small parties in the summer, consisting of an experienced geologist, a topographer, a naturalist, and sufficient canoemen to man two or three canoes. Rapid reconnaissance surveys are made with boat log, Rochon micrometer, telemeter, or plane-table; astronomical observations are made for time, latitude, and compass variation; many photographs are taken, and observations made on geology, mineral deposits, natural history, ethnology, climatology, water power, volumes of streams, and other natural phenomena. Supplies are carried in the canoes to last two, three, or sometimes four months, depending on the extent of country to be covered, and expeditions are made into all parts of the country. Such parties are not expensive, and give the best results for the money expended, though the results depend very largely on the ability and experience of the leader of the expedition. These methods have been very successful in the past and will no doubt be continued in the future; for it is difficult to see how any radical change or improvement can be made in them, having regard to cost and the physical characteristics of the country to be explored.

Progress, however, is slow, and because of the distance to be travelled and the area to be explored it is hardly possible for one of these summer expeditions to spend more than three months in new territory; in the more northern areas, because of climate as well as distance, the limit is two months. Allowing for delays on account of storms and bad weather the average length of new routes surveyed by a single party, now that all the easier water routes have already been traversed, would be about 400 or 500 miles. This amount is bound to decrease as time goes on, and it becomes necessary to follow routes that are more and more difficult. To make up for loss of time exploratory parties will soon be compelled to winter in their fields, but even where this is resorted to it will take many years to cover the ground that remains for the Canadian explorer.

[Note by the Editors: In the paper on the same subject, read before the Ottawa Field-Naturalists' Club, and published with a map in the *Ottawa Naturalist*, May 1890, the late Dr. G. M. Dawson computed the then unexplored area as 954,000 square miles. (See *Proceedings R.G.S.*, New Series, vol. **12**, p. 555.) See also the paper by Professor W. L. Grant, *Geographical Journal*, vol. **38**, p. 362, October 1911.]

ON THE ACCURACY OF BASEVI'S DETERMINATIONS OF THE VALUE OF GRAVITY IN INDIA.

R. D. Oldham, F.R.S.

IN the years 1865–71 a very elaborate series of determinations of the value of gravity at a number of stations in India was carried out by Captain J. P. Basevi, who lost his life when trying to complete the series by observations in the centre of the Himalayan Range, but not before he had completed a determination at Moré, at a height of 15,427 feet above the level of the sea. These observations were afterwards completed, tabulated, and published ('Account of the Operations of the Great Trigonometrical Survey of India,' vol. 5, 1879). They immediately attracted attention on account of some remarkable peculiarities revealed, and none more than the observation at Moré, which was of an especially remarkable character, and has been discussed from various points of view in connection with speculations on the origin of mountains and of the phenomenon known to geodesists as compensation.

The accuracy of these observations was unquestioned till in 1893–97 fresh observations were made at some of Basevi's stations by the Austrian Navy, which indicated that the earlier results were all in defect by about ·040 dyne. For this and other reasons it was decided to inaugurate a new series of gravity determinations, and the first result of these was to reveal a discrepancy of over ·100 dyne between the value adopted, as the result of prolonged and numerous observations, at Dehra Dun by Basevi and that obtained by Colonel G. P. Lenox Conyngham in 1904. As the new survey proceeded, observations at a half-dozen of Basevi's stations revealed defects of the value of the force of gravity varying from 0·026 to 0·110 dyne, distributed without any apparent reference to locality, and the conclusion appeared inevitable that the whole of the older observations were affected by an irregular source of error, the amount of which could not be estimated with any approach to accuracy in any individual instance. From this conclusion it seemed to result that the whole of Basevi's observations ceased to have any value, and would have to be ignored. A comparison of the old and the new observations has, however, convinced me that this conclusion goes too far, and that Basevi's results, if properly interpreted, have still a real value and importance where they have not been superseded by more modern observations.

In making a determination of the amount of the force of gravity at any place the first step is the measurement, with the utmost accuracy, of the period of a pendulum of known dimensions. To this measurement certain corrections have to be applied for the effect of temperature, of the pressure of the atmosphere, and of the flexure of the stand. The first two of these corrections were known and applied, so far as they had been determined, in Basevi's time; but the necessity of the last had not been recognized, and it was considered sufficient if the stand was sensibly rigid. It has however been found that even the most massive and solidly built masonry will yield more or less to the swing of the pendulum and so affect the period; and a method has been devised by which this effect can be measured and allowed for. Had Captain Basevi followed the usual course of having brick pillars built at each station for the support of his instrument, we should have had to do with a source of error of variable and undeterminable amount; but instead of adopting this procedure he constructed a strongly braced wooden stand, which was carried from one station to another, and always erected on a platform constructed at ground-level. This procedure and apparatus were used at every station except three; at Mian Mir and Moré a tripod stand of lighter construction was used, and at Dehra Dun the heavier stand was mounted in a specially constructed room, in a manner which seriously modified the results. The observations may therefore be divided into three groups: (1) the standard stations, at which the heavy braced stand was mounted on a platform at ground-level; (2) the stations of Mian Mir and Moré, at which the lighter tripod stand was used; and (3) the station of Dehra Dun. In each of these groups the conditions of observation were so different that no comparison is possible, and each must be dealt with separately.

At six of the standard stations observations have been made in the newer series, and in every instance the older value is in defect, as compared with the newer, by amounts which are shown below:—

Mussooree	·042 dyne
Nojli	·027 ,,
Kaliana	·047 ,,
Colaba	·026 ,,
Madras	·042 ,,
Kalianpur	·052 ,,
Mean	·039 ,,

This difference may be taken as representing, presumably, the correction for the effect of flexure of the stand, which should have been applied to Basevi's values. It will be seen that this correction varies between the values of −·026 and −·052, with a mean of −·039 dyne, so that, if Basevi's values are expressed in the metric system to the second decimal point and a correction of −·04 applied, the result will be correct within ·01 dyne of the true value.

We now come to the stations of the second group, at which the lighter stand was used. This stand was not tried by Basevi at any of his standard stations, and so we have no basis for a direct comparison; but we have Colonel Lenox-Conyngham's observation at one of the stations, Mian Mir, at which it was used. Here the later observation gave a defect of ·109 dyne as compared with the earlier, a defect which may be attributed to the flexure of the stand. From this it seems that the use of the lighter stand introduces a correction of about twice as much as in the case of the heavier, and probably an uncertainty in the same proportion, so that the correction which must be applied to Basevi's determination at Moré will lie within the limits of −·11 ±·02 dyne.

At Dehra Dun the same stand was used as at the standard stations, but the observations were made in a room specially adapted for the purpose of determining the temperature correction; in this a set of flues was built and a temporary wooden floor put in, at a level of 5 feet above the original concrete floor of the room, the wooden stand being supported on four brickwork pillars each 5 feet high by 1½ foot square at the base, tapering to only ½ foot square at the top. Seeing that Colonel Lenox-Conyngham, using pillars 1 foot 8 inches high by 2 feet 3 inches square at the bottom and 1 foot 6 inches at the top, and a much lighter apparatus, found it necessary to introduce corrections of from ·015 to ·020, and in one case as much as ·035 dyne, it is easy to understand how the taller and more slender pillars and heavier pendulum used by Captain Basevi might introduce an error, due to flexure of the support, of ·100 dyne. There is independent evidence that this is the correct explanation of the discrepancy in Basevi's preliminary observation at Dehra Dun, which was made in a simpler routine of observation, but agreed with the standard ones in being made with the same stand, supported on a solid platform at ground-level. The value obtained was equivalent to 979·036 dynes ('Account of the Operations,' etc., vol. 5, p. 118), or ·027 dyne less than that adopted by Colonel Lenox-Conyngham as the result of his observations.

CIVILIZATION AND CLIMATE.

Civilization and Climate.— Ellsworth Huntington, Ph.D. Yale University Press. (London: H. Mitiord.) 1915. Pp. 333 + xii. *Maps and Diagrams.* 10*s.* 6*d. net.*

PROF. HUNTINGTON has aimed in this work at constructing two maps of the world, the first to show the distribution of civilization and the second to show the distribution of those combined climatic effects which make for efficient human labour both mental and physical. Since civilization is an aspect of human efficiency, and since the two maps agree in their main outlines, it is urged that the climatic factors are partly responsible for the distribution of civilization as it occurs both in the past and in the present.

The measurement of civilization has already been described in these pages (*Geogr. Journ.*, vol. 47, p. 51, January 1916) in our review of a pamphlet which now forms part of the larger book. It will suffice here to recall the fact that the civilization map which Prof. Huntington has made differs little from a map of the world showing the density of population. The complete investigation into civilization was then considered, and the re-examination of that study in relation to the whole book does not lead the writer to change the views previously expressed.

The major portion of the complete work deals with climatic effects and consists of three sections. The first is introductory and discusses previous attempts, such as those of Ratzel, to demonstrate the importance of climate as a factor in the development of civilized life. The method