

ART. VIII.—*A Manual of Surveying for India, detailing the mode of operations on the Revenue Surveys in Bengal and the North-Western Provinces. Prepared for the use of the Survey Department, and published by the authority of the Government of India. Compiled by Captains F. Smyth and H. L. Thuillier, Bengal Artillery. Calcutta. 1851.*

SEVERAL years ago, we gave an account* of the great *Trigonometrical Survey*, which was then, and is now, being carried on in India. During the six years that have elapsed since the publication of our article on that subject, we have again and again thought of giving a similar account of the *Revenue Survey*,—a less imposing, but scarcely less important work. The appearance of the “Manual” of Captains Smyth and Thuillier, affords us a favorable opportunity of carrying this intention, at last, into effect: at the same time that it supplies us with much information, which will enable us to do much more justice to the subject than we could have done at any earlier period. We are therefore about to take a “Survey” of this “Manual of Surveying,” and to adopt it as the “basis” of our remarks on the Revenue Survey of India. There will be advantages attendant upon this method, of carrying on simultaneously our notice of the book, and our account of the operations to which the book relates;—but as there is no unmixed good, either in this world, or even in the microcosm of the *Calcutta Review*, it is probable that there may be disadvantages also. It will be for our readers, after the perusal of the present article, to strike the balance of good and evil.

We intend to discuss with all freedom the merits and demerits of the “Manual;” and at the same time, to give a general view, without condescending upon details and technicalities, of the objects of the Revenue Survey, and the methods adopted in conducting its several operations. The former object may be of some service to the students who are to make use of the Manual, and may, perhaps, not be without its use also to the authors or compilers of it; especially as we understand that the edition is already exhausted; and that a second will soon be required. If we at all succeed in the latter object, our reward will be the reflexion that we have suggested some new thoughts to our readers, and given them definite ideas, instead of vague ones, on some points on which it is well that

* *Calcutta Review*, Vol. IV., Art. 3.

intelligent men should be informed. Perhaps we are not the less likely to succeed in this latter object, from the circumstance of our belonging to that class, for whose instruction we write. It is probable, that we may be able to give them the information that they require, and in the form in which they require it, better than could be expected of a professional surveyor, who would with difficulty sympathize with the ignorance of his readers, would suppose that they must know more than they actually do of subjects with which he has so long been so familiar, and would be apt to imagine that the details, which are so important to the carrying on of the work, are fitted to be of more interest than they really are, to the ordinary laical reader.

It is very obvious that a service in which so many persons are employed, and in which so many and so various duties are performed from day to day, imperatively requires that there should be a book of this sort, to assist those who are intending to enter into the department, to qualify themselves for the duties that are to devolve upon them, and to assist those actually employed, in constantly improving their qualifications. But it is not only to the *employés*, actual or prospective, of the department to which the authors belong, that the book may be useful. A large class of civilians are officially required to come in contact with the survey operations, and to them the Manual will be indispensable. Moreover, there are multitudes of people in India, that have occasion, frequently, to execute surveys of roads, rivers or grounds. Every officer in the army *may*, at some time, be called upon to do so; every indigo planter, and indeed, every resident in the Mofussil, must frequently have occasion to survey fields and villages; and it may be greatly to his advantage to be able to do so correctly. To these classes, therefore, and probably to many others also, this Manual of surveying will be of essential use.

The Manual consists of five *parts*, and an appendix; and it will give some initial idea of the completeness and comprehensiveness of the work, if we just state the general titles of these parts. They are as follow: I. *Geometry and Trigonometry*. II. *Surveying instruments*. III. *On Surveying*. IV. *On the Khusrah, or native field measurement*. V. *Practical Astronomy, and its application to Surveying*. We proceed to notice these subjects in their order; dwelling at greater or less length upon each, as the intention of our article may direct.

The adage that "there is no royal road to mathematics," seems destined to acquire fresh confirmation from every attempt

that is made to simplify the elements of Geometry, beyond the point of simplification that they received at the hands of Euclid. We have had occasion to see several attempts of this kind, and none of them have struck us as being, in any considerable degree, successful. The one before us is as good as most of its predecessors, and no better. If therefore it were put forth with the view of answering the purpose of a full treatise on the elements of Geometry, to the supercession of Euclid, we should censure it as a failure. But as it is given with no such ambitious pretension, but only professes to contain a series of those propositions that are of most general use in survey operations, our censure is, in great measure, disarmed. It may well, indeed, be a matter of doubt, whether it would not be better in the long run to send all aspirants for employment in the survey department, directly to Euclid, and require of them that they should thoroughly master the first six books of his Elements. But as the authors must have come into contact with a large number of such aspirants, and must know well their talents and their opportunities of study, it is fitting that we should defer to their judgment, on a matter, regarding which they have so good means, and regarding which we have no means at all, of forming a correct opinion. Instead, therefore, of recommending that the geometrical propositions should be excluded altogether from the next edition, as we confess our own feelings would prompt us to do, we shall content ourselves with offering a few hints, by which the propositions, as they stand, may perhaps be made somewhat more useful to the students of the present edition, and which we are confident that the authors will receive in good part, and take into consideration, while preparing their next edition for the press.

There are few mathematical subjects that have given rise to a greater amount of discussion than the doctrine of parallel lines. It must be admitted that Euclid's method of treating the subject is neither so elegant nor so rigid as might be desired; but we are by no means certain that any of the methods proposed as substitutes are better than that which they are designed to supersede. The inelegance of Euclid's method consists in this, that for the purpose of proving the doctrine of parallel lines, he introduces a proposition (I. 16) which is immediately superseded and rendered useless, after that doctrine is established—a scaffolding which is not a part of the edifice, but is yet indispensable to the erection of it. Now the elegance of a train of geometrical reasoning consists in nothing more than in its introducing no such scaffolding, but in making

every proposition of permanent value, as part of the structure itself. The comparative want of rigidity consists in the assuming, as an axiomatic truth, a proposition which, to most minds, is not axiomatic (12. ax.), but seems rather to require demonstration. We are of opinion that Legendre has succeeded in establishing the doctrine of parallels in an unexceptionable manner, (although this is not the opinion of many mathematicians); but his method is confessedly of too abstract a nature to be available at the early stage of a mathematical course, at which parallel lines must be introduced. With this exception, we believe that all writers who have deviated from Euclid's method have, overtly or covertly, made some assumption of which the axiomatic nature may be questioned—as, for example, that the distance between parallel lines is constant—that two straight lines, parallel to the same straight line, cannot pass through any point—or that if one straight line be at right angles to each of two straight lines, every line at right angles to the one of these lines, shall be at right angles to the other.

The assumption made by our authors is, that the interior angles made on one side of a line falling upon two parallel lines, is equal to some constant quantity. This assumption is made tacitly, and then it is easily proved that this constant quantity must be two right angles;—as thus,—the interior angles on one side of the incident line, are either equal to, greater or less than, two right angles; but as the lines on one side of the incident line “are not more parallel than” their continuations on the other side of the incident line, the interior angles on both sides must be equal to, greater or less than four right angles, according as those on one side are equal to, greater or less than two: but these four angles are equal to four right angles, since they are two pairs of adjacent angles, made by one line standing upon another line: consequently the two interior angles are equal to two right angles. Q. E. D. Now every step in this demonstration is unexceptionable, provided we admit the tacit assumption on which it is based: but it does not appear to us that this assumption is at all admissible. We have stated that hitherto no attempt to dispense with some assumption has been quite successful: and it would be altogether unreasonable to look for a successful attempt in so unpretending a geometrical course as that before us: but we do think that our authors should avoid so violent an assumption as that we have pointed out, and that the students of the work should be warned what it is that they are required to admit.

In the course of our fault-finding “Survey,” we come next to the tenth theorem, which is thus enunciated, “*In any triangle*

A B D, the half of each side is the sine of the opposite angle." Now this is far too loose an enunciation. Of course our authors mean, that the half of each side is to the radius of the circumscribed circle, as the sine of the opposite angle is to the trigonometrical radius. But as this meaning, although implied in the demonstration, is not explicitly pointed out even there, the enunciation will almost certainly mislead the tyro, who will be almost sure to suppose that one of the sides, and not the radius of the circumscribed circle, is assumed as the trigonometrical radius.

We may also notice an error that occurs in the course of the demonstration of this theorem, in which it is said, that the *chord* of an arc is the measure of the angle which that arc subtends at the centre. And we may express our doubts, as to the legitimacy of the third corollary of the next theorem. The theorem is that of Euclid, "Straight lines which join the extremities of equal and parallel straight lines towards the same parts, are also themselves equal and parallel;" and the corollary is, "It is also plain that the opposite sides of a parallelogram are equal, for it has been proved that $A B C D$ being a parallelogram, $A B=C D$, and $A D=B C$." Now, however true this conclusion be, it does not seem to us to be logically deducible from the premises. Because a particular figure has its opposite sides both parallel and equal, it does not seem to follow immediately, that every figure, which has its opposite sides parallel, has them also equal. The demonstration of the seventeenth theorem, which is *Eucl. vi. 1.*, is only applicable to the case of triangles, whose bases are commensurable. "Let any aliquot part of $A B$ be taken, which will also measure $B D$." But what if $A B$ and $B D$ be to one another as the side of a square is to its diagonal? Where shall we get a line that shall be an aliquot part of the one, and shall also measure the other?

Having thus freely found fault with several of the demonstrations contained in this little sketch of the elements of geometry, it is but fair that we should state that several others seem to us very neat and ingenious. We would mention, for instance, the sixteenth theorem, which is *Eucl. III. 36*, and which is very well demonstrated by the aid of proportion, which Euclid, of course, could not use in his third book. The twenty-first theorem (*Eucl. vi. 19*) is also very neatly proved.

This may be the proper place to point out what, we conceive, ought to be introduced somewhere into the book, viz., a short treatise on the doctrine of proportion. We do not think that it ought to be taken for granted, that those, for whom so elementary a treatise is designed, are so familiar with this doctrine, as to be acquainted with the propositions, that if four

quantities are proportional, they are proportional also when taken alternately; and that the rectangle contained by the lines, which form the extremes of an analogy, is equal to the rectangle contained by the lines that form the means.

We pass over the chapter on logarithms, merely remarking that the explanation is sufficiently clear; but that the notation adopted for expressing the logarithm of a decimal fraction is inaccurate, the negative sign being put before the logarithm, as if it affected the whole of it, instead of being placed, as is usual, over the index, to shew that it affects it only. Also the rule for finding the logarithm of a number not in the tables is inaccurate.

Here also we would have had introduced a lesson on the method of subtracting, by adding the arithmetical complement of the number to be subtracted. We can testify, from large experience, the great saving of time, and diminution of the chances of error, that result from the constant use of this method, in extensive logarithmic calculations, such as must occur in the conduct of a large survey.

The fifth, sixth and seventh chapters of this first part, headed respectively "*Trigonometry*," "*Mensuration of planes*," and "*Useful Problems in surveying*," are much fuller than the preceding chapters, and seem to us almost all that can be desired, in order to equip the young surveyor for a most important part of his work. He, who has any enthusiasm in his profession, will do well to make this part of the Manual his constant study. By modifying the problems in every possible way, and solving examples in numbers, both with and without logarithms, he will acquire such familiarity with the matter, both in its principles and its details, that he will be able, with some interest, to act in accordance with the rules which he thoroughly understands, and, if necessary, to depart from those rules, and act with confidence on his own judgment, in cases to which the rules are not applicable. Thus he will have the double advantage over his fellows, that he will take pleasure in the ordinary routine work, which is mere drudgery to them; while he will be fit for work which they are unable to perform, and for responsibility which could not be imposed upon them.

As our object is a thoroughly practical one, we may point out one or two things, which might, still further, improve this part. And first, we do not think that the ambiguity of what is called the ambiguous case in plane Trigonometry, is noticed with sufficient prominence. In the first place, it is stated, that "if any three parts of a plane triangle be given, (one part being a side,) any required part may be found by construction and calculation."

Now this, though of course generally true, is not so universally. The only allusion that we find to the ambiguity, is in an example, when the subject is rather hinted at than explained. "In the triangle ABC, there is given $AB = 240$, the angle $A = 46^\circ 30'$, and $BC = 200$; to find the angle C *being acute*, the angle B, and the side AC." It may be quite true, that the surveyor in the field will generally know whether the angle to be calculated is to be acute or obtuse; but this will not always be the case: and even this advantage is sacrificed when the calculator and surveyor are different persons. The ambiguity ought, therefore, to be prominently brought to the calculator's notice, that he may be always on the look out for it, when he has to do with cases in which it may occur; otherwise, he will be liable to commit blunders, which may vitiate many results, and introduce into a whole survey, confusion that will not easily be got rid of.

We would suggest also, that the method of finding the angles of a triangle, when the three sides are given, by means of the proposition, $bc : (s-b)(s-c) = \text{Rad}^2 : \text{Sin}^2 \frac{1}{2} A$, ought not to have been omitted in such a treatise. It is so much more direct than the method of dropping a perpendicular, and is, moreover, so well adapted to logarithmic calculation, that it seems to us decidedly preferable to the other method.

The last of the problems seems to require a passing notice. It is, "to determine the area of a piece of ground, having the map given, by weight." The method consists in drawing parallels on the map half an inch apart, and others at right angles to them. Thus the whole face of the map is divided into squares. Of these a certain number will be complete, and those through which the boundary passes will be imperfect. First, all the squares must be carefully weighed, any part of which contains any portion of the ground to be measured, and then all the portions of the outer squares that lie beyond the boundary must be cut off, and the remainder weighed. Thus the first weight will be to the second, as the area included within all the squares originally weighed is to the required area. But the first and second terms of the proportion are ascertained by the weighing; the third is known by the scale of the map, and consequently the fourth can be found at once. Now it appears to us that it would be much better, instead of destroying the map by crossing its surface with pencil lines, and cutting off its margin close by the boundary, to copy its outline through tracing paper on which the squares had been previously drawn, and then to proceed with the tracing paper as if it had been the map. The same tracing paper might be afterwards used for a smaller map. But we should imagine that it would be

quite sufficient, excepting for maps on a very small scale, to lay upon the map a sheet of transparent paper divided into squares of a quarter or an eighth part of an inch in the side, and simply to count the perfect squares, and then the imperfect squares, and add to the number of the former half the number of the latter, assuming that on an average the boundary would bisect all the squares that it cut. We do not think the error, that could result from this assumption, would be greater than that which might be expected to result from the most careful weighing, even with a fine balance. But if greater accuracy were desired, it might be secured by diminishing the sides of the squares on the tracing paper. If these were made a sixteenth, or even a twelfth part of an inch, no considerable error could be committed by estimating, in the way we have indicated, the quantity of land contained in a map, unless the scale of the map were very small indeed.

Part II. treats of "Surveying instruments." It gives clear and distinct explanations of the construction and use of the various instruments employed, and will be very useful to the surveyor. We know not any suggestion that we can offer for the improvement of this part; and therefore pass it over with only stating, that we have been much struck on its perusal, with the amount of ingenuity displayed in this humble but important branch of applied science. It is the boast of our jurists, that there is no injury that man can receive from the hands of his fellow-man, which the English law does not afford means of redressing; and we may say, that there is no purpose, which the surveyor, or the experimenter, or any body else, can desire to effect, which our instrument-makers do not provide him with an instrument for effecting. Our readers may remember the account we gave of the original commencement of the great trigonometrical survey, when the only instruments available were, a chain, that had been intended as a present to the emperor of China, and a transit instrument of a most rheumatic constitution. Now, it would appear from the description of our authors, that there is almost an *embarras de richesses*, and that the difficulty will not be, as then, to find an instrument that will do the work, or even to find one that will do it well, but to choose from all those that will do it well, the one that will do it best.

We have said, that we intended to offer no suggestion for the improvement of this part of the work; but it has just struck us, that to non-professional people like ourselves, its value would be considerably enhanced by the addition of a short chapter, "on substitutes for instruments," or what sailors

might call *jury instruments*. It is useful to the professional man to be able to measure an angle to the tenth part of a second; but it is not without its use to the non-professional traveller to be told how, with the aid of a small shaving glass and a staff, or (if he be too anti-sybaritic to add these luxuries to the Napierian allowance of a "bit of soap")—by the aid of the back of a silver watch and a sword-scabard, he may measure the height of an inaccessible object, within two or three feet. We are sure that Captains Smyth and Thuillier could very easily point out an abundance of such contrivances, to assist the pursuers of knowledge under difficulties.

The third part treats "of Surveying," and seems to us to be admirably executed. Our authors evidently know very well, that the excellence of a surveyor consists, not in genius or in any flashy characteristic, but in good talents, united with steady perseverance and constant pains-taking. They therefore condescend upon the minutest details in their instructions to the young surveyor, and urge constantly upon him the importance of doing every thing always in the best manner. From our notions of what a survey ought to be, we should say that the expression, "well enough," should be religiously excluded from the surveyor's vocabulary, and that it should be impressed upon him, that nothing is *well enough* done, if it be possible to do it better. There is never any saving of time, in the long run, by doing any work in a careless, and consequently inaccurate, manner. And in this department especially, the man who really does most work, is the man who does his work best, not he who gets over the ground with the greatest rapidity. The two following rules we venture to quote, as of very general application, not to surveying operations only, but to almost all the matters in which men are occupied:—

9th. The surveyor should never allow himself to get into the habit of making his observations, whether angles or bearings, in a careless manner, under the impression, that a small error in one observation, will, perhaps counterbalance itself in the next; he will find it more profitable in the end, to make *ten* careful observations during a day's work, than a hundred careless ones. The same remarks hold good for chain measurements.

10th. No observation, memorandum, or note, should ever be recorded on slips of paper, and rejected, or be thrown aside as unimportant or useless; it is too commonly the practice to do this; but the time may come, when the surveyor would hail with delight the recovery of the remarks or calculations, however roughly noted, which he had before thrown away.

These are golden rules, and in proportion to the scrupulosity with which he adheres to them, or rather in proportion to the conviction, matured into an unalterable habit, which constrains him to adhere unconsciously to them, will be the surveyor's success in his work.

We can scarcely express too strongly our approbation of this part of the work. The instructions are full without being very tedious : and the surveyor, who ponders them, will be prepared to meet all the difficulties that are likely to arise in the course of his work, to surmount those that can be surmounted, and not to be delayed or discouraged by those that are the necessary result of the imperfection of the methods prescribed and the instruments employed, and which he is consequently not expected to surmount.

It is in this part that we get a full detail of the various operations that are carried on in connection with the revenue survey of India, an account of the extent of country that has been hitherto surveyed, of that which remains still to be surveyed, and of the cost of the survey, past and prospective. From the description given, it would appear that the methods adopted for carrying on the survey are of the best possible description. The great object is, by means of a good system of division of labour, to secure that no one be employed in doing aught that he is not qualified to do, and no one be employed in inferior work, who is qualified for superior. In order to effect this, it is of course necessary that a methodical and energetic mind should regulate the whole ; and such a mind we should suppose, from the "Manual," is the present head of the revenue survey, one of its authors. We can only give the most general notion of the mode in which the survey is conducted.

First of all the settlement officer, or revenue collector, is charged with the duty of marking out the boundaries of the Parganahs on the ground, and furnishing to the surveyor a rough sketch called a *Thak-bust*, or demarcation map. With this sketch in his hand a man goes round the boundary of the Parganah, fixing stations at its various points, and clearing the ground for the measurement of lines and the observation of angles from station to station. Another man, or set of men, are set to perambulate the boundaries of each village within the Parganah. All this is preliminary to the survey, properly so called. The revenue collector ought to be a year in advance of the surveyors, and the "line-cutters" must at least keep well ahead of them, so that no delay may occur. The surveyor's duty is then to run a line from station to station, and to ascertain the length and direction of every part of it. As this line cannot follow the windings of the boundary exactly, it is carried as near to the boundary as possible, within or without ; and offsets are measured to the boundary itself. Every measurement, whether of length or direction, is entered in a field book. When the surveyor has gone quite round the Parganah, and returned to the point whence he set out, it is evident that on transferring

all his lines to paper, in proportionate lengths and in the right directions, the plan ought exactly to "close," or the last line ought to end where the first began. This it will never do exactly, but it must do so within certain limits of error, and if these limits be exceeded, every effort must be made to discover where the error has occurred; and, if these efforts fail, the work, must be done over again. If the amount of error be within the limits, it must be apportioned amongst the several lines and angles.

While the Parganah-boundary-surveyor has been going on with this process, several parties of village-boundary-surveyors have been performing precisely the same process with respect to the several villages within the circuit. It is evident that the work of each one of these surveyors also must "close" with itself; and not only so, but the aggregate of the villages must just fill up the Parganah.

If the fields belonging to a village be tolerably large, and with moderately straight and well defined boundaries, it seems to be the duty of the village surveyor to measure and define them, and to fill up all the topographical information, necessary to give a complete view of the face of the country, its trees, its buildings, and its crops. This is done both by entry in the field book, and by the construction of what are called "chudder maps," which present a general idea of the character of the country. But if the fields be very small, and their boundaries very irregular, the survey of them is handed over to a native official, who conducts it in a much ruder way than that adopted in the main survey. This is called the *khusrak* measurement; and, as it is always checked by the general survey, since the whole ground measured must always fill its boundary, it is sufficiently accurate for all practical purposes.

Such is the whole of the work performed in the field. Sufficient data are obtained for the construction of accurate maps of the district surveyed; and the preparation of these maps is the duty of a portion of the establishment during the period when field operations are suspended by the weather. The survey department is required to furnish in duplicate a village map, on the scale of one mile to an inch, and a Parganah map on the scale of four miles to an inch, for every village and Parganah surveyed. These are constructed from the *chudder* maps and field books of the surveyors and *khusrak* measurers. These Parganah maps are again built up into Zillah maps on the scale of sixteen miles to an inch. It is also required of the department to construct for government all the maps that they may require for any purpose, civil or military, such as the records stored up in the Surveyor-General's office enable them to construct.

All this seems very short and simple in the description; but it is necessarily a tedious, and in many cases a difficult process. The village boundaries are so irregular, and the limits of error allowed are so small, that the surveyor requires to have all his eyes about him. As moreover a great part of the details of the work is done by natives who do not understand English, it may be conceived that the process of constructing a map from their field-books is not a very attractive amusement. "With such an extent of native agency (say our authors) as is employed on all the surveys in India, it is a great object to plot all work in the field. It saves an immensity of labour, and the chances of accuracy are greatly increased. By the aid of the drawing board much can be sketched in, and the first impression of a locality is not lost, but at once represented on the plan. Field-books kept by natives ignorant of English may better be imagined than described. It is always difficult for any surveyor to understand fully a field-book kept by another person; but where novices on ten or fifteen rupees per mensem attempt to keep such records, and hurry on at the railroad pace of a revenue survey in the present age, we do not envy the person who has to protract from them. The native surveyor, who brings in his board well filled, displays at once what amount of work he has done; and a superintending officer is able to see at a glance what confidence is to be placed on the topography so defined."

We have omitted to mention that another thing is necessary in order to make any of these maps complete, that is, the determination of the meridian line. For all that we have said hitherto, a map might lie in any direction; but whenever the direction of any one line upon it is fixed, then the direction of the whole of the lines, and the proper bearings of every point, are ascertained. It is therefore necessary to ascertain the direction of the meridian line at some place within the district surveyed, or rather at several places, in order that one ascertainment may be a check upon the others. This is done in each Parganah survey by astronomical observations. For the village surveys, it is sufficient to ascertain it by the compass, allowing for variation.

We should also have stated that it is the duty of the survey department to calculate the area of each field, village and Parganah. In the North West Provinces these computations are the basis of the revenue settlement. In the Lower Provinces, where the permanent settlement obtains, this is not necessary; but the survey is not the less useful in these provinces, as in its absence much of the land is apt to be lost

sight of altogether, small estates being swallowed up by large ones. Then when the Jumma or revenue on these estates is not paid, and the estates are put up for sale, it is found impossible to put the purchaser in possession.

To give an idea of the extent to which the revenue survey in this presidency has proceeded, we cannot do better than present the following extract, which exhibits clearly both what has been done, and what remains to be accomplished :—

From the year 1822, when the Revenue Surveys first commenced, up to the year 1830, the rate of progress at which the operations proceeded was extremely limited. Only 3,020 square miles, a little more than half a square degree, had then been performed in seven years, with ten Officers employed in the department—the annual rate of progress of each Surveyor ranging from fifty square miles to 338 as a maximum: and at this rate it was estimated that, the area of Bengal and the North-Western Provinces being 310,000 square miles or 77 square degrees, would require 481 years to accomplish.* The Officers employed in those days, however, had little or no assistance; and the duties, performed then by the Revenue Surveyor himself, are now entrusted to competent assistants and sub-assistants, with large native establishments under them, whilst the Surveyor acts as a Superintendent over the whole as described in a former Chapter; the result of which has been, that during the last twenty years, or since 1830, the whole of the North-Western Province Districts, all Behar and Orissa, and a considerable portion of Bengal Proper, have been completed as detailed below † No less than 46 districts of unsettled estates, amounting to 101,519 square miles, and 13 districts of Bengal and Behar, perpetually settled

* Account of the present system of Survey, &c., by Captain Herbert, Deputy Surveyor General. Calcutta, 1830.

† UNSETTLED DISTRICTS SURVEYED.

1. Paneeput.	25. Banda.
2. Hurlanah.	26. Allahabad.
3. Delhi.	27. Goruckpore.
4. Rohtuck.	28. Azimghur.
5. Gorgaon.	29. Jaunpore.
6. Suharanpore.	30. Mirzapore.
7. Mozuffurnuggur.	31. Benares.
8. Meerut.	32. Ghazee-pore.
9. Boolundshuhur.	33. Jolun.
10. Allyghur.	34. Dehra Doon.
11. Bijnour.	35. Buttianah.
12. Moradabad.	36. Sohagpore.
13. Budaon.	37. Ramghur.
14. Bareilly.	38. Ajmere.
15. Phillibet.	39. Mairwarra.
16. Shajehanpore.	39. Total N. W. P.
17. Muttra.	
18. Agra.	40. Pooree.
19. Furruckabad.	41. Cuttack.
20. Mynpooree.	42. Balasore.
21. Etawah.	43. Cachar.
22. Cawnpore.	44. Jynteah.
23. Futtehpore.	45. Chittagong.
24. Humeerpore.	46. Assam.

SETTLED DISTRICTS SURVEYED.

47. Midnapore.	54. Behar.
48. Hidgelee.	55. Purneah.
49. Hoogly.	56. Tirhoot.
50. Shahabad.	57. Maldah.
51. Sarun.	58. Bhangulpore.
52. Patna.	59. 24-Pergunnahs.
53. Monghyr.	
	59. Total Surveyed

DISTRICTS UNDER SURVEY.

1. Rajshye.	5. Goalparra.
2. Beerbhoom.	
3. Baraset.	5. Total.
4. Mymensing.	

DISTRICTS FOR SURVEY.

1. Nuddea.	10. Dacca.
2. Jessore.	11. Dacca Jellal-pore.
3. Burdwan.	12. Backergunge.
4. Bancoorah.	13. Sylhet.
5. Dinagepoor.	14. Tipperah.
6. Moorsheadabad.	15. Bulloeah.
7. Bogra.	
8. Rungpoor.	15. Total.
9. Pubna.	

estates, yielding an area of 53,295 square miles, have thus been surveyed in detail and mapped, leaving twenty districts of Bengal, comprising 57,990 square miles, to be taken up, five of which are now in hand.

In addition to this, the newly acquired territory of the Punjaub and Cis and Trans Sutledge have come under the Revenue operations, and afford a fine field of employment for the department.

The total area of the British possessions in India, including Scinde, Punjaub, Jullundhur Doab and Tenasserim, has been carefully estimated at 800,758 square miles, and the Native States at 508,422 square miles, making a grand total of 1,309,200 square miles, as the area of British India. This vast superficial extent of territory is confined within a length of 11,260 miles of external boundary. The *inland* frontier from Tenasserim round by the Himalayan range of mountains to Cape Mouze in Scinde is 4,680 miles, whilst the *coast* line from Singapore round the Bay of Bengal, up the Malabar Coast to Kurrachee, is 6,580 miles. Of the Native States about 200,000 square miles are already surveyed, leaving about 308,442, almost all wild hilly jungle and of little value, to be taken up.*

To this we shall only add that about fifteen and a half lakhs of rupees have been already expended, and that the work still to be done may be expected to cost about eleven and a half lakhs—a very moderate sum certainly for the survey of such an immense empire, and better expended than many of the sums that go into the disbursement side in the financial accounts of many governments.

It may be well here to point out, that while the village maps can be built up with sufficient accuracy into a Parganah map, and the Parganah maps may even be joined without much inaccuracy to form a Zillah or district map, these last will not, without important modifications, fit into one another, so as to form a general map of India. All the operations of the revenue survey are conducted on the hypothesis that the earth is an extended plane. Now although this supposition will not deviate far from the truth when it is applied to a very small portion of the earth's surface, it will be altogether inaccurate when we have to do with a large extent of territory. Now as one very important object of the revenue survey is to fill up the outlines ascer-

* Of the Native States some of the following are the most conspicuous:—

<i>Estimated Area in Sq. Miles.</i>	<i>Estimated Area in Sq. Miles.</i>
Oude, (Lucknow)	Bhopal
Mysore	Rewah
Hydrabad, (Nizam's).....	Protected Seikh and Hill-States. 15,188
Joudhpoor	Oodepore
Gwallior	Sattara
Bhawulpoor	Kolapore
Golab Singh's Territories	Cutch
Berar, (Nagpore)	Kotah
Jeypore, &c.	Indore
Bickaneer	Travancore
Jeysulmeer	Uwar
Baroda and Kattyawar	Bhurtpore
Jhansae	15,570
	6,764
	9,837
	11,614
	9,061
	3,445
	6,764
	4,550
	4,467
	4,773
	3,673
	1,978

tained by the great trigonometrical survey, to put sinews and flesh upon the colossal skeleton which that survey constructs, it is evident that all the results of the revenue survey must be subjected to a Procrustean process in order that they may be available for this purpose. This however is not, we believe, done in this country. If we mistake not, the district maps are transmitted to the Court of Directors, and undergo in London that transformation which is necessary to fit them for the duty they have to perform in affording the data for a correct map of all India. We may take this opportunity of noticing that the great trigonometrical survey is going on rapidly and successfully, and that we may hope ere long to see as complete a map of India as there exists of any country in the world. This will be a noble achievement; and although it may not be hailed with so much jubilation as attended the conquest of Scind, when the Governor-General told his "brethren and friends," that "*my* armies have resumed this province from Beloochí usurpation, and opened the navigation of the Indus to all the world;" or so much as attended the conquest of the country of the Koh-i-núr—yet will its consequences be highly important, and substantial glory will accrue to those by whose enterprise it will have been accomplished.

There is a vast deal of matter in this part that we must pass over without any notice. But we must make an exception in favor of the seven chapters, which have been contributed by "Baboo Radhanauth Sikdar, the distinguished head of the computing department of the great trigonometrical survey of India, a gentleman whose intimate acquaintance with the rigorous forms and modes of procedure adopted in the great trigonometrical survey of India, and great acquirements and knowledge of scientific subjects generally, render his aid particularly valuable." (Preface, p. viii.) These chapters are clear and accurate, distinguished by a severity of style which contrasts very favorably, in our estimation, with the somewhat inflated diction of a considerable portion of our English-educated youths, and which tends to confirm us in an opinion that we have long ventured to entertain, notwithstanding its being opposed by high authorities, that mathematical studies are well fitted to produce a salutary influence on the national mind in this country.

The fourth part of the manual is, as we stated at the outset of this article, on the *khusrah* or native field measurement. This measurement is resorted to in all cases in which the fields are very small and irregular, and is effected by a distinct class of men from those employed in the professional survey. Till a

short time ago, the only instrument employed by these Amins was a rod or rope ; but many of them have lately been furnished by Capt. Thuillier with compasses, which enable them to estimate angles and bearings with tolerable accuracy. This must add greatly to the value of their work. These measurements are done by contract ; and it seems to be admitted that the rates allowed are too small to enable any man to live by the trade. But the means of eking out a livelihood are not far to seek. It must have been to this class of officials that the facetious Panch Kouri Khan alluded, when he described the Campaswallas as demanding an offering each morning to propitiate the genius of the magnetic needle, and to make it traverse, in order to which a certain amount of silver was deemed indispensable. That there may be occasional instances of oppression on the part of the subordinates in the regular survey is very probable ; but with them such instances are the rare exception. With the Amins they must of necessity be the rule. *Il faut vivre* is their motto. Now how is this state of things to be remedied ? By increasing the contract rates, and enabling the contractors to live honestly ? We know not whether this would not increase the evil. At present an Amin goes to a village, attended by his Mohurrir, his cook, his two rope-carriers, his peada, his chatta-bearer, &c.—in all perhaps a party of a dozen. This party he quarters upon the village until his work is done ; and every member of the party has an implied license to make the most of his position. But double the Amin's income, and he will double the number of his attendants : and each attendant, being now the *attaché* of a doubly great man, will of course double his exactions, and so, we take it, these exactions will increase by a law as regular as that by which gravitation diminishes with the distance of the attracting mass, and will be directly as the square of the functionary's official income !

It must be acknowledged, however, that the Zemindars and village officials are to blame for a considerable part of this exaction. It is their duty to point out the boundaries of the fields, and to afford all needful aid to the Amin. But it would be a sad sacrifice of their dignity were they to respond to his call without a becoming delay of a week or a fortnight. Meantime the Amin and his party are kept waiting in idleness ; and what then ? *Il faut vivre* ;—and then it is such a nice amusement for our idle men to gather a few rupees ;—and then the villagers are all persuaded that the Amin has it absolutely in his power to increase or diminish their rents at his pleasure, by making his needle point in one direction or another ;—and then—*il faut vivre*. Whereas on the other hand, if these village potentates

would enable the amin to set about his work at once, he would soon find it to be for his interest to finish his measurement with as much despatch as might be compatible with the required amount of accuracy, and to be off to the next village to repeat the same process there.

These exactions are however no laughing matter to the poor villagers, who if they could speak French would certainly answer the amin's *il faut vivre*—with a *nous ne voyons pas la nécessité*. But what can be done to prevent it? Oppression is the *genius loci*, the *dharma*, as our Bengali friends express it, of the land; and until this *dharma* be reversed, every man who has it in his power will oppress every man in every way that he can.

In this part there is an interesting, and somewhat amusing chapter on the standard, or rather the standards, of lineal and superficial measure in India. The following sketch is evidently taken from the life :—

In some of the local offices the standard measure is simply a matter of tradition, and, when applied for, the Nazir of the Court is directed to report on the correct length of the *kath* or *luggee*. This he does with the utmost simplicity by holding up his own arm, from the elbow to the tip of the little finger, sometimes adding that as he is a small made man, one, two, or four fingers' breadth must be added on. The Collector on this gives an order for a rooboocary to be sent to the Surveyor Sahib, to the purport of the standard in use in his District being "one *kath*, four fingers," and the *luggee*, or *russee*, being so many of such lengths. This vague and uncertain information, however, should not satisfy a surveyor. Such data for such a purpose are manifestly absurd, and yet it is daily in practice, in many districts in the Lower Provinces, where Amins are sent out to *investigate* into special cases connected with the Civil and Judicial Courts.

The fifth part of the manual is on "Practical Astronomy, and its application to surveying." It is contributed by Babu Radhanath Sikdar; and the remarks that we made on his other contributions to the volume are nearly as applicable to the one now before us. We should have liked a little more detail, and somewhat fuller explanations, which might have been given without materially increasing the size of the volume. Moreover, we have a decided preference for *reasons* over *rules*; and should have liked very much to have had the spherical triangles, to which the computations refer, exhibited to us, and explanations given of the mode of solving them, instead of merely directions to add the cosecant of one arc to the cosine of another, and to regard the result as double the tangent of a third. We have little doubt that the Babu would himself have preferred this method of doing his work, had he not considered himself precluded from adopting it by the space

allotted to him, or by the previous acquirements of his readers.

The appendix consists of several useful tables, to which it is not necessary for us to refer.

And now we have brought our review of this volume to a close, and have incorporated such notices as we thought might be generally interesting of the objects, methods and present state of forwardness of the revenue survey. We would only add in conclusion that it appears to us that it would be well, in the next edition, to divide the work into two volumes, which might be sold either together or separately. A long time must elapse before a man, who requires to study the first chapter of the first part, can have any occasion for much that is in the following parts; while many readers might start from a point far in advance of the beginning; and many of those who begin with the beginning can scarcely be expected ever to reach the end. If this recommendation be acted upon, we may add to it the suggestion that a short treatise on spherical trigonometry would form as appropriate an introduction to the second volume as that on plane trigonometry would form to the first. The introduction of such a treatise would give far greater freedom in the treatment of various matters relating both to terrestrial and celestial measurements.

We have now only to express our conviction that—despite the errors that we have pointed out in no cavilling spirit—the *Manual of Surveying for India* is a good and a seasonable book, reflecting much credit on its authors, and capable of being very useful to all persons employed in, or seeking to be employed in, the department for whose use it is specially intended, and to many others who are unconnected with that department.

NOTE BY THE EDITORS.

From a press of matter, although we have considerably exceeded our usual limits, we have been reluctantly compelled to postpone several Articles and Notices, intended for publication in our present issue. In connection with certain apparent discrepancies of opinion, we would request our readers to bear in mind the Eclectic character of the *Review*. By comparing, for instance, the first article of the present number, with former articles on "Our Judicial System and the Black Acts," on "The Penal Code," and "Revelations of the Police and Courts," they will obtain a much clearer view of what our Judicial System really is, than if we had advocated one side only, however ably.