TOPOGRAPHICAL SURVEYS IN THE BENGAL PRESIDENCY.

The Regular Survey Parties were seven in number, and were employed in the Topography of the under-mentioned States and Districts:—

The Regular Surveys.

No. I.—In Gwalior and Central India.

No. II.—In the Upper Godavery Districts and the Province of Berar.

No. III.—In the Chutisgurh District and the Bustar Dependency of the Central Provinces, and in the Jaipur, Panchipetta, and Madagul Dependencies of the Vizagapatam Agency.

No. IV.—In Chota Nagpore, Jushpur, and Sirgoojah.

No. V.—In Rewah and Bundelkund.

No. VI.—In the Kossiah and Jynteah Hills, and on the border of the Garrow Hills.

No. VII.—In Jeypore, Ulwar, and Shekawattee.

Other operations unconnected with the Regular Surveys.

(2). In addition to the above, the Military Reconnoissance of Bhootan and the Dooars was completed to the furthest points reached by the Bhootan Field Force; the remaining field work of the Pegu Survey was finished, and the necessary steps for the early completion of the Maps of the Province were taken.

Out-turn of Regular Surveys in 1865-66.

(3). The seven Regular Survey Parties have accomplished an aggregate area of 17,889 square miles of final Topographical Survey, on the scale of one inch to the mile, with an area of 18,664 square miles of triangulation as a basis for future operations. The city of Jeypore and the Cantonments and City of Sipree were surveyed and mapped on the scale of one inch to 500 feet; the new Cantonments of Morar were partially surveyed on the same scale; the site of the new Cantonment at Pokri on the Himalayas was surveyed on the scale of one inch to 200 feet, and contoured at vertical intervals of 10 to 40 feet. 11,052 acres of land in Rewah, to be transferred to the British Government in exchange for other lands, were surveyed on the scale of one inch to 20 chains; and 1,061 linear miles of Boundary Survey were traced in the four Districts of Berar.

(4). The total cost of the above operations amounted to Rs. 3,48,654 for all charges, permanent and contingent, and inclusive of the Military pay of all Military Officers employed in the Department. The numerical details of the work and cost of each Party are exhibited in the following Statement:—

Designation of Survey.	Topography on scale of one inch to the mile in Square Miles.	Triangulation in Square Miles.	Measurement of Village areas in acres.	Boundary Survey in linear Miles.	Surveys of Cities and Cantonments on scale of 1 inch to 500 feet.	Contour Survey on the scale of 1 inch to 200 feet.	Cost in Rupees.
No. I Party	2,395	.....	.....	.....	1½	.....	51,097
„ II „	1,949	195	.....	1,061	.....	.....	41,403
„ III „	3,105	5,000	.....	.....	.....	.....	57,865
„ IV „	3,702	4,800	.....	.....	.....	.....	52,421
„ V „	3,208	4,539	11,052	.....	.....	.....	59,230
„ VI „	1,160	1,370	.....	.....	.....	.....	50,609
„ VII „	2,370	2,780	.....	.....	1	1	36,029
Total ...	17,889	18,684	11,052	1,061	2½	1	3,48,654

(5). Debiting the total cost of the operations against the area of final survey on the scale of one inch to the mile only, as is usually done in order to obtain the ratio between the cost of the operations and the out-turn of work, the rate per square mile of final survey will be seen to be Rs. 19-8-0, which, however, would be somewhat reduced if allowance were made for the cost of the work of other descriptions which has been executed during the current year.

Cost of Survey per Square Mile.

(6). In my Administration Report on the operations of the Topographical Surveys for 1864-65, I have shown that there has been a steadily progressive advance in the quantity of the work which has been turned out annually in this Department during the five years commencing in 1860-61. But I deprecated any further advance in this direction, and pointed out that there was already a tendency to aim at accomplishing a larger amount of work than could be satisfactorily completed. I showed that while the Triangulation, on which the details of the Topography are based, is of a very high order of accuracy and does not need to be improved, the accuracy of the delineation of the details, by the usual method of plane tabling without the aid of measuring chains, was liable to be called in question, and that this portion of the work required to be more thoroughly tested and examined in the field than had hitherto been customary.

Further increase in annual out-turn of work not desirable.

Additional checks on the accuracy of the topographical details necessary.

(7). The Government of India has been pleased to support these views in a letter (No. 5497, dated 16th October 1866, from the Secretary to the Government of India in the Home Department), from which the following paragraphs are extracted :—

"4. The Governor General in Council, I am to state, fully concurs in your "views on the subject, and readily accepts the principle stated in para. 5 of the "Report that the out-turn of work should not, on any account, be permitted to ex- "ceed the amount that can be accomplished with an appropriate degree of fidelity.

"5. You have shown (paras. 7 and 11) that, so far as the Topographical "Triangulation is concerned, no serious errors can occur without detection, and "that the operations of the year have been carried out with all the accuracy which "could be desired. But as regards the detailed topography, you remark that "'some further check over the accuracy of the interior details is required than the "chance of their examination in the field by Executive Officers, who often have "so great an amount of work of other descriptions to get through that they have "much difficulty in finding time to undertake these examinations;' and you state "(para. 10) that checks, similar to those introduced by Colonel Thuillier in the "Revenue Surveys, *viz.*, the running of check lines over portions of the field "work, are now being introduced into the topographical operations. The Gov- "ernor General in Council, I am to state, considers that you rightly attach great "importance to the institution of measures calculated to ensure a proper test of "the accuracy of the work performed, and His Excellency in Council will be glad "to learn the result of the steps taken in that direction."

(8). Too short a time has elapsed to elicit much information regarding the results of these verificatory operations. As yet only one Executive Officer has been able to submit sketches showing both the original survey and that of the ground over which check lines have been run; the respective independent delineations of detail are, on the whole, very satisfactory, coinciding in most instances, and rarely exhibiting larger errors than could well be avoided; one Plane Table Section, however, had to be rejected and resurveyed.

Results of the tests already applied.

(9). Eventually it may be feasible for each Survey Party to draw out Returns showing the magnitude of the several errors on a given length of check line, their number, and its proportion to the number of coincidences. These Returns will be useful in order to effect a comparison between the relative degrees of accuracy attained by the different Surveyors, and

Suggestions for defining the limits of error allowable under the varied circumstances in which Surveyors are placed.

they may enable precise rules to be laid down, defining the limits of allowable error, under all the varied circumstances in which an Indian Surveyor is liable to be placed. For the whole of the different Districts under survey do not require to be delineated with the same amount of minutiæ, nor indeed do all parts of the same District; some are rich, fertile, and populous; others poor, wild, and hidden in forest; it would be a waste of time and often an impossibility to survey the latter with as much attention to accuracy and amount of detail as the former; as a rule, however, it is better to obtain an excessive amount of accurate detail, than to be satisfied with what may be found to be too little when these tracts of country are brought into better communication with the surrounding regions, and their resources are further developed.

(10). The accuracy of the Maps of the Topographical Surveys will in general depend on the number of points fixed by triangulation or traversing as a basis for filling in the details of the ground, and on the number of stations at which the Plane Table is set up for delineating the said details. *Cœteris paribus*, the more numerous these are in a given area, the more exact should be the results. In illustration of the different circumstances under which different Survey Parties are placed, the following Table is given, showing the relative number of fixed Points and Plane Table Stations in a square mile in each survey :—

Designation of Party.	Number of Points per Square Mile.	Number of Plane Table Stations per Square Mile.	Remarks.
No. I Party	·104	6·2	The number of points is determined from the average of field seasons 1864-65 and 1865-66, excepting for No. III Party, whose Returns for 1865-66 are incomplete. The number of Plane Table Stations is for the last field season only.
„ II „	·049	0·8	
„ III „	·032	2·6	
„ IV „	·054	5·2	
„ A „	·082	5·0	
„ VI „	·138	1.2	
„ VII „	·097	2·8	

(11). The out-turn of the topographical triangulation of the past field season and the errors thereof are exhibited in the following Table. The quality is as excellent as can be desired; the quantity differs much in the different Parties, varying with the extent of the triangulation of former years which was available for the Topography :—

Designation of Party.	Number of Triangles.				Triangular errors in seconds.		Discrepancies between common sides in inches per mile.				Remarks.
	1st Class.	2nd Class.	3rd Class.	4th Class.	1st Class.	2nd Class.	1st Class.	2nd Class.	3rd Class.	4th Class.	
No. I Party ...	1	5	7	94	0″·5	3″·2	5·2	4·3	...	7·9	
„ II „ ...	...	34	...	...	..	10·0	...	3·2	...	...	
„ III „ ...	3	13	110	...	7·7	10·0	0·5	...	5·5	...	Returns incomplete.
„ IV „ ...	...	6	80	439	...	6·4	...	1·0	2·6	12·8	
„ V „ ...	...	110	553	...	...	10·5	...	5·8	12·3	...	
„ VI „ ...	10	15	25	180	9·0	18·0	3·4	5·2	6·9	25·0	
„ VII „ ...	15	44	47	444	2·3	3·7	0·5	0·7	7·0	15·6	
Averages ...	...	...	...	...	4″·9	8″·8	2·4	3·4	6·9	15·3	

The necessity for preparing special Maps for reduction by Photography.

(12). During the past recess, Captains Melville and Murray, whose Parties were located at Masoori, near my own head quarters, prepared certain experimental Maps, under my superintendence, for reduction by Photography. The Maps of this Department have,

for upwards of a year, been drawn so as to be adopted for Photography, brush-work having been exchanged for pen and ink in the hill shading, and all colors being prohibited other than those which possess strong actinic properties. Such Maps can be well copied to full scale by Photography, but they cannot be reduced by the same process without the printing becoming too microscopic to be easily legible. In all Maps, whether of large scale or small, the printing of the names must be sufficiently large, to be easily read without the assistance of lenses or magnifying glasses; thus, however much the scale may be reduced, there is a limit beyond which the size of the printing must not be reduced. Consequently the topographical Maps, on the scale of one inch to the mile, which contain as much detail as the scale will admit of, and in which names are printed no larger than is necessary for legibility, are not susceptible of reduction by Photography, without becoming too microscopic and confused to be of general utility.

(13). To overcome this difficulty, and secure as much aid as possible from Photography, it is necessary to prepare Maps with a special view to their reduction by Photography. The simplest, quickest, and most economical method of so doing is to make a tracing of the original Map, omitting all minor details which might confuse the reduced Map, but exhibiting the positions of the chief towns and villages, and the principal orographical features and water-courses, and printing all names three to four times larger than on the original Map. Coarse drawing is better suited than fine for this purpose, and less labor is required in the proportion of 1 to 3 or 4 than in drawing manuscript Maps, on the reduced scale, after the method which has invariably been followed hitherto. The Maps thus specially prepared are found to be excellently adapted for reduction by Photography to the Atlas Sheet scale of one quarter of an inch to the mile, and the reductions are more exact, more artistic, and of greater practical utility than the manuscript reductions. There is at present every reason to anticipate that this process may be introduced into the operations of all the Survey Parties, with the double advantage of improving the quarter inch Maps and diminishing the labor with which they are prepared. Captain Melville is an excellent Photographer, and his labors in this direction have been most assiduous and meritorious.

(14). I will now proceed to report on the general operations of the respective Survey Parties, full details of which will be found in Appendix B in extracts from the Annual Reports of the several Executive Officers, some of which furnish much interesting information regarding the Districts under survey.

EXECUTIVE SURVEYS.

No. I PARTY.—GWALIOR AND CENTRAL INDIA SURVEY.

Personnel.

Captain A. B. Melville, Executive Officer in charge.
Lieutenant Charles Strahan, R. E., Military Assistant on special duty in the Bhootan Dooars.
Lieutenant E. W. Samuells, Assistant Revenue Survey, under instruction.
Mr. H. Horst, Civil Assistant.
„ H. J. Bolst, ditto.
„ G. P. Chill, Sub-Assistant.
„ G. McArthy, „
„ G. Allnutt, „
„ G. Murphy, „
„ G. Esteve, „
Native Surveyors and Draftsmen Joala Pershad, Abdool Sumud Khan, Goolam Mahomed, Chooramun.

(15). This Party was employed in portions of the Native States of Gwalior, Jeypore, Kotah, and Jhalawur, on the north and south banks of the Chumbul River, between the parallels of 25° 15′ and 26° 15′, and the meridians of 76° 30′ and 77° 15′. The ground which was finally surveyed on the scale of one inch to the mile, and of which all details, Topographical as well as Trigonometrical, were completed, embraces an area of 2,395 square miles. In addition to this the Cantonments and City of Sipree, and part of the new Cantonments of Morar, were surveyed on the scale of one inch to 500 feet.

(16). The following Table shows the area of survey on the one inch scale and the average number of Plane Table Stations in a square mile, by each person who assisted in this portion of the operations :—

Out-turn of field work on the one inch scale.

Names.	Area in Square Miles.	Number of Plane Table Stations in a Square Mile.
Captain Melville	75	3·5
Lieut. Samuells	50	13·0
Mr. Horst	480	5·0
„ Bolst	375	5·0
„ Chill	390	6·5
„ McArthy	270	7·4
„ Allnutt	180	6·6
„ Murphy	120	5·5
„ Esteve	27	10·8
Native Surveyors.		
Joala Pershad	180	6·5
Abdool Sumud Khan	105	6·8
Goolam Mahomed	125	9·0
Chooramun	18	21·9
General average of Plane Table Settings		6·4

I note with approval that the Junior Assistants were only permitted to undertake a small amount of work, and were required to go over the ground very carefully and slowly, as is shown by their large proportion of Plane Table Stations.

(17). The native forts of Rimtembour and Kundhar fell within the area under survey ; they are considered of much importance, and so jealously guarded that much difficulty was experienced in persuading the Maharajah of Jeypore to permit of their being surveyed ; it was feared that our Officers would be prevented not only from entering the forts themselves, but from visiting the high ground immediately around them, which would then have had to be left as blanks on our Maps. Fortunately, Captain Melville succeeded, after some days' delay, in overcoming the Maharajah's objections, and obtaining permission to make the surveys, but only on the condition that he alone should do them, without the aid of any European Assistants. The forts and surrounding country are briefly described in his Narrative Report.

Opposition to survey of native forts successfully overcome.

(18). So large an amount of triangulation had been executed in advance of the Topography that no further extension was needed during the field season under notice ; but 73 additional points were fixed within the area of the operations of the preceding season's triangulation. Captain Melville also found it necessary to determine the positions of 68 points in the dense forest and jungle on the lett bank of the Koonoo River, by the method of traversing, as triangulation would have been impossible without incurring great expense for line cutting. Traverses were carried through the forest, starting from a fixed point on one side, and closing on another on the opposite side, and laying down the positions of several points in the interior, to aid the detail Surveyors; a very simple and expeditious method of calculating the rectangular co-ordinates of the points of the traverse, and reducing them with fair approximation to the spherical co-ordinates of Latitude and Longitude, was adopted by Captain Melville, and is described in his Narrative Report, and may be followed with advantage by all Surveyors who find themselves in similar difficulties.

Additional points fixed by traversing as well as triangulation.

(19). The Koonoo jungles were found to contain many more villages than had been anticipated, the ground appearing to have once been cultivated to a considerable extent; an old Budhist temple, with some beautiful carving and a long inscription, was found in one of the densest parts of the forest, near the source of the Parung River; and numerous sites of ruined villages are indicated by groups of large tamarind trees. But now the country is overgrown with jungle, and inhabited only by Sheriahs, who are described as "perfect wild men of the woods, going about nearly naked, and subsisting almost entirely on wild fruits and roots."

Recess operations.

(20). During the subsequent recess, five General Maps were completed on the scale of an inch to the mile, the Cantonments and City of Sipree were mapped on the scale of an inch to 500 feet; a Chart of the triangulation and a Degree Sheet of topographical details were completed on the scale of the Indian Atlas, one quarter of an inch to the mile; two copies of the Triennial Report of the Gwalior Survey for the years 1862-63 to 1865-66 were compiled, one for the use of the Surveyor General's Office, the other for transmission to the India Office. Captain Melville also undertook the preparation of the experimental Maps for reduction by Photography, which have already been described in paras. 12 and 13 of this Report. The amount of the computations is given in the margin.

Triangles	107
Latitudes and Longitudes ...	12
Heights	22
Traverses	15

Military reconnoisance of the Bhootan Dooars.

(21). Lieutenant Charles Strahan, R. E., the Military Assistant attached to this Party, was deputed on special duty to go on with the Military reconnoissance of Bhootan and the Dooars, which had been commenced during the previous field season by Captain Godwin Austen. In order that Lieutenant Strahan might be in a position to make the most of any opportunities of carrying a survey into the interior of the Bhootan Mountains, which might offer in the probable event of the advance of the British Troops to Panakha, I obtained from His Excellency the Commander-in-Chief the services of a Party, consisting of an Officer (Lieutenant Holdich) and four Corporals of the Royal Engineers, and 12 Native Sappers, to assist in the operations of the survey. The submission of the Bhootiahs prevented the anticipated advance from being made; consequently Lieutenants Strahan and Holdich were employed in extending the reconnoissance of the Dooars eastwards from the meridian of Buxar, up to which it had already been brought by Captain Godwin Austen, to the Monass River, where the Dooars terminate; with the aid of some Sketches made by Mr. Nicolson, this work was nearly completed, and is now lithographed.

No. II PARTY.—HYDERABAD SURVEY.

Close of the Hyderabad Survey.

(22). During the year under review, the field operations of what has for many years been known as the Hyderabad Survey were brought to a termination. Commenced in the year 1855, this survey has accomplished the topographical delineation, on the scale of an inch to the mile, of a vast extent of country, embracing the Districts of Oomraotee and Woon, the Pergunnah of Gangra, the Upper Godavery Talooks from Sironcha to Bhudrachellum, the Ramgeer and part of the Mahore Circars, comprising in all an area of 20,578 square miles. The operations have been conducted throughout under the supervision of Mr. Mulheran, who, after several years of service in the Great Trigonometrical Survey, was appointed to the charge of the Hyderabad Topographical Party.

(23). The operations of the past field season have comprised the survey of the following Talooks: Nugur, Albaka, Cherla, Bhudrachellum, and Rakapile, of the Upper Godavery District, covering a total area of 1,879 square miles; also the demarcation and survey of the boundaries of the four districts, Oomraotee, Akola, Mekhur, and Woon, of the Province of Berar, the aggregate length of which amounts to 1,061 linear miles.

Personnel.

James Mulheran, Esq., Executive Surveyor in charge.
Mr. A. Chamarett, Civil Assistant.
„ J. B. Smith, Senior Sub-Assistant.
„ Farrell, Sub-Assistant, 1st Class.
„ Ogle, „ 2nd Class.
„ Scanlan „ „
„ Chennel „ „
„ Maine, „ 3rd Class.

Native Surveyors.

Ram Chundar, Junardun Rao, Pandarao, Baparao, Sheikh Omar.

(24). The following Table shows the area of the survey on the one inch scale, and the average number of Plane Table Stations in a square mile, by each person, who assisted in this portion of the operations:—

Name of Surveyors.	Area surveyed.	Average Number of Plane Table Stations in a Square Mile.
Mr. Chamarett	321	0·60
„ Farrell	70	1·47
„ Ogle	310	·96
„ Scanlan	314	·58
„ Chennel	207	·96
„ Maine	216	·71
Ram Chunder	356	·72
Junardun Rao	155	·58
General average		·76

Details of Topography.

The above figures sufficiently indicate that the work has not been of a very close and detailed nature, but this is explained by the circumstance that the ground under survey is for the most part buried in forest and jungle. Portions of the District have been resurveyed, as a check on the original operations, with the result of corroborating the general accuracy of the details, so far as it had been found practicable to render them.

Boundary demarcation.

(25). Mr. Mulheran has afforded valuable assistance to the local authorities in the demarcation of several boundaries, more particularly on the frontier line between the Nimar District of the Central Provinces and the Oomraotee District of the Hyderabad Assigned Territories; the Commissioners who were recently deputed to report on certain disputes regarding this boundary have come to the conclusion that it has been accurately outlined on Mr. Mulheran's Maps, and have recommended its adoption accordingly.

Recess operations.

(26). During the recess six General Maps and 44 boundary slips were completedon the scale of one inch to the mile, also a reduced Map on the geographical scale of a quarter of an inch to the mile; a general Report on the whole of the operations of the survey from its commencement in 1855 to its close in the present year has been begun, and should be completed during the next recess.

Future operations.

(27). The Party has now been moved northwards into the Central Provinces, to be employed in the hilly tracts south of the Nerbudda River, appertaining to the Districts of Hoshungabad, Baitool, Chindwarra, Seonee, and Mundla; such portions of these Districts as are unsuited for Revenue Survey will be surveyed topographically.

No. III PARTY.—CENTRAL PROVINCES AND VIZAGAPATAM AGENCY.

(28). This Party, which has for many years been employed in Ganjam and Orissa, was at work during the field season under review in the Chutteesgurh District and the Bustar Dependency of the Central Provinces, and in the Jaipur, Panchipetta, and Madugul Divisions of the Vizagapatam Agency.

Personnel.

Lieutenant Colonel G. H. Saxton, Executive Officer in charge.
Lieutenant A. E. Downing, Military Assistant.
Mr. D. Atkinson, Civil 2nd Assistant.
„ R. W. Chew, Sub-Assistant.
„ J. Harper, „
„ F. Adams, „
„ J. May, „
„ T. Claudius, „
„ T. Leonard, Apothecary.
Hediatoolla, Native Surveyor.

Final Survey.

(29.) The following Table shows the area of final survey on the one inch scale, and the average number of Plane Table Stations in a square mile, by each of the Assistants who were employed in the topographical delineation, of which the total area completed amounts to 3,105 square miles:—

Name of Assistants.	Area surveyed in Square Miles.	Average Number of Plane Table Stations in a Square Mile.
Lieut. Downing	78	1·8
Mr. Atkinson	419	No return.
„ Chew	326	1·1
„ Harper	549	1·5
„ Adams	450	2·0
„ May	375	8·5
„ Claudius	450	1·7
Native Surveyor Hediatoolla	458	1·5
General average		2·6

Remarks on the accuracy of the details.

(30). Colonel Saxton has devoted much time to the personal examination in the field of the work of the detail Surveyors. I notice with approval his commendation of the Field Maps executed by Mr. May "as evincing great care and labor;" the average number of Plane Table Stations made by this Assistant is more than four times greater than that of any other detail Surveyor in the Party. Regarding the general accuracy of the details of this survey, Colonel Saxton reports that "he could point out "portions of 10 to 20 square miles in extent, in the Maps to be sent in this "season, where the positions of villages and the runs of minor water-courses can- "not with certainty be accurate to within a quarter of a mile, but where, sup- "posing them to be only wrongly placed to that extent, for all practical purposes, "the error would be of no importance, though under a rigorous test it would "appear great."

The triangulation.

(31). The triangulation was extended in advance as far south as the parallel of 18° 15′, and west to the meridian of 81° 45′; it embraces an area of about 5,000 square miles, in which there were 39 stations of observation; the total number of points which were laid down has not yet been reported.

Recess operations.

(32). During the recess, eight Sheets of the General Maps on the one inch scale and two Sheets of the Geographical Maps on the quarter inch scale, were completed; no details are given of the amount of computations, but a large quantity of secondary computations is said to be in arrears.

No. IV PARTY—CHOTA NAGPORE SURVEY.

(33). During the field season under review, this Party has been employed in completing the survey of the Districts of Chota Nagpore proper, and commencing work in the Districts of Jushpur and Sirgoojah.

Personnel.

Captain G. C. Depree, Executive Officer in charge.
Mr. F. B. Girdlestone, Assistant Surveyor.
Mr. G. A. McGill.
„ J. Vanderputt.
„ A. J. Wilson.
„ T. W. Bobanau.
„ A. G. Wyatt.
„ A. J. James.
„ G. Barker.
Native Surveyors and Draftsmen.
Mr. J. H. Wilson.
Baboo M. S. Dutt.
Mr. C. D'Cruz.

(34). The ground which was finally surveyed, and of which all details, topographical as well as trigonometrical, were completed, comprises an area of 3,702 square miles. The following Table shows the area apportioned to each detail Surveyor, and the average number of Plane Table Stations in a square mile:—

Final Survey.

Name of Surveyors.	Area surveyed.	Average Number of Plane Table Stations.	Remarks.
Mr. Girdlestone	176·0	5·0	Forests and hills.
„ McGill	442·0	5·6	Pats and cultivation.
„ Vanderputt...	502·4	7·9	Much details and hills.
„ Wilson (senior)	449·8	3·5	Forests and hills.
„ Bobanau	440·0	4·0	Forests and cultivation.
„ Wyatt	474·8	4·1	Hills and cultivation.
„ James	398·9	5·9	Hills and much cultivation.
„ Wilson (junior)	421·1	3·1	Forests.
Baboo Dutt	397·0	7·5	Forests, hills, and cultivation.
General average		5·2	

Much pains appear to have been bestowed on the examination of the accuracy of the survey of the interior details, Captain Depree having devoted two months of the field season to this purpose, during which he surveyed 66½ miles of check lines, 37½ more miles being run by an Assistant. I notice with approval that one Plane Table Section, which was found to be inaccurate and unsatisfactory, was portioned out between the whole of the Assistants, and resurveyed before the return of the Party to recess quarters.

(35). A net-work of triangulation was thrown over the greater portion of Sirgoojah and Jushpur, covering an area of 4,800 square miles, in which 255 points were fixed by observations taken at 53 stations, giving an average of one point in an area of 18·75 square miles.

The triangulation.

(36). In the course of the recess eight Sheets of the General Maps (½ a degree in longitude by ¼ of a degree in latitude) were completed. Three Sheets of Geographical Maps, 1° in latitude by 1° in longitude, on the scale of ¼ of an inch to a mile, and a Chart of the triangulation on the latter scale were also finished. The extent of the computations has not been specified clearly, but they are reported to have been completed up to date.

No. V PARTY.—REWAH AND BUNDELKUND SURVEY.

(37). The operations of the past year have been carried on in the territories of the Maharajah of Rewah, and in several of the native states of Bundelkund. In addition to the ordinary topographical operations on the scale of an inch to the mile, which embrace an area of 3,208 square miles, several villages to the north of the Railway Line, belonging to the Maharajah of Rewah, which it is proposed to transfer to the British Government in exchange for other villages lying south of the line, were surveyed on the scale, 4 inches to the mile, and the traverse system, of the Bengal Revenue Surveys; their aggregate area amounts to 11,052 acres.

Personnel.

Captain W. G. Murray, Executive Officer in charge.
Lieutenant W. F. Badgley, Military Assistant.
Mr. R. A. Bell, Civil Assistant.
„ C. H. Neale, ditto.
„ E. S. P. Atkinson, Sub-Assistant.
„ C. F. Hamer, ditto.
„ A. D. Howard, ditto.
„ C. T. Evans, ditto.
„ T. D. Ryan, ditto.
Native Surveyor Nubbee Bux.
„ „ Prem Raj.
„ „ Abdhoor Ruheem.
„ „ Abdool Ruhman.

(38). The following Table shows the area completed by each Assistant employed on the one inch survey, and the average number of Plane Table Stations in a square mile:—

Survey of details.

Name of Surveyors.	Area surveyed.	Average Number of Plane Table Stations.
Lieutenant Badgley	140·0	2.63
Mr. R. A. Bell	202·3	8·10
„ Neale	289·1	2·57
„ Atkinson	333·5	5·65
„ Hamer	407·9	4·61
„ Howard	343·7	4·72
„ Evans	158·9	4·54
„ Ryan	61·7	1·96
Native Surveyor Nubbee Bux	336·8	4·22
„ „ Prem Raj	498·5	7·34
„ „ Abdhoor Ruheem	317·2	6·84
„ „ Abdool Ruhman	118·8	5·74
General average ...		5·02

I notice with satisfaction that Mr. Bell's Topography is reported by Captain Murray to be executed in a most masterly and most accurate manner; the number of his Plane Table Stations is a sufficient proof of the care with which he has worked.

(39). The triangulation which was executed in advance as a basis for future Topography covers an area of 4,539 square miles, and furnishes 313 points (which were fixed by observations taken at 60 Trigonometrical Stations), thus giving an average of one point in an area of 14·5 square miles.

The triangulation.

(40). During the recess, eight General Maps (15′ in latitude by 30′ in longitude) on the one inch scale, and one Geographical Map (1° in latitude by 1° in longitude) on the quarter inch scale, have been completed; three Sheets of the General Maps were copied in the manner described in para. 13 for reduction by Photography. The extent of the computations is exhibited in the margin; they are reported to be complete up to date, as far as the requisite data were forthcoming.

Recess operations.

663 Triangles.
88 Latitudes, Longitudes, and Azimuths.
142 Heights.
8 Ray Traces on the side of the Great Trigonometrical Survey Triangles, giving an average error of 4·6 inches per mile.

No. VI PARTY.—KOSSIA AND GARROW HILLS SURVEY.

Personnel.

Captain Godwin Austen, Executive Officer, absent on leave, &c.
Lieut. R. V. Riddell, R. E., Officiating Executive Officer.
Mr. N. A. Belletty, Civil Assistant.
„ H. H. Atkinson, Sub-Assistant.
„ J. B. Landeman, ditto.
„ C. Low, ditto.
„ P. Gilhooly, ditto.
Native Surveyor Daliludin.

(41). Captain Godwin Austen having suffered much from ill health contracted in the course of his services in Bhootan and the Dooars, was obliged to obtain leave of absence, on medical certificate, for the field season, at the termination of which he was temporarily employed in learning the Art of Photo-zincography at the Head Quarters Office of the Trigonometrical Survey. He did not serve with the Party during any portion of the year under review, his place as Executive Officer being temporarily held by Lieutenant Riddell, R. E.

Physical and climatic difficulties.

(42). The physical and climatic difficulties which are encountered in the Kossia and Garrow Hills are very formidable. One Assistant, Mr. Landeman, contracted a severe illness in the course of his operations, and had to be removed to Cherra Poonjee for medical treatment, but I regret to say that he died very shortly after reaching the station; others of the Assistants suffered more or less from fever, and there was more illness than usual among the European portion of the Establishment; on the other hand, among the natives there was very much less.

Out-turn of final survey.

(43). During the season under review, operations have been carried on in the Kossia and Jynteah Hills, the Kamroop and Nowgong Districts, North Cachar, and on the border of the Garrow Hills. The total area of final survey on the one inch scale amounts to 1,160 square miles; the portions performed by the several Assistants, and the average number of Plane Table Stations per square mile, are as follows:—

Name of Surveyors.	Area surveyed.	Average Number of Plane Table Stations.
Mr. Atkinson	370	0·7
„ Landeman	220	No return.
„ Low	250	0·8
„ Gilhooly	220	2·3
Native Surveyor Daliludin	90	1·6
General average		1·2

Proposed reduction in scale of survey on reaching the Garrow Hill.

(44). Lieutenant Riddell is of opinion that the Garrow Hills should be surveyed on the scale of half an inch to the mile, or one-half the ordinary scale of the Topographical Surveys. They are described as being so covered with jungle that the Plane Tablers will not be able to work up to the one inch scale, and so exceedingly unhealthy that short field seasons must be anticipated as a matter of course. The proposed change of scale would probably enable the Surveyors to get over as much ground in a short season as other Surveyors working on the large scale for a season of the usual duration; this will prevent the cost of the survey per square mile from rising above the present average, while the amount of topographical delineation, which will be given, will probably suffice for all practical purposes.

The triangulation.

(45). The triangulation which was executed during the season covers an area of 1,370 square miles, and furnishes, by observations taken at 29 stations, 155 fixed points, thus giving an average of one point in an area of 8·8 square miles.

(46). During the recess, two General Maps (15′ in latitude by 30′ in longitude) on the one inch scale, were completed and a third was nearly finished; tracings of 3½ Plane Tables were made for the use of the Civil Authorities; and four Charts of the triangulation were drawn on the quarter inch scale. The computations were all brought up to date; their number and nature are shown in the margin.

Recess operations.

230 triangles, 163 heights.

No. VII PARTY.—RAJPOOTANA SURVEY.

(47). This Party was employed during the greater portion of the field season in the native states of Jeypore, Ulwar, and Shekawattee; but when the season was little more than half over, I received an urgent request from the Government of India in the Public Works Department to make immediate arrangements for the survey of the site of the new Cantonments for European Troops, which are to be erected at Pokri in the Himalayas. I therefore directed Lieutenant Strahan to suspend his regular operations, and to proceed to Pokri with all his Assistants as quickly as possible.

Personnel.

Lieutenant George Strahan, R. E., Executive Officer in charge.
Mr. J. F. Baness, Civil Assistant.
„ R. Todd, Sub-Assistant.
„ H. J. Hussey, ditto.
„ C. Tapsell, ditto.
„ F. Kitchen, ditto.
„ C. Kirk, ditto.
„ W. Stotesbury, ditto.
Native Surveyors Kalka Pershad, Hurlall Sing, Mahomed Ali, Harbans, J. Noah.

(48). In Rajpootana 2,370 square miles of survey on the scale of an inch to the mile, were completed, and the city of Jeypore, with the surrounding hills and forts, were surveyed on the scale of an inch to 500 feet. The amount of work on the inch scale, and the number of Plane Table Settings by each Surveyor, are given in the following Table:—

Survey in Rajpootana.

Name of Surveyors.	Area in Square Miles.	Average Number of Plane Table Settings per Square Mile.
Mr. Baness	210	4·2
„ Todd	380	3·9
„ Hussey	390	1·1
„ Tapsell	480	2·8
„ Kitchen	240	1·6
„ Kirk	360	2·5
„ Stotesbury	310	3·5
General average		2·8

(49). The triangulation which was executed in advance as a basis for future topography covers an area of 2,780 square miles, and fixes 357 points, or one on an average in an area of 7·8 square miles, by observations which were taken at 62 stations.

Triangulation.

(50). At Pokri the operations consisted in making a survey of a strip of the crest of the range about 4½ miles in length, and about 900 feet in breadth, on the scale of an inch to 200 feet, contoured at 10 feet vertical intervals, along the ridge and the lateral spurs. Lieutenant Strahan is entitled to much credit for the manner in which he carried out this survey, under considerable difficulties; he had no Assistant in his Party who had received any previous training in either the theory or the practise of levelling, for the Assistants in the Topographical Department are so rarely employed in other duties than plane tabling and triangulation that they are not trained in the other branches of surveying; he had, therefore, to commence operations by teaching his Assistants their new duties. Fortunately, I was able to secure for him the aid of an Engineer Officer and a Party of European Sappers,

Survey at Pokri.

who had been employed in similar duties in the Ordnance Survey of Great Britain, and whose services were placed at my disposal by His Excellency the Commander-in-Chief; with their assistance the work progressed rapidly, though much delay was caused at the outset, because the site for the new Cantonments was not definitely fixed until some time after the Surveyors had assembled at Pokri. The field operations were protracted to so late a period that the Party did not return to recess quarters until the middle of June.

Recess operations.

(51). In consequence of the interruption which took place in the work of the Rajpootana Survey, so many Plane Tables were left incomplete that only two of the General Maps on the scale of an inch to the mile could be completed; four more were finished to the extent of the available materials; an admirable Map of the city and suburbs of Jeypore was drawn in two large Sheets on the scale of an inch to 500 feet; the survey of Pokri was mapped on the scale of an inch to 200 feet, and reduced and printed by Photo-zincography on half that scale, in the Trigonometrical Survey Office at Dehra; this Map is interesting as being the result of the first contoured survey which has ever to my knowledge been made in the Himalayan Mountains. The nature and extent of the computations which were completed during the recess, mainly in connexion with the Rajpootana Survey, are shown in the margin.

557 Triangles.
107 { Latitudes, Longitudes, and Azimuths.
53 Heights.

THE PEGU SURVEY.

Captain W. H. Edgcome, R. E., in charge.
Mr. W. Montgomerie.
„ W. S. Burnet.
„ A. Cooper.

Native Surveyors.

Gour Chunder.
Ramloosain.
Moung Hpo.
Moungkheng.

(52). In my Administration Report for 1864-65, I explained the circumstances under which it became necessary, in order to ensure the speedy completion of the Pegu Survey, to give the general supervision of the operations to Captain Edgcome, R. E., who, though at present the Principal of the Madras College of Civil Engineering, had held the superintendence of the survey for several years. During the present year, Captain Edgcome has exercised a general control over the whole of the operations, but his attention has been more particularly directed to the completion of the traverse calculations and the mapping of the Province, while the field work, of which some 8 to 900 square miles remained to be done, has been carried on under the superintendence of Mr. Montgomerie, the Senior Uncovenanted Assistant attached to the Party.

Completion of field work of Pegu Survey.

(53). I have now the gratification to be able to report that the whole of the field work has been completed, and that the general Geographical Maps of the Province, on the scale of one quarter of an inch to a mile, will probably be finished by the end of the present month.

Mapping remaining to be executed.

Captain Edgcome is also preparing a series of Maps, on Sheets of an uniform size of about 24 inches by 18, showing the several townships into which the five Districts of the Province are divided; there will be 64 of these Maps in all, one for each township; they are being drawn on the scale of one inch to the mile, with the exception of three or four townships, for which a smaller scale is necessary to bring them into a single sheet of paper, and which, though of large area, are little better than wild jungly tracts, with few villages and scarcely any cultivation. These Maps show the boundaries of the several Teiks into which the townships are divided; they will be compiled in five sets, one for each District; 36 are already completed, and 28 remain, which may certainly be expected to be finished by the end of the current official year.

(54). I have had an opportunity of inspecting the records of this survey, almost the whole of which are now with Captain Edgcome at the Civil Engineering College, Madras. I find that they contain a considerable amount of statistical information regarding the Physical Geography of the Province; also detailed descriptions of the boundaries of Teiks and Townships, returns of the number of inhabitants in each village, the tribes to which they belong, their general occupation, the number of head of cattle, carts, boats, wells, tanks, lakes, and fisheries, and the average depth of water in the wells. These returns were originally prepared in the Burmese language, from information furnished to the Native Surveyors by the headmen of the villages; some have been translated into English, and abstracted in the form of Tabular Statements, but about two-thirds still remain for translation and compilation. On the completion of the mapping, Captain Edgcome and his Assistants will compile Statistical Returns embodying the whole of the information acquired; these should be printed in separate series, one for each District, to accompany the sets of Township Maps. They will thus furnish a complete summary of the results of the survey operations, which will probably be found of much use to the Civil Officers of the several Districts. They may be expected to be completed within six months after the mapping is finished, or by the 1st October 1867, by which date the operations of this long protracted survey should be brought to a close.

Statistical Returns to be compiled and published on which the operations of the survey will be brought to a close.

J. T. WALKER, *Lieut. Colonel*, R. E.,
Officiating Surveyor General, and Superintendent of Topographical Surveys in Bengal.

GENERAL REPORT ON THE OPERATIONS IN THE DRAWING, LITHOGRAPHIC, AND PHOTOGRAPHIC BRANCHES OF THE SURVEYOR GENERAL'S OFFICE.

Calcutta, 11th December, 1866.

The amount of work performed in the Drawing, Lithographic, and Photographic Branches of the Surveyor General's Office, Calcutta, in 1866, is as follows:—

General Surveyor's Office, Drawing and Compiling Branch.

Maps.	Scale.	Remarks.
	Miles. Inch.	
General Compilation of the Chota Nagpore Division	4 = 1	Inserted portions of Chota Nagpore, Manbhoom, Singbhoom, and Dhalbhoom. Work of Season 1863-64 in progress.
General Compilation of the Ganjam and Orissah Survey	4 = 1	Inserted field work of Season 1864-65; portions of Ryepore, Belaspore, Sumbulpore, Grome, Small Tributary States, in progress.
General Compilation of the Hydrabad Survey	4 = 1	Inserted the Chumoor Talook of Ramgeer Circar, part of Mahoir, and the District of Sironcha.
General Compilation of Rewah and part of Bundelcund	4 = 1	Inserted work of Seasons 1863-64-65, Northern portion of Rewah.
Duplicate Copies of the Degree Sheets, or General Maps of Season 1864-65, of the Hydrabad Topographical Survey ...	4 = 1	For office record prior to despatch of the originals to England. All completed.
Ganjam and Orissah Topographical Survey	4 = 1	
Chota Nagpore Division Topographical Survey	4 = 1	
Gwalior and Central India Topographical Survey Degree Sheet No. 3, Season 1864-65	4 = 1	Ditto ditto in progress.
Ditto ditto Chart of Triangulation for Degree Sheet No. 3	4 = 1	Ditto ditto completed.
Chart of Triangulation with Trigonometrical Data, Rewah Topographical Survey ...	4 = 1	Ditto ditto completed.
Ditto ditto of Gwalior and Central India Topographical Survey for Degree Sheet ...	4 = 1	Ditto ditto in progress.
Compilation of the Delhie and Hissar Divisions, lapsed Jagheers and adjoining Native states	4 = 1	In progress. The districts of Delhie, Gorgaon, Rohtuck, Hansee, Kurnal, lapsed Jagheers, and Umballa have been inserted.
Part of Afghanistan, between the Parallels of 33° to 34° 30′ N. Latitude, and the Meridians of 68° 18′ to 70° 30′ E. Longitude.	4 = 1	Completed and ready for transmission to England, to be incorporated on Atlas Sheet No. 4.
Central Provinces and adjacent British and Native States	8 = 1	Added on of portions Chunia Kimidi, Kalahandi, Patna Karial, Bodasamar, Phuljer, Noagur, and Bamra.

Maps.	Scale.	Remarks.
Punjab Map in 8 Sections, Section 8 additions to Native States	8 = 1	Completed, ready for press.
General Index Map of the Punjab, Skeleton.	16 = 1	Eastern Section one-half completed.
Rough Sketch Map of the Siam and Tenasserim Boundary, to accompany Lt. Bagge's report	2 = 1	3 copies on Vellum Cloth prepared for the Secy. to Govt. of India, Foreign Dept.
Government Cinchona Plantation, District Darjeeling	Ml. In. 1 = 4	Copy for the Conservator of Forests, Bengal.
Sketch Map of a portion of the Western Bengal Dooars, from Surveys by Lts. G. Straham, R. Holdich, and J. O. Nicolson...	4 = 1	2 copies on Tracing Cloth for the Commissioner and Revenue Surveyor.
Survey of the boundary between Oudh and Rohilcund made in 1802 by Captain T. Wood	$1\frac{1}{3}$ = 1	Copy on Tracing Cloth for the Deputy Commissioner, Mohumdee.
Plans and Sections of the proposed sites for new Cantonments at Benares	various	For the Secy. to Govt. of India, Military Dept.
Copies of Lt. Hodge's Maps of the Soonderbuns, District Backergunj, from Surveys in 1830-31, Sheets Nos. 3, 10, 12, 14, 15, 16	1 = 1	Copies for office record, made from originals in the possession of the Commissioner of Soonderbuns.
Map of Hazara	2 = 1	Tracings for the Commissioner, Peshawur Divn.
Map of Eusofzaie	2 = 1	
Lithographed Maps, colored...	various	1356 copies for issue to Govt. officials, and sale.
Atlas Sheets	4 = 1	182 ditto ditto.
Photographed Maps	various	106 ditto ditto.

LARGE SCALE PLANS OF CANTONMENTS AND CITIES.

	Inches Mile.	
Meerut Cantonments...	6 = 1	Reduced from 8 to 6 inches = 1 mile; completed.
Hazareebagh Cantonment	6 = 1	Ditto ditto nearly finished.
Fort of Gwalior, with the country 3 miles round and Cantonment of Morar... ...	6 = 1	Ditto ditto; the drawing of Hills remains to be done.
Murree Sanatarium	6 = 1	Reduced from 10 to 6 inches = 1 mile. Hills to be drawn.
Dalhousie ditto	6 = 1	Ditto ditto ditto.
Cantonment and City of Lucknow	6 = 1	Ditto addition of Suburbs from recent Survey in progress. Reduced map in progress.
Dinapore Cantonment	6 = 1	Reduced from ; completed.
Ferozepore ditto	... ...	In progress; a copy of the original furnished by the Executive Engineer.

Copies of several Plans, Maps, and Sketches of various kinds have also been prepared by extra labour, for which payment has been made by applicant.

The out-turn of the Photographic Branch is embodied in the Statement following:—

Statement of Work performed in the Photographic Branch, Surveyor General's Office.

Class or description.	Original Sheets.	Subject.	Plates, Negatives.	Prints.	Size of Plates and Remarks.
Topographical and Revenue Survey Maps, Plans, &c.	3	Degree Sheets, Hydrabad Survey ..	6	24	16 × 18
	1	Ditto Ganjam and Orissah Survey ..	4	16	12 × 15
	9	Hydrabad Survey, 1 inch=1 mile ..	24	360	16 × 18 and 12 × 15
	5	Charts of the Coast of Arabia ..	38	152	12 × 15
	1	District Chittagong ..	6	120	16 × 18 and 12 × 15
	3	Sheets of Chota Nagpore Division Survey ..	18	36	12 × 15
	4	Degree Sheets of ditto ..	4	8	12 × 15
	5	Gwalior & Central India Survey, 1 Inch Scale..	31	305	12 × 15
	1	Ditto Degree Sheet ..	4	104	12 × 15
	4	District Lohardugga M. C. 4 ..	4	8	7 × 9
	1	Ditto Pergh, Pulamow ..	10	40	12 × 15
	3	Ditto M. Cs. 1, 2, and 3 ..	..	155	12 × 15. Reprinted.
	1	Purgunnah Dumoh ..	..	4	Ditto Ditto.
	1	Ditto Charwah ..	1	2	7 × 9
	2	Sheets 3 and 4 of Oudh ..	8	128	16 × 18
	10	Sheets of Hooshungabad Survey ..	10	20	7 × 9
	11	Village Plans of ditto ..	11	22	7 × 9
	..	Ditto ditto ..	11	22	12 × 15. Parts of each reproduced to scale.
	1	Plan of Sepree ..	1	2	7 × 9, reduced to ⅓th.
	1	Rampoor Jagheer ..	2	4	11 × 12, reduced to ½.
	1	Dumoh City Plan ..	2	2	12 × 12
	1	District Nursingpore ..	4	80	12 × 15
	4	District Dumoh, M. C. Maps ..	18	120	12 × 15
	1	City of Nagpore ..	4	16	
	1	Districts Tipperah and Noacolly ..	8	32	12 × 15
	2	Oudh (Southern portion) ..	14	52	12 × 15
Carbon Transfers to Stone.	1	Village Plan of Charwa ..	3	6	7 × 9. Experimental.
	1	District Hooshyarpore ..	9	9	12 × 15
	1	Pergunnah Mangurh, District Dumoh ..	8	18	12 × 15
	1	Plan of Kamptee ..	6	31	16 × 18 and 12 × 15
	1	Ditto Sepree ..	8	8	15 × 12
	5	Hill and Line Sketches ..	5	5	20 × 22 and 15 × 12. Experimental.
	1	Part of Dumoh District ..	..	5	
	1	Plan of Moradabad ..	4	4	
	1	City of Nagpoor ..	..	4	
	2	Sheets 3 and 4 of Oudh ..	..	14	
	3	Gwalior Survey, 1 inch=1 mile ..	18	18	12 × 15
General.	1	Topographical Drawing Specimen ..	6	6	Enlarged to four times the scale of original Plates 7 × 9
	1	Ditto ditto ..	4	50	Reduced to ¼th.
	7	Reductions of Type ..	7	7	7 × 9. Experimental.
	1	Conventional Signs ..	1	2	7 × 9. Reduced to ¼th.
	105		322	2021	

In addition to the above, several successful carbon transfers to stone have been made, and photo-lithographs produced of intricate Maps and Plans which, by the ordinary process of working on transfer paper and then transferring to stone, would have taken many months to accomplish.

The aid which the Photographic Branch of the Office now renders in the speedy reproduction of the results of our latest Revenue and Topographical Surveys, cannot be too highly estimated. During the past year copies of the Map of Chittagong and dependent Hill States, the Southern half of Oudh, comprising several Districts—Oonao, Roy Bareilly, Lucknow, Pertabgurh, Sooltanpore, Fyzabad, and Duriabad—and the Map of the Districts of Noacolly and Tipperah, have been reproduced from manuscript compilations and placed before Government; copies have also been freely circulated to local officers. Similarly, the 1 Inch=1 Mile and ¼ Inch Degree Sheets of several Topographical parties have also been reproduced and issued.

Lieutenant Waterhouse, who was appointed to the charge of the Photographic Office on 18th July, 1866, after studying the different processes employed in the G. T. Office at Dehra Doon, joined his appointment here on the 10th December, 1866.

Statement of the Works executed in the Surveyor General's Office, Lithographic Branch.

Description of Maps Lithographed.	Number of Maps or Sections.	Number of Stones used.	Number of impressions or Printings.	Maps transferred and not yet printed.
16 Miles = 1 Inch.				
Map of the Central Provinces and adjoining British and Native States, Sheet No. 1 ...	1	1	297	
Ditto ditto, Sheet No. 2 ...	1	1	275	
Ditto ditto, Sheet No. 3 ...	1	1	297	
Ditto ditto, Sheet No. 4 ...	1	1	303	
8 Miles = 1 Inch.				
Map of District Tipperah	1	1	325	
„ of District Fyzabad	1	1	100	
„ of District 24-Pergunnahs, Nuddeah, Jessore, and Backergunj	1	1	603	
„ of Saugor and Nerbuddah Territories ...	2	2	100	
Punjab Compilation Map, Sheet No. 1	1	1	.....	1
Ditto ditto, Sheet No. 3	1	1	.....	1
Ditto ditto, Sheet No. 4	1	1	.....	1
4 Miles = 1 Inch.				
Lahore Division Map	4	4	1,200	
Mooltan Division Map, Sheet No. 1	1	1	300	
Ditto ditto, Sheet No. 2	1	1	220	
Ditto ditto, Sheet No. 3	1	1	300	
Ditto ditto, Sheet No. 4	1	1	220	
Map of District Jacobabad, Shikarpore, and Rohree (in colors)	2	8	696	
Ditto Jhansie and Lulutpore, &c., in Bundlecund	4	4	1,000	
Ditto Backergunj (in colors)	1	1	440	
Ditto Saugor	1	1	300	
Ditto Derah Ghazee Khan	3	6	750	
Ditto Akyab	2	6	1,500	
Ditto Nowsherah	1	2	.....	1
Rajshahye Division	2	2	100	
Oudh Revenue Survey, Sheet No. 3	2	2	.....	1
Ditto ditto, Sheet No. 4	2	2	.....	1
2 Miles = 1 Inch.				
Districts Nagpoor and Wurdah (in colors)	4	8	2,800	
„ Mooltan	6	6	600	
Map of District Hoshyarpoor	2	2	.....	1
1 Mile = 1 Inch.				
Map of Main Circuit, Nos. 3 and 4, District Dinajpoor	1	1	300	
Ditto No. 9 ditto ...	1	1	300	
Ditto Nos. 1 and 2, District Akyab...	1	1	300	
Ditto No. 3 ditto ...	1	1	300	
Ditto No. 5 ditto ...	1	1	300	
Ditto No. 6 ditto ...	1	1	.....	1
Ditto No. 9 ditto ...	1	1	.....	1
Ditto No. 10 ditto ..	1	1	300	
Ditto No. 13 ditto . .	1	1	300	
Ditto No. 21 ditto ...	1	1	.....	1
Ditto No. 22 ditto ...	1	1	300	
Ditto No. 23 ditto ...	1	1	300	
Ditto Nos. 14, 15, and 16, containing part of the Tehree State, Bundlecund	2	2	.....	1
Carried over...	66	84	15,426	11

Description of Maps Lithographed.	Number of Maps or Sections.	Number of Stones used.	Number of Impressions or Printings.	Maps transferred and not yet printed.
Brought over...	66	84	15,426	11
Map of Main Circuit, No. 27, containing Northern part of the Oorcha State ...	4	4	.....	1
Ditto Nos. 22 and 23, containing part of the Tehree State, Bundlecund	2	2	.....	1
Ditto Nos. 18, 20, and 21, District Lulutpore	2	2	.....	1
Ditto Nos. 5 and 9, District Manbhoom	2	2	600	
Ditto No. 8 ditto ...	2	2	600	
Ditto Nos. 6, 7, and 10 ditto ...	1	1	.....	1
Ditto No. 12 ditto ...	1	1	.....	1
Ditto Nos. 13 & 14 ditto ...	1	1	.....	1
Ditto Nos. 16 & 19 ditto ...	4	4	.....	1
Ditto Nos. 11 & 14, District Backergunj	1	1	300	
Ditto No. 12	2	2	600	
Ditto Nos. 16, 20, 22, 23, & 24, District Backergunj	2	2	600	
Ditto Nos. 18, 19 & 21, District Backergunj	2	2	600	
Ditto No. 1, District Tipperah ...	1	1	.....	1
Ditto No. 2 ditto ...	1	1	.....	1
Ditto No. 3 ditto ...	2	2	600	
Ditto Nos. 4 & 6 ditto ...	2	2	.....	1
Ditto No. 5 ditto ...	1	1	300	
Ditto No. 7 ditto ...	1	1	.....	1
Ditto No. 8 ditto ...	1	1	.....	1
Ditto No. 9 ditto ...	1	1	.....	1
Ditto No. 10 ditto ...	1	1	.....	1
Ditto No. 11 ditto ...	1	1	.....	1
Ditto No. 12 ditto ...	1	1	300	
Ditto Nos. 1, 2, 3, & 11, District Nursingpoor	2	2	600	
Ditto Nos. 4 & 12, District Nursingpoor	1	1	.....	1
Ditto No. 5, District Nursingpoor ...	1	1	300	
Ditto Nos. 6 & 9 ditto ...	1	1	.....	1
Ditto No. 7 ditto ...	1	1	.....	1
Ditto No. 8 ditto ...	1	1	.....	1
Ditto No. 10 ditto ...	1	1	300	
1 Mile = 1 Inch.				
Map of Main Circuit, Nos. 1, 2, & 3, District Bhandara	2	2	600	
Ditto Nos. 4 & 5 ditto	1	1	.....	1
Ditto No. 6 ditto	1	1	300	
Ditto No. 7 ditto	1	1	300	
Ditto No. 8 ditto	1	1	300	
Ditto No. 9 ditto	1	1	.....	1
Ditto No. 10 ditto	1	1	.....	1
Ditto Nos. 23, 24, and 25, District Jubbulpoor ...	2	2	600	
Ditto No. 6, District Dumoh	1	1	250	
Ditto Nos. 1, 2, & 3 „ Seebsaugor	1	1	.....	1
Ditto Nos. 1, 2, 3, & 4 „ Darjeeling	4	4	600	2 Sections done remaining.
Gwalior and Central India for Topographical Survey Sheets, Nos. 16, 43, and 46	5	5	.....	3
District Nuddeah — Sheet No. 1	1	1	745	
„ No. 2	1	1	630	
„ No. 3	1	1	600	
„ No. 4	1	1	600	
„ No. 5	1	1	600	
„ No. 6	1	1	600	
„ No. 7	1	1	600	
„ No. 8	1	1	600	
Carried over...	142	160	29,051	37

Description of Maps Lithographed.	Number of Maps or Sections.	Number of Stones used.	Number of Impressions or Printings.	Maps transferred and not yet printed.
Brought over...	142	160	29,051	37
District 24-Pergunnahs, Sheets Nos. 1, 2, 3, 4, 5, & 6	6	6	.....	6
Map of District Sylhet, Nos. 2 and 3	2	2	.....	2
Oudh Division, Sheets Nos. 1 and 2	2	2	.....	2
Town and Cantonment of Jacobabad	1	1	100	
2 Plans of City and Cantonment of Roy Bareilly ...	1	1	100	
Military Cantonment, Town, and Suburbs of Akyab	1	1	100	
Plan of the Cantonment of Sanawar	1	1	174	
Ditto of Cantonment of Sabathoo	1	1	150	
Ditto of Kamty Cantonment	3	3	.....	1
Ditto of the City and Cantonment of Sepree ...	2	2	.....	1
Index Sheets of Map of Nuddeah	1	1	600	
Small of India (in colors)	1	8	3200	
Ditto ditto scale 200 miles = 1 inch	1	1	550	
Index to the Districts and Divisions of India ...	1	1	200	
Telegraph Map of India (small)	1	1	30	
Ditto ditto (in colors); scale 96 = 1 inch ...	1	2	12	
Interruption Chart of Telegraph, India	1	1	32	
Sketch Map showing the lines of Telegraph connecting India and Europe	1	1	.....	1
Sketch Map of Cachar, showing the grants of Lands under the Assam rules, &c.	1	1	1,000	
District of Beerbhoom, with the principality of Bishenpore	2	2	.....	1
British Burmah, Sheet No. 4	1	1	.....	1
Sketch Map of North-West Frontier of Punjab ...	1	1	.....	1
4 Sketch Maps showing the distribution of Deodar and other coniferous trees, &c., on the Chenab and Ravi in Chumlea territory	4	4	480	
Plan of Port Blair, Andaman Isles	2	2	.....	1
	181	208	35,779	53
MISCELLANEOUS MAPS, PLANS, &c.				
Sketch Map to accompany a report of the route passed over by the *Salween* Expedition; Map of Central Provinces for Mr. Temple's Report; Sketch Map of the Forest Tracts and Roads, Central Provinces; Cyclone Report Map, Plate II; Plans of Screw Mooring, &c.; General Map of Jherria Coal Field; Sketch Map to show the connected course of principal Rivers in Eastern Bhootan; portion of the Map of Rawal Pindee District; 2 Shujreh Maps of Lohardugga District; 10 General Sectional Maps to illustrate Dr. Vercher's Paper; 14 Sketches illustrative of the Floods in Beerbhoom District; 2 plans of Port Blair; and several small Plans, Sketches, Diagrams, &c.	81	82	24,995	
	262	290	60,774	53
Survey Department Forms, Circulars, &c.	.....	.....	123,056	
Memo. and Docket Forms, &c.	.....	.....	7,730	
Grand Total ...	.....	.....	191,560	

Lithographic Branch.

The out-turn of work in the Lithographic and Printing Branch of the Office is given in detail in the following Statement.

ABSTRACT.

Description of Works.	Number of Impressions.	Value or selling price.		
		Rs.	As.	P.
Divisional, District, and Pergunnah Maps, Plans of Towns, &c.	35,779	51,389	0	0
Miscellaneous Diagrams, Plans, Sketches, &c....	24,995	7,457	4	0
Survey Department Forms, Circulars, &c.	123,056	9,844	8	0
Memo. and Docket Forms, &c...	7,730	154	8	0
	191,560	68,845	4	0
Permanent Establishment		25,929	1	10
Contingent expenses		5,225	8	5
Extra ditto		2,231	1	6
Cost of Paper (estimated)		6,052	7	0
		39,438	2	9
Add 10 per cent. on cost of Stock, Stone, and for wear and tear of Machinery (estimated)		3,620	0	0
Grand Total		43,058	2	9

Of the Maps transferred to stone and not yet printed, but proofs of which have been taken and are under examination and correction, or are delayed for revision, there are no less than fifty-three; several of these are passing through the hands of the stone correctors, and will soon be ready to be struck off.

New presses, &c. Mr. Lawrence.

The greater portion of the new presses and stones referred to in para. 26 of my last Report have been received from England, and the remainder, it is expected, will soon be here. But before the additions to the stock of machinery can be employed, increased accommodation for the Press Office will be absolutely necessary. This subject will hereafter be referred for the consideration and orders of Government by the Surveyor General (Colonel Thuillier), who, since this Report was commenced, has rejoined his appointment.

Maps issued on service.

Five thousand and eighty-one copies of Lithographed and Photographed Maps and Plans, and the Engraved Sheets of the Indian Atlas, have been issued to Government officials on Service.

The following is the state of the accounts connected with the sale of Maps up to the 31st December, in continuation of para. 29 of my last Report :—

Dr. *Cr.*

	Rs.	As.	P.		Rs	As	P
Balance in hand or in deposit in Bank of Bengal as per printed Report for 1864-65	2,421	4	2	By amount transferred to the Government of India, vide No. 228, dated 27th June, 1866	5,000	0	0
Amount realized by sale of Maps and collection of Map Fees from 9th May, 1866, up to the 11th December, 1866, including Rs. 3,671-6-0 shown in last account, but not realized ...	3,801	10	0	By amount paid to the Collector of Benares for 5 Maps of Benares, vide No 301, dated 3rd August, 1866 ...	26	8	0
Amount deposited in the Bank of Bengal for copying Map	453	8	6	By amount of refund to Major Graham, vide No 203, dated 16th June, 1866	2	12	0
				Rs. As. P.			
				In Bank of Bengal, including Rs. 453-8-0 on account of Map copying 1,097 12 1			
				In hand in Treasure Chest... 273 0 6			
				Unadjusted balance ... 276 6 0			
					1,647	2	7
Total ...	6,676	6	2	Total ...	6,676	6	7

NOTE.—The following sums were due on account of sales of Maps on dates given below :—

Messrs. Thacker and Co., Account Sale to 6th December 1865, due 3rd March 1867	Rs.	1,069	10	3	Received and deposited in Bank since the above was sent to Press.
Messrs. D'Rozario and Co.		56	0	0	
Calcutta School Book Society		12	9	6	
Mr. D. Atkinson		8	0	0	
Officiating Collector, Dacca		6	0	0	
Total	Rs.	1,152	3	9	

JAMES L. GASTRELL, *Lieut.-Colonel,*

Offg. Deputy Surveyor General.

APPENDIX B.

EXTRACTS FROM THE NARRATIVE REPORTS

OF THE

EXECUTIVE OFFICERS IN CHARGE

OF THE

TOPOGRAPHICAL SURVEY PARTIES.

EXTRACT FROM THE NARRATIVE REPORT OF CAPTAIN A. B. MELVILLE, OFFICIATING IN CHARGE No. 1 TOPOGRAPHICAL PARTY, No. 35 A, DATED 25TH JULY 1866.

I reached Jeypoor on the 8th November, and remained there three or four days. During this time I had an interview with the Maha Raja, who, after some hesitation, sent a chéla or confidential servant with me to show me over the forts of Rimtimbour and Kundhar, stipulating, however, that I should take no European assistant with me, and should survey the forts and the adjacent country myself. I started from Jeypoor on the 14th November and reached Madhopoor on the 20th. Here I commenced plane tabling, and was engaged in this work till the 18th December. I visited both forts and surveyed accurately the ground about them on the inch scale.

Rimtimbour is about 5 miles from Madhopoor; it is an isolated flat-topped hill, situated amongst a mass of parallel ragged sandstone ranges covered with jungle.

To the north-east of it there is a very pretty valley containing two good sized lakes surrounded by easy sloping hills which break into very precipitous scarps on the sides opposite to the valley. On account of the ragged nature of the hills and the double scarp, the fort can only be approached by certain passes or gorges, all of which either have been or are fortified.

The position, though commanded by neighbouring hills, is naturally very strong on account of the difficulty of approach.

The only fortification consists of a curtain wall along the top of the scarp of the hill on which the fort is situated with bastions at irregular distances along it.

There are two zigzag approaches exposed in every direction to a flanking fire. The supply of water depends on tanks, but these are of great depth and do not dry up in the hot weather This fort is supposed to be of great antiquity, and is considered impregnable by the Rajpoots. Each of their principal clans as well as the Maha Raja of Jeypoor is represented by a Killadar in the fort, and the office is generally an hereditary one. The consent of all the Killadars has to be obtained before any thing can be done. There are a certain number of villages assigned for the support of the garrison. The garrison is local and consists of certain families who have remained in the fort for generations. In Rimtimbour it consists of 700 or 800 men. They are a very wild ragged-looking set and terribly addicted to opium eating, and by no means well armed.

There must be altogether in the fort some 40 or 50 guns. Those I saw were by no means of a large bore and very old, but I heard they had lately got some new cannon which they refused to show me.

Altogether, though in former days this fort must have been of great importance, it would not interfere with any future military operations, and would most likely only be a refuge for budmashes and rebels. The main roads between the Chumbal valley and Jeypoor Pass through Madhopoor, and this city once occupied, the fort would comparatively be of no moment. The city of Madhopoor seems formerly to have been a more important place than it is now; it is situated in a valley surrounded by hills and only approachable by certain passes, and there is still a considerable brinjari traffic through it, principally of Sambar salt, and it also lies on one of the main roads between Jeypoor and Kotah Boondi.

Kundhar fort, though not so inaccessible, is a stronger position than Rimtimbour; it is on an isolated hill about 2 miles distant from the nearest scarp. It is defended by only a curtain wall, and has one entrance defended by flanking fire. The guns in this fort are better and of a larger bore than those of Rimtimbour, and the garrison and Killadars are altogether much more smart looking and soldier-like. There is an abundant supply of tank water. The garrison is local like that of Rimtimbour, and consists of 400 or 500 men.

The town of Kundhar immediately below the fort, is a considerable place. This fort is of no importance in a strategical point of view, as, though it commands the Banas River where it leaves the hills, no main road of any sort runs up the river valley.

The Banas River, between the point where the Moreil joins it and its junction with the Chumbal, is dangerous on account of its quicksands, which are very treacherous and constantly shifting.

I took up a theodolite with me and established a station on the southern temple of the fort, as having obtained admittance I thought it as well to make a precedent, so many objections having often been raised to our having stations in the hill forts which often occupy the most commanding points.

Having completed my plane tabling and the observation of some obligatory heights, I proceeded to inspect all the assistants that I could conveniently on my way south to the Konoo jungle.

I inspected Messrs. Horst, Bolst and Murphy, north of the Chumbul, and Messrs. Chill, M'Carthy, and Esteve south.

I found the first 5 getting on very well, and the portion of work I examined in the field I found accurately and well delineated. Mr. Esteve, as I mentioned before, I had to recall to Head Quarters for further instructions.

The jungle on the left bank of the Konoo River, through which it had been found impossible to extend the triangulation as shown in the skeleton chart of 1864-65 extended over about 9 plane table sections between Lat. $\left\{\begin{matrix}25\ 15\\26\ 5\end{matrix}\right\}$ Long. $\left\{\begin{matrix}76\ 45\\77\ 15\end{matrix}\right\}$ and as I was anxious that these plane table sections should be taken up and completed this season, it was necessary to devise some way of supplying the plane tablers with points from which they could start and on which they could close their plane table traverses. On account of the level nature of the ground and height of the jungle it would have been impossible to carry on a minor triangulation, so I determined to fix the positions of all the villages that I could by traverse at the same time fixing poles in trees every 2 or 3 miles along the main roads.

The system I adopted was as follows: I started from a point whose latitude and longitude was determined, and wherever practicable I closed on another point fixed by triangulation. The difference between the latitude and longitude of the closing stations deduced by traverse and that obtained by triangulation, gave the total error of the traverse both in distance and Azimuth, and this error was easily divided off amongst the intermediate points by a rule of three sum, assuming that the error increased according to the distance traversed.

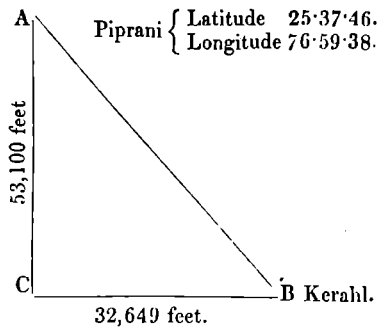
The co-ordinates of the different intermediate points from the initial station were first computed in feet and then reduced to minutes and seconds of latitude and longitude by table C in the Appendix of the Manual for Surveying.

These values added or subtracted to the latitude and longitude of the initial station according to their signs gave the latitude and longitude of each intermediate point, and a correction to bring these values into accordance with the true value of the closing station was applied as mentioned before.

This system of working traverse is as accurate as need be, simple and expeditious, and gives results quite close enough for the scale of survey, viz., 1 mile=1 inch.

The difference between the value of latitude and longitude as deduced from Table C and as regularly worked out in the usual form is shown in the next page.

The average error of the traverses appears to be about 50 feet in latitude and 50 in longitude per mile; considering these traverses were carried through very dense jungle where often with 10 or 12 cutters working a head, the rays were not above 200 or 300 feet, and where it was difficult to get over 2 or 3 miles a day, the error does not seem excessive.



To find Azimuth of Kerahl from Piprani

$$\text{Tan. A} = \frac{BC}{AC}$$

Log 32619 = $\bar{4}$·5138699
Log 53100 = 4·7250945

9·787754 = log tan. 31° 35′ 8″
∴ Azh. = 360°—31° 35′ 8″
= 328° 24′ 52″

To find base AB.

$$AB = \frac{BC}{\text{Sin A}}$$

Log 32619 = 4·5138699
Log Sin 31° 35′ 8″ = 9·7191416

4·7947283 = log 62334
∴ AB = 62334.

	Stn. A Piprani	Stn. B Kerahl
	λ 25·37·46	A 328·24·52
	L 76·59·38	Log c. 4· 7947283
P.	$\bar{3}$·9958854	λ = 25·37·46
Cos. A.	9·9303677	△ λ = —8·46·0
c.	4·7947283	λ¹ = 25·29· 0·0
δ¹ λ	$\bar{2}$·7209814	—525·9
Q.	$\bar{1}$·9976473	L = 76·59·38
Sec. λ	0·0449811	△ L = + 5·56.4
Tan. A	9·7887739	L¹ = 77·5·34·4
δ¹ L	$\bar{2}$·5523837	+ 356·8
Sin. λ	9·6360355	
δ¹ A	$\bar{2}$·1884192	+ 154·32
R	8·38043	π + A = 148·24·52
Sin. A	9·71914	△ A = + ·2·33·7
c	4·79473	B = 148·27·25·7
δ² λ	$\bar{1}$·08272	— 0·1
S	0·34366	
Cot A	0·21122	
δ² L	$\bar{1}$·64160	— 0·4
T	0·13903	
δ² A	$\bar{1}$·78063	— 0·6

By Table (C) Appendix of Manual Surveying.

Length of one (1″) of lat. in the mean latitude of traverse = 100. 95 feet.
Difference in lat. between Piprani and Kerahl = $\frac{531.00'}{100.95}$ = 526″0
Lat of Kerahl = –25° 37′ 40″. 0—8′ 46″ 0° = 25° 29′ 0″. 0
Length of 1″ of long. in the lat. of Kerahl = 91·61 feet.
Difference in long. between Piprani and Kerahl = $\frac{32649}{91.61}$ = 356·4
Long. of Kerahl = 76° 59′ 38″.0+5′ 56″. 4 = 77° 5′ 34″. 4.

Comparative results of two methods of computations.

	Latitude.	Longitude.
By Computation..	25—29—0·0	77— 5—34·4
By Table C.....	25—29—0·0	77— 5—34·4
Difference =	0— 0—0·0	0— 0— 0·0

These traverses were conducted with a 7-inch theodolite and two perambulators set to different readings to avoid error. These traverses also acted as a check on the plane tables as a regular traverse field book was kept; while only the latitudes and longitudes of a sufficient number of points were supplied them.

As in many portions of these jungles, tracts of several square miles exist where no ravines or detail of any sort are to be met with, the drainage passing over the surface of the rock, the instructions I gave to the plane tablers were as follows: to start from Trigonometrical or

traverse stations, and to work round along the roads in triangles of two or three miles the side. Thus no feature of the ground could be left out, as any ravine or watercourse in the triangle must intersect one of the sides, and when found could be easily followed up to its source. Between 60 and 70 stations were fixed by theodolite traverse in the jungle, including all the principal villages. I was engaged in traversing and distributing the new plane tables amongst the assistants up to the end of February, when I had to run into Gwalior to see the Political Agent.

The 2nd batch of plane tables were divided as follows:—

Mr. Horst took up plane table 48 between lat. $\frac{25-45}{26-0}$ and long. $\frac{77-0}{77-15}$ and a portion of 41 which had been left unfinished the season before. Mr. Bolst took up plane table 57 north of Shahabad. Plane tables 49 and 118 between lat. $\frac{25-30}{25-45}$ and long. $\frac{76-45}{77-15}$ were divided between Messrs. Chill, Allnutt and Murphy, and Native Surveyor Golam Mahomed.

Lieut. Samuells, Assistant Revenue Surveyor, directed to do 6 months' duty with No. 1 Party (*vide* Surveyor General's letter No. 459, dated 28th August 1865,) joined me just before I was leaving for Gwalior. I accordingly showed him a little of our style of working and directed him to meet me at Sipree on my return.

I reached Sipree on my return from Gwalior on the 16th February, and as I had been requested both by the Political Agent and by General Tombs commanding at Morar, to make a large scale plan of the Sipree city and cantonments, I set to work to make a minor triangulation assisted by Lieut. Samuells. This was completed in a few days, and I started Mr. Esteve and Native Surveyor Chooramun on the detail work. As Abdool Samud had been obliged to come into Sipree sick, and was unable to do hard work, I left him to assist Mr. Esteve and Choramun, both new hands, in case they got into difficulties.

I left Sipree on the 22nd February, and as I intended that Lieut. Samuells should take up the plane table left unfinished by Abdool Samud Khan, I marched with him to Shahabad and saw that he was perfectly competent to work independently before I left him.

From Shahabad I returned to the Koonoo jungles, where some more traverse points were needed. I inspected all the assistants at work, and found every thing progress ing favorably with the exception that there were several cases of fever. During the month of March, Messrs. Chill, M'Carthy, Allnutt, Murphy, and Esteve, and Native Surveyors Joala Pershad and Abdool Samud Khan all suffered severely from fever, especially Mr. M'Carthy. Many of the native establishment were also laid up. The cause of this fever I attribute to bad water. As the hot weather advances, the tanks and koonds in the jungle dry up, and water becomes very scarce. The little that remains is so contaminated by dead leaves, ordure of cattle, &c. that it often becomes perfectly offensive.

I returned to Sipree on the 18th March and directed Mr. Esteve and Native Surveyor Chooramun, who had completed their work, to proceed and assist Mr. Bolst, who did not expect to be quite able to complete his section by the end of the field season. I then marched south to inspect Joala Pershad; he was getting on slowly on account of fever, but his work, as far as I tested it, seemed accurate and good.

I then proceeded to Nimdant G. T. station, where there was rather a scarcity of plane table points; I accordingly fixed several more and then marched to inspect Lieut. Samuells. I found him getting on very well; he has a very good idea of delineating ground, and promises to make a very good topographical surveyor.

I left him on the 27th March, and proceeded north, inspecting all the assistants on my road. I reached Palpoor on the 2nd April and commenced plane tabling a square in the S. E. corner of Mr. Horst's table in the hopes of preventing a blank.

I had only been at Palpoor, however, two days when I received a letter from General Tombs, commanding at Gwalior, requesting me to arrange for a survey of the new cantonment at Morar.

This plan was required on account of the Government having sanctioned an extension of the cantonment of above two square miles. The number of troops in Morar is to be largely increased, and is to consist for the future of two Regiments of European Infantry, one Regiment

of European Cavalry, and three batteries of Artillery, besides Native troops. Formerly there was only one Regiment of European Infantry and no European Cavalry.

I accordingly marched to Gwalior, which I reached on the 8th, and proceeded to make a triangulation of the new ground taken up for the cantonment. This I completed on the 14th and proceeded to Agra.

It had been my intention to leave two Native Surveyors to complete the detail work of this plan, but the only experienced hands had suffered so severely from fever, that I was unable to carry out this arrangement, and had to leave the detail work to be carried out in the rains.

The camp reached Agra by the 18th April, and nearly all the Assistants were assembled by the 20th.

The extent of country surveyed, as shown in the accompanying statement is 2,395 square miles, the greatest portion of which is difficult ground, either covered with heavy jungle or intersected with ravines. Several blanks were unavoidably left in the jungle owing to the number of Assistants down with fever.

The delineation of the ground is fair, and I believe perfectly accurate. The plane table sections of Messrs. Horst and Bolst are, as usual, first rate; those of Messrs. Chill, M'Carthy, and Allnutt very fair, and the two latter show a great improvement on their last year's work.

Mr. Murphy's is fair for a new hand. Mr. Esteve wants considerable practice in drawing before he will be well able to delineate ground.

Native Surveyors Joala Pershad, Abdool Samud Khan, and Gholam Mahomed turned out very fair tables. Native Surveyor Choramun wants more practice but promises fairly as to his drawing. Abdool Soobhan had no opportunity of showing what he was capable of in plane tabling, as I had only time to instruct him for a few days, but he shows great aptitude for computation, and, together with Mr. Harris, was most useful in computing traverse field computations and in recording.

No extension of triangulation was made this year, in consequence of the very large amount the triangulation was in advance of the topographical details (*vide* Statement A).

The jungles on the top of the scarp on the left bank of the Koonoo which we have been principally employed this year in surveying, contain many more villages than we originally anticipated, and appear at some earlier time to have been much better cultivated than now. In one of the densest parts of the jungle close to the source of the Parung River I discovered an old Buddhist temple with some beautiful carving and a long inscription, copy of which I forwarded to the Asiatic Society, Calcutta. Large tamarind trees are also met with in certain parts, which are almost a certain indication of old village sites. The best cultivated portion and richest soil is the southern portion between Burgon and Rajpoor. North of Burgon there is scarcely any cultivation and only a few Sheriah villages, which are some times at a distance of 10 or 12 miles from the nearest water.

The timber consists chiefly of Sal, Sagoon, Taindoo, Mulkhero and Mowa. There are a few teak sapplings here and there.

Large quantities of gum are collected from the Sal trees, in fact it forms the main support of the Sheriahs, who exchange it with Buniahs for ottah. The gum is used in the manufacture of dyes.

The Sheriahs, who are the real inhabitants of these jungles, appear to be an aboriginal race. They seem scarcely to have any religion, and only intermarry among themselves. They are perfect wild men of the woods, go about almost naked, and subsist almost entirely on wild fruits and roots.

Their harvest season is when the Mowa berries are ripe; they are passionately fond of this fruit and regularly intoxicate themselves on it. They are very clever at wood cutting and are first-rate trackers.

A considerable revenue might be obtained by cutting timber in these jungles, floating it down the Parung and Koonoo rivers into the Chumbal during the rains, and forming it into rafts, which could easily be navigated down the Chumbal River into the Ganges

These jungles form a regular refuge for all the budmashes about, and there is one if not several bands of dacoits who go about cattle lifting and looting villages.

Heerapoor was looted only a few days before I reached it, and on one occasion my camp was threatened.

I cannot speak too highly of the assistance we were rendered by the Gwalior officials during the past season. It was a difficult thing to keep so many camps supplied with provisions in a tract of country totally destitute of supplies, but through the exertions of the Durbar vakeel attached to the Head Quarter's camp and the civility of the Sheopoor Soobah, Colonel Philose, we experienced no difficulty.

The traversing through these hot parched jungles under a burning sun, and with a hot wind blowing for a considerable portion of the time, was a most trying and laborious work, and I would respectfully beg to bring to the notice of the Surveyor General the good conduct of the Assistants both European and Native who always worked cheerfully and willingly.

These jungle tracts abound with wild beasts, especially tigers; a few lions also still remain about Palpoor. In some parts, but more especially about Shahabad, many villages have been deserted on account of man-eaters. Within the last three years upwards of 200 tigers have been killed by shooting parties from Morar and Goonah.

The principal portion of the recess has been occupied in the preparation of the triennial report, and in completing general maps. As will be seen in the statement, no computations are in arrears, and all maps for which complete materials existed have been compiled and sent in.

The proposed plan for next field season's operations is as follows. The Head Quarters and main portion of the party will be employed in Jeypoor territory between Latitudes $\left\{\begin{smallmatrix}26\text{-}0\\27\text{-}0\end{smallmatrix}\right\}$ and Longitudes $\left\{\begin{smallmatrix}76\text{-}30\\77\text{-}\ 0\end{smallmatrix}\right\}$. The remainder of the party under the military or Senior Civil Assistant will proceed south of the Chumbal into Gwalior Territory and fillup the blanks that were unavoidably left in the Koonoo jungles.

The triangulation will be completed as far east as 76° and south to 25° and will be taken up partly by the Executive Officer and partly by the Military Assistant, who will also check the detail work of the plane tablers.

During the recess Native Surveyors Joala Pershad and Abdool Samud Khan were sent to Morar to complete the detail survey of the large scale plan of the cantonment. This plan will be tested at the beginning of next field season.

Lieutenant Samuells, Assistant Revenue Surveyor, doing duty, left the Gwalior party to rejoin his own on the 1st of July, and Lieutenant C. Strahan, R.E., rejoined from the special survey he had been employed on in Bhootan on the 16th July.

EXTRACT FROM THE NARRATIVE REPORT OF LIEUT. C. STRAHAN, R. E., IN CHARGE BHOOTAN SURVEY, DATED 17TH MAY 1866.

Strength of the party.

The party consisted of myself, Lieutenant Holdich, R. E., in charge of a detachment consisting of 4 Corporals and 12 Sappers, and a Native establishment of 28 men in all.

Party leaves Dehra 11-10-65, arrives at Doobree 13-11-65.

The Native establishment left Dehra on the 11th of October 1865, and on the 13th the whole party including the Sappers left Roorkee by bullock train for Gazeeabad, and arrived in Calcutta on the 21st. It was not, however, until the 13th of November that we disembarked from the Government Steamer "Sir Wm. Peel" at Doobree, on the right bank of the Burhampooter.

Change of plans, in consequence of peace being concluded.

Here we received news that peace was just being concluded with the Bhooteahs, so I thought it better, instead of sending half to Buxa and half to Dewangiri as I had intended, to take the whole party up to General Tytler and ask him what he now wished us to do.

Party arrives at Kooch Behar 18-11-65.

Accordingly I marched the camp to Kooch Behar, where I left it whilst I went on by forced marches to the head-quarters camp at Tapsee.

Arrival at Tapsee.

On arriving there on the 20th November I reported myself to General Tytler, who referred me to Major Lumsden, Deputy Quarter Master General, and it was then decided that, having started Lieutenant Holdich from Chinchu La, the top of the range above Buxa, I should march across country to Dewangiri, if possible triangulating from the stations of the Assam longitudinal series on my road, and from there start another survey to work west to meet Lieutenant Holdich's.

Camp reaches Buxa.

I at once telegraphed to Lieutenant Holdich to bring the camp as fast as possible to Buxa, and he arrived on the 24th of November, having experienced a good deal of difficulty in getting good carriage. I, in the mean time, had employed myself in cutting the jungle on the top of the range at Chinchu La, in order to get an uninterrupted view of the hills. On the 28th November we had every thing ready to commence work, but the weather was so cloudy that even at sunrise we never could obtain a view.

Commence work from Chinchu La.

On the morning of the 4th December, we had, for about two hours after daybreak, a clear view of all the hills, and I was enabled to fix our position and start the plane table. We then marched towards Tapsee, hoping to find another clear point from which to fix the different peaks to which I had taken rays. On my arrival at Tapsee I was unfortunately attacked with fever, which laid me up for more than a week; I was able, however, to do a little work from the camp, but the weather was greatly against surveying.

Lieut. Holdich's work stopped by an accident.

Whilst I was ill, Lieut. Holdich unfortunately met with a severe accident from a stone falling on his leg, whilst climbing a steep hill, so that I was obliged to continue the work alone.

Return to Chinchu La.

As any expedition to the interior, beyond the point to which our troops had advanced, were strictly forbidden by an order from the Commander in Chief, and having filled in up to that point and as far beyond as possible, I, with General Tytler's consent, returned to Chinchu La, in order to make my way eastward along the hills, and to fill in the Dooars from that point to which Captain Austen had surveyed last year. Lieut. Holdich remained at Tapsee.

Started on expedition along Chinchu La range.

On the 26th of December I started with a flying camp to march along the ridge which runs in an easterly direction above Buxa, and after a good deal of difficulty, on account of the cloudiness of the atmosphere and the jungle, I reached the last point of the range overlooking the

Chinchu or Rydak at the point where it enters the Dooars. From here I had a splendid view, and was enabled to correct my work up to this point.

Return to Buxa.

On my return to Buxa on the 5th January 1866, I found Lieutenant Holdich at Buxa better but still quite unable to walk. Here I was again delayed by fever, but only for two or three days.

March into the Dooars and start Lieut. Holdich.

Having obtained 5 elephants from the Commissariat Department, the whole camp, except a few sick men under Corporal Gill (himself sick) who remained in Buxa, moved down to Santrabári at the foot of the hills, and the next day to Alipoor. Here I got a guide and interpreter and made a final separation of the two camps, Lieutenant Holdich's and mine. Lieutenant Holdich, being still unable to walk, and consequently unable to go into the hills, took the flat country south of the road running nearly east and west between Alipoor and Dutmah, whilst I took the hills and the country north of the road. I gave him all the points in the hills already fixed, and promised to send him any I might fix in future, that he might check his traversing whenever possible. I enclose a report of his operations from this time.

Work continued east of Alipoor in the plains.

From Alipoor I worked eastward, either by traversing with a small subtense instrument or whenever clear enough working with the plane table by means of the points I had fixed in the hills. In this way I worked up to Haldibari, a Police Station about 1½ miles west of the Sunkos Rivèr, from which place I found it necessary to make another expedition to the hills to fix more points and also to visit the Begoo Pass.

Start for the Begoo Pass.

Having, with some difficulty, obtained a guide, I started a flying camp carrying all supplies with us, and reached without difficulty the foot of the hills the first evening. The track, for it was not worthy of the name of a path, after the first 4 miles led us along the right or west bank of the Sunkos. It would be quite impassable in the rains as it runs now, but there is no reason why it should not run parallel to the river a short distance from the bank, so as to be out of reach of the floods, if it were ever necessary to make a road there.

Reach the hills near Begoo.

On the second day we left the river again, and early in the afternoon reached Begoo, having had some trouble in finding the path, which in some places had been obliterated by the jungle. Begoo was formerly a collection of a few huts, where the Begoo Soubah lived during the cold weather months whilst collecting the revenue from the villages in the Dooars; during the rainy season and hot weather it was deserted, the Soubah returning to Gedana, a day's march beyond; now nothing remains but a few charred posts. It is situated on a small plateau on the south side of a spur overlooking the plains, and about 300 feet above a small stream called the Sobraon; it is I should think, about 1,800 or 2,000 feet above the plains. Unfortunately my boiling point thermometer, although carefully packed in cotton in a box, beside being in its own case, had broken, and I was unable to test any heights.

Reconnoitre round Begoo.

From Begoo itself I found I was unable to do any thing, so I sent a party to reconnoitre up the ridge to the west, whilst I explored along the road to the interior. I found there was no difficulty in getting along the road except in one place where it had slipped down, but it was all through such dense jungle that nothing could be done in that direction.

March up ridge above Begoo.

The reconnoitring party having reported the ridge practicable we started the next morning, and after four days' hard work I succeeded in getting my plane table to the top. The latter part of the ascent was so rocky and the jungle was so thick that it was only by handing the table from one man to another and cutting every inch of the way, that we were enabled to get up.

Obtain a good view.

It was well worth the trouble, however, for the next morning it was beautifully clear, and I was enabled to take rays to hills far into the interior, almost up to the latitude of Andophorung.

Return to Haldibari.

Having finished at this point, I returned to Haldibari and worked my way again from here eastward to Rymana.

From here I had intended making another excursion into the hills, but I received a letter from Lieutenant Holdich saying that he had heard a report that there was to be an advance at once from Dewangiri to recover the guns; to ascertain the truth of this I marched on into Dutmah, but as it appeared from all I could hear to be a very small advance for only two or three marches, I thought it a pity to break off my season's work, and decided on continuing it until I heard something further.

Received news of a fresh advance from Dewangiri.

From Dutmah I visited Bishensing, the road to which I had great difficulty in finding as the jungle had so overgrown it that the guide could not keep to it. From Bishensing the principal road to the interior commences. The range crossed is higher than that at Buxa, but the hills are far less rocky, so that the whole road might be dug out with pickaxes and shovels, blasting being scarcely ever required. Bishensing itself is not so suitable for a depôt, as there is not so much room, and there is a scarcity of water, unless you go a considerable depth below where there is a large stream.

Visit Bishensing.

There is also a scarcity of water for a day's march beyond Bishensing, but after that my Bhooteah guide said there were a number of small streams continually crossing the path.

Scarcity of water on road.

The first village met with on the road is Chitta (called by the inhabitants of the Dooars Cheerung) which is three day's march from Bishensing. It is situated on a spur above the Sunkos River, here called by my guide the Poonootsampo, with apparently a good deal of level ground about it, but as I saw it from some distance, and from a great height above it, it was difficult to judge.

Village of Chitta or Cheerung.

I had immense trouble in getting a view at all here, on account of the jungle, for, the hills being less rocky here than in other parts I had visited, all the ridges and peaks were covered with high tree jungle, far too thick and heavy for my small party to clear.

Difficulty of getting a view, on account of jungle.

I did succeed in finding a tolerably clear point and from which I should have had a most extensive view, but unfortunately the weather was now (23rd February) so continually hazy that, even at sunrise, I had a very broken and interrupted view, so that many of the long rays I had previously taken and by means of which I had hoped to fix hills far into the interior were lost.

Obliged to return for want of supplies.

I could not stay another day to get a better view, as we were running short of provisions and were a long way from our supplies, so, fearing to push on to Chitta where I might have got a fresh supply of rice, as I had strict orders not to go beyond the outer ranges, I was reluctantly obliged to content myself with what view I could get then and to march back towards Dutmah.

On my return to Dutmah I found that more news had come about the advance, and that Lieutenant Holdich being at the time in Dutmah had marched at once to Dewangiri.

Lieutenant Holdich marches to Dewangiri.

After two days' halt at Dutmah to rest my coolies who were rather knocked up by the last expedition, I started again, March 1st, for Reepoo, about 11 miles east of Begoo, from which place, (Reepoo) there is a small pass into the interior. I had obtained a first-rate guide, and we reached Reepoo without mishap on the second day, but here my guide's knowledge ended, and I was obliged to find the path to the interior for myself. No regular path had ever been made, for the Bhooteahs had always used the bed of the river, up which I marched but was unable to find where the road left the river. For, after following what seemed to be the path for some miles, we suddenly lost all traces of men, and had to make our way to the top of the ridge as we best could. In going back I again looked for the path, but could not ascertain for certain where it ran, but I think the dotted line in the map must be approximately where it crosses the range. Here again I was unlucky in not getting a good view, for, although there were no clouds, yet the atmosphere itself was so thick that I could not see more than 10 or 12 miles.

Start for Reepoo.

This expedition filled in all the Dooars up to the Dutmah and Bishensing road, and I was now very anxious to meet Mr. Nicolson, to ascertain what he had done. On reaching the Alipoor and Dutmah road I found that he had unfortunately passed by a day or two before, whilst I was in the hills, and was by that time close to Kooch Behar. I understood, however, from him that he had filled in, in detail, all east of Dutmah, in which case the Dooars were complete.

Dooars finished.

Captain McGregor of the Quarter Master General's Department marched into Dutmah the same day as I did, on his way to Bagh Dooar to explore a short distance into the interior along an old and disused pass there, and to ascertain, if possible, the true course of the Madi Chu, (called in the old maps Mateesum), the river running under Pongso.

Captain McGregor's arrival at Dutmah.

I determined to accompany him to see whether I could not add something to that almost unknown part of the hills. Accordingly on the 15th March we started, marching through Sidlee and Bijnee, near which place we crossed the Monass, the eastern boundary of the Bhootan Dooars, having heard from Mr. Nicolson that the road on the eastern bank was easier and passed through more villages than that on the western bank, and that we should have no difficulty in recrossing at Matagoree the point opposite to Bagh Dooar.

Accompany Captain McGregor to Bagh Dooar.

We reached Matagoree without difficulty, but found that, unfortunately, on account of the melting of the snows, the river had risen and was now quite impassable even for unladen elephants, so that our expedition was brought to an abrupt termination, for there were no other fords in the whole course of the river, and the nearest ferry was two long marches off. The weather during the whole of this expedition was so hazy, that even if we had succeeded in crossing, I do not think I should have been able to do anything; for during no part of the 24 hours could we ever see above 10 or 12 miles. Captain McGregor continued his march to Dewangiri, and I marched back towards Dutmah to see if I could not carry on the work from there by traverse.

Reach Matagoree.

At Dutmah I was again attacked by fever, and finding my men falling ill one after another very rapidly I was obliged to remain quiet for a few days.

Attacked by fever at Dutmah.

On the 31st March there was a heavy storm and signs of the rains coming, so that I thought it was unwise to attempt entering the jungles with my camp in such a state of sickness, I, therefore, marched at once for the Burhampooter, where I got two native boats, on board one of which I took my sick men, sending the elephants and other classies to march to Doobree, where I met them again on the 5th April.

March to Doobree.

Here I heard that Lieut. Holdich and his party had passed down the river only the day before on board one of the river steamers.

Lieutenant Holdich passed Doobree day before my arrival.

Fortunately we had not long to wait for another steamer, for two days after the "Agra" called and took us up, landing us at Kooshtea on the 12th April.

Embark on board "Agra" and reach Kooshtea.

At Kooshtea, I found the classies belonging to Lieutenant Holdich's party in camp waiting for me, Lieutenant Holdich having proceeded to Calcutta with his detachment of Sappers. Most of these men I found down with fever, although they had been quite well on their arrival.

Meet Lieutenant Holdich's classies.

From Kooshtea we proceeded by rail to Calcutta, where nearly the whole party had fever more or less, and one classie died of cholera.

Proceed to Calcutta.

In Calcutta I discharged most of the classies, giving each of them a ticket to Allahabad, near which place they all lived. The remainder were men who came from Dehra or its neighbourhood, and accompanied me to that place in charge of the instruments, &c.

Discharged classies.

Arrive at Mussooree.

From Gazeeabad I came by dāk, leaving the classies (8 or 9 in number) to march up in charge of the Tyndal, and arrived in Mussooree on the 1st May 1866.

Lieut. Holdich's work.

Lieut. Holdich was very unfortunate in meeting with the bad accident I mentioned above, just at the beginning of the season; when we separated in the middle of January he was still quite unable to put one foot to the ground, and was frequently obliged to lay up to prevent the wound from getting inflamed. It, however, healed rapidly from that time, and by the middle of February he had quite recovered, but his work was then stopped by the news from Dewangiri, which induced him to march at once in that direction, so that he had only a month at work, most of which time he was unable to walk. This, and the fact that he had a most difficult country to survey, nearly all jungle, without any hills to assist, fully accounts for the small quantity of work sent in by him.

General description of country.

The whole of the country through which I surveyed, with the exception of patches of cultivation about Mahakalgoree, Hallibari, Dutma, and a few other villages, was covered with high grass or tree jungle, intersected by two or three large and an innumerable number of small rivers, all almost without exception running north and south. The jungle also extends over all the outer ranges of hills, until you get into the interior amongst the higher and rockier ranges.

The greater part of this jungle is completely uninhabited, indeed the whole of the country between Alipoor and Dutma road and the hills is now uninhabited, for the few villages there were formerly are now deserted and in ruins. There are two or three small patches cleared in the centre of the jungle where cotton is grown, but they are very small and cannot yield any quantity to speak of. The men build little huts of grass and boughs, and remain here during part of the cold weather, returning to their own villages when the rains begin. There is a good deal of Sāl and other timber in parts, which will be, I should think, of some value, as during the rains there is plenty of water in all the streams to float down any sized logs. Most of the jungle, however, seems to be utterly useless except to the sportsman.

General description of inhabitants.

The inhabitants of the villages in the Dooars appear to be all either Meches or Rajbunses, the Rajbunses being apparently the original inhabitants, and the Meches a tribe which has migrated there. Both races are characterised by great cowardice and extreme disinclination to assist a European. They carry this to such an extent that it is very difficult, even at a tolerably large village, to induce them to sell you any supplies at all; and if they see a European coming along the road, or even hear the report of a gun, they will sneak away and hide in the jungle like wild beasts. They are mostly very poor, living on rice and a good deal on dried fish, which they catch in great quantities in the small rivers by drugging the water, and also by means of long conical baskets made of bamboo. They keep large herds of cattle, but never milk the cows, the calves being always allowed to be with their mothers. Instead of ghee they use oil. They appear to grow very little besides rice; round the village they grow patches of the herb from which they extract their oil, and also plaintain trees. They live in small bamboo huts thatched with grass, the floor of which is generally formed of beaten earth 6 inches or 1 foot in height; but in some cases they are raised 4 or 6 feet on poles, and in most villages you will see one or two such raised huts. Very few Bhooteahs ever seem to live entirely in the plains, and those that do generally have some very good reason for it, such as their having deserted from some Soubah's service or been banished from their own country.

Description of Bhooteahs.

Of the villages and habits of the Bhooteahs themselves I know very little, as the only inhabited hill village I entered was Marichom, just beyond Tapsee; all the other villages I only saw from long distances with a telescope. They build very much larger and better houses than the men in the plains, either of stone and wood or mud, with overhanging wooden roofs, and generally of two stories.

Roads.

The roads through the Dooars are of the rudest description. When running north and south, as most of them do, for there are few roads besides those that lead up to the hills, they nearly always follow up the bed of a river, so as to avoid going through the jungle. It is very tedious work, however, marching all day over round stones, and there is generally a path to be found along one bank or

the other. When going through the jungle they are mere tracks, very difficult to follow, as the tracks made by the wild animals are often as plain if not plainer. In the hills the only road of any importance that I marched along was the Bishensing road; up to Bishensing (about 2,000 feet above the plain) it was excellent, and for half a day's march beyond it, above that it was one mass of fallen trees and bamboos, blown and broken down by a violent storm of wind and snow which had passed over two or three days before I went there. The road itself was very good, but the fallen jungle was so thick that it made it harder work getting along it than it would have been had there been no road at all. I visited two other small passes, the Begoo and Reepoo mentioned in the body of the report. The Begoo road, as far as I was enabled to explore, was perfectly practicable for laden coolies but not for baggage animals, and was still in very good repair, except in one place where the face of the hill had slipped down, carrying away the road, but this could have been repaired in an hour or two. The village of Gèdana is one day's march from Begoo, and beyond this again is Dagana, the residence of the Daga Pilo. I was never enabled to see these villages, and can only guess at their position from the information given me by my guide. From Dagana there is said to be a road which joins the Bishensing road at Chitta, but my guide did not seem to be very clear as to his knowledge of this part of the country, for he had never been there and only spoke from hearsay. About the Reepoo Pass I could find out very little. It is apparently a very small and unimportant pass, probably only leading to one or two villages in the neighbourhood.

Bishensing road.

Begoo road.

Reepoo road.

The large road running from Alipoor eastward has been made by us, but in many places it is very difficult to get along on horseback, on account of the numerous unbridged nullahs, some of which are very muddy and awkward to cross. The large rivers are crossed in boats made of a trunk of a large tree hollowed out, or rafts made by binding a bamboo platform on two or occasionally three of these boats.

Alipoor and Dutma road.

The only rivers of any size which fell into my work were the Rydak (Bhooteah name Chinchu) and the Sunkos (Bhooteah name Poonootsampo); both these rivers take their rise in the snowy range. The Chinchu flows by Chupcha, Marichom, and Tapsee, soon after passing which place it flows in a south-east direction until it enters the Dooars, when it again flows south and takes the name of the Rydak, branching out into numerous channels and flowing over a stony bed. It is unfordable by men, but fordable in most places in the plains by elephants. The water is beautifully clear and cold, and runs in a strong stream. In the hills the Bhooteahs formerly had several cane bridges thrown across, or cages slung on cane which were pulled backwards and forwards. There is one such bridge still in existence below Marichom.

Rivers.

Chinchu River.

The Poonootsampo flows from Poonakha, by Andophorang and Chitta (Cheermy) and out into the Dooars near Begoo, when it changes its name to the Sunkos. It is considerably larger than the Rydak, and flows through the Dooars in a very wide stony bed, and frequently breaks up into numerous channels; it is fordable by elephants in the plain, but in the hills can only be crossed by bridges. Neither of these rivers would be of much use as navigable rivers near the hills, on account of the strength of the stream and the rapids.

Poonootsampo River.

The next most important rivers were the Saralbanju which rises near Bishensing, the Longa and Gongya which flow near Dutma, the Godadhar, Sekoo and Naoning which run between Mahakalgoree and Alipoor. Many of these smaller rivers are very awkward indeed to cross even on elephants, except at the regular fords and ferries, on account of the soft muddy banks; at Haldibari, I very nearly lost an elephant in a little stream not more than one foot deep in water, but the bottom was such soft mud that he sank and rolled over, and we were obliged to cut his load off him before he could free himself. All the large rivers flow over stony or sandy beds.

Other smaller rivers.

The difficulties of surveying a country so covered with jungle and in such a cloudy atmosphere were very great. In the hills no assistance could be obtained from natives, as that part of the country was uninhabited, and even where there were Bhooteah villages the men appeared

Difficulties of carrying on the survey.

never to leave the roads, so that guides to the tops of the ridges were not to be had ; this frequently caused great loss of time and inconvenience. Then again, when the top of the ridge was gained, it was frequently so covered with tree jungle as to be useless for survey purposes, and more time was taken up in searching for a clear spot, or one sufficiently so for my small party to manage. The place being prepared, a view was never obtained except at day break and for an hour or so after sunrise, which necessitated sleeping on the spot, frequently at long distances from water. All supplies, too, had to be carried, which added greatly to the number of coolies required ; and it was very difficult to keep up communication with the depôt. I generally left at the foot of the hills, for I could never tell for certain where I was going to be two days in advance, as so much depended on the state of the jungle ; there were no roads, and we frequently cut a path through the jungle for miles. Great quantities of wild elephants and rhinoceros frequent the outer ranges of hills, and the paths made by them assisted us a good deal.

Instruments used.

In the Dooars when practicable I always worked with the plane table, by means of the hill points, but when the hills became invisible I carried on the work by traversing with a small subtense instrument. In the hills every thing was done with the plane table.

Sickness during the season.

Most of the season I had very little trouble with fever amongst the men, and it was only towards the end that I had many patients, and then they all seemed to break down at once. Lieutenant Holdich had the misfortune to lose one Corporal and one Sapper, who died, the one of fever and the other of cholera ; I lost one classic of cholera in Calcutta, but no men with me died of fever, although several are still ill.

I have just received a notice of the despatch of the maps and traverses done by Mr. Nicolson which should arrive here in a day or two. These will enable me to make up a map of the whole of the Eastern Dooars as far as the Monass River, and east of that has been already surveyed by the Revenue Department. There is, however, a bit of the hill country between the Saralbanga and Monass Rivers yet unsurveyed, about 40 miles in length.

EXTRACT FROM THE NARRATIVE REPORT OF J. MULHERAN, Esq., SURVEYOR IN CHARGE No. 2 TOPOGRAPHICAL PARTY, DATED 21ST AUGUST 1866.

A survey of the boundaries of the four districts of Berar having been authorised in your letter No. 457 of the 28th August 1865, it became necessary to arrange for this in connection with the completion of the Topographical Survey of the Upper Godavery district, and the re-survey of a portion of the old survey of the Mahore Circar adjoining the Pemganga.

The Upper Godavery district having been triangulated during the previous season, and the points required for the several boards projected before closing office, Mr. Senior Civil Assistant Chamarett was detached on the 10th November to Sironcha with four Sub-Assistants, and two Native Surveyors to complete the topographical details of the Talooks of Nugur, Albaka, Cherla, Badrachelam, and Rakapali; and a portion of the Kummamet Circar, comprising 1,879 square miles of country, the whole of which, excepting that immediately djoining the principal rivers, is over-run with heavy forest.

The successful mode in which Mr. Chamarett effected the survey entrusted to him, having already been brought to your notice in the Narrative Report submitted with my letter of the 17th April, I have only to add that the whole of the plane tables were submitted for the inspection of the Deputy Commissioner of the Upper Godavery district, to whom the peculiarities of the ridges and valleys adjoining the Godavery are well known, and that they elicited his entire approval particularly the portion completed by Mr. Chamarett himself.

The following is the extent of work completed by each Assistant and Native Surveyor:—

	Sq. Miles.
Mr. Senior Civil Assistant Chamarett	321
„ 2nd Class Sub-Assistant Ogle	310
„ 2nd „ do. Scanlan	314
„ 2nd „ do. Chennell	207
„ 3rd „ do. Maine	216
Native Surveyor Ramchander	356
„ „ Janardan Rao	155
Total Area Square miles....	1,879

Portions of the above Mr. Chamarett was requested to have re-surveyed by Assistants employed upon adjoining boards. In his report he refers to the work entrusted to each, and to the tests applied to satisfy himself regarding the general correctness of all that was completed. As he, however, omitted to notice in detail the differences in the re-survey of portions of the work completed by Mr. Second Class Sub-Assistant Chennell and Native Surveyor Ramchander, I requested Mr. Senior Civil Assistant Neale to supply the omission, and beg herewith to submit that Assistant's report accompanied by copies of the re-surveys to which he refers.

The boundary survey of the four districts of Berar, and the re-survey of a portion of the Mahore Circar, was undertaken by myself, and the following Assistants:—

Mr. 1st Class Sub-Assistant	Farrell.
Native Surveyor	Pandarao.
Do. do.	Baparao.
Do. do.	Shaik Omar.

Mr. Farrell was detached on the 20th November from Anjangao, to select and clear the required points between the stations of Wai and Saoli, of the Poasad Triangulation by Mr. McGill, and the stations of Omri and Salwa of the Omerkin* Triangulation adjoining Mahore. Between the 20th November and 14th December, we selected and cleared 27 stations, the observations to which I completed on the 20th December. Mr. Farrell rejoined

* Originating from the Great Arc side "Sukli to Bitergnon."

me at Wakori on the 16th December, and after assisting me to compute the results of the triangulation, and project the points required, was detached to fill in the topographical details between the villages of Toudgao and Ansing, embracing about 70 square miles.

Mr. Farrell was subsequently employed in tracing the southern boundary of the Maiker district between the villages of Gandriwara, and Hinra, a distance of 233 miles, which he satisfactorily completed before returning to quarters.

Native Surveyors Pandarao and Baparao were detached on the 20th November with a suitable party, and a portion of the lithographed and plane table section sheets, to trace the boundaries dividing the southern from the northen districts, agreeably to the directions given by the Surveyor General in letter No. 2 of the 20th January 1863.

Pandarao commenced his trace from the village of Borgao on the Warda to Scola, near the junction of the boundaries, of the Omraoti and Akola districts; and from thence to the village of Chaosala near Anjangao, a distance of 169 miles, upon which he was employed for a period of 51 days, including the time occupied in marching from Ellichpore. He then returned to Scola and proceeded west, tracing the line that separated the Akola district from that of Maiker as far as the village of Chunpipri, a distance of 170 miles. From this point, agreeably to instructions, he rejoined me at Borhanpore, and was again detached to trace the line of railway running through Berar as far as the Warda, a distance of 139 miles, which he satisfactorily completed, marking the several stations on the line, and outlining the extent of ground attached to each before returning to recess quarters.

Baparao commenced his trace from the village of Hukli on the boundary of the Wone and Maiker districts, and continued the same to Kini, a distance of 70 miles, upon which he was employed for a period of 24 days. From Kini he was detached to Worajagad, a distance of 140 miles, and directed to return to Waroda by the Pemganga River, the southern boundary of the Wone district, a further distance of 200 miles, and to outline the boundaries of such villages of the Wone district, as paid revenue for land situated to the south of the Pemganga, which river was, with the consent of the Nizam's Government, made the boundary of the south-eastern portion of Berar. The object of this trace was to ascertain by personal inquiry, whether, in adopting the Pemganga river as the southern boundary of the Wone district, any notification was necessary as regarded land, the revenue of which was paid partly to the Nizam's Government, and partly to the administration of the Hyderabad Assigned districts.

Statement A, herewith appended, will satisfy you that four of the villages of the Wone district are situated to the south of the Pemganga, and that the land attached to four others is situated partly to the north and partly to the south of that river. Also, that about 800 Beegas of land, Moglai measurement, north of the Pemganga, is cultivated by the inhabitants of four villages belonging to the Nizam's territory, and the revenue collected on account of the same paid into the Yotmahl Treasury.

The boundaries of the several villages above referred to have been outlined in traces No. 7 of the Maiker District, and Nos. 10, 11, and 12 of the Wone district of the boundary survey of the four districts of Berar referred to in another portion of this report.

I would add that as the deserted Pergunnah of Korta has been re-transferred to the Nizam, the boundary of the Wone district leaves the Pemganga at the point marked A, and returns to the same at the point marked B, as shown in trace No. 9 of the Wone district boundary.

Subsequent to completing the boundary trace of villages south of the Pemganga, Baparao was directed to outline the boundary of the Maiker district, west of the village of Warodi, and extending as far as the village of Gonderwari, near Rissore, a distance of 80 miles, which he satisfactorily completed before returning to quarters.

The following is the extent of secondary triangulation completed by myself and Native Surveyor Sheik Omar. The whole of the stations were easy of access, and no difficulty of any kind was experienced in procuring provisions; the greater portion of the tract adjoining the Pemganga being highly cultivated, and fairly populated:—

	Square Miles.
Secondary Triangles	34
Area of Triangulation.....	195

The angles were observed with 12-inch theodolite No. 10 on Zeros 0°. and 180°. The signal used for hill stations was the usual pole and brush supported by a large pile of stones. The station was sometimes marked on the rock *in situ*, and sometimes on a stone buried in the ground.

The average error of the common sides is under 0·27 feet per mile, and the following are the differences exhibited in closing upon the following sides of Mr. McGill's triangulation of season 1857-58.

	Log. of feet.	Feet.	Miles.	
Wai H. S. to Saoli H. S.....	4·2029026....	15955.....	3·022	By Mr. Mulheran.
Do.	4·2028230....	15952.....	3·021	By Mr. McGill.
Difference.....	796	3	1	
Wai H. S. to Manjerjaola H. S.	4·4815039....	30304	5·740	By Mr. Mulheran.
Do.	4·4814093....	30298	5·738	By Mr. McGill.
Difference.....	946	6	2	

	Latitude	Longitude.	
Wai H. S.....	19° 58′ 14″ 03.	77° 17′ 6″48.	By Mr. Mulheran.
Do.....	14·14	6·67	By Mr. McGill.
Difference.....	0·11	0·19	
Manjerjaola H. S.	19° 56′ 25″. 22.	77° 22′ 2″.62	By Mr. Mulheran.
Do.	25·29	2·73	By Mr. McGill.
Difference.....	0·07	0·11	
Saoli H. S.....	19° 57′ 38″.72.	77° 19′.49″. 54	By Mr. Mulheran.
Do.	38·79	49·69	By Mr. McGill.
Difference.....	0·07	0·15	

The above employed me from the 10th November to the 24th December, including the time occupied in marching to Yotmahl and Bassim, and having the Commissioner's instructions regarding the transfer from Wone to the Omraoti and Akola districts of all villages through which the Nagpore dāk road passed.

The object of this transfer was to prevent the constant questions that were raised regarding the police jurisdiction of the two districts when robberies were reported by travellers proceeding to Nagpore, portions of the road being in the Wone, and portions in the Omraoti district.

After completing the triangulation that was required for the re-survey of a portion of the old Hyderabad Survey, and detaching Mr. Farrell to complete the topographical details of the same, I proceeded to Hingoli, Lunar, Maiker, the Sudder station of Janiphal, Chikli, and Baragaon, making inquiries regarding detached villages south of the general boundary of the Maiker district, the Commissioner having expressed a wish that these should be outlined with a view to his recommending that they might be exchanged for others adjoining the general boundary.

The only village belonging to Maiker that is not included within the general boundary of that district, is the one known as Bara Kini, which Mr. Farrell has outlined, and which I have marked in trace No. 3 of the Maiker district as being 2 miles west of the Maiker boundary.

From Baragaon I returned to Otra-de-peit, and after arranging with Mr. Farrell for what was required, proceeded to Akola to receive the instructions of the Commissioner regarding the mode in which he wished me to assist in the settlement of the dispute regarding the boundary of Makote, and to procure from the office of the Deputy Commissioner

a copy of the lithographed sheet required for outlining the boundary of a portion of the Bathalwaddy Circar.

From Akola, after hearing of the satisfactory progress of the several parties employed in outlining the boundaries of Berar, I proceeded to Borhanpore to await the arrival of the Boundary Commissioners, who had been directed to meet at that place prior to proceeding to the ridges adjoining Jeitghar and Makoti.

Shortly after my arrival at Borhanpore, Native Surveyor Pandarao reported the completion of his portion of the boundary, and was again detached to trace the line of railway running through Berar.

From Borhanpore I accompanied the Boundary Commissioners to Chunkari, one of the villages near which the boundary of Jeitghar was declared to run, by people interested in the retention of the northern slopes of Makoti. While moving over the lower ridge of the Chunkari plateau with the Boundary Commissioners, the branch of a tree swept Captain Farrell and myself off the back of the elephant, severely injuring my side and back, and intensifying for a considerable period the ordinary difficulty experienced in breathing while ascending hills.

The inquiry instituted by the Boundary Commissioners at Chunkari, having resulted in their confirming the correctness of the boundary of Makoti as outlined by my party, a report detailing the origin and progress of the dispute between the border Chiefs of Jeitghar and Zeinabad, and the gradual encroachment of the latter from the limits of Manjrote to the principal village of the Makoti Pergunnah was submitted for such orders as the Resident of Hyderabad and the Chief Commissioners of the Central Provinces considered necessary.

I am not aware whether the recommendation of the Boundary Commissioners regarding the whole of Makoti, as outlined by my party, being made over to Berar has been acceded to; or whether the evidence recorded regarding the sale of Makoti, as well as Jeitghar to the Soubah of Borhanpore, will render further inquiry necessary. As all, however, admitted that the father of the late Rajah held Jeitghar in Jagheer from Scindia, and Makoti from the Nizam, it is difficult to understand upon what grounds any sale of the Jagheerdar's lucs and roosūms, even if proved, can affect the sovereign rights of the Nizam to the whole of the Pergunnah of Makoti.

The following computations, plans, and maps have been completed, or are in progress of completion :—

Computation of 34 triangles.	3 copies.
Do. of 50 deductions of latitudes and longitudes	3 copies.
Office copies of past season's field sections completed, with the exception of one table.	12 sheets.
Chart of triangulation with numerical data, season 1865-65, scale 4 miles =1 inch	1 copy.
Duplicate Angle book, season 1865-66.	1 copy.
Boundary trace of the four districts of Berar, scale 1 mile=1 inch	44 slips.
Index map of ditto, scale 16 miles=1 inch	1 copy.
Boundary map of four districts of Berar supplied to the Commissioner	1 copy.
Duplicate copy of register of villages, season 1865-66.	1 do.
Register of villages adjoining the boundary of each district of Berar	1 copy.
Duplicate copy of above.	1 copy.

Fair Maps.—Scale 1 mile=1 inch.

Map G, completed by Mr. Scanlan, but rejected on account of slight errors in graticule and in the tracing of the field sections. The duplicate has been traced and the streams half completed.

Map H, completed with the exception of the jungle and foot notes.

Map I, completed with the exception of the jungle and foot notes.

Map J, completed with the exception of a small area of jungle, heading and foot notes.

Map K, contouring of half the hills, foot notes and jungle remaining.

Map L, two-thirds of the contouring finished, foot notes and jungles remaining.

Re-survey map.—Mahore Circar—half the hills contoured, heading, foot notes and jungle remaining.

Quarter-inch map of G, H, I, J, K, and L, half the hills contoured, heading, foot notes and jungle required.

In furnishing the above list of the progress of the work, and of what still remains to be completed, it affords me much pleasure bringing to your favorable notice that Mr. Senior Civil Assistant Neale has been of the greatest assistance to me in affording instruction to the several Assistants and Native Surveyors of the party. He has taken a leading part in all that has been required, and has relieved me of much anxiety regarding the successful completion of what has still to be done. The fair map of the hilly portion of the Rakapali Talook has been entrusted to him, and will, I hope, afford you entire satisfaction.

Mr. Senior Civil Assistant Chamarett, I am sorry to say, has been unable to attend office with the usual regularity owing, he informs me, to his having suffered from fever and dysentery contracted in the forest near Rakapali. He superintended the projection of the ¼-inch and 1-inch maps of the Upper Godavery district during my absence on privilege leave. All but one, *viz.*, Map G have been passed as correct in the lines of projection, but I regret to add an infraction of departmental orders of 20th July 1864, and 6th April 1866, has occurred in not limiting each map on the 1 inch scale to 30′ of longitude and 15′ of latitude, and that on the ¼-inch to half degree squares.

In bringing this to your notice, I beg to express a hope that it will not lead to any inconvenience, and to solicit your kind consideration to the circumstances under which it took place.

A reference to the accompanying Sketch A will satisfy you that had instructions been strictly followed, the number of maps would have been increased from 6 to 14. This, although not adding greatly to the actual labour of mapping, would have entailed a considerable amount of extra printing. In this qualification the party is unfortunately weak, there being only two whose printing is sufficiently creditable for introduction into the fair maps, and of these the health of one is not particularly good. As regards the ¼-inch map no less than 10 on that scale would have been necessary owing to the peculiar position of the ground surveyed last season. This division would not only have rendered them faulty in appearance, but troublesome to connect, whether for purposes of compilation or photography.

Mr. Chamarett, Mr. Farrell.

In submitting the above for your favorable consideration, I have no desire to justify the departure from departmental orders, but simply to satisfiy you that the infraction originated in a desire to reduce the amount of labour required, and will not occur again unless a little latitude in these matters is allowed to Executive Officers.

Mr. Senior Sub-Assistant Smith resigned in September last year, and although re-appointed in November, he only rejoined the party in May. During the recess he has been employed in making 44 traces on the 1-inch scale of the boundary survey of the four districts of Berar, in outlining an index map of the same on the scale of 16 miles to one inch, and in drawing up a description of the boundary of each of the districts, which I beg herewith to submit with a rough copy of the index map of the 44 traces. Mr. Smith has always given me the greatest satisfaction, both in the field and in quarters, and would, but for his unfortunate persistence in resigning, have merited the promotion that he was promised by the Surveyor General in February 1865.

Mr. Smith.

Mr. 1st Class Sub-Assistant Farrell has been of great assistance in completing the fair maps, being nearly, if not quite, equal to Mr. Chamarett in printing. He has always given me satisfaction, being attentive to his work, and careful in completing what is entrusted to him.

Mr. Farrell.

Messrs. Ogle and Scanlan are very efficient Sub-Assistants. Both have been lately promoted to the grade of 2nd Class Sub-Assistants, and are very attentive to their work.

Messrs. Ogle and Scanlan.

Mr. 2nd Class Sub-Assistant Chennell is very anxious to give satisfaction and promises to be an efficient Sub-Assistant. At present, although attentive to his work, and regular in his attendance at office, he is somewhat thoughtless in his habits, which I am trying to correct. I intend to employ him under my own eye during the approaching field season, and hope to be able to submit a favorable report of the secondary work entrusted to him.

Mr. Chennell.

Mr. 3rd Class Sub-Assistant Maine has been attentive to his work, and has given satisfaction, notwithstanding the accident to the fingers of his right hand. I intended to employ him under Mr. Chamarett upon secondary triangulation, and hope to be able to recommend him at the close of the field season as deserving of promotion to the next superior grade.

Mr. Maine.

The Native Surveyors have all given satisfaction both in the field and in quarters, particularly Ramchander and Pandarao. I have explained to the latter the prospects held out to them in your letter of the 10th July 1866 on condition of their serving in Bengal, but have been unable to overcome their aversion to leave the Central Provinces and the Deccan. I should greatly regret losing their services, and beg to recommend a small increase to their salaries to prevent their looking elsewhere for employment.

Having enumerated the several maps that I hope to be able to submit before taking the field, I beg to enclose a sketch of the extent of triangulation that I am in hopes of completing during the approaching field season. My object in taking the eastern portion of the work is to enable me to furnish the most satisfactory sides for extending the triangulation to the east. That entrusted to Messrs. Neale and Chamarett will not extend beyond the sides of the great arc series. I have applied to Captain Oakes for a trace of the southern boundary of his survey and to Mr. Shelverton for a sketch of his triangulation. Both have promised what I applied for.

I beg to add that as great inconvenience will arise from my leaving any portion of the unsurveyed tract referred to in your instructions of the 10th ultimo untouched by the triangulation, I intend to fix as many points as possible in the portions that will ultimately be taken up by the Revenue Survey. This will enable me hereafter to add such tables to my own portion of the work as may be considered necessary, and will also furnish points for the satisfactory connection of both surveys.

I beg to submit a skeleton progress map on the scale of 16 miles=1 inch, showing area surveyed by each Assistant during the season under review; also area surveyed prior to that season, with form of principal series.

I beg also to submit a tabular return of work completed agreeably to the form furnished.

EXTRACT FROM THE NARRATIVE REPORT OF LIEUT. COLONEL G. H. SAXTON, IN CHARGE No. 3 TOPOGRAPHICAL PARTY, DATED AUGUST 1866.

After closing the recess duties last year we took the field on the 9th December with the strength given in the margin. This list differs from that given for previous season as follows: Mr. Raynor was ill and could not take the field, and as he subsequently resigned, must be considered as removed. Abdul Rayman dead, and Neelacuntam and Mahomed Ameen dismissed. This diminution of strength seriously affects the out-turn of work now being reported upon. The accession to the party has also been important. Lieutenant Downing joining as Military Assistant on the 19th November in time to take the field. On special application to the Madras Government I succeeded in securing the valuable assistance of a good 2nd Dresser or Native Doctor.

Lieut. Colonel G. H. Saxton, in charge.
Lieut. Downing, Military Assist.
D. Atkinson, Civil Assistant.
R. W. Chew, Sub-Assistant.
J. Harper, do. do.
F. Adams, do. do.
J. A. May, do. do.
T. Claudius, do. do.
Hidiatoola, Native Surveyor.
T. Leonard, Apothecary.
C. Appia, 2nd Dresser.

R. P. Rayner, S. A., did not take the field.

Arrangements for the field.

This being the first year we had recessed at Waltair, we found considerable difficulty in preparing our marching equipments. The dread of entering the Jeypore jungles was far more intense amongst the labouring classes of that district than we had found to be the case amongst the people of the more distant districts of Ganjam and Cuttack, we had to pay at much higher rates, and even then with greater difficulty obtained men and cattle, and in the matter of bearers so largely required, I was obliged to get them from Ganjam. This dread amongst the bearers was so great that I could not get men to accompany my camp for a few marches towards Vizianagram, the reason given being that they feared being taken on to the hills. I was greatly inconvenienced until the 50 men from Ganjam joined my camp about the 16th.

Instructions and orders to Assistants.

Lieutenant Downing as Observatory Assistant accompanied me for triangulation duties, and all the remaining hands were given plane tables; two tables, as usual projected by myself, were given to each, and instructions were issued how they were to assist each other in case of need, and the whole area given was divided so as to secure squaring off down to a continuous line of Lat. 19° 45′ below which work could be extended if found practicable. Each Surveyor received advance of pay for himself up to end of January, and public funds to cover the payment of his Government establishment and contingent expenditure until I might visit them later in the season. Mr. Atkinson, as Senior, was given a supervising authority over all during the time I should remain too far distant for immediate reference. His position amongst the others was fixed as central as could be, with the further object given to him of re-observing a principal angle of his own of a former season which I had reason to be dissatisfied with. The position given to Messrs. Claudius and Hidiatoola was that in which they had the previous season been employed under my own personal supervision. Messrs. Chew and Adams were instructed to watch over and assist these less experienced Surveyors.

Triangulation.

I commenced my duties by ascending "*Marapili*" H. S. of the Coast series G. T. S. On the 21st December I visited another hill station of my own in the plain near to boundary of surveyed and unsurveyed country, before ascending the ghauts, and then on 28th observed on "*Kumarai*" H. S., G. T. S. which is in the first range of hills. I then progressed through the highlands of Madagal and Jeypore, making numerous stations on the highest hills and in the cultivated valleys, until I fixed the principal station "*Andrahal*," in continuation of my former work, by a triangle whose sides are 34·4 and 39·7, on a base of 28·8 miles. This station is that connected with "*Kumarai*" G. T. S., also, by one intermediate "*Sinkram*" H. station, the two distances being "*Andrahal*" to "*Sinkram*" 36·4 miles, and "*Sinkram*" to "*Kumarai*" 15·4 miles. "*Andrahal*" is situated on the western extremity of the highlands, and looks down to the west, on the jungly plain of "Malkangiri, on north side of the Godavery

valley; as "*Kumarai*" does to the east, down on the plain of Vizagapatam Collectorate. The angle at Sinkram between these two principal stations, "*Andrahal*" and "*Kumarai*," is about 150°, giving a distance between the two just 50 miles, in a direction E. N. E. (which is about perpendicular to the general run of the highlands), as the breadth of the highest plateau at this part. This junction with the Coast Series is effected by secondary triangles, which will next season be made more complete by observations required on stations further south than I reached this season, but to which the observations have been carefully taken. In the field I approximately computed the triangles connecting the two series, and the coincidence in value was exact. The log of distance in feet differed only by a unit in the last place. From this I may anticipate a very satisfactory junction when it is rigorously computed. I have deferred that object until next season, because I found that the Coast Series stations, being along the most easterly points of the highlands, with the considerably higher hills immediately behind them, and over which my series must reach them, caused a great difficulty and perhaps impossibility, in effecting a symmetrical junction and moreover my series would have to be deflected across the 50 miles of highlands above shown, whereas by continuing the series south in my own direction, I shall come directly on to the Coast Series, in about the same distance, 50 miles. In the meantime the intermediate area is closely filled with points, laid down by the secondary operations. From "*Andrahal*," I fixed forward stations, and then descended the Western Ghauts, and visited "*Munas*" the most advanced principal station of my series, as yet observed on. From this position I turned north, making secondary stations all along the extreme western limit up to which I propose extending my survey during the next few years, that is about 81°-45′. On this duty I continued up to Lat. 19°-45′, where I reached my plane tablers' ground. During this progress I visited and completed the angles on my principal station "*Tulsi*." It was now close upon 1st March, and I had still to visit one principal station, and execute some further secondary work in the highlands to eastward, to fill up the ground bordering on the old Ganjam Survey, in about Lat. 18°-45′. I now commenced my inspection of detail Surveyors, on which I will remark presently, and in this place finish my notice of the triangulation.

Coincidence in Linear value on an approximate junction with Coast Series G.T.S.

Most advanced. Principal Station "*Munas.*"	
Lat.	18-20-29·43
Long.	82-0-9·72
Height	2,282 feet
to accord with G.T.S.	+ 23 „
Corrected value..	2305 „

Being alarmed at the state of the weather, which had become extremely hazy, I hastened to reach "*Sikma*" hill station by the new moon of 16th March, in hopes of favourable change about that time. Owing to the extreme dryness of the season, the burning of the jungles was earlier and fiercer than usual. By hurrying my movements as far as the state of my fatigued cattle, &c. would allow me, I managed to ascend the hill on the 16th, but all in vain, the weather continued quite prohibitive of observation to very distant stations until the 2nd April when I succeeded in getting the one principal angle which was a desideratum to my season's work. I also obtained other less important objects, which in the previous season had been missed, owing to the same cause. I now made all possible haste to get over the remaining observations before the weather again became unfavorable, and by the 6th April had visited three more stations, and closed work, and on the 9th descended the Ghats.

Detained by unfavorable weather on "*Sikma*" H. S. from 16th March to 2nd April.

The triangulation in advance is very considerable; that to the south will be more satisfactorily computed after further observation, and after a complete junction with the Coast Series, and so much will remain on hand for the present; but the quantity to be this season finally computed and submitted with chart, is far in excess of the requirements for the detail to be taken up next season.

General remarks.

In reporting upon this head I will go back to my own proceedings of 27th February: when I had reached the ground "*Dongar*" hill station was laid down last season, by intersection only, and this year was made the closing point joining the two seasons secondary trigonometrical operations. This station lies on the extreme S. W. corner of the space programmed for the season's survey, but owing to Mr. Raynor's failing at the last moment to take the field was not taken in

Detail Survey.

Lieutenant Downing executed in March 78 square miles.

hand. Lieutenant Downing, who up to this time, had ably assisted me in observatory duties, was directed to take up as much of this 15′ square, as he thought he could accomplish during the rest of the season. After visiting "*Dongar*" hill station together, and having projected his plane table, I left him on this ground to work in continuation of Mr. Chew's table.

Mr. Chew, 326 square miles.

Mr. Chew had, by my request, joined my camp, and I proceeded with him through his work making stations at several places; Mr. Chew looked wretchedly ill when he first arrived in my camp, but on my remarking afterwards to him that his appearance had so greatly improved, he said he was not ill when he came, but the change was the result of meeting some one after being so long alone in the jungles. Being satisfied with Mr. Chew's work and progress, I gave him particular instructions to visit and inspect Mr. Claudius, whom I had intended visiting this season, but found I could not manage it and fulfil the rest of my plans.

Mr. Claudius, 450 square miles.

Mr. Chew reports very satisfactorily upon Mr. Claudius' survey. During the previous season Mr. Claudius was my Observatory Assistant whilst triangulating his portion of ground with which he was well acquainted, and he received particular injunctions not to extend his work beyond what he felt his points were amply sufficient, on which to give good detail. His map is neatly executed. I visited this Surveyor during the two previous seasons, supervising his plane tabling personally, to a more than usual extent, and feel satisfied that his present season's duties are well done.

Mr. Adams, 450 square miles.

From Mr. Chew's board, I passed into Mr. Adams' ground. In these jungly tracts there is great difficulty in tracing the whereabouts of my Surveyors, when even within their boards, and I am generally many days finding them out, and accordingly send messengers some time before. On this occasion Mr. Harper reached my camp before I had seen Mr. Adams, who, however, came in during the day. Having them both with me, I arranged my course along the junction of their boards, from west to east, where they had both partially laid down the detail, and I had the opportunity of comparing and testing their work in that unfinished state. The weather was very unfavourable from haze, and the country very wanting in natural objects near enough to be seen, and made use of as plane table points, and thus I witnessed an extreme instance of the difficulty of surveying flat jungly tracts. Indeed under the circumstances and position we were then in, very little could be done, but I had much reason to be pleased at noticing the manner in which these two Surveyors questioned each other, and tested the position of places and objects mutually laid down on their tables, each explaining how he had been able to fix the position, balancing their respective values, and noting accordant items for final work. I request your favourable notice of the very large quantity of work executed by Mr. Harper this season; he voluntarily undertook more than his share, and persevered to its completion though suffering in health.

Mr. Harper, 549 square miles.

Hidiatoola, 458 square miles.

For the same reason as with Mr. Claudius, I was unable to visit Hidiatoola, as originally intended. On both of the two preceding seasons I personally inspected this Native Surveyor at his plane tabling, and have always been able to report favourably upon him in all respects. The ground given to him was, as before stated, where he had previous experience. It was, moreover, without features requiring much skill to delineate, and he was particularly warned not to extend his work, or give anything beyond what he was able to be sure of. When leaving Mr. Adams, I directed him to make an inspection of Hidiatoola's work, and particularly report to me on it. Mr. Adams reports very favourably upon it, as accurate and very fairly executed, as far as he looked into it.

Mr. Atkinson, 419 square miles.

I then passed on into Mr. Atkinson's board and joined his camp. I found him, with his plane table in position, at work. I remained with him two days, during which we marched through his board and encamped beyond it. He made a few plane table stations as we went along, but the haze was so thick, that very little could be done.

Mr. May's position was rather out of the way for me to visit him, and would have taken up a good deal of my time, and perhaps inconvenienced him, as he was in a most difficult country for moving about. I visited Mr. May at his field work the previous season, and he bears the highest character, as a skilful draftsman, and careful Surveyor, and this season had resolved to limit the quantity to enable him to execute his map with more than usual accuracy and care. I anticipate your approval of his field maps, as evincing great care and labour.

Mr. May, 373 square miles.

The strength of my party as above given was made the most of for detail survey, of which the total amount, 3,103 square miles, is as much as could be expected in such country, far more difficult than the larger area given in season 1864-65 when the party was considerably stronger as already shown.

General remarks.

Your reply, dated 28th February, to my last year's report did not reach me until too late to attempt to take advantage of your instructions this season. I was anxious to have a specimen of Lieutenant Downing's style of plane tabling, and moreover from the reduction in my strength, was unable to work up to my programme, and had an inconvenient corner which I could not otherwise square up with the other tables, and so my Military Assistant did not, as you would have approved of, assist me in making a more complete inspection of my Sub-Assistants. By the help of Lieutenant Downing and the extra exertion of Mr. Harper, the detail is squared off in a most convenient manner, and with the exception of the higher standard of testing called for in the above reply, and in your subsequent printed instructions, my season's operations are in all other respects complete and satisfactory, and everything in the best state for future progress. A great portion of the area surveyed is dense jungle, with considerable flats, and in these flat portions, trigonometrical stations are few, and even those with difficulty seen by the plane tabler. Every expedient of traversing between points capable of check is adopted by my Surveyors, and they make no pretension in such cases to a degree of accuracy which would stand a test, available and suitable in a country less difficult of delineation by means of a plane table. In the field with Mr. Harper, when discussing with him his mode of procedure, and the means at his disposal for laying down the detail in a portion of his ground, where he had to adopt unusual expedients, he remarked that he would guarantee the results of his work, to be within, I think he said, a tenth of a mile, of the truth; on reminding him now, he says he thinks, he said an eighth of a mile, and I had an opportunity of fairly testing with satisfactory result the position of a tree brush of his fixing under extreme circumstances. In such tracts of country, so frequent in my field of survey, the details required to be laid down are of minimum importance, being scarcely anything beyond the position of the villages, (mere hamlets of three or four huts,) and the general drainage of the country. I question whether it is desirable to adopt measures for more accurate delineation when, as I think will be the case, the success will entail an extra expenditure, far beyond the value of the object in view. I could point out portions of 10 or 20 square miles in extent, in the maps to be sent in this season, where I feel sure the position of villages and the run of minor watercourses, cannot with certainty, be accurate to within ¼ of a mile, but where, supposing them to be wrongly placed only to that extent, for all practical purposes, the error would be of no importance, though under a rigorous test it would appear very great.

The late special instructions on the subject of inspecting detail Surveyors and testing their work, too late for application this year.

The triangular error in the principal triangles is larger than usual. The maximum one of 12·64 is large for a 10-inch instrument, but I think it is accounted for by the ray between the two stations "*Sikma*" and "*Tulsi*" passing over very mountainous country, along the run of the ghats, separating the middle plateau of Jeypore and low country of Malkangiri, and especially near "*Tulsi*," the hills are very high, and the ray nearly impinges on the end of Tulsi Hill itself, at a mile or so from the station. All the angles were carefully observed to heliotropes. In the secondary operations I have all classes of triangles, but none far removed from the check of the principal series, and no error of appreciable amount. The heights are fairly accordant. I have computed on reciprocal vertical angles, between my principal station of "*Andrahal*," and the Coast Series H. S. "*Kumarai*"

Average Triangular error.

Heights.

Height of "Kumarai."
By Coast Series..... 3,984 feet
G. and O. Survey .. 3.961 „
Difference.... 23 „

through the intermediate H. S. "*Sinkram*" as described in paragraph 6. The discrepancy in my value, as compared with the Coast Series, is given in the margin. I will here remark that since season 1859-60 the operations of this party have had no check, and this discrepancy cannot be considered unsatisfactory, after six years' operations.

Cost per square mile estimated on detail only.

The cost per square mile, Rs. 20, is higher than usual with this survey. The reduced strength of the party being amongst the less highly paid detail Surveyors, on whose work alone the estimate is made, the increased strength being (the Military Assistant) of the more expensive form, giving little detail return, my own promotion, and the difficult nature of the country, all combined to raise the mileage rate. In taking a general, or individual view, of the labours of the year, there is no lack of energy, or outturn of work, and all are entitled to commendation. I would here record my opinion that the standard for mileage rate, as hitherto laid down, for cost of topographical surveys, has always been below what was possible in difficult country, and is now quite incompatible with the enhanced expenditure on every head, and higher standard of accuracy now called for.

Angle Books and Computations.

These are very voluminous, although much work of the present season will be retained. They comprise work executed by Lieutenant Armstrong and Mr. Atkinson two seasons back, and my own of season 1864-65, kept back for reasons given in my last report and approved of by you. This report being called for at so early a date, I am unable to fill up these items with completeness in the tabular form accompanying. The amount, however, may be stated as greatly in excess of that sent in any previous year, and will tax my office severely to get through.

Recess duties.

The recess duties are now progressing well. The computations are done chiefly by myself, assisted by Lieutenant Downing, Mr. Harper, and Mr. Claudius, and will be incessant during the whole recess. I anticipate your approbation for all our maps this year. The field maps are, I think, quite equal to the best yet submitted from this office, and the fair maps are being executed with every possible care; and in accordance with your instructions lately given. I beg here to remark upon the advantages of recessing in this climate: as usual my Surveyors returned from the field much shattered by fevers, and with a less favourable station would have taken much longer to recruit their strength.

Future plans.

For next season I propose to adopt a course very similar to that of the past season. I would proceed in the first instance in about Lat. 17° 30' to 18° 0 to complete my secondary triangulation, and effect my junction with Coast Series, which will only require two or three principal stations beyond those already fixed. Immediately west of this I would also effect a junction with Mr. Mulheran's intersected points, about the Saveri River, near its confluence with the Godavery. I should probably not be able to complete the observations this year, as I shall not require for computation more than what will enable me to work up for the area already observed on, and must bear in mind your instructions about testing the detail Surveyors. The plane tables will be arranged 30′ to 45′ in Lat. deep all along from the surveyed ground on the east, as far west as my trigonometrical points serve, and immediately south of the work done this season. My party will be so weak, that no plane tablers will be spared from that work, and supervising and examining will be done by myself and Military Assistant. The subject of keeping up the strength of my party is a great perplexity. I have now only one Native Surveyor, and see no prospect of obtaining suitable recruits. The emolument is insufficient to attract qualified men and previous experience shows the difficulty of taking inexperienced men for training, with much prospect of success. Then again the failure in obtaining candidates willing to serve with this party keeps me with only six Civil and Sub-Assistants. The cause of this state of things is apparently the inadequacy of the emolument for service of so arduous and dangerous a nature, but the effect instead of being economical, is quite the contrary, for whilst the more expensive portion of the party, is at full strength, its supervising power is expended on a minimum amount of out-turn. With an efficient Military Assistant such as I now have, 12 detail Surveyors

Difficulty of keeping up the strength of the Party.

could be kept fully employed, and the credit of the party and the advantage to the State would be nearly doubled, with an expenditure increased by a comparatively trifling amount.

Extensive unsurveyed gap.

An extensive gap exists on the boundary between the Ganjam and Vizagapatam agencies, comparatively near the coast. This tract is inhabited by a tribe called Saoras; they bear the character of being dangerously inhospitable. Semi-military operations have been necessary the last two years to punish them for roberries and murders hitherto practised by them with impunity. This isolated unsurveyed tract lies in the midst of country mapped under the operations of the old Ganjam survey party, before it was placed under my superintendence, and was omitted from the sole reason, that it was unsafe and impracticable for the Surveyors to enter it; that this suspicion was not groundless was shown by the late Mr. Snell's camp being attacked by the Saoras in the low country bordering on the hills. His bullocks, and indeed everything in his camp, even to his crockery, was carried off. More recently the operations of the Coast Series were diverted to avoid entering this tract. My own operations a few season's back extended to the neighbourhood of this tract, in Ganjam on the north-east side, and for one season my progress was suspended, but under special arrangements I was able to make, with the cordial assistance of the agent, Mr. Forbes, the work was completed the following season, to the full extent of my intentions. During the two seasons preceding this now being reported on, my own camp marched to and from the field, through Palkonda of Vizagapatam, and Kimidy of Ganjam, which border on the hills occupied by this and other unruly tribes, and there was ample evidence, from reports of highway robberies, &c., and the police thannahs and patrols along the road, that unusual apprehensions existed.

The time now arrived when the Saora country gap must be surveyed.

The above remarks are made because I have for years looked forward to the time when the survey of this gap would be a necessary duty for me to undertake, and I have never meditated the possibility of leaving it undone, when it actually came in contact with my regular and systematic progress. That time now approaches, and whilst I had it in consideration, and had consulted with the authorities, (local civil) your own letter calls my attention to it. This is by no means the first or only instance of my coming across such difficulties, but under the confidence and support given to my requisitions by the Government, the head of the department, and the local civil authorities, there has been no instance of failure on our part, or of serious collision with the hill tribes, and no portion remains unsurveyed, of the vast hills and jungles extending from Balasore down to the latitude I have now reached.

Not the first instance of similar difficulties.

Description of country surveyed.

In my last year's report, from paragraphs 12 to 18 inclusive, I gave some description of the country surveyed, and have little to add this year. The triangulation has extended further south, taking in considerably more of the highlands of Jeypore, and of the adjoining tributary State Madagal, and also covering great part of the jungly plain of Malkangiri, into which there is a descent of about 1,000 feet, from the central 2,000 feet high level plateau of Jeypore and Bastar. These two generally level tracts are separated by a wall-like run of the hills, extending from the highlands on the east, to a great range running from the "Indrabati" on the north, in a southerly direction in about long. 81° 30′ and up to which my triangulation extends at that part. The "Sileru" and "Koolab" or " Saveri," are the chief streams, both flowing in a south-westerly direction. The former falls at once from the highlands into the lower plain of Malkangiri, and the latter taking its rise in the same part of the highlands, takes a northerly direction, and after running its course through the second plateau, then takes its S. W. direction, passing by a troubled descent, through the above described wall-like run of the hills, into the lower country, and through valuable teak forests. It here seems to define a natural boundary between Bastar and Jeypore, but disputes between these two dependencies exist, and one important one at this part has been given to me for decision. These two rivers lower down join, and then fall into the Godavery about Lat. 17° 32′ and Long. 81° 20′, a position which I look at, as the S. W. extreme limit of the G. and O. Survey oper-

Run of hills supporting the 2,000 feet high plateau of Jeypore and Bastar.

Rivers. Sileru and Koolab.

ations. The detail maps this season give the boundary between the two presidencies, Bengal and Madras. The source and upper course of the "Mahanadi" River is shown. The maps sent in by me now give with very little exception, the whole course of that great river, almost to the sea, and there even, the mouth of the river at False Point, comes into my work on the coast, done during the mutiny season. The source of the "Tel," (the chief tributary of the Mahanadi), is also laid down this year, with about 48 miles of its course till it reaches the limit of the previously sent in maps, in which its whole course is shown. I have thus nearly done with the drainage to the north, or Mahanadi valley; one stream, the "Hati," will run north out of my eastern board of next season.

Mahanadi.

Tel.

Hati.

I beg to place on record the exemplary conduct of every member of this party during the past season, and commend them to your favourable notice. With regard to recommendation for promotion, I will merely state that of the Civil Assistants; three of them will complete two years' service in their present grades, as stated in the margin, and I recommend them after such date for promotion as the state of the Department generally will allow of the indulgence. The services and qualifications of my Military Assistant are well known to you, and will no doubt receive your consideration; with me, he has on all occasions given his most efficient assistance.

D. Atkinson, 2nd Civil Assistant, will complete two years service in present grade on 1st April 1867.
R. W. Chew, Senior Sub-Assistant do.
do. do.
T. E. M. Claudius, 3rd Class Sub-Assistant
do. do. 23rd August 1866.

EXTRACT FROM THE NARRATIVE REPORT OF CAPTAIN G. C. DEPREE, STAFF CORPS, IN CHARGE No. 4. TOPOGRAPHICAL PARTY, No. 41, DATED 5TH SEPTEMBER 1866.

I must premise, that in compliance with your order No. 72-488, dated 8th June 1866, directing that this report shall be submitted more than two months before the usual time, it must of necessity be somewhat incomplete. The computations at the present time have been only partially carried out, and the fair copy maps will not be completed until November next; any results or details obtainable hereafter I propose to submit later in the recess.

The history of the operations of this party from 1856, the year of its formation, up to date will be found in my report No. 127 of 15th November 1862, and it has been regularly continued in my reports No. 53 of 1st October 1863, No. 35 of 8th November 1864, and in No. 47 of 1st November 1865 already referred to.

System of Survey.

The operations of the late field season have as usual been based on the instructions contained in Colonel A. S. Waugh's Pamphlet "Instructions for Topographical Surveying." In addition, each Surveyor was supplied with a perambulator or chain, with which measuring instruments and his plane table he was enabled to traverse and delineate ground which otherwise could not have been dealt with.

Programme of Triangulation.

My para. 41 of No. 47 of 1st November 1865 describes the proposed plan of triangulation as follows:—"I propose myself to continue the Jushpur Series until it joins the Khuria Series laid out by Mr. Girdlestone; I shall then observe the northern stations (of the latter,) until a junction has been obtainedwith the Calcutta Longitudinal Series. I then shall turn south and lay out a series towards Odeypur as near the meridian of 83° as possible. In the mean time Mr. Girdlestone will proceed into Odeypur, and arrange a continuation of the Kolhan Series into Nagpore, and will turn north to meet me when he reaches 83° meridian."

Narrative of Triangulation.

The above programme was carried out except that it was found impracticable to carry the series on 83° over the mass of high land called the Mynepat. The large triangles had therefore to be discontinued on Latitude 23° 10', and they having been broken into smaller ones, these afforded bases from which two sets of small triangles, arranged in a serial form, emanated, and biforcating extended towards the south on the east and west side of the Mynepat. The large series I propose to call the "Sirgooja" as it covers a large part of that estate.

Meantime with his usual energy, and with equal success, Mr. Girdlestone had extended the Kolhan Series westwards of the side Kusang to Lotta H. S. S., until the meridian of 82° 30 was reached; and turning north he selected a meridional series of symmetrical polygons, covering a large area of the Central Provinces, Odeypur, Koria and Sirgooja, and closed on the side Lul to Mirchadhi of the Calcutta Longitudinal Series. I propose to call it the Koria Series. This triangulation encloses an area of 5,500 square miles, and as far as I am able to judge, it will complete the principal series of this division. The principal triangulation, the result of several years' operations, when complete, will form with the Calcutta Longitudinal Series a quadrilateral of 550 miles periphery, consisting of the G. T. S. Series on the north, the "Kolhan" "Lohardugga" and "Koria" Series on the south, east, and west respectively.

After doing the above arduous service, for the country was most difficult and thinly inhabited, Mr. Girdlestone rejoined my camp, and working regularly with myself with the theodolite and angle books, proceeded on the 21st February to observe independently the angles of the "Khuria" Series, which he brought to a completion on the 4th March; meanwhile I marched to inspect the detail Surveyors.

Mr. Barker, a newly-appointed Sub-Assistant, recorded in the angle book the observations of myself and afterwards of Mr. Girdlestone.

Skeleton Chart.

The vellum-cloth sheet forwarded with my monthly report for May, I request may be attached to illustrate this report.

4,800 square miles of ground, almost all of a very jungly character, thinly inhabited, and covered with hills and pats were prepared for survey with 254 trigonometrical points consisting of cleared trees and poles and piles of stones, to render which visible, unusually heavy clearings of jungle were necessary, owing to the peculiar formation of the flat hills called pats. These new stations when augmented by those of former years lying in the same area sum 279, giving an average of 1 to 170 square miles. The number of trigonometrical stations would have been larger had hills been evenly distributed over the whole area, but certain tracts are destitute of any sort of hill features, and are covered with forest.

Detail of Triangulation.

The Sirgooja Series consisting of large single triangles, furnishes no means of comparison of sides except in one instance.

The Khuria Series being double has numerous common sides. The average discrepancies between which are 0·2 feet per mile. The southern portion of this series was observed by Mr. Girdlestone.

The junction series between the "Khuria" and "Jushpur" Series, which is based on the revised data of the Calcutta Longitudinal Series, affords a second value of the side Gungru to Tareni H.S.S., which was determined last year on the data brought up from the Sumbulpore Series G.T.S., *vide* Statement B., consequently the spherical co-ordinates of last year's triangulation will require a correction of 2·82 and 0·55 respectively in latitude and longitude to make them accord with those of the present season.

All the triangulation was executed with the Troughton and Simms' 10-inch theodolite, No. 70. Principal secondary angles were measured on the usual four zeros with two or three observations to each zero. The secondary were observed on two zeros with two or three observations, and the tertiaries were observed once on right and once on left face. They consist as follows:—Principal secondary 6, secondary 80, and 400 tertiaries, or total 486 triangles, giving respectively 5, 41, and 210 stations, or total 256.

There have been arranged, but not computed out as yet, het heights of 156 stations, including numerous villages and river bed stations, for determining the lowest level and slope of the water sheds and courses; also of all brick buildings to be seen in the principal villages of Pertabpur, Bisrampur, Lakanpur, ruins of Depadih, and hot springs of Sirgooja. The highest hill in Chota Nagpore at present determined is an inacessible pat called Mailan; it is 4,024 feet above the sea, is higher than the Meghasini Hill in Cuttack, and probably comes next after Parasnath amongst the hills in this part of India.

Heights.

The heights of Gungru and Tareni obtained from the two sets of data, are as usual accordant, being only 3·9 feet mean difference. The principal secondary and secondary double deductions give a mean difference of 5·1 and 6·2 feet; the latter is the means of ten values; altogether 251 deductions of heights will be made.

Immediately to the west and north of the detail survey of former season a block of 3,702 square miles has been mapped by the Surveyors named below.

Detail Survey.

Names.	Square Miles.	Number of Plane Table Stations.	Average No. of Stations per Square Mile.	Remarks.
Mr. Girdleston	176·0	873	5·0	Forests and hills.
,, McGill	442·0	2,486	5·6	Pats and cultivation.
,, Vanderputt	502·4	3,988	7·9	Much details and hills.
,, Wilson, Senior	449·8	1,557	3·5	Forest and hills.
,, Babanau	440·0	1,757	4·0	Forest and cultivation.
,, Wyatt	474·8	1,961	4·1	Hills and cultivation.
,, James	398·9	2,371	5·9	Hills and much cultivation.
,, Wilson, Junior	421·1	1,324	3·1	Forest.
,, Dutt	397·0	2,974	7·5	Forest hill and cultivation.
Total ...	3,702·0	19,291	5·2	

The table given above shows the number of square miles executed by each Surveyor, the number of plane table stations, and the average stations per square mile.

The number of stations made by Messrs. Wilson, Senior and Junior, are larger than shown, because their country being generally of a plain forest covered character, when the plane table could only be fixed at long intervals, they have filled in many details by 2nd class routes, *i.e.* the Surveyor starts from an interpolated station, measures with a rope along a jungle path, noting in a field book all objects until he arrives at some spot where he can fix his position. The error of the route is thus shown, and objects are inserted in their relative positions. Mr. Bobanau setting up his table measured many offsets to fix the details of cultivation for which he has received two marks.

Experience has shown me, that the statement contained in paragraph 41 of the *Topographical Instructions*, that a "skilful draftsman can be expected to survey 5 square miles a day" is much too great. I took upon myself to reduce the quota expected from each plane table from 2 to 1½ boards or to 405 square miles, being convinced that 3 miles is the outside any man can survey accurately, giving them 5 months + 26 days + 3 miles=468 miles.

Mr. Vanderputt's country was that most easy to survey. Mr. Girdlestone's required the greatest physical exertion; parts of his detail depend largely upon perambulator work. The boards of his, Messrs. Wilson, Senior and Junior, contained most jungle and fewest villages.

Resurvey.

One board of open cultivated country with a few small hills only, of 270 square miles, surveyed by Draftsman C. D'Cruz was rejected on examination, and I was obliged to call in the aid of my Assistants to effect its resurvey, each man taking a part, excepting Baboo M. S. Dutt, who obtained a sick certificate; the gap was filled in before the party returned to recess. I here beg to bring to your notice the good conduct of the Assistant, the Civil and Sub-Assistants, and Draftsman in this instance, who, notwithstanding that the hot weather was at its maximum, willingly and cheerfully did their duty, and undertook this extra labour.

Pertals.

Pertals were run through the cultivated country to test the detail of as many Surveyors as possible. These are called 1st class routes; they run between trigonometrical stations, the distances being measured by perambulator or double chain, and the plane table being set up by the "back ray" at each distance. Mr. Wilson, Senior, ran 37·5 miles, and 66·5 were run by myself, making a total of 104 miles.

Test by Pertal.

Mr. Girdlestone who compared the pertals and field sections assigns the following order of correctness:—

1	2	3 Miles Pertal.	4
I Class..	Mr. Vanderputt.	13·25	"Coincidence perfect."
	,, Girdlestone.	2·00	Do. do.
II. Class.	,, Bobanau.	8·25	"Equal."
	,, M. S. Dutt.	12·75	
III. Class.	,, James.	27·00	"About equal in merit, if anything, Mr. James ranks a little above the other two."
	,, McGill.	17·25	
	,, Wilson, Junior.	9·25	
IV. Class.	,, Wyatt.	14·25	"Part of Mr. Wyatt's full board might come under Class III., but the 1½ sections last surveyed differ most of any Surveyor's work from the pertal."

Inspection and test of Field sections.

After the completion of my share of the triangulation, I proceeded to test the boards of the detail Surveyors, visiting each man in succession, commencing on the 28th February and ending on the 1st May. In this interval also I ran the 66·5 miles of pertal. I shall be glad to furnish particulars of the examination of each Surveyor's work if desired. At present I will give a brief summary of each only. The detail of Messrs. Vanderputt and Wilson I found as correct as it ever has been. I noticed a most marked improvement in Mr. McGill's style;

I believe his work now to be of very excellent quality. I found some mistakes in the jungly tract first executed by Mr. Bobanau, these were owing to his not having used his perambulator or rope, but his latter work has probably not been excelled in accuracy. M. S. Dutt's work seemed very good, and one grave error only was discovered, in which he was fined. I was obliged to condemn some square miles of Mr. James' survey, but his excellent later and prior work, and his cheerful compliance with my call for the resurvey of D'Cruz's board, seemed to me to condone his mistake. Draftsman D'Cruz's board was condemned *in toto* as before reported. I had no opportunity of inspecting Mr. Girdlestone's detail, but it is evidently all that is required.

Discrepancy with Revenue Survey and with old work.

The boundary line agrees well in the two Surveyors; where features have been cut by the main circuit lines the coincidences are good; in some places, however, the sketching within the mile strip surveyed by this party beyond its boundary differs considerably. The coincidence with old work is satisfactory; in the jungly tract of Biru, Mr. Wilson, Junior's, work disagreed with Mr. Wyatt's of last season. I, therefore, ordered Mr. Wilson to resurvey a strip one mile wide right along and within Mr. Wyatt's work; this resurvey occupied a mean position between the two adjoining Surveyors.

Progress of the Detail Survey.

The remainder of Chota Nagpore proper was completed this season, a considerable part of the Jushpur Raja's estate, and a part of the large estate of the Raja of Sirgooja has also been mapped, these forming part of Sheets Nos. 104 and 105 of the Atlas of India.

Duration of Field season.

The party took the field on the 20th November 1865, and had all returned to quarters on 28th May 1866. The further limit of survey was about 90 miles from Dorunda.

Commencement of Recess.

Regular office duties were resumed on 25th of May, and have been continued uninterruptedly, with the exception of one day when office was closed, at six days of six hours per week. If the work will admit of it a week's holiday will be taken during the Doorga Puja.

Leave of Absence.

Mr. Wilson, Senior, has obtained one month's leave on private affairs; Mr. Wilson, Junior, two months on sick privilege. There has been less casual leave on medical certificate than usual.

After my having obtained two months' leave on privilege, you have been pleased to cancel it, except on the production of a medical certificate.

Computation.

The principal and secondary computations have been done by myself and Mr. Girdlestone. All the tertiary triangles have been arranged by me, also the heights, and the final computations of these are being done by Mr. Girdlestone, assisted by one or other of the Assistants; hitherto Messrs. Bobanau, Low, and James have been employed. They will consist as follows :—

6 Principal secondary triangles.

80 Secondary do. .....
400 Tertiary do. ..... } In duplicate.

251 { Heights principal .....
Do. secondary and tertiary .....
Do. deductions single ..... } In duplicate.

* { Alphabetical List .....
Synopsis ..... } In triplicate.
Sheets General Report Triangle ..... Single.

The following computations will be submitted to your office in due course :—

1 Complete set of computations bound in one volume.

1 Copy General Report consisting of ..... { Skeleton Triangle. Synopsis. Alphabetical List.

* Cannot be filled up at present.

1 Alphabetical List of villages arranged by Pergunnahs.

2 Vols. Horizontal Angle books of 139 pages in duplicate.

3 Vols. Vertical Angle books of 129 pages in duplicate.

Fair copy of Sheets of Atlas of Ch. Nagpore, 1 inch = 1 mile.
Ditto ditto 4 miles = 1 inch.

8 Sheets will be submitted worked up solely in pen and ink. They number 18, 28, 29, 30, 38, 39, 40 and 41. Also 3 degree Sheets Nos. III., VI. and VII., worked in the same style.

Field Sections.

27 Field sections will be submitted; the parts forming D'Cruz's rejected board have been copied on one 15+15′ sections which have been finished up completely; this has been done to obviate the retention of many loose sheets.

Sickness in Camp.

The party was generally more healthy than during any former year, except only when the hot weather came on, then almost every man was affected, and the presence of Mr. Apothecary Hamilton alone prevented their return for medical aid to Ranchee, and causing a gap in the work.

I have now to report on the conduct and qualifications of the various members of this party: I have before reported that "there is no more orderly, or willing, or industrious body of Her Majesty's servants than they of the No. 4 Party," and I now repeat those words without any qualification whatever.

Mr. Girdlestone.

I reported last year that Mr. Girdlestone would probably become competent to take charge of a party after the season just past, and I have now little doubt but that should it (unfortunately for this party) be necessary for the good of the service, to give him a charge, success would attend his endeavours. He has arranged with great skill a principal and two secondary series of triangulation, he is fully conversant with the use of vernier instruments, and has observed independently one series. He is a rapid and accurate computer, and reliable in every way. He is only not a skilled draftsman but has improved. I commend him to your notice as worthy of any promotion the rules admit of his receiving.

Mr. McGill, 2nd Civil Assistant.

There is no member of the party who has improved more in late years than this Civil Assistant. He has become a really excellent draftsman, having executed a good share of the contouring in the fair maps; his field sections now leave but little to be desired. He is acquainted with the theodolite, and all in computations, but he is a slow computer. I propose to recommend Mr. McGill's promotion from the date of his having served 2½ years from his last promotion, or from 1st October 1867.

Mr. Vanderputt, Senior, Sub-Assistant.

This Surveyor has taken general charge of the mapping under myself. He is not acquainted with triangulation or the computations, his forte being drawing and detail surveying. His field sections look at a glance the best of the party. Returns already given show them to be of larger area, to possess more stations a mile than any other, as well as to give the best comparison with the pertal. I propose to recommend Mr. Vanderputt's promotion from the date of his having served 2½ years from his last promotion, or from 1st of October 1867.

Mr. Wilson, Senior, 1st Class Sub-Assistant.

This Surveyor is thoroughly efficient in every branch of a topographer's duty, and has always been highly reported upon. I propose to recommend Mr. Wilson's promotion from 1st October 1867, when he will have been seven years in the service.

Mr. Bobanan, 2nd Class Sub-Assistant.

This Surveyor is a trained and accurate plane tabler. He can use vernier theodolites, and he is an unusually quick and accurate computer; on this account I recommend him for promotion from the 1st of November next as a Sub-Assistant of "superior intelligence and utility;" he will then have been five years in the service.

Mr. Wyatt, 2nd Class Sub-Assistant.

Transferred to No. 6 Topographcial Party from the 12th June last; did good service during the last two seasons as a detail Surveyor, he has never been taught to compute as he was ignorant of mathematics. If he had remained with this party I should have recommended his promotion in 2½ years from the last date.

Mr. C. Low, 3rd Class Sub-Assistant.

This Surveyor joined this party on the 14th July last. He tells me he has gone through three field seasons, and that he has executed 70 and 270 square miles of detail. I find that he is a very neat and careful outliner of maps, a fair contourer, and he has computed all the tertiary triangles in a neat style, and with ordinary correctness. I have had no further opportunity of judging of his power. He is painstaking and industrious, and I recommend that he be promoted from the 1st August last, when I find he completed three years service nearly.

Mr. A. James, 3rd Class Sub-Assistant.

This Sub-Assistant seems turning out very successfully; he is an improving draftsman, and has been taught to compute triangles, showing aptitude for the same. He has been steadily employed on the fair maps, outlining, &c., and has done good service in the field during the two last seasons, turning out a full complement of detail. I recommend Mr. James for promotion from 1st January 1867, when he will have served 2 years 6½ months.

Mr. Barker, 3rd Class Sub-Assistant.

Appointed October 1865; has been taught to record in the angle books and to plane table, and in quarters he has been employed on the simple processes of mapping. He did a mile or so of detail in the field, after being taught by Mr. Girdlestone, and then fell sick and returned to quarters.

Mr. J. H. Wilson, Draftsman.

This Draftsman, whose appointment has been sanctioned by you from the date of the proposed resignation of Mr. Bobanau, would gladly accept a Sub-Assistantship in any party except No. 6. He seems to be of a delicate constitution, and probably would break down in the Garrow country if posted to that survey. I think it would be for the good of the public service that he should be promoted to the pay of Rs. 100 per mensem, and continue to do duty with this party as draftsman or probationer.

Baboo M. S. Dutt.

This Native Surveyor has turned out a full quota of detail; his plane table stations are 2nd on the list for number, and he is in the 2nd class as shown by the pertal. He has been employed in outlining and printing the fair copies in office.

Baboo H. D. Dutt.

Is a learner only; he was taught by his brother last year for three months of the field season, but he is not capable of undertaking any independent work.

Baboo S. C. Dass.

Has taken his discharge from the close of the field season.

Baboo B. N. Tripatty, English writer.

Is a fair copyist. He has arranged all the Pergunnah village lists, and copied the angle books. He is willing, and makes himself generally useful.

Proposed employment in the ensuing Field season.

I propose to observe the angles of the Koria Series with the new 12-inch theodolite, commencing from the side of the Calcutta Longitudinal Series and working southwards. Some one Sub-Assistant to accompany me as recorder, and to learn the use of the theodolite, and I would depute Mr. Girdlestone, to assist by filling in secondary stations with the 10-inch; all the other Surveyors will then be available for pushing on the detail.

Country for Survey.

That for detail contains oases of cultivation amongst hills and jungles; that for triangulation consists of much jungle, many hills, and few villages.

Arrears.

I trust that, as usual, no arrear of maps or computations will be found to exist.

EXTRACT FROM THE NARRATIVE REPORT OF CAPTAIN W. G. MURRAY, STAFF CORPS, IN CHARGE No. 5 TOPOGRAPHICAL PARTY, No. 306, DATED 1ST OCTOBER 1866.

Party breaking ground in the Field, Route of March, &c.

The party assembled at Chunar on the 6th of October, and having with difficulty procured the necessary carriage, we were at length enabled to march on the 23rd towards Mirzapore, and proceeded along the Great Deccan Road to our destination. On the 1st November the party separated, and went to their respective areas as quickly as possible.

Lieutenant Badgley and Abdool Rahman went with the head quarter camp, to take some Barometrical heights of the Rewah Waterfalls, and making a detour arrived at the ground to be plane tabled by the latter, on the 9th November. After thoroughly instructing both Lieut. Badgley and the Native Surveyor they were left to their own resources, and commenced independent work on the 15th.

Plan of Triangulation and arrangements for ditto.

As the surveys of Rewah and of the Bundelkund States are in all cases kept separate and distinct, I shall endeavour throughout this report to keep them so to the best of my ability, and I will, therefore, first comment on the triangulation in Bundelkund which was conducted by myself. This triangulation consisted chiefly in breaking down the sides of the Amua Series and extending to the westward as far as 80° and joining on to the triangulation of 1864-65, which had arrived as far north as 24°45′; the Classies were employed in poling up, and Native Surveyor Ali Ahmed in reconnoitring, but the Native Surveyor got into difficulties at the G. T. station of Marfa, and I had consequently to revise the whole of his work. I made a large plan survey of the Fort of Kalingir which is now occupied by two Companies of the Native Infantry Regiment at Nagode, and on the completion of this duty I selected the stations, and laid down the topographical points on the plane table as well as I could, and then proceeded to Nagode to meet Lieut. Badgley to whom I gave instruction in the theodolite, and also as to the way in which he was to carry on the triangulation south of the Soane River.

I was enabled to finish the triangulation of the Boondela States by the 26th February, when I received orders to take up the survey of some of the villages in Rewah lying to the north of the railway line, and this to be done by the system prevailing in the Revenue Surveys. On this head I will comment more at length in its proper place. Lieut. Badgley left me to go to his work on the 17th January, and commenced at the eastern extremity of his work on the 2nd February; he finished work on the 12th April. This work also consisted in breaking down the principal sides of the Calcutta Longitudinal Series, and joining on to Lieut. Riddell's triangulation of 1863-64 to the north, Mr. Bell's triangulation of 1864-65 to the east, and Captain Wroughton's triangulation of Sohagpoor, executed during the years 1841-42 to the south. This work had been laid out by Mr. Bell in 1864-65 as far west as 81°15′, but he had not been able to observe at all his stations on account of the severe epidemic which prostrated four-fifths of his camp.

Triangulation completed and remarks on ditto.

The total area triangulated this field season amounts to 4,539·2 square miles, of which 2,100 was in Bundelkund and 2,430·2 square miles in Rewah. Observations were taken from 61 stations; 33 in Rewah and 28 in Bundelkund, and verticals taken from most of them.

The total area now triangulated amounts to 14,831 square miles, of which 10,531 square miles are in the Rewah territory and 4,300 in Bundelkund.

The triangulation this field season is good in figure, and the results obtained by computation are pretty fair. Out of 110 triangles, there are only 30 whose angles are below 30° or above 90°, and most of them exceed these limits by a very small quantity.

Work done by Assistant Executive Officer.

Lieutenant W. F. Badgley of the Staff Corps, the Assistant Executive Officer in this party, has worked hard and well during the season under review, and his work for a first season's work is very creditable.

Having assisted me in taking and working out a few Barometrical heights, Lieutenant Badgley after due and ample instruction in delineating ground, was put on to the topography of a half table in Bundelkund, and although the work is done perhaps a little coarser than what is usually sent in by the Assistants, still the ground is well and accurately shown, and I am much pleased with his efforts in this line.

With a little more practice Lieutenant Badgley would become a neat and practised Draftsman, whilst his great energy and plodding perseverance already render him a most efficient Surveyor. On the completion of the topography Lieutenant Badgley after receiving instruction in the working of the theodolite, and in the method adopted by us of carrying on the triangulation, executed very good work indeed, and his first season's work will contrast favourably with that of more practised Surveyors. He used one of the new pattern 14-inch theodolites, and a new pattern 6-inch theodolite with two verniers. In the recess Lieut. Badgley has been engaged entirely on the computations, which have been turned out this season quicker and neater than I have ever before seen them. In topography Lieutenant Badgley executed 140 square miles with an average number of plane table stations to the square mile 2·63.

In triangulation Lieutenant Badgley executed 2,439·2 square miles over a wild, rugged, and difficult line of country.

In the recess Lieutenant Badgley, in conjunction with Mr. Hamer, has computed as follows :—

57 1st class secondary triangles.
99 2nd „ „ „
86 1st „ „ Latitudes and Longitudes.
88 Heights of stations.
54 „ of poles and 3 Ray traces besides writing up for the General Report.

Success of detail parties. Area topographically surveyed.

The topography this season shows a decided improvement on any previous year's work, both as regards quantity and quality, and I think I may fairly claim an improvement in its accuracy also, whilst the general effect of the delineation is good.

The total area topographically surveyed amounts to 3,273·4 square miles, but of this 65 square miles done by Mr. T. D. Ryan was rejected as quite unfit for publication, reducing our total area to 3,208·4 square miles. Of this 1,380·1 square miles are in the Boondela States, and the balance therefore 1,988·3 are in the Rewah State.

Our gross total area therefore amounts to 7,794·4 square miles, viz. 6,474·3 in Rewah and 1,320·1 square miles in Bundelkund.

Inspection of Assistant's work.

I regret much to be unable to show any improvement in this necessary duty, but when I was free to attend to it, having completed the triangulation of the Boondela States, north of 24°45′, I was obliged to go and take up the survey of some Rewah villages on the large scale of 20 chains to an inch. Native Surveyor Prem Raj was inspected by me on the ground and I found his work accurate. Mr. Evans was also inspected by me at Nagode, and I deputed Mr. Howard to revise the whole of Native Surveyor Abdool Rahiman's work which he did in a most complete manner. Mr. Neale was constantly supervising Mr. Ryan's second piece of work, and reported favorably on it, but this year I hope to be able to run lines of traverse through the greater portion of what was left undone, and I hope to be able to report favorably on the accuracy of the work hitherto executed by this party which has not been so tested.

Exertions of each Assistant. Mr. Bell.

Mr. R. A. Bell, Civil Assistant, commenced the topography entrusted to him on the 9th November 1865 and finished 151·1 square miles by the 24th January 1866, when he joined my head quarter camp at Kirwee, and received a fresh plane table and fresh instructions to revise Mr. Antrobus' rejected work of last season. This duty Mr. Bell would have carried out most satisfactorily, and by the 3rd March he had done some 51·2 square miles of most excellent work ; but as he was the nearest Assistant to me I was obliged to take him off this work to come and assist me in the survey of the Rewah villages lying north of the Railway line, and which

required careful survey by chain and theodolite on the scale of 20 chains = 1 inch. In all 11,052·33 acres were surveyed over a very difficult and broken tract of country.

The total of Mr. Bell's topography is 203·3 square miles. In office Mr. Bell has contoured the whole of General Maps Nos. 5 and 7, part of 32, and shaded up No. 3.

In the rough maps on scale 1 inch = 1 mile for reduction to scale of 4 miles = 1 inch, Mr. Bell has completed 2, viz., the Geographical Map No. IV. for Bundelkund and the North-West Section of Geographical Map No. V.

All Mr. Bell's topography is executed in a most masterly and most accurate manner. He usually works with 7 or 8 plane table stations to the square mile. This field season the average was 8·10 per square mile.

Mr. C. H. Neale, Civil Assistant, was deputed to teach Mr. Sub-Assistant T. D. Ryan, and this duty he commenced on the 13th November 1865. Having worked with him till the 30th, Mr. Ryan was left to his own resources from that date, and Mr. Neale commenced on his own work in Myhere.

By the 11th January Mr. Neale had completed 99·6 square miles of very good topography. He then marched to his work in Rewah, and commenced work on the 17th February, and by the 28th April he had finished 189·5 square miles, with an average of 2·57 plane table stations to the square mile. His total area is 289·1 square miles.

On the 1st May 1866 Mr. Neale was transferred to No. 2 Party, the Hydrabad Survey, and I am sure his service as a Surveyor will be appreciated by the officer in charge, as Mr. Neale is a really good Topographical Surveyor.

Mr. Atkinson.

Mr. E. S. P. Atkinson commenced work near the Katra Pass on the 31st October, and by the 13th November he had finished the work consisting of 23·0 square miles. He then proceeded to Myhere to take up his half table south of that city. Between the 29th November and the 13th January Mr. Atkinson completed 128·5 square miles. Again he proceeded to his ground to the south of the Rewah State bordering on Bhokar, and between the 12th February and the 3rd May he completed 182 square miles.

All this topography was executed in a first-rate way, and is really good honest work. Mr. Atkinson deserves great credit for the great improvement shown not only in the character but also in the drawing of his plane table sections.

The total area completed by Mr. Atkinson amounts to 333·5 square miles, for the most part in a very difficult and broken country. The average number of plane table stations per square mile is 5·65.

In office Mr. Atkinson has completely finished General Maps Nos. 9 and 10, portion of No. 14, and the contouring of No. 3, and of the maps for reduction to scale 4 miles = 1-inch he has completed the N. W. section of No. VI. and the S. E. section of No. X.

Mr. Hamer.

Mr. C. F. Hamer promoted to 2nd Class Sub-Assistant from 1st May by D. O. 68, dated 30th May 1866, commenced work in the Bundhair hills on the 12th November, and by the 14th January he had completed 136 square miles, although at one time suffering from a severe fall off his horse which obliged him to go into Myhere for medical treatment. On the 8th February he commenced on his other portion in Rewah, and by the 25th April had finished the full table or 271·9 square miles. His total area amounts to 407·9 square miles, and is executed in a very creditable manner.

The average number of plane table stations per square mile is 4·61.

In office Mr. Hamer has computed against Lieut. Badgley, and of course done the same amount of work. He has also drawn out the charts for the Geographical Maps Nos. V., VI.

Mr. Howard.

Mr. A. D. Howard, 3rd Class Sub-Assistant, has worked well and steadily throughout the year under review. I had the pleasure to recommend this young Assistant for promotion, but the rules of the service prevented my request being complied with. Mr. Howard commenced his Bundelkund topography on the 13th November, and by the 6th January had completed 136 square miles: on the 14th

February he commenced his Rewah plane table, and by the 22nd April had completed 207·7 square miles.

His total area is 343·7 square miles with an average of 4·72 plane table stations per square mile.

In office Mr. Howard has been computing with Mr. Evans, and they have computed 5 Ray traces, 53 1st class secondary and 454 2nd class secondary triangles, besides making some data required by No. 4 Party or the Chóta Nagpore Survey.

Mr. Howard has also made himself useful in a variety of small though necessary ways, and he certainly is one of the best computers and most ready assistants in the office.

Mr. Evans.

Mr. C. T. Evans, 3rd Class Sub-Assistant, commenced work on the 13th November, and by the 10th January had completed 73·2 square miles of topography. Mr. Evans' progress was impeded considerably by the difficult nature of the ground to be surveyed which was on the top of the Bundhair plateau, and densely wooded with large forest trees. Some severe attacks of fever also hindered his work, and at one time he was compelled to seek change of air and medical treatment at Nagode.

Mr. Evans commenced his second portion of work on the 5th February, and by the 14th April had only completed 85·7 square miles, but this harrassing fever never left him the whole season, and I was ultimately compelled to get him to my head quarter camp, and put him in the Doctor's hands.

I am, however, perfectly satisfied with the total out-turn of work executed by Mr. Evans, although it is only 158·9 square miles.

The average number of plane table stations per mile is 4·54.

In office Mr. Evans has computed against Mr. Howard, and also took a share in getting ready the data for Captain Depree. In addition to this Mr. Evans got ready the triangulation charts for the Geographical Maps, Numbers III. and IV. (Bundelkund).

Mr. Ryan.

Mr. T. D. Ryan, 3rd Class Sub-Assistant, after having received 17 days' instruction from Mr. Neale started on independent work on the 1st December, but the amount he did, viz., 65 square miles, was not sufficiently good to send in, and I have consequently directed Mr. Evans to re-survey the whole of it. On the 17th February he again started on some work in Singrowlee, having Mr. Neale at hand to consult and receive instruction from, and I am happy to say this work bears evidence of being much more carefully done. It will, however, be thoroughly looked over, and if necessary revised by Mr. Howard.

His total area is 61·7 square miles with an average of 1·96 plane table stations per square mile.

On the 4th April Mr. Ryan met with an accident by carelessly playing with a powder flask and causing it to explode. Mr. Neale was afraid to undertake the cure himself, and very wisely sent him into Mirzapoor, where Dr. Loch kindly attended him.

In office Mr. Ryan has been useful in making out alphabetical lists of stations and villages, comparing village and angle books, and making out indices of orders, letters, &c. He also went away for three weeks on leave, having suffered from the effects of the climate.

Mr. Wainwright.

Mr. E. A. Wainwright was appointed a 3rd Class Sub-Assistant by D. O. 63, dated 9th May 1866, with effect from 1st May, and posted to this party by memorandum No. 361 of same date. He joined us on our arrival at Mussoorie.

His work in office has been much the same as Mr. Ryan's, viz. making out an alphabetical list of villages and comparing the same, a most tedious and disagreeable task which, however, he has done very well.

Shaik Nubbeebux.

Native Surveyor Shaik Nubbeebux has also worked very well during the year under review. He commenced his Bundelkund topography on the 13th November, immediately south of Mr. Evans, and like him was only able to finish 64·9 square miles, the ground being so extremely difficult to survey.

On the 9th February he commenced his work in Rewah, and by the 4th May had completed his whole table or 271·9 square miles. His total area was 336·8 square miles, and the average number of plane table stations per square mile was 4·22.

In office Nubbee Bux has entirely finished General Map No. 6 and part of No. 32, whilst the printing of the quarter-inch map and chart No. 2 (which was finished by myself) was executed by him. His work both in the field and in office is always good.

Prem Raj.

Native Surveyor Prem Raj commenced work on the Nagode table on the 10th November and had it finished by the 21st December, an area of 136 square miles. On the 9th January he commenced his work in the Rewah State, and by the 1st May had completed 362·5 square miles. His work 498·5 square miles is good, with an average number of plane table stations per square mile 7·34.

In office the Native Surveyor has traced all the general and quarter-inch maps for reduction, viz., General Maps 7, 8, 9, 16, 17, 19, 20, 32, 34, 36, and Reduction Maps Nos. IV., V., VI., X. He also traced the line of boundary asked for by Captain Depree.

Abdool Raheem.

Native Surveyor Abdool Raheem commenced work with Mr. Neale on the 13th November, and finished an area of 136 square miles by the 24th December.

On the 17th January be began on his Rewah plane table, and by the 10th May had completed 181·2 square miles. The work was of a difficult nature, and to all appearances appears to be fairly and honestly done.

His total out-turn is 317·2 square miles, and his average number of plane table stations per square mile is 6·84.

In office Abdool Raheem has been employed on the printing of the General Maps. Nos. 3, 5, and 7 were printed by him, and he is now engaged on the printing of General Maps Nos. 34 and 36.

Abdool Rahman.

Native Surveyor Abdool Rahman, after having received due instruction from myself, started on independent work on the 14th November, and by the 17th January had completed the area assigned to him, viz. 118·8 square miles. This was very easy and level ground, and after having had it inspected by Mr. Howard, I am enabled to state that the work was well done. He was then sent with Mr. Bell to learn the way to survey hilly and raviny ground, and when Mr. Bell came on to the survey of the Rewah villages north of the railway line, Abdool Rahman was employed in inking up the streams of the General Maps.

In office he has printed up General Maps Nos. 5, 6 and 32, as also the headings for the General Report.

Remarks on the Country triangulated.

In Bundelkund as soon as you descend the northern Punnah scarp, the features of the country gradually change, and in place of large sandstone plateaux, densely wooded, with long gentle slopes from one side, and bounded by precipitous walls on the other, gentle undulations and a thick cropping out of granite hills meet your view. A country almost made for triangulation and topography, but the hills are very difficult to ascend, as immense boulders and huge slabs almost prevent a climb to the highest peak, as is the case at Kartal, a principal station of the Amua Series, the highest peak of which is quite inaccessible.

The topography of this part of Bundelkund will look very well.

In Rewah the triangulation was carried over a very wild, rugged, and inhospitable tract of country, whilst the dense forests made it a matter of extreme difficulty to select enough points for the topography. This has been, however, successfully done by Lieut. Badgley, who certainly has taken great pains over the work entrusted to him.

The forests in these parts are chiefly Sal, and are only passable at certain seasons of the year.

The topography of the Kymore range this year was easy and indeed so was nearly all that was done in Bundelkund. The real difficulty is on the top of the Bundair range of hills, where the jungle is so dense and so high that the view on all sides is completely shut out. I fear a great deal of this range will have to be done by chain or perambulator traverses.

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In Rewah, however, the topogrophy was of a more difficult natare, nearly all the plane tables being more than usually complicated, and plain and level ground being seldom met with, whilst the villages as a rule were small, and supplies were scanty and not easily obtainable I may mention Mr. Neal's, Mr. Atkinson's, Mr. Howard's, Mr. Hamer's and Native Surveyor Abdool Raheem's plane tables as being in very difficult ground.

Recess duties, Maps, and computations.

The computation of the circuits required for the survey of those villages lying north of the Jubbulpore Railway line and belonging toRewah, which circuits were done with a 7-inch theodolite and a chain originally 105·6 feet long, and projected on the scale 20 Gunter's chains = 1 inch, were made out in duplicate, one copy being sent in with the maps and papers, the other retained in this office for record.

The ordinary computations worked out during the recess were done in duplicate and consisted of the following:—

110	1st Class	secondary	triangles.
553	2nd „	„	Latitudes and longitudes.
86	1st „	„	Heights.
88	1st „	„	„
54	2nd „	„	„
1	Obligatory height.		
8	Ray traces.		

The heights of 86 points were determined by trigonometrical levelling and 4 by barometrical observations, whilst 313 points were laid down for the topography.

The General Reports of Rewah and Bundelkund, kept separate, are written up to date.

The alphabetical list of villages and of latidutes, longitudes, and heights are also made up to date.

The Persian Khana Shumari is also written out fair, and a large mass of statistical information has been made out as far as we have gone.

The angle books are made out in duplicate, compared and bound.

Of the maps.—General Maps Nos. 3, 5, 6, 7, 9, 19 in Rewah, and Nos. 11 and 32 in Bundelkund are ready and accompany this report.

General Maps Nos. 8, 14, 16, 17, 18, 34 and 36 are in hand, and will I trust be far advanced by January.

Of the Geographical Maps done with shading and reduced by the Pentagraph, No. II. accompanies this report and No. III. is in hand.

Of those drawn to scale 1 mile = 1 inch to be reduced by photography, No. IV. in Bundelkund, the N. W. quarter of No. V., the N. W. quarter of No. VI., the S. E. quarter of No. X. are ready and also accompany the report.

The charts for these last mentioned maps are drawn out but not yet printed—they will be sent up from camp to your office.

Two large area maps of the villages surveyed by Mr. Bell and myself, charts and tracings for Captain Depree, and a small rough and skeleton chart for your office, have also been sent in during our stay here.

Area of Triangulation.

The area triangulated as stated above is 4,539·2 square miles.

Area of Topography.

The area of topography executed this field season and fit for publication is 3,208·4 square miles.

Errors of Triangulation.

In the Rewah triangulation, the triangular error of 1st class secondary triangles is 12″·831 the error of the sides is 6·22 inches per mile, whilst the Ray traces show the difference between our own and the work of the Calutta Longitudinal Series, as being 5·7 inches per mile. The mean error of the heights is 4·264 feet.

The greater portion of this work was executed with a new pattern 6-inch theodolite by Troughton and Simms.

In the Bundelkund triangulation, the triangular error of the 1st class secondary triangles is 8″·196; the error of the sides is 5·46 inches per mile, and of 2nd class secondaries 12·25 inches per mile. The Ray traces show the difference between our work and the sides of the Amua Series 3·4 inches per mile.

The mean error of the heights is 2·420 feet.

All this work was executed with 10-inch theodolite by Troughton and Simms.

Health of the Party.

The health of the party has on the whole been very good. Messrs. Atkinson and Evans have suffered from fever, the former slightly, the latter severely, and Native Surveyor Nubbee Bux has also been complaining.

Our daily rate of sick including camp followers and guards with the head-quarter camp, has been about 7, but most of these have had only trifling ailments.

General remarks and opinion on the work executed.

I think we may say that our work is satisfactory. In the topography, the amount in quantity has increased, and I feel certain that the quality and accuracy of the work has also improved. In 1863-64 we did 1,824·9 square miles with 7 men at work. In 1864-65 we did 2,761·1 square miles with 9 Assistants on the topography, and this field season with an average of 10 plane tablers our out-turn is 3,208·4 square miles. I do not think it is possible to survey with real accuracy more than a plane table and a half during the season, and always try and impress it on the Assistants, and assure them that no one will find fault with the smallness in quantity of the work they bring in as long as it is accurate.

I do not think there is any material difference in the triangulation from former years. The Ray traces, being the real test of the accuracy of the work, as they compare the work of the survey with the minute work of the Great Trigonometrical Survey, upon whose sides our work is based, show an improvement, for, whilst in 1864-65 the average error as shown by 7 Ray traces of work done by the 14″ and 10″ theodolites to be 4·9 inches per mile, this season the error of the 10″ theodolite work is only 3·4 inches, whilst of the work executed chiefly by a 6″ theodolite the average error is 5·7 inches per mile, or the two combined an average error over the whole work of 4·6 inches per mile.

The work executed on the principles maintained in the Revenue Surveys by chain and theodolite was new to us in every way, and our chains being of a length never used by them, and it being impossible to check them in any way, as we had no standard bars or standard measure of any sort, has come out fairly.

The maps on the scale 1 mile = 1 inch show, I think, a slight improvement on last year, whilst the new method of drawing the geographical maps to full scale, and afterwards reducing them by photography, is a most beneficial measure, and will ultimately enhance the value of our maps considerably.

The computations are turned out very clean and neat, and the alphabetical lists of villages and computations, which are nearly finished, are done in a very creditable manner.

Recommendations. Messrs. Howard and Evans.

At the beginning of the season I recommended Messrs. Howard and Evans for promotion, and as I have been much pleased with their work in office, I again beg to bring them to your notice as two good, honest, hard-working and efficient Surveyors. I shall be very glad indeed to hear it is possible to give them the promotion which, in my opinion, they fairly merit.

I am happy also to be able to state that the promotion awarded to Messrs. Atkinson and Hamer has only incited them to work still harder and more zealously than before.

Programme of the ensuing season.

The programme for the field season 1866-67, as contained in my letter No. 247 of the 28th June, having met with your approval, will be adopted as closely as possible. It is as follows:—

"By a reference to the map sent (and to which all the numbers in this report refer) you will perceive that the work which can be done in Bundelkund is a long dis-

tance away from the area to be done in Rewah, and as the completion of the Rewah work is greatly to be desired, I propose to start all the Assistants on it early in January; and to enable me to do this, I will not set them to work on the Bundelkund areas (except in plane tables 71 and 74) because they would only have about a month's actual work, and the area completed would be but small and incomplete.

"I therefore propose to divide the work as below:—

Mr. Bell on Plane Tables		51, 52, 53	Area	170	square miles.
Mr. Atkinson	do.	26, 30	do.	406	do.
Mr. Hamer	do.	43, 71	do.	374	do.
Mr. Howard	do.	13, 14, 34	do.	211	do.
Mr. Evans	do.	32, 74	do.	332	do.
Nubbee Bux	do.	31, 44	do.	361	do.
Prem Raj	do.	42, 48	do.	300	do.
Abdool Raheem	do.	47	do.	180	do.
		or a total of about.....		2,334	do.

and of these Assistants Messrs. Atkinson, Hamer, and Evans can commence work as soon as they arrive on their ground (about the beginning of November) because plane tables 26, 32, 71, and 74 are in open ground north of the Soane River, and there is no fear of malaria such as prevents our working south of that river before January.

"I propose then to march to Rewah direct, and leave the office tent and draftsmen there, start Mr. Bell on the survey of the Rewah city on the large scale called for in D. O. No. 73, dated 12th September 1864. Mr. Bell will instruct Messrs. Ryan and Wainwright on this work and make them help him. In January these two Sub-Assistants can proceed, the one to Myhere, the other to Nagode, and make plans of the cities Myhere and Nagode, on the completion of which they will both proceed to Punnah, and make the survey of the city there.

"Lieutenant Badgley and Mr. Howard can proceed to triangulate up to the longitude line 80° 0, which they ought to and would finish by the 15th December, and then at once march down to their ground in the Rewah territory. Lieutenant Badgley will lay down the boundary in Abdool Raheem's table No. 47, having done which he could finish the Rewah triangulation.

"Mr. Bell after completing his three small pieces of plane tabling will (as will also Lieutenant Badgley after completing the triangulation) run traverses through the work as directed in a late departmental order.

"The Native Surveyors and Draftsmen will stay at Rewah, and go on with the maps, till it is time for them to start for their own plane tables.

"The officer in charge can run lines of traverse through the work and inspect the different Surveyors at various times, and if possible he might be able to go down to Ummerkuntak, and make out the report called for by the Surveyor General in his letter No. 3 of 22nd July 1862. This duty if not done during the ensuing field season must be done the season after.

"Plane table No. 49, coloured in blue stripes, can be taken up if there is sufficient time.

"By this programme there will be no doubt as to the completion of the work assigned, unless severe sickness should incapacitate any of the Assistants, but even then we would have a reserve of three Assistants able to plane table in case of need."

Concluding Remarks.

Where one and all have endeavoured to do their duty, and have done it in almost every instance to my entire satisfaction, it may seem invidious to bring any members of the party more prominently forward to receive the expression of your satisfaction at their labours.

To Messrs. Bell and Atkinson, and Native Surveyor Nubbee Bux, for the exertions in the Drawing Department, and to the computers generally my thanks are again due for the zeal and energy they have shown in conducting the current duties of the office, and the

cordial help they have always afforded me in any manner when called upon to do so whilst their gentlemanly conduct at all times, and their honest work both in the field and in office, make it a pleasure (a great pleasure) to be associated with them in the manner I am; and, as it is probable I shall be obliged by ill-health to seek change of scene and climate before another report is due, I must here record my entire satisfaction and cordial approval of all that has been done by the Assistants now in this party, and I shall always look back with pleasure to the days when we were members of the same Survey Party.

In conclusion I beg to express a hope that you will be pleased with the result of our year's work; and should such fortunately be the case, that you will let the Assistants know that you are satisfied with the result of their labours.

EXTRACT FROM THE NARRATIVE REPORT OF LIEUT. R. V. RIDDELL, R. E., IN CHARGE No. 6 TOPOGRAPHICAL SURVEY PARTY, No. 68 A., DATED 14TH AUGUST 1866.

At the commencement of the field season (6th October 1865) the party consisted of—

Lieutenant R. V. Riddell, R. E., in charge.
Mr. N. A. Belletty, Senior Civil Assistant.
Mr. H. M. Atkinson, 1st Class Sub-Assistant.
Mr. J. B. Landeman 3rd „ „
Mr. C. Low „ „ „
Mr. P. Gilhooly „ „ „

Native Surveyors.

Nasseer Addin, in the office of the Surveyor General, Calcutta.
Abdoor Aheem.
Daliludeen.
1 Writer, 1 Native Doctor.
1 Tindal, 1 Duffadar, and 80 Signallers, Carriers, &c.
1 Jemadar and 19 Burkundazes.

The area triangulated during the previous season was 1,500 square miles, a greater area than I could hope would be surveyed in detail, and I was inclined to spread the work over a less compact area than would have been desirable in other respects, on account of the extremely unhealthy character of the lower ground at the commencement and end of the season, that each Surveyor might have a portion of his survey, in country where he could work, until driven out by the heavy rains, six weeks later than would be safe for his work in the lower ranges.

Observations had to be taken at several stations at the western extremity of the country triangulated in 1864-65, and a few more points determined in that neighbourhood to admit of the whole width of the hills being plane tabled as far west as the meridian of 91°. east longitude; but the chief part of the triangulation was to be carried out to the east of the Assam and Cherrapoonjee Series of the G. T. Survey.

Mr. N. A. Bellety was instructed to select and build stations for a polygonal series of principal triangulation, to be extended from Sapedbeneng and Shillong east station (secondary stations of the G. T. Survey) as far as the meridian of 92°· 30' east longitude, also to pole up the intervening country for minor triangulation, and to fix signals on the sites of old secondary stations of the G. T. Survey, in the Jowaie and Jynteahpore country. On completing this, to proceed and complete the triangulation on the west side of the Kossiah hills· Mr. Belletty started with a Native Surveyor and as many Classies as could be spared on the 6th November.

Mr. H. M. Atkinson started on the 6th November with instructions to keep Native Surveyor Daliludeen with him, until he should be sufficiently well acquainted with the use of the plane table to work alone, then to start him at work on the three northern sections of plane table 24. Then Mr. Atkinson himself was to complete the southern six sections of plane table 24, and to carry on the survey of plane table 26 to the foot of the hills, which would extend over three sections only; if possible, Mr. Atkinson was also to extend the survey of plane table 32 southwards to the foot of the hills, or over the three northern sections of plane table 33.

The late Mr. J. B. Landeman left Cherrapoonjee on the 6th November, and was instructed to break ground in the neighbourhood of Nunklow and Maopani H. S., to take up two sections on the north-east corners of plane table 29, and the eastern six sections of plane table 27.

Mr. P. Gilhooby to take up the remainder of these two plane tables, 27 and 29.

Mr. C. Low to complete the survey of plane table, 30, of which he had finished about 45 square miles in the season 1864-65.

I remained with Mr. Gilhooly for 9 or 10 days, going out with him daily, at the end of which period he seemed able to work independently. I left him on the 24th November.

After leaving Mr. Gilhooly I proceeded to Sapedbeneng to extend a minor secondary triangulation to the north, and east, from Sapedbeneng, Umter, Tepkilabama, and Myang, (stations on the east flank of the G. T. Survey Series). By the 1st of February, 10 stations had been selected, and poles fixed, over an area of 600 square miles. And by the 10th of March the triangulation of the same with a 7-inch theodolite had been completed. Nearly the whole of this area is covered with dense jungle, and though it has a fair allowance of paths, the rate of progress of selecting the stations and fixing poles was necessarily slow. From the 10th of March to the 15th April I was engaged observing at 7 principal stations selected by Mr. Belletty, and completing the triangulation of about 270 square miles of country. I was delayed, on an average, four days at each station, longer than the time necessary for observations; being unable to pitch the observatory tent, on account of the strength of the wind.

By the 1st of February Mr. Belletty had returned to Shillong, having selected and prepared for observations 10 principal stations and two secondary ones, and poled up an area of a little over 1,000 square miles, extending to the meridian of 92·45 east longitude, and between the parallels of 25·20 and 25·45 north latitudes. This was farther east than I had required, but for six weeks nearly Mr. Belletty had not received any of my letters which contained answers to his reports and questions. Had Mr. Belletty received these, he would have started for the completion of the triangulation (commenced the previous season on the western side of the G. T. Survey Series) by the end of December, and would have had sufficient time to fix in carefully selected points for poles over the portion of the country unsurveyed on the borders of the Garrow country. As matters have turned out, there will be a scarcity of points to guide the plane tablers over a strip of about 5 miles in width, extending nearly across the hills on that side. Mr. Belletty returned from this work about the middle of April, and proceeded to test the work executed by Mr. H. M. Atkinson.

The total area triangulated by Mr. Belletty and myself amounts to 1,370 square miles during the past field season, and extends the previous work as far west as the meridian of 91 east longitude, and east to 92-15 east longitude, across the whole width of the hills, with the exception of a small strip at the south-east corner of the area. The triangulation on the whole is not so good as might have been expected from the instruments used, and what is generally produced in other parties; but in connection with this I must point out that, both in this last field season and in the previous one, the observations were not commenced till the month of March, by which time strong gales had set in, and it was found utterly useless to attempt to wait for a quiet day before commencing observations; the observer would have been detained at one station until obliged to seek shelter from the rains.

On many occasions I have noticed the cross level of the 14-inch theodolite thrown 50 or 60 divisions (of the attached scale) off the level by a sudden gust of wind. This part of the triangulation I shall in future endeavour to carry out at the commencement of the field season, but hitherto the minor triangulation, even if of the most inferior order allowed, has been of the utmost importance to furnish work for the plane tablers, and the two best months of the year have been devoted to carrying on the work in the more unhealthy tracts of the country.

The total area topographically surveyed amounts to 1,160 square miles, which, with the exception of 90 square miles surveyed by Native Surveyor Daliludeen, has been successfully completed. That surveyed by the Native Surveyor will have to be revised, the character of the ground not being correctly shown, though the position of large streams, roads, and villages, were all accurately defined.

Mr. H. M. Atkinson completed 370 square miles, all the work expected of him, except about 30 square miles, which were obliged to be left unfinished by the setting in of the rains and the sickness of his party. His work was examined by Mr. Belletty after his return from the triangulation; at the end of April, Mr. Belletty marched nearly two-thirds across Mr. Atkinson's table, visiting three or four prominent peaks, from which he had a good view of the ground, testing the work as he

Mr. Atkinson.

proceeded, and pronounced the work correct as far as he had seen it. Mr. Atkinson's services, which I have brought to your notice on a late occasion, have already been favorably recognised.

Mr. Landeman.

The work of the late Mr. Landeman was only partially inspected by me early in March. I had intended to visit another portion of this work at a later period, when I believed the whole would have been completed, but the unfortunate death of this Officer, leaving the portion of country unfinished which I wished to inspect, rendered the plan useless, as the work will have to be examined when completed during the field season of 1866-67. The late Mr. Landeman reported to me in January that he anticipated being able to finish some of the work which had been told off to Mr. Gilhooly in addition to his own, and in March his progress warranted the statement, the out-turn of work for the time was good, viz. 220 square miles from the middle of November to the middle of March, executed in excessively difficult country, almost entirely covered with dense jungle.

Mr. Low.

At the end of April I marched across the whole width of Mr. Low's table, keeping the line of the main ridge in that locality (from which, for about ten miles, I could overlook the country to the north, to beyond the limits of Mr. Low's work, and to the south to within two miles) fixing the table at intervals; I intersected all the main features, turns, and junctions of streams, and my position was so high above the ground I was examining that I could not have had better means of testing generally the accuracy of the work, short of going over the the whole work myself. One portion was so inaccurate that I was obliged to reject it. To re-survey this, occupied Mr. Low from a fortnight to three weeks, and eventually I was obliged to recall him to quarters before the completion of his work, as he and his party, though in healthy tracts, were beginning to suffer from fever, and could not get through the remaining portion under a fortnight, which might have spread over five or six weeks. Mr. Low completed 250 square miles.

Mr Gilhooly.

After examining Mr. Low's work, I pursued the same course with Mr Gilhooly's, entering the ground from the east; I examined the country to the Kollong rock (a noted prominent feature in this part of the country, and situated very nearly in the centre of Mr. Gilhooly's work), from the top of which I obtained a complete view of the country surveyed by Mr. Gilhooly; from this point I went to the south, and with the exception of one or two mistakes, which might have arisen while inking in a not very clearly defined day's work, found the work correct. From this I returned to recess quarters on the 30th April. At the beginning of April, Mr. Gilhooly had finished this portion of his work, and took up a portion of what remained unsurveyed of Mr. Low's share, of which he completed about 46 square miles by the end of the month, when a slight attack of fever, which he could not shake off, incapacitated him for work in the field, and the rains setting in necessitated my recalling him. Mr. Gilhooly completed 220 square miles.

The field season lasted on an average six months. The months of March and April were accompanied by gales of longer duration and greater violence than usual, according to many of the inhabitants. During these gales survey work is greatly delayed, for it is almost impossible to set up a plane table, or to hold up an umbrella, for several days in succession; even small tents pitched in comparatively sheltered spots must be watched carefully, and are often blown down or split into shreds.

By the middle of April the Native establishment, with the exception of those with the plane tablers, were sent into quarters. By the 21st of May the whole party had returned to Cherrapoonjee, where office had been opened on 1st May for such of the party as had arrived in quarters.

The country triangulated during the past field season, on the east of the Assam and Cherrapoonjee series, lies for the most part in the Kossiah States of the hills.

The northern strip on the low Terai, extending some fifteen miles from the rise from the plains, is considered to be under the jurisdiction of the Kamrup District, of which Gowhatty is the chief civil station; this portion is inhabited by a distinct class of people often called "Meekirs," in features more similar to the Kossiahs than to the Assamese, having a language of their own, but speaking and understanding a little of the language of both people; they are slight and

small, and of a peculiar sallow sickly-looking hue, more industrious, and of more temperate habits than the Kossiahs.

On the west of the G. T. Series, the country is supposed to be part in the Kossiah Hills District, gradually verging into the Garrow territory; there does not appear to be any definite boundary between these lands; the Raja of one of the larger Kossiah States (Nongstain) claims power over, and levies taxes from a number of villages (called Garrows) beyond the supposed limits of his State.

As a general rule all the country up to an elevation of nearly 3,000 feet, is covered with dense jungle, chiefly bamboo, but in the large valleys, and extending some way up the slopes of the hills, a large variety of forest timber is found, most of which is used extensively for timber structures, whether bridges or buildings, along the main roads.

The country topographically surveyed, with the exception of part of the late Mr. Landeman's share, is all in the Kossiah States, extending on the west to very nearly the limit of the comparatively bare country, even at the water-shed between the plains of Bengal and Assam. The Surveyors with small parties are in constant difficulties with regard to supplies, and generally receive very little assistance from the villagers in their ground. Even on the borders of the district of Sylhet, the Magisterial Perwanahs are sometimes not treated with the slightest respect, information is procured with difficulty, and often seems untrustworthy, one or two villages on the boundary, between the work of two Surveyors, though identically placed by both, having been called by different names.

The principal rivers met with this last year are—

The Umiām, rising half way between Dinghei hill station, and Laidera H. S., follows a southerly direction for 3 or 4 miles, then turns to the north-east, and holds a tolerably even course in that direction for the next 8 or 10 miles from the turn; the slopes of the hills rise abruptly from the river, the feeders falling at several points over precipices, and here and there forming water-falls of from 300 to 400 feet in height. This portion of its course is excessively wild and rugged. The Umiām passes Sapedbeneng Hill station about 2 miles to the south, at nearly the same distance north of Maocharain H. S., and then onwards in the same north-easterly direction beyonds the limits of this year's observations. At the foot of the Dinghei Mountain, on the south-east side, the stream in the cold weather is about 100 feet wide; here it is crossed by a timber-bridge.

The Digroo, rising about a mile to the north of Sapedbeneng, follows a westerly course for about twelve miles through gently undulating hills, sweeps round to the north, and emerges from the hills about 9 miles east of Gowhatty, running in a north-easterly direction. At Borne Haut, where this river leaves the hills, and for a few miles above, it was navigable for small canoes, even as late as the month of February. The width here is about 250 feet.

The Moken, rising on the east side of the Shillong Hill, very quickly cuts a deep course for itself, the sides of its slopes being very rugged and precipitous. This runs off towards Assam, and I think, joins the Umiām before that river leaves the hills.

The Mangat, rises close to the Moken, about two miles nearer the south, flows parallel to the last-named river for two or three miles, and then turns sharp to the south passing at the east foot of the spur on which Nongjirong H. S. is situated, about 1,400 feet below the station. The road usually followed from Jowai to Cherrapoonjee, crosses the Mangat just below Nongjirong, and in the rains is frequently impassable.

A road is being opened from Gowhatty to Shillong which follows, with little deviation, a line directly south of Gowhatty as far as near Mofflong. The gradient of this road is supposed never to exceed four in one hundred to be suitable for cart traffic. The road is eventually to be carried across the hills to Sylhet or Sonāmgang; it is already partially open, but little used, great mortality having occurred amongst the coolies employed in the construction, and there being no villages of any consequence near the line taken for 4 or 5 marches after entering the hills from Gowhatty. The nearest route from Shillong to Gowhatty is by a road, half bridle-path, half foot-path, running directly north from Shillong until it meets the Digroo at Borne, 9 miles south-east of Gowhatty. This road runs through a locality more thickly populated than that selected for the large road, though only (3) three villages are actually on the road from the

foot of the hills to within a short march of Shillong. These two roads run through the country triangulated by me in February, and are crossed by several village tracks.

A few of the Garrow people may often be seen in the village of Nongstain on a bazar day. Cotton forms the chief medium of this traffic which is bartered by the Garrows for iron implements made by the Kossiahs, and cloth imported by them from the bazars at the foot of the hills. At Nongstain, though it is the principal village of a large Kossiah State, the inhabitants generally scarcely understand the people of Cherrapoonjee.

The country laid out for triangulation by Mr. Belletty (as yet not triangulated) lies chiefly in the Jynteah territory, under British jurisdiction, a small portion, though in the hills, is supposed to be included in the Nowgong district.

The recess duties are being carried on steadily.

10 Principal triangles.
15 1st class secondary.
25 2nd class do.
·18 Computations of principal latitude and longitude.
·45 Do. secondary do. do. have been completed.

Two horizontal angle books and two vertical angle books have been examined and copied, and more than half of the computations of the previous two years have been arranged and copied in duplicate for submission in the shape of a General Report. Over 200 computations of minor secondary triangles remain yet to be done, and about the same number of computations of heights. These I hope to have completed before the end of October.

Mr. A. G. Wyatt, 2nd Class Sub-Assistant, joined on the 1st of this month, and Lieut. M. T. Sale, R.E., I expect by the middle of the month ; the number of hands for computing will then be nearly double the present strength.

The original plane table sheets have all been finished up ; two sheets of the fair map, of an average of two plane tables each, have been projected and pentagraphed ; streams, names of stations, villages, &c., inked in, and, as far as the original will admit of, will be finished, I anticipate, by the end of the recess.

The office chart of triangulation has been checked and reduced to a scale of 4 miles = 1 inch, and will be submitted with the General Report.

The health and efficiency of the party as regards the Native establishment was better than in the previous year ; the percentage of sick did not amount to one-third of what prevailed in the former year, but amongst the European portion, on the whole, there was rather more sickness, and one death. The ground plane tabled had a far greater proportion of unhealthy localities.

I would recommend that the whole of the Garrow territory, when it be taken up, be surveyed on half the present scale, or on the scale of 2 miles = 1-inch ; the rate of progress would probably be greater. What the difference in rate of progress would be I cannot say, as I have never worked myself on the scale I suggest, but I think a fewer number of points would be required to be fixed trigonometrically, and the plane tabler would still have a greater number of points (some of them very conspicuous) on his board ; at present in the jungly tracts, the plane tablers cannot work up to the scale. The Garrow territory is described as entirely covered with jungle, and from the appearance of the country on its eastern side I can believe the description to be tolerably correct, and it is with accuracy described as exceedingly unhealthy, about equivalent to the worst portions of the remainder of the range. A short field season must, therefore, be anticipatad while the party is engaged in that direction. The whole country west of the meridian of 91° east longitude which will be contained in one degree sheet of 60 minutes + 60 minutes, is Garrow territory.

The average discrepancy between the values obtained for common sides, in principal triangles, is, on the extension from the west flank of the G. T. Series, 5 inches per mile, on that from the east 1·8 inches per mile ; mean 3·4 inches per mile. In the 1st class secondary

triangulation with 14-inch and 12-inch theodolite, 5·16 inches per mile, 2nd class secondary with 7-inch theodolite, 6·9 inches. The minor secondary triangulation has not yet been computed, the error will be entered in Statement A.

My intended programme for the ensuing field season is to leave the triangulation to Mr. Belletty alone; the principal stations at which observations are required are already selected, and the platforms built. A fair proportion of marks for the plane tabler have been erected; the secondary triangulation to be extended if possible as far east as the meridian 92·30 east longitude, by the middle of March. After that date I do not purpose carrying on any triangulation, as the weather has hitherto proved most unfavourable for such operations, after that date I propose to accompany the remainder of the party, and assist and superintend personally the plane tabling operations, and endeavour to ensure the detail survey of the whole width of the hills as far west as 91 east longitude. In a portion of this ground I expect to have to fix some more points for the plane tablers. As the ground to be surveyed with the exception of the small piece left unfinished by Mr. Atkinson is all compact, I hope that, should any difficulty occur to any of the Assistants, I should speedily be able to render him assistance. Mr. Belletty ought to be able to complete ample triangulation to ensure plenty of ground ready for the season, 1867-68.

EXTRACT FROM THE NARRATIVE REPORT OF LIEUTENANT GEORGE STRAHAN, R. E., IN CHARGE No. 7 TOPOGRAPHICAL SURVEY PARTY, DATED 30TH SEPTEMBER 1866.

The past field season, viz., that of 1865-66, of which I now have the honour to forward you the Narrative Report, is the first in which No. 7 party has been completely and finally separated from No. 1, from which it emanated, and it will be as well if, before describing the operations of the season, I state briefly the arrangements which were made for its separation, and the data on which its work is based.

The nucleus of this party was formed so far back as 1863, at the suggestion of Colonel D. G. Robinson, then in charge of No. 1 party, by the appointment of several extra European Assistants and Native Surveyors, who were to be trained under his superintendence until No. 7 party should be strong enough to undertake independent work. I had the honour of being appointed to the charge of No. 7 party by G. G. O. Military Department, Simla, 23rd August 1864, No. 691, since which time I have, in conjunction with Captain Melville, been equipping, instructing, and organizing the party for future operations.

Towards the close of last recess the party was fit to commence independent work, and my report will, therefore, commence from 1st of October 1865, the date on which I took the field last season. The line of demarcation between the two parties was fixed at the meridian of 76 in your letter No. 203 J, of 28th June, the Rajpootana party being to the west and the Gwalior party to the east of that line; in addition to which No. 7 party undertook that part of Ulwar and other Native States which lie north of Lat. 28°, and between the meridians of 76 and 77. The Rahoon Series of the G. T. Survey runs down the meridian of 76, and on this series the whole triangulation of the work hitherto done by No. 7 party is based. We also have had the advantage of having the Goorhagurh G. T. Series on the meridian of 75°, and I proposed to connect these two series by principal ones of my own with the greatest care and the best instruments available, so as to divide this strip of country, 1° in breadth, into portions each embracing one square degree, and bounded by the most reliable triangulation. The two first of these connecting series were commenced in the field season of 1864-65, and were fully described in the report of that year's work. One of these has been now completed, and a full account of it will be found below.

Sufficient triangulation had been completed during the season of 1864-65 to enable me to set my plane table Surveyors to work alone, and in fact it proved sufficient to occupy them to the end of the season. The computations are so arranged that they are quite independent of those of No. 1 party, being in no way based upon or referable to them, but only to the Rahoon G. T. Series, as it appeared to me to be advisable that they should henceforth be as totally independent of one another as any other two parties. I do not wish it to be supposed, however, that I have not availed myself of any useful points laid down by No. 1 which are outside my boundary, on the contrary I have procured a list of the latitudes and longitudes of all such, and they have proved most useful.

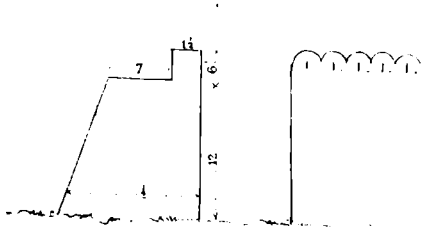
The strength of the party on leaving Dehra was as follows:—

Lieutenant G. Strahan, R.E., in charge, Mr. 1st Civil Assistant J. F. Baness, Messrs. 3rd Class Sub-Assistants Hussey, Todd, Tapsell, Kitchen, Kirk, Stotesbury, and Native Surveyors Kalkapershad, Hur Lall Sing, Hurbuns, and Mahomed Ali; and the programme I proposed was as follows:—I intended myself to start all the Sub-Assistants at their respective plane tables, instructing the younger ones, and satisfying myself that the older ones had not forgotten their work, and then leaving them under Mr. Baness, who had a plane table section allotted to him near them, to proceed to Jeypoor, taking Messrs. Kirk and Kitchen with me to triangulate the city, and arrange for the large scale plan of it, and on the completion of this to finish the principal series joining the Rahoon and Goorhagurh Series alluded to above, and extend the triangulation in other directions. Mr. Baness, on completion of his first table, was to join my camp, receive instructions in triangulation, and then commence work on his own account with a 7-inch theodolite. This programme was carried out, with the exception of the work allotted to Mr. Kirk, for on reaching Jeypoor I found that the detailed survey

of the city could be efficiently carried on by one Sub-Assistant, I therefore sent Mr. Kirk to take up a section to the west of Jeypoor between lat. $\frac{26-45}{27-0}$ and long. $\frac{75-30}{75-45}$.

The camp left head-quarters at Dehra on October 1st, and the whole party assembled at Delhi on the 16th idem. A sharp attack of illness prevented my leaving it before the 21st, the intervening five days being employed in projecting tables. Five days' march brought us to the frontier of Ulwar, where the ground allotted to Mr. Todd lay; this being his 3rd season I thought it unnecessary to stop more than one day with him to start his plane table and to refresh his memory. On the 11th day, November 1st, Messrs. Baness and Stotesbury were detached, the latter to be superintended by Mr. Baness until he could be trusted to produce accurate work, his plane table of the previous year not having proved satisfactory. On the 16th day, November 6th, Messrs. Tapsell and Hussey were detached. I remained one day with the former to satisfy myself that he was thoroughly conversant with the art of plane tabling, and then taking Messrs. Kitchen and Kirk with me, marched straight to Jeypoor, which was reached on the 19th day from Delhi, viz., on 8th November. After an interview with Captain Beynon, the Political Agent of Jeypoor, I commenced the reconnaisance and triangulation of the city, preparatory to the survey of it on a scale of 500 feet to 1 inch. The observing and the greater part of the computations were sufficiently advanced in a fortnight to commence a detailed survey, a portion of which I did before Mr. Kitchen, as surveying on this large scale must be an excellent lesson for him in plane tabling on the 1 inch scale. The plan comprises 8 plane table sections, each 1′ of latitude + 2′ of longitude. Two of these I completed myself as a sort of pattern of what I wished done, and then left Mr. Kitchen to complete it. Nearly one month passed in Jeypoor, much delay being occasioned by the necessity of sending word to the authorities every evening of exactly the very spots which we wished to visit the next day on the surrounding hills and forts. When this regulation was complied with, we experienced very little difficulty in gaining admittance every where. Such is the jealousy, however, of the Rajpoots that the first day on which I approached one of their forts in Jeypoor, without having taken the precaution of having an authorized official with me, they threatened to fire on us unless we immediately withdrew, though they knew well at the time that our survey was sanctioned, and even encouraged, by the Maharaja himself. This, however, was the only case in which we received any insults or annoyance. I believe that the practice of giving notice one day before hand where we intend to go, is instituted to enable the killadars to conceal their artillery, for I have several times noticed from outside the forts objects which I believed to be guns, and which, when I was admitted inside, had disappeared.

The city of Jeypoor was built in the reign of Jeysingh, or rather it was removed from its former site at Ambair to where it at present stands. It is said to have been designed by an Italian, and contrasts most favorably with all other Indian cities I have visited. The blocks of houses are all laid out in rectangles, and the city is traversed by four main streets at right angles to one another and leading to four principal gates. These main streets are about 50 yards broad, and paved at the side as in English cities for the convenience of foot passengers. This plan is apparently not approved of for the foot passengers, for the most part use the central roadway in company with the vehicles, as they find the pavement too hot for their bare feet. The city is enclosed by a high and massive wall, on which circular towers or bastions of masonry are built at regular intervals. The section of the city wall is shown in the accompanying sketch; though not quite uniform all round, the greater part is built in this form. It is pierced for two sets of loopholes as shown in the elevation, about four feet apart. It is in good order, almost in its entire circumference, and is solidly built of blocks of stone embedded in mortar. The bastions or towers are built inside and outside the wall, alternately, the outer ones rise from 4 to 8 feet above the wall, the inner ones something less. The section differs slightly in other parts, but not sufficiently so to merit special mention. The city is



surrounded on three sides by steep and rocky, but not high, hills, on the most prominent points of which are situated six forts, there being also a seventh fort on the side towards the plain. These forts derive what strength they have from their position only, the masonry of them being of a very small section and indifferent quality, the fort of Ambair excepted, to which I could not succeed in obtaining admittance; this fort from outside appears to be of very massive construction. There are two lakes in the amphitheatre of hills surrounding the city, one within the palace gardens, and the other at the north end of it; this latter is nearly 3 miles in circumference and abounds with alligators, which are esteemed sacred, and worshipped by the inhabitants. The lake appears to be entirely artificial, and is formed by damming up a water-course with a very massive masonry dam between 30 and 40 feet high; its picturesque effect is much increased by a palace which rises from beneath its waters, the foundations being aid at the bottom of the lake, and no island of any sort apparent. Towards the northern side a force would have great difficulty in approaching the city, the only practicable road being through a gorge in the hills which is very strongly fortified; on the southern side, on the contrary, there is nothing but the wretched little fort of Hatroi to prevent an army from marching up to the very walls. I had several interviews with the Maharaja, as I considered that an explanation of the uses of an accurate plan of his city and territory in person would do more towards securing his co-operation than any amount of writing. He took great interest in theodolites and other intruments I showed him, and expressed himself as much pleased with the progress of the survey. In all my communications with him I was greatly assisted by Captain Beynon, the Political Agent, to whom my best thanks are due for his hearty co-operation. The population of the city is estimated at 90,000, of which less than 10,000 are Mahomedans. There are no arts or manufactures carried on there calling for special mention, except perhaps the beautifully carved marble ornaments procurable there. Sanganeer, a large city a few miles to the south-west, is celebrated for its manufactures of paper and cloth.

The survey of the city was conducted on the same principles as the one-inch survey, the plane table being employed throughout, with the exception of a few streets and lanes in the city, where the use of the chain became indispensable. The latitudes and longitudes of many of the more conspicuous temples, houses, &c., have been computed, and have been sent in with the other computations.

On leaving Jeypoor I inspected Mr. Hussey's and Mr. Kirk's plane tables, and found them accurate, and then proceeded to extend the triangulation to the north-west of Jeypoor. During the first week in January a severe attack of illness obliged me to proceed to Hissar, the nearest station for medical advice, leaving the field operations in charge of Mr. Baness. The medical officer there strongly cautioned me against leaving in less than a fortnight; I therefore applied for this period of sick leave, which was granted me.

On returning to work I inspected Mr. Todd's work, which I found so satisfactory, and showing such a marked improvement on his work of previous years, that I was induced to recommend him at once for promotion, which was granted, D. O. No. $\frac{69}{465}$, dated 4th June 1866. Mr. Baness joined me about this time for instruction in triangulation, and having remained with me for about 10 days, appeared sufficiently versed in the use of the theodolite to be trusted alone; I therefore detached him to fill up gaps in the main triangulation, with points for the detail Surveyors, and proceeded myself to complete the connecting series between the Rahoon and Goorhagurh G. T. Series alluded to in paragraph 3.

This series consists of a quadrilateral, hexagon and pentagon; all the signals with the exception of those at Harnath were luminous, the instrument invariably isolated, and every care taken to ensure as much accuracy as could be obtained with the instrument used, viz., a 14-inch theodolite, without sacrificing more time than the object in view seemed worth. The angles were measured on zeros $\frac{0}{180}$, $\frac{15}{195}$ $\frac{30}{210}$ $\frac{45}{225}$. The series starts from base Jilo to Khelna of the Rahoon Series, and joins on to the base Miradass, Bhoomba of the Goorhagurh Series, and the results are briefly as follows:—

By Rajpootana Survey.	Miradass S.	27·35·59·53	74·56·11·15	192 35·15·0		1324·2
	Bhoomba S.	27·46·41·84	74·58·52·42	12·36·29·9		1262·3

Miradass to Bhoomba Log. ft. = 4·8225698 Feet = 66461·45.

Hence the discrepancy of Rajpootana Survey with G. T. Survey is—

At Miradass	—0″·14	+ 0″.25	+ 4″·86	+ 7·0
At Bhoomba	—0″·18	+ 0″.26	+ 3″·10	+ 1·1

Linear discrepancy in feet = —2·34 feet.

The computations of this series were performed without any regard being had to weights of angles, these being all assumed equal, nor was the method of minimum squares employed for computing the corrections to the various angles. One-third of the spherical excess was subtracted from each angle, and then the triangles were treated as plane ones, and an arithmetic mean of the values of the side of continuation of each polygon was taken as the base for the next. Two of the rays in the pentagon are grazing rays, and gave much trouble in observing; in one instance a trench had to be cut in the sand to allow the heliotrope to be seen at all. No attempt has been made this year to reconcile or disperse the errors shown in the tabular statement above, the whole triangulation up to the present time being based on the Rahoon Series alone. The errors are far too small to be important or even visible on the 1 inch to a mile scale; and I think the best plan of dealing with them will be to make no use of the Goorhagurh elements at present, except by frequently comparing them with my own wherever we have stations in common to avoid the errors of the latter from increasing until they become noticeable; my object in neglecting the Goorhagurh elements for the present being partly to avoid the distortion that would be introduced into my own triangulation, and the consequent large values of the discrepancies of common sides, and partly that the dispersion of the errors over the intervening stations would be a work of great trouble, and it is not easy to determine any system upon which it could be done otherwise than in an arbitrary manner. A junction one degree southwards of the one in question will be completed next season, (there being only one figure wanting) and I anticipate some light being thrown upon the cause of the discrepancies shown above by means of it. On passing to the westward of the Goorhagurh Series, I would of course base the triangulation on its elements instead of my own, but so long as my work lies between the two G. T. Series, the above plan seems adapted to the end in view.

The rest of the season was employed in extending the network of secondary triangulation, the extreme latitudes embraced by the season's work being 26°50′ and 28°25′, the greater part of it lying in the district of Shekawatti.

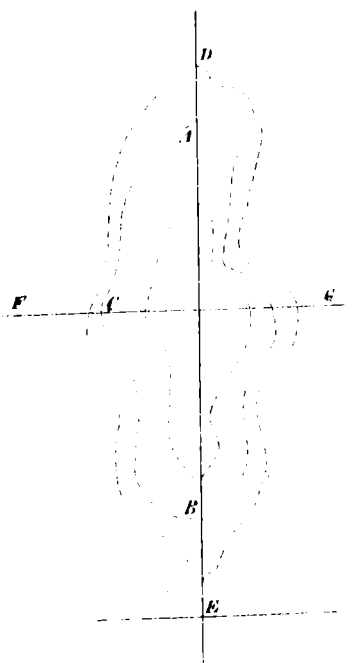
It is an easy district to survey, being little more than a sandy plain with a few low hills on it, very little cultivated, though not very thinly inhabited. The only crop grown in any quantity is "bajree;" wheat is only cultivated in small patches round the villages. The inhabitants are remarkable for their thieving propensities and total contempt for all authority. They never molested my camp except in one case, where a camel was stolen, but appeared to treat us with sulky enmity rather than with open hostility. They are divided into clans, each of which is governed by a Thakoor, and in many cases it happens that several Thakoors hold joint authority in a large city, which gives rise to endless feudal squabbles. Jhoonjhnoo, the capital district, is ruled by no less than five of these petty chiefs. Camels are bred in great numbers in the district, wild animals are scarce; a few ravine deer and neelgye being the only large ones that came under my observation. The portion of Jeypoor visited by me this season is a far more fertile country than Shekawattee, growing opium, wheat, gram, carrots, and cotton in large quantities, and a little sugar cane, though it is of an inferior quality. There are but few roads and little traffic, though this I am convinced would be much changed for the better if the country were better ruled, and some of the robbers driven out of the district. The climate is bitterly cold and wet in January, and the early part of February, but very dry in April; the variations in temperature in 24 hours are very great and trying.

We were obliged to leave our field work nearly one month earlier than usual, having been called upon to execute a survey of a site of a new cantonment at "Pokri." The party were all assembled at Delhi on the 15th day, viz. April 1st, after receiving orders for this survey, and proceeded thence without delay to Pokri. This change of our field operations has most unfortunately delayed the out-turn of two general maps for another season, for the amount of ground allotted to each Sub-Assistant had been so arranged as to enable each exactly to complete it, and in consequence of our sudden removal no less than four tables are left with

a small corner incomplete. This is the more to be regetted as I found on reaching Pokri that we were there before we were required, several of the committee being still absent, and those few who were present seemed quite at a loss to know how to employ us. From your letter No. 211 of 10th March I concluded that the site for the cantonment was definitely fixed, and nothing remained but to make a contoured survey of it, as directed in your letter No. 200 General Wheeler must have been strangely misinformed on this matter, for I found that the committee wished me to contour the ridge from Pokri to the foot of Deoban, a distance of fully 8 miles, to enable them to select a site, a task which it would be wholly impossible, even with the assistance of the Engineer Officers and European Sappers from Roorkee, to have completed under 4 or 5 months; under these circumstances I recommended a reconnoisance first, and then when the site was finally determined, a contoured survey of it. This did not, however, meet with approval, and after the delay of a few days in searching for water and examining the ground, I commenced the contouring of "Thana Tongri" or "Chilmeri" hill, at Captain Peile's request. I had completed at least two-thirds of this when the President of the committee wished me to survey a ridge beyond this called Chakraota, and which was the position most approved of by the majority of the committee. This I completed, and then was requested to go back and complete the "Chilmeri" hill; this one being the particular one still in favour with Captain Peile. This vacillation induced me to refer the matter to you in my letter No. 2 of 4th May 1866, and your reply and the correspondence arising therefrom resulted in a survey contoured at 10 feet vertical intervals for upwards of 4 miles along the ridge between Pokri and Deoban, and on its lateral spurs, and embracing both the Chilmeri and Chakraota sites; on the completion of this we returned to recess quarters in Dehra.

This was the most laborious and unpleasant piece of surveying I ever undertook. I had no Assistant in the party who even knew the use of a level, and they were one and all unacquainted with the theory and practice of contouring. Lieuts. Bisset and Rogers with their European Sappers were the only persons to whom I could look for any assistance at first; I found them most useful, without them the survey could not possibly have been completed before the rains set in. The Sub-Assistants of my party are trained to one especial duty, viz. that of plane tabling, and this is an art so totally distinct from levelling and traversing that a knowledge of one is of very little use in the others. There is no doubt, however, that young Surveyors are much improved by a survey like this on a large scale, both in sketching hill features and in obtaining a broader view of surveying in general.

This being, if I am rightly informed, among the first, if not the very first contoured survey executed in this country, I shall, at some risk of being tedious, enter somewhat fully into the methods I have employed, and more especially into the division of labour. I adopted two systems, one at Chilmeri and one at Chakraota: *first*, with regard to the Chilmeri hill; carrying out in part the suggestions conveyed in your letter No. 200, I selected a central point, and with a 6-inch theodolite I marked out two lines with flags, one going centrally along the ridge and the second passing through it at right angles. These I intended to be the bases of the survey. I then proceeded to level them, having large pegs at every 20 feet vertically, and measuring with rods the horizontal distances between them with great care. These pegs were numbered with heights reckoned downwards from the central point. The conformation of the ground being a more or less regular ridge, I divided the whole party into two sections, giving Lieutenant Bisset one side of the ridge and taking the other myself. Each of these sections was divided into two, one to level and lay out the contours, and the other to follow and traverse them in. I found this arrangement answer admirably. The method will be clear from an inspection of this diagram. A party of levellers start from A and peg out the contour,



check themselves at C and finally close on B, the accuracy of their work being thus ascertained by the agreement of the contour with pegs C and B: when the line A B was extended in either direction, another cross line at right angles was laid off and levelled in the same manner as at E.

Secondly, at Chakraota I partially modified this method, and instead of making A B strictly a straight line I followed the windings of the summit of the ridge, the cross lines being laid off at convenient intervals of about half a mile, and generally corresponding to some conspicuous watershed. This change necessitated the traversing and accurate plotting of the central and cross lines, but on the other hand keeping to the summit of the ridge very much diminished the labour of levelling them, and is on the whole I think best adapted to this style of survey. In plotting, the central and cross lines are first laid down (every care being taken to ensure accuracy) and the position of the contours marked on them, and then the traversing of each contour is plotted down, the error of the work being easily ascertainable by the closing of it at the cross lines. I may mention here that the little errors of closing, unavoidable in traversing, were dispersed so as to fall on the steepest ground, where they would be of the least consequence. The traversing of the contours was done with two 5-inch prismatic compasses belonging to No. 7 topographical party, which answered the purpose well, the measurement being done with steel chains. Had I known the distance to which the survey would eventually extend, I should certainly have measured a few triangles to embrace the whole of it, and to ensure the position of the several ridges being relatively correct. They are not liable to any large error even without triangulation, but only to such as may occur in a carefully conducted traverse, and I judged that accuracy of detail was more important in a survey of this sort, than minute accuracy in the relative positions of distant points. The greater part of the instrumental contours are at 40 feet vertical intervals, but where the ground is at all flat, intermediate ones were measured at 20 feet; the 10 feet contours are merely put in by eye on a sketch on which the instrumental contours had been previously plotted. This survey was finally completed, including the fair map of it, on the 2nd June, and office opened in Dehra on the 8th. Another copy of it has lately been made in this office for reduction by Photozincography to ½ scale *i.e.* 400′ to an inch.

The office duties have been steadily carried on since the 8th of June, and the attendance of the Assistants has been very regular; office hours from 10 to 4, except on Saturdays. The details of the computations and mapping, &c., will be found in Statement A, and will I trust meet with approval. The average No. of fixings per square mile seems rather small, but a reference to the maps will show that in Mr. Kitchen's and Mr. Hussey's work where the average is lowest, the detail to be put in is very scanty. I have, however, suggested to them that in future more fixings will be advisable. It was quite impossible to arrive at any exact statement of the cost of the Pokri survey per mile, but I have estimated it at Rupees 5,000. The chart submitted shows the present state of the network of triangulation; all principal rays of G. T. Survey are shown in thick black lines, those of No. 7 party in thin black lines, and secondary triangulation in red. The intersected or tertiary points in blue, are shown only, where the detail survey is complete, for these alone have been tested. In future, the triangulation will be sent in on the same sheet of paper as the quarter-inch maps, but owing to gaps left by our being summoned up to Pokri, no quarter-inch sheet is ready this season.

Mr. J. F. Baness, my Civil Assistant, has turned out his plane tabling in his usual excellent style, and his triangulation, considering the small size of the instrument with which he was working, a 7-inch theodolite, and that this was his first season, is very satisfactory. I fully expect that his work in this branch of surveying, next year with the new 12-inch Theodolite, which will be at his disposal, will show him to be as good an observer as he is detail Surveyor. His experience in the department has been of as great assistance to me as his skill and taste in mapping.

Mr. Todd's detail surveying gave me great satisfaction, so much so that I recommended him for promotion during the field season. I have much pleasure in observing that his promotion has been granted, and I have no doubt he will prove a valuable member of the department. He has been employed entirely on mapping during the recess, and has made great progress.

Mr. J. H. Hussey's plane tabling this year was satisfactory, but his general health is so bad that I was obliged to give him very easy ground, as he is physically incapable of doing

any rough work. He was at Pokri only until the middle of May, as he is unfit for climbing the hill sides, and proved far more useful in copying and comparing the angle books in Dehra, than he could ever have done at Pokree.

Mr. C. Tapsell turned out very satisfactory work this year, both in the field and recess. He is a very careful and painstaking Sub-Assistant, and I have consequently recommended him for promotion.

Mr. F. Kitchen was employed the greater part of the season on the large scale survey of the city of Jeypoor. His hill sketching hardly came up to my expectations, but great allowance should be made, for this work being new to him, and quite different from our 1 inch to a mile survey. Mr. Kitchen is an energetic Assistant, and a very promising computer, being both rapid and accurate.

Messrs. Kirk and Stotesbury have turned out fair work in the field, the latter especially is very much improved in hill sketching and promises to draw well. They are both inclined to be rather careless in their computations, but they are quite recently appointed to the department, and will I am sure improve very much on this point. They work steadily and are regular in their attendance at office, and on the whole gave me satisfaction. Mr. Kirk, owing to an affection of the chest, was unable to remain at Pokri, and was employed in Dehra copying angle books.

My Native Surveyors performed their duties efficiently. Kalkapershad was employed in laying out triangulation and poling up, Hurlallsingh in recording for me, Harbans in office work, and Mahomed Ali in recording for Mr. Baness.

Next season I propose to complete the principal series between the Rahoon and Goorhagurh Series on the Lat. 26° 45,′ and extend the triangulation southwards between the meridians 74°·0′ and 76°·0′. Mr. Baness will complete the triangulation of the N. W. corner of the degree between 28°0′ and 29°0′ latitude, and longitude 75°0′ and 76°0′, and will superintend the Sub-Assistants who are plane tabling near him. Those in the neighbourhood of Jeypoor will be under my imediate superintendence. Next season's work will complete all of Atlas Sheet No. 49 that lies within my district.

REPORT ON THE OPERATIONS OF THE PEGU SURVEY FOR THE YEAR 1865-66, BY CAPTAIN W. H. EDGECOMBE, R.E., DATED 21ST AUGUST 1866.

Introductory.

In my Report for 1864-65, dated 22nd June 1865, it was stated that the field work of the survey was so near completion, that the field establishment for the year under review might be reduced to 1 Assistant with 4 Native Surveyors.

Area for Survey.

After all the detail work of the previous season had been plotted, I ascertained that about 850 square miles of country remained for survey, together with the running up of a few streams here and there to their source. This was reported in my letters Nos. 348 and 373, dated 8th July and 7th August 1865 respectively, and a skeleton map showing the unsurveyed portions, was at the same time submitted.

Before detailing the results of the work of the past field season (December 1865 to May 1866) I propose to notice the work of the previous recess (May to December 1865).

Work of Recess, May to December 1865.

This period was occupied in the completion of all computations; calculations and plotting of the previous season's field work, including between 400 and 500 miles of theodolite traverse, and over 9,000 square miles of country surveyed with prismatic compass and perambulator. About 2,000 square miles of survey were also compiled in full detail on No. 4 Sheet of the General Map during this period.

Strength of Party during Recess.

The strength of the survey party at the commencement of the recess was—

1 Superintendent,
1 Assistant,
2 Sub-Assistants,
14 Native Surveyors,

but 8 Surveyors were discharged on 15th November 1865 (on completion of the mapping of all their detail work of previous season) under authority conveyed in No. 147 dated 15th July 1865 from under Secretary to Government of India, Home Department, to address of Officiating Surveyor General.

Superintendent with portion of Establishment go to Madras.

Work of the Madras Party.

In accordance with orders of Government, I left Rangoon for Madras on 18th August 1865, accompanied by Sub-Assistants Barnett and Cooper, and 2 Native Surveyors; and we were engaged in the reduction of the detail work of past season to $\frac{1}{4}$-inch scale for compilation in Sheets Nos. 3 and 4 of General Map, as well as on the preparation of various township maps on 1-inch scale.

On 1st March 1866 the services of one of the Native Surveyors (employed in Madras) was dispensed with, on the completion of his work.

Completion of No. 4 Sheet.

On 10th February 1866 No. 4 Sheet of General Map on $\frac{1}{4}$-inch scale was forwarded to the Surveyor General's office for publication. This sheet embraces an area of 7,689·76 square miles in Pegu division, comprising nearly the whole of the Prome and Myan-oung district of Bassein. About 3,700 square miles in Arracan Province are also included in this sheet.

Township Maps.

Before close of the year under report, 12 maps (on 1-inch scale) of townships in the Prome and Myan-oung districts were completed, embracing an area of 2,848 square miles.

Field Establishment.

The field work of the past season was entrusted to my Assistant, Mr. Montgomerie, and 4 Native Surveyors.

Area for Survey.

This work comprised (as before stated) between 800 and 900 square miles of country lying in the Rangoon, Prome, and Myan-oung districts, and included in No. 3 Sheet of the General Map. Mr. Montgomerie left Rangoon for the field on 29th December 1865, and his Surveyors on 26th idem.

Distribution of work.

To Mr. Montgomerie was assigned about 130 miles of traverse work with theodolite, of which his Progress Reports show about 100 to have been completed. This work was for the purpose of connecting the previous season's surveys of Sub-Assistants Barnett and Cooper, and thus fixing accurately the positions of all important points between Rangoon and Toungoo.

The 4 Native Surveyors were employed in the Zayawaddee and Bhaunee townships, (in Rangoon district) the Tsan-yuay township in the district of Myan-oung and the Myo-doung township in Prome district, and have completed the whole of the work assigned to them.

Nature of the country surveyed.

With the exception of the portion in the Tsan-yuay township (and even that is not favourable ground for survey) all the country surveyed during the past season comprises wild, inhabited and hilly tracts, covered with dense jungle and extremely unhealthy.

Difficulty in procuring carriage and labour.

Mr. Montgomerie reports that he experienced very great difficulty in procuring carriage and labour, and this considerably retarded his progress.

Health of the parties.

Completion of all field work.

All the party too suffered more or less from fever. In spite of these drawbacks, however, I am happy to report the completion of all the field work of the long protracted survey of Pegu, and have every confidence in completing all the mapping by the close of the current official year; on which occasion I shall avail myself of the opportunity of bringing to the notice of Government the services of all who have been engaged in the work.

Cost of the Survey.

The total expenditure up to 1st May 1866 I estimate to be Rs. 4,54,759-13-1, which as the area surveyed (including portions of Martaban and Arracan embraced in the four sheets) is about 30,700 square miles, represents an average rate of Rs. 11-7-3 per square mile, which I consider a high rate for the survey in question, but the cause of which has been fully explained in previous Reports.

Sheets published.

Sheets Nos. 1, 2, and 4 of the General Map are completed, and the remaining Sheet (No. 3) is now in hand, and only awaits the compilation of the results of the past season's work, and this should be effected by close of current year, leaving thus only for completion the series of township maps; but these should all be ready for publication by the end of current *official* year.

Conclusion.

As remarked in my Report on the operations of the Pegu survey up to March 1865 (the date of my relieving Captain FitzRoy, the late Superintendent) irrespective of the general maps, there exists in this office a large mass of records, gazetteers, statistical returns, &c. containing most valuable information regarding the geography and geology of the province which might be profitably disposed of after the publication of the maps, and which, if required, I shall be happy to compile in the form of a "Complete Report on the Pegu Topographical Survey from its commencement to its close."