fails to see minute differences which are perceptible enough to the raiser or his workmen. Nor must it be thought that these variations, difficult as they are to recognise in the beginning, are unimportant. On the contrary, they are interesting, physiologically, as the potential origin of new species, and very often they are commercially valuable also. These apparently trifling morphological differences are often associated with physiological variations which render some varieties, say of wheat, much better enabled to resist mildew and disease generally than others. Some, again, prove to be better adapted for certain soils or for some climates than others; some are less liable to injury from predatory birds than others, and so on. These co-relations, then, are matters of the greatest importance to the biologist intent upon the study of progressive modification, and to the merchant and the cultivator for practical reasons.

So far we have been alluding to variations in the plant as grown from seed, but similar changes are observable in the ordinary buds, and gardeners are not slow to take advantage of these variations. The buds taken from the base of a plant not unfrequently differ from those which are developed higher up, and these differences are perpetuated by propagation by means of cuttings or grafts. An interesting illustration of the variability in flower-buds is furnished by the gigantic Chrysanthemums which attract so much attention in late autumn. Without entering into technical details, it may be briefly stated that the cultivator selects certain buds, or one bud occupying a special position, and pinches off and rejects most or all the others. The result is not only a flower-head of large size, such as we might expect under the circumstances, but also, in very many cases, one which presents different characteristics to those which are manifested by the other buds when allowed to develop themselves. "As like as two peas in a pod" is, therefore, a motto which has not the significance it had before we had observed that the peas are mostly different, sometimes very much so, and the same thing happens, as has been shown, in the ordinary leaf- and flower-buds; doubtless each cell has its peculiarity, which only awaits a Röntgen ray or some other means to become visible.

Before we leave the subject of buds, some mention may be made of that form of bud-variation which the gardeners speak of as "sporting." Sports are bud-variations which occur suddenly, without assignable cause, and often simultaneously in different regions widely separate. Thus we get peaches and nectarines on the same bough, black and white grapes on the same shoot, or even in the same bunch, finely-cut leaves on a branch that normally produces broad or entire leaves, and so on. The gardener who is on the alert takes care to remove such buds, and to propagate them by cuttings or grafts. If raised from cuttings or layers, the duration of the sport is indefinite; if propagated by grafting, their duration is naturally conditioned by the life of the stock. The problems afforded by sports are of great interest, and are by no means fully solved. Many of them may arise from atavism, or a reversion to an ancestral condition; but of this there is no proof, neither can we appreciate the reason why such reversion should take place. Some may be the result of the dissociation of previously mixed characteristics. Of this we frequently see unmistakable evidence. Thus hybrid berberries frequently show on the same plant an un-mixing or separation of the characters belonging to the two parent-forms.

This brings us to the subject of cross-breeding as a means of obtaining new or improved varieties. Cross-breeding may occur in all degrees from the case where the pollen of one flower is transferred, by insect or other agency, to the stigma of another on the same branch, to that in which the pollen is transferred to the flower on a plant of a different species. Watch a bee travelling over the great disc of a sun-flower, and it will become obvious that (always provided the stigmas be in a receptive condition) cross-fertilisation of neighbouring flowers must take place.

There are endless adaptations which ensure cross-fertilisation, and on the other hand there are very numerous structural arrangements which necessitate close fertilisation, or the fertilisation of a flower's ovules by pollen produced in the same blossom. In view of the copious literature on this matter, it is not necessary here to enter into further detail. It is enough to say that some of the most astonishing results of the gardener's art are due to this practice of repeated cross-fertilisation. When the cross is effected between plants of two different species the term "hybridisation" is made use of, but it is obvious that there is only a difference of degree between the fertilisation of different flowers on the same plant and that of flowers belonging to different species, or even genera.

The tuberous Begonias, before alluded to, are the results of the successive intercrossing or hybridisation of several species, and the result is the production, within little more than a quarter of a century, of a race or garden-group, not to be matched in nature, and so distinct as to have been thought worthy not merely of specific but of generic rank.

Many recognised genera, we might even say most, are not so sharply differentiated as are these Begonias from others of the same family. These extreme crosses apparently are not effected under natural conditions, and some botanists even hesitate to admit the occurrence of hybrids in nature except under very exceptional circumstances. The gardeners and cultivators, however, have long considered certain forms to be of hybrid origin, and one of the most interesting things in this connection of late years is the positive evidence which cultivators have been able to bring forward as to the existence and the parentage of natural hybrids. Certain orchids, now rather numerous, were, from the appearances they presented, assumed to be "natural hybrids" between certain species. That such assumptions were correct has now been proved by the production in our orchid houses of forms indistinguishable from those met with in a wild condition, as the direct consequence of the designed fertilisation of one flower by the pollen of another.

Fairchild, a nurseryman at Hoxton, and the founder of the Flower-sermon, was the first on record to raise a hybrid Pink. Indeed, this is the first artificial hybrid of any kind on record, and it dates from 1719. From that time to this gardeners have gone on selecting, cross-breeding, hybridising. At one time some good folk looked askance at such operations as an interference with the laws of Providence. So much was this the case, that one eminent firm of nurserymen in the early part of the century led their customers to believe that certain heaths (Ericas), which they had for sale, were imported direct from the Cape of Good Hope, instead of having been raised by cross-fertilisation in their own nurseries at Tooting!

Gardeners for the most part pursue their experiments with no scientific aim. The names of Philip Miller, Thomas Andrew Knight, and of Dean Herbert, amongst others, suffice to show that some gardeners appreciate the deep scientific value of these every-day procedures. From the labours of these men and their successors it is made obvious that the cultivator, by availing himself of natural tendencies and natural agencies, and by his power of eliminating conflicting or unpropitious elements, does actually bring about, in a relatively very short period, the same results that occur under natural conditions only after the lapse of a prolonged period. Do not these facts show the desirability for our own biologists to study carefully the results obtained by the gardener, and better still to enter, as their great leader Darwin did, the field themselves as experimenters.

There can be few departments in which greater promise of important results can be held out.

MAXWELL T. MASTERS.

THE ROYAL OBSERVATORY, GREENWICH.

ON Saturday last, the Astronomer Royal presented his annual report to the Board of Visitors of the Royal Observatory, Greenwich. Following the usual custom, a number of astronomers and other men of science were invited to inspect the buildings and instruments of the observatory. The subjoined extracts from the report give a general idea of progress made in some departments since the middle of May last year.

Work with Equatorials.

The new equatorial with photographic telescope of 26 inches, presented by Sir Henry Thompson, is now nearly finished and ready for inspection at Sir Howard Grubb's works. Sir Henry Thompson has completed his valuable gift by the addition of a Cassegrain reflecting telescope of 30 inches aperture, to be carried in place of the counterpoise at the other end of the declination axis.

The 28-inch refractor has been in constant use for micrometric observations during the year, and for spectroscopic observations till November last year.

The measures of the dimensions of Saturn and his rings,

begun last year, were continued on nine nights, and the results communicated to the Royal Astronomical Society in November. The diameters of Jupiter were measured on nineteen nights with the filar micrometer and, for comparison, with the double-image micrometer; the results were communicated to the Royal Astronomical Society in May. The weather during the opposition of Jupiter and Neptune made it impossible for any systematic search to be made for Jupiter's fifth satellite, and the position of Neptune's satellite was only observed on one night.

The Photographic Chart and Catalogue.

With the Astrographic Equatorial 502 plates, with a total of 1224 exposures, have been taken on 123 nights in the year ending May 10, 1895. Of these, 135 have been rejected for various reasons.

The following statement shows the progress made with the photographic mapping of the heavens between May 11, 1895, and May 10, 1896:—

	For the Chart (Exposure 40 m.).	For the Catalogue (Exposures 6 m., 3 m., and 20 s.).
Number of photographs taken	118	353
,, successful plates	89	247
,, fields photographed successfully	79	223
Total number of fields photographed successfully since the commencement of the work	490	732

The question of the utilisation of the photographs taken for the Astrographic Chart, and the formation of a catalogue of stars down to the eleventh magnitude by means of photography, has occupied much attention during the past year, and a satisfactory working scheme for the measurement of the photographic plates and determination of the positions of the stars on them has been brought into operation. It is estimated that if no unforeseen difficulties arise the measures and calculations for the Greenwich Astrographic Catalogue of Stars down to the eleventh magnitude, from Dec. 64° N. to the Pole, will be completed in about seven years, and that the positions of about 120,000 stars will be determined with a degree of accuracy at least twice as great as that of the Astronomische Gesellschaft Catalogues from meridian observations. When it is considered that the Greenwich Astrographic Catalogue will contain about ten times as many stars as the catalogues of the Astronomische Gesellschaft for the corresponding zones, and that the Astrographic Catalogue for the whole heavens will give the positions of from two to three million stars with an accuracy hitherto unattained, and at a relatively small expenditure of labour, the great advantage resulting from the application of photography to the mapping of the heavens will be sufficiently evident.

Spectroscopic and Heliographic Observations.

Since the date of the last report, 189 measures have been made of the displacement of the F line in the spectra of 17 stars, as well as 33 measures of the F line in the spectrum of the moon for comparison.

The spot activity of the sun has steadily declined from the date of the last report. The mean daily spotted area of the sun was decidedly smaller in 1895 than in 1894, but a greater number of small spots was observed.

Magnetic Observations.

The variations of magnetic declination, horizontal force and vertical force, and of earth currents have been registered photographically, and accompanying eye observations of absolute declination, horizontal force and dip, have been made as in former years.

The principal results for the magnetic elements for 1895 are as follows:—

Mean declination	16° 57′·4 West.
Mean horizontal force	3·9739 (in British units). 1·8323 (in Metric units).
Mean dip (3 months, January to March)	67° 15′·3 (by 9-inch needles). 67° 14′·8 (by 6-inch needles). 67° 16′·6 (by 3-inch needles).
Mean dip (4 months, September to December)	67° 10′·7 (by 9-inch needles). 67° 11′·8 (by 6-inch needles). 67° 12′·4 (by 3-inch needles).

Uncertainty attaches to the results for mean horizontal force, owing to the permanent effect of the iron in the new Altazimuth Pavilion.

From April to August 1895, during the progress of the building work on the new Altazimuth, the observations of magnetic dip were subject to great uncertainty on account of the masses of iron for the building being stored near the north end of the New Library in immediate proximity to the dip instrument. And after the completion of the building—that is to say, since September 1895—the results of magnetic dip are affected to the extent of about 3′ or 4′ by the permanent iron in the building and instrument. An independent determination at a place sufficiently removed from the Altazimuth building is urgently required. The question, however, has necessarily been deferred, pending the settlement of the site for the new Magnetic Pavilion, which is to be built in Greenwich Park.

The magnetic disturbances during the year 1895 have been comparatively trifling. There were no days of great magnetic disturbance, and sixteen days of lesser disturbance. Tracings of the photographic curves for these days, selected in concert with M. Mascart, will be published in the annual volume as usual. The calculation of diurnal inequalities from five typical quiet days in each month has been continued.

Meteorological Observations.

The mean temperature of the year 1895 was 49°·3, being 0°·1 below the average for the 50 years 1841–1890.

During the twelve months ending April 30, 1896, the highest daily temperature recorded was 87°·3 on September 24. On May 30 a temperature of 86°·2 was recorded. The temperature rose above 80° on 26 days in 1895 as compared with seven days in the preceding year. The monthly mean temperatures were all in excess of the average values with the exception of the month of October, which was in defect. The mean for September was in excess to the amount of 4°·7; that for November in excess by 4°·2, and that for March 1896 by 4°. The mean temperature for the twelve months May 1895 to April 1896 was 51°·1, being 1°·7 above the 50 years' average.

The characteristics of the fine and hot month of September require to be examined in detail. It has been mentioned that the highest temperature of the year (87°·3) occurred on September 24, a temperature greatly exceeding all temperatures previously recorded at this advanced period of the year during the 54 years 1841–1894. Only two instances of higher temperature, both in the earlier part of the month, have been experienced in September, viz. 92°·1 on September 7, 1868, and 87°·7 on September 1, 1886.

The winter of 1895-96 was very mild, and there were only 19 days on which the temperature of the air fell to or below the freezing-point. The lowest winter temperature was 24°·3 on February 25, 1896.

The mean daily horizontal movement of the air in the twelve months ending April 30, 1896, was 275 miles, which is 6 miles below the average for the preceding 28 years. The greatest recorded movement was 1002 miles on December 5, and the least 70 miles on October 20. The greatest recorded pressure of the wind was 27·5 lb. on the square foot on March 16, with an extreme hourly velocity of 49 miles.

The number of hours of bright sunshine recorded during the twelve months ending April 30, 1896, by the Campbell-Stokes instrument was 1176 out of the 4465 hours during which the sun was above the horizon, so that the mean proportion of sunshine for the year was 0·263, constant sunshine being represented by 1. In the corresponding period for 1894–95 the number of hours of sunshine was 928, and the mean proportion 0·208.

The rainfall for the year ending April 30, 1896, was 19·76 inches, being 4·78 below the 50 years' average. This is the smallest rainfall since the year 1884–85, when the fall was 19·61 inches. In 1864–65 the rainfall was 17·71 inches, and in 1858–59 it was 17·38 inches. The number of rainy days in the twelve months was 151.

Re-organisation of the Staff.

The scheme for the re-organisation of the staff, referred to in last two reports, has now been sanctioned. With a view to strengthening the supervising power and increasing the permanent subordinate staff, an additional chief assistant is appointed, and the five second-class assistants of the old staff are to be replaced by eight established computers, two of these to be of a higher grade, the number of temporary computers being correspondingly reduced. The future staff will be thus constituted:—

Upper staff, two chief assistants and five assistants; lower staff, two higher grade established computers and six established computers; temporary staff, non-established computers.

Mr. P. H. Cowell was appointed the additional chief assistant on April 20, and it is hoped that the appointments of the established computers will very shortly be made. Mr. Criswick has retired on pension after a useful and honourable service of forty-one years at the Observatory, and Mr. Hollis has been promoted to fill the vacancy thus occasioned in the staff of first class assistants.

THE ROYAL SOCIETY OF CANADA.

THE annual meeting of the Royal Society of Canada was held at Ottawa on May 18, and the three following days. In addition to the papers read before the literary sections of the Society, a large number of important papers were presented in the two Science Sections.

In Section III. (Mathematical, Physical and Chemical Sciences), Profs. Cox and Callendar presented the results of recent investigations carried on by them in the physical laboratories of McGill University, in which they have succeeded in demonstrating that Röntgen rays are not unaffected by magnetic attraction, as Röntgen states, but on the contrary are affected in a marked manner when tested experimentally under favourable conditions, the approach of the magnet causing a marked deviation of the kathode rays within the tube in one direction, and at the same time a corresponding deviation of the Röntgen rays without the tube in the opposite direction. These observations are of especial importance as bearing on the question of the relation of Röntgen rays to the kathode-rays, Röntgen having considered the former as differing from the latter in that they were not influenced by magnetism.

In the same Section, papers were also read by Messrs. Alex. R. Mellanby and John T. Farmer, Royal Commissioners' Scholars, on investigations carried out in the laboratories of McGill University; the former, "on an investigation as to the thermal and plant efficiencies of compound, triple and quadruple expansion engines," and the latter, "on the efficiency of $\frac{1}{2}$-inch jets from circular orifices, impinging upon surfaces of different forms."—Prof. Bovey communicated the results of a series of experiments on the strengths of the woods of the hemlock, red pine, and white pine.—Mr. Howard Barnes presented the results of a series of very accurate measurements of the temperature of the waters of the St. Lawrence, opposite Montreal, during the coldest part of last winter. It was shown that the greatest variation in temperature did not exceed $\frac{1}{100}$ of a degree Centigrade. The measurements were carried out with a view to ascertaining whether the formation of frazil ice was accompanied by any considerable changes in temperature, such as have been described by some observers. It was found that as the river does not vary throughout its depth by so much as one-hundredth of a degreee from the freezing point, the formation of frazil does not depend on any considerable lowering of the temperature of the water. The formation of fine needles of ice all through the water of the river is probably aided by fine particles of sand and other suspended material acting as nuclei, since earthy matter is found embedded in the frazil attached to the under side of the surface ice.

In Section IV. (Geological and Biological Sciences), Sir William Dawson read a paper on fossil sponges and other organic remains from the rocks of the Quebec Group at Little Metis.—Prof. D. P. Penhallow read a paper which embodied his final deductions on the generic characters of the North American Coniferæ as exemplified in the microscopic structure of the woods.—Prof. Ramsay Wright gave the results of his studies of a great number of minute forms of life obtained from certain of the Canadian fresh-water lakes by means of a very fine tow-net, among which he describes a number of new species, and compares others with closely allied forms already recognised in the lakes of Scandinavia and other parts of Europe. He also communicated a paper by Mr. E. C. Jeffery, on the morphological nature of the medullate stellar structures of certain plants.—Dr. George M. Dawson, in a communication on secular climatic changes in British Columbia, showed from a study of the rainfall of the Province, as evidenced by the varying height of lakes without outlet, that the last few years have been more humid than any preceding them in a period of about fifty years.

Other papers were read by Prof. Edward E. Prince, Dr. A. R. C. Selwyn, Dr. William Saunders, and others.

The usual public lecture was delivered by Prof. Prince, Dominion Commissioner of Fisheries, on the fishery industries and resources of Canada.

The Society decided to petition the Dominion Government to establish a marine biological station at some point on the Atlantic Coast of Canada, as soon as possible, as recommended in a recent report of the Dominion Commissioner of Fisheries.

Prof. Ruttan and Prof. Adams, of McGill University, and Mr. W. Bell Dawson, of the Hydrographic Service, were elected Fellows of the Society, to fill three vacancies recently caused by death.

The meeting was well attended, and was successful in all respects. At the conclusion of the meeting the Fellows of the Society were entertained at a garden party, by their Excellencies the Earl and Countess of Aberdeen, at Rideau Hall.

THE CIRCULATION OF ORGANIC MATTER.

AT the evening meeting of the Royal Institution on Friday, April 24, Dr. G. V. Poore gave a discourse on the circulation of organic matter. Without attempting to define "organic matter," Dr. Poore began by saying that all organic matter was combustible, and that all our combustibles were of organic origin. A comparison was made between combustion in a furnace and the combustion of food in the body of an animal, and it was shown that whereas in the furnace the fuel was used up and furnace wore out, in the animal there was increase of size, while its droppings stimulate the soil to an increased production of food. This apparent increase was probably due to the holding in suspension by the extra growth of plants of both water and soluble salts, which otherwise would percolate the soil and find their way to the sea. Recent experiments made it certain, also, that some of the atmospheric nitrogen was appropriated by microbes in the soil. The animal was a true regenerative furnace, and led to the increase of the herbage at the expense of the sea on the one hand, and the atmosphere on the other. It was impossible to imagine an increase in one direction without some compensating decrease in another direction. When organic matter collected under water, fermentations were set up and the organic matter was reduced instead of being oxidised. The tendency of organic matter, when thus treated, to form combustible bodies was very remarkable. The inflammable gases which sometimes formed in cesspools, and the marsh gas evolved by mud in ponds and rivers, were familiar examples, as were also the alcohols formed by the fermentation of carbohydrates. Our immense stores of coal and peat were due to the silting up of marsh plants in past ages and in recent times, and so-called mineral oils were certainly of organic origin, as were also the nitrates which were so much used in the manufacture of explosives. If we were to judge what *has been* by what *is*, it was impossible not to come to the conclusion that life must have preceded combustion in this world. This biological theory of the cosmogony made the world subject, like all other things, to the processes of development, evolution and decay, and he believed that such a theory had fewer drawbacks than might at first sight appear.

Organic matter was our capital in this world, and the more frequently we could make it circulate the greater would be our increase of material wealth. If we burnt it or threw it into the sea, we thereby spent money for dissipating our capital; but if we placed it on the land, we increased our capital and earned frequent dividends. The *rôle* of microbes in the soil, in bringing about the humification and nitrification of organic matter, was next dealt with. It was shown that farming without frequent additions of organic matter to the soil, must end in ultimate failure. We found everywhere that vegetable organisms co-operated with animals in the destruction and circulation of organic matter, and it appeared to be probable that the correlation of the biological forces was not less rigid than the correlation of the physical forces.

Allusion was made to the observations of M. Megnin on the destruction of animal bodies by successive squadrons of insects and microbes, and many facts were brought forward to show that the comparatively new doctrine of symbiosis was probably of universal application. The intestines of every animal swarmed with microbes which were essential for digestion, during life, and at death were active in starting the dead body upon the cycle of events which led to its ultimate circulation and re-