floating balls give the impression of high-tension electrical discharges without appreciable current, similar, for example, to Tesla-currents; on the other hand, the attached balls appear to possess a lower tension but greater current density.

11. The *floating* balls have the red colour of meteorites in the lower atmosphere. They shun good conductors and generally choose a path through the air. They appear to be actually "attracted" to enclosed spaces, such as houses and rooms, which they enter through the open window or door, sometimes even through small cracks. The chimney, with its conducting but self-inductionless gases, is a favourite path for the balls, so that they frequently appear to enter a house through the kitchen fire. After the ball has circulated around a room several times the latter appears to lose its power of attraction, and the ball leaves it by some aerial path, frequently the one by which it entered, but occasionally along a new one. Ball lightning, when floating in the air, is not dangerous to human beings, even when it appears in the middle of several persons. It appears to avoid them in the same way that it avoids all good conductors. Occasionally a ball makes two or three oscillatory vertical movements, which may extend to several metres or be confined to a few centimetres. When these oscillatory movements are combined with horizontal translation, the ball seems to progress in a series of hops or jumps. Frequently this vertical movement is confined to a single descent from the clouds to a few metres above the ground, followed by an immediate re-ascent.

12. The *attached* balls are dazzlingly bright, and blue or white in colour. They attach themselves to good conductors and prefer the highest points. If the conductors are horizontal, for example metal rain-gutters to roofs, the balls frequently roll along them. They heat the objects to which they are attached or along which they roll, and if the human body is such a conductor, serious burns result, sometimes with fatal effects.

13. When ball lightning is about to change from the floating to the attached state, after a short withdrawal, it makes a sudden dart on to a neighbouring good conductor, for example water. On touching the conductor it may continue to exist as an attached ball, or it may come to an end either quietly or with an explosion. Balls which fall from the clouds generally strike the ground where they explode.

14. When the reverse change is made, that is, from the attached to the free state, the ball simply rises from its support and floats upwards, generally along an inclined path towards the clouds; but usually such balls are rapidly extinguished.

The above description does not cover all the characteristics of ball lightning reported by observers, but it is a very fair representation of the outstanding features of the phenomenon. Every one who studies the reported cases may not agree with Dr. Brand regarding the relative stress he gives to the various factors, but as every characteristic tabulated can be found in several of the accounts, they must all be taken into account when formulating an explanation.

Very wisely Dr. Brand does not give much space to trying to find an explanation. He recounts the various experiments which have been made and the most important of the explanations offered, and comes to the conclusion that the problem of the nature of ball lightning is still unsolved.

The frontispiece and the last page of the book are the most intriguing and tantalising of the whole. The frontispiece shows two photographs of ball lightning, which are said to have appeared when a short circuit occurred during the tests of a 13,500 horse-power, 12,000 volt generating plant. The photographs were supplied by a Norwegian engineer, A. Nielsen, but in spite of numerous letters, Dr. Brand has been unable to extract from Herr Nielsen any details of the experience!

Chemistry at the British Empire Exhibition.

(1) Fine Chemicals and Scientific Exhibits.

THE Chemical Section in the great Palace of Industry at Wembley occupies nearly 30,000 square feet and is unquestionably one of the best organised, most artistically displayed, and interesting sections in the whole of the Exhibition. Very wisely the general principle has been adopted of not letting space to individual firms, each of which would, in the ordinary way, have been allowed to do what they pleased in the shape of decoration, type of stand, and method of displaying their exhibit, irrespective of the effect upon their immediate neighbours and the sections as a whole. Instead of this, blocks of space have been allocated to representative associations of the different industries, which have thus been able to deal with the exhibits of all the individual firms constituting their membership in a comprehensive and dignified manner so as to give the best effect, both collectively and individually.

Accordingly, on these lines the Chemical Section has been organised in a very efficient manner by the Association of British Chemical Manufacturers. The arrangement is such that the stands relating to heavy chemicals occupy one end, and include paints, varnishes, coal tar products, aniline dyes, disinfectants, acids and alkalis, alum, and similar products, extending to nearly the middle of the entire section. We then have fine chemicals, alkaloids, pharmaceutical products, salt, and photographic chemicals, together with an area of 2500 square feet that has been allocated to a purely "Scientific Section," another good example of the value of group control, since this would have been impossible under ordinary conditions with individual firm exhibits. Finally, at the opposite end we have soaps, perfumes, polishes, and similar products. A further great advantage of the supervision of the entire section by the Association of British Chemical Manufacturers is that not only is the whole display neat and well organised, but also well-known artists have been engaged to make the best of the section from an artistic point of view.

The wisdom of this course is seen not only by the general design, including tall and decorative gilt columns, but also by the beautiful frieze painted by Mr. Cosmo-Clark, which runs round the entire circuit of the inner walls at the top, to a total length of about 200 yards, representing, in striking colours, the chemical industry at work.

Finally we have the production of a fine volume, "Chemistry in the XXth Century," in which many well-known men of science have collaborated. It is of course quite impossible to deal adequately with such a magnificent display; and every chemist ought to make a point of visiting Wembley and studying the Chemical Section in detail, so as to be able to realise to the full the importance and diversity of his science, and the strides that have been made by Great Britain in this direction since the War.

The fine chemicals, together with the Scientific Section, is perhaps more impressive than the heavy chemicals, especially from the point of view of the resources of the British chemical industry, and there is a very fine display of alkaloids, anæsthetics, medicinal products of every description, perfumes, and pure laboratory chemicals.

Many chemists have a vague sort of idea that in these specialised branches of organic chemistry, Great Britain is behind other countries, especially Germany. A visit to Wembley will, however, soon convince them in a very emphatic manner that this is not now the case. It is of interest in this connexion to recall that when the International Exhibition was held in London in 1862, it was confidently expected that our chemical manufacturers would maintain the lead in the production of pure and heavy chemicals which they held at that time; but this promise was not fulfilled. There had been improvements since the Exhibition of 1851, and the Catalogue of the next great Exhibition contained the following notable announcement:

"A collection of products illustrating the discovery of the coal-tar dyes formed by the first workman in this fertile field, Mr. W. H. Perkin, is also exhibited: in fact, the various dyes are particularly well represented. The coal-tar series is most fully represented, and numerous specimens of the lichen and madder dyes are also exhibited. Altogether, the specimens exhibited will tend to show that England has now become the dye-producing nation of Europe, instead of having to depend on Holland, France, and other countries for the supply of lichen and madder dyes wherewith to ornament the produce of her millions of silk, woollen, and cotton looms.

"The larger and coarser kinds of chemicals, such as alum, soda, copperas, the prussiates, etc., in the manufacture of which this country has always been pre-eminent, are here as a matter of course. Some splendid specimens of salts in a high state of purity are exhibited by many well-known firms; and the more delicate materials of absolute purity for laboratory use show that English manufacturers can compete most satisfactorily with those of the Continent in this respect."

Returning to the Exhibition at Wembley, the prominence of Great Britain in the manufacture of alkaloids and similar products is well indicated by the exhibits, for example, of Messrs. Whiffin and Sons, Ltd., Messrs. May and Baker, Ltd., Messrs. Howard and Sons, Ltd., Messrs. Boots, Ltd., and Messrs. The British Drug Houses, Ltd.

Messrs. Whiffin have specialised in the large scale manufacture of alkaloids for more than seventy years, and included in the wide range of their products are to be seen atropine, hyoscine, caffeine and its salts (introduced in 1888), emetine, nicotine (largely used in horticulture for killing "green fly" and other insects), salicin (introduced in 1870), now used also in the treatment of influenza as well as rheumatism, and strychnine, first manufactured by Whiffins in 1859. Also there is shown a wide range of their well-known quinine compounds, together with camphor, and iodides, including iodoform and potassium iodide.

Messrs. May and Baker, Ltd., have also a wide range of medicinal products, including seidlitz powders, the new drug novarsenobillon ("914"), bismuth salts, mercuric chloride, and other mercury salts, the highest grades of camphor, including "flowers" entirely free from oil and moisture, the well-known "Baker" anæsthetic ether, chloroform made from acetone, and alkaloids, particularly strychnine, arecoline, and yohimbine.

Messrs. Howard and Sons' stand is arranged in the attractive form of an apothecary's shop, and included in the long list of products are quinine and cinchona products, aspirin tablets, and new synthetic products for use as special solvents in research work, such as isopropyl alcohol and cyclohexanol.

Messrs. Duncan Flockhart and Co. show a complete range of anæsthetics, vaccines, and other medicinal preparations, including the original "white label" chloroform, prepared from ethyl alcohol, the purest form of anæsthetic ether, ethyl chloride, extractions from animal glands, such as adrenalin from the suprarenal gland, pituitary fluid, and thyroid gland tablets, together with a whole list of vaccines and tuberculins, prepared in the laboratories of the Royal College of Physicians in Edinburgh. Particularly interesting is peptone, used in the treatment of special cases of spasmodic asthma.

Messrs. Burgoyne, Burbridges and Co., Ltd., have also a complete range of medicinal products, especially chloral hydrate, of which they are the largest manufacturers in Great Britain, sodium salicylate, camphor mono-bromide, and citrates, with capsules, pills, compressed tablets, amphoules, and suppositories.

Messrs. The Burroughs Wellcome Company have a striking display of their many well-known "Tabloid" fine chemical and medicinal products, including particularly compact medicine chests, the "Wellcome" brand of insulin hydrochloride, and a display of living medicinal plants from their farm at Dartford.

Messrs. J. and E. Sturge, Ltd., display precipitated chalk and various similar products for dentifrices, as well as cream of tartar and other salts of tartaric and citric acids, and Messrs. Boots Pure Drug Co., Ltd., show all kinds of medicinal products, especially insulin of their own manufacture, the new drug stabilarsen (an improvement on salvarsan), saccharine, of which they are the largest manufacturers in Great Britain, together with alkaloids, especially atropine, whilst there is included a complete model of their large works and research departments in Nottingham.

Messrs. The British Drug Houses, Ltd., an amalgamation in 1908 of a number of very old-established and well-known London firms of manufacturing chemists, display an extensive selection of their specialities, including alkaloids, pure medicinal chemicals, laboratory chemicals, pharmaceutical products, and many proprietary and toilet specialities, especially "vanishing cream." Included in this list is medicinal glucose, insulin, a product on which "B.D.H." have specialised particularly, having solved the technical problem of its production in less than three months. It is refreshing to note also that through the activities of this firm our former dependence on Germany for fine laboratory chemicals, stains for the microscope, and similar products, no longer exists. Messrs. Hopkin and Williams, Ltd., prove this also by their fine display, which includes uranium compounds for the pottery and allied industries, cerium compounds, and thorium compounds for incandescent mantles.

Perfumes are also a prominent section. Messrs. J. and E. Atkinson, Ltd., display a range of their productions, especially their well-known "eau de Cologne," and Messrs. W. J. Bush and Co., Ltd., have an extensive exhibit, not only of perfumes and essences, but also fine chemicals for all kinds of industries. Prominent is the famous Mitcham lavender water, originally introduced in 1749 by the old firm of Potter and Moore, which now belongs to Messrs. Bush, as also does Messrs. Buisson Frères. Particularly impressive are the handsome caskets and beautiful cut-glass bottles in which all the perfumes are contained. In this connexion also the stand of Messrs. E. Rimmel, Ltd., is noteworthy.

The Scientific Section, although somewhat limited in space, is full of interest for both the ordinary man and the man of science. In the centre is a striking and ingenious scientific toy, the "fiery fountain," prepared by the Manchester College of Technology, in which a graceful cascade of water falls on to a glass flower, and by some means not apparent the water appears to catch fire, giving in broad daylight various vivid colours, whilst it also shows a brilliant iridescence as it overflows into a tank below.

To the chemist, the display of alkaloids by Dr. T. A. Henry and Prof. F. L. Pyman is particularly impressive, including hyoscine, used in "twilight sleep," and the very deadly aconite alkaloids prepared from plants in Japan, India, and Great Britain, which have long been used by various savage races for poisoned arrows. British chemists and technologists, certainly unknown to the general public, have, as already indicated, always occupied a very prominent place in the science of alkaloids, and the whole of the exhibit has been prepared in Great Britain. Further, as indicating the very valuable research work undertaken in this country, there is shown a selection of the tropane alkaloids, particularly hyoscine, the iso-quinoline group, including a very large group of alkaloids, such as narcotine, cotarnine, hydrastinine, berberin, and corydaline. Again we have the glyoxaline group, the jaborandi alkaloids, such as pilocarpine and isopilocarpine, together with many purely synthetic alkaloids. In this work, the names of prominent British chemists are Jowett, Pyman, Dobbie, Lauder, Perkin, Salway, Remfrey, Plant, Barger, Field, Carr, Paul, Stedman, and White.

Prof. A. G. Perkin shows specimens relating to his well-known work on the constitution of natural dye-stuffs, as well as original specimens of artificial dye-stuffs prepared by the late Sir William Perkin, including dyeings with the original aniline dye "mauve." Natural plant dye-stuffs are also shown by Dr. Everest, whilst Prof. Hewitt has a large number of the closely related styrylpyrylium salts. As regards the terpenes, Prof. W. H. Perkin illustrates the synthesis of limonene, the first natural terpene to be prepared in the laboratory, and of epicamphor, the well-known isomeride of ordinary camphor.

In view of the rapidly increasing importance of catalysis in modern chemistry, both from a theoretical and a practical point of view, the space devoted to this question seems very small. Included, however, are specimens of hardened oils, prepared by Messrs. J. Crosfield and Sons, Ltd., and a scale model plant for the catalytic oxidation of ammonia (Messrs. The United Alkali Co., Ltd.), together with various catalytic processes in connexion with alcohol, acetaldehyde and acetic acid.

Particularly interesting is the colloid section arranged under the supervision of Prof. J. W. McBain, showing, for example, colloidal carbon, clay, and soap solutions, rubber "sols," an exhibit of dopes for aircraft work, and the filtration of colloids by the stream line filter.

Very valuable also is the exhibit arranged by Sir Robert Robertson, showing the progress in the field of explosives during the periods 1900–1924 in the same order as described in "Chemistry in the XXth Century." Nitroglycerine and nitrocellulose were manufactured on a large scale on scientific lines by 1900, together also with blasting gelatine and cordite, the first smokeless powder in fact having been introduced in 1882. There are included models showing the displacement process for making nitroglycerine, introduced by Nathan, Thomson, and Rintoul, and also of a complete acetone recovery factory. Indeed, the research section dealing with explosives is one of the most striking of all, but it is impossible to mention the many lines of research indicated in connexion with the decomposition and stability of explosives, viscosimetry, and the process of nitration. It is stated that at one time during the War, Great Britain produced every week 2000 tons of cordite, 1500 tons of trinitrotoluene, 3000 tons of ammonium nitrate, 300 tons of picric acid, and 200,000 tons of nitric and sulphuric acids. Particularly interesting is the explosive amatol, a mixture of T.N.T. and ammonium nitrate, manufactured in vast quantities, up to 4000 tons a week, for land operations.

Of great interest are the models, to an exact scale of 100 million to 1, of the crystalline structures of elements and inorganic compounds, showing the individual atoms, as prepared by Prof. W. L. Bragg, based on the analysis of the structure by means of X-rays.

Prof. A. Smithells shows the four main constituents of coal—fusian, durain, clarain, and vitrain—with photographs of the micro-structure, and Sir Ernest Rutherford has a fine exhibit from the Cavendish Laboratory, Cambridge, in connexion with radioactivity and its bearing on atomic structure, showing, for example, the method of counting the α-particles and of measuring the wave-length of the γ-rays from radium-B.

Much chemical apparatus and many general exhibits are also shown, but it is only possible to mention one or two, such as Messrs. Brunner Mond's phase rule models, Dr. F. Mollwo Perkin's display of oils from the low temperature carbonisation of coal, torbanite, lignite, and other carbonaceous products, while Dr. J. Newton Friend deals with the intricate subject of the rusting and corrosion of metals. There is also a particularly interesting collection, from the Royal Institution, of apparatus used by the late Sir James Dewar.

Finally the photographic section will be found to be of the greatest interest and assistance to devotees of this art.

Progress in Biology.[1]

By W. BATESON, F.R.S.

WE have reached contemporary developments. The study of variation, and indeed of several branches of what we now call genetics, especially cross-breeding, had been pursued with vigour in the 'sixties and 'seventies, but had totally lapsed. Renewal of those inquiries led at once to an advance. We saw that the received ideas as to the magnitude of variations, and especially as to the interrelations of the domesticated breeds, were largely erroneous. As in regard to the incidence of sterility in interspecific crosses, so in regard to variation, we found ourselves among an intricate mass of empirical observations, obeying none of the principles which the orthodoxy of the time presupposed. The incidence of variation was utterly capricious, and was determined neither by utility, nor the antiquity of the feature, nor by the conditions of life, nor by any other ascertainable circumstance.

Most of the genetical work of the early time had been perfunctory and unsystematic. Godron, Naudin, Verlot, Carrière, Morren, and many more, had all seen interesting things, but they had not looked close enough. A single man, Mendel, had worked in a different fashion. Again, by one small bit of clean experimenting, a fact of a new class had been discovered. The evidence of this new witness showed us whole ranges of phenomena in their right perspective and proportions. We had at once a rationale which disposes of such outstanding mysteries as reversion and the determination of sex. Only those who remember the utter darkness before the Mendelian dawn can appreciate what has happened. Stories which then seemed mere fantasies, are now common sense. When I was collecting examples of variation in 1890, I remember well reading the fanciers' tales about dun tumbler pigeons being almost always hens, and about the "curious effects of crossing" with cinnamon canaries, but I would never have dared to repeat them, any more than Darwin ventured to quote Girou de Buzareingues (1828) to the effect that in cattle the milking-character was mainly transmitted by the bull—a proposition with which the researches of Pearl and others have now made us familiar.

Though Mendelian analysis has done all this, and very much more of which I will presently speak, it has not given us the origin of species. It has finally closed off a wrong road. I notice that certain writers who conceive themselves to be doing a service to Darwinism, take thereupon occasion to say that they expected as much, and that from the first they had disliked the whole thing. I would remind them that the class of evidence to which we were appealing was precisely that to which Darwin and every other previous evolutionist had appealed. Mendelian analysis led to the discovery of the transferable characters, not merely in sporadic instances but as a group, and the study of their behaviour enabled us to avoid endless misinterpretations into which our predecessors had consistently fallen. If we now have to recognise that the transferable characters do not culminate in specific distinctions, the acknowledgment will not come from us alone. The old belief of systematists that real species differ from each other in some way not attainable by summation of varietal characters is no longer contestable, and we know now upon what to concentrate. It is no occasion for dismay. We have not to go back very far. We do not understand specific differences, nor can we account for the adaptative mechanisms. Was it to be expected that we should? Biology is scarcely a century old, and its intensive study is of yesterday. There is plenty of time ahead.

The identification of the transferable characters and their linkages has led to a further discovery of the greatest—I might almost say, of romantic—brilliancy, which must have consequences as yet inestimable. Morgan and his colleagues have, as is well known, proved that some, probably all, of this group of characters are determined by elements transmitted in or attached to the chromosomes. It may be, as Bridges has indicated in regard to sex, that the visible distinctions are produced not so much by the presence or absence of a bit of special chromosome material, as of an interaction between the several chromosomes as a whole, and much depends on that issue; but however that may be, henceforth the study of evolution is in the hands of the cytologists acting in conjunction with the experimental breeder. As to what the rest of the cell is doing, apart from the chromosomes, we know little. We think that in plants the presence or absence of chloroplasts may be a matter of extra-nuclear transmission. Perhaps the true specific characters belong to the cytoplasm, but these are only idle speculations.

While all this has been going on we learn of advances developing from a totally different quarter—palæontology. Those whose work has lain in other fields can form only a dim and tentative understanding of these new lines of discovery. We look eagerly to the palæontologists for a full exposition. We have heard that they, especially the group of investigators connected with the American Museum, have collected wonderful series, in numbers hitherto never attainable, ranging through many geological epochs, demonstrating a continuity of succession between very dissimilar forms of life. For an introduction to this subject I am greatly indebted to Prof. D. M. S. Watson. In

[1] Continued from p. 646.