optical properties, occasionally by the fluorescence, but usually by the absorption, as studied by a spectrum microscope, and whenever possible by the position of absorption bands under identical known conditions. This latter is very important, since their position may vary considerably with the character of the solution. I never attempted to obtain the pigments pure, in a state fit for chemical analysis, so as to determine their chemical composition.

The number of distinctly different colouring matters in flowers must be very great, and to study them completely would occupy a long time. The distribution of the different kinds is sometimes very definite, but often the reverse. In the genus Hypericum are sometimes small dark spots in the petals, and sometimes small dark rounded bodies are attached to the sepals. These are coloured by a pigment which gives a spectrum with narrow, well-marked absorption bands, which could not be mistaken for any other. This occurs in all the species I examined, but in no other flowers. On the contrary, there is a blue pigment, giving a sufficiently well-marked spectrum with several absorption bands, met with in many flowers separated about as much as possible botanically.

Much may be learned by the use of reagents. Vegetable pigments may be divided into three groups by the action of sodium sulphide, which I called Groups A, B, and C. Group A is at once made nearly or quite colourless by the addition of a small quantity of this salt. Group B is not at all altered when alkaline or neutral, but is at once made nearly colourless when acid. Group C is not changed even when acid. When made colourless the pigments are not permanently decomposed, but recover their colour when evaporated to dryness. I do not fully understand the cause of these effects.

Then, again, much may be learned from the action of citric acid and a weak alkali. The colour and spectra of many reds, purples, and blues are very different in acid, neutral, or alkaline solution. Some yellow pigments are made thirty times more intense by an alkali, whilst others are unchanged. As a rule, none of the above changes is due to a permanent alteration, but in some cases it is useful to employ stronger reagents, which decompose the natural pigments, such as nitrite of soda with the addition of a little citric acid. As an example I may cite the pigment of the common yellow garden crocus. This gives a strongly fluorescent yellow substance, unlike that produced in the case of any other flower I have examined. The only objection to such powerful reagents is that they may produce highly coloured substances from colourless bodies in the plant, and not merely alter the coloured constituent. As an interesting example I may name a deep red substance produced in the case of the different species of geranium examined, but not in the case of any other plant.

My remarks so far apply only to colouring matters soluble in water. Orange, orange-yellow, and lemon-yellow flowers are in most cases coloured by one or other of the four yellow pigments met with in green leaves, or by various mixtures of them, which are distinguished by the absence or presence of two absorption bands. These vary considerably in position according to the nature of the solvent, lying much nearer the red end of the spectrum when the pigment is dissolved in carbon bisulphide than when in benzol or alcohol. These absorption bands can also be seen in the spectra of the flowers themselves, and for some time I was unable to understand why in the case of *Chelidonium majus* they lay materially nearer the red end than in nearly all other yellow flowers which gave the same spectrum when the pigment was in solution, until I came to the conclusion that in Chelidonium it occurs in a free state, and not dissolved in oil or wax. There are other cases in plants where the spectra show that the pigments exist in a solid state, which would explain slight differences in tint.

We may now consider facts very common in cultivated plants, viz. a great variety of colours. In many cases this is easily explained, because we can see that two pigments exist, either alone or mixed in various proportions, one frequently being a yellow insoluble in water, and the other a blue or red soluble in it. As an example, I refer to the common wallflower of our gardens (*Calendula vulgaris*), which is sometimes a clear yellow, sometimes a sort of crimson, but more commonly a crimson brown. The yellow is a xanthophyl soluble in carbon bisulphide; the crimson is a pigment soluble in water; the common colour is a mixture of these two, and gives the same spectrum as a yellow and a purple petal combined. We have a similar case in chrysanthemums and various other flowers. The common garden marigold is sometimes a pure yellow and sometimes a true orange or an intermediate tint, which is due to two different pigments alone or variously mixed. One or other of these may occur separate in different parts of the same flower in some plants.

In some flowers we find a considerable variety of tints, probably due to another cause. The common bedding geraniums of our gardens are a good example of this. At one time I thought that such varying tints might be due to varying acidity, but did not obtain satisfactory proofs, though it may be true in some cases. I, however, studied several closely allied pigments from other plants, and found that they seemed to agree in nearly every particular, except that the absorption bands in the spectra were not exactly in the same place. An excellent example of this kind is the red pigment of blood, giving two very well-defined absorption bands, which differ in position if the oxygen is replaced by carbonic oxide or nitrous oxide. Also the red pigment found in many birds' eggs, which I named oorhodeine, gives precisely the same remarkable and well-marked spectrum as the product of the action of strong sulphuric acid on the red pigment of blood, except that the position of the absorption bands differs distinctly. My suggested explanation of the difference in the colour and spectra of a number of the pigments in flowers is that some fundamental constituent is the same, but modified by some varying substance in combination.

A few flowers contain pigments which give spectra with unusually well-marked absorption bands. As remarkable examples I may mention the crimson Cineraria and the deep blue Lobelia of our gardens. The spectra are of almost exactly the same character, having two dark absorption bands, only they occur at a different part of the spectrum. I am unable to say whether this shows any relationship between the pigments, but the difference in the position of the bands is perhaps too great.

It will thus be seen that a very great number of distinct pigments are found in flowers, sometimes having a very restricted distribution, and sometimes the reverse. Then, again, the plant may be able to form two or more quite distinct colouring matters, either alone or mixed in varying proportions. In some cases the pigments seem to be easily subject to change, as though some constituent could be substituted for another. In one way or another there is thus great scope for variation, perhaps not brought into play, or only to a limited extent, in wild plants, but sometimes to a remarkable extent by cultivation.

H. C. SORBY.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The Vice-Chancellor has received a letter from Baron von Hugel, curator of the Museum of General and Local Archæology and of Ethnology, recording a gift from the Rev. John Roscoe, of the Church Missionary Society, of exceptional value and interest. It consists of a second instalment of selected native manufactures from Uganda. The chief value of the gift lies in a unique set of relics of deceased Baganda kings, which, enclosed in ornate cases, were preserved by the people under the name of Lubare (*i.e.* the Deity) in special shrines placed under the guardianship of hereditary custodians. Of these king-gods, the most sacred objects of Baganda cult, three generations are represented in the present collection.

With the first Roscoe collection, which was supplemented by a valuable gift of objects from the Katikiro of Uganda, the University acquired Kibuka, the war god of the Baganda, who with all his appurtenances was safely unearthed from his ruined shrine in the Mawokota district. In this deity, as in the Lubare, personal relics form the essentials, and in Kibuka are enshrined the jaw-bone, &c.,

of the deified chief of that name, a renowned fighter who lived in the reign of Nakibinge, the eleventh king of the Baganda.

Objects such as these are not readily to be obtained; indeed, it required years of careful investigation and all the knowledge and experience gained in the field by this veteran missionary to negotiate their safe removal from the ancient shrines of Uganda to the show-cases of the University museum.

MANCHESTER.—Daily observations at the meteorological Observatory of the University at Glossop Moor are now being taken with kites or captive balloons, and preliminary records of the results are being published every day in the *Daily Telegraph* and other papers. The work, which has been instituted by Prof. A. Schuster, F.R.S., is under the immediate direction of Mr. J. E. Petavel, F.R.S., assisted by the following staff:—Mr. Travis Rimmer, resident observer at Glossop Moor; Messrs. T. V. Pring and W. A. Harwood, and Miss Margaret White, voluntary assistants. The generous cooperation of the meteorological observatories at Buxton, Huddersfield, Stonyhurst, Sheffield, and Manchester will facilitate the working out of comparative results, in the subsequent utilisation of the observations, and should add greatly to the value of this investigation of the meteorology of the upper atmosphere.

AT a dinner of the Bristol University College Colston Society on Tuesday, the president, Mr. G. A. Wills, stated that contributions towards a university for Bristol have in the past two years amounted to 40,000*l.* He also announced that his father, Mr. H. O. Wills, has promised 100,000*l.* towards the endowment of the university for Bristol and the west of England provided a charter be granted within two years.

THE national importance of brain-power produced by universities, as well as sea-power obtained by a strong navy, was insisted upon by Sir Norman Lockyer in his presidential address to the British Association in 1903; and a comparison was made of the expenditure on higher education with that on battleships. Prof. Turner, of the University of Birmingham, speaking at Stourbridge on January 6 in connection with the Stourbridge and District Higher Education Committee, used similar illustrations in referring to the cost of technical education. He pointed out that the Birmingham University and other local colleges and universities obtain a total grant per annum of about 100,000*l.* Let this be compared with our naval expenditure, and it is found that to build one battleship of the *Dreadnought* type absorbs the whole of the funds allocated to the local universities for seventeen years. Battleships are a necessity, but the Army and Navy cannot exist apart from the nation's third line of defence—its internal manufactures—and these depend largely upon the rearing of an educated and skilled people.

THE annual meeting of the Geographical Association was held on January 8. Mr. Douglas Freshfield, who presided, said that last year he had found it necessary to comment on the extraordinary decision of the Civil Service Commissioners to exclude geography from the examinations for the higher branches of the Civil Service, including the Foreign Office, but now he was able to congratulate the association upon a reversal of that decision. The report read supplied evidence that the association continues energetically its work of improving geographical instruction. Major Close delivered a lecture on map projection. It may be noticed that various lectures on the teaching of geography have been arranged by the association. The first will be delivered by Mr. G. G. Chisholm on January 24, at 8 p.m., at University College, and the second, on scientific method in the teaching of geography, by Prof. R. A. Gregory, on February 14 at the same place and time. The remaining lectures will be delivered on alternate Fridays upon the following subjects:—Physical geography as an essential part of school geography, Mr. T. Alford Smith; how to teach the geography of a country, Prof. L. W. Lyde; orographical maps as the basis of the geography lesson, Dr. A. J. Herbertson; and geographical laboratories, Mr. A. T. Simmons. Particulars may be obtained from Mr. J. F. Unstead, 5 Wiverton Road, Sydenham.

THE issue of *Science* for December 20, 1907, contains the annual opening address delivered last October by Prof. F. F. Wesbrook, of the University of Minnesota, before the faculty of science of the University of Manitoba at Winnipeg. Discussing the needs of the Canadian university, Prof. Wesbrook instituted an interesting comparison between what is required in the direction of higher education in Manitoba and the similar needs of the University of Minnesota, which was founded nine years earlier than the Canadian institution. Although Manitoba has had a university since 1877, it cannot be said as yet to have made provision for it which is at all adequate. Manitoba has now a population of about 380,000, and with all the demand on her for increased university facilities has only been able to expend approximately 16,000*l.* for building and permanent improvement, and for maintenance 3000*l.* per annum (which until last year was only 1200*l.*), with an addition of 5000*l.* from land grant and other sources, making a total current expenditure of 8000*l.* per annum. In the case of Minnesota University, there were in 1887 only 412 students registered out of a State population of 1,180,000, and there was available 7000*l.* from State funds and a total of practically 14,000*l.* from all sources, with a total student attendance per ten thousand population of 3·49. In 1906 the population of the State had nearly doubled, the University attendance had increased to 3956, the total funds derived from the State to 50,300*l.* per annum, the total annual current expense of the University, exclusive of buildings and permanent improvements, was 108,400*l.* per annum, and the attendance at the University for each ten thousand of State population was twenty students. The total expenditure for maintenance, exclusive of State grants for hospital maintenance, special investigations, library expenses, repairs, and so on, will this year be above 132,600*l.* Well may Prof. Wesbrook urge the people of Manitoba to emulate the American example he cites. It is to be hoped that the approaching visit of the British Association to Winnipeg will assist the Canadian authorities in developing the University.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, November 14, 1007.—"On the Cranial and Facial Characters of the Neandertal Race." By Prof. W. J. **Sollas.**

As a result of a comparison of the calvarium of the Neandertal race with that of the aborigines of South Australia, it is shown that a much closer resemblance exists than some authorities have supposed, especially as regards the calottal height, Schwalbe's ("bregma") angle, and the bregma index. The chief differences are to be found in the cephalic index, the continuity of the frontal torus, and the deeply impressed character of the frontal fossa.

Comparisons based on the glabella-inion line are misleading, owing to the inconstancy in position of the inion.

The exterior foramino-basal angle owes its perplexing anomalies to the fact that its magnitude is determined by five variables, one of which is connected with the cranial height, so that in depressed forms of skull it acquires a higher value than might otherwise be expected.

The Gibraltar skull is the only example of the Neandertal race which presents the bones of the face and the basi-cranial axis in undisturbed connection with the calvarium. Its characters, apart from the cranial vault, are unique; no other known skull possesses so long a face or such a large and broad nasal aperture. In profile, the nasal curve flows into that of the glabella, without any sudden change of flexure, that is, there is no nasal notch, such as occurs in the Australians.

The orbit, as in all skulls of the Neandertal race, is distinguished by its excessive height above a line drawn from the nasion to the middle of the fronto-zygomatic suture.

The sphenethmoidal angle has been measured from the limbus sphenoidalis by a line drawn to the crista galli on the one hand and the basion on the other; it exceeds the corresponding angle of the lowest known South Australian skull, similarly measured, by 16° 30′.