they act like brutes. If there be one who quarrels with another, he who is victorious kills him who is conquered, and seizing his wives and children goes and sells them to another. If a man is fairly well to do, he has three or four slaves. Sawbwas and the chief men have each, according to their power, 10, 20, 30, 40, or 50 odd male or female slaves. Regarding the work of the slaves: they do not have to work separately: they work together with the master of the house or his sons and daughters. When they eat and drink also, the master of the house does not eat good food separately by himself; the slaves and the master eat together.

At Marawa hill, the territory of the Kansa Kachins ends. Beyond this territory the Kan-loungs dwell, viz. Chief Sa-goo-noung on Kansan-poon, sawbwa Mawloowa on Mawloo-poon, sawbwa San-oung-lee on Mo-goung Maing-koung, akyeewa Pouk-lee-shoung on Tone-poon hill, sawbwa Laboola on Sakee-poon, sawbwa Laboo-shoung on Sin-poung-poon, sawbwa Saramatee on the See-hnin (snowy) mountains. The King-Sawbwa of the Kan-loungs, Maran-gyee of Nga-kone-la-poon, died and was succeeded by his son, La-baing-ka-shin-teing-nan, who now exercises governing authority. The Kan-loung Kachins are so called from being separated from the other Kachins, their name meaning "acknowledged rebels." The sawbwa Ma-ran-gyee is more mighty than all other Kachin sawbwas. He is wise in his speech; his designs, conceptions, and plans are good; he has many adherents, and is able to govern many. Being acknowledged by many, he attacked, captured, and killed the neighbouring sawbwas, and appointed such men as he deemed fit to govern as his lieutenants. His possessions thus increased from one hill to another, lieutenants being appointed to govern each hill.

The jurisdiction of (these) Kan-loungs extends on the east to Sakee-poon and Sanka-poon; on the west beyond the Ma-lee or 'Big river,' on the south to Marawa hill, the territory of the sawbwa Souk-kan; on the north to the confines of the Kanti territory. As these people form a large tribe, they commit raids year by year. When about to make war, expenses in the shape of money have not to be given. The chiefs assemble large numbers of men, and by giving to each four or five ticals, as the case may be, of opium, cause these large numbers to follow and attack and destroy. When victory has been obtained, the grown-up inhabitants of the conquered village are put to death, and the youths captured are sold by each captor. Over the village thus overcome is placed a lieutenant to govern. These lieutenants do not, like the sawbwas of the Kansa tribes, exact legs of cattle or pigs from their subjects. Should there be any business, they have first to obtain the orders of the Kan-loung King, Labaing-ka-shin-teing-nan, before they can order or act.

As there is not sufficient space for cultivation in the region inhabited by these people on account of their large numbers, they have to cultivate *tounggyas* for three or four years successively in one spot. They do not get sufficient rice for food, and have to supplement it with arums, yams, vetches, and maize. Some, not obtaining a harvest from one year to the other, have, during the rains, to eat arums, yams, &c., instead of rice. They do not change their habitations from one hill to another. They are in the habit of dwelling in one place. Living as they have done for a long time, there are few large trees on the hills. Not a Shan or Burman visits their country. If he wishes to visit, he can only do so by making friends with the sawbwa, and the sawbwa personally coming out and receiving him, and personally following or accompanying him on his going and return.

Regarding the customs of these people: when a man and woman set up house, the man has to give to the parents of the woman, cattle, pigs, gongs, muskets, *das*, slaves, clothes (*pasos*), spears and money, and for his wife's use he has to give coral beads, *tamgines*, jackets, broadcloths, &c., according to his circumstances. If he is not able to give them on the spot, he has to give a guarantee that he will do so hereafter. After the gift, or the guarantee to make the gift, the woman is brought to the man's house, and the man has to feast the bringers of the woman with rice and curry, and spirits and liquors. To the elders also he has to give blue waist-cloths and *sha-ban-dee* turbans, *das*, or spears according to their degree. The man then shows the woman all the work to be done in the house, and bids her do the work. After having set up house for a long period, when the man dies, the woman cannot set up house with any other: the brother, elder or younger, has to set up house with her. If there be no brother, the deceased man's father (the woman's father-in-law) takes possession and makes her his wife. In the same way, if the elder brother dies, his wife is taken over by the younger brother, and *vice versâ*. If the father dies, the son takes over his father's wives, except his own mother, and makes them his own. If the first wife dies, the husband goes to his deceased wife's parents, and asks for another wife, and they must give him her elder or younger sister—a woman who is unmarried. If there be no sister to give, they have to give a female relative. A relative of the wife's is greatly respected, being styled "father-in-law's relation." When any such come, the son-in-law has to give property in proportion to their worth. Husbands and wives must not be at enmity with each other; there is no such custom as divorce. If the husband be bad, the wife cannot separate; and if the wife be bad, the husband cannot separate. If the husband wishes to do so, he has to give double the property he originally had to give her. If the woman wishes to do so, she has to give quadruple the amount of property originally given. If the man sets aside his wife and takes another, his head wife has the right to take possession of all the property of the younger wife, as

well as to sell her. The husband sells his son's wife's sons and daughters to somebody else. If the father dies and the mother sets up house, not with her husband's relative, but with some man who is not connected with the father, the woman's son, saying that she does not pay heed to her character, sells her. The young unmarried men and women, so long as they are not brothers and sisters, act as they please inside the apartments of the house.

Regarding the customs of these Kachins: when they sacrifice cattle or pigs to the *Nats* in the house of a big or small man, the skulls of cattle, with their horns, and the skulls of pigs, are carefully hung up for people to see in the front passage leading to the house, in proximity to the steps, or on the front post of the house. When a Kachin dies, he has a splendid funeral, and after cattle, pigs and poultry have been killed, all are feasted for three or four days with food and liquor. Young men and women come from one quarter to another, and surrounding the dead body dance and jump day and night. The body is interred in some sacred spot, which is surrounded with a trench about two feet broad and some three feet deep, and the centre heaped up like a small hill. The body is enclosed in a coffin. Posts are then erected and a roof carefully constructed. When the body is being interred, paddy, arums, flasks of *koung* and spirits, *das* and wallets, are interred with the body, and on the grave a post is erected, and the skulls of cattle and pigs are hung up for people to see.

On either side above the nape of the neck a certain Kachin has two switches of hair of the thickness of one's thumb and some four cubits long, each of which encircles the head three times. The top hair-knot as generally worn is also worn (by him).

The Lieutenant named Sa-goo-noung has a snake's head with horns of the thickness of the axis of a spinning wheel and about one inch long.

The Mo-goung Maing-koung swabwa, has a flat black stone, like a test stone, in shape somewhat like the palm of a man's hand, from which something like oil oozes. If the side where there are projections like the thumb, the fore, middle, and little fingers be placed below, and the side like the base of the palm above, the side like the base of the palm goes down and the side like the fingers erects itself shortly after without man's intervention.

Having arrived on the 2nd November at Bamo, we made enquiries regarding the road. We left on the 7th by boat, and on the 13th stopped at the mouth of the Poot-tay. I got out at night and took observations of the stars. When we arrived at Haw-ka village on the 16th, I took observations of the stars, on the 16th, 17th, and 18th. Leaving on the 20th, we halted at Ka-cho on the 23rd. We got ashore on the 24th, and put up in the house of a Shan saya.

We subsequently spoke like friends and sounded the saya about going to the sources of the Irrawaddy.

While living in this village I took observations of the stars on the 30th November; on the 2nd and 3rd December also I took the stars. On the 6th, 10th, and 11th I took the sun. The villagers were at variance with the Kachins, and at 8 o'clock at night the gates were closed, and every one had in turn to patrol armed. Moreover, a tiger had come and carried off pigs, dogs and poultry.

While considering how to go up, we met Nga Da, the Kachin swabwa of Paroo hill, made friends with him, and accompanied him; and having enquired about going to the sources of the Meh-ka, 'Little river,' and been informed by the Paroo sawbwa that there was no one who would go to the sources of the stream, we returned on the 23rd to Ka-cho.

The Ka-cho villagers told us: "Do not go up the Kachin hills. The Kachins are a very wicked tribe. We from our youth upwards have never gone up. We dare not go. We are exceedingly afraid." But we said to the saya of Ka-cho and the Pin-ba sawbwa, come and follow us, they replied: "No one from our village dare go, but if you sayas wish to go, we will, if you pay us, follow you as partakers in your good or bad fortune." Accordingly we started on the 15th January, and arrived on the 18th at Pouk-san hill. When in that village, it began to rain, and at night we could not see the stars on account of the clouds. On the 21st we took the sun; we left on the 23rd. On the 24th we crossed the Meh-ka or 'Little river' and arrived at noon at the house of sawbwa Marekka-tantoo-naw on Kate-tway-poon, where we stayed awhile to cook and eat food. This sawbwa is not like other men: he is a curious man. When young he had hair like ordinary people. When between 20 and 30, a confused mass of hair about the thickness of one's thumb grew on both sides of his head above the beginning of his back hair. This confused, twisted hair was not like hair growing elsewhere on the head; it was exceedingly intertwined, and could not be combed out. It grew day by day; and this man's age is 50 odd years now. This inter-twisted hair is about four cubits long on each side, and each side is bound round his head three times. There are altogether six encirclings of hair around his head. He has moreover his other hair worn after the fashion of all in a top-knot. His turban consists of nothing but his hair bound round.

With this sawbwa also we spoke amicably, giving him what presents we had, and making friends before we departed.

That day we slept at the house of akyeewa Touklone-ka on Pone-ka hill. With the Kachins of this village also we spoke amicably, departing as friends. On the 25th we slept at the sawbwa Souk-kan's house at Marawa. Here too we spoke amicably with the Kachins.

On the 26th we slept at the house of sawbwa San-oung-lee, Mo-goung-maing-koung hill in the territory of the Kan-loung Kachins. With the people of the village we spoke

amicably, gave presents, and made friends. On the 31st January and the 1st February we took observations, and on the 2nd arrived at aykeewa Pouk-lee-shoung's house on Tone-poon hill. Here we spoke amicably with the villagers, making enquiries as to the road, and so forth.

We accordingly had to come back, and on the 23rd November we reached Ka-cho.

Extract from a Report on operations connected with the survey of Gilgit, by LIEUT.-COLONEL H. C. B. TANNER, *Deputy Superintendent, Survey of India, dated 28th December* 1880.

OBSERVATIONS with a theodolite have been taken at 17 stations, of which three belong to last year's work. 145 points have been fixed trigonometrically, and were computed whilst the survey was in progress. When the final computations are done, many of these points will be thrown out owing to their doubtful accuracy; and some new ones which have not yet been computed, will be introduced in their place. Owing to the rough nature of the mountain tops it has seldom been possible to use a stand, the theodolite generally having been set up on a well built cairn with a flat slab at top. Over the cairn the stones have been piled up so that each of the stations are well marked for future identification. When I say that I have fixed 145 hill peaks, I do not wish it to be understood that the points have the accuracy of those hitherto accepted by the Great Trigonometrical Survey. The apexes of some of my triangles are so acute, that an error of one minute at either of the ends of the base would make an error of ten miles in the position of the point. I hope, however, at some future time, to be able to improve the shape of the triangles, so that my points shall be true to a tenth of a mile. As to heights, a considerable number of peaks have been measured, but owing to cloudy weather some important ones have been observed for position only. On some of the peaks it was necessary to place the instrument at the very edge of giddy precipices, and then, sometimes, one only of the verniers of the horizontal limb could be read, and that with considerable risk and difficulty.

Beyond the mouth of the Warshigum River I could only see one village, Khalti, on the Gilgit River; but in longitude 72° 55′ I fixed two grand peaks near the source of the Shundas Lake, between which I could see the dip of the valley. The Ishkoman Valley drains a large area of glaciers, and joins the Gilgit River near Aish. The junction was mapped last year, and this season the course of the stream has been approximately traced for about 20 miles; beyond, it was lost to view amongst towering peaks covered with perpetual snow, which, from Guranjur station, the most northerly connected with the Great Trigonometrical Survey of India, stretch right across the westerly, northerly, and eastern horizon. Such a landscape as was presented to me from that commanding station, 17,200 feet above the sea, I am not likely to forget. To the north, two thousand feet below me, was a sharply defined watershed, from which a couple of glaciers took their rise, smooth at their origin, with a few crevasses parallel to the face of the mountain; lower down, riven into deep chasms, with green ice piled up between them in fantastic shapes. Beyond this rose immense naked needles, and saw-like ridges, backed up by a mass of lofty mountains averaging from 22 to 25,000 feet. At their bases are fields of snow, and a network of glaciers. There is here no single snowy range such as is presented by a distant view of the Himalayas when seen from the lower hills, but, instead, a vast wilderness of isolated mountains of every possible form, among which it is impossible for the surveyor to determine the lines of drainage. Far away to the west, more than a hundred miles distant, is the faint, cloud-like group round Tirich Mir, which attain from 24 to 25,000 feet: and to the north of that famous mountain, a very remarkable double peak in the Hindu Kush of more than 24,000 feet. Carrying the eye to the right is another high, rough peak, also in the Hindu Kush; and still further eastward, seen here and there, between the craggy mountains of Yasin and Mastuch, are the very rounded and smooth summits of the snowy mountains of the watershed of the Indus and Oxus. The view from Guranjur to the southward is comparatively tame, for in the Kaghan Hills and the Indus Gilgit Watershed there are few peaks of perpetual snow. One of them (T_{16} of the Great Trigonometrical Survey), which is only 19,000 feet high, stands up conspicuously from amongst its neighbours; to the eastward are the bold, high peaks of the Indus, among which are K_2, 28,000, and Nangaparbat nearly 27,000 feet. From Guranjur I observed a very high mountain to the north-west, which from its colour could not, I think, have been less than 80 or 90 miles distant, and if this distance be approximately correct, it must lie somewhere between the two branches of the Oxus, north-west of Sirhadd. It is possible that it may be one of the group depicted by Colonel Gordon on the sketch facing page 131 in his "Roof of the World." I unfortunately obtained no second ray to it.

The only guide one has in estimating the distances of remote snow peaks is their colour, far off snow always having a slight pink tinge, and though I have been sometimes misled, and have made considerable errors in guessing the distances of mountains, yet I believe I am right in supposing that I have seen two very high peaks beyond Chitral, and one beyond Sirhadd. The rounded forms of high snow-capped mountains is due to the constant piling up of snow on them when their summits are not too sharp; in some cases the apparent height of mountains may be increased by hundreds of feet; for in high altitudes, where the cold is intense, even the rays of the sun, powerful as they are in a highly rarified atmosphere, take several days even to form a hard covering over the freshly fallen snow. Even after two clear days I have seen the powdered snow flying in clouds off the upper slopes of Nangaparbat, and I doubt if snow melts at all at such an altitude.

Such mountains as K2, Nangaparbat and Rakhaposhi, are too sharp to allow the snow to lie on them in any quantity; it almost immediately descends to a lower altitude in the form of avalanches and then it gradually hardens and becomes glacier ice; but the great group round Tirich Mir have rounded tops, and this renders them sometimes difficult to intersect with accuracy.

In my last year's report I explained the difficulty in surveying the great flattened range which lies between the Indus and the Gilgit rivers. We have now obtained nearly all the topography of that remarkable region which is situated on the northern slope of its ill-defined watershed; and to the eastward, a small portion of the southern slope as well. It is an immense tangle of exceedingly sharp ridges, which zigzag about in the most perplexing manner. There are hundreds of peaks of nearly the same height, and so like each other, that after moving a few miles they cannot be recognized. I have eight stations in this tract which vary from 15,000 in the east, to 17,500 in the west Towards the head-waters of the Gilgit river the peaks assume bolder forms, and attain to 22,000 feet. One very marked feature in this range is the extraordinary number of mountain-lakes or tarns, which are found as many as three or four together at the sources of all the small feeders. I was encamped for a week or more at the head of a high valley, and here were three lakes, with a fourth in course of formation. Opposite my tent was a small glacier with one crevasse only, and a small moraine. The glacier was busy night and day in flinging stones down into the ravine and damming it up. Already it had formed a broad and extensive marsh, which at some future time will be a deep sea-green lake like the others. The uppermost of the tarns, which even in August was covered with little icebergs, had been made by the scooping action of ice, but the others were pent up by the moraines of small side glaciers which, owing to climatic change, now no longer exist. The lake region has an altitude of about 14,000 feet, and is wild and desolate owing to the scanty herbage and to the waste of mountain *débris* which is piled around; sometimes, when backed by high cliffs, these still, green pools are highly picturesque, and some few again, when surrounded by high crags and lofty rock needles, are almost grand. The Dards of Gilgit, who never ascend above the range of the Ibex, and who were very reluctant to accompany me into these wild solitudes, say that these holes and tarns were once the abodes of snakes and monsters, which were destroyed by one of their saints in years gone by. And I must confess that, without some knowledge of the action of ice, their existence in the minds of people who believe all the high and inaccessible places in the south to be frequented by spirits and fairies, is likely to be attributed to supernatural causes.

Some of the slopes above the level of the lakes, when seen from a distance, often present the appearance of downs of grey sand, but a closer view shows them to be composed of huge wedges, slabs and blocks of volcanic rock. Sometimes there occur whole ridges, of remarkably rounded form, which, from top to bottom, are made up entirely of such *débris*. A heap of broken metal, carefully patted down and rounded over, ready to be used for macadamizing our roads, is an exact miniature representation of these curious ridges. I, myself, cannot understand how these mountains have been so completely crushed and thus smoothed over, leaving not a single trace of the original rock *in situ*. In these regions the surveyor has often to travel miles over these dreary expanses of shattered rocks, which are often only just balanced one on another, and has to use the utmost agility to avoid being crushed beneath the tottering boulders which are ready to topple over at the slightest disturbance. When covered with even a thin covering of snow they are almost impassable and highly dangerous to cross.

I must not omit to mention the most interesting point in all this wild mountain region, which, in September last, after two unsuccessful attempts, I was so fortunate as to reach. I had long wished to obtain a near view of the northern slopes of Nangaparbat and of its glacier valleys, which join the Indus opposite the independent settlement of Gor, and after a most perilous passage over a narrow, rugged ridge, surrounded by enormous precipices, which tried my nerves to the utmost, I found myself confronted by what is probably the most magnificent snow view on the globe, embracing as it does a slope of very nearly 24,000 feet (vertical measurement), with its glaciers, snow-fields, ice-cliffs, and jagged needles of naked rock extending from the summit of this king of mountains down to the Indus, which flows in a deep channel at its base. My feeble pen is unequal to the task of giving any adequate description of this superb and impressive view which I contemplated from the edge of a tremendous precipice, whose summit is 16,000 feet above the sea, and which rises sheer and unbroken from the forests and vineyards of Gor, situated an immense depth below me.

The sharp peak of "Deo Mir," the "Mountain of the Gods," as it is called by the Dards, was distant just 23 miles, and the forest, which was seen as a sharply defined narrow belt, in which the pines could only just be distinguished, was less than half that distance; whilst the Indus, with its brown and sterile banks, was only seven miles off.

Without being a botanist, I have been able to make a large collection of specimens for my botanical friends, and I may as well give here a few facts relating to the distribution of vegetation in Gilgit. I will mention first that most useful tree the pencil cedar, which has a range in altitude greater than any other tree, for I have found it continuously from 14,400 feet down to 6,000. At the camping ground of Molcha, 8,000 feet above the sea, near Minowar in the Gilgit Valley, I found one specimen of this tree with a girth of 30 feet, measured 6 feet above the ground. It is still vigorous and healthy, and without blemish, and is supposed to be 300 years old, and is said not to have increased perceptibly in size

within the memory of man. Its circumference exceeds by many feet that of any other of its kind I have met with.

The *pinus excelsa** has a far less limited range, for it grows on the Gilgit slopes only, where the melting snows yearly leave a deposit of soil, with moisture sufficient to sustain vegetation throughout the summer; its range is from about 9,500 feet to 12,000, and that of the *abies smithiana*, which is found in less profusion, has narrower limits. The deodar does not grow in Gilgit, nor have I ever seen the *picea webbiana*. The edible pine, *pinus gerardiana* has already been stated by Drew to grow in Astor; it also is found round Chaprot, and thick forests of it grow just below Gor, and add greatly to the picturesque appearance of that settlement, for were it not for those trees, the slopes which are too dry to support any other vegetation, would be brown and burnt up, like all the low ranges in Gilgit below 9,000 feet. The edible pine, *chilgoza* of the Afghans, may be said to extend from 7 to nearly 10,000 feet.

* The largest *pinus excelsa* I have measured had a girth of 14 feet, and a height of about 130 or 140 feet.

The birch is very common throughout Gilgit, it overlaps below into the belt of *pinus excelsa*, and grows as high up as 12,500 feet. Growing among the birch, and extending some hundred feet above it, is a very useful and widely spread shrub, which, with the exception of the pencil cedar, is the best fuel one meets with in these mountains; it likes marshy places, has brown, smooth, bark, and bears a small white flower which in seed time gives out a fine silky cotton. Though probably used by every Himalayan traveller, yet I have been unable to ascertain its botanical name.

The upper limit of Gilgit vegetation is pretty constant at 16,200 feet, where sometimes a few hardy flowers and a coarse grass may be met with in favourable situations. Above this the rocks are stained with grey and yellow lichens, but how high up the latter extend I know not. Besides the trees whose ranges I have above laid down, I should mention the *tamarisk*, which appears to thrive as well at 6,000 feet in the dry barren valleys of Gilgit, as it does amongst the oozy mud islands at the mouth of the Indus. It may grow above 6,000 feet, but I have not seen it myself beyond that. In the narrow belt of vegetation which contours so exactly round the Gilgit mountains are many wild fruits; wood strawberries abound, and at a slightly higher altitude are capital red raspberries; besides these, we have a small, sour, hairy, gooseberry, and a very nice green one, brushed with pink on one side. There are also black currants which have the flavour of red. On the margins of the watercourses in the low valleys there is a small sweet fig which is very good, and in the spring a red raspberry of insipid taste. I must refer those who require information regarding the flowers of Gilgit to Mr. Duthie, to whom I have given a large collection of dried specimens.

There are no oaks in Gilgit, and the wild olive is very rare; the slopes, which in other regions are clothed with those trees, being here sprinkled with that detestable plant the wormwood, with its overpowering smell. Its range is from 5,500 feet up to 11,000.

Before closing these hasty notes, I would wish to say a few words on the country beyond Hunza, which I was so lucky as to see from two of my high stations. My view extended to the watershed of the Yarkund and Shimshal rivers, where I observed two snow peaks of about 21,000 feet, just peeping up behind a wonderful array of lofty needles, amongst which—though I could not determine exactly at what point—the Hunza river makes its way. The Shimshal Pamir lies between the two snow peaks and the needles, and if my very feeble fixing of the former be at all correct, then the area assigned to that Pamir on the map is far too great. It is hopeless to expect any further extension of our trigonometrical survey in that direction, though perhaps I may be able to improve the shape of my excessively acute triangle, for my rays were taken through a narrow gap between Rakhaposhi (25,500 feet), on the western extremity of the great northern barrier of Cashmere, and a mountain of nearly equal height on the eastern end of the high range which separates Gilgit from Little Gubjal.

In the present disturbed state of the Dard races round Gilgit, it is impossible to say what survey operations we may hope to carry on during next summer, but should the Gilgit country be closed to us, a very considerable amount of survey may yet be achieved, by observing with a theodolite from one of the high points east of Bunji, and from another on the northern slopes of Nangaparbat west of Astor. If stations of over 19,000 feet could be reached, independent observations to all my high mountains towards Chitral could be obtained, and probably others could be fixed as well; but I must give a word of caution to any one who may attempt this task, and who may not have had experience in fixing high remote peaks. Tirich Mir, the greatest of the western mountains up to this time known, appears from my highest stations west of Gilgit as an exceedingly insignificant hill; indeed, until I had computed my triangles, I was not aware that I had been so fortunate as to fix that important peak; but from the Bunji range, distant over 160 miles from it, it would be exceedingly minute, and unless its position were exactly known to the observer before hand, it might escape his notice altogether. I may conclude by adding that though Tirich Mir is the highest mountain fixed by me in the far west, yet it is not nearly so important to geographers as the double peak in the Hindu Kush, about ten miles south-east of Varg in the Oxus valley. This mountain is over 24,000 feet, and has two well-defined points which rise out of two roundish symmetrical hills, which are nearly hemispheres. Though I have seen no notice by travellers of this commanding mountain, yet from its great height, and its position, probably in the very watershed of the Hindu Kush, it must be visible over a wide area to the inhabitants of Badakshan and Wakhan.

Extract from the Narrative Report, dated 23rd October 1880, *of* CAPTAIN A. W. BAIRD, R.E., *in charge Tidal and Leveling Operations.*

EVALUATION OF TIDAL CONSTANTS.

THE values of the several tidal constants which have been determined for various ports, from the harmonic analysis of all the observations which have been taken during the past year, will now be given.

The tidal constants are divided as usual into two groups—one composed of the short period tides, the duration of which in no case exceeds 24 hours; the other of long period tides, whose duration ranges from a fortnight to a year.

In the harmonic theory of the tides, the principal constituents of the short period tides are represented by fictitious stars, moving in circular orbits at certain known velocities—the arguments of motion—in the plane of the Equator. They are usually indicated by the letters S, M, O, K, &c. Each of these is, in its turn composed of a number of tidal constituents, also moving in circular orbits, but with different velocities, which are mutually related, those of the second and subsequent constituents being twice, thrice, or some integral multiple of the first. Their periods are determined in the following manner. When the revolution of the fictitious star is performed in, or about, 24 hours, the primary period is the one corresponding to the argument of motion of the star; when it is performed in, or about, 12 hours, the primary period corresponds to twice the argument of the motion of the star; the subsequent periods are fractions of the primary, corresponding to the multiples of the velocity. The tidal constituents after the first are sometimes called semi-diurnal, ter-diurnal, quarter-diurnal, and so on, and the smaller of these are usually called *Overtides.*

Every tidal constant is expressed numerically by two constants, viz. R, and ϵ. R denotes the linear value of the amplitude, viz. the semi-diameter of the orbit, which is equal to half the range between the highest and lowest levels of the constituents; ϵ denotes the angular value of the "epoch;" it may be defined to be the number of $\frac{1}{360}$ parts of the period—or number of degrees of the orbit—which any tidal constituent has still to execute from the instant when the fictitious star crosses the meridian of the place of observation to the instant when the constituent reaches its maximum.

The constants R, and ϵ, of the tidal constituents, are respectively distinguished by the subscripts 1, 2, 3, representing the relations of their periods to that of the primary period.

Three only of the fictitious stars, viz. S, M, and K, have more than one constituent of sensible magnitude. The constituent which causes any fictitious star to produce its greatest effect on the sea-level is rarely the first, and more frequently the second. The greatest effect of any single star is invariably produced by R_2 of M; afterwards usually by R_2 of S, and R_1 of K, to the last of which the phenomenon of *Diurnal Inequality*, which is so marked a feature in Indian tides, is chiefly due. The first significant constituent of MS is of the fourth period, amplitude R_4.

The first constant in the table of constants for each port is A_0, which signifies the height of the mean level of the sea above the level corresponding to the zero of the gauge.

It may be here said, once for all, that the values of the linear quantities A and R throughout these tables are invariably expressed in English feet.

VALUES OF THE TIDAL CONSTANTS AT ADEN.

Lat. 12° 47′ N., Long. 44° 59′ E.

The following are the amplitudes and epochs evaluated for Aden observations, 1879-80 :—

Short-period Tides.

	S.	M.	K.	O.	P.	J.	Q.	L.	N.	λ.	υ.	μ.	MS.	2 SM.
A_0 ...	5·768	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
R_1 ...	0·073	0·050	1·308	0·710	0·389	0·128	0·100	.....	.....	.....	.....	.....	.....	.....
ϵ_1 ...	107°·95	260°·85	118°·64	317°·43	301°·19	127°·68	316°·63	.....	.....	.....	.....	.....	.....	.....
R_2 ...	0·603	1·556	0·240	.....	.....	.....	.....	0·025	0·437	0·018	0·155	0·084	.....	0·022
ϵ_2 ...	248°·43	226°·43	229°·11	.....	.....	.....	.....	01°·77	220°·04	300°·74	230°·51	187°·77	.....	108°·44
R_3 ...	.....	0·019	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
ϵ_3 ...	.....	216°·01	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
R_4 ...	0·006	0·011	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0·007	.....
ϵ_4 ...	263°·00	318°·06	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	134°·45	.....
R_5 ...	0·005	0·006	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
ϵ_5 ...	217°·78	337°·10	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
R_6 ...	0·001	0·003	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
ϵ_6 ...	212°·01	79°·35	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

Long-period Tides.

Lunar monthly tide	...	...	$R = 0{\cdot}033$	$\epsilon = 4°{\cdot}6$
„ fortnightly „	...	...	$R = 0{\cdot}062$	$\epsilon = 354°{\cdot}5$
Luni-solar „ „	...	...	$R = 0{\cdot}014$	$\epsilon = 42°{\cdot}0$
Solar annual „	...	...	$R = 0{\cdot}404$	$\epsilon = 2°{\cdot}7$
„ semi-annual „	...	...	$R = 0{\cdot}110$	$\epsilon = 94°{\cdot}2$

The mean level of the sea (A_0) is slightly lower than in 1877-78.

The main lunar tide, R_2 of M, is slightly greater than in 1877-78, viz. 1·56 against 1·42. The main solar tide has also a somewhat greater amplitude, viz. 0·69 against 0·66. The epoch of both the main tides agree well with those of 1877-78.

With reference to the main diurnal tide R_1 of K, the amplitude is 1·37 against 1·32 of 1877-78, both of which are very high in value; its epoch also agrees well with what was formerly found.

The amplitudes and epochs of all the other tidal constituents agree fairly well with what was formerly obtained; but for the long period tides, the Solar Annual is 5 per cent greater in amplitude than for 1877-78, while the solar semi-annual is 50 per cent less.

The proportion between the two main tides for the year under review is about 1 to 0·45, which is very nearly the same as was found for 1877-78, when the proportion was almost exactly the same as that given by theory.

The proportion of the smaller lunar elliptic semi-diurnal tide (L), to the main lunar tide, is about one-half what theory would assign; whereas for 1877-78 the proportion nearly agreed with the theoretical value.

The proportion between the larger lunar elliptic semi-diurnal tide (N) and the main lunar tide, although less than in 1877-78, is still greater than the theoretical proportion, viz. 0·28 against 0·19.

The proportion of the evectional semi-diurnal tide (λ), to the main tide, is less than was found for 1877-78, but still it is greater than the theoretical proportion.

With regard to the other evectional tide (ν), the proportion to the main tide is about one-tenth, which is (3) three times as great as theory would assign, and 40 per cent greater than in 1877-78.

The variational tide (μ) has precisely the same proportion to the main tide as in 1877-78, which is more than double what theory gives.

The luni-solar declinational semi-diurnal tide (R_2 of K) is exactly the same in proportion to the main tide as obtained in 1877-78, which is slightly greater than the theoretical value.

The luni solar compound semi-diurnal tide (2 SM) in its proportion to the main tide is slightly less than in 1877-78, but agrees fairly well with what was obtained at Bombay.

But the main feature of the Aden tides is the large proportion which the diurnal components bear to the main tide, and this is again shown by the analysis of the 1879-80 observations.

The proportion of the solar diurnal tide R_1 of S is very nearly the same as that in 1877-78, which was double what obtains at Bombay, and about 50 per cent greater than that at Karrachi. It is remarkable that the proportion of this tide at Kárwár is nearly the same as at Aden, and only in two instances have the values obtained at other ports exceeded this proportion, viz. at Tuticorin, and Paumben, (where it was 6 per cent of the main tide,) while at Aden, and Kárwár it is about 5, and 4, per cent respectively.

With regard to the solar diurnal tide (P), the proportion to the main tide is about 25 per cent, similar to what was found in 1877-78, a value which is very much greater than at any other Indian port, except perhaps Beypore, where the proportion is 21 per cent of the main tide.

With regard to the luni-solar declinational tide (K), the same remark applies as in 1877-78, *it being* actually *nine-tenths* of the main tide—a *magnitude* which is *unprecedented*.—

The proportions of the other diurnal tides O, J, and Q to the main tide all agree well with the proportions in 1877-78; that of O is remarkable at Aden, being nearly 50 per cent of the main tide, the usual value at other Indian ports being between 20 and 30 per cent.

The proportion between P and O comes within the limits given by theory; that between J and Q is slightly greater than in 1877-78, and both are much higher than the maximum proportion given by theory. The proportion between O and K is nearly the same as 1877-78, which, although less than the minimum proportion given by theory, agrees well with the proportions obtained at Bombay, and Kárwár.

The overtides of S and M at Aden are all small, and agree well in their proportions to the main tide with what was found in 1877-78.

With regard to the long period tides, the proportions to the main tide (except for the solar annual and solar semi-annual) are much the same as in 1877-78; the solar annual tide being slightly greater, and the semi-annual only half, in proportion to the main tide, to that found in 1877-78.

The solar annual tide at Aden is very great, but is exceeded in value (in proportion to the main tide) at Beypore, and Vizagapatam, at which latter place it actually attains the unprecedented proportion of half the main tide, *thereby exceeding the main solar semi-diurnal tide.*

VALUES OF THE TIDAL CONSTANTS AT KURRACHEE.

Lat. 24° 53′ N., Long. 67° 0′ E.

The observations from which the following tidal constants have been deduced, were taken by the small self-registering tide-gauge working under the supervision of Mr. Price Port Engineer, and have hitherto been unreduced:—

S.

	1873-74.	1874-75.	1875-76.	1876-77.	1877-78.	1878-79.
A_0 ...	7·079	7·152	7·153	7·134	7·207	7·331
R_1 ...	0·083	0·076	0·079	0·087	0·088	0·044
ϵ_1 ...	155°·03	152°·50	150°·45	156°·98	180°·85	166°·94
R_2 ...	0·943	0·949	0·953	0·936	0·961	0·922
ϵ_2 ...	321°·19	319°·93	319°·94	318°·09	321°·14	324°·14
R_4 ...	0·010	0·008	0·008	0·012	0·010	0·009
ϵ_4 ...	325°·52	6°·42	353°·25	17°·21	23°·43	29°·43
R_6 ...	0·004	0·007	0·009	0·006	0·005	0·008
ϵ_6 ...	311°·99	308°·53	294°·60	259°·05	274°·57	291°·09
R_8 ...	0·000	0·003	0·002	0·001	0·002	0·001
ϵ_8 ...	26°·57	265°·60	282°·53	206°·57	254°·06	126°·03

M.

R_1 ...	0·083	0·119	0·112	0·022	0·029	0·075
ϵ_1 ...	146°·08	143°·24	72°·80	310°·60	357°·49	312°·63
R_2 ...	2·406	2·434	2·457	2·386	2·391	2·462
ϵ_2 ...	294°·34	292°·79	291°·65	290°·24	290°·29	294°·78
R_3 ...	0·029	0·025	0·035	0·035	0·052	0·046
ϵ_3 ...	332°·61	337°·31	345°·47	342°·39	325°·18	325°·69
R_4 ...	0·021	0·019	0·023	0·018	0·023	0·030
ϵ_4 ...	12°·28	9°·41	15°·25	352°·12	13°·61	358°·59
R_6 ...	0·044	0·051	0·049	0·044	0·018	0·048
ϵ_6 ..	213°·06	214°·44	207°·00	205°·18	192°·98	209°·70
R_8 ...	0·003	0·005	0·005	0·005	0·005	0·004
ϵ_8 ...	160°·78	199°·87	298°·26	279°·15	247°·88	262°·06

K.

R_1 ...	1·379	1·426	1·442	1·403	1·406	1·418
ϵ_1 ...	141°·36	139°·04	136°·34	132°·79	130°·98	131°·39
R_2 ...	0·336	0·317	0·344	0·361	0·331	0·288
ϵ_2 ..	326°·63	322°·93	321°·63	314°·11	305°·12	316°·30

O.

R_1 ...	0·736	0·756	0·767	0·762	0·760	0·763
...	309°·85	311°·79	314°·98	317°·05	320°·65	326°·28

P.

	1873-74.	1874-75.	1875-76.	1876-77.	1877-78.	1878-79.
R_1 ...	0·393	0·386	0·367	0·368	0·423	0·440
ϵ_1 ...	318°·07	315°·97	314°·92	318°·97	312°·92	314°·34
	J.					
R_1 ...	0·067	0·101	0·121	0·090	0·029	0·094
ϵ_1 ...	165°·25	129°·82	141°·36	158°·38	172°·13	147°·07
	Q.					
R_1 ...	0·136	0·144	0·161	0·146	0·128	0·169
ϵ_1 ...	326°·07	324°·60	315°·08	307°·28	322°·40	324°·12
	L					
R_2 ...	0·053	0·062	0·051	0·101	0·066	0·037
ϵ_2 ...	89°·08	122°·45	133°·65	113°·06	104°·65	99°·02
	N					
R_2 ...	0·572	0·542	0·580	0·584	0·539	0·651
ϵ_2 ...	279°·70	277°·38	274°·26	272°·50	271°·44	272°·59
	λ					
R_2 ...	0·040	0·021	0·009	0·039	0·079	0·062
ϵ_2 ...	81°·01	2°·10	274°·79	119°·73	54°·91	2°·44
	μ					
R_2 ...	0·052	0·052	0·065	0·063	0·106	0·039
ϵ_2 ...	235°·54	275°·89	260°·16	278°·69	214°·61	293°·68
	R					
R_2 ...	0·021		0·008		0·069	
ϵ_3 ...	326°·79		48°·66		14°·01	
	T					
R_2 ...	0·012		0·122		0·059	
ϵ_2 ...	311°·88		62°·99		34°·62	
	MS					
R_4 ...	0·022	0·020	0·030	0 033	0·029	0·032
ϵ_4 ...	308°·67	304°·67	314°·75	312°·98	324°·67	349°·31

2SM.

		1873-74.	1874-75.	1875-76.	1876-77.	1877-78.	1878-79.
R_2	...	0·007	0·017	0·024	0·012	0·025	0·019
ϵ_2	...	126°·94	148°·81	97°·32	115°·18	64°·24	168°·68
				ν			
R_2	...	0·113	0·022	0·148	0·200	0·211	0·124
ϵ_2	...	239°·29	320°·99	316°·97	284°·47	234°·45	209°·14
				Long period Tides.			
Solar annual	R ...	0·250	0·149	0·086	0·197	0·170	
	ϵ ...	95°·4	56°·3	75°·8	79°·9	119°·6	
Solar semi-annual.	R ...	0·211	0·172	0·173	0·145	0·087	
	ϵ ...	162°·5	156°·6	167°·3	163°·8	69°·7	
Lunar monthly.	R ...	0·050	0·057	0·058	0·085	0·110	
	ϵ ...	55°·8	23°·7	103°·2	42°·1	49°·0	Not yet calculated.
Lunar fortnightly.	R ...	0·016	0·054	0·014	0·046	0·065	
	ϵ ...	237°·4	49°·2	26°·0	356°·2	19°·2	
Luni solar synodic fortnightly.	R ...	0·041	0·039	0·014	0·013	0·037	
	ϵ ...	42°·6	332°·3	185°·4	195°·2	314°·8	

Regarding the values obtained for the short-period tide for Kurrachee 1878-79, the following remarks are applicable:—

The value of (A_0) the mean level of the sea, 7·331, is the highest yet obtained at this place.

The amplitude of the main lunar tide (R_2 of M) is higher than was obtained in the two previous years, but less than any of the values from 1868 to 1872. The value of the main solar tide (R_2 of S) agrees fairly well with that obtained for the four previous years. The value of the main diurnal tide (R_1 of K) is also fairly accordant with the last four years' values.

The proportion between the two main tides R_2 of S, and R_2 of M, (0·375) agrees with the mean proportion obtained from 1868 to 1873, which is less than was found from 1874 to 1878, and this proportion falls short of the equilibrium theoretical value (0·476).

The proportion of the smaller lunar semi-diurnal tide, L, is 0·15 of the main tide, which is much less than was formerly obtained in Kurrachee, and is only about half the theoretical proportion. With regard to the larger component of the lunar semi-diurnal tide N, the reverse is the case, the proportion being 0·265, which is greater than has hitherto obtained at Kurrachee in former years, and in each of the former years the proportion was greater than the theoretical proportion 0·192.

With regard to the lunar perturbation tides λ, ν, and μ, the first agrees fairly with former values, which were about three times the theoretical; the second, ν, also agrees fairly well with former values, viz. about double the theoretical proportion; but the third, μ, is much less than was formerly found, being 0·016 of the main tide for the year 1878-79, the theoretical value being 0·022.

With regard to the solar elliptic semi-diurnal tides R, and T, the former would appear to be excessive in its proportion to the main tide, being 0·028; whereas in all former years the proportion was about ·01 of the main tide, and the theoretical proportion is only ·004. On the other hand, the larger component T agrees well with the theoretical proportion (0·028), while in former years it was almost always too great.

The luni-solar declinational semi-diurnal tide K, agrees fairly well with the theoretical value, as was also the case in former years.

With regard to the diurnal tides, R_1 of S is only about one-half in proportion to the main tide of what was formerly found at Kurrachee; but R_1 of P, R_1 of K, R_1 of O, R_1 of J. and R_1 of Q all agree well with their former proportions to the main tide, while R_1 of M is much greater than in the two preceding years, but is fairly concordant with the proportions obtained previously to those years.

The proportions of the overtides of S and M to their main tides, agree well with those formerly obtained.

With regard to the long period tides, their amplitudes and epochs have not been evaluated, as the daily differences were not considered reliable.

With reference to the long-period tides for 1877-78, the lunar monthly tide has an amplitude about double of that of former years. The solar annual tide is less in amplitude than is usually found at Kurrachee by about 10 per cent, if the value for 1875-76 (which was abnormally small) is neglected. Its epoch, however, is much later than usual, being about the middle of July. The solar semi-annual tide is only about half as great as obtained in the previous four years; its epoch also differed greatly from that of the previous four years, although it agrees with the value obtained in 1870-71.

VALUES OF THE TIDAL CONSTANTS FOR KARWAR, 1879-80.

Lat. 14° 48′ N., Long. 74° 5′ E.

The following are the amplitudes and epochs evaluated for the

Short period Tides.

	S.	*M.*	*K.*	*O.*	*P.*	*J.*	*Q.*	*L.*	*N.*	λ.	*ν.*	*μ.*	*R.*	*T.*	*MS.*	2 *SM.*
A_0	5·541	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	...	...	...	...
R_1	0·075	0·025	1·052	0·543	0·274	0·056	0·145	.....	.....	.....	.....	.....	...	...	...	...
ϵ_1	148°·57	277°·06	125°·87	329°·21	312°·73	133°·65	340°·54	.....	.....	.....	.....	.....	...	...	...	...
R_2	0·629	1·709	0·196	.....	.....	.....	.....	0·045	0·420	0·004	0·134	0·055	0·006	0·046	...	0·004
ϵ_2	336°·44	301°·36	312°·80	.....	.....	.....	.....	157°·55	281°·59	306°·10	294°·07	240°·92	161°·20	88° 59	...	355°·31
R_3	.....	0·014	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	...	..	...	...
ϵ_3	.....	282°·62	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	...	..	...	...
R_4	0·007	0·057	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	...	...	0·028	...
ϵ_4	87°·36	18°·15	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	...	...	73°·51	...
R_6	0·007	0·010	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	...	...	...	...
ϵ_6	57°·63	276°·58	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	...	...	...	...
R_8	0·002	0·003	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	...	...	...	...
ϵ_8	295°·46	43°·02	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	...	...	...	...

Long period Tides.

Lunar monthly	$R = 0·058$	$\epsilon =$	14°·3
„ fortnightly	$R = 0·070$	$\epsilon =$	340°·9
Luni-solar	$R = 0·023$	$\epsilon =$	269°·5
Solar annual	$R = 0·344$	$\epsilon =$	307°·3
„ semi-annual	$R = 0·083$	$\epsilon =$	201°·8

The value of (A_0) mean level of the sea for 1879-80 is slightly smaller than in the preceding year, being 5·541 feet above zero against 5·650 for 1878-79.

The value of the main lunar tide (R_2 of M) is very slightly greater in amplitude than was found in 1878-79: its epoch agrees almost precisely with that of the previous year.

The value of the main solar tide (R_2 of S) is almost precisely the same as that for 1878-79: its epoch too also agrees well.

The main diurnal tide (luni-solar R_1 of K) is slightly less in amplitude than it was in the preceding year: its epoch, however, agrees well.

The solar elliptic semi-diurnal tides L and N are respectively less and greater in amplitude than what was found in 1878-79, although their epochs agree fairly well with what was found for the previous year.

With regard to the moon's perturbation tides (λ, *ν*, *μ*), there is a considerable difference both in amplitude and epoch for all three from what was found in 1878-79.

The lunar declinational diurnal tide (O) is somewhat less in amplitude, while the solar diurnal declinational tide (P) is somewhat greater than was found in 1878-79.

The elliptic diurnal tides (J and Q) are both greater in value than obtained in 1878-79: their epochs, however, agree well with those of the former year.

With reference to the long period tides for Kárwár for 1879-80, the solar annual tide has an amplitude of 0·34 feet against 0·17 of the previous year, that is, double its value in the

preceding year. The same remark applies to the solar semi-annual tide, which has an amplitude of 0·083 against 0·045 for 1878-79.

The epoch of the solar annual tide occurs about 14 days before the epoch as found from the 1878-79 observations, *i. e.* about the 25th January, while for the former year it was about the 8th February.

The proportions between the two main tides agree fairly well with the proportion for the previous year, and the proportions of the lunar elliptic semi-diurnal tides also agree with those for 1878-79, that of L being precisely the same as the equilibrium theoretical proportion, while that for N is slightly in excess.

The proportion of the evectional semi-diurnal tide (λ) to the main lunar tide, is much less than is given by theory, while that for the other lunar tide (ν) is about double the proportion of that given by theory.

The proportion of the variational semi-diurnal tide agrees fairly well with the equilibrium theoretical value.

Both of the solar elliptic semi-diurnal tides (R and T), are almost exactly the same in proportion to the main lunar tide as the equilibrium theoretical proportion.

The proportion of the luni-solar declinational semi-diurnal tide (R_2 of K) agrees well with the proportion for the former year, which again agreed exactly with the equilibrium theoretical value.

The proportions of the diurnal tides R_1 of S, R_1 of P, R_1 of K, R_1 of O, and R_1 of Q, all agree fairly well with the proportions of the previous year; but the proportion of the diurnal tides (R_1 of M and R_1 of J) are somewhat different, the former being about half and the latter more than double of the proportions found in 1878-79.

The proportion of P to O is slightly different from that in 1878-79, but both the proportions come well within the extreme limits given by theory.

The proportion of J to Q is much greater (0·584) than was found in 1878-79 (0·413), while the maximum proportion given by theory is 0·417.

The proportion of O to K, although exactly the same as that found in 1878-79, is much less than the minimum proportion given by theory (0·657).

The proportions of the overtides of S and M are all small, and agree fairly well with those of the previous year. This remark also applies to the Helmholtz tide (MS), which is 0·012 of the main lunar tide.

The proportion of the long period tides to the main lunar tide call for no special mention, except the solar annual and semi-annual, both of which are twice as great in proportion as was found in 1878-79.

VALUES OF THE TIDAL CONSTANTS FOR BEYPORE, 1878-79.

Lat. 11° 10′ N., Long. 75° 49′ E.

The value of the *mean level of the sea* for the 1878-79 observations was found to be 5·385 feet *above* the zero of the gauge, or 14·323 feet *below* bench-mark A, and 23·076 feet *below* bench-mark C.

The following shows the amplitudes and epochs of the tidal constituents as determined from the 1878-79 observations for Beypore :—

Short period Tides.

	S.	*M.*	*K.*	*O.*	*P.*	*J.*	*Q.*	*L.*	*N.*	λ	ν	μ	*MS.*	*2SM.*
A_0 ...	5·385	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
R_1 ..	0·021	0·030	0·748	0·372	0·184	0·039	0·036	.....	.....	.....	.....	.....	.....	.....
ϵ_1 ...	119°·85	27°·20	135°·06	330°·52	318°·03	146°·24	346°·27	.....	.....	.....	.....	.....	.....	.....
R_2 ...	0·331	0·892	0·075	.....	.....	.....	.....	0·018	0·188	0·004	0·034	0·023	.....	0·006
ϵ_2 ...	10°·96	328°·32	350°·04	.....	.....	.....	.....	184°·84	304°·03	4°·99	246°·84	197°·73	.....	66°·07
R_3 ..	.....	0·011	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
ϵ_3 ...	.....	210°·65	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
R_4 ..	0·004	0·021	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0·010	.....
ϵ_4 ...	130°·09	41°·48	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	74°·31	.....
R_6 ..	0·004	0·009	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
ϵ_6 ..	252°·47	114°·77	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
R_4 ..	0·001	0·003	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
ϵ_4 ..	20°·56	129°·06	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

Long period Tides.

Lunar	monthly	tide	...	...	$R = 0{\cdot}069$	$\epsilon = 6°{\cdot}0$
„	fortnightly	„	...	...	$R = 0{\cdot}106$	$\epsilon = 355°{\cdot}7$
Luni solar	„	„	...	...	$R = 0{\cdot}065$	$\epsilon = 230°{\cdot}0$
Solar annual		„	...	...	$R = 0{\cdot}307$	$\epsilon = 311°{\cdot}2$
„	semi-annual	„	...	...	$R = 0{\cdot}139$	$\epsilon = 226°{\cdot}0$

The proportion between the two main tides (R_2 of M and R_2 of S) is 0·371, which agrees with what was found at Kárwár, but is considerably less than the theoretical proportion.

The small lunar elliptic semi-diurnal tide (L) agrees fairly well in its proportion to the main tide with what obtains at other Indian ports, and is a little less than the theoretical proportion.

The proportion for the larger tide (N) is more nearly accordant with the theoretical porportion than was found at the northern ports of the Bombay Presidency, but is still a little greater than the theoretical proportion, while at the southern ports, Paumben and Tuticorin, the proportion is less than assigned by theory.

The proportions of the moon's perturbation tides (λ, ν, μ) agree well with the theoretical proportions.

The luni-solar declinational semi-diurnal tide is less in proportion to the main tide than has been found for any port in India, and is considerably less than the theoretical proportion, viz. 0·084 to 0·127.

With regard to the diurnal tides, the proportion of R_1 of K is exceedingly high, and approaches closely to what was found at Aden, being 84 per cent of the main tide, which is about double the value at Bombay and Kurrachee.

The proportions of the other diurnal tides R_1 of P, R_1 of M, R_1 of O, R_1 of J, and R_1 of Q are all about 20 per cent (in their proportion to the main tide) greater than obtains at Kárwár, where the proportions again were all greater than at Bombay and Kurrachee.

Thus the whole of the diurnal tides, except R_1 of S, are greater in their proportion to the main tide, than they are at the Indian ports north of Beypore, and approach closely in their proportions to the Aden diurnal tides; but R_1 of S, although agreeing well in its proportion to the Bombay value, is only about half what was found at Kárwár and Aden.

The proportion between the solar and lunar diurnal declinational tides P and O is 0·496, which agrees well with the values at Bombay, Kurrachee, Kárwár, and Aden, and is within the limits of the theoretical values.

The proportion between J and Q is more nearly accordant with the theoretical proportion than at Aden, but is still higher than the theoretical proportion.

The proportion of O to K is much the same as at Bombay, Kurrachee, Aden, and Kárwár, and less than the theoretical minimum proportion.

With regard to the overtides of S, and M, there is nothing very remarkable, except that R_4 of M is slightly greater in its proportion to the main tide than generally happens, being 0·023.

With reference to the long period tides at Beypore, the lunar monthly tide bears a much higher proportion to the main tide than is generally found in Indian ports; this is also true with regard to the lunar fortnightly and luni-solar fortnightly tides, both of which are from three to four times as great in their proportion to the main tide as is usually found.

The solar annual tide also is very large at Beypore, being almost 35 per cent of the main tide, which is very much greater than the proportion at Aden, where it was found to be abnormally high.

The solar semi-annual tide has also a large amplitude at Beypore, being almost double what it is at Karachi, and even greater than at Aden.

It may be remarked, with reference to the long period tides at Beypore and Aden being very large, and also the luni-solar diurnal tide (K) being very great in both places, that the latitude of the two ports is much the same, viz. 12° North.

The complete separation of the main lunar and main solar semi-diurnal tides (M and S), together with their respective epochs, furnishes a ready means of finding the time of spring-tides, or the time at which the two tides are exactly the same in phase.

For instance, the main solar semi-diurnal tide at Beypore attains its maximum when *twice* the mean sun's hour angle from the meridian is 20°·0. Similarly, the main lunar semi-diurnal tide attains its maximum when *twice* the mean moon's hour angle is 328°·3. Dividing the difference between those two epochs by *twice* the difference between their respective daily motions, we obtain an interval at which the two tides are coincident after the time of new or full moon. The difference between the two daily motions is 12°·191: the result for Beypore is 2·12 days, or about 2 days and 3 hours.

VALUES OF TIDAL CONSTANTS FOR PAUMBEN, 1878-79.

Lat. 9° 16′ N., Long. 79° 11′ E.

The following shows the amplitudes and epochs deduced from the 1878-79 observations at Paumben:—

Short period Tides.

	S.	M.	K.	O.	P.	J.	Q.	L.	N.	λ	ν	μ	MS.	2 SM.
A_0 ...	2·000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
R_1 ...	0·036	0·024	0·317	0·127	0·105	0·009	0·028	.....	.....	.....	.....	.....	.....	.....
ϵ_1 ...	146°·13	203°·69	126°·01	324°·07	313°·73	149°·24	2°·35	.....	.....	.....	.....	.....	.....	.....
R_2 ...	0·377	0·578	0·120	.....	.....	.....	.....	0·021	0·075	0·017	0·016	0·004	.....	0·010
ϵ_2 ...	90°·11	44°·70	68°·92	.....	.....	.....	.....	253°·30	27°·25	241°·18	79°·85	73°·92	.....	7°·43
R_3 ...	.....	0·016	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
ϵ_3 ...	.....	167°·59	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
R_4 ...	0·005	0·010	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0·021	.....
ϵ_4 ...	280°·82	104°·08	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	289°·75	.....
R_6 ...	0·002	0·010	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
ϵ_6 ...	245°·50	30°·34	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
R_8 ...	0·004	0·005	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
ϵ_8 ...	248°·50	286°·60	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

Long period Tides.

Lunar monthly tide ...	...	R = 0·059	ϵ = 349°·0
„ fortnightly „ ...	...	R = ·056	ϵ = 343°·4
Luni-solar „ „ ...	...	R = ·016	ϵ = 175°·4
Solar annual „ ...	...	R = ·122	ϵ = 298°·9
Solar semi-annual „ ...	...	R = ·138	ϵ = 95°·5

The proportion between the two main tides (R_2 of M and R_2 of S) is 0·652, which is very much greater than the theoretical proportion (0·476), and is the only instance on record, except at Tuticorin, where such a high proportion obtains; at Tuticorin the main solar tide is actually 72 per cent of the main lunar tide.

In one instance only, of all the tidal observations hitherto analysed (viz. at Portland break-water), has the theoretical proportion been exceeded, and the proportions at Paumben and Tuticorin of the solar semi-diurnal tide must be looked upon as abnormally high.

The proportion of the smaller lunar elliptic semi-diurnal tide (L) to the main tide is slightly greater than theory would assign, while that of the greater co-efficient (N) of this tide is considerably less, proportions which are exactly opposite to what obtains at all ports except Tuticorin.

The proportion of the moon's perturbation tide (λ) is high, while that of the other (ν) is low, and the proportion of the variational tide (μ) is also low.

The luni-solar declinational semi-diurnal tide (K) is one-fifth of the main tide at Paumben, which is higher than is usually found, except at Tuticorin, where in fact the whole of the semi-diurnal tides agree well in proportion with Paumben.

With regard to the diurnal tides, there is nothing very remarkable; R_1 of K is perhaps slightly larger than obtains at most places, but is almost the same as was found at Kurrachee and is very much less than obtains at Kárwár, Aden, and Beypore.

R_1 of S is about double in proportion to that at Bombay and Kurrachee, but agrees well with Tuticorin. R_1 of P, approaches closely in its proportion to the mean between Kárwár and Beypore, but is nearly double of what was found at Tuticorin. R_1 of O is much the same in proportion as found in Bombay, which is a good deal less than the proportion obtaining at Kurrachee and Kárwár.

R_1 of Q agrees fairly well with Bombay and Kurrachee in its proportion.

The proportion between P, and O, solar and lunar declinational tides, is very much greater than has been found at any other place: the maximum proportion according to theory is 0·574, while at Paumben it has been found to be 0·832.

The proportion of J to Q has generally been found to be greater than theory would assign, but at Paumben it is actually less, and only at one other port (Tuticorin) has this been found to be the case.

The proportion of O to K is also lower than is generally found.

With regard to the overtides, the only ones of importance appear to be R_3 and R_4 of M, which are respectively 0·028 and 0·033 of the main tide, proportions higher than are usually found.

The long period tides at Paumben give proportions to the main tide higher than are usually found, except for the solar annual, which, although three times as great as at Bombay and Kurrachee, is only half of what obtains at Beypore, and Vizagapatam. But for the solar semi-annual tide the proportion is the largest yet obtained, being 24 per cent of the main tide, and this would point to its being a meteorological tide, due almost entirely to wind, having one maximum in the north-east and one in the south-west monsoon.

It has been often noticed at Paumben that the tidal current through the pass seems to flow entirely in one direction for six months in the year, and in the opposite direction for the other six months: the epoch of this tide occurs about the 6th May and 6th November. The epoch of the solar annual tide at Paumben occurs about the 14th January, which is about the middle of the north-east monsoons.

VALUES OF THE TIDAL CONSTANTS FOR VIZAGAPATAM, 1879-80.

Lat. 17° 41′ N., Long. 83° 17′ E.

The value of the *mean level of the sea* from the year's observations was found to be 4·991 feet *above* the zero of the gauge, or 13·968 *below* bench-mark C.

The following shows the amplitudes and epochs deduced from the 1879-80 observations at Vizagapatam :—

Short period Tides.

	S.	*M.*	*K.*	*O.*	*P.*	*J.*	*Q.*	*L.*	*N.*	λ.	*ν.*	*μ.*	*MS.*	2 *SM.*
A_0 ...	4·991	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
R_1 ...	0·025	0·036	0·303	0·152	0·112	0·038	0·011	.....	.....	.....	.....	.....	.....	.....
ϵ_1 ...	100°·62	230°·02	60°·05	248°·60	245°·86	47°·42	290°·21	.....	.....	.....	.....	.....	.....	.....
R_2 ...	0·674	1·500	0·203	.....	.....	.....	.....	0·053	0·350	0·021	0·112	0·029	.....	0·009
ϵ_2 ...	280°·15	246°·61	254°·24	.....	.....	.....	.....	90°·48	241°·17	16°·05	241°·02	230°·10	.....	211°·64
R_3 ...	.....	0·007	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
ϵ_3 ...	.....	329°·25	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
R_4 ...	0·001	0·014	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0·007	.....
ϵ_4 ...	359°·93	306°·38	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	343°·14	.....
R_6 ...	0·001	0·003	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
ϵ_6 ...	123°·00	137°·86	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
R_8 ...	0·001	0·004	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
ϵ_8 ...	72°·90	165°·84	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

Long period Tides.

Lunar monthly tide ...	...	$R = 0·021$	$\epsilon = 22°·5$
,, fortnightly ,, ...	...	$R = 0·036$	$\epsilon = 3°·1$
Luni-solar ,, ,, ...	...	$R = 0·075$	$\epsilon = 24°·2$
Solar annual ,, ...	...	$R = 0·740$	$\epsilon = 190°·1$
,, semi-annual ,, ...	...	$R = 0·301$	$\epsilon = 88°·6$

The proportion between the two main tides (R_2 of M and R_2 of S) agrees fairly well with the theoretical value. The proportions between the two lunar elliptic tides, although agreeing well *inter se*, are slightly larger than the theoretical proportion.

The moon's perturbation tides (λ and ν) are each double the theoretical proportion, but for μ the proportion is slightly less.

The luni-solar declinational semi-diurnal tide (K) agrees well in its proportion with the theoretical value; this has usually been found to be the case at other ports.

One of the main features of the tides at Vizagapatam is, that the diurnal tides are very small in proportion to the main lunar tide, being almost in every case about one-half what obtains at Kurrachee and Bombay.

The smallness of the main diurnal tide (R_1 of K) is remarkable, being only 26 per cent of the main tide, which is the least proportion yet obtained in India, with the exception of Hanstal at the head of the Gulf of Cutch.

Vizagapatam being the first station in the Bay of Bengal where observations have been deduced, it would be interesting hereafter to see if this feature, viz. the smallness of the diurnal tides, obtains at other ports in the Bay.

The proportion between P and O is much larger than the theoretical maximum proportion, and in this it approaches more nearly to what was found at Paumben than at any other port.

The proportion between J and Q is most remarkable. Theory would assign a value of about 0·4, that is to say, Q would be about two and a half times as great as J; but at Vizagapatam J is actually about three and a half times greater than Q.

The proportion between O and K is a little less than was found at other places.

The overtides of S and M are all small, and call for no special mention. *But the most remarkable feature of the Vizagapatam tides* is the exceedingly high proportion of the solar annual tide, which is almost half the magnitude of the main lunar tide: this is about double what was found at Aden, where it was first noticed to be abnormally high. The solar semi-annual tide also is very large, although not quite so great as at Paumben.

The epoch of the solar annual tide occurs about the end of September; the epoch for the semi-annual tide occurs about the beginning of May, and beginning of November, dates which agree well with what was found at Paumben; which is still further evidence of this tide being mainly due to wind.

GEOGRAPHICAL COMPILING AND DRAWING BRANCH, SURVEYOR-GENERAL'S OFFICE, CALCUTTA.

Statement showing the nature of the work performed, and the progress made, from 1*st October* 1879 *to* 30*th September* 1880.

Maps.	Scale. In. Miles.	Remarks and Progress.
India ; 6 sheets, outline and names	1 = 32	Fresh additions and revisions from recent surveys to date, made on dry print proofs of sheets I, III, IV, and VI, for insertion on copper-plates.
India, No. 3 ; 2 sheets, outline and names.	1 = 64	Revision of new transfer proofs to date, and completion of all unsurveyed blanks, for a *second* edition in outline. In progress.
India ; 1 sheet, outline	1 = 96	Reduction of above. Provincial and other boundaries, railway lines, territorial and other principal names, completed and inserted on a dry print proof of outline for engraving.
India, No. 3 ; 4 sheets, outline and names.	1 = 64	Fresh additions and revisions from recent surveys to date made on dry print proofs, for insertion on copper-plates.
Bengal ; 2 sheets, outline and names.	1 = 16	Plate transfer proofs, in outline examined, revised, and completed for a new edition. Hill drawing, on dry print proofs from the plates, in progress.
Punjab ; 4 sheets, outline and names.	1 = 16	New compilation, to embrace all recent surveys to date. Drawing and compilation in progress. To be engraved.
Central Provinces ; 2 sheets, outline and names.	1 = 16	Hill drawing on mounted silver prints of the original compilation in outline completed for engraving.
Central India Agency ; 2 sheets, outline and names.	1 = 16	Fresh additions made on dry print proofs from plates, from recent surveys to date. Hill drawing on mounted silver prints of the original compilations in outline, in progress for engraving.
Rajputana Agency ; 2 sheets, outline and names.	1 = 16	
Berar. (Hyderabad Assigned Districts), 1 sheet.	1 = 8	New compilation. Drawing in progress.
Southern Afghanistan ; 4 sheets ...	1 = 4	Compilation and drawing in outline, embodying all the recent surveys to date. In progress.
Northern Afghanistan	1 = 32	Compilation and drawing complete with hills, embracing all recent surveys ; for embodyment in sheet 2, fifth edition, map of Turkestan.
Seat of war, Northern Afghanistan ; 4 sheets ; country between lat. $\frac{35°\,0'}{35\,45}$ N. and long. $\frac{68°\,0'}{71\,30}$ E	1 = 4	General compilation. Additions from recent surveys and various fresh materials to date, made and drawn complete with hills. Blue prints of same, redrawing in progress.
Route map, Punjab, Cashmere, and Western Himalayas.	1 = 32	Compilation and drawing on west, with revisions to date, on a dry print proof from plate. In progress.
Country round Kabul	1 = 1	Sheet II. Tracing on vellum cloth from a rough original.
District Maps.		
Farukhabad	1 = 8	Drawn for the *Gazetteer*, North-Western Provinces.
Bahraich	1 = 4	The new boundary between Bahraich and Nepal inserted on a proof for a new edition.
Backergunge	1 = 4	Extracted from the sheets of the Atlas of India, and prepared and completed to date for publication.
Noakholly	1 = 4	
Sylhet	1 = 4	
Cachar	1 = 4	
Dacca	1 = 4	
Mymensingh	1 = 4	
Furreedpore	1 = 4	
Rungpore	1 = 4	
Hazaribagh	1 = 4	
Index Maps.		
Assam, 8-mile sheets	1 = 64	An index to the 8-mile sheets drawn.
Index to the sheets of the Atlas of India.	1 = 96	Revisions to date made on a dry print.
India, showing imperial surveys in progress to 1st October 1880.	1 = 128	Prepared for report, 1879-80.
Atlas of India, showing state of engraving and publication to 1st October 1880.	1 = 256	
Surveys of India (Topographical) showing the sheets published.	1 = 32	

GEOGRAPHICAL COMPILING AND DRAWING BRANCH, SURVEYOR GENERAL'S OFFICE, CALCUTTA.

Sheets of the Atlas of India, 1 *inch* = 4 *miles.*

12, S.E.	Part of Kattywar	Further additions drawn with hills, to complete sheet on the west.
18, N.W. S.E.	Parts of Bahawalpur and Bickaneer Native State.	Additions on north-west corner drawn to complete. Additions drawn in outline to extent of survey.
31, N.W.* S.W.* N.E.* S.E.*	Parts of Montgomery, Ferozepore, Sirsa, and Hissar districts, and Patiala, Bahawalpur and Bickaneer.	Bahawalpur portion drawn complete; additions from recent surveys in progress.
32, N.E. S.E.	Parts of Bickaneer, Shaikawati, and Hissar.	Additions drawn on west to complete.
33, N.W. S.W.	Parts of Jodhpore and Bickaneer.	Further additions drawn on west to complete.
35, N.W.	Part of Oodeypore	Additions on west drawn in outline to complete.
36, N.W.* S.W. N.E. S.E.	Parts of Guzerat and Central India Agency.	Drawn in outline to extent of survey. Additions drawn in outline to extent of survey.
37, N.E.	Parts of Khandesh, &c. ...	Additions drawn complete with hills.
38, N.W.* N.E.* S.E.*	Parts of Nasik and Ahmednagar districts and Hyderabad.	Drawing in outline in progress.
48, N.E.	Parts of Bijnor, Dehra Dun, &c.	Drawing in outline in progress.
53, S.W.	Part of Central India Agency	Further additions drawn complete with hills.
60, N.E.*	Part of Mysore	Drawing in outline in progress.
66, N.E. S.W. S.E.	Parts of Bijnor, Kumaun and Garhwal.	Hills drawn complete with additional outline and names.
67, N.W.* N.E.* S.W.* S.E.*	Parts of Tarai, Kumaun, Moradabad, Budaun, and Bareilly districts.	Drawing in outline completed of 67 S. E. and drawing of the other three quarters in progress.
69, S.E.	Parts of Hamirpur and Banda districts.	Drawing in outline of additions on north to complete. In progress.
118, F. P.	Parts of Jalpaiguri, Cooch Behar, Bhutan, &c.	Revision of south-eastern portion of sheet (Goalpara) completed in outline from recent survey.
119, F. P.	Parts of Rungpore, Maldah, Dinagepore, Mymensingh, &c.	Revision of Goalpara district, on the north-east of sheet, completed with Hills.

* The 13 quarters marked* are new sheets.

Standard Sheets of the Topographical Survey drawn for reproduction.

	Scale. In. Miles.	
Ganjam and Orissa Survey.		
Sheets 68, 89, 90, 91 in one	1 = 2	Fair drawn complete with hills from the original field sheets.
Hyderabad Survey in 18 *sheets.*		
Sheets 1, 2, 3, 4, 6, 7, 11, 12, 14, 16, 17, 18.	1 = 1	Fair drawn complete with hills from the original field sheets.
Sheets 5, 8, 9 and 10 in one, 13, 15 ...	1 = 1	Fair drawn in outline from the original field sheets. Hills in progress.
Central Provinces Survey.		
Sheets 14, 15, and 9	1 = 1	Fair drawn complete with hills from the original field sheets.
Khasi, Garo, and Naga Hills Survey.		
Sheets 13, 23, 27, and 28, originals	1 = 2	Unsurveyed blanks in the original sheets filled in from recent surveys, for a 2nd edition.
Simla and Kalka Road Survey.		
Sheet 5 D.	6 = 1	Fair drawn from the original field sheet.
Thal Chotiali Route Survey.		
Sheet 1	1 = 4	Compiled and drawn complete with hills from the original field sheets.

GEOGRAPHICAL COMPILING AND DRAWING BRANCH, SURVEYOR-GENERAL'S OFFICE, CALCUTTA.

Miscellaneous Maps, Tracings, &c.

	Scale. In. Miles.	
Soolay Pagoda and town of Rangoon.	.....	Exhibits A, B, C, and D. Four sections drawn on vellum cloth from originals.
Zaimukht valley and country adjoining British territory.	.....	Drawn on vellum cloth for reproduction and issue.
Gunja Tract	1 = 1	Drawn on vellum cloth for Secretary to the Board of Revenue, Lower Provinces.
Murree and Kahuta Tahsils ...	4 = 1	Tracing made on vellum cloth showing progress of survey to 1st January 1880.
Mullah's Explorations in 1878 ...	1 = 8	Sketch to illustrate. Drawn for the General Report of 1878-79.
Country between Pishin and Shorawak.	1 = 4	Traced on vellum cloth from the original sheets, and drawn for reproduction.
Triangulation Chart, Kandahar, minor series, 1879.	1 = 4	Tracing made on vellum cloth.
Route of mission from Kandahar to Herat in June and July 1839.	1 = 4	Tracing made on vellum cloth.
Country between Karez-i-ata and Panjwai, Southern Afghanistan.	1 = 1	Fair drawn for reproduction from the original plane table sections.
Route Survey in 4 sections from Madadalari station to Lehri, by Captain Beavan.	1 = 1	Fair drawn for reproduction from the original plane table sections.
Jellalabad district, Afghanistan, with the Kunar and Laghman valleys, showing tribal divisions.	1 = 2	Drawn from various materials complete with hills. To be lithographed for the Punjab Government.
Boundary between district Bahraich of Oudh, and Nepal, along the Rapti river, from pillar 13 to pillar 20.	1 = 4	Fair drawing made for Resident, Nepal, from an original supplied.
Reconnaisance Survey, part of N. E. Beluchistan, by Captain Maitland.	1 = 4	Traced and drawn complete with hills from the original sheets, for reproduction.
India, Frontier Trade Map ...	1 = 96	A dry print from the plate of India 93 miles, completed in outline to illustrate "Report on the Frontier Trade of India," for the Government of India. Hills in progress.

548 sheets of various engraved, lithographed, and photozincographed proofs, examined, corrected, and added to for publication in a complete form.

J. F. BANESS,
Surveyor and Chief Draftsman.

JOHN O. N. JAMES,
Assistant Surveyor-General.

Work done by the Examining Branch from 1st October 1879 to 30th September 1880.

Subjects examined ...	Original standard sheets of topographical surveys and standard sheets compiled in Surveyor-General's Office, as also large scale plans and triangulation charts of the various topographical survey parties ...	40 sheets.
	Original compilations of parts of atlas sheets and other maps compiled in Surveyor-General's Office	27 do.
	Engraved proofs in outline, names, &c., in various stages, and general and provincial maps	
	Photographed and lithographed proofs of various scales, including maps, plans, atlas sheets, &c. (examination and additions of new territorial boundaries, &c.)	254 do.
Hill shading in brush of atlas sheets, 22 N. W.; 129 S. W. and S. E.; 130 S. E.; 138 N. W. and S. W., and 45, pen-work horizontal shadings of two standard sheets, Nos. 13 and 15, Central Provinces Topographical Survey, and scraps of other maps of the North-West Frontier		9 do.
Work compiled	Standard sheets Nos. 13, 14, and 15, Central Provinces Topographical Survey, part of atlas sheet 37 N. E., and assisted in the compilation of the 1st edition, seat of war map (Afghanistan), and also subsequent editions	5 sheets & scraps.
Projection of compilation maps and atlas sheets, the latter marked on copper-plates by this section for the engravers		21 sheets.
Miscellaneous work ...	Supply of numerical data (latitudes, longitudes, and heights) to various district officers, also areas of districts, &c.	
	Computation of atlas graticule.	
	Calculation of revenue survey coordinates into latitudes and longitudes.	
	Reports, memoranda, &c.	

A. CHAMARETT,
Surveyor, Sec. II., Examining Branch.

JOHN O. N. JAMES,
Assistant Surveyor-General.

PROGRESS REPORT OF THE ENGRAVING BRANCH FROM THE 1ST OCTOBER 1879 TO THE 30TH SEPTEMBER 1880.

General Maps, &c.

Title of map.	Outline and writing.	Hills and sand-hills.	Remarks showing progress.
	Sq. In.	Sq. In.	
Map of India, 32 miles=1 inch—			
Sheet 1	51 W.	.....	Additional outline and writing completed.
,, 3	275 O. W.	.....	Heavy additions and corrections to outline and writing nearly done.
,, 4	146 W.	.....	Corrections and heavy additions to writing, in progress.
Map of India in 4 sheets, scale 64 miles=1 inch.	378 W.	.....	Corrections and heavy additions to writing, completed to the four sheets.
Map of India, scale 96 miles= 1 inch.	196 W.	.....	Alterations to suit authorized spelling of names. As far as drawing, completed. Plate put down.
Map of Bengal in 2 sheets, scale 16 miles=1 inch.	131 W.	.....	Corrections and heavy additions to writing nearly completed. In progress.
Map of Central Provinces in 2 sheets, scale 16 miles = 1 inch.	607 O. W.	.....	Outline completed. Writing more than half done. In progress.
Map of Rajputana in 2 sheets, scale 16 miles=1 inch.	234 O. W.	.....	Corrections to outline done. Writing completed. Plates put down, waiting for fresh materials.
Map of Central India Agency in 2 sheets, scale 16 miles= 1 inch.	385 O. W.	.....	Additional outline done. Writing nearly completed. In progress.
Map of Assam, scale 16 miles= 1 inch.	20 O. W.	.....	Corrections of outline and additional writing completed.
Map of Himalaya Routes, scale 16 miles=1 inch	206 W.	.....	Writing well advanced. In progress.
Plan of Calcutta	.....	.....	Corrections and alterations done.
Chart of Colombo Harbour (for the Marine Survey Department).	.....	.....	Additional cultivation and jungle completed. Plate finished.
Chart of the Indian Ocean ...	50 O.	.....	Border projections and magnetic variation curves completed. Outline just commenced.
Scale plate, 5,280 feet to the inch.	.....	.....	Repaired and figures cut. Plate finished.
Scale clinometer	.....	.....	Engraved and finished.
Idiometer machine	.....	.....	Well advanced. In progress.
Scale vernier	.....	.....	Engraved and finished
Imprint plates	.....	.....	Alteration of dates done.
Map headings for Topographical Surveys.	.....	.....	Repaired and finished.
Map heading, Hyderabad Topographical Survey.	.....	.....	Engraved, and transfer sent to press.

INDIAN ATLAS SHEETS (*New*) *completed and published.*

NOTE.—The progress during the year is shown in square inches. A full sheet of the Atlas contains 927·2 square inches; quarter plate 231·8 square inches.

Atlas sheets—			
18 S. W.	.....	134 sand	Complete up to margins.
18 N. W.	6 W.	80 ,,	
22 S. W.	.....	80 hills	
37 N. E.	160 W.	120 ,,	
53 S. W.	.....	135 ,,	
91 N. W.	.....	59 ,,	
92 N. W.	.....	168 ,,	
92 S. W.	.....	46 ,,	
129 N. E.	.....	12 ,,	Completed up to limits of survey.
129 N. W.	8 W.	49 ,,	
129 S. W.	.....	116 ,,	
130 N. E.	.....	96 ,,	

PROGRESS REPORT OF THE ENGRAVING BRANCH FROM THE 1st OCTOBER 1879 TO THE 30th SEPTEMBER 1880.

INDIAN ATLAS SHEETS (*New*) *in progress.*

Title of map.	Outline and writing.	Hills and sand-hills.	Remarks showing progress.
	Sq. In.	Sq. In.	
Atlas sheets—			
12 S. E.	12 W.	.....	A small portion of fresh outline done. Writing nearly completed. In progress.
13 N. E.	.....	.....	Slight additions.
19 N. E.	3 W.	3 sand	Small portion of outline and writing completed. Sand-hills, ⅛ of the drawing done. Plate put down for more urgent work.
22 N. E.	6 W.	.....	Writing as far as drawing completed.
22 N. W.	.....	3 hills	Hills and jungle completed as far as drawing.
22 S. E.	.....	.....	Heavy portion of river water-line and jungles completed as far as drawing.
31 N. W.	.....	.....	Border and projections completed.
31 S. E.	... ...	.....	Outline just commenced.
32 S. W.	20 O. W.	59 sand	Ditto ditto. Outline and writing completed as far as drawing. Sand-hills nearly finished.
33 N. W.	16 O. W.	30 ,,	Heavy portion of fresh work up to margin. Outline and writing completed. Sand-hills half done. In progress.
33 S W.	30 O. W.	.....	Writing completed as far as drawing; the remaining portion up to margin, outline done. Writing just commenced.
35 N. W.	49 O. W.	.....	Outline completed as far as drawing. Writing and figures ¾ done. In progress.
35 S. W.	35 O. W.	.....	*Outline and writing completed as far* as drawing.
36 N. E.	40 O. W.	.....	Heavy portion of fresh outline completed. Writing ¼ done. In progress.
36 S. E.	50 O. W.	.....	Small portion of fresh outline and writing completed.
36 S. W.	52 O. W.	.....	Outline and writing completed as far as drawing.
53 N. W.	40 O. W.	.....	Outline completed up to margin. Writing ⅛ done. In progress.
66 N. E.	10 W.	92 hills	Corrections and two tablets on the margin completed. Hills in progress.
66 S. E	25 W.	25 ,,	Corrections and two tablets on the margin completed. Hills just commenced.
66 S. W.	30 W.	.....	Two tablets on the margin done, with heavy addition.
67 S. E.	.....	.....	Outline just commenced.
77 N. E	190 O. W.	.....	Outline completed. Writing more than half done. In progress.
86 S. E.	.....	2 hills	Hills completed as far as drawing.
129 S. E.	116 O. W.	.....	Outline completed up to margin. Writing ⅛ done. In progress.
130 S. E.	23 O. W.	.....	Heavy portion of fresh outline and writing completed.
138 N. W.	.....	10 hills	Writing completed as far as drawing. Hills almost half done. In progress.
138 S. W.	21 W.	.....	Writing completed as far as drawing.

Additions and Corrections to Indian Atlas Sheets.

8 S. E.	65 W.	.....	Heavy portion of fresh work. Writing nearly completed.
23 N. W.	.....	.....	Slight additions.
32 S. E.	20 W.	65 sand	Heavy portion of fresh work. Writing and sand-hills done. Plate finished.
66 N. W.	12 W.	.....	A tablet on the margin engraved and heavy additions to the plate.
71 N. E.	.....	49 hills	Jungle and hills of new survey completed.
72 N. E.	.....	.....	Slight corrections and additions to hills done.
54	.....	185 hills	Heavy addition. Repairing hills and jungles completed.

PROGRESS REPORT OF THE ENGRAVING BRANCH FROM THE 1st OCTOBER 1879 TO THE 30TH SEPTEMBER 1880.

Additions and Corrections to Indian Atlas Sheets—concluded.

Title of map.	Outline and writing.	Hills and sand-hills.	Remarks showing progress.
	Sq. In.	Sq. In.	
Atlas sheets—			
62	.....	.....	Small portion of railway and station names engraved.
63	.....	.....	Corrections to outline done. A few additional station names engraved.
65	50 W.	12 hills	Portion of new survey. Writing done. Hills ¼ done. In progress.
79	.....	.. ...	Small portion of railway and a few station names engraved.
80	.....	.....	Corrections to outline done. Some additional station names engraved.
81	.....	.....	Ditto ditto.
102	300 O. W.	.....	Additions and corrections to outline done. Writing recut. Completed.
103	.....	.....	Small portion of railway engraved.
104	.....	.....	Ditto ditto.
118	38 O. W.	.....	Heavy additions. Outline and sand-bank completed. Writing ¼ done. In progress.
119	.....	.....	Slight corrections and additions.
121	.....	.....	Corrections done.
	4,106	1,630	Grand total of square inches of new work on all the plates.
Repairing of old Full Indian Atlas sheets.			
38	.....	106 hills.	Repairing hills almost ½ done. In progress.
41	.....	302 ,,	Heavy sheet. Repairing hills completed.
49	.....	12 ,,	Small portion of hills repaired. Completed.
55	.....	509 ,,	Heavy sheet. Repairing hills completed.
73	300 W.	.....	Writing repaired. Completed.
106	.....	292 ,,	Heavy sheet. Repairing hills ¾ done. In progress.
115	.....	90 ,,	Heavy sheet. Repairing hills completed.
116	.....	25 ,,	Hills repaired. Completed.
120	431 W.	.....	Heavy sheet of writing recut. Nearly completed.
	731	1,336	Total square inches of repairs.

Miscellaneous work, viz. notes and references on plates, borders, &c.

8 Plates.—Outside names and figures completed; 37 N. W.; all four quarters of 48, 67 N.E., 67 N.W., 67 S.W.

8 Ditto.—Slight corrections and additions have been made to atlas sheets 51 S.E., 51 S.W., 51 N.E., 86 S.W., 87 N W., 90 S.W., 124 S.W., and 130 N.W.

20 Ditto.—Outside names and figures in progress—31 N.E., 31 S.W., three quarters of 134 and 135, all four quarters of 69, 145, and 146.

12 Ditto.—Outside names and figures completed—all four quarters of 38, 39. and 49.

Number of plates in hand during the year, 145.

Copper plate Printing.

Proofs	894
Transfers	414
Impressions	4,375
Total ...	5,683

Steel-facing completed.

The preparation for steel-facing copper plates was commenced on the 3rd December 1879. The first trial plate was steel-faced, and approved by the Surveyor-General on the 7th January 1880, from which date up to the 30th September 1880 the following atlas sheets and miscellaneous plates have been steel-faced. Indian atlas sheets 29, 39, 41, 42, 47, 50, 58, 60, 61, 62, 63, 73, 74, 75, 79, 102, 114, 3 N.E., 10 S.W., 18 S.W., 18 N.W., 22 S.W., 23 N.W., 34 S.W., 35 N.E., 51 S.E., 51 S W., 69 N.E., 70 S.W., 71 N.E., 90 N E., 90 S.E., 90 S.W., 91 N.W., 91 S.W., 124 N.E., 130 N.E., 130 N.W., 130 S.W. Colombo Harbour chart, large tint plate B, and one small scale of shade plate.

Full sheets steel-faced	17
Quarter ,, ,, ...	22
Miscellaneous ,, ...	3
Total ...	42

C. W. COARD,
Superintendent, Engraving Branch.

JOHN O. N. JAMES,
Assistant Surveyor-General.

Table A.

Tabulated Statement of the principal Records prepared in the several Executive Offices of the Revenue Branch, for the year ending 30th September 1880.

Province.	Survey party.	District.	Cadastral: Sheets.	Cadastral: Amin's field sketch-books.	Cadastral: Field area statements.	Atlas sheets 4″ = 1 mile.	Quarter sheets 2″ = 1 mile, or standard 1″ maps.	Triangulation charts and index maps.	Area traverses: Main circuit with azimuth computation.	Area traverses: Village or sub-circuit.	Field-books: Main circuit.	Field-books: Village or sub-circuit.	Original field plans.	For Settlement Department: Traces of sheets.	For Settlement Department: Khasra field area statements.
			No.	Vols.	Villages.	No.	No.	No.	Vols.	Vols.	Vols.	Vols.	No.	No.	Villages.
								CADASTRAL SURVEYS.							
N.-W. Provinces	No. 4	Ghazipur	16″ scale 801	.....	1,524	.....	10 partially	1 Index map	1	3	1	6	*Vide* sheets	111	1,524
	,, 5	Banda	1,117(*a*)	173(*a*)	1,209(*a*)	140(*a*)	.....	.....	.....	.....	.....	.....	.....	20	4
	,, 6	Mirzapur	692	.....	805	.....	6 not commenced	1 Index map	2	4	2	12	*Vide* sheets	55	723
		Jaunpur	1,067	.....	1,371	11	16 partially	1 Ditto	4	3	4	18	Ditto	.....	1,371
Bengal	,, 7	Pooree	32″ scale 3,362(*a*)	122(*a*)	23	46 complete 18 skeleton	.....	1 Ditto	3	10	4	24	13 on 4″ 45 on 4″ 2 vols. orgl. bd. plans.	3,362 on 32″ 1,051 skeleton. 264 ditto	941
British Burma	,, 8	Bassein	16″ scale 471	.....	179	.....	7 not commenced	1 Ditto	1	1	1	2	*Vide* sheets	188	188
	,, 2	Hanthawaddy	1,105	.....	279	.....	11 partially	1 Ditto	2	6	2	5	Ditto	319	294
			Horizontal and vertical angle-books.	Triangle computation.	Computation of heights.			VILLAGE AND TOPOGRAPHICAL SURVEYS.							Areas of villages.
			Vols.	Vols.	Vols.	Chs.									
Punjab	No. 1	Dera Ismail Khan	.....	.....	.....	50 (size 400 × 500).	.....	1 Index map	1	1	1	1	*Vide* sheets	34 Trace maps	71
		Rawalpindi	.....	.....	.....	45 (size 7¼′ × 3¾′).	.....	1 Ditto	.....	.....	.....	.....	45 on 4″	45 Blue prints for Forest Department.	.....
N.-W. Provinces	,, 3	Saharanpur	.....	.....	.....	3 of Patri forest. 4 on 6″ city & civil station.	.....	.....	1		1	15	3 on 4″ Patri forest 4 on 6″ city and civil station.	.....	.....
		Muzaffarnagar	.....	.....	.....	.....	43 on 2″ scale for reproduction.	1 Ditto	1	5	1	17	190 on 2″ (320 × 240 Chs.) 99 on 2″ (5′ × 3¼′).	.....	.....
		Meerut	.....	.....	.....	.....	47 on 2″ scale for reduction.	1 Ditto	1	4	1	6	33 on 2″ do.	.....	.....
		Jumna River Survey	.....	.....	.....	Chs. 38 (size 400 × 500).	.....	.....	.....	.....	.....	.....	*Vide* Atlas sheets.	.....	.....
	,, 4	Budaun	.....	.....	.....	Chs. 9 (size 400 × 500).	.....	.....	.....	.....	.....	.....	Ditto	6 on 4″	.....
Bombay	,, 10	Poona, Ahmednagar, Tanna and Colaba.	4	1	1	.....	32 on 2″	1 Atlas reduction ¼″ 2 Traverse index maps. 1 Triangulation chart.	1	2	1	2	52 on 2″	18 skeleton plots.	Copies of all traverse data.(*b*)
	,, 11	Sholapur, Ratnagheri, Satara and Colaba.	2	2	1	.....	24 on 2″	2 Index maps 2 Triangulation charts.	3 Main and sub-traverse.		4 Main and sub-traverse.		26 on 2″	.....	Ditto.

(*a*) Includes work of previous seasons.

(*b*) Also 1 volume of rectangular co-ordinates.

Deputy Surveyor-General's Office;
Calcutta, 1st October 1880.

F. CODDINGTON, *Major*,
Deputy Superintendent at Head-Quarters.

Table B.

Statemnt of Work performed in the Drawing and Compiling Branch of the Deputy Surveyor-General's Office during the 9 months extending from 1st January to 30th September 1880.

Title of Map.	Scale.	Remarks.
	Inch. Mile.	
PUNJAB.		
Districts Bannu and Dera Ismail Khan in 41 sheets, standard size, 30′ × 15′	1 = 1	Graticule lines have been inserted on 122 original 4″=1 mile sheets, comprising sheets Nos. 2, 3, 6, 7, 10, 14 and 15, and sent to press for photo. reduction to half scale.
Number of sheets published to date, 5.		The 2″ blue prints received from press of sheets 1, 4, 5, 6, 7, 8, 9, 11, 12, 13, 16, 17, 20, 21 and 25, have been typed and re-drawn in black for reduction to 1″ scale, and all examined, except sheets 6, 7, 11, 13, and 16. Sheets 24, 25, 28, 29 and 32 (drawn last year) have been examined. The following 2″ sheets (blue prints) have been re-drawn and sent to press for reduction and publication on 1″ scale, viz. Nos. 1, 4, 8, 12, 20, 24, 28, 29, and 32, of which sheets 1, 4, 8, 12 and 24, have been published to date.
Districts Bannu and Shahpur, Sakesar Sanitarium, in 2 sheets ...	16 = 1	The original plan, drawn in the Executive's office, was examined, lines of longitude and latitude inserted, and sheets completed for photo. re-production to scale. Publication has been completed.
District Sirsa, in 16 sheets, standard size, 30 × 15′	1 = 1	The original 1″ sheets prepared in the Executive's office were examined with 4″ village sheets, corrected, completed and made suitable for photo. re-production, and sent to press. Publication has been completed.
District Ssa, preliminary district map and sheet index ...	¼ = 1	Drawn, examined, and sent to press for publication by photography. Publication has been completed.
NORTH-WESTERN PROVINCES.		
District Muttra, in 7 sheets, standard size, 30′ × 15′	1 = 1	The five 2″ sheets drawn last season have been examined, and the remaining two have been drawn, examined, and sent to press for photo. reduction. Publication has been completed.
District Moradabad, in 13 sheets, standard size, 30′ × 15′ ...	1 = 1	The 2″ blue prints of sheets 30, 46, 63 and 64, have been re-drawn in black, but await additions from the adjoining districts Bijnor and Tarai to complete them to margin. No sheets yet published.
District Budaun, in 11 sheets, standard size, 30′ × 15′ ...	1 = 1	Graticule lines inserted on 51 of the 4″=1 mile maps, comprising 6 standard sheets Nos. 33, 34, 51, 52, 53 and 67, sent to press for photo. reduction to 2″ scale previous to being re-drawn in black for final reduction to 1″. None yet published.

Table B.—*continued.*

Title of Map.	Scale.	Remarks.
	Inch. Mile.	
Oudh (new edition) in 65 sheets, standard size, 30′ × 15′ ...	1 = 1	The original maps, with graticule lines inserted, comprising sheets 100, 120, 129, 130, 144, 146 and 147, sent to press for lithography. One sheet, No. 144, has been published.
BENGAL.		
District Midnapore, in 18 sheets, standard size, 30′ × 15′ ...	1 = 1	The 2″ sheets 2, 3, 6, 9, 12, 13, 15, 16 and 18, drawn last year have been examined, corrected and completed for press; sheet No. 5 completed up to margin by addition from Bankoora district; sheets 1, 4, 7 and 10, drawn in Executive's office, have been examined and completed for press; 2″ sheet 14 has been drawn. Portion of district Balasore is being added, which will complete 3 sheets up to margin. All but sheets 8, 11, 14 and 17 have been published.
District Noakholly, in 12 sheets, standard size, 30′ × 15′ ...	1 = 1	Graticule inserted on original 1″ maps, and skeleton standards 30′ × 15′ prepared for guidance of Litho. press. No proofs received to date.
BOMBAY.		
Deccan Topographical Survey, 2″=1 mile, between latitude 17° and 20°-45′ including the Konkan, in 96 sheets, standard size, 30′ × 15′ ...	1 = 1	Since the last report, 2″ standard sheets Nos. 26, 27, 28, 32, 49 and 53, drawn in Executives' offices, have been examined and completed for publication and sent to press; of which sheets 49 and 53 have been published.
Number of sheets published to date, 50.		
INDEX MAPS.		
Of districts Dera Ismail Khan and Bannu; Rawalpindi; Saharanpur; Muzaffarnagar; Meerut; Ghazipur; Ballia; Banda; Mirzapur; Jaunpur; Cuttack and Pooree; Hanthawaddy; Bassein; Deccan and Konkan	On various scales.	Brought up to date and re-published to illustrate the Annual Report of 1879-80. The Bassein index was re-typed, and hill portion re-drawn in head office.
Miscellaneous Traces, &c.		
Traces of 9 atlas sheets of Ganges Deara Survey of 1865-66, showing in red the positions of village boundaries as surveyed in 1842-46	4 = 1	For Collector of Patna.
Traces of 6 villages of district Patna	4 = 1	For do. do.
Trace of Dalleseri River, 1858-63 (3 sections)	4 = 1	For Commr. Dacca Div.
Traces of 3 atlas sheets of district Hooghly	4 = 1	For Govt. of Bengal.
Traces of 5 atlas sheets of district Pilibhit	4 = 1	For Collector.

Table B.—*continued.*

Title of Map.	Scale.	Remarks.
Miscellaneous Traces, &c.—continued.	Inch. Mile.	
Traces of 4 atlas sheets of district Karnal, showing Jumna River and adjoining villages ...	4 = 1	For Deputy Supdt., No. 3 Party.
Map of portion of Bannu district ...	4 = 1	For Geological Survey.
Lá and Nisfi khiraj estates surveyed 1878-79, inserted on the original 4″ congregated village sheets, district Kamrup	4 = 1	For office record.
Inserted on a set of printed maps of Sindh the co-ordinate data, traverse stations, and lines and series of triangles, along the Runn of Cutch	1 = 1	For Surveyor-General.
Overlaps for Deccan sheets of 1879-80	2 = 1	For Executives.
Specimen map for reduction to 1″ scale	2 = 1	For circulation to Survey Parties.
Trace of triangulation chart of district *Hazara*	½ = 1	For Executive Engineer.
Insertion on 4-mile map of the boundaries of districts Bannu and Peshawar, and overlap surveyed in district Kohat	¼ = 1	For Surveyor-General.
Map coloring.	No. of sheets.	
Maps colored for Surveyor-General's Office	96	Exclusive of cadastral maps.
Maps colored for Revenue Survey Office	96	
Maps colored for despatch to India Office	650	
Maps colored for issue to Government officials	987	
Total ...	1,829	
Examination of proof-sheets.		
Photozincograph proofs ...	194	
Lithograph proofs ...	42	
Examination of Original Maps.		
District Sirsa, of seasons 1876 to 79	4 = 1	132 sheets, of which 10 per cent. were finally examined and corrected and defects communicated to Executive Officer.
Do. Budaun „ 1875 to 79	4 = 1	210 sheets, of which 10 per cent. were examined and corrected, and defects communicated to Executive Officer.
Do. Cuttack „ 1877 to 79	4 = 1	24 sheets examined for publication.
Do. Banda „ 1876 to 77	4 = 1	79 sheets ; first examination completed.
Deccan Topographical Survey (Bombay), 1877 to 79 ...	2 = 1	6 sheets examined and corrected for press, and defects brought to notice of Executive Officer.
Ditto do. do. 1879-80	2 = 1	6 sheets ; first examination completed.

Table B.—*concluded.*

Title of Map.	Scale.	Remarks.
Traverse data, &c., supplied.	Inch. Mile.	
Of districts Dacca and Mymensingh along Dalesseri River ...	.....	For Commissioner, Dacca Division.
Of Jumna and Ganges Rivers ...	.....	„ Do. do.
Of districts Jaunpur and Oudh ...	.....	„ Deputy Supdt., No. 6 Party.
Of Banghi Khell Hills ...	.....	„ Do. No. 1 „
Of districts Azamgarh and Ghazipur	.....	„ Do. No. 4 „
Of Sind along the Runn of Cutch ...	.....	„ Surveyor-General.
Of district Budaun, description of bench-marks, Sections I to XX ...	.....	„ Irrigation Department, N.-W. P.
Computations examined.	Season.	
District Moradabad ...	1871 to 77	Examination of a percentage has been made in each district with the original maps, and the defects found have been communicated to the Executive Officers.
„ Budaun ...	1875 to 78	
„ Cuttack ...	1877 to 79	
„ Muttra ...	1871 to 74	
Miscellaneous work.		
Detail statement of the publication of the 4″ maps of the N.-W. P., showing numbers, &c., of original maps on record, &c. ...	.....	For N.-W. P. Government.
Revised area statements of Districts Muttra, Midnapore, Hooghly, and Jhung, according to revised limits	.....	For record.
The correction of maps and records according to changes notified in Gazettes, &c.	.....	For local governments, and office record.
Calculation of co-ordinates for the projection of the 1″ standards of districts Dera Ismail Khan and Bannu, Midnapore, Balasore, Noakholly, Backergunge, and Budaun	.....	For use in preparation of maps for publication.

Deputy Surveyor-General's Office;
Calcutta, the 1st October 1880.

F. CODDINGTON, *Major*,
Deputy Superintendent at Head-Quarters.

Table C.

State of Publication of Cadastral Maps up to the 30th September 1880.

Districts.	Number of Sheets.								
	Maps prepared.			Published.					Remaining to be published.
	Up to 31st December 1879.	Added during past 9 months.	Total up to 30th September 1880.	Up to 31st December 1879.	During 1880. By Surveyor-General's Office.	During 1880. By Calcutta Firms.	During 1880. By Allahabad Press.	Total up to 30th September 1880.	
N.-W. Provinces.									
Agra	2,894	(a)48	2,042	2,894	30	.....	.....	2,933	(g)9
Azamgarh	930	.....	930	930	.....	.....	.....	930	.....
Banda	(b)3,319	(a)10	3,329	(b)1,823	566	.....	.....	2,389	940
Bijnor	31	.....	31	.....	31	.....	.....	31	.....
Ghazipur	245	(c)1,441	(c)1,690	245	335	.....	.....	580	1,106
Humirpur	2,920	.....	2,920	2,926	.....	.....	.....	2,926	.....
Jaunpur	(b)1,052	(c)1,401	(c)2,453	1,036	738	.....	.....	1,774	679
Moradabad and Tarai	4,023	.....	4,023	4,023	.....	.....	.....	4,023	.....
Muttra	1,058	.....	1,058	1,058	.....	.....	.....	1,058	.....
Mirzapur	.....	(c)882	(c)882	.....	181	.....	.....	181	701
Total ...	17,078	3,782	20,860	15,636	1,890	.....	.....	17,425	(d)3,435
British Burma.									
Bassein	.....	510	510	.....	.....	.....	.....	.....	510
Hanthawaddy... ...	.....	1,043	1,043	.....	.....	.....	.....	.....	(e)1,043
Total ...	.....	1,553	1,553	.....	.....	.....	.....	.....	1,553
Bengal.									
Patna and Gya ...	3,054	.....	3,054	3,054	.....	.....	.....	3,054	.....
Shahabad	4,924	.....	4,924	4,924	.....	.....	.....	4,924	.....
Pooree (Khorda estate)	3,359	.....	3,359	.....	1,010	.....	.....	1,010	(f)2,349
Total ...	11,337	.....	11,337	7,978	1,010	.....	.....	8,988	2,349
Grand Total, N.-W. Provinces, Burma, and Bengal ...	28,415	5,335	33,750	23,513	2,900	.....	.....	26,413	7,337

(a)—Added owing to re-arrangement of sheets.
(b)—Figures of last return changed to agree with final publications.
(c)—These figures are approximate and liable to alteration.
(d)—Increase is chiefly owing to this statement being made up to 30th September instead of 31st December as heretofore.
(e)—61 have been sent to press.
(f)—Publication discontinued at request of Board of Revenue, pending final disposal of maps.
(g)—All at press.

Detail of Examination in connection with Publication.

Province.	Number of Sheets.					Remarks.
	Examined and rendered suitable for photo-zincography.	Traced and examined for zincography.	Proof copies examined previous to press order.	Colored and subsequently examined.	Printed maps examined and returned.	
North-Western Provinces	2,270	87	1,916	1,800	813	Scale 16 inches to a mile.
British Burma	61	.....	.....	.....	.....	Ditto.
Bengal	654	17	1,010	690	.....	Scale 32 inches to a mile.
Total ...	2,985	104	2,926	2,490	813	

Deputy Surveyor-General's Office;
Calcutta, 1st October 1880.

F. CODDINGTON, *Major*,
Deputy Superintendent at Head-Quarters.

STATEMENT OF WORK DONE BY THE LITHOGRAPHIC BRANCH, SURVEYOR-GENERAL'S OFFICE, BETWEEN THE 1ST OCTOBER 1879 AND 30TH SEPTEMBER 1880.

Work done for the Survey Department.

DESCRIPTION OF MAPS.	Scale of maps.	Size of each sheet.	Number of sheets.	Number of coloured copies.	Number of uncoloured copies.	Total number of copies.	Number of impressions.	Value.	REMARKS.
New Maps, &c., drawn during the year.								Rs. A. P.	
GENERAL MAPS.									
Map of Assam, in 9 sheets, sheets Nos. 6, 7 and 9, and title sheet No. 9.	Drawn on transfer paper.	1 inch = 8 miles	Imperial ...	3	305	300	605	1,355	1,252 6 11	
Map of India, in 2 sheets, sheets Nos. 1 and 2.	Corrections, additions, and chalk hills drawn on stone.	1 inch=64 miles	Double royal	2	...	520	520	1,040	1,617 15 8	
Map of India, in 8 sheets, sheet No. 2.	Drawn on polished stone.	1 inch=32 miles	Double elephant.	1	...	.....	.....	.....	184 7 2	Not yet printed.
Ditto ditto ditto ...	Drawn on grained stone.	Ditto	Ditto ...	1	...	.....	.....	.....	184 7 2	Ditto.
Outline map of India	Drawn on stone	1 inch=128 miles	Imperial ...	1	...	.....	.....	.....	95 5 0	Ditto.
INDEX MAPS.									
Index to the sheets of district Rajshahye.	Corrections and additions made.	.....	Half-sheet, double royal.	1	...	282	282	282	72 9 5	
Index to the sheets of district Maldah.	Ditto ditto ...	.....	Ditto ...	1	...	282	282	282	56 15 6	
Index to the sheets of the map of Assam	Corrections, &c., made.	.....	Foolscap ...	1	...	182	182	182	32 4 8	
Index maps, Nos. 1, 2, 5, 6, 7 and 8 and 9, parties to accompany Annual Report.	Re-drawn on stone.	.....	Ditto ...	6	...	.....	.....	.....	406 0 7	Not yet printed.
REVENUE SURVEY MAPS.									
Map of district Maldah, in 7 sheets, sheets Nos. 1, 2, 4, 5A, and 7.	Drawn on transfer paper.	1 inch = 1 mile	Double royal	5	...	1,410	1,410	1,410	1,777 6 1	
Map of district Maldah, in 7 sheets, sheet No. 6.	Ditto ...	Ditto	Ditto ...	1	...	.....	.....	.....	381 3 4	Not yet printed.
Map of district Julpaiguri, in 13 sheets, sheets Nos. 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, and 13.	Ditto ...	Ditto	Ditto ...	13	...	.....	.....	.....	2,270 8 0	Ditto.
Map of district Noakholly, in 12 sheets, sheets Nos. 3, 8, 9, and 12.	Ditto ...	Ditto	Ditto ...	4	...	.....	.....	.....	563 14 7	Ditto.
Map of Oudh Revenue Survey, sheets, Nos. 100, 129, and 144, 2nd edition.	Ditto ...	Ditto	Ditto ...	3	...	.....	.....	.....	478 9 4	Ditto.
Maps transferred from Engraved sheets of the Atlas of India.									
GENERAL MAPS.									
Map of Indian Atlas, quarter sheets, Nos. 60 S.-W. and 71 N.-E.	Corrections and colour stones prepared.	1 inch = 4 miles	Half-sheet atlas	2	185	65	250	585	110 9 6	
Map of Indian Atlas, full sheet, No. 111.	Corrections, additions, &c., and colour stones prepared.	Ditto	Antiquarian ...	1	150	50	200	500	218 15 0	
Ditto ditto ditto, Nos. 68 and 103.	Corrections and additions made.	Ditto	Ditto ...	2	...	.....	.....	.....	277 4 9	Not yet printed.
Ditto ditto ditto, No. 104.	Corrections, additions, and colour stone prepared.	Ditto	Ditto ...	1	...	.....	.....	.....	115 9 5	Ditto.
DISTRICT MAPS.									
Map of district Mymensingh ...	Corrections and additions made.	1 inch = 4 miles	Antiquarian ...	1	...	.....	.....	.....	27 5 0	Ditto.
Do. of ditto Dacca	Ditto ditto	Ditto	Atlas ...	1	...	.....	.....	.....	31 0 3	Ditto.
Do. of ditto Furreedpore ...	Ditto ditto	Ditto	Ditto ...	1	...	.....	.....	.....	53 8 0	Ditto.
Do. of ditto Backergunge ...	Ditto ditto	Ditto	Ditto ...	1	...	.....	.....	.....	68 3 0	Ditto.
Do. of ditto Noakholly ...	Ditto ditto	Ditto	Imperial ...	1	...	.....	.....	.....	15 14 11	Ditto.
Do. of ditto Sylhet	Ditto ditto	Ditto	Atlas ...	1	...	.....	.....	.....	54 0 2	Ditto.
Maps, &c., drawn previously, but printed during the present year.									
GENERAL MAPS.									
Map of Assam, in 9 sheets, sheet No. 2.	Corrections, additions, and colour stones prepared.	1 inch = 8 miles	Imperial ...	1	150	50	200	500	773 13 4	
Ditto ditto, sheet No. 3	Colour stones prepared.	Ditto	Ditto ...	1	155	50	205	515	109 7 10	
Ditto ditto, sheet No. 5	Ditto ...	Ditto	Ditto ...	1	155	50	205	519	66 12 0	
Sketch map of the countries between Hindustan and Caspian Sea.	Coloured by hand	1 inch = 64 miles	Double elephant.	1	...	675	675	675	301 9 8	
INDEX MAP.									
Index to the sheets of district Furreedpore.	.....	.....	Half-sheet, double royal.	1	...	282	282	282	56 7 2	
Carried over ..	.....	.....	.....	60	1,100	4,198	5,298	8,127	11,555 2 11	

STATEMENT OF WORK DONE BY THE LITHOGRAPHIC BRANCH, SURVEYOR-GENERAL'S OFFICE, BETWEEN THE 1st OCTOBER 1879 AND 30th SEPTEMBER 1880.

Work done for the Survey Department.

Description of Maps.	Scale of maps.	Size of each sheet.	Number of sheets.	Number of coloured copies.	Number of uncoloured copies.	Total number of copies.	Number of impressions.	Value.	Remarks.
								Rs. A. P.	
Brought forward ...	.....	.....	60	1,100	4,198	5,298	8,127	11,355 2 11	
Revenue Survey Maps.									
Map of district Furreedpore, in 13 sheets, sheets Nos. 4 and 13.	.....	1 inch= 1 mile	Double royal...	2	...	504	504	504	600 14 0	
Map of district Rajshahye, in 11 sheets, sheets Nos. 5, 6, 7, 8, 9, 10, and 11.	.....	Ditto ...	Ditto ...	7	...	1,974	1,974	1,974	1,485 1 7	
Map of district Maldah, in 7 sheets, sheets Nos. 3 and 5.	.....	Ditto ...	Ditto ...	2	...	504	504	504	266 4 5	
Maps, &c., transferred previously from the engraved sheets, but printed during the present year.									
District Maps.									
Map of district Rungpore ...	Further corrections and additions made and colour stone prepared.	1 inch= 4 miles	Atlas ...	1	100	50	150	250	80 11 8	
Ditto Dinagepore ...	Ditto ...	Ditto ...	Double elephant.	1	150	50	200	350	90 14 7	
Ditto Shahabad ...	Ditto ...	Ditto ...	Antiquarian...	1	150	50	200	350	184 1 9	
Ditto Julpaiguri ...	Ditto ...	Ditto ...	Imperial ...	1	150	50	200	500	121 4 7	
Ditto Gya	Ditto ...	Ditto ...	Double royal...	1	150	50	200	350	113 8 7	
Reprints.									
General Maps.									
Outline map of India, in 2 sheets, sheets Nos. 1 and 2.	Colour stones prepared.	1 inch=64 miles	Double royal...	2	150	31	181	960	236 4 6	
Outline map of India, No. 2A ...	Corrections of railways and colour stones prepared.	1 inch=128 miles	Imperial ...	1	100	63	163	463	123 14 1	
Sketch map of the Provinces of Bengal, Behar, and Orissa.	.....	1 inch=32 miles	Double royal...	1	...	25	25	25	11 7 0	
Map of Jamoo Territories, in 3 sheets, sheets Nos. 1, 2, and 3.	.....	4 inch = 1 mile	Special ...	3	...	300	300	300	198 5 5	
Map of Eastern Bengal, sheet No. 10.	Colour stone prepared.	1 inch = 8 miles	Imperial ...	1	150	50	200	350	87 13 6	
Map of Punjab, sheet No. 1 ...	.....	Ditto	Double royal.	1	...	100	100	100	34 11 2	
Do. of British Burmah, Pegu Division, sheets Nos. 3 and 4.	.....	1 inch = 4 miles	Special and Antiquarian.	2	...	68	68	68	47 0 0	
Index Maps, to accompany Annual Report.									
Index maps, Nos. 1, 2, 5, 6, 7, 8, and 9 parties.	Corrections and colour stones prepared.	.....	Foolscap ...	6	2,400	300	2,700	5,500	417 5 10	
Index to the Indian Atlas, showing state of the Engraving to 1st October 1879.	Ditto ...	.....	Ditto ...	1	400	50	450	850	69 8 0	
Outline map of India, showing the progress of the Imperial Survey up to 1st October 1879.	Ditto ...	1 inch=128 miles	Imperial ...	1	400	.....	400	1,600	163 12 8	
District Maps.									
Map of district Darjeeling ...	.....	1 inch = 4 miles	Double royal	1	...	100	100	100	24 4 9	
Do. of ditto Tipperah and Noakholly, with chalk hills.	.....	Ditto	Imperial ...	4	...	150	150	1,200	59 15 6	
Map of district Seatkot	.....	1 inch = 2 miles	Atlas	2	...	150	150	300	59 15 6	
Total ...	.....	.....	.....	102	5,400	8,937	14,337	24,845	10,004 6 0	
Miscellaneous maps, &c. ...	.....	.....	.....	16	...	.....	2,458	2,708	640 2 2	
Departmental forms	.....	.....	.....	41	...	.....	24,452	31,712	3,769 3 4	
Grand Total ...	.....	.....	.....	159	5,400	8,937	41,247	59,265	20,512 11 6	

Work done for other Departments.

Names of Departments.	Number of maps.	Number of sheets.	Number of sheets coloured.	Number of sheets uncoloured.	Number of copies.	Number of impressions.	Value.
							Rs. A. P.
Foreign Department	13	13	1	12	768	1,138	779 14 9
Military ditto	18	34	5	29	3,690	5,989	1,956 4 0
Home, Revenue and Agricultural Department	5	9	.....	9	1,380	2,160	821 14 4
Telegraph Department	6	6	.....	6	4,188	5,148	519 2 0
Bengal Office	18	18	.....	18	29,828	7,408	808 0 2
Marine Survey Department	8	3	1	2	296	728	214 2 1
Sanitary Commissioner	2	2	1	1	886	2,826	488 13 1
Quartermaster-General	58	58	.....	58	6,794	6,071	503 14 3
Meteorological Reporter to the Government of India ...	9	9	3	6	4,407	5,388	628 8 10
Archæological Survey of India	52	52	.....	52	37,180	19,305	4,498 0 11
Geological Survey of India	2	2	2	.....	1,486	7,831	655 5 4
Miscellaneous drawings	80	80	12	68	28,197	21,024	5,059 5 4
Maps, &c., drawn, but not printed	37	52	11	41	.....	.....	1,418 9 4
Total ...	303	338	86	302	1,19,100	85,016	18,351 14 5

STATEMENT OF WORK DONE BY THE LITHOGRAPHIC BRANCH, SURVEYOR-GENERAL'S OFFICE, BETWEEN THE 1st OCTOBER 1879 AND 30th SEPTEMBER 1880.

Statement of Type Work executed, exclusive of value of Transfers, &c., already included in the cost of the several Lithographic Maps, &c.

Subjects.	Items.	Number of copies.	Number of impressions.	Value. Rs. A. P.
Circular orders	11	1,310	1,310	42 9 0
Memoranda, &c.	475	1,74,026	2,33,511	3,692 9 0
Forms, &c., for Survey Department	46	59,024	1,30,526	2,560 6 0
Transfers of headings, foot-notes, references to published maps, for Photographic Branch.	1,801	19,953	19,953	2,039 4 0
Total ...	2,333	2,54,313	3,85,300	8,334 12 0

General abstract of out-turn and value of work performed.

Subject.	Number of sheets.	Number of copies.	Number of impressions.	Value. Rs. A. P.
Departmental Work.				
General and district maps, &c.	36	5,647	12,955	5,955 11 2
Index maps	11	4,178	7,378	705 2 7
Revenue survey sheet maps, scale 1 inch=1 mile	16	4,512	4,512	4,225 10 1
Miscellaneous maps, &c.	16	2,458	2,708	649 2 2
Departmental forms	41	24,452	31,712	3,769 3 4
Maps drawn, but not printed	39	.....	.....	5,207 14 2
Total ...	159	41,247	59,265	20,512 11 6
Work done for other Departments	338	1,19,100	85,016	18,351 14 5
Total of drawing and printing in Lithographic Department ...	497	1,60,347	1,44,281	38,864 9 11
Work done in Type Department	2,333	2,54,313	3,85,300	8,334 12 0
Total value ...	.....	.....	.....	47,199 5 11

Statement of Expenditure.

	Rs. A. P.
Establishment	34,077 2 8
Contingent charges	4 976 9 1
Total ...	39,053 11 9

Surveyor General's Office,
Lithographic Branch,
Calcutta, 9th November 1880.

R. V. RIDDELL, *Captain*, R.E.,
Assistant Surveyor-General,
In charge Lithographic Branch,
Surveyor General's Office.

Extract from a Report by MAJOR S. H. COWAN, R.E., *Assistant Superintendent, Survey of India Officiating in charge of the Photographic Branch, Surveyor-General's Office—Season* 1879-80.

I HAVE the honour to submit the usual tabular statements showing the amount of work performed in this branch of your office during the past year, from 1st October 1879 to 30th September 1880.

A comparison of the out-turn with that of the previous year is presented in the following table:—

	Ordinary Work.				Cadastral Maps.				Remarks.
	1879-80.	1878-79.	Difference.	Difference in square inches.	1879-80.	1878-79.	Difference.	Difference in square inches.	
Original sections	1,409	1,222	+187	.....	3,673	3,941	−268	.....	
Negatives... ... ... No.	1,928	1,322	+606	.....	2,886	3,401	−515	.....	
Ditto square inches ...	5,91,190	4,73,322	.....	+1,10,868	22,16,448	26,00,432	.....	−3,92,984	
Photoxraph transfer ... No.	1,933	1,180	+753	.....	3,115	3,359	−244	.....	
Ditto square inches ...	5,93,970	4,31,017	.....	+1,64,953	23,92,320	25,76,364	.....	−1,84,044	
Silver prints ... ... No.	1,028	192	+836	.....	.....	.....	.....	.....	
Ditto inches	1,11,004	42,220	.....	+68,844	.....	.....	.....	.....	
Pigment prints ... ... No.	29	245	−216	.....	.....	.....	.....	.....	
Ditto inches	8,452	1,01,092	.....	−92,640	.....	.....	.....	.....	
Platinum prints ... No.	.....	.....	.....	.....	.....	.....	.....	.....	
Ditto inches	.....	.....	.....	.....	.....	.....	.....	.....	
Transfers to zinc	1,313	1,004	+249	.....	3,661	4,162	−401	.....	
Number of pulls	1,25,150	1,12,014	+13,136	.....	1,18,681	1,03,150	+15,531	.....	
Ditto of printed sheets, single.	2,56,670	1,44,912	+1,11,758	.....	1,18,081	1,03,150	+15,531	.....	
Ditto ditto ditto, combined.	2,40,309	1,26,334	+1,13,975	.....	94,031	86,125	+7,906	.....	
Proofs	1,282	3,159	−1,877	.....	3,032	7,529	−3,906	.....	

The increase in the ordinary work is due to the great demand for maps of Afghanistan.

The cadastral work has proceeded regularly throughout the year, at a rate considerably below the full power of the establishment. The supply of originals in the Revenue Office ran low during the cold weather of 1879-80, and the supply was only kept up by receipts of maps surveyed in the same season. But since June 1880, when the Board of Revenue, North-Western Provinces, directed that the system of congregating several small adjoining villages in one sheet should be discontinued and each village published by itself as a separate map, the work of the zincographers has been very heavy. For example, in one batch of eight sheets received from the Revenue Survey Office, there were 50 different villages. These were photographed on eight negatives, from which eight transfers were prepared and put down on zinc. From each plate as many retransfers were pulled as there were villages in the sheet; from each retransfer all the villages but one were cut out, and this one, with its proper title, adjoining village names, and notes, was put down on a zinc plate by itself. Previous to the issue of this order, sheets containing congregated villages were printed as they stood, 25 copies being supplied for each village on the sheet.

The expenditure of the office during the same period (Survey year, 1879-80) has been as follows:—

	Rs. A. P.	Rs. A. P.
Superintendent's salary	10,862 2 1	
Establishment	24,107 4 9	
House-rent and taxes	4,482 13 6	
Contingencies	1,898 10 7	
		41,350 14 11
Chemicals, &c., received from England	4,840 4 4	
Ditto ditto Medical Store Department	57 12 0	
Stores and materials received, other departments	629 3 3	
Paper received from England and Government Stationery Department	3,004 6 10	
Books and periodicals received from England, no invoice ..	.....	
		8,531 10 5
Cadastral Surveys.		
Establishment	21,155 3 0	
Contingencies	4,696 0 0	
		25,851 3 0
Chemicals and stores received from England	20,491 1 6	
Ditto ditto ditto Medical Store Department ...	105 0 0	
Stores and materials from other departments	386 12 6	
Paper received	4,350 12 3	
		25,333 10 3
Total ...	1,01,067 6 7	1,01,067 6 7

The total expenditure for the previous year, 1878-79, was Rs. 1,02,348-14-2.

The necessity, on financial grounds, for the separation of the cadastral expenditure on wages, chemicals, stores, and contingencies from the corresponding expenditure on ordinary office work has long been a great inconvenience. If carried out strictly, it would

have prevented the transfer or loan of labour or materials from the office side to the cadastral or *vice versâ*, unless the smallest item could be brought to account, which was hardly practicable when the work of the two branches was going on side by side in the same rooms. And, further, no charge was made against the cadastral branch for superintendence, house-rent, and some other items, of all of which a large share was fairly debitable to it. Until it could be authoritatively decided what this share should be, it was impossible to draw up a regular scale of charges for work done in the ordinary office branch.

Your proposal to the Government of India, in December 1879, to include the expenditure of the Cadastral Branch in the Survey budget and recover from the different Provincial Governments the value of the cadastral maps supplied to them at the fixed rate (for 1880-81) of Rs. 15 for 25 copies of each photozincographed map and Rs. 10 for 25 copies of each zincographed map, has enabled this office to dispense with separate indents for the chemicals and stores required for the two branches* and to use a fixed scale of charges for work done.

* The establishment bills will still be kept separate.

No changes have been made during the year in the processes regularly used, nor has any new process been introduced. The work of the office is, as before, almost confined to photozincography, the amount of silver prints, pigment prints, carbon prints, collotypes, and platinum prints being comparatively very small. A method of multiplying copies of circulars, rough drawings, &c., invented in Germany and extensively used in England (where it is known as the hektograph, multiscripts, &c., &c.), was tried and found to succeed here, and a quantity of the necessary materials for working it was made up and supplied to officers in Afghanistan.

Statement showing the Value of the Work done for other Departments from 1st October 1879 to 30th September 1880.

Names of Departments.	Number of sections.	Number of negatives.	Number of complete copies.	Number of silver and other prints.	Cost.	Remarks.
					Rs. A. P.	
Government of India, Foreign Department.	6	5	1,500	.....	113 11 0	
Government of India, Military Department.	39	36	1,742	.....	580 10 9	
Government of Punjab, Public Works Department.	2	11	390	.....	340 6 3	
Government of Bengal	2	2	550	.....	98 2 6	
Inspector-General of Military Works	59	131	11,795	.....	4,094 15 6	
Quartermaster-General ...	127	116	8,751	.....	2,950 15 3	
Director of Garrison Instruction ...	2	2	250	.....	76 12 0	
Inspector-General of Ordnance ...	22	5	22,500	.....	635 10 0	
Marine Survey Department ...	20	47	7,830	.....	2,363 15 8	
Port Office	12	26	1,021	.....	906 10 3	
Geological Survey of India ...	1	1	617	.....	49 13 6	
Director-General of Railways ...	1	3	475	.....	151 14 9	
Manager, Rajputana State Railway...	5	1	500	.....	134 2 6	
Engineer in Chief, Western State Railway.	11	11	900	.....	267 0 0	
Executive Engineer, Public Works Department, N. N. State Railway.	12	10	3,600	.....	306 0 0	
Executive Engineer, Architect and Building Department of Public Works.	9	19	390	.....	72 11 5	
Superintending Engineer, West Jumna Canal.	33	33	495	.....	1,086 7 0	
Superintending Engineer, West Sone Circle.	1	4	110	.....	90 0 0	
Chief Engineer, East Indian Railway	1	1	200	.....	60 0 0	
Superintendent, Carriage and Wagon Department, East Indian Railway.	1	4	50	.....	69 2 0	
Executive Engineer, Benares Division	5	4	500	.....	715 4 7	
Ditto, Calcutta Municipality.	17	11	1,050	.....	263 0 9	
United Service Institution ...	13	14	12,610	.....	1,040 14 9	
Asiatic Society	3	2	6,000	.....	237 3 0	
Deputy Commissioner, Amraoti, Berar	1	4	20	.....	105 0 0	
Private Secretary to His Honor the Governor of Bombay.	1	1	100	.....	32 12 0	
Sir Robert Sandeman, K.C.S.I. ...	.....	.....	18	.....	31 1 10	
Captain R. Beavan	.....	.....	10	.....	5 0 0	
Assistant Engineer, Beluchistan ...	.....	.....	2	.....	1 0 0	
F. S. Grouse, Esq., Officiating Deputy Magistrate and Collector.	13	2	3,900	.....	56 15 9	
E. C. Buck, Esq.	.....	.....	.....	700	248 0 0	Silver and platinum.
Superintendent, Government Printing	39	8	106,926	.....	1,404 12 10	
Captain Cole, R.E.	2	6	150	.....	140 0 0	
Principal Thomason College ...	3	6	500	.....	36 10 6	
Inspector-General of Police, Bengal..	1	1	200	.....	55 12 6	
Meteorological Reporter to Government.	1	1	460	.....	43 4 9	
Irrigation Department, Public Works Department, Punjab.	12	24	2,760	.....	1,388 0 6	
Forest Department	39	39	558	.....	960 10 3	
Colonel Tanner	.....	.....	.....	26	52 0 0	Silver.
Total ...	516	591	199,430	726	21,266 8 4	
Cadastral, North-Western Provinces (Photozincographs).	2,160	2,160	58,616	.....	33,126 14 0	
Cadastral, North-Western Provinces (Zincographs).	367	Nil	9,369	.....	3,476 12 0	
Cadastral, Burma (Specimen Photozincograph).	1	1	120	.....	27 13 0	
Cadastral, Bengal (Photozincographs)	941	941	40,463	.....	15,761 12 0	
" " (Zincographs) ...	73	Nil	3,139	.....	857 12 0	
Total Cadastral ...	3,542	3,102	1,11,707	.....	53,250 15 0	
Grand Total ...	4,058	3,693	3,11,137	726	74,517 7 4	

S. H. COWAN, *Major*, R.E.,

Offg. Asst. Surveyor-General, in Charge Photographic Branch, Surveyor-General's Office.

Extract from the Narrative Report of J. B. N. HENNESSY, ESQ., M.A., *Deputy Superintendent, First Grade, in charge Head-quarters Office, Trigonometrical Branch, Dehra Dun, for* 1879-80.

COMPUTING BRANCH.

Calculating Branch.

THE following cost-table of work done in the Computing Branch is similar to the corresponding tables exhibited in the reports for previous years:—

Cost-table in Rupees, 1879-80.

CLASSES.	October.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.	Average per cent.
1. Records, library	63	60	31	42	44	50	190	70	54	38	25	17	2½
2. Computations	177	301	238	234	202	308	319	321	309	474	306	578	16
3. Accounts, returns, correspondence	454	333	208	342	230	201	377	428	380	407	493	433	17
4. Supply	22	33	98	45	68	128	31	32	55	71	101	28	3
5. Press-copy	497	293	350	405	503	708	350	444	411	354	326	288	20
6. Press-proofs	270	283	211	233	231	219	306	312	280	200	313	360	13
7. Charts	16	24	16	32	...	23	12	12	50	32	18	47	1
8. Stations	64	63	29	124	139	28	88	98	126	58	31	81	3½
9. Leave, holiday	196	457	640	396	265	176	203	184	38	163	171	51	12
10. Miscellaneous	323	253	270	167	259	165	245	209	328	208	341	242	12
Total ...	2,081	2,100	2,100	2,100	2,100	2,100	2,100	2,160	2,100	2,125	2,125	2,125	100

Classes 2 and 5 are intimately connected, and are best considered in combination. They indicate a percentage of 36 against 32½ of last year—an increase due chiefly to the wants of officers who, having returned from the frontier, needed help in getting through the calculations of their field results. Otherwise, the average percentages above shown are nearly as usual.

Calculating branch.

The particulars of the work, indicated in a general manner in the preceding table, are given hereafter in such detail as seems desirable.

Class 1, *Records, Library.*—The work under this head shows a small decrease in the average per cent as compared with former years.

Class 2, *Computations.*—

Principal Triangulation (in duplicate).

SOUTHERN TRIGON.—Reduction of quadrilateral figures, computed 2
Ditto simple polygonal figures, computed 6
Ditto compound figures, computed 2
Spherical excesses, computed 35
Principal triangles, corrected 35
Latitudes, longitudes, and azimuths computed (single deductions) ... 28

Secondary Triangulation (in duplicate).

N. W. QUADRILATERAL AND N. E. QUADRILATERAL. (Chiefly Kumaun and Garhwal, and Jodhpore series).
- Traverses, computed 25
- Triangles, ditto or adjusted 550
- Ditto, feet and miles only, computed... ... 80
- Latitudes, longitudes and azimuths, computed or corrected 360
- Auxiliary azimuths, computed... 175

BELUCHISTAN TRIANGULATION.—
- Triangles, computed 360
- Ditto, feet and miles only, computed 150
- Latitudes, longitudes, and azimuths computed 270
- Heights, computed 237
- (Besides, preparing synopsis of results, abstracting angles, horizontal and vertical, &c., &c.)

NOTE—This kept a pair of computerss teadily at work *(without interruption)* for *three* whole months.

OBSERVED LATITUDES.—Reduced North Polar distances of 140 stars from six different catalogues to epoch 1850. Computed results of fourth and fifth visits to Kalianpur, giving values of the latitude of that station by 40 and 30 pairs (respectively) of North and South stars. Computed latitude of Dodagunta from observations by Colonel Lambton, 9 values by North stars and 7 values by South stars.

The work performed under this class cannot be *tabulated* further. It may, however, be added that a few sets of time, latitude, and barometric observations were reduced for officers returned from Afghanistan. Some Actinometric observations taken at head-quarters were reduced. Two new auxiliary tables were computed, xxxiii of 35 pages (mile equivalents in feet and links for ·001 to 10 miles), and xxxiv for finding the subtended angle from an observed vertical to a point not visited. Tables were also computed for incorporation in the volume of electro-longitude work, &c., &c., &c.

Class 4, *Supply.*—Data in manuscript has been supplied to 20 officers. In a few instances this involved considerable time in preparation. Over 800 despatches of forms, maps, charts, books, &c., have been made.

Class 5, *Press Copy* —

N. W. QUADRILATERAL.—SYNOPTICAL VOLUME VII.—Prepared tables of errata, addenda, references and contents.

JODHPORE SERIES.—Compared data for plates; tables illustrative of *final reduction;* in hand, secondary triangles (so far as computed).

EASTERN SIND SERIES.—Prepared (in part) descriptions of stations, abstract of angles, sums of squares and reductions of figures.

S. E. QUADRILATERAL, VOLUME VI.—Prepared some tables which were wanting to complete the set required for illustration of account of final reduction, vocabulary of native terms, contents and errata et addenda.

Synoptical Vol. X.
Ditto „ XIII.

Prepared addendum to descriptions of principal stations; also put together Vizagapatam tidal observations for incorporation in Introduction of volume xiii.

SYNOPTICAL VOLUME XII.—Introduction written.

N. E. QUADRILATERAL, VOLUMES VII AND VIII.—Prepared (in part) table of contents; introduction, including account of final grinding, *partly* done; Introductory accounts of triangulation on Budhon, Rangir, and Amúa series, about three-fourths done; also

EAST CALCUTTA LONGITUDINAL SERIES.—Azimuth and co-ordinate lists prepared.

ASSAM LONGITUDINAL SERIES.—Azimuth and co-ordinate lists compared.

EASTERN FRONTIER SERIES, CALCUTTA MERIDIONAL SERIES.—Co-ordinate lists examined and corrected.

NORTH PARASNATH SERIES; NORTH MALUNCHA SERIES; KARARA SERIES.—Examined generally and re-arranged the co-ordinate lists.

S. W. QUADRILATERAL.—Description of principal stations, Singi series, compiled, and those of *all* the series of this quadrilateral compared. Reduction of figures finished for about the fourth of the quadrilateral which remained undone at time of last report.

SOUTHERN TRIGON.—Reduction of figures compiled for great arc, sections 8 to 12; Bombay, longitudinal; Mangalore, meridional; Madras, longitudinal; South Konkan, Ramnad, longitudinal; and Madras coast series (needs comparison). Abstract of observed angles, sums of squares table, and table showing E. M. S. of observation and graduation prepared for the entire trigon. The two latter subjects need comparison.

OBSERVED LATITUDES.—Completed collection and tabulation as below :—

(1)—Lists of stations arranged alphabetically, chronologically, and latitudinally.

(2)—A preliminary station table, giving name of station, series, latitude, longitude, observer, instrument, date, number of stars observed north and south, number of observations (in general) to each star, and total number of observations.

(3)—Lists of stars observed at each of the 104 stations, furnishing 117 distinct sets of observation.

(4)—List of all stars arranged according to right ascensions in six sub-lists, corresponding to as many catalogues and periods.

(5)—A general compilation of all the 906 stars observed, showing the several catalogues in which they are or are not forthcoming, number of determining measures, and other parts necessary for further progress.

(6)—A general list of all stars arranged according to right ascensions, showing the several stations at which they have been observed, &c., &c.

(7)—A similar list, with argument, North Polar distance, and furnishing in addition the years in which each star was observed, &c., &c.

ELECTRO-LONGITUDE VOLUME.—Seventeen forms for publication of results prepared after discussion, according to instructions received from Lieutenant-Colonel Campbell; some transcription done; and all press copies sent in by Colonel Campbell examined generally before sending to the printer.

MISCELLANEOUS.—Spirit leveled heights No. 1, Bombay Presidency.—Tables of contents and errata prepared (the latter is being extended). No. 2, Bombay Presidency.—Manuscript examined generally, and tables of contents and errata prepared Letter press compiled for preliminary chart of the Beluchistan series. Also letter press examined for preliminary chart of Kelat series, Eastern Frontier series (1877-78), and Burma secondary triangulation (1878-79). Several pages of observed angles have been abstracted for the Eastern Frontier series, south of 23°.

Class 6, *Press Proofs*.—This class is not susceptible of explanatory remarks. It has cost during this year rather less than the average percentage as compared with that of former years.

Class 7, *Charts*.—Examined or compared—

Final	Reduction chart of the N. E. quadrilateral. Budhon meridional series. Rangir ditto ditto. Karara. Chendwar.
Preliminary ...	Kelat series, season 1879-80. Eastern Frontier series, season 1877-78. Madras Coast series, season 1878-79. Index chart of secondary triangulation in British Burma (for office use). Rough chart of southern trigon (for office use).

In addition, examined plates showing the figures of the Brahmaputra series (for illustrating professional volume of N. E. quadrilateral), skeleton chart of principal triangulation (for illustrating professional volume vi); also examined generally, chart illustrating pamphlet of spirit levels No. 2, Bombay Presidency.

Class 8, *Stations*.—Of additional duplicate lists one has been completed, making a total of 337 districts accounting for 3.197 stations, and four supplementary lists descriptive of 24 stations have been issued to district officials.

Class 10, *Miscellaneous*.—Cause of discrepancy between values of spirit-leveled points about Hubli, as obtained by operations southwards from Bombay, and northwards from Bangalore, examined into and reported on. Pages of several hundred pamphlets of spirit levels arranged preparatory to stitching. Distribution list for synoptical volumes carefully prepared. Adie's new standard barometer compared and examined, with the object of eliciting the causes of large fluctuations in the corrections due thereto, especially between morning and evening observations. New range (1 to 500 yards) for the Mussoorie Volunteer Rifles, measured. Quarterly list of maps and charts published at Dehra furnished to Surveyor-General's Office at Calcutta; and three sets of pages printed at Dehra regularly forwarded to the same office for safe custody. Help afforded to various officers going to, or returning from, the Frontier. 49 sets of time observations to the sun, taken and reduced. Meteorological observations taken at Dehra twice daily on every day of the year, and at Mussoorie for six months; the results for Dehra supplied to the Meteorological Reporter to the Government, North Western Provinces, and daily weather telegrams for Mussoorie as well as the anemograms for both Dehra and Mussoorie supplied to the Meteorological Reporter to the Government of India.

TYPOGRAPHIC BRANCH.

The work annually performed by this branch during the past five years is briefly given in the following table, where the unit (a page of foolscap) is the same throughout.

	1875-76.	1876-77.	1877-78.	1878-79.	1879-80.
Pages composed	1,179*	1,535	2,050	1,844	1,421
,, printed	349,000	495,673	630,894	590,043	494,136

* Averages for a twelve-month.

An analysis of the pages composed, furnishes the following—

	Pages.		Pages.
For volume V ...	... 129	For Synoptical volume VII ...	... 21
,, ,, VI ...	... 279	Ditto volumes of N. E. Q.	... 217
,, volumes VII and VIII ...	... 36	Ditto of S. E. Q.	... 8
,, ,, of S. W. Q. ...	... 250		246
,, ,, of electro-longitude	... 46	For pamphlets of spirit-leveled heights	... 76
	740	For auxiliary and other working tables	... 55
		Charts, orders, memoranda, &c.	... 304

Total ... 1,421 pages.

Photo-zincographing Branch.

The following are details of the work executed by this Branch:—

MAPS.

SUBJECT.	When published.	Number of parts.	Number of sheets printed.
Prints of maps published in former years	.....	83	4,945
Guzerat survey, sheet No. 28, section North-Western	October 1879 ...	1	17
Guzerat survey, sheet No. 28, section South-Western ... ... (*For Irrigation Department, Bombay*)	,, ,, ...	1	18
Guzerat survey, sheet No. 6, in four sections	,, ,, ...	4	132
Tirah and the neighbouring country	,, ,, ...	2	307
Kumaun and Garhwal *forest* map, sheet No. XXXIV *(for Forest Department)*	,, ,, ...	1	58
Parts of Arabia and Persia, sheets 1, 2, 3 *(for Colonel Ross, Political Resident, Persian Gulf)*	,, ,, ...	3	52
Plan of the country around Moré *(Plate VIII of Vol. V of the Account of the Operations, &c.)*	November ,, ...	1	364
View of Moré Plain *(Plate IX of the Account of the Operations, &c.)*	,, ,, ...	1	444
Eye-sketch of the Route-march from Patta Kissar Ferry to Herat	,, ,, ...	1	52
Hundes or Narikhorsum and Monyul	,, ,, ...	2	252
Parts of Arabia and Persia, sheets 4, 6, 7 *(for Colonel Ross, Political Resident, Persian Gulf)*	,, ,, ...	3	54
Dehra Dun and Siwaliks (1-inch scale), sheet No. 1	,, ,, ...	1	179
Index to Cutch survey	,, ,, ...	1	424
Dehra Dun and Siwaliks (1-inch scale), sheet No. 2	December ,, ...	1	211
Ditto ditto (ditto), ditto 3	,, ,, ...	1	214
Index to Guzerat survey	,, ,, ...	1	462
Do. to Kattywar ditto	,, ,, ...	1	480
Plan of Government Botanical Gardens, Saharunpore (for Superintendent of the Garden)	,, ,, ...	1	107
Guzerat survey, sheet No. 6	,, ,, ...	1	171
Map of Explorations in Sikkim and Great Tibet, by Explorer L. (1875-76)	,, ,, ...	1	446
Guzerat survey, sheet No. 29, section 1	,, ,, ...	1	88
Sketch Map of the Darjeeling Division, Bengal, *(for Forest Department)*	,, ,, ...	1	387
Guzerat survey, sheet No. 7	January 1880 ...	1	180
Parts of Arabia and Persia, sheets 8, 10, 11, 12, *(for Colonel Ross, Political Resident, Persian Gulf)*	,, ,, ...	4	66
Dehra Dun Municipality and Cantonment	,, ,, ...	2	319
Kattywar survey, sheet No. 60	,, ,, ...	1	134
Ditto do. ,, 51	,, ,, ...	1	137
Gilghit and surrounding country	February ,, ...	1	137
Kattywar survey, sheet, No. 41	,, ,, ...	1	135
Ditto do. ,, 52	,, ,, ...	1	130
Guzerat survey, do. ,, 7, section N. W.	,, ,, ...	1	33
Route-map from Herat to Obe through Rousebagh and Kurukh	March ,, ...	2	54
Guzerat survey, sheet No. 49, section 1	,, ,, ...	1	84
Ditto do. do. 9	,, ,, ...	1	86
Ditto do. No. 7, do. S. E.	,, ,, ...	1	34
Ditto do. do. S. W.	,, ,, ...	1	33
Kumaun and Garhwal *forest* map, sheet No. LIII *(for Forest Department)*	,, ,, ...	1	56
Guzerat survey, sheet No. 7, section 1	April ,, ,,	1	87
Ditto do. ,, 7, do. 2	,, ,, ...	1	87
Ditto do. ,, 7, do. 3	,, ,, ...	1	85
Ditto do. ,, 7, do. N. E. *(for Bombay Irrigation Department)*	,, ,, ...	1	35
Sketch Map of territory between Cabul and the Mustagh Pass *(for Major Biddulph)*	,, ,, ...	1	303
Guzerat survey, sheet No. 6, section 2	,, ,, ...	1	86
Ditto do. ,, 27	,, ,, ...	1	180
Kumaun and Garhwal *forest* map, sheet No. XVII *(for Forest Department)*	May ,, ...	1	65
Ditto ditto ditto No. XXXV *(for ditto)*	,, ,, ...	1	66
Ditto ditto ditto ,, XLI *(for ditto)*	,, ,, ...	1	70
Guzerat survey, sheet No. 25	,, ,, ...	1	190
Ditto do. ,, 49, section 11	,, ,, ...	1	90
Ditto do. ,, 49, do. 12	,, ,, ...	1	80
Turkestan map, sheet No. 2 (reduced to half scale)	,, ,, ...	1	7
Kumaun and Garhwal *forest* map, sheet No. XXIII *(for Forest Department)*	June ,, ...	1	67
Kumaun and Garhwal *forest* map, sheet No. XXXIX *(for ditto)*	,, ,, ...	1	66
Ditto ditto ditto No. XL *(for ditto)*	,, ,, ...	1	67

MAPS—*continued.*

Subject.	When published.	Number of parts.	Number of sheets printed.
Kattywar survey, sheet No. 53	June 1880 ...	1	136
Guzerat do. do. ,, 27, section N. E. *(for Irrigation Department, Bombay)*	,, ,, ...	1	20
Turkestan map, sheets Nos. 1 and 2 [tin-foil retransfers] ...	,, ,, ...	2	4
Guzerat survey, sheet No. 27, section North-Western	July ,, ...	1	20
Guzerat survey, sheet No. 27, section South-Eastern ... ... *(For Irrigation Department, Bombay)*	,, ,, ...	1	17
Guzerat survey, sheet No. 27, section South-Western	,, ,, ...	1	19
Guzerat survey, sheet No. 6, section 1	,, ,, ...	1	88
Ditto do. ,, 7, do. 4	,, ,, ...	1	85
Ditto do. ,, 27, do. 1	,, ,, ...	1	95
Ditto do. ,, 27, do. 2	,, ,, ...	1	85
Ditto do. ,, 27, do. 3	,, ,, ...	1	117
Ditto do. ,, 27, do. 4	,, ,, ...	1	87
Sketch Map to illustrate progress of recent surveys beyond the Sind Frontier	,, ,, ...	1	58
Kattywar survey, sheet No. 39	,, ,, ...	1	89
Reconnaissance of the Tarnak and Khushki Rud Valleys, from Shahjui to Kandahar	August ,, ...	1	240
Map of Sibi and the Lower Bolan	,, ,, ...	1	116
The Tarnak and Ghazni Valleys, from Shahjui to Ghazni ...	,, ,, ...	1	244
Sketch Map of Ghazni and the surrounding country ...	,, ,, ...	1	227
Kumaun and Garhwal *forest* map, sheet No. LII *(for Forest Department)*	September ,, ...	1	70
Guzerat survey, sheet No. 26	,, ,, ...	1	158
Cutch and the Runn	,, ,, ...	1	12
Total ...	.....	173	15,100

Besides the foregoing, 588 blue prints, and 1,021 silver prints (433 subjects) were prepared for the use of the Engravers and for Executive Officers.

CHARTS.

Subject.	When published.	No. of parts.	No. of copies printed.
Gora Meridional series ... ... Final	Dec. 1879 ..	1	375
Eastern Frontier series, season 1877-78 ... Preliminary	Jan. 1880 ...	1	67
Thyetmyo *viâ* Prome, &c., to Cape Negrais (secondary) season 1878-79 ... ... ,,	,, ,, ...	1	61
Trans-Indus Triangulation (portion of) by Lieutenant J. T. Walker, R.E. ... ... Rough	,, ,, ...	1	22
North Maluncha Meridional series ... ... Final	Feb. ,, ...	1	370
Amúa Meridional series ... ... ,,	,, ,, ...	1	345
Madras Coast series, season 1878-79 ... ... Preliminary	,, ,, ...	1	65
Kumaun and Garhwal Triangulation, 1864-78 ... Rough	,, ,, ...	2	69
Ditto ditto, 1871-72 ... ,,	March ,, ...	1	33
Budhon Meridional series ... ... Final	,, ,, ...	1	340
Triangulation in Northern Afghanistan ... Rough	May ,, ...	1	55
Chart illustrating Pamphlet of Spirit-leveled Heights, No. 2, Bombay Presidency	June ,, ...	1	505
Chart showing Chains of Principal Triangulation west of 92° ...	,, ,, ...	1	332
Reduction chart of the South Maluncha Meridional series, Final	July ,, ...	1	381
Ditto ditto Párasnath ditto ,,	,, ,, ...	1	417
Rangir Meridional series ... ... ,,	August ,, ...	1	384
Total ...	.....	17	3,821

DIAGRAMS.

Subject.	When published.	No. of copies printed.
Polygons and other figures to illustrate figural reductions for volumes of the Great Trigonometrical Survey, Bench-marks, &c.	Nov. 1879...	588
	March 1880...	8
	May ,, ...	14
	June ,, ...	20
	August ,, ...	684
	Sept. ,, ...	957
		2,271
Professional and Office Forms	1879-80...	17,230
Labels for packing synoptical volumes, Great Trigonometrical Survey ...	.....	679

The total number of negatives taken is 909, the number of chromo-carbon prints, 1,070, and the number of transfers to zinc, 196.

Contrasting the work performed since 1875-76 we have :-

Year.	Maps.	Blue-prints.	Silver-prints.	Charts.	Diagrams.	Forms, &c.
1875-76	14,025	12	126	1,678	9,722	18,314
1876-77	12,348	108	189	9,225	3,956	21,384
1877-78	12,481	195	426	4,531	4,877	23,736
1878-79	20,229	1,394	353	2,642	2,603	20,070
1879-80	15,100	588	1,021	3,821	2,271	17,909

An abstract of the work executed during the past five years stands thus :—

Subject.	Number of Prints.				
	1875-76.	1876-77.	1877-78.	1878-79.	1879-80.
Maps, charts, and diagrams	25,425	25,529	21,889	25,474	21,192
Blue-prints	12	108	195	1,394	588
Silver-prints	126	189	426	353	1,021
Forms, &c.	18,314	21,384	23,736	20,070	17,909

The decrease in the total number of maps, as compared with the total for the previous year, is due to the circumstance that the latter total included no less than 8,568 copies of Afghanistan and Turkestan maps, while in 1879-80 the number of copies of these maps printed, was below 500.

Drawing Branch.

16. The work performed in this Branch is as follows :—

Description of Work.	No. of Sheets or Diagrams.		Scale one inch = miles.	Remarks.
	Finished.	In hand.		
Final Charts.				
Rangir Meridional series	1	.....	4	For reduction by photo-zincography.
Budhon ditto	1	.....	4	
Gurwáni ditto	1	.....	4	
Karára ditto	1	.....	4	
Huriláong ditto	.....	1	4	
Chendwar ditto	1	.....	4	
Calcutta ditto	1	.....	4	
Reduction chart of the South Párasnáth series	1	.....	4	
Ditto of the South Malúncha series	1	.....	4	
Ditto of the North-East Quadrilateral ...	1	.....	16	
Ditto of the Jodhpur Meridional series ...	1	.....	4	
Skeleton chart of principal chains of triangulations west of Meridian of 92°	1	.....	96	
Preliminary Numerical Charts				
Beluchistan series, season 1877-79	.....	1	4	For reproduction on full scale by photo-zincography.
Kelat ditto 1879-80	1	.....	4	
Kandahar ditto 1878-79	1	.....	4	
Compilation.				
Spirit-leveled heights, sheets 75, 80, and 82	.....	3	2	For photo-zincography.
Parts of Arabia and Persia for Colonel E. C Ross, Political Resident, Persian Gulf, in extension of his map ...	2	.....	12	
Map of the Kuram and Khost Vallevs surveyed in 1879 by Major Woodthorpe, R.E., and Captain Martin, S.C ...	1	.....	4	
Preliminary maps of parts of Afghanistan, sheets 1, 2, and 3, for Captain C. Strahan, &c.	3	.....	1	
Proliminary map of part of Afghanistan for Captain C. Strahan, &c.	1	.....	4	
Sketch Map of territory between Kabul and the Mustagh Pass, for Major Biddulph	1	.....	16	
Language Map of countries between Kabul and Leh, for ditto.	1	.....	32	
Turkestan Map, sheets Nos. 3 and 4 (5th edition) ...	2	.....	32	

Description of Work.	No. of Sheets or Diagrams. Finished.	In hand.	Scale one inch = miles.	Remarks.
Compilation—*concluded*.				
Atlas reductions of sheets 1 and 2, Kumaun and Garhwal survey.	2	2	Atlas scale.	For incorporation in atlas sheets.
Atlas reductions of sheets 1, 2, and 3, Dehra Dun and Siwaliks survey.	1			
	Sections.	Sections	Miles.	
Levels in the Sindh Sagar Doab, Derajat Circle	12	4	2	For level sheets.
Map of Sibi and the Lower Bolan, by Major Beavan ...	1	.....	2	For photo-zincography.
Sketch Map to illustrate recent survey operations beyond the Sind Frontier	1	.....	16	For photo-zincography.
Miscellaneous.				
Prepared a trace of "The Mullah's" map of explorations for the Foreign Office	1	.....	8	To accompany Narrative.
Prepared rough chart of the Southern Trigon	1	.....	12	
Drew "The Mullah's" route-map to illustrate his report ...	... ..	1	8	Suspended.
Completed Colonel Tanner's Map of country round Gilghit ...	1	.....	4	For photo-zincography
			Versts.	
Prepared tracings of map of route from Obe to Herat ...	2	.....	2	Ditto.
			Miles.	
Revised, corrected, and enlarged route-map of Western Himalayas, Punjab, &c....	.....	1	32	For engravers.
Prepared forms, professional and others	16	.....	.....	For photo-zincography.
Prepared rough charts of the following :— (1)—Colonel Tanner's and Captain C. Strahan's points in Afghanistan. (2)—Quetta triangulation. (3)—Rays to Peaks, Lieutenant Walker's triangulation (Trans-frontier.) (4)—Khanpisura series. (5)—Eastern Sind series (approximate)				
Prepared rough charts for Major Leach, Captain Holdich, and Colonel Tanner	... ..	.....	.....	
Drew rough map of explorations by "The Mullah," "Havildar" and other explorers	1	.....	8	For silver prints.
Prepared tracings of the Bari Doab and Rechna Doab Canals, sheets	.....	.....	.....	For level sheets.
Prepared descriptions and diagrams of bench-marks of above-named canals, and of the bench-marks of the Sind Sagar Doab Canals	.....	.....	.....	
Prepared tracing of contoured map of Bannu Valley and Index Map of leveling operations of Sind Sagar Doab ...	.....	.....	.....	
Inserted boundaries in charts of the following triangulations :— (1) Assam Valley ; (2) North-Eastern Longitudinal series ; (3) Eastern Calcutta Longitudinal series.				
Examined, corrected, and passed for the press, original maps of topographical surveys	36	.....	Various scales...	For photo-zincography.
Examined and passed for the press, proofs of maps and charts Coloured, 8,838 maps. In hand, the new list of maps and charts in Drawing Office.	254	.....	Ditto.	

In addition to the foregoing, considerable help was afforded to Captain Holdich and Major Woodthorpe in shading the fair sheets of their surveys, and in sorting and despatching various maps (originals, prints, &c.) that had accumulated at Mussoorie from the collections brought in by Frontier Officers; besides other miscellaneous duties required chiefly in connection with the war in Afghanistan.

Correspondence and Stores.

The year's correspondence is represented by about 1,300 letters and some 600 office Memos. &c. The wants of Trans-frontier Officers were necessarily large. In all, of instruments 175 were despatched, and 298 received; of stores, 11 articles despatched and 23 received; presenting a total of 56 packages, and 47 parcels despatched, and of 116 packages and 198 parcels received.

Solar Photography.

As mentioned in last report the solar photography work was suddenly interrupted by the death of the photographer, Mr. M. Meins. The work was resumed, under orders from the Secretary of State, by Mr. L. H. Clarke, Surveyor, 2nd grade, after sufficient training,

on 17th December 1879. The period under review comprises 289 days, of which the working facts will be found in the following table.

1879-80.	Number of Days.				Number of Negatives.						Number of Days when Solar Phenomena were	
	Negatives taken.	Failures.		Total.	Runs.	Solar Phenomena.					Visible.	Absent.
		Bad weather.	Various causes.			Spots and faculæ.	Spots only.	Faculæ only.	None.	Total.		
December	8	6	1	15	7	.....	9	.....	6	22	5	10
January	25	6	.....	31	23	14	17	6	9	69	19	12
February	21	7	1	29	15	18	9	1	7	50	17	12
March	28	.....	3	31	21	34	9	2	8	74	23	8
April	29	1	.....	30	24	13	18	3	17	75	18	12
May	28	3	.....	31	21	22	10	6	4	71	26	5
June	24	6	.....	30	18	11	28	2	.....	59	24	6
July	18	13	.....	31	13	3	9	2	9	36	11	20
August	20	5	.....	31	17	18	22	.....	6	63	23	8
September	25	5	.....	30	18	8	34	.....	.....	60	25	5
Total ...	232	52	5	289	179	141	171	22	66	570	191	98

Total number of silver prints—1,346.

From above, and from facts of preceding reports, may be gathered—

With regard to bad weather, when the sun was invisible throughout the day, the percentages are—

1877-78 ... ... 9 in 100 days, obtained from 273 days.
1878-79 ... ... 11 ditto ditto 89 ,,
1879-80 ... ... 14 ditto ditto 289 ,,

The last is reckoned on the complete year of 365 days, because when the work was in abeyance in October and November bad weather very rarely occurs.

Again, as regards visible solar phenomena, we have—

1877-78 ... ... Phenomena visible on 27 in 100 days obtained from 273 days.
1878-79 ... ... 25 ditto ditto 89 ,,
1879-80 ... ... 66 ditto ditto 289 ,,

from which the increase in so called "solar activity," as measured by number of days, when features were visible, is obvious. In all, Mr. Clarke took 579 negatives including runs, and prepared 1,346 silver prints; the weekly despatch of these to the India Office was made with the usual punctuality.

Mean Velocity in miles of the winds which blew at Dehra Dun during twelve months of 1879-80 *for each hour of the day.*

Civil Hours.	October.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.
0 to 1	1·61	1·62	1·43	1·55	1·62	1·50	2·13	·77	·80	·03	·13	·12
1 „ 2	1·06	1·10	1·29	1·45	1·31	1·83	1·50	·74	·77	·00	·13	·12
2 „ 3	1·10	·72	1·04	1·39	1·24	1·23	1·00	·71	·77	·00	·13	·28
3 „ 4	1·03	·66	·61	·97	·97	1·00	·70	·39	·30	·03	·03	·08
4 „ 5	·70	·41	·68	1·10	1·14	·73	·73	·19	·27	·10	·00	·20
5 „ 6	·60	·62	·32	·68	·90	·73	·70	·23	·20	·06	·03	·20
6 „ 7	·40	·45	·61	·87	·59	·73	·47	·42	·23	·23	·00	·08
7 „ 8	·20	·31	·50	·59	·59	·47	·57	·32	·53	·13	·10	·00
8 „ 9	·43	·18	·32	·42	1·34	·37	·70	·39	·73	·13	·10	·16
9 „ 10	·63	·54	·48	·61	1·17	1·07	1·47	·77	1·10	·42	·32	·66
10 „ 11	1·07	·96	1·03	1·23	1·59	1·97	1·67	1·97	1·63	·39	·29	·56
11 „ 12	1·43	1·36	1·31	1·35	2·10	2·03	2·47	1·97	1·77	·68	·35	·60
12 „ 13	1·71	1·52	1·64	1·68	2·14	2·27	2·83	1·94	1·70	·68	·52	·83
13 „ 14	1·52	1·62	1·79	1·58	2·34	2·17	2·93	1·94	1·77	·74	·48	·83
14 „ 15	1·42	1·55	1·86	1·74	2·41	2·37	3·23	3·00	2·07	·94	·81	·58
15 „ 16	·90	·93	1·54	1·52	3·24	2·70	3·63	2·97	2·57	·61	·42	·75
16 „ 17	·19	·10	·46	·87	1·79	1·53	2·33	2·58	2·33	·32	·42	·42
17 „ 18	·39	·24	·25	·32	1·45	·57	1·00	2·61	1·67	·19	·42	·21
18 „ 19	1·39	1·03	·64	·48	·93	·07	·60	2·13	·47	·19	·16	·17
19 „ 20	1·90	2·07	1·50	1·06	1·17	·57	1·13	1·74	·33	·13	·19	·21
20 „ 21	1·84	2·41	1·89	1·71	1·21	1·73	1·87	2·03	·37	·13	·42	·21
21 „ 22	2·19	2·10	1·93	1 52	·93	2·40	1·90	2·10	·53	·00	·32	·17
22 „ 23	2·19	2·31	1·54	1·65	1·45	2·17	2·17	1·35	·43	·00	·13	·13
23 „ 24	1·77	1·90	1·57	1·42	1·45	1·80	1·93	1·16	·77	·06	·13	·25
Sums ...	27·67	26 71	26·23	27·75	36·07	34·01	39·56	34·42	24·11	6·19	6·03	7·72
Average ...	1·15	1·11	1·09	1·16	1·46	1·42	1·65	1·43	1·00	0·26	0·25	0·32

Monthly Meteorological results taken from the Register kept at the Head-quarter's Office, Trigonometrical Branch, Survey of India, Dehra Dun.

Year and Month.	Barometer.						Hygrometer.				Thermometer.								Rain.		Wind.	Cloud.	
	At 9-30 A. M.			At 3-30 P. M.			At 9-30 A. M.		At 3-30 P. M.		Dry Bulb.				Wet Bulb.								
	Highest.	Lowest.	Monthly Mean.	Highest.	Lowest.	Monthly Mean.	Monthly mean temperature of dew point.	Monthly mean humidity.	Monthly mean temperature of dew point.	Monthly mean humidity.	Maximum in sun's rays.	Minimum on grass.	Maximum in air.	Minimum in air.	Monthly mean in air.	Maximum wet.	Minimum wet.	Monthly mean wet.	Number of days it fell.	Fall in inches.	Most frequent direction.	At 9-30 A. M.	At 3-30 P. M.
1879.																							
October ...	27·831	27·567	27·697	27·735	27·468	27·608	61·5	·680	63·2	·565	103·5	43·6	86·5	52·9	71·5	77·5	46·0	63·5	4	·52	N.	1	2
November ...	·873	·675	·783	·790	·595	·702	47·4	·699	47·9	·432	93·0	31·4	78·2	40·0	61·4	65·2	36·7	52·5	....	.....	S.W.	...	1
December ...	·904	·681	·797	·804	·584	·710	41·1	·618	41·2	·431	85·2	29·2	72·0	36·9	55·0	59·0	33·5	47·3	2	·66	S.S.W.	2	2
1880.																							
January ...	·928	·594	·742	·848	·527	·664	46·2	·730	47·2	·493	90·5	31·5	76·1	35·2	56·5	70·2	36·7	50·3	3	1·67	S.S.W.	2	3
February ...	·852	·435	·713	·763	·455	·640	47·7	·743	48·8	·565	86·7	29·0	75·5	35 0	56·9	62·4	33·9	50·2	8	3·90	S.S.W.	5	6
March ...	·821	·472	·658	·729	·379	·558	55·6	·548	57·1	·409	106·8	42·0	91·8	48·8	71·4	74·3	44·9	60 0	...	.....	S.S.W.	1	2
April ...	·707	·463	·582	·591	·384	·483	55·2	·396	51 4	·266	115·4	51·9	98·2	60·2	80·0	75·5	48·8	63·7	3	·31	S.W.	2	3
May ...	·643	·405	·510	·547	·280	·413	61·5	·453	61·4	·407	118·7	56·1	101·0	60·8	81·7	81·0	54·4	67·4	8	2·47	S.S.W.	2	5
June ...	512	·218	·362	·428	·154	·282	70·1	·597	68·1	·501	121·7	62·7	106·4	68·1	86·7	87·2	54·0	73·5	12	9·10	W.	5	6
July ...	·494	·289	·397	·433	·238	·337	74·7	·862	76·3	·841	109·6	68·0	90·0	70·5	79·1	81·4	66 5	74·6	26	33·34	S.E.	6	9
August ...	·569	·371	·452	·470	·295	·377	73·6	·778	75·1	·708	110·8	66·3	91·0	68·9	80·3	80·6	65·5	74·4	17	16·97	S.W.	5	6
September ...	·763	·440	·581	·633	·350	·494	70·7	·775	71·9	·727	108·3	61·6	90·5	65·0	77·4	79·1	62·3	71·7	12	13·44	N N.W.	4	6

Note.—The height of the Barometer cistern above mean sea-level at Karachi is 2232·41 feet.

Reg. No. 12216J - 350 - 26 3-81.

Extract from the Proceedings of the Government of India, Home, Revenue and Agricultural Department (Surveys),—No. , dated Simla, the May 1881.

READ—

General Report on the Operations of the Survey of India during the year 1879-80, submitted with the Surveyor General's letter No. 908, dated 2nd April 1881.

RESOLUTION.—The third report of the amalgamated Department of the Survey of India deals, as usual, with the surveys in process of execution by the Trigonometrical, Topographical, and Cadastral Survey parties, with geographical and miscellaneous operations, and with the work of the head-quarter offices at Calcutta and Dehra Dún.

2. The Surveyor General reports that, in respect to Peninsular India, the principal triangulation of the whole country may now be regarded as fully completed. In Northern India the small chain of triangles which has yet to be executed will probably be finished within a few months. During the year three parties were employed on principal and one on secondary triangulation. Colonel Branfill, whose skill and energy in the conduct of the modern operations in Southern India are commended in the Report, brought the work of the Madras coast party to a close. After an interval of nearly a century, a regular series of triangles has thus been now laid down between Madras and Cape Comorin; and a branch series has been extended to connect the Survey of India with that of Ceylon. Colonel Branfill's party also executed some secondary triangulation, fixing the positions of the light-houses at Pondicherry and Negapatam, and linking a chain of triangles extending northwards to Ponáni with one brought down from the Mangalore longitudinal series of 1873-74. In Eastern Sind, under the orders of Captain Rogers, an area of 1,278 square miles was covered by principal triangulation; the chain of secondary triangles between Khelat and Quetta was finished; and a work of much immediate practical value, that of reducing the operations and preparing the charts of the triangulation between Jacobabad, Quetta, Khelat, Kandahar, and in the Khakrez valley was carried on by Mr. Hennessey. The Eastern Frontier party was occupied in Siamese territory in the neighbourhood of Bankok. Its progress was somewhat impeded by sickness and other difficulties; but Captain Hill cordially acknowledges the assistance which he received from the Siamese Government and the British Consul. To this party belonged the late Mr. H. Beverley, whose services had been assiduous and successful, and whose death, at a comparatively early age, is much regretted. In British Burma an inconsiderable amount of secondary triangulation was effected around and to the north of Bassein. The triangulation between Rangoon and the main-land opposite the Krishna shoal was abandoned; and, instead of it, a traverse was executed forming one of the main circuits on which the cadastral survey of the Hanthawaddy district will be based.

3. Topographical surveys were in progress in Mysore, the Deccan, Khandesh, Guzerat, Kattywar and Cutch, Rajputana and Central India, in the Muzaffarnagar and Meerut districts of the North-Western Provinces, and in the Sylhet district of Assam. Eleven parties in all were engaged upon these operations, as in the preceding year. The Mysore party was to a great extent employed in mapping the Mysore and Kanara Frontier for the use of the Boundary Commission; 1,911 square miles of detailed topography were executed in the Malnad forests; and 188 square miles in the vicinity of Bangalore. The smallness of the outturn is explained by sickness and the exceptional character of the country. The total area surveyed by the party up to the end of last field season amounts to 9,316 square miles, chiefly in the Nundydroog division. About two-thirds of the State, or 18,000 square miles, remain to be surveyed in detail, of which the greater part has been covered by preliminary triangulation in advance. Of the two Deccan parties, one in the south accomplished an outturn of 2,028 square miles of topography, principally around Sholápur, but including also a small portion of the Konkan south-west of Mahábaleshvar. Large scale maps of the city and cantonment of Satára were also completed. Further northwards, in the part of the Konkan prepared by preliminary triangulation during

the preceding season, the topographical survey was commenced by the second party in a hilly country covered with dense jungle. Eleven hundred and fifty square miles were also surveyed in the Deccan above the Ghats. The Khandesh party, in addition to some triangulation and traversing, completed the detail of a tract to the west and north-west of Dhulia in the Khandesh district, including the upper basin of the Pánjhra valley. The work of the Guzerat party is published on various scales—1-inch, 2-inch, and 4-inch respectively. Ordinary topography was in progress in the Ahmedabad, Broach, and Surat Collectorates, and in the Baroda, Mahi Kánta, Rewa Kánta and Sachin States. The 4-inch forest survey of the Dangs was continued. The outturn of topography executed by this party was somewhat diminished by causes similar to those which impeded the party in Mysore. With the completion of the district of Okhámandal, at the western extremity of the Kattywar peninsula, the general survey of that province came to an end. The question whether it is necessary to fill in the breaks in the boundaries of the taluks or sub-divisions of the several Native States, can, if still undecided, be determined by the Government of Bombay. In Cutch 1,639 square miles were finally surveyed on the 2-inch scale for reduction to the 1-inch scale on publication. The topographical delineation of Rajputana proceeds rapidly, as a desert country offers few obstacles to the surveyor; and an area of 6,928 square miles was mapped in the Bikaneer State. The Rajputana party, in addition to its topographical work, produced a map, on the 12-inch scale, of the city of Bikaneer, and made progress with the 24-inch surveys of the Solon and Dagshai cantonments in the Simla hills. The operations of the Gwalior and Central India party were not carried on within the territory indicated by its name. It was employed, during the season under notice, in the south of the Rajput State of Oodeypore, and in a tract to the east of the Lúni river, near Sindri, within the State of Jodhpore. The outturn was small, but the country was difficult; a great part of it resembling, in the words of Major Steel, "a petrified stormy sea." The area topographically surveyed in detail by the Malwa party in the Jhábua State of Central India was also partly and for similar reasons less than might have been expected. Its operations included a map on the 6-inch scale of the city and environs of Dhár in the Native State of that name. In the Meerut division of the North-Western Provinces, where a 2-inch topographical survey of the districts between the Ganges and the Jumna is gradually progressing from north to south, the work in the Muzaffarnaggar district was brought to a close; whilst an area of about 400 square miles was mapped in the north of the Meerut district. The objects of Major Badgley's party in the Sylhet district of Assam are of a rather special character. Waste lands, which have been or may be taken up for tea cultivation, are being mapped, and a forest survey is being carried on in the south-east corner of the district. The party effected little, having been hampered by want of carriage and compelled, by heavy rain and floods, to leave the field at an unusually early date. The season, moreover, was unhealthy; and the work lay amongst dense forests, or in swampy ground. Looking to general results throughout the country, it is observed that, notwithstanding the serious difficulties which, in several instances, hindered or restricted the operations, the total outturn of topography does not compare very unfavourably with that of the previous year, as will be apparent from the following figures:—

Area surveyed topographically in square miles.

Scale.	1878-79.	1879-80.	Increase or decrease.
½-inch	5,424	7,138	+1,714
1-inch	8,778	4,794	—3,984
2-inch	9,179	9,664	+185
4-inch	218	117	—101
Total ...	23,599	21,713	—1,886

There is thus a net decrease of 1,886 square miles. The most considerable diminution is in the outturn of area surveyed on the 1-inch scale; and this is

due to the decreased amount of work executed by the Gwalior and Central India, Malwa, and Mysore parties. In each of these cases an explanation of the circumstances which retarded progress has been given in the Report of the Surveyor General.

4. The village or mauzawar surveys on the 4-inch scale were much less extensive than in the preceding year, owing to the break-up of the party which, after the completion of the Sirsa district, had been destined for, and had actually begun work in, Jhelum. The outturn of the year was 2,118* square miles, as against 4,491 in 1878-79; and nearly the whole of this area lay in the Punjab. In point of fact, the village revenue survey of the old type, which was the usual concomitant or precursor of settlement operations before the work of detailed field measurement was made over, as is now generally the case, to professional surveyors, was restricted to the single district of Dera Ismail Khan. A fair outturn was obtained in the Bhakkar tahsil of this district, amounting to 1,334 square miles of the cis-Indus *Thal*, a tract forming part of the generally barren and sandy grazing grounds which constitute the great triangular expanse between the Indus and the Jhelum. The party has yet to execute the survey of about 3,800 square miles in the *Thal* of Dera Ismail Khan and Muzaffargarh. The 4-inch forest survey of the Murree and Kahuta tahsils in the Ráwalpindi district was completed; some forest reserves were mapped in the plains; and some preliminary work was effected in the Kala Chitta hills lying between Attock and Pindigheb. All the other 4-inch surveys were more or less special in character and very limited in extent. The survey of the Khorda Government estate in the Pooree district of Bengal had hitherto been classed as a cadastral survey; but, as mentioned in last year's review, a change of system has been introduced, the interior village measurements being made by the Settlement Department, and the professional party supplying boundaries and the details of the hills. In the previous Report, it was anticipated that the work in Khorda would be finished by September 1880: but this expectation does not seem to have been realised; for the map opposite page 19 of the present report shows a good deal of ground traversed in advance which was not surveyed on the 4-inch scale during the season. The area completed (125 miles of 4-inch and 40 miles of 32-inch survey) was exceedingly small, and the cost, Rs. 55,666, considerable. This amount, however, includes expenditure in completing the records of previously surveyed portions of the estate. The party suffered much from fever, and other circumstances are mentioned in the Report which contributed to reduce the outturn. The 4-inch survey of the Jumna villages between the North-Western Provinces and the Punjab was continued along the Karnál and Muzaffarnagar boundary, and covered a small strip at the north-west corner of Meerut. In the Bánda district some forest reserves were mapped on the same scale.

5. Cadastral or field surveys were prosecuted in the permanently-settled districts of the North-Western Provinces, and in several districts of the Pegu division of British Burma now coming under a regular settlement for the first time. With the exception of the trifling area of some 20 square miles, the cadastral survey of the temporarily-settled district of Bánda had been finished in the preceding season. Operations were in progress to the north of the Mirzapur district, to the south and east of the Jaunpur district, and to the west and south of Gházipur. The survey of Mirzapur began, and that of Jaunpur was almost finished. The Gházipur survey is about half done. The attention of the Government of the North-Western Provinces and Oudh will be invited to the remarks at page 21 of the report, where it is suggested that the Jaunpur party, on completion of its work, might have been suitably employed on the survey of the Benares district, which, however, the Lieutenant-Governor would, for the present, defer. At the same time the Surveyor General may consider whether the Jaunpur party might not be transferred to British Burma, if it is not required by the Government of the North-Western Provinces and Oudh.

It was mentioned in last year's review that it had not then been finally determined whether the field or the holding should be taken as the unit of survey for the professionally conducted settlement measurements in British

* This includes 40 miles of 32-inch survey in Pooree.

Burma. This question has since been decided in favour of the field. Two cadastral parties were at work in Burma—one in the Hanthawaddy district, under Captain Sandeman, and the other, superintended by Major Andrew, in Bassein. Operations have subsequently been extended to the Tharrawaddy district, as noted in the Report. The Government of India cordially concurs with the Surveyor General in acknowledging the promptitude with which the Survey Officers, and more particularly Captain Sandeman, have supplied the Settlement Department with the necessary maps and statements. This has enabled the Chief Commissioner to report the assessments of nine circles in the Syriam and Bassein townships, which were sanctioned in February last; and the Governor General in Council has much pleasure in observing that, so far, the progress made in the Burma surveys, executed, as they have been, under novel and, in some respects, difficult conditions, has been very creditable to the Survey Department. The commendable care bestowed by Captain Sandeman on the training of Burman Surveyors has been previously noticed.

6. The subject of the "miscellaneous" surveys in the Darjeeling district has been recently under discussion with the Government of Bengal. Field work in that district has now ceased; and the question of continuing the geographical survey of Sikhim, which has been partially carried out by Lieutenant Harman, the officer in charge of the Darjeeling party, will be further considered on his return from leave.

7. Of other geographical operations, the most important were those which were conducted by the Survey Officers accompanying the several columns of the Army in Afghanistan and Biluchistan during the second phase of the Afghan War. The survey has been taken for the most part on the $\frac{1}{2}$-inch or $\frac{1}{4}$-inch scale, supplemented by rough reconnaissances and by native information in the less accessible places. Generally speaking, the detailed survey extends from Pesháwar to Kabul *viâ* the Khyber pass and the Kuram valley, but excluding Bara and Tíra, and the Afridi country lying between the Pesháwar district and a line drawn a little to the north of Thal. South-west of the Kuram valley it has taken in a great part of Khost. A radius of 15 miles to the north and west of Kabul, and of 50 miles to the south in the direction of the Logar valley, would approximately cover the rest of the country mapped in Northern Afghanistan. In Biluchistan and Southern Afghanistan the area delineated is much less compact. With some breaks, which were merely reconnoitred, it may be described as reaching Girishk on the west from Fort Munro on the Dera Ghazi Khan frontier. It includes Khushk-i-Nakhud, the country around Kandahar, a great part of the Khojak-Amran range, Pishin, a tract to the north and north-east of Quetta, and the neighbourhood of Dada and Sibi along and to the west of the line of rail. The northern and southern surveys have been connected by the survey of the route from Kandahar to Ghazni through the Khushk-i-Rud, Tarnak, and Ghazni valleys. The total area mapped during the season in Northern Afghanistan is estimated at 11,180 square miles; and the Surveyor General is invited to state, in his next report, the total area mapped or reconnoitred by the Survey Department, whether in North or South Afghanistan or in Biluchistan, throughout the whole period of the military operations.

8. The Governor General in Council has again to notice with much satisfaction the distinguished and valuable services of the Survey Officers during the war. His acknowledgments are due to the military officers and the civilian surveyors mentioned by the Surveyor General in the Report; and more particularly to Captain Holdich, R.E., who was in charge of the survey of Northern Afghanistan; to Major Woodthorpe, R.E., who executed much important work in Kuram and accompanied General Ross on his march through Maidan to meet Sir Donald Stewart on his advance from Kandahar; to Lieutenant Gore, who was attached to Sir Donald Stewart's force on this occasion and effected a junction with the survey brought down by Major Woodthorpe from Kabul; to Lieutenant-Colonel E. P. Leach, V.C., whose report on his operations in Southern Afghanistan has been separately acknowledged; and to Lieutenants the Hon'ble M. G. Talbot and Longe, who were with General Sir F. Roberts on his memorable march from Kabul to Kandahar and were present at the battle which succeeded it. The Governor General in Council has further observed the foot-note at page 34 of the report which recounts the valuable service rendered

by a Native explorer near the Sherpur cantonments and in Kafiristan. The Surveyor General should report whether this man has received any special reward, and, if not, whether he deserves one.

9. The remarks of the Surveyor General on the general organization of survey operations with an army in the field will be brought to the notice of the Military Department and of the Secretary of State in continuation of previous papers on the same subject.

10. Good progress is reported in tidal operations, which is due to the efficient superintendence of Captain Baird. Tidal instruments were set up at six additional places, and observations are now made at thirteen tidal stations, *viz.*, Aden, Kurrachee, Bombay, Karwar, Beypore, Paumben, Madras, False Point, Rangoon, Elephant Point, Moulmein, Amherst, and Port Blair. The several stations are being connected by lines of spirit-levels; and levels will be taken during the course of the cadastral surveys in British Burma. The electro-telegraphic operations for the determination of differences of longitude again remained in abeyance, as no officers were available for the work.

11. The issues of maps from the Surveyor General's office in Calcutta increased from 28,737 maps, valued at Rs. 38,274 in 1878-79, to 33,796 maps, of the value of Rs. 57,005. There was a large demand for maps of Afghanistan and the North-West Frontier; and much new geographical material was utilised with great promptitude. A preliminary edition of the map of India, on the scale of 1-inch=64 miles, was published by the Lithographic Branch to meet immediate requirements. The number of cadastral maps of the North-Western Provinces published during the year was 2,527. Many of these had been plotted during the field season of 1879-80, and the great majority of them were photozincographed. Numerous maps of the Khorda Government estate were reproduced by the same process. The Mathematical Instrument Department issued during the year 14,103 instruments, valued at Rs. 1,07,230. The further details given of the working of the head-quarter offices at Calcutta do not call for any remark.

12. At Dehra Dún the work of the final reduction of the observations and measurements of the Great Trigonometrical Survey is progressing satisfactorily. Vol. VI of the account of the operations is being published; Vols. VII and VIII are under preparation; and the printing of Vols. IX and X has commenced. Three of the synoptical volumes, containing a précis of the results of the triangulation, were published, and three more were completed but not bound.

13. Several of the extracts from the narrative reports of the executive officers given in the Appendix have been read with interest. Amongst these are the notes of Colonel J. Macdonald on the Konkan, of Captain Sandeman on the Syriam township, and of Captain Holdich on the Logar valley. The remarks of Captain Heaviside, of the Khandesh Survey, on the Mangya Tungya hills and the Balsána temples, will be communicated to the Director General of the Archæological Survey. Lieutenant-Colonel Tanner's report on the surveys around Gilgit, and the translation of the notes of the Native explorer on the Irrawaddy river above Bamo, contain interesting information on remote localities hitherto little known.

14. The thanks of the Government of India are due to the Surveyor General for his able superintendence of the Department.

ORDER.—Ordered, that copies of the Resolution be forwarded to the Surveyor General of India; to the Local Governments noted in the margin; and to the Foreign and Military Departments. Also that a copy, with a copy of the Report, be sent to the Director General of the Archæological Survey of India in advertence to paragraph 13.

Madras.	Central Provinces.
Bombay.	British Burma.
Bengal.	Assam.
N. W. P. and Oudh	Coorg.
Punjab.	

True Extract,

C. GRANT,

Offg. Secy. to the Govt. of India.

1881

GOVERNMENT OF INDIA.

HOME, REVENUE AND AGRICULTURAL DEPARTMENT.

SURVEYS.

RESOLUTION.

No.

Dated Simla, the May 1881.

SUBJECT.

Review of the General Report on the operations of the Survey of India during the year 1879-80.

Govt. Central Branch Press, Simla,—No. 150 H., R. & A. D.—30-5-81—010.