

three sides by the flame and thereby spontaneously ignited by its radiation", giving rise to the effects observed which accompany the spin.

The view that activated combustion must be associated with the compression wave in order to maintain detonation is supported by experiments in which a small  $\frac{1}{4}$  in. nitrogen gap (obtained by means of the special tap) in the column of explosive gas causes the detonation and spin to be destroyed and only reinitiated when the flame front again catches up the compression wave. It is interesting to learn that, contrary to Dixon's results, the velocity and stability of the detonation wave is enhanced rather than diminished by intensively drying the carbon monoxide mixtures. Addition of hydrogen appears to give rise to a multiplicity of spinning heads, and more than 2 per cent of hydrogen tends to prevent the spin, though detonation is maintained.

The remainder of the present memoir relates to experiments on the effect of magnetic and electric fields on the propagation of detonation. Very strong magnetic fields were obtained by magnets of special design. A transverse field of 35,000 gauss had no appreciable effect on the detonation owing to the short time (0.005 sec.) the flame is within the field, but longitudinal fields of 22,000 gauss over a length of 58 cm., or of 35,000 gauss over 8 cm., caused an appreciable slowing down of the rate of travel of the detonation by about 50 m./sec. The effects of the magnetic field were not large. Strong electric fields (up to 5,000 volts per cm.),

on the other hand, had a very marked effect, particularly when the flame travelled in the direction negative to positive potential; for example, when the detonation passed the negative electrode, both spin and detonation were suppressed, the flame speed decreasing to about 1,000 m./sec. by the time the positive electrode was reached and continuing to fall as it proceeded into the no-field region (see Fig. 3). For passage in the direction positive to negative there was a slight acceleration of the flame.

It is supposed that the positive  $\text{CO}^+$  ions are important for the maintenance of activation in the detonation head, and that if these are drawn out of the flame front, the activation is not maintained and so the spin and eventually the detonation are destroyed by separating the region of activation from that of the region of high compression. This is borne out by the fact that in dry carbon monoxide mixtures or when hydrogen (0.3 per cent) is present, the 'damping' influence of the field on the detonation is counteracted. In methane mixtures, too, the spin and velocity were not influenced by the field.

There can be no doubt that these experiments form a highly interesting addition to information about the behaviour of the detonating type of explosive in gaseous mixtures. A. C. E.

<sup>1</sup> *J. Chem. Soc.*, 3010; 1926.

<sup>2</sup> *Phil. Trans.*, A, 230, 363; 1932.

<sup>3</sup> Bone, Fraser and Wheeler, *Phil. Trans.*, A, 235, 29; 1935.

<sup>4</sup> Le Chatelier, *C.R.*, 130, 1756; 1900. Egerton and Gates, *Proc. Roy. Soc.*, A, 114, 137; 1927. Bone and Fraser, loc. cit.

## A Century of Botany\*

1835—1885—1935

By Prof. F. O. Bower, F.R.S.

UP to 1885, the whole field of botany was supposed to be covered by the professor himself. The elementary teaching might embrace the spirit of all its branches: but the science as a whole was then like a bomb with its pin drawn out, ready to burst into divergent lines for which neither personnel nor accommodation were prepared. Stimulating the time surely was, but exacting to the point of impossibility. The best course for the new professor in Glasgow was then to select some branch as his own special study, and by preference one cognate with local history. Personal experience gained elsewhere pointed to the mosses and ferns, a line of specialisation which

would renew continuity with the Hookerian tradition. Moreover, the overcast skies of Glasgow gave conditions suitable for their culture. So after an interval of half a century, the special line of research followed there by Sir William Hooker was resumed.

With the new ordinances framed under the Act of 1889 came changes of organisation, which had the effect of levelling up the Scottish university system to that of England. The establishment of degrees in science stimulated higher courses in all the departments, and this led, of necessity, to their expansion both in staff and in equipment. Under the new ordinances, the differentiation of elementary and advanced classes involved an

\* Continued from p. 941.

increased staff. The appointment of additional lecturers and assistants stimulated research, for which space was now available.

A group of botanical investigators was thus formed, who not only pursued the special study of the living Archegoniatae, but also extended their comparisons to the cognate fossils. The co-operation of Lang and Gwynne-Vaughan with myself established that 'triumvirate', who worked happily and fruitfully together for twelve years. In close relation with us that remarkable palaeo-phytologist, the late Dr. Robert Kidston, a prince of amateurs, was also associated. With his aid new problems of comparison between past and present vegetation were opened. As results it may suffice to quote the series of memoirs by Kidston and Gwynne-Vaughan on the fossil Osmundaceae, and those by Kidston and Lang on the fossils of the Rhynie Chert, carried out after Dr. Lang had moved to Manchester. These show the value of the co-operation between Dr. Kidston's house at Stirling and the Glasgow Department. Happily, under his will all the type specimens of these classic works, together with others of untold value, are now in safe keeping in the Department. Thus Glasgow became once more a centre for study of the Archegoniatae. A ready channel of publication was offered by the Royal Society of Edinburgh. Its resources, with financial aid from the Carnegie Trust, have made a stream of published work available from the Glasgow Department which, in scientific value and beauty of production, will bear comparison with any produced elsewhere.

Passing now to the present time, we may ask how botanical organisation in 1935 strikes one who can compare it by personal contact with that of the previous century. As we have seen, up to 1885 each aspirant to a chair in botany was assumed to possess a general knowledge of and sympathy with all branches of his subject. These were themselves less differentiated than now, and some scarcely distinguishable unless as parts of a compact whole. Segregation followed quickly on the revival of the 'seventies and 'eighties. I well remember Sir Joseph Hooker saying ruefully to me in the early 'eighties, "You young men do not know your plants". That was at the time when systematic botany was beginning to lose its hold as the main staple in Britain. His judgment was true: we did not know them in the Hookerian sense.

A counterpart to Hooker's plaint may be found in the ironic hyperbole of a distinguished physiologist, who is reported to have said at a later date, "I suppose I do know half a dozen species of the British flora". These illustrations suggest the inevitable effect of that fission of a science which is apt to follow upon its detailed study. Hence as

the years went on the position of the head of a botanical department, so often single-handed, became increasingly difficult. If he attempted to keep abreast of all branches he would become, like a medieval knight, overweighted by his armour of facts and theories, and ever less able to keep his place in the front line of research. Extinction as an effective unit would loom large.

From 1885 onwards there has been an increasing desire among young investigators to publish their results early. This offers promotion as its reward: for a published output of detailed research commonly weighs more with a selection committee than general knowledge, or the ability to administer and to teach. A premium is thus placed upon early specialisation, and the young aspirant is in danger of developing "like an ill-roasted egg, all on one side". Some great departments already have special sub-departments of pomology, of citrus fruits, or of bananas, to which specialists severally devote their lives. Among these various cults we may well ask, where do the major departments of morphology, physiology and classification come in? Doubtless each of the minor branches is in touch more or less directly with one or more of these foundations of the organised whole. But each may be pursued without any realisation of what that whole actually is.

A necessary corrective will be an avoidance of too early specialisation, and the cultivation of the type of mind that strikes a fair balance between the fundamental branches. This is indispensable above all for the administrative head, who is responsible for maintaining a balance between the various branches in the organisation of his department. There is no difficulty in finding among young graduates those able to carry out special inquiries of detail. What will be required more and more urgently as time goes on is the synthetic mind, that ranges over a wide field with adequate command of detail, and is able to compare, evaluate and deduce. This is essential for the all-round botanist, that less common type from which comes the successful head of a department. Risks of development await both types. The former may continue his analysis and never advance beyond providing recorded details for others to use. He may, however, develop powers of synthesis as he proceeds, and through successive steps of increasing constructive power attain some more responsible position. The risks of the naturally synthetic mind are different. If the young investigator is dexterous in presentment of his results, he may soon find himself advanced to a position of command. Then comes for him a testing time, when a decision must be taken whether administration or research shall dominate. The nature of his office will probably give

opportunity for both, and the precedence of one or other will be largely a matter of his own choice. At first the question rarely presents itself in an acute form. The cumulative effect of years often decides whether their victim shall quite unconsciously become part of an organising machine: or whether he shall continue to be a direct influence in creative science. Happy is the man who can do both.

It is not difficult to cite examples that illustrate these divergent results. In the lives of some of our greatest men the strangle-hold of administration has tended to choke the active spirit of personal observation. Among those who have passed away we may contrast the lives of Huxley and his friend Darwin. I well remember at South Kensington the glass jars holding material of the pearly nautilus which awaited the dissection that never found its place among Huxley's crowded hours of departmental committees and meetings of the Royal Society Council. On the other hand, Darwin, cloistered at Down, was free at a like age to continue his work on orchids and earthworms. Michael Foster and Thiselton-Dyer, who shared with Huxley the burden of the reorganisation of practical biology in the 'seventies, left little behind them as their published record beyond textbooks and official documents. Administration atrophied personal research in both of them. Even Bayley Balfour, who had shown his mettle as an investigator before he was thirty years old, spent his best period in ministering to the scientific wants of others: and only returned in his last years to the detailed systematic work in which he was a master. It is not for us to judge in such instances whether or not the results of administration have justified the sacrifice of personal opportunity for creative work. We are all debtors to these great men. But they are here cited as examples of a prevalent danger that grows more insistent as years advance. Administrative activity and continued personal research are conflicting factors in the individual life. The former has often become dominant even where the instinct of inquiry is strong.

Returning, in conclusion, to the intra-departmental aspect of this question, the most vital relation is between the professor and his students. How will his decision as to the balance between administration and research affect them? It may be urged, in support of giving priority to the former, that the smooth working of a well-organised department amply justifies the time and thought that it demands. The larger the department, the more pressing the demand will be: the students feel the result of good organisation, though few of them would analyse it back to the source. On the other hand, the effect of a prevailing atmosphere

of research in a department is tonic and stimulating. It was the very essence of the Huxleyan revival that it converted every student into a potential investigator. The stimulus should emanate from the head of the department, passing either direct from him, or through lecturers and demonstrators to the individual student. But the method loses its point if the professor himself is in practice a mere administrator. Such chains of influence are felt rather than visualised; often the stimulus is almost unconsciously conveyed. An allusion in a lecture to experiences in the field, or an observation on material collected abroad, gathers up the attention of a class and makes it think more effectively than floods of fact at second hand.

A still more direct influence follows if a student penetrates with a question to the private room, and the professor rises from his microscope to reply; perhaps he may even allude to some observation that is interesting him at the moment. The student at once feels that he is in touch with the margins of knowledge. The opportunity for such touches is lost if the private room is a mere 'office'. I have found it sometimes known by that paralysing name. The undifferentiated private room, part laboratory part administrative centre, has qualities worth retaining not only for economy of space and time, but also in affording occasional completion of contact between the potential researcher and the professor actually at work.

Thus dangers lurk within the growing elaboration of a scientific department. Not the least of these will be to secure a due balance between administration and research in the person of its official head. Again I say, happy is the man who can hold the balance until strength itself fails. Among the distinguished graduates of Glasgow we possess two notable examples. Sir Joseph Hooker's youth was spent in acquiring experience and material; his middle age in working it up, in the intervals of administration as director of the Royal Gardens at Kew; in his old age he brought to completion systematic works of the greatest magnitude and value; but in the very last years of his long life we saw him still engaged in describing species new to science. On the other hand, Lord Kelvin continued the administration of his Department of Natural Philosophy for more than half a century; concurrently he carried on his own researches, and applied their results practically to the requirements of modern life. Until the day of his death he remained Chancellor of the University of Glasgow, and held the honourable title of a Research Student under Ordinance. Neither of these great men ever relaxed his hold upon personal observation. There is no stronger link than this between a professor and the real student.