ton by Prof. C. G. Abbot, the retiring president, and reported at length in *Science* of March 6. The address forms a valuable apercu of the subject from Herschel's pioneer actinometric observations down to the experiments made late last summer under the joint auspices of the Smithsonian Institution and the U.S. Weather Bureau on the employment of *ballons-sondes* in pyrheliometric investigation. With regard to the solar constant, the mean value of 690 measurements made in connection with the Astrophysical Observatory of the Smithsonian Institution during the period 1902–13 is stated to be 1·933 calories per sq. cm. a minute, a value which is probably accurate to 1 per cent. It will be noted that this period covers one sun-spot cycle, and it is also stated that the Mount Wilson measures indicate that the solar radiation is more intense at spot maximum than at minimum, the sun thus showing affinity with variable stars of the *o*-Ceti type.

THE ACTION OF GRAVITY ON GASEOUS MIXTURES.—M. G. Gouy, in a recent communication to the Paris Academy of Sciences (*Comptes rendus*, vol. clviii., pp. 664–8) extends to the terrestrial atmosphere his researches on gaseous mixtures which during 1912 led him to the conclusion that pressure could not be the cause of the general displacement of the Fraunhofer lines towards the red. We may direct attention to the fact that the suggestion he then made that perhaps the explanation of this phenomenon would be found in the Doppler effect has received striking confirmation on purely spectroscopic grounds very recently in the work of Mr. Evershed (NATURE, March 19, p. 69). The present paper affords a mathematical demonstration of the impossibility of stratification according to density by the action of gravity on the gases in the earth's atmosphere where the pressure exceeds that of a Crookes tube as the final result indicates that under these conditions the effect of gravity on the composition of the air is too slow to produce sensible effects.

GROWTH AND CULTIVATION OF HOPS.

THE close attention which is being given in many foreign countries to the scientific study of plants of economic importance is evidenced in the two reports on the hop lately published by Dr. J. Schmidt. Although the cultivation of hops in Denmark is at present restricted to about 100 acres, Dr. Schmidt, of the Carlsberg Laboratory, Copenhagen, was recently commissioned to visit this and other countries with the object of collecting information on the most modern methods of cultivation, and also to collect data and material likely to prove of value in the work of breeding improved varieties of hops for cultivation in Denmark. In 1910 the physiological department of the Carlsberg Laboratory began a series of investigations on the hop plant (*Humulus lupulus*, L.), with a view of obtaining information of theoretical and practical interest regarding this plant. These reports by Dr. Schmidt are the first-fruits of this work.

In the first report, the growth in length of the stem and its diurnal periodicity is dealt with. One of the first problems for investigation that presented itself was to ascertain if the foreign varieties of hops obtained from southern regions which are being grown in the experimental garden attached to the Carlsberg Laboratory have a different rate of growth in the northern climate of Denmark from the wild-growing plant of that country. In the course of making these investigations, which are not yet concluded, the experiments detailed in this first report were made.

Dr. Schmidt was at the outset inclined to the belief —a belief, by the way, which is firmly held by the practical hop-growers of Kent—that the growth of the hop stem, or "bine," would be strongest during the night. Observations on a number of plants soon showed, however, that the reverse is the case. The least growth took place during the six hours 9 p.m. to 3 a.m., which proved that darkness was not the dominant factor of growth. It might have been expected that the growth-promoting factor of darkness would first show itself as an "after-influence," and that consequently the greatest growth would be during the following morning period, 3 a.m. to 9 a.m. It was found, however, that the strongest growth occurred during the period 3 p.m. to 9 p.m., immediately preceding the darkest period, the value for the rate of growth increasing evenly from the minimum of the latter period to the maximum of the afternoon period.

In the two main series of experiments, which were carried out in 1911 from the end of April, to the end of June, and in 1912 during July, the plants, growing in an unheated glasshouse, were kept as far as possible under natural conditions. The measurements were made continuously at 6 o'clock in the morning, 12 o'clock noon, 6 o'clock in the afternoon, and at 12 o'clock at night. The diurnal oscillations of temperature were followed by means of a thermograph.

Further experiments made seemed to show conclusively that the influence of the temperature on the rate of growth under natural conditions predominates over the influence of humidity; as the author remarks, "the growth-promoting power, which high humidity is known to have under natural conditions, is 'covered' by the influence of the temperature, so that it appears as if only the temperature was of any importance for the rate of growth of hop-stems."

The results of the investigations are summed up as follows:—"The growth in length of hop-stems under natural conditions has a very distinct diurnal period, the rate of growth being smallest during the night, greatest during the day. This periodicity is determined by outer factors, among which the temperature has such a predominant influence that under natural conditions it determines the rate of growth."

The second report deals with investigations into the rotational movement of the hop-stem. In experiments with vigorous three-year-old hop-plants, in an unheated glasshouse, the stems were found to show, during May and June, a rotational movement amounting on an average for one to two weeks' observations to about 120° an hour, or one-third of the rate of the minute hand of the clock. The following table records the facts observed with two hop-plants, one (No. 14) obtained from Germany, the other (No. 36) from England:—

	No. of whole days under observation	Total rotation in degrees	No. of turns	No. of turns in 24 hours (Average)	No. of degrees an hour (Average)
Plant No. 14					
Shoot *a* ...	9 ...	24865° ...	69 ...	7·7 ...	115°
,, *b* ...	9 ...	25875 ...	72 ...	8·0 ...	120
,, *c* ...	11 ...	29810 ...	83 ...	7·5 ...	113
Plant No. 36	13 ...	37600 ...	104 ...	8·0 ...	120

The rotational movement proved to have a very distinct daily periodicity, the rate being greatest during the day, least at night. This daily periodicity is determined by external factors, among which the temperature is of such dominating importance that

[1] Johs. Schmidt: (1) "The Growth in Length of Hop-stems and its Diurnal Periodicity" (*Comptes rendus des travaux du Laboratoire de Carlsberg*, 10me vol., 2me livraison, 1913).
Idem. (2) "The Rotational Movement of Hop-stems and its Diurnal Periodicity" (*l.c.*, 3me livraison, 1913).

its variation under natural conditions is determinative for the rate of rotation.

A graphic comparison of the fluctuations in the rate of rotation and degree of humidity showed that there was no connection between them under the (natural) conditions prevailing when the observations were carried out.

From some laboratory experiments with pot-plants it appeared that the rotational movement is not different, or at any rate not essentially different, in the dark and in scattered daylight.

An endeavour was made, with the minimum temperature (which "lies in the neighbourhood of 4°") as starting point, to obtain an expression of the relative quantities of heat, which were of importance for the rate of rotation. The numbers obtained, which are called "active quantities of heat," show that there is a very complete agreement between fluctuations in these and in the rate of rotation, the fluctuations showing a perfect synchronisation under the conditions observed.

Comparative experiments with twining bean-plants, and with *Lonicera periclymenum*, L., showed that a similar daily periodicity in the growth in length and rate of rotation of the stem occurred and that temperature is here also the determining factor. The author concludes by remarking:—"It is probable that the growth movements in many plants living under climatic conditions such as ours, where great temperature fluctuations occur in a diurnal period, have a diurnal periodicity which follows that of the temperature." E. S. S.

EDUCATION IN INDIA.[1]

IN the two substantial volumes before us Mr. Sharp gives an exceedingly able and comprehensive summary of the educational work done in India in the period 1907–12. The value of this record is enhanced by the inclusion of a Resolution of the Government of India dated February 21, 1913, summarising its educational policy, and forming a masterly exposition of its aims. A member of the Council of the Government of India has now been appointed with special charge of education, and the first incumbent of the post is Sir Harcourt Butler, who is to be congratulated on this very able summary.

The impression gained from the volumes is that education in India has now entered on a new and hopeful page of its history, for the progress made in the past five or ten years has been very great. Every effort is being made not only to widen the area of education, but also greatly to improve its methods, while in the forefront the formation of the character of the pupils is rightly insisted on. There are also clear signs that in the future efforts will be made to raise the status of those engaged in education, and to make their position such that the post of a teacher will be much sought after, and not taken as a last resource, as is largely the case at the present time.

India is sometimes pictured as a single country, but it really shows far greater complexities in education than Europe itself. It is computed that there are about thirty-eight million children of school-going age in the area dealt with in this report, while there are only 176,225 educational institutions of all classes, and in these six and three-quarter million pupils are under instruction. Almost all of these are boys, and the most trustworthy figures show that in 1911–12 for every mille of population of school-going age there were 268 boys and 47 girls under education. Five years previously these figures were 227 and 32 respectively. This really represents rather rapid progress, though compared with civilised Europe, India is still very far behind in the education of its masses.

Until recent years more attention was paid to the development of higher education than to that of the masses, but this has been largely changed during the past ten years, and now primary education is being largely fostered.

The type of higher education at first introduced was unpractical, largely literary, and tended to superficial knowledge, and in a large proportion of the students it did not fit them for their work in after life. Various efforts at reform were made, but the first effective movement came from Lord Curzon when Viceroy of India, who in 1901 summoned a representative conference which dealt with the whole subject of education from the university down to the primary stage. Numerous far-reaching reforms were formulated, and the history of many of the reforms is illustrated in the work under review.

One of the results of the conference was the Universities Act of 1904, under which regulations were framed, which came into force about the beginning of the period which is dealt with in Mr. Sharp's volumes. This Act was most bitterly opposed, but it is now admitted that it has produced a general and most important improvement in both university and secondary education, for some of the universities in India have large powers over the secondary schools which prepare candidates for university education, as they regulate the courses of study and even have powers of inspection, etc. It is probably true to say more progress has been made during these five years in improving and consolidating secondary and university education than in any previous quinquennium, for institutions which were working inefficiently have ceased to be recognised and have disappeared, while others have been helped and made more efficient. Indeed, the report indicates there have been great improvements in the courses of instruction in colleges and schools, also in thoroughness of study, in the more practical requirements in the study of, and examination in, science subjects, and finally in considerable improvements in discipline and in the formation of character, due to the students being compelled to live in recognised hostels (on which much money has been spent) or in messes under proper supervision.

The reforms due to the Educational Congress of 1901 included a large extension and improvement in primary education and its more efficient inspection, and a recommendation that greater attention should be paid to the teaching in and through the vernaculars. Both these reforms have made large progress during the past five years, and are undoubtedly leading to sounder education. Attention is now also being paid to manual training and nature-study. An endeavour to obtain more trained teachers in all stages of education is occupying considerable thought, and efforts are being made to effect this, but when it is stated that there are 215,518 teachers in India, who all ought to be trained, the magnitude of the problem is seen to be almost overwhelming.

Increased attention has also been given to female education, which, owing to the peculiar difficulties arising from the customs of the people themselves, has always been, and still is, in a very backward condition. As the result of this increased attention during the five years, the number of girls at school has increased by 47·7 per cent., but even this large increase only brings up the percentage of girls at school to the population of girls of school-going age to 5·1 per cent. Strenuous efforts are being made to

[1] Progress of Education in India in 1907–12. Sixth Quinquennial Review, by H. Sharp. Vol. i., pp. xvii+284+index; vol. ii., pp. 292. (Calcutta: Superintendent Government Printing, India, 1914.) Prices, vol. i., 6s.; vol. ii., 3s.