V.

An Account of the Measurement of an Arc on the Meridian on the COAST *of* COROMANDEL, *and the Length of a Degree deduced therefrom in the Latitude* 12° 32′.

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IN a former Paper which I had the honour to communicate to the *Asiatick* Society, I gave a short sketch of an intended plan for establishing a series of connecting points commencing from the *Coromandel* Coast, and extending across the Peninsula; but that Paper was only meant to convey a general idea of the principles on which the work was to be conducted; a more circumstantial and scientific account, it was thought, would be more to the purpose, when I had the means of putting the plan in execution, and detailing the particulars. Since that time I have received a most complete apparatus, which has enabled me to proceed on the scale I originally proposed, and what is here offered is the beginning of that work, being the measurement of an arc on the meridian, from which is deduced the length of a degree for the latitude 12° 32′ which is nearly the middle of the arc.

The triangles here mentioned are those only, from which the arc is obtained, and the base line, the foundation to the whole, is a measured line near the Sea Coast, an account of which is here subjoined.

SECTION I. An account of the Base Line.

Some time had been taken up in examining the country best suited for this measurement, and at length a tract was found near *St. Thomas's Mount*, extremely well adapted for the purpose, being an entire flat, without any impediment for near eight miles, commencing at the race ground, and extending southerly. This being determined on, and the necessary preparations made, it was begun on the 10th of *April*, and completed on the 22nd of *May*, 1802.

I had expected a small transit instrument from *England*, for the purpose of fixing objects in the alignement, and for taking elevations and depressions at the same time; but that instrument not having arrived, I thought it unnecessary to wait, particularly as the ground was so free from ascents and descents; I therefore used the same apparatus as I had formerly done, viz. the transit circular instrument and the levelling telescope fixed on a tripod with an elevating screw in the center. In all horizontal directions, this telescope fully answers the purpose, and as there has been no deviation from the level to exceed 26′ 30″ excepting in one single chain, and those cases but very few, I feel entirely satisfied as to the accuracy of the whole measurement.

The chain which was made use of is the one I formerly had, and I was fortunate enough to receive another from *England*, made also by the late Mr. Ramsden, and this having been measured off by the standard in *London*, when the temperature was 50° by Fahrenheit's thermometer, it afforded me an advantage of correcting for the effects of expansion, a circumstance in which I was by no means satisfied in the former measurement. In order, therefore, to have a standard at all times to refer to, I have reserved the new chain for that purpose, and used the old one only as a measuring chain, by which means I can always determine the correction for the wear.

By referring to the annexed table, it will appear that there are only four angles of depression, and two of elevation, taken in the whole length of the base; the rest are all horizontal measurements, and many of them consist of a great number of feet before it became necessary either to sink or elevate the coffers; when that was done, great care was taken to mark the termination of the preceding measurement; and for that purpose a small tripod was used in the shape of a T, with three iron feet to run into the ground, the straight side of which T was placed in the line. Another small T was made with its top also parallel to the line, and fixed upon the large one so as to slide to the right or left, and upon that again was a long piece of brass made to slide out at right-angles to the top of the T; in the middle of this brass a mark was made, which was brought to a plumb line let fall from the arrow, and the height from the brass to the arrow was noted down; when the succeeding chain was laid, which was to commence the new level or hypothenuse, the arrow was then brought, so that a plumb line freely suspended, would coincide with the mark on the brass slider. The height of that chain above the brass was likewise taken, by comparing those two heights the elevation or depression of the new commencement was determined, and those differences noted in the seventh and eigth columns of the table. The differences of the two aggregates contained in those columns, when applied to the ascents and descents, will therefore shew how much one extremity of the base is above the other. The height of the chain at the commencement and termination of the whole was of course taken from the ground.

All the other particulars respecting this measurement are nearly the same as that in the *Mysore* country, a full account of which has been published in a former volume of the *Asiatic* Researches. Some little alterations have been made in the coffers; that is, they were all of the same length, and the whole together about ninety-six feet, so as to give room for the pickets with the brass register heads. Their sides continued to the ends, and their depth on each side was the same, for the purpose of being turned every day that they might fall into a curve by their own weight and that of the chain. I also used tripods with elevating screws in the center, for supporting the coffers, making no other use of pickets than for the drawing and weight posts, and for carrying the register heads. The top of each stand on tripod was a thick circular piece of wood fixed firmly to the end of the elevating screw, and a slip of board was fastened across the circular top, screwed into the center, and allowed to turn round. When the ends of two coffers were placed on the top piece, this slip of board was admitted into the under part of each, and prevented their sliding off, a precaution that was very necessary on account of the high winds.

The point of commencement of the base was had by dropping a plummet, from the arrow of the chain suspended by a silken thread. A long but small bamboo picket had been driven into the ground till its top was level with the surface, and the cavity of the bamboo was such as just to receive the plummet, and when the first chain was in the coffers, drawn out by the weight at the opposite end, it was adjusted by the finger screw at the drawing post in such a manner that the plummet might hang suspended over the cavity of the bamboo, while the thread was applied to the arrow. This was done within the observatory tent, that the plumb line might hang freely without being disturbed by the wind. The bamboo picket was preserved with great care during the time I was observing for the latitude, and was then protected under the frame of the zenith sector. When the tent was removed, a large bamboo flag-staff was erected, whose cavity covered the picket, and in that state it remained until the measurement was completed.

At the termination of the base, being the end of a chain, one of the large hooped pickets was driven into the ground till its top was on a level with the coffers and under the arrow of the chain. The opposite end being adjusted by the finger screw, the arrow at the leading end was nearly the center of the picket. A mark was made, and a small round headed nail was driven in till it was level with the surface. The chain was again applied, and the arrow cut the center of the nail. The picket had been driven upwards of two and a half feet into very hard clay.

But that those extremities may be preserved, in case they may hereafter be referred to, I erected small masses of hewn stone eight feet square at the bottom and four at the top, the axis of those masses being made to pass through the points of commencement and termination, and in order that this might be correctly done, the following method was used.

I marked ont the foundation of the building, so that the picket might be as nearly in the center of it as possible. The earth was dug about a foot deep, reserving a space round the center untouched. After the foundation was brought to a level with the surface, the first tier of stones was laid, being one foot in height. The inner part was then filled up with stones and mortar, taking particular care at the same time that the center was not touched. The next tier of stones was then laid, which was six feet square and one foot high. This also was filled in with great care, and some cement and bricks put gradually round the picket. After that the last tier was laid which was four feet square and also one foot high.

When these stones were firmly fixed small silken threads were drawn across each other in the diagonals of the square. A plummet (pointed) was then suspended from the point of intersection of those threads, and they were so moved that the point of the plummet coincided with the center of the nail in the picket. The position of these threads being determined, marks were inserted in the stone. The cavity was then filled up, and a square thick stone was fixed in the middle of the mass, having a circular place of about four inches diameter, sunk half an inch deep, and whose center was marked by a point. This point, by moving the stone and again applying the silken threads was brought to coincide with the point of intersection, and then it was firmly fixed and pointed.

Precisely the same kind of building was erected at the beginning of the base, but in place of having a picket in the center, four large hooped ones were driven into the ground, forming a square of about ten feet, the small bamboo picket being intended as the center. Silken threads were then drawn across from the diagonal pickets, and so moved, that the plummet first used, suspended from the point of intersection of the threads, might drop into the cavity of the bamboo. That being adjusted, lines were drawn on the tops of the pickets where the threads had been extended. The building was then erected, and the center both of the second and last tier, was marked by the intersection of those threads when applied to the marks on the pickets.

Such has been the mode of defining the extremities of the line. The buildings are well built of stone and some brick, and will remain for years, if not injured by acts of violence. They are intended to receive an instrument on the top, and the points are points of reference if it should ever be thought necessary to have recourse to them.

EXPANSION OF THE CHAINS AND THEIR COMPARATIVE LENGTHS.

As I wished to be satisfied with respect to the expansion of each of the chains, and their comparative lengths, I made a course of experiments for both purposes. I had accordingly the coffers arranged near the ground, that the drawing and weight posts might be driven deep and firmly fixed. Both the chains were then put into the coffers, and the comparisons made as follows:

April 10, at six P. M. the temperature by a mean of five thermometers was 85°,6.

Three comparisons were made, and the old chain exceeded the new one, nine divisions of the micrometer screw.

April 10, at six A. M. the temperature by a mean of five thermometers was 79°.

Four comparisons were made, and the old chain exceeded the new one nine divisions. Therefore at the commencement, the old chain exceeded the new one in length, nine divisions of the micrometer.

May 23. After the base was completed, the temperature by a mean of five thermometers, was 86°.

By a mean of five comparisons, the old chain exceeded the new one	10,65	divisions.
24. The temperature by a mean of five thermometers was 84°.		
And a mean of six comparisons, gave the excess of the old chain above the new one - - -	11,08	do.
25. The temperature was 87°.		
And a mean of two comparisons, gave - -	11,00	do.
Mean	10,86	do.

Hence it appears, that at the conclusion of the base, the old chain was longer than the new one, 11 divisions of the micrometer very neatly, so that it had increased from being in use, 2 divisions, or $\frac{2}{208}$ inches.

These experiments were made with great attention, and when either chain was stretched out by the weight, it was carefully brought into a line in the coffers.

As I had reserved the new chain for a standard, and knowing the temperature at which it had been measured off in *London*, I considered it an object to determine its rate of expansion and contraction compared with the thermometers which had been in use in measuring the base, since these were but common ones, and might probably differ from those made use of by General Roy and others, who had determined the expansion of metals by the pyrometer; and I was further induced to do this, from seeing the great variation among them, when the degree of heat became above one hundred, which it generally was in the coffers every day before I left off. To avoid those irregularities arising from the expansions being checked by the resistance from the pressure on the coffers, I chose the times of sunrise, and from one to two o'clock, P. M. for making the observations. Sunrise in *India* is generally the coolest time of the twenty-four hours, and the chain had during the night, on account of the uniform state of temperature, full time to free itself from any resistance. At the hottest part of the day likewise there is a considerable time when the thermometers are nearly stationary, which will afford time for the resistance in the coffers to be overcome, and it is necessary to pay particular attention to this circumstance, for the chain will be perceived to lengthen often for nearly half an hour after the thermometers are at their highest.

I had made a great many experiments prior to the measurement, but found great irregularity, partly from not attending sufficiently to the above circumstance, and partly from the unsteadiness of the drawing post, notwithstanding it was driven deep into very hard ground, and secured, as I thought, by having large stones pressed close on each side of it. To remedy this latter inconvenience, I had a staple driven into a brick wall, into which the iron was fixed with the adjusting screw for the chain, after which I perceived a perfect coincidence with the arrow and mark on the brass head, except what arose from the trifling expansion and contraction of the iron which held the chain. I then began a new course of experiments on both the chains, and the results were as follows:—

Experiments for determining the expansion of the new Chain.

1802. Month.	TIME.	Mean of 5 Thermometers.	Change of Temperature.	No. divisions.	Total expansion and contraction.	Total due to 1°	REMARKS.
					Inches.	*Inches.*	
June 4.	2 P.M.	116,4					Weather clear and windy during the whole of these experiments.
5.	⊙ rise.	83	33,4	51	,245157	,00734	
	2 P.M.	123,8	40,8	64	,307648	,00754	
6.	⊙ rise.	82,5	41,3	64	,307648	,00744	
14.	⊙ rise.	80					
	2 P.M.	119,1	39,1	60	,288420	,00737	
15.	⊙ rise.	81,4	37,7	57	,273999	,00727	
	2 P.M.	121,9	40,5	63	,302841	,00747	
16.	⊙ rise.	79,7	42,2	66	,317262	,00752	
					Mean	00,742	

Experiments for determining the expansion of the old Chain.

1802. Month.	TIME.	Mean of 3 Thermometers.	Change of Temperature.	No. divisions.	Total expansion and contraction.	Total due to 1°	REMARKS.
June 8.	⊙ rise.	83,5					Cloudy weather and high winds during the whole of these experiments.
	2 P.M.	110,3	26,8	42	,201894	,00749	
9.	⊙ rise.	85,2	25,1	40	,192280	,00766	
	1 P.M.	110	24,8	39	,187473	,00755	
12.	⊙ rise.	80,2					
	2 P.M.	108,1	27,9	42	,201894	,00724	
13.	⊙ rise.	83,3	24,8	38	,182666	,00736	
	2 P.M.	111,3	28	42	,201894	,00721	
14.	⊙ rise.	80	31,3	46	,221122	,00706	
					Mean	,00737	

It appears from these results, that the expansion due to 1° of the thermometer is less than what has been allowed by experiments made in *England*, but this might arise from the thermometers, as they were such as could be purchased in the shops, and therefore most probably of the best kind. Great care, however, was taken to watch the moment when they stood the highest, and though they varied from one another considerably at that time, yet that variation was generally the same in equal temperatures.

The reductions from the hypothenuses to bring them to the horizontal level, were made by numbering the feet from the old chain as they were measured, viz. by calling 32 chains 3200 feet, which would be 3200,115 feet by the new chain; but this would produce no sensible error in the versed sign of a very small angle, and on that account these decimals were not taken into the computation, which was thought less necessary, since the whole deduction did not amount to three inches. Neither was any notice taken of the different heights of the hypothenuses or levels one above another, as that difference was too trifling to affect a length of thirty or forty chains. The base has therefore been considered at the same distance from the center of the earth, before it was reduced to the level of the sea, and the perpendicular height of the south extremity, which I have considered as nearly the general height, has been taken for that purpose. That perpendicular height was obtained by comparing the south with the north extremity, and the height of the latter was determined by observations made at the race-stand and on the sea-beach, where allowance has been made for the terrestrial refraction. The following is the manner in which it has been determined:

On the top of the race-stand, the under part of the flag on the beach was observed to be depressed $9' 30''$; and at the beach, the top of the race-stand was elevated $7' 15''$. When the instrument was on the platform of the race-stand, the axis of the telescope was on a level with the top of the railing, which was observed from the beach. But at the beach the axis of the telescope was four feet below the part of the flag which had been observed.

The horizontal distance from the station on the stand to that on the beach is $=19208$ feet. Then as $19208 : 4 :: \text{Rad} : \tan. 43''$, which must therefore be added to the observed depression of the flag— Hence $9' 30 + 43'' = 10' 13''$ is the depression of the axis of the telescope on the beach, observed from the race-stand.

Now the station on the beach is nearly at right angles to the meridian, therefore, by allowing

60957 fathoms to the degree, 19208 feet will give an arc of 3′ 9″ very nearly, which is the contained arc. And the difference between the depression and elevation being 2′ 58″, we have $\frac{3' 9'' - 2' 58''}{2} = 5'',5$ for the terrestrial refraction. Hence, since the observed elevation of the stand, *plus half*, the contained arc would give the angle subtended by the perpendicular height of the stand above the telescope at the beach, were there no refraction, we shall have $7' 15'' + \frac{3' 9''}{2} - 5'',5 = 8' 44''$ for the true angle subtended by the perpendicular height, which being taken as tangent, to the horizontal distance and radius, we have R : tan. 8′ 44″ :: 19208 : 48,797 feet the height required. But the axis of the telescope on the beach was determined by levelling down to the water, to be 21,166 feet above the sea. Which, added to the above, give 69,963 feet for the perpendicular height of the top of the stand above the level of the sea.

Now the top of the race-stand was determined by levelling to be 31,25 feet above the north extremity of the base; which taken from the other, leaves 38,713 for the north extremity of the base above the sea, which extremity being, by the table, 22,96 feet above the south extremity, we shall have 15,753 feet from the perpendicular height of the south extremity of the line above the level of the sea; and from this height the length of the base has been reduced.

The angles of elevation and depression were taken by the circular instrument, from a mean of several observations, and the error of collimation was corrected by turning the transit over, and the horizontal plate half-round. But the weather was rather dull during the whole of these operations.

TABLE.

Containing the particulars of the measurement of a base line near *St. Thomas's Mount*, commencing in latitude 13°,00′,29″,59 N. and extending 40006,4418 feet South Westerly, making an angle with the meridian 0° 10′ 36″. The first column contains the number of the hypothenuse, or measured distances. The second the length of each in feet. The third the angles of elevation and depression (which each hypothenuse makes with the horizon). The fourth the quantities to be subtracted from the respective hypothenuse to reduce it to the horizon. The fifth the perpendicular ascents and descents to each hypothenuse. The sixth the commencement in inches of every hypothenuse above or below the termination of the one preceding; and the seventh contains the mean temperature during the respective measurement.

No. of the hypothenuse.	Length of each in feet.	Angles of elevations and depressions.	Deductions from each hypothen.	Perpendicular.		Commencement from the last.		Means of 5 Thermometers.	REMARKS.
				Ascents.	Descents.	above Inch.	below Inches.		
		° ′ ″							
1	600	0 19 40	,00984		3,4325	25,5		86,6	Commenced
2	500	0 26 00	430		3,7815			81,9	the 10th
3	2100	0 26 30	,06237		10,1878	2,5		84,5	April, 1802.
4	300	Level.				2,37		94,5	
5	600	do.					7,37	84	
6	100	do.				2,75		90,4	
7	400	do.				5,75		95,3	
8	500	do.				1,12		82,2	
9	100	do.				5,0		91	
10	400	do.				4,0		93,2	
11	300	do.					7,25	93,3	
12	300	0 20 30	,00534		1,7890		8,25	84,9	
13	100	Level.					10,0	90	In the water.
14	100	3 02 30	,14088	5 3062			8,5	96	Bank of a
15	100	Level.				8,		107,4	Tank.

No. of the hypothenuse.	Length of each in feet.	Angles of elevations and depressions.	Deductions from each hypothen.	Perpendicular.		Commencement from the last.		Means of 5 Thermometers.	REMARKS.
				Ascents.	Descents.	above Inches.	below Inches.		
		° ′ ″							
16	100	Level.					40,87	105,8	
17	200	do.					11,75	82,2	
18	200	do.					14,12	83,4	
19	500	do.					6,12	89,2	
20	300	do.					5,25	92,9	
21	700	do.				12,25		87,5	
22	300	do.					7,87	93,7	
23	500	do.					17,5	92,8	
24	900	do.					10,12	91,2	
25	400	do.					4,75	85,8	
26	500	do.					10,62	85,8	
27	300	do.					11	93,5	
28	400	do.					12	86,8	
29	1200	do.					11,37	88,9	
30	600	do.				3,5		86,7	
31	1700	do.				9,37		90,6	The 2 chain
32	700	do.				4		85,4	in the
33	200	do.				10,75		91,3	*Chingle-*
34	800	do.				7,5		91,5	*pet* road.
35	400	do.					12,75	94,8	
36	2000	do.					15	90	
37	2100	do.					6,9	91,5	
38	3200	0 04 50	,00320	4,4991		8,8		90,1	
39	900	Level.					1,8	96,9	
40	1200	do.					11,4	90,5	
41	800	do.					7	93,7	
42	1400	do.					6,7	93,4	
43	1100	do.					2,8	90,9	
44	500	do.					3	93,4	
45	600	do.				2		88,7	
46	1200	do.				10,2		93,8	
47	3200	do.				7,2		93,1	
48	1400	do.				7,2		90,4	
49	2200	do.				5,6		91,8	Completed the
50	800	do.				7,3		97,3	22d May,
									1802.
	40000		,23593	9,8053	25,1908	181,16	272,06	90,8	

North above the south extremity 22,96 feet in perpendicular height.

At the commencement, the old chain (with which the measurement was made) exceeded the new one by nine divisions of the micrometer, equal to $\frac{0{,}043463}{12}$ feet. Therefore $100 + \frac{0{,}043263}{12} \times 400$ will be the measures in lengths of the new chain, equal 40001, 4420

At the conclusion, the old chain exceeded the new one by eleven divisions, consequently it had increased by wear two divisions of the micrometer = 0,0008 feet. Hence $\frac{,0008}{2} \times 400 = 0{,}1600$ feet, is the correction for the wear, which add . . . . +0, 1600

Whence the apparent length of the base, will be 400,016020 lengths of the new chain, ... 40001, 6020

The sum of all the corrections in column fourth for obtaining the horizontal distances, is 0,2359 feet, which must therefore be deducted —0,2359

And this will give the apparent horizontal length of the base, in terms of the new chain 400,013661 lengths, or 40001,36661

The mean temperature for the whole base is 90°, 8 and the new chain was measured off when the thermometer stood at 50° hence to reduce the whole horizontal length to the standard temperature of 62°, the equation will be expressed by $\frac{(90°, 8-50°) \times 0.0071-(62°-50°) \times 00.1237}{12} \times$ 400,013661 feet, or 5,1162 feet which must be added, ... , +5,1162

Hence the whole horizontal distance corrected for 62° will be, ... 40006,4823

Which reduced to the level of the sea will be, ... 40006,4418

Note, the quantity +,0074 inches is the expansion of the chain due to 1° of the thermometer as determined by my own experiments detailed in the annexed memoir. By General Roy's experiments with the pyrometer, it was +,00763 inches.

The quantity +,01237 inches is the expansion of 100 feet of brass due to 1° of the thermometer.

By the experiments I made in the *Mysore* the expansion of the old chain was +,00725 inches due to 1°. By these experiments it is +,00737 inches, but I give the preference to the latter on account of the chains being fixed to the wall.

The radius of curvature for reducing the base to the level of the sea, is assumed at 3448748 fathoms being the radius to the meridional circle on which one degree is computed to be 60191 in the latitude of 13°.

SECTION II.—*Observations for determining the Angle which the Base Line makes with the Meridian.*

At the North end of the base latitude	13° 00 29″, 59 N.
September 24th, on the evening the polar star when at its greatest Eastern elongation was observed to make an angle North Easterly with the base line produced, ...	1° 35′ 08″, 7
The apparent polar distance of the star at that time was 1° 44′ 40″ 2 with which and the above latitude, the computed azimuth was, ...	1 47 25, 7

Therefore the line when produced Northerly will make an angle with the meridian North Easterly, ...	0	12	17, 0
September 26*th*, on the evening the angle North Easterly with the base line produced was, . . .	1	35	13, 1
The apparent polar distance on that day was, 1° 44′ 39″ 8 which will give the azimuth, . .	1	47	25, 2
Therefore the angle between the line and meridian will be, ...	0	12	12, 1
September 30*th*, on the evening the angle was observed, ...	1	35	06, 7
The apparent polar distance for that day being 1° 44′ 38″ 1 the azimuth will be, ...	1	47	23, 5
Hence the angle by this observation is, ...	0	12	16, 8
At the South end of the base—Latitude.	12	53	52, 8
October 7*th*. In the morning, the polar star when at its greatest western elongation, was observed to make an angle N. Westerly with the base line produced . . .	1	59	36, 9
The apparent polar distance at that time was 1° 44′ 35,7, and this with the above latitude will give the azimuth.	1	47	18, 2
Therefore the angle which this line produced, makes with the meridian North Easterly.	0	12	18, 7
And the mean of these four is . . .	0	12	16,15

The last observation was made under the most favourable circumstances, it being just day light;

the flag-staff at the north extremity of the line was observed immediately after the star; and the morning being perfectly clear, no unsteadiness or uncertainty arose from the effects of the vapour, which had occasioned the difference between the angles on the 24th and 26th.

When the observation was made on the 30th, a blue light was fixed at the south end of the base.

SECTION III.—*Commencement of the operations from the base. The large theodelite.*

After the completion of the base line, there remained nothing of importance to be done until I received the large instrument, which arrived in the beginning of *September*. I had however made an excursion down the sea coast, as far as *Pondicherry*, for the purpose of selecting the properest stations for determining the length of a meridional arc. This and the measurement of a degree at right-angles to the meridian I considered as the first object of this work: I accordingly lost no time in proceeding to accomplish these desiderata.

The instrument above alluded to was made by Mr. CARY, and is in most respects the same as that described by General ROY in the Philosophical Transactions for the year 1790, with the improvements made afterwards in the microscopes, and in an adjustment to the vertical axis, by which the circle can be moved up or let down by means of two capstan screws at the top of the axis. These are mentioned in the Philosophical Transactions for 1795, in the account of the trigonometrical survey. By sinking the circle on the axis, it is better adapted for travelling, and when the microscopes are once adjusted to minutes and seconds, on the limb of the instrument, the circle can always be brought back to the proper distance from them. Great attention however is necessary in bringing the axis down, so that the wires in each microscope being fixed at opposite dots on the limb, they may coincide with the same dots when the circle is turned half round, or made to move entirely round, and in a contrary direction to what it had been moved before; which latter method has been recommended by the maker. This circumstance respecting the axis should be most scrupulously attended to before the adjustment of the micrometers begin, so that when by arranging the lenses in such a manner that ten revolutions of the micrometer may answer to ten minutes on the limb, and therefore one division to one second, the circle can always be brought to its proper height, by trying the revolutions of the micrometer.

It has however been found from experience, that unless in cases of very long and troublesome marches, it is not necessary to sink the axis. The carriage being performed altogether by men, there is not that jolting which any other mode of conveyance is subject to, and as I found, that a considerable time was taken up in adjusting the axis before the revolutions of the micrometers could be brought to their intended limits, I therefore laid it aside, unless under the circumstances above mentioned.

The semicircle of the transit telescope is graduated to 10′ of a degree in place of 30′, which was the case with the semicircle described by General Roy, and the micrometer to the horizontal microscope applied to this semicircle, making one revolution in two minutes, and five revolutions for ten minutes on the limb; and the scale of the micrometer being divided into sixty parts, each part is therefore two seconds of the circle.

A number of experiments have been made for determining the error of the semicircle, and to ascertain the place of the fixed wire in the horizontal microscope, so as to divide the error. It has appeared in the event, that the telescope being in its right position, (that is, when the limb and microscope were on the left hand,) and the fixed wire placed at Zero on the semicircle, when the circle or limb of the theodelite was turned 180° in Azimuth, and the telescope turned over, the fixed wire was then distant from Zero on the opposite part of the arc by a mean of a great many observations 2′ 57″, the half of which is therefore the error. This half was carefully set off from Zero by the moveable micrometer wire, and the fixed one brought to coincide with it. On the right application of this error, there will be 1′ 28″, 5 to add to the elevations and subtract from the depressions. The observations for determining this quantity were repeated at different times, and under the most favourable circumstances; the adjustments of the whole instrument being frequently examined, and the level applied to the telescope, reversed at most of the observations. For the line of collimation, as these corrections depend on having a well-defined object, I fixed a bamboo upwards of a mile distant from the observatory tent, and tied round it several narrow stripes of black silk, one of which was near the horizontal wire when the axis of the telescope intersected the staff after being brought to a level by the bubble. Then the instrument being adjusted, and the telescope directed to the bamboo, being perfectly level, and the wire of the micrometer in the piece brought to the intersection of the cross wires, the angular distance to the mark on the bamboo was measured by the runs of that micrometer, and the wire brought back to the point of intersection of the other wires. The circle was then turned half round and the telescope reserved or put again into the same Ys. The levelling adjustment was then made, and the angular distance from the intersection of the wires to the black mark again taken, half the difference between which and the former was of course the error of collimation. This error was repeatedly reduced till it became very small, half by the finger screw of the clamp to the semicircle, and half by the adjusting screws to the levelling rods. After that, the remaining error was repeatedly examined and found to be 2″,36 to be subtracted from the elevations and added to the depressions when the telescope is in the ordinary position, or when the semicircle and microscope are on the left hand; but *vice versa* when in the contrary position. These errors of the semicircle and line of collimation being opposite, the result from comparison will be, "That when *elevations* or *depressions* are taken with the semicircle, 1′26″ must be added to the *former*, and subtracted from the *latter*."

And that when the elevations and depressions are taken by the micrometer in the eye piece 2″,36 must be *deducted* from the *elevations* and added to the depressions.

The micrometer in the focus of the eye-glass of the transit telescope is the same in all respects as the one mentioned by General Roy, that is to say, the circle or scale is divided into one hundred divisions, and there is a nonius fixed to the upper part of the telescope, which defines the revolutions of the micrometer as far as ten for the elevations and ten for the depressions. The following experiments have been made with the same marked bamboo, for ascertaining the value of these divisions, and it has been found that seven revolutions and 61,4 divisions are equal to ten minutes on the limb of the semicircle, so that one division is equal to ,788 of a second.

TABLE

Of experiments for determining the valuation of the revolutions and divisions on the micrometer in the eye-piece of the telescope.

Month.	Micrometer Divisions.	No. of seconds.	Value of 1 Division.	Month.	Micrometer Divisions.	No. of seconds.	Value of 1 Division.
	d				d		
Nov. 26.	994,5	783,5	0,788	Nov. 26.	1000	780	0,780
	994	787	0,782			800	0,800
	994	773	0,777			787	0,787
	1005		0,788			794	0,794
	1002	794	0,794			788	0,788
						782	0,782
		Mean -	0,788				
						788	0,788

Hence one second will be equal to 1,269 divisions.
One minute . . . . 75,72 ditto.
Ten minutes . . . . 757,2 ditto.

SECTION IV.

Angles taken with the large theodelite between 27th *September* 1802, and 13th of *April*, 1803.

AT THE NORTH END OF THE BASE.

Between	*And*	*Observed Angles.* ° ′ ″
South end of the base,	Mount station, . . .	91 09 04
	Perumbauk hill, . .	09 47 58,9
Perumbauk hill,	Mount station, . . .	81 21 05,2

AT THE SOUTH END OF THE BASE.

Between	*And*	*Observed Angles.* °	′	″
North end of the base,	Mount station, . .	11	19	32,5
	Perumbauk hill, . .	113	56	47,3
Mount station,	ditto, ...	102	37	14,8

AT THE MOUNT STATION.

North end of the base,	South end of the base,	77	31	23
	Perumbauk hill, . .	88	06	38,2
South end of the base,	ditto, ...	10	35	12,9
Perumbauk hill,	*Mungot* station, . .	92	30	03,6
	Mullapode hill, . . .	63	30	18,2

AT PERUMBAUK HILL.

North end of the base,	South end of the base,	56	15	26
	Mount station, . . .	10	32	16,8
South end of the base,	ditto, ...	66	47	42
Mungot station,	ditto, ...	36	58	15,1
	Coonoowaucum hill,	59	43	12,9
	Mullapode hill, . . .	42	52	13,9
Mullapode hill,	*Coonoowaucum* hill,	16	50	59

AT MUNGOT STATION.

Perumbauk hill,	*Coonoowaucum* hill,	88	03	47,6
	Mullapode hill, . . .	79	08	56,4
Mullapode hill,	*Tandray* station, . .	124	40	24,2
Mannoor station,	ditto, ...	75	25	54,8
Mount station,	*Perumbauk* hill, . .	50	31	41,7
Mullapode hill,	*Munnoor* station, .	49	14	29,4

AT MULLAPODE HILL.

Between	*And*	*Observed Angles.* °	′	″
Perumbauk hill,	*Coonoowaucum* hill,	139	29	07,8
Coonoowaucum hill,	*Munnoor* station, .	81	21	03,0
Tandray station,	ditto, ...	52	53	20,0
	Mungot station, . .	28	17	36,7

AT MUNNOOR STATION.

Mungot station,	*Coonoowaucum* hill, .	100	27	11,4
	Mullapode, ...	49	34	32,4
	Tandray station, . .	44	15	34,9
Mullapode hill,	ditto, ...	93	50	05,9
	Coonoowaucum hill,	50	52	39

AT TANDRAY STATION.

Mungot station,	*Munnoor* station, .	60	18	30,7
	Mullapode hill, . . .	27	02	00,1
Munnoor station,	ditto, ...	33	16	30,8
Mullapode hill,	*Urrumbaucum* hill,	94	00	01,7
	Poonauk hill, ...	80	48	38,8

AT URRUMBAUCUM HILL.

Mullapode hill,	*Tandray* station, . .	43	02	50
	Poonauk hill, ...	111	52	28,9

AT POONAUK HILL.

Mullapode hill,	*Urrumbaucum* hill,	39	25	15,6
	Tandray station, . .	27	13	47,4
	Maumdoor hill, . . .	49	19	0,46

AT POONAUK HILL.

Between	*And*	*Observed Angles.* °	′	″
Allacoor hill,	*Padree* station, ...	23	52	57,5
	Urrumbaucum hill, .	32	18	50,7

AT ALLACOOR HILL.

Poonauk hill,	*Padree* station, . . .	91	22	13
	Urrumbaucum hill, .	110	08	22,3

AT PAUDREE STATION.

Poonauk hill,	*Allacoor* hill, ...	64	44	52,1

AT MULLAPODE HILL.

Poonauk hill,	*Tandray* station, . .	71	39	26,3
	Urrumbaucum hill, .	28	42	12,6
	Maumdoor hill, . . .	58	02	19
Tandray station,	*Urrumbaucum* hill, .	42	57	07,9
Perumbaucum hill,	MOWBRAY's house, .	35	17	00
Maumdoor hill,	*Carrangooly* hill, . .	45	48	00,5

AT MAUMDOOR HILL.

Mullapode hill,	*Poonauk* hill, ...	72	38	40
	Carrangooly hill, . .	69	50	21,5
Carrangooly hill,	*Woritty* hill, ...	44	46	21,6

AT CARRANGOOLY HILL.

Mullapode hill,	*Maumdoor* hill, . .	64	21	44,1
Maumdoor hill,	*Woritty* hill, ...	80	37	28,3
Permacoil hill,	ditto, ...	28	33	28,6
	Vellungcaud hill, . .	36	40	28,2

AT WORITTY HILL.

Carrangooly hill,	*Maumdoor* hill, . . .	54	36	13,1
	Permacoil hill, . . .	109	25	09,4
Permacoil hill,	*Coonum* hill, ...	17	46	10,3

AT PERMACOIL HILL.

Between	And	Observed Angles.		
		°	′	″
Woritty hill,	*Carrangooly* hill, . .	42	01	25,1
	Coonum hill, ...	134	51	00,6
Coonum hill,	1st flag on red hill, .	53	13	11,8
Vellungcaud hill,	*Carrangooly* hill, . .	28	58	23,4
	New station on red hill,	98	29	08,8
Mooratan station,	ditto ditto, . .	15	57	39,8
	Chengcaud station, .	42	57	14,4
Mylum station,	ditto ditto, .	29	29	41,3

AT VELLUNGCAUD HILL.

Permacoil hill,	*Carrangooly* hill, . .	114	21	15,4
	New station on red hill,	37	15	17,4

AT THE NEW STATION ON RED HILL.

Permacoil hill,	*Vellungcaud* hill, . .	44	15	33,8
	Mooratan station, .	99	25	04,4

AT MOORATAN STATION.

Chengcaud station, ...	*Permacoil* hill, . . .	85	13	36,0
	Trivandepoorum hill,	64	42	38,5
1st *Coonum* hill,	1st flag on red hill,	81	48	30
	Chengcaud station, .	54	33	15
New station on red hill, . .	*Permacoil* hill, . . .	64	37	21,4

AT THE FIRST FLAG ON RED HILL.

Coonum hill,	*Permacoil* hill, . . .	38	54	56,4
	Station near *Mooratan*,	76	26	03,1

AT COONUM HILL.

Permacoil hill,	*Woritty* hill, ...	27	22	53,3
	1st flag on red hill, .	87	51	51,8

Between	*And*	*Observed Angles.* ° ′ ″
1st flag on red hill, . . .	Station near *Mooratan*,	21 45 26,9
Chengcaud station, . . .	ditto, ...	76 02 09,3

AT MYLUM STATION.

Permacoil hill,	*Chengcaud* station, .	129 25 52,8
	Mooratan station, .	73 09 50,7
	Waritty hill, ...	46 21 11,4

AT CHENGCAUD STATION.

Permacoil hill,	*Mylum* station, . . .	21 04 26,9
	Mooratan station, .	51 49 03,6
Trivandepoorum hill, . .	ditto, ...	66 08 35,2
Coonum hill, .	ditto, ...	49 24 33,75

AT THE STATION OF OBSERVATION AT TRIVANDEPOORUM HILL.

Mooratan station, . . .	*Chengcaud* station,	49 08 53,9
Referring light near *Tripnumbaucum*,	Polar star, west elongation,	
	February 3, .	11 29 43,25
	4, .	44,9
	5, .	44,33
	7, .	40,5
	9, .	42,2
	10, .	39,6
	11, .	43,67
Referring light near *Tripnumbaucum*,	Blue light on *Mooratan* station, . .	7 57 45,36

The angles in general have been taken three and four times, and every time that the object was observed, both microscopes were read off thrice, and two separate field books kept for making out the angles. What are here recorded, are the means taken from the two books. In case a difference in those angles, noticed at the time, left any reason to suspect an error in the instrument, the division between the dots was carefully examined, as well as those to the right and left, and if any error was discovered, allowance was made accordingly.

SECTION V. TRIANGLES.

North End of the Base from the South End of the Base 40006,4.

No.	Stations.	Observed Angles.	Diff.	Spher. Excess.	Error.	Angles for calculation.	Distances in feet.
		° ′ ″	″			° ′ ″	
1.	North end of the base,	91 09 04,0	—,03			91 09 04,2	
	South end of the base,	11 19 32,5	—,02			11 19 32,6	
	Mount station,	77 31 23,0	—,03			77 31 23,2	
		179 59 59,5	,08	,08	—,58	180 00 00	
	Mount station from { North end of the base,						8046,7
	Mount station from { South end of the base,						40965,8
		° ′ ″	″			° ′ ″	
2.	North end of the base,	9 47 58,9	—,01			9 47 58,8	
	South end of the base,	113 56 47,2	—,08			113 56 47,2	
	Perumbauk hill,	0 0 0				56 15 14	
				,07		180 00 00	
	Perumbauk hill from { North end of the base,						439718
	Perumbauk hill from { South end of the base,						818903

North end of the Base from Perumbauk *Hill* 43971,8.

No.	Stations.	Observed Angles.	Diff.	Spher. Excess.	Error.	Angles for calculation.	Distances in feet.
		° ′ ″	″			° ′ ″	
3.	North end of the base,	81 21 05,2	—,03			81 21 05,1	
	Perumbauk hill,	10 32 16,8	—,02			10 32 16,8	
	Mount station,	88 06 38,2	—,03			88 06 38,1	
		180 00 00,2	,08	,08	+,1	180	
	Mount station from North end of the base,						8046,7
	Mount station from *Perumbauk* hill,						43495,4

South End of the Base from Mount Station 40965,8.

No.	Stations.	Observed Angles.	Diff.	Spher. Excess.	Error.	Angles for calculation.	Distances in feet.
		° ′ ″	″			° ′ ″	
4.	South end of the base,	102 37 14,8	—,06			102 37 14,7	
	Mount station,	10 35 12,9	—,02			10 35 12,9	
	Perumbauk hill,	0 0 0	—,01			66 47 32,4	
						180	
	Perumbauk from South end of the base,						8189,2
	Perumbauk from Mount station,						43495,5

It appears from examining the above triangles, that there is a difference in the distance from the north end of the base and Mount station, by the first and second triangles, and also a difference in the distance from the south end of the base to *Perumbauk* hill. It may be necessary to notice here, that there was great difficulty in taking all these angles, on account of the very thick vapour which constantly floated near the surface of the flat where the base line runs, almost immediately after day-light, to very near the time of sun-setting. All the angles, and particularly at the north and south end of the base line, have been repeatedly taken, and the only time when the flag-staff appeared distinctly, was in the morning of the 7th of *October*, when I observed the polar star at the south end of the base line.

It was discovered, that at *Perumbauk* hill, there had been an error in reading off the south end of the base, most probably of 10″ from the micrometers, as all the angles which had a reference to that point, exceeded what they ought to have been by ten or twelve seconds. In consequence of this disagreement, I chose to take the supplemental angle in the second and fourth triangles, after the other angles had been corrected. The distance of the north end of the base from *Perumbauk*, as determined in the second triangle, being taken as a base in the third triangle, wherein the three angles have been observed to determine the distance from *Perumbauk* to the *Mount*, and from the north end of the base to the *Mount*, it appears that the latter distance comes out within 0,4 of a foot to what had been brought by the first triangle; and that the distance from the south end of the base to *Perumbauk* hill, derived from the second and fourth triangles, differ only ,14 of a foot. The distance from the *Mount* to *Perumbauk* being that from which all the operations are to commence, I wished to be as particular as possible in determining it, and the results from the third and fourth triangles make it 43495,4 and 43495,5, differing only one-tenth of a foot.

Mount station from Perumbauk *Hill* 43496,4.

No.	Stations.	Observed Angles.	Diff.	Spher. Excess.	Error.	Angles for calculation.	Distances in feet.
		° ′ ″	″			° ′ ″	
5.	Mount station, *Perumbauk* hill, *Mungot* station,	92 30 03,6 36 58 15,1 50 31 41,7	—,18 —,08 —,08			92 30 03,4 36 58 15 50 31 41,6	
		180 0 0,4	—,34	,″3	+,1	180	
		Mungot station from { *Perumbauk* hill					[illegible]92,1
		Mount station					33886,8

Perumbauk *Hill from* Mungot *station* 56292,1.

No.	Stations.	Observed Angles.	Diff.	Spher. Excess.	Error.	Angles for calculation.	Distances in feet.
		° ′ ″	″			° ′ ″	
6.	*Perumbauk* hill,	42 52 13,9	—,16			42 52 13,[illegible]	
	Mungot station,	79 08 56,4	—,25			79 08 55,7	
	Mullapode hill,	57 58 51,5	—,17			57 58 51	
		180 0 01,8	—,58	,59	+ 1,4		
	Mullapode hill from { *Perumbauk* hill, - -						65205,2
	{ *Mungot* station, - -						45169,5

Perumbauk *Hill from* Mullapode *Hill* 65205,2.

No.	Stations.	Observed Angles.	Diff.	Spher. Excess.	Error.	Angles for calculation.	Distances in feet.
		° ′ ″	″			° ′ ″	
7.	*Perumbaucum* hill,	16 50 59	+,3			16 50 59,5	
	Mullapode hill,	139 29 7,8	—,9			139 29 07,0	
	Coonoowaucum hill,	0 9 9				23 39 53,5	
				1,99			
	Coonoowaucum hill from { *Perumbauk* hill, - -						105534,6
	{ *Mullapode* hill, - -						47088,5

Mullapode *Hill from* Coonoowaucum *Hill* 47088,5.

No.	Stations.	Observed Angles.	Diff.	Spher. Excess.	Error.	Angles for calculation.	Distances in feet.
		° ′ ″	″			° ′ ″	
8.	*Mullapode* hill,	81 21 03,0	—,2			81 21 02,8	
	Coonoowaucum hill,	0 0 0	—,10			47 46 18,3	
	Manoor station,	50 52 39,0				50 52 38,9	
						180 00 00,0	
	Manoor station from { ~~*Mullapode* hill,~~ - -						~~44044,4~~
	{ *Coonoowaucum* hill, -						60006,6

Mullapode *Hill from* Mungot *station* 45109,5.

No.	Stations.	Observed Angles.	Diff.	Spher. Excess.	Error.	Angles for calculation.	Distances in feet.
		° ′ ″	″			° ′ ″	
	Mullapode hill,	81 10 56,8	—,21			81 10 57,4	
9.	*Mungot* station,	49 14 29,4	—,13			49 14 29,8	
	Munnoor station,	49 34 32,4	—,14			49 34 32,8	
		179 59 58,6	—,48	,48	—,9	180	
	Munnoor station from { *Mullapode* hill, - -						44944,3
	Mungot hill, - - -						58633,6
		° ′ ″	″			° ′ ″	
	Mullapode hill,	28 17 36,7	+,04			28 17 36,4	
10.	*Mungot* station,	124 40 24,2	—,6			124 40 23,6	
	Tandray station,	27 02 00,1	—,1			27 02 00	
		180 0 01		,42	×,3		
	Tandray station from { *Mullapode* hill, - -						81731,9
	Mungot station, - -						47105,3

Mullapode *Hill from* Munnoor *station* 44944,3.

No.	Stations.	Observed Angles.	Diff.	Spher. Excess.	Error.	Angles for calculation.	Distances in feet.
		° ′ ″	″			° ′ ″	
	Mullapode hill,	52 53 20	—,2			52 53 21	
11.	*Munnoor* station,	93 50 5,9	—,3			93 50 08	
	Tandray station,	33 16 30,8	—,1			33 16 31	
		179 59 56,7		,7	—,4	180	
	Tandray station from { *Mullapode* hill, - -						81732,7
	Munnoor station, -						65325,7

Mungot *station from* Munnoor *station* 58633,7.

No.	Stations.	Observed Angles.	Diff.	Spher. Excess.	Error.	Angles for calculation.	Distances in feet.
		° ′ ″	″	″		° ′ ″	
12.	*Mungot* station,	75 25 54,8	—,3			75 25 54,5	
	Munnoor station,	44 15 34,9	—,2			44 15 35	
	Tandray station,	60 18 30,7	—,2			60 18 30,5	
		180 00 00,4		,64	—,2	180	
	Tandray station from *Mungot* hill,						47105,9
	Tandray station from *Munnoor* station,						65325,4

In the quadralateral formed by *Mullapode* hill, *Mungot* hill, *Munnoor* station, and *Tandray* station, the side *Mullapode* and *Tandray* is common to the tenth and eleventh triangles, the first of which gives it 81731,9 feet, and the latter 81732,7 feet, the mean of which is 81732,3 feet, which becomes the base for extending the triangles westerly. These results appear to be sufficiently correct, since the bases on which the two triangles have been formed, were derived from the different sides of the triangle *Perumbauk* hill, *Mungot* hill, and *Mullapode* hill, viz. one from the side *Mullapode* hill and *Mungot* hill, the other from the side *Mullapode* hill and *Perumbauk* hill, on which was computed the side *Mullapode* hill and *Coonoorwaucum* hill, and from that again the side *Mullapode* hill and *Munnoor* station, which, however, came out the same as when obtained from the distance *Mullapode* hill and *Mungot* hill.

It will also appear that in the triangle computed on the base *Mungot* hill and *Munnoor* station, that each of the sides, *Munnoor* station and *Tandray* station, and *Mungot* and *Tandray* become common to the triangles, *Mullapode* hill, *Munnoor* and *Tan-*

dray and *Mullapode* hill, *Mungot* and *Tandray*, each to each, and that in the first case, there is a difference of $\frac{3}{10}$ and in the second of $\frac{6}{10}$ of a foot. These circumstances will, I conceive, prove the operations to be sufficiently satisfactory.

Mullapode *hill from* Tandray *station* 81732,3.

No.	Stations.	Observed Angles.	Diff.	Spher. Excess.	Error.	Angles for calculation.	Distances in feet.
		° ′ ″	″			° ′ ″	
	Mullapode hill,	42 57 07,9	—,4			42 57 08,2	
13.	*Tandray* station,	94 00 01,7	—,8			94 00 01,6	
	Urrumbaucum,	43 02 50	—,4			43 02 50,2	
		179 59 59,6		1,6	—,8	180	
		Urrumbaucum from			*Mullapode* hill,	- -	119444,7
					Tandray station,	- -	81587,1
		° ′ ″	″			° ′ ″	
	Mullapode hill,	71 39 26,3	—1,1			71 39 25,2	
14.	*Tandray* station,	80 48 45,7	—1,3			80 48 44,4	
	Poonauk mullah,	27 31 47,4	—0,8			27 31 50,4	
		179 59 59,4		3,2	—3,8	180	
		Poonauk hill from			*Mullapode* hill,	- -	174555,7
					Tandray station,	-	167839,7

Poonauk *hill from* Urrumbaucum *hill* 90339,4.

No.	Stations.	Observed Angles.	Diff.	Spher. Excess.	Error.	Angles for calculation.	Distances in feet.
		° ′ ″	″			° ′ ″	
	Poonauk hill, -	32 18 50,7	—,1			32 18 51	
15.	*Urrumbaucum*,	0 0 0				37 32 47	
	Allicoor hill, -	110 8 22,6	—,5			110 8 22	
				0,67			
		Allicoor hill from			*Poonauk* hill,	-	58638,4
					Urrumbaucum hill,	-	51436,9

Poonauk *hill from* Allicoor *hill* 58638,4.

No.	Stations.	Observed Angles.	Diff.	Spher. Excess.	Error.	Angles for calculation.	Distances in feet
		° ′ ″	″			° ′ ″	
16.	*Poonauk* hill,	23 52 57,5	—,09			23 52 57	
	Allicoor hill,	91 22 13	—,9			91 22 13	
	Paudree station,	64 44 52,1	—,08			64 44 51	
		180 2,6		,37	+2,2	180	
	Paudree station from *Poonauk* hill,						64815,7
	Paudree station from *Allicoor* hill,						26248,9

Mullapode *hill from* Urrumbaucum 119444,7.

No.	Stations.	Observed Angles.	Diff.	Spher. Excess.	Error.	Angles for calculation.	Distances in feet
		° ′ ″	″			° ′ ″	
17.	*Mullapode* hill,	28 42 12,6	—,3			28 42 12,6	
	Urrumbaucum,	111 52 33,6	—1,9			111 52 32,3	
	Poonauk hill,	39 25 15,6	—,8			39 25 15,1	
		180 1,8		2,4	—,9	180	
	Poonauk hill from *Mullapode* hill,						174554,3
	Poonauk hill from *Urrumbaucum* hill,						90339,4

Mullapode *hill from* Poonauk *hill* 174585.

No.	Stations.	Observed Angles.	Diff.	Spher. Excess.	Error.	Angles for calculation.	Distances in feet
		° ′ ″	″			° ′ ″	
18.	*Mullapode* hill,	58 02 19	—1,5			58 2 18	
	Poonauk hill,	49 19 4,6	—1,5			49 19 3,5	
	Maundoor,	72 38 40	—1,9			72 38 38,5	
		180 00 3,6		4,9	—1,3	180	
	Maundoor from *Mullapode* hill,						138685,5
	Maundoor from *Poonauk* hill,						155157,2

Maumdoor *hill from* Mullapode 138685,5.

No.	Stations.	Observed Angles.	Diff.	Spher. Excess.	Error.	Angles for calculation.	Distances in feet.
		° ′ ″	″			° ′ ″	
19.	*Maumdoor* hill,	69 50 21,5	—1,2			69 50 19,5	
	Mullapode hill,	45 48 0,5	—1			45 48 58,5	
	Carrangooly hill,	64 21 44,1	—1,2			64 21 42	
		180 6,1		3,4	+2,7	180	
	Carrangooly hill from { *Maumdoor* hill, - -						110182,4
	{ *Mullapode* hill, - -						144405,4

Carrangooly *hill from* Maumdoor *hill* 110282,4.

No.	Stations.	Observed Angles.	Diff.	Spher. Excess.	Error.	Angles for calculation.	Distances in feet.
		° ′ ″	″			° ′ ″	
20.	*Carrangooly* hill,	80 37 28,3	—1,1			80 37 27	
	Maumdoor hill,	44 46 21,6	— ,7			44 46 20,5	
	Wooritty hill,	54 36 13,1	— ,7			54 36 12,5	
		180 00 03		2,5	+,5	180	
	Wooritty hill from { *Carrangooly* hill, -						95282,8
	{ *Maumdoor* hill, - -						133481,5

Wooritty *hill from* Carrangooly *hill* 95282,8.

No.	Stations.	Observed Angles.	Diff.	Spher. Excess.	Error.	Angles for calculation.	Distances in feet.
		° ′ ″	″			° ′ ″	
21.	*Wooritty* hill,	109 25 09,4	—1,1			109 25 07,7	
	Carrangooly hill,	28 33 28,6	—,22			28 33 27,8	
	Permacoil hill,	42 01 25,1	—,13			42 01 24,5	
		180 00 3,1		1,4	+1,7	180	
	Permacoil hill from { *Wooritty* hill, - -						68041,5
	{ *Carrangooly* hill, -						134236,4

Carrangooly *hill from* Permocoil *hill* 134236,4.

No.	Stations.	Observed Angles.	Diff.	Spher. Excess.	Error.	Angles for calculation.	Distances in feet.
		° ′ ″	″			° ′ ″	
	Carrangooly hill,	36 40 28,2	—0,1			36 40 26	
22.	*Permacoil* hill,	28 58 23,4	—0,1			28 58 22	
	Vellungcaud	114 21 15,4	—1,2			114 21 12	
		180 00 07,0		1,4	+5,6	180 00 00	
	Vellungcaud from { *Carrangooly* hill, -						71374,2
	{ *Permacoil hill,* - -						88004,7

Permacoil *hill from* Vellungcaud *hill* 88004,7.

No.	Stations.	Observed Angles.	Diff.	Spher. Excess.	Error.	Angles for calculation.	Distances in feet.
		° ′ ″	″			° ′ ″	
	Permacoil hill,	93 29 08,8	—,9			93 29 08	
23.	*Vellungcaud,*	37 15 17,4	—,3			37 15 17	
	New station,	0 0 0				44 15 35	
				1,6		180 00 00	
	New station on red hill from { *Permacoil* hill, - -						76334,1
	{ *Vellungcaud* hill, -						124716,7

Wooritty *hill from* Permacoil *hill* 68041,5.

No.	Stations.	Observed Angles.	Diff.	Spher. Excess.	Error.	Angles for calculation.	Distances in feet.
		° ′ ″	″			° ′ ″	
	Wooritty hill,	17 46 10,3	+,1			17 46 09	
24.	*Permacoil* hill,	134 51 00,6	—,9			134 50 58,5	
	Coonum hill,	27 22 53,3	+,3			27 22 52,5	
		180 00 4,2		,5	+3,7	180 00 00	
	Coonum hill from { *Wooritty* hill - - -						104887,5
	{ *Permacoil* hill, - -						45150,5

Permacoil *hill from* Coonum *hill* 45150,5.

No.	Stations.	Observed Angles.	Diff.	Spher. Excess.	Error.	Angles for calculation.	Distances in feet.
		° ′ ″	″			° ′ ″	
25.	*Permacoil* hill,	53 13 11,8	—,3			53 13 11,5	
	Coonum hill,	87 51 51,8	—,3			87 51 51,5	
	1st Flag on red hill,	0 0 0				38 54 57	
				,6		180 00 00	
	First Flag on red hill from { *Permacoil* hill, - -						71825,3
	{ *Coonum* hill, - - -						57567,7

Permacoil *hill from* Wooritty *hill* 68041,5.

No.	Stations.	Observed Angles.	Diff.	Spher. Excess.	Error.	Angles for calculation.	Distances in feet.
		° ′ ″	″			° ′ ″	
26.	*Permacoil* hill,	102 06 30,9	—,50			102 06 30,9	
	Wooritty hill	0 0 0				31 32 18,3	
	Mylum station,	46 21 11,4	—,13			46 21 11,3	
				,77			
	Mylum station from { *Permacoil* hill, - -						49184,8
	{ *Wooritty* hill, - -						91939,0

Permacoil *hill from* Mylum *station* 49184,8.

No.	Stations.	Observed Angles.	Diff.	Spher. Excess.	Error.	Angles for calculation.	Distances in feet.
		° ′ ″	″			° ′ ″	
27.	*Permacoil* hill,	72 26 53,3	—,34			72 26 53	
	Mylum station,	73 09 50,7	—,34			73 09 50,4	
	Mooratan station,	0 0 0				34 23 16	
						180 00 00	
	Mooratan station from { *Permacoil* hill, - -						83351,9
	{ *Mylum* station, - -						83030,3

Coonum *hill from first Flag on red hill* 57567,7.

No.	Stations.	Observed Angles.	Diff.	Spher. Excess.	Error.	Angles for calculation.	Distances in feet.
		° ′ ″	″			° ′ ″	
28.	*Coonum* hill,	0 0 0				21 45 27	
	1st Flag on red hill,	76 26 03,1	—,1			76 26 03	
	Mooratan station,	81 48 30	—,1			81 48 30	
				0,29		180 0 0	
	Mooratan station from { *Coonum* hill, - - -						56538,5
	First Flag on red hill,						21550,1

Permacoil *Hill from the new station on red hill* 76334,1.

No.	Stations.	Observed Angles.	Diff.	Spher. Excess.	Error.	Angles for calculation.	Distances in feet.
		° ′ ″	″			° ′ ″	
29.	*Permacoil* hill,	15 57 39,8	—,1			15 57 38	
	New station,	99 25 04,4	—,28			99 25 2,4	
	Mooratan station,	64 37 21,4	—,04			64 37 19,6	
		180 00 5,6		0,42	+5,18	180 0 0	
	Mooratan station from { *Permacoil* hill, - -						83348,4
	New station on red hill,						23231,9

Permacoil *hill from* Mooratan *station* 83350,15.

No.	Stations.	Observed Angles.	Diff.	Spher. Excess.	Error.	Angles for calculation.	Distances in feet.
		° ′ ″	″			° ′ ″	
30.	*Permacoil hill,*	42 57 14,4	—,4			42 57 16,2	
	Mooratan station,	85 13 36	—,6			85 13 37,6	
	Chengcaud station,	51 49 04,4	—,4			51 49 06,2	
		179 59 54,8		1,4	—6,6	180 00 00	
	Chengcaud station from { *Permacoil* hill, - -						105668,2
	Mooratan station, -						72254,7

Coonum *hill from* Mooratan *station* 56538,5.

No.	Stations.	Observed Angles.	Diff.	Spher. Excess.	Error.	Angles for calculation.	Distances in feet.
		° ′ ″	″			° ′ ″	
31.	*Coonum* hill,	0 0 0				76 02 09,5	
	Mooratan station,	54 33 15	—,2			54 33 15	
	Chengcaud station,	49 24 35,7	—,2			49 24 35,5	
				0,8		180 00 00,0	
	Chengcaud station from *Coonum* hill,						60654,3
	Chengcaud station from *Mooratan* station,						72252,9

Mooratan station *from Chengcaud* station 72253,8.

No.	Stations.	Observed Angles.	Diff.	Spher. Excess.	Error.	Angles for calculation.	Distances in feet.
		° ′ ″	″			° ′ ″	
32.	*Mooratan* station,	64 42 38,5	—,5			64 42 35	
	Chengcaud station,	66 8 35,2	—,5			66 8 32	
	Trivandepoorum,	49 8 53,9	—,4			49 8 53	
		180 00 7,6		1,4	+6,4	180 00 00	
	Trivandepoorum from *Mooratan* station,						87360,7
	Trivandepoorum from *Chengcaud* station,						86367,6

The angles have been taken with much care, and I believe with as much accuracy as the nature of such a process admits of; difficulty, however, very frequently arose from the haziness of the weather, which rendered the objects at the very distant points extremely dull, and occasioned some irregularity in the angles. Whenever that happened, the observations were often repeated, and in case any one, in particular, was different from the other so much as ten seconds, it was rejected till the three angles of the triangle had been observed. If the sum of these angles was near what it ought to be, no further notice was taken of it; but should the sum of the three angles be nearer the truth by taking it into the account, and that there appeared an irregularity in the other two observed angles, I have made it a rule to take each observed angle as a correct one, and divide the excess or defect between the other two, and then compute from the given side the other two sides; and after doing the same thing with each of the angles successively, a mean of the sides thus brought out was taken, which, to certain limits, will always be near the truth. I then varied the selection of the observed angles, rejecting such as I had reason to doubt; and by correcting them, and computing the two required sides of the triangle, those which gave the sides nearest to what had been brought out by the other method, were adopted, let the error be what it would. This, however, has rarely happened; and when it did, great precaution was used; and no angle was rejected without some reason appeared to render it doubtful.

In correcting the observed angles to obtain those made by the chords, I have used the formula given by the Astronomer Royal, in his demonstration of M. De Lambre's problem, which appears in the Philosophical Transactions for 1797. The spherical excess is of course had from the well known method of dividing the area of the triangle in square seconds, by the number of seconds in the arc equal to radius, where the number of feet in a second may be had by using the degree as has been commonly applied to the mean sphere, or the mean between the degree on the meridian and its perpendicular. This being of no further use than to check any error that might happen in computing the corrections for the angles.

In converting the sides of the triangles into arcs, the length of a degree has been computed for every ten degrees from the meridian to its perpendicular on an Ellipsoid, whose diameters were in the ratio of one to 1,0067, which is derived from taking the degree on the meridian, in latitude 50° 41′ to be 60851, and the degree perpendicular thereto 61182, in the same latitude. These data would give the meridional degree, in latitude 13°, to be 60191, and the degree perpendicular equal 60957, which, however, is not the case; but no sensible error will arrive in making those corrections from taking the arcs a few seconds more or less than the truth.

SECTION VI.

Reduction of the distances to the meridian of Trivandeporum, *for determining the length of the terrestrial arc.*

The sides of the great triangles, from which the arc is derived, falling very nearly in the same meridian, and not more than 16363,3 feet west from the meridian of *Trivandeporum*, the south extremity of the arc, there required no reference to any hypothesis of the earth's figure for getting the exact distance between the parallels, so that the latitude of a point where a great circle falling from the station of observation near *Paudree*, will cut the meridian of *Trivandeporum* at right angles, may be determined with sufficient accuracy by computing spherically, and the distances, when reduced to the meridian, (the distance from *Trivandeporum* to *Coonum* hill excepted,) may be considered as the chords of arcs on the meridian, and therefore the arcs themselves may be had, by allowing 60494 fathoms to the degree, as had been obtained from the sum of those reduced distances, the sum therefore of all these arcs will make the whole meridional arc, which is a nearer approximation to the truth.

Seeing that a line drawn from the station of observation at *Paudree*, to the station at *Maumdoor* hill, would fall nearly in the direction of the meridian, that distance has been computed, by taking the sides *Poonauk* hill to *Maumdoor* hill, and *Poonauk* hill to *Pâdree*, and using the internal angle at *Poonauk* hill, corrected for the chords. This, however, was scarcely necessary, except for shewing the arrangement of the points.

The following table will shew the arrangement of the sides, and their reduction to the meridian of *Trivandeporum*.

Stations at	Stations referred to.	Bearings referred to the meridian of *Trivandeporum*.	Distances.	Distances from the parallels of the Meridian.	Distances from the parallels of the Perpendicular.
Trivandeporum,	*Coonum* hill,	5 31 50,3 N. W.	125129,1	12059,8 W.	124547,5 N.
Coonum hill,	*Wooritty* hill,	0 03 18,4 N. W.	104887,5	108,3 W.	104887,4 N.
Wooritty hill,	*Carrangooly*,	52 45 21,9	95282,8	75851,4 E.	57666,0 N.
	Maumdoor,	1 50 51,2 N. W.	133481,5	4303,5 W.	133412,5 N.
Maumdoor,	*Paudree* station,	1 02 09,7 N. E.	211512,1	3824,4 E.	211477,5 N.

THE NORTHINGS REDUCED TO ARCS.

Trivandeporum to *Coonum* hill,	. .	124548,77
Coonum hill to *Wooritty* hill,	.	104887,47
Wooritty hill to *Maumdoor* hill,	.	133413,15
Maumdoor hill to *Paudree* station,		211478,57
Length of the terrestrial arc,	. . .	574327,96
Or fathoms,	. . . .	95721,3266

SECTION VII.

Observations by the Zenith Sector for the latitude of Paudree *station, and the station near* Trivandeporum; *and the length of the celestial arc.*

The zenith sector, with which these observations have been taken, was made by Mr. RAMSDEN, and is the one alluded to by General ROY, in the Philosophical Transactions for 1790, being then unfinished. The radius of the arc is five feet, and the arc itself is of that extent to take in nine degrees on each side of the zenith. It is divided into degrees, and smaller divisions of 20′ each, which are numbered. Each of these last is again subdivided into four, of 5′ each. The micrometer which moves the telescope and arc, is graduated to seconds, and one revolution moves the arc over 1′ 10″ 08‴, but the scale being large, a small fraction of a second can be easily defined. The construction, and improvements to the zenith sector, are so well known, that a minute description of it here would be unnecessary. It will therefore suffice to say, that as far as so delicate an instrument can be managed in a portable observatory, or travelling tent, which never can offer the advantages of a fixed, well contrived building, I have every reason to be satisfied with it.

The time I commenced observing at *Paudree* station was during the heavy part of the monsoon, which occasioned frequent interruptions: and although I had intended observing by at least three fixed stars, I only succeeded to my satisfaction in one, which was *Aldebaran*. With that star I had a fortunate succession for about sixteen nights; some few of those observations being less favourable than the others, were rejected, and the rest, from which the latitude was determined, appear in the following table, arranged in the order in which they were taken.

During the time I was at *Trivandeporum*, near *Cuddalore*, the weather was settled and serene, and the nights perfectly clear, so that I had an unlimited choice of stars, but having been successful with *Aldebaran*, I chose that star for determining the length of the arc.

As I consider the celestial arc more likely to be erroneous than any terrestrial measurement, I have thought it necessary to give some account of the manner of observing and of adjusting the instrument, for after two years experience, I have found, that notwithstanding the great powers of the zenith sector, extreme delicacy and attention are requisite to render the observations satisfactory. The following method of adjustment I have always practised. After having brought the vertical axis nearly to its true position by the adjusting screw at the bottom, or so that the wire of the plummet would bisect the same dot when the telescope was moved to the opposite side, or half round on the axis, I then examined whether the dot at the centre of the horizontal axis was bisected, and whether the wire moved in the vertical plane clear of the the axis; for unless it be perfectly free, all the observations will be false. When I had bisected the dot, I either took out the microscope and looked obliquely, or did the same by a magnifying glass, and by that means I could discover the smallest parallax. If it admitted being brought nearer to the axis, it was done; but I found from experience, that it was more eligible to leave the wire at a sensible distance than to bring it very near. Having satisfied myself in this particular, I examined with the microscope again in front, moved the wire freely in the vertical plane, and then bisected the dot. The telescope was then moved, so that the wire was brought over the dot zero on the arc, and the same precaution used with respect to the wire moving free of the arc; and here, as well as above, I found it best to allow a sensible distance between the wire and the arc.

The microscope by which the upper dot in the horizontal axis is examined, being fixed by the maker, the axis of vision is of course at right angles to the vertical plane, and will meet that plane in the centre of the axis, but the lower microscope is moveable, and requires care to fix it so as to have the wire in the axis of vision, and be free from the effects of parallax, this I have done by moving it along the brass plate in front of the arc, till the wire appeared free from curvature, and then adjusted the dot. In these late observations, I have generally made the final adjustment by the light of a wax taper, for the wind being sometimes high and troublesome, I found there was much irregularity in the observations, until I adopted that method. I therefore closed the doors and windows of the observatory tent, so as to have a perfect stillness within. The distance of the wire from the axis and the arc is likewise better defined by a taper by noticing the shadow in moving the light to the right and left.

In fixing the instrument for the star, great care was taken to have it placed in the meridian, which was done by a mark at near the distance of a mile, (generally one of my small flags), the polar star, having been previously observed by the large theodolite for that purpose. The telescope was then moved in the vertical till the wire of the plummet was at the nearest division on either limb to the zenith distance of the star, which could always be nearly known. The micrometer, having been put to zero, was firmly screwed, and the dot on the limb carefully bisected, the instrument was turned half round; the adjustment examined and corrected, if necessary. That being done, the degrees and minutes, &c. on the arc were noted down, as was also the particular division on the micrometer scale, at which the index stood, and the fractional part of a division in case there were any. In this state every thing remained to within fifteen or twenty minutes of the time the star was to pass, when I repaired to the tent, and again examined whether the wire bisected the dot; if it did not, the instrument was again adjusted to the same dot, and the horizontal axis also examined by the upper microscope, all this being done, the sector was placed in the meridian.

When the star entered the field of view, the micrometer was moved gently till the star was near the horizontal wire, but not bisected till it came near the vertical, that the micrometer might not be turned back, but continue moving in the same direction. This I did to avoid any false motion in the micrometer screw, and I was led to this precaution by the repeated experiments I had made in examining the divisions on the arc, for it sometimes happened after moving the arc over one of the divisions till the wire bisected the next dot; and then turning it back again, that the index of the micrometer was not at the same second, but had passed over it perhaps one, and sometimes two seconds; but by moving over the next five minutes in the same direction, the number of revolutions and seconds were always what they ought to be, to some very small fraction. This anomaly, however, only happened in some situations of the screw, and to avoid any errors arising therefrom, I adopted the above method.

The zenith distance of the star being now had, on one part of the arc or limb, after the same process had been gone through the next night, with regard to the adjustment, the zenith distance was taken on the other part of the arc, by turning the instrument half round on its vertical axis. The mean of these two was therefore the true observed zenith distance, and half the difference was the error of collimation. For applying these to the purpose in question, the mean of the zenith distances being corrected for refraction, the declination of the star for each of these nights, was corrected for nutation, aberration, &c. to the time of observation, and the mean of the two taken for determining the latitude.

In this manner has the whole series of observations been continued, by turning the sector half round every night, for the purpose of observing on opposite parts of the arc, and each compared with its preceding and succeeding one. In pursuing this method, it was unnecessary to notice the error of collimation for any other purpose than as a test to the regularity of the observations; for until they became uniform, no notice was taken of the zenith distances, concluding that there had been some mismanagement, or some defect in the adjustment.

The following tables contain the observations by the star *Aldebaran*, for determining the length of the arc.

Observations at the station near Paudree.

Day of the month.	Mean of the zenith distance on each arc.	Mean of the corrected declinations.	Latitude.
	° ′ ″	° ′ ″	° ′ ″
Nov. 23d and 24th,	2 46 32, 5	16 06 20,70	13 19 48,20
24th and 25th,	2 46 32,40	16 06 20,69	13 19 48,23
25th and 26th,	2 46 31,78	16 06 20,68	13 19 48,90
30th and 1st *Dec.*	2 46 31,60	16 06 20,61	13 19 49,01
Dec. 1st and 2d,	2 46 32,60	16 06 20,60	13 19 48,0
2d and 3d,	2 46 32,90	16 06 20,58	13 19 47,68
12th and 13th,	2 46 30,96	16 06 20,39	13 19 49,43
13th and 14th,	2 46 28,57	16 06 20,36	13 19 51,79
Error of collima. applied. 27th,	2 46 29,71	16 06 19,64	13 19 49,93
		Mean	13 19 49,018

Observations at the station near Trivandeporum.

Day of the month.		Mean of the zenith distance on each arc.	Mean of the correct declinations.	Latitude.
		° ′ ″	° ′ ″	° ′ ″
February	10th and 11th,	4 21 27,14	16 06 18,00	11 44 50,86
	11th and 13th,	4 21 24,04	16 06 17,93	11 44 53,89
	13th and 14th,	4 21 23,04	16 06 17,87	11 44 54,83
	14th and 15th,	4 21 25,10	16 06 17,83	11 44 52,73
	15th and 16th,	4 21 26,73	16 06 17,79	11 44 51,06
	16th and 17th,	4 21 25,60	16 06 17,75	11 44 52,15
	24th and 25th,	4 21 24,17	16 06 17,44	11 44 53,27
	25th and 26th,	4 21 25,17	16 06 17,40	11 44 52,23
	26th and 27th,	4 21 25,04	16 06 17,37	11 44 52,33
			Mean	11 44 52,59

Latitude of the station near *Paudree* 13 19 49,02 —
Latitude of the station near *Trivandeporum* 11 44 52,59

Difference of latitude, *nearly*. 1 34 56,43

The latitude of a point where a great circle passing through *Paudree* station, and cutting the meridian of *Trivandeporum* at right angles, will be 13° 19′ 49″,02 —, from which deduct the latitude of the station at *Trivandeporum*, equal 11° 49′ 52″,59, will leave 1° 34′ 56″,43, or 1°,58233 nearly; by which divide the number of fathoms in the terrestrial arc = 95721,3266, &c. we shall have 1° = 60494 fathoms, nearly, for the degree in the middle of the arc, or latitude 12° 32′ nearly.

APPENDIX.

Since the account of the meridional arc was made out, I have completed the measurement of a degree perpendicular to the meridian in latitude 12° 32′ nearly, which is derived from a distance of fifty-five miles and upwards, between *Carangooly* and *Curnatighur;* two stations nearly east and west from each other; and the following triangles have been made use of to obtain that distance.

Distance, Carangooly *from* Permacoil 134236,4.

No.	Stations.	Observed Angles.	Diff.	Spher. Excess.	Error.	Angles for computation.	Distances in feet.
		° ′ ″	″	″	″	° ′ ″	
33.	*Carangooly,*	38 00 53,47	—0,74			38 00 53	208418,2
	Permacoil,	103 08 30,05	—2,64			103 08 27,5	131808,9
	Maillacherry Droog,	38 50 42,44	—1,71			38 50 39,5	
		180 00 05,96		4,08	+1,88	180 00 00,0	

Carangooly *from* Maillacherry Droog 208418,2.

No.	Stations.	Observed Angles.	Diff.	Spher. Excess.	Error.	Angles for computation.	Distances in feet.
		° ′ ″	″	″	″	° ′ ″	
34.	*Carangooly,*	30 44 38,7	—1,3			30 44 37,0	291189,3
	Maillacherry Droog,	105 42 14,3	—5,1			105 42 09,0	154625,8
	Curnatighur,	43 33 15,1	—1,0			43 33 14,0	
		180 00 08,1		7,4	+0,7	180 00 00,0	

The distance from *Curnatighur* to *Maillacherry* has also been brought out from a northern series of triangles derived from the side of *Poonauk* hill and *Maumdoor* hill, of the great triangle *Maumdoor*, *Poonauk*, and *Mullapode* hill: the triangles are *Poonauk*, *Maumdoor* and *Hanandamulla*; *Hanandamulla*, *Maumdoor*, and *Telloor*; *Telloor*, *Hanandamulla* and *Curnatighur*; *Curnatighur*, *Telloor* and *Maillacherry Droog*. Upon the distance from *Curnatighur* to *Maillacherry* as a base, the distance from *Curnatighur* to *Carangooly* has been computed, and differs only two feet from that derived from the side *Carangooly* and *Maillacherry Droog*: but there was some variation in the angles taken at *Poonauk* hill, which renders it doubtful, for the present, which to select; I have therefore relied on the single distance given in the thirty-fourth triangle.

Of the Polar Star Observations at Carangooly *and* Curnatighur, *and the Length of a Degree, perpendicular to the Meridian, deduced therefrom, for the Latitude of* 12° 32′ *nearly.*

As the method of determining the difference of longitude of two places, by taking the angle with the meridian and each station reciprocally, requires very great accuracy, I have thought it necessary to give an account of the observations for that purpose, and to state at the same time, the difficulty of taking them, particularly at *Curnatigur*, whose great height subjected it to a constant haziness, whereby the blue lights at *Carangooly* were repeatedly fired without effect, appearing too faint to be seen when the wires of the telescope were illuminated: some nights, however, were favourable, when the whole of the lights were distinctly seen; but the anxiety, which occurs on such occasions, will sometimes cause irregularities in the angles; a few on that account, when the lights expired before the observations were thought sufficiently satisfactory, have been rejected. Those which appear in the following account, are such as I have deemed good, though there is a greater difference among them than I could have wished. But as I had no positive reason for setting them aside, I have accordingly used them; and have endeavoured to lessen the error, by increasing the number of observations, at *Carangooly*, between the polar star, at its greatest western elongation, and the referring lamp at *Sallawauk*.

			°	′	″
March	20,	in the evening, ...	0	34	48,4
	21,	. . . .			52,9
	22,	. . . .			52,8
	23,	. . . .			48,8
	25,	. . . .			50,2
	26,	. . . .			48,0
	27,	. . . .			46,9
	29,	. . . .			45,4

Between the Lamp at Sallawauk *and the Blue Light at* Curnatighur.

March 30,	. . . 84° 38′	24″,0
	. . . .	23 ,55
April 4,	. . . .	19 ,2
	. . . .	20 ,0
	. . . .	22 ,62
Mean		84° 38′ 21″,87

TABLE. *Containing the apparent Polar Distances of the Star, and the apparent Azimuths for the Nights of Observation; and also the Angles between the referring Lamp and the Meridian of* Carangooly.

March 1803.	Apparent Polar dist.	Latitude.	Apparent Azimuth.	∠ Star and Lamp.	∠ Pole and Lamp.
20	1 44 22,32		1 46 55,32	0 34 48,4	2 21 43,72
21	1 44 22,62		1 46 55,63	0 34 52,9	2 21 48,53
22	1 44 22,88		1 46 55,90	0 34 52,8	2 21 48,70
23	1 44 23,16	12° 32′ 12″,27	1 46 56,18	0 34 48,8	2 21 44,98
25	1 44 23,71		1 46 56,72	0 34 50,2	2 21 46,92
26	1 44 24,01		1 46 57,05	0 34 48,0	2 21 45,05
27	1 44 24,28		1 46 57,33	0 34 46,9	2 21 44,23
29	1 44 24,82		1 46 57,89	0 34 45,4	2 21 43,29
				Mean - -	2 21 45,67
Observed angle between the lamp and *Curnatighur,* -					84 38 21,87
Observed angle meridian of *Carangooly* and *ditto,* - -					87 00 07,54

Observations at Curnatighur, *between the Polar Star, at its greatest eastern Elongation, and the referring Lamp at* Maudimungalum.

May 14, in the morning, . . .	82° 26′	25″,6
15, ...		25 ,2
16, ...		25 ,6
20, ...		28 ,29
21, ...		26 ,1

Between the referring Light and the Blue Lights at Carangooly.

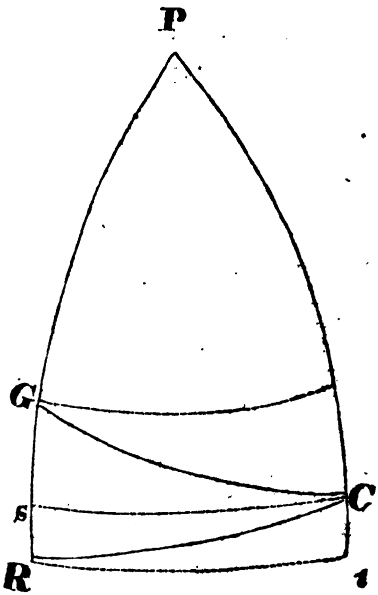
May 18,	....	8° 35′ 34″,50
	....	36,30
	....	40,10
	....	42,0
	....	41,25
	....	38,20
	....	35,57
	....	38,40
	Mean ....,	8 35 38,26

TABLE. *Containing the apparent Polar Distances of the Star, the apparent Azimuths for the Time of Observation, and also the Angles between the referring Lamp and the Meridian of* Curnatighur.

May 1803.	Apparent Polar dist.	Latitude.	Apparent Azimuth.	Angle Star and Lamp.	Angle Pole and Lamp.
	° ′ ″		° ′ ″	° ′ ″	° ′ ″
13	1 44 36,4	12° 34′ 38″,87	1 47 10,76	82 26 25,6	84 13 36,36
15	1 44 36,78	12° 34′ 38″,87	1 47 11,15	82 26 25,2	84 13 36,35
16	1 44 36,96	12° 34′ 38″,87	1 47 11,34	82 26 25,6	84 13 36,94
20	1 44 37,68	12° 34′ 38″,87	1 47 12,08	82 26 28,29	84 13 40,37
21	1 44 37,85	12° 34′ 38″,87	1 47 12,25	82 26 26,1	84 13 38,35
				Mean - -	84 13 37,67
Observed angle between the lamp and *Carangooly,*				- +	8 35 38,26
Observed angle meridian of *Curnatighur* and *Carangooly,*					92 49 15,93

If the mean of all the angles be taken, the observed angle at *Carangooly,* between the meridian and *Curnatighur,* will be 87° 00′ 07″,54; and the observed angle at *Curnatighur,* between that meridian and the station at *Carangooly,* will be 92° 49′ 15″,93. In order, therefore, to correct these angles for spherical computation, it will first be necessary to ascertain the distance between the parallels of *Carangooly* and *Curnatighur,* so that the one being known, the other may be obtained.

Let *PC* and *PG* be two meridians, and let *C* and *G* be the stations at *Carangooly* and *Curnatighur*. Let *C*s be a parallel of latitude at *C*, meeting the meridian of *Curnatighur* produced, and let *CR* be a great circle perpendicular to the meridian of *Carangooly* falling from that place, till it meet *PG* produced in *R*.



Now *GCR* is a spheroidical triangle, and the chord of the arc *GC* is given from the thirty-fourth triangle; and since the angle *PGC* is known, the angle *CGR* is known, being equal 180° *minus* the observed angle at *Curnatighur*, or 87° 10′ 44″,07.—And by the same reasoning the angle *GCR* will be given, being equal the angle *PCR* (90°) *minus* the observed angle at *Carangooly*, that is 2° 59′ 52″,46—Hence, by first considering this as a plane triangle, and taking the angle at *R*, the supplement to the other two, the sides *CR* and *GR* may be obtained, and used as arcs for correcting the angles at *C* and *G*, which will then be 2° 59′ 52″,2 and 87° 10′ 43″,79 respectively, which are the angles made by the chords of the arcs *CG* and *RG* at *C* and *G*. Hence the supplement to these (89° 49′ 24″,01) will be the angle at *R* made by the chords of the arcs *RC* and *RG*. From these data will be had *RC*=290837,8, and *RG*= 15228,74 feet.

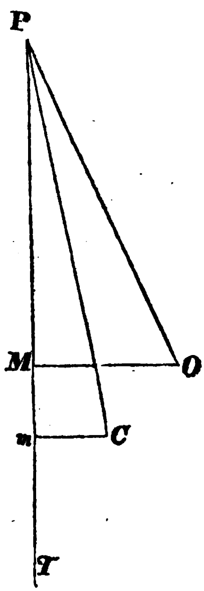
But to find the small space *R*s on the meridian of *Curnatighur*, between the perpendicular arc and parallel from *Carangooly*, let the triangle *CR*s be taken as a plane one. Then if to the corrected angle *CR*s (89° 49′ 24″,01) be added the supplement to the spherical excess in the triangle *RCG* (0″,5), we shall have 89° 49′ 24″,51 for the angle s*RC*. Draw *Rt* parallel to s*C*, meeting the meridian of *Carangooly*, produced in *t*. Then since the angles *PtR* and *P*s*C* are equal by construction; and the triangles s*CR*, *CRt* considered as plane ones, the angle *CRt* is equal half the difference of the angles *PCR* and *PRC*, that is $= \frac{90° - (89° 49' 24'',51)}{2} = 0° 5' 17'',74$. Hence is given the two angles *CR*s, s*CR*, and the side *CR*, by which the small side *R*s is had, equal to 448,02 feet, which, deducted from *GR*, gives *G*s= 14780,72 feet, equal to an arc of 2′ 26″,58 on the meridian, and this is the difference of the latitudes of *Carangooly* and *Curnatighur*. Hence if the latitude of **Carangooly* be 12° 32′ 12″,27, that of *Curnatighur* will be 12° 34′ 38″,85, and their respective complements will be 77° 27′ 47″,73 and 77° 25′ 21″,15. Hence in the triangle *PCG*, on the spheroid, is given the two sides *PG* and *PC*, the co-latitudes of *G* and *C*, and the two observed angles *PCG* and *PGC*.

Then as the tan. 77° 26′ 34″,44 (half the sum of the sides *PG* and *PC*) to tan. 0° 1′ 13″,29 (half their difference) so is tan. 89° 54′ 41″,73 (half the sum of the angles), to tan. 2° 56′ 10″,23 (the half

* When the polar star observations were made at *Carangooly*, no double azimuths could be taken, and therefore the latitude of the place was necessary to compute the azimuths, in order to get the direction of the meridian. As I wished to deduce the latitude of *Carangooly* from that of the observatory at *Madras*, the following method was used to obtain it.

Let *P* be the pole, *PT* the meridian of *Trivandeporum*, *O* the observatory at *Madras;* and let *C* be the station at *Carangooly*, *T* that at *Trivandeporum*, *OM* an arc of a great circle, perpendicular to *PT*, falling from the observatory, and *Cm* another perpendicular arc from *Carangooly*. Then if the ratio of the earth's diameters be taken as 1 to 1,003567, and the degree on the me-difference of the angles). Therefore 92° 50′ 51″,96 and 86° 58′ 31″,5, will be the angles at *Curnatighur* and *Carangooly*, such as would have been observed on a sphere, the latitudes and longitudes being the same. Then by using these angles, with the sides *PC* and *PG*, and computing spherically, the angle *CPG*, or difference of longitude, will be 48′ 47″,75, with which, and the side *PC*, or co-latitude of *Carangooly*, in the triangle *PCR*, right angled at *C*, the side *CR* will be had equal 0° 47′ 37″,45.

Now the chord of this arc is the distance *CR*, equal 290837,8 feet, and therefore the arc itself is 290841 feet nearly. Hence 47′ 37″,45 : 290841 :: 60′ : 366355,08 feet, or 61059,2 fathoms nearly, which is the length of the degree perpendicular to the meridian at *Carangooly* *.



ridian be 60494 fathoms; by using these data, and computing on the elliptic hypothesis, the degree perpendicular to the meridian 12° 32″ would be 60906 fathoms, which for the present purpose is made use of.

By the triangles, the point *O* is east from the meridian of *Trivandeporum* 190561,12 feet, and north from the perpendicular at that station 480563,62 feet. Also *C* is east 63690,8 feet, and north 287100,96 feet, from which, and applying the above degrees, we shall have the arc *TM* 1° 19′ 26″,4; *Tm*=47′ 27″,56; and therefore=*Mm* 31′ 58″,84. Also *OM* 31′ 17″,13, *Cm*=10′ 27″,42, and *PO* 76° 55′ 56″,7, the latitude of the observatory being 13° 04′ 09″,3.

Then in the spherical triangle *POM*, right angled at *M*, we have Cos *OM* : Rad :: Cos. *PO* : Cos *PM*=76° 55′ 48″,72, to which add the arc *Mm*, there will be had *Pm*=77° 27′ 47″,56, the co-latitude of the point *m*.

Then again as rad. : Cos *Cm* :: Cos *mP* : Cos *PC*=77° 27′ 47″,77; therefore the latitude of *Carangooly* will be 12° 32′ 12″,23.

* The ratio of the earth's diameters has been determined, by using the degree as brought out here, and the one in latitude 50° 41′, as deduced from the measured arc between Greenwich and Paris, which is 60851 fathoms; and these two give the ratio of the polar to the equatrial diameters to be 1 : 1,003567, supposing the earth to be an ellipsoid.

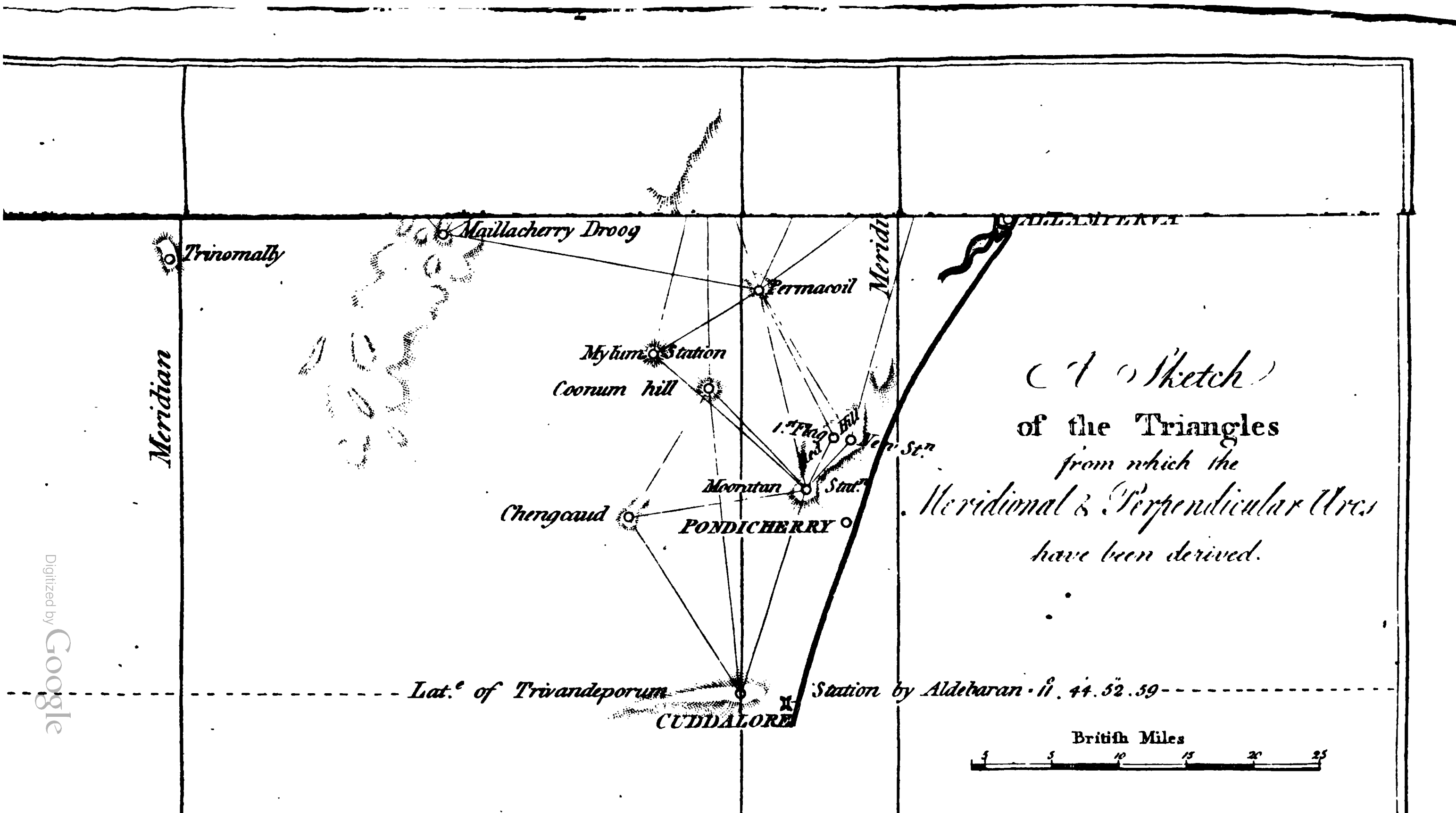
POSTSCRIPT.

Since the above has been written, the triangles derived from the side *Maumdoor* and *Poonauk*, and brought down westerly as far as *Woritty*, have been computed, and it appears that the distance between *Maumdoor* and *Woritty*, which is common to both series, exceeds the former by 6,9 feet; so that the mean of the two, equal 133485,0 feet, has been taken for obtaining anew both the meridional and perpendicular arcs; the former of which is 574337,04 feet, and the latter 290848,5 feet; whence the degree on the meridian will be had 60495 fathoms nearly, and the degree perpendicular to the meridian at *Carangooly* 61061 fathoms nearly.

The difference of 6,9 feet is more than what I expected, but it has been occasioned by the great difficulty in getting the angles in the great triangle, *Maumdoor*, *Mullapode*, and *Poonauk*. But as it appears that the side *Mullapode* and *Maumdoor* has been in excess, and the side *Poonauk* and *Maumdoor* in defect, it must follow that the mean distance of *Maumdoor* and *Woritty*, brought out by triangles derived from these two sides, must be very near the truth.

Now this latitude has been made use of to find the latitude of *Curnatighur*, and the same process has been followed for finding the length of a degree on the perpendicular in the latitude of *Carangooly* as is here given; and that degree taken, with the easting of the observatory from the meridian of *Carangooly* to compute the latitude a second time, which came out 12° 32′ 12″,27, and is here applied for re-computing the perpendicular degree: but the difference is too trifling to affect the difference of longitude, and therefore the degree comes out the same.

It is scarcely necessary to notice, that the distance of the observatory from the meridian of *Trivandepoorum* being so trifling, no spheroidal correction has been thought requisite for obtaining the latitude of the point *M*, and much less for that of *C*.


A Sketch
of the Triangles
from which the
Meridional & Perpendicular Arcs
have been derived.
Meridian
Meridi
Trinomally
Maillacherry Droog
Permacoil
Mylum Station
Coonum hill
1.st Flag
Hill
New St.n
Moonitan
Stat.n
Chengaud
PONDICHERRY
CUDDALORE
Lat.e of Trivandeporum
Station by Aldebaran · 11 . 44 . 52 . 59
British Miles
5
5
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25


A Sketch
of the Triangles from which the
Meridional & Perpendicular Arcs
have been derived
British Miles
Naggery nose
Lat.de of Paudree Station by Aldebaran - 13 19 59 . 2
Allicoor hill
Urrumbaucum hill
Poonauk hill
Tandray
Fort St. George
Observatory
Sholanguur hill & Pag.
Munnoor
Mongot
St. Thomas' Mount
Base
Vellore Droog
Hununda-malla
Mullapode hill
Perumbauk hill
Kalhasghur
Conoorvaucum hill
Covelong
Meridian of Trivandeporum
Maumdoor hill
Meridian of Carangooly
Curnatighur
Tellore hill
Carangooly hill
Sadras
Chittepet hill
Wooritty hill
Vellungeaud hill
Meridian of Curnatighur
Maillacherry Droog
Allamperva
Trinomally
Permacoil
Mylum station
Coonum hill
Flag
Red Hill
New St.n
Mooratan Station
Chengcaud
Pondicherry
Lat.de of Trivandeporum Station by Aldebaran 11 .. 52 . 59
Cuddalore
1938-1
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