what extent reactions of the type under discussion have now permeated many fields of organic chemistry. The obvious importance of these developments, both from the theoretical and practical points of view, indicates that the time is approaching when it will become necessary to reconsider the manner in which the subject of organic chemistry is presented to the student. In the past the teaching of organic chemistry has been founded to a very large extent on the almost universal and invariable tetravalency of carbon. The newer approach must embrace not only the reactions of the tetravalent carbon molecule but also those of the trivalent carbon radical. It is also pertinent to recall that in the past the raw materials for the organic chemical industry have been derived almost exclusively from coal, but at the present time raw materials are also provided in ever-increasing quantity from the by-products of the petroleum industry. These raw materials, primarily hydrocarbons of various types, are frequently compounds normally regarded as inert, but which are by no means so inert towards reagents which give rise to free radicals or atoms. It is therefore to reactions of this type that we must look in order to develop fully the new resources now placed at our disposal. For these reasons I have chosen to include such reactions, not, it is hoped, entirely without justification, under the title of "The New Organic Chemistry".

- ¹ Gomberg and Bachmann, *J. Amer. Chem. Soc.*, **46**, 2339 (1924).
- ² Grieve and Hey, *J. Chem. Soc.*, 1797 (1934).
- ³ Hey and Waters, *Chem. Reviews*, **21**, 169 (1937). Hey, *Annual Reports of the Chemical Society*, **37**, 250 (1940).
- ⁴ Hey, *J. Chem. Soc.*, 1966 (1934).
- ⁵ "Organic Reactions", **2**, Ch. 6 (John Wiley and Sons, Inc., New York, 1944).
- ⁶ Swain and Todd, *J. Chem. Soc.*, 674 (1941).
- ⁷ Ghosh, Pascall and Todd, *J. Chem. Soc.*, 1118 (1940).
- ⁸ Coates, Cook, Heilbron, Hey, Lambert and Lewis, *J. Chem. Soc.*, 401 (1943).
- ⁹ Bradbrook, Haworth, Heilbron, Hey and I.C.I., Ltd., U.S.P. 2277629; Haddock and I.C.I., Ltd., B.P.530881.
- ¹⁰ Brown, Kharasch and Chao, *J. Amer. Chem. Soc.*, **62**, 3435 (1940).
- ¹¹ Kharasch and Brown, *J. Amer. Chem. Soc.*, **62**, 925 (1940).
- ¹² Kharasch and Brown, *J. Amer. Chem. Soc.*, **64**, 329 (1942).
- ¹³ Ziegler *et al.*, *Annalen*, **551**, 80 (1942).
- ¹⁴ Kharasch and Kleiman, *J. Amer. Chem. Soc.*, **65**, 491 (1943).
- ¹⁵ Price and Tate, *J. Amer. Chem. Soc.*, **65**, 517 (1943).
- ¹⁶ Price and Durham, *J. Amer. Chem. Soc.*, **65**, 757 (1943).
- ¹⁷ Price, *J. Amer. Chem. Soc.*, **65**, 2380 (1943).
- ¹⁸ Breitenbach and Maschin, *Z. phys. Chem.*, **A**, **187**, 175 (1940).
- ¹⁹ Schulz and Wittig, *Naturwiss.*, **27**, 387 (1939).
- ²⁰ Schulz, *Naturwiss.*, **27**, 659 (1939).
- ²¹ Price and Durham, *J. Amer. Chem. Soc.*, **64**, 2508 (1942).
- ²² Blomquist, Johnson and Sykes, *J. Amer. Chem. Soc.*, **65**, 2446 (1943).

AN EXPERIMENTAL TREATMENT OF THE APICAL MERISTEM IN FERNS

By PROF. C. W. WARDLAW
University of Manchester

IN *Dryopteris aristata* an attempt has been made to observe the effect of isolating the apical meristem from the adjacent lateral tissues, while maintaining continuity with the pith parenchyma below. The first step was to ascertain the practicability of the operation. The procedure involves an operation roughly comparable with 'ringing' in an older region of the shoot, in that the incipient vascular tissue is severed. The difficulty lies in the fact that the treatment has to be applied to a minute region—the

Fig. 1. DOWNWARD VIEW OF A SMALL APEX OF *Dryopteris aristata* SHOWING THE APICAL MERISTEM (STIPPLED) AND A SUCCESSION OF YOUNG LEAF PRIMORDIA (l_1, l_2 , ETC.). THE SYSTEM OF VERTICAL INCISIONS BY WHICH THE APICAL MERISTEM IS ISOLATED FROM ADJACENT LATERAL TISSUES IS INDICATED. ($\times 54$.)

meristem—the tissue of which is soft, delicate and readily injured. Thereafter it remained to be seen whether a meristem so treated would prove capable of further growth. The successful outcome of such an experiment seemed likely to throw light on (1) morphogenetic processes at the shoot apex; (2) translocation of nutrients to the shoot apex; that is, whether this takes place by way of the undifferentiated vascular tissue or by upward diffusion over the whole cross-sectional area of the shoot; (3) the factors influencing the differentiation of the vascular system; that is, whether the effective stimuli proceed basipetally from the apex or acropetally from the older pre-formed parts; and (4) the physiological dominance normally exercised by the shoot apex over lateral buds or bud-primordia.

For these experiments the common broad-shield fern *Dryopteris aristata* was selected, plants of all sizes being obtainable in abundance. Previous experience has indicated that this species possesses very considerable vitality under experimental treatment.

An apex of *D. aristata*, as seen in longitudinal median section, may, for convenience, be considered to include three regions in basipetal sequence: (1) the apical meristem which consists of a single

Fig. 2. LONGITUDINAL MEDIAN SECTION OF A LARGE APEX OF *D. aristata* SHOWING THE ISOLATION OF THE APICAL MERISTEM BY VERTICAL INCISIONS. ($\times 6$.)

Fig. 3. LONGITUDINAL MEDIAN SECTION OF A SMALL APEX OF *D. aristata* SHOWING THE DETAILS OF AN ISOLATED MERISTEM. *m*—*m'*, APICAL MERISTEM, WITH LARGE APICAL CELL, *a*; *sc*, SCALE; *l.a.*, LEAF APEX; *v.t.*, VASCULAR TISSUE IN INITIAL PHASE OF DIFFERENTIATION; *p*, PITH. THE VERTICAL INCISIONS ARE SHOWN; THE ISOLATED MERISTEM IS CONTINUOUS WITH A THIN SHEET OF INCIPENT VASCULAR TISSUE AND MEDULLARY PARENCHYMA. ($\times 100$.)

layer of superficial cells, including the apical cell, of distinctive appearance and chemical reaction; (2) the region of initial differentiation, in which leaf primordia, buds and scales originate superficially from cells within or on the margin of the apical meristem and in which stele, cortex and pith can first be distinguished internally; and (3) the region of subsequent differentiation which merges downwards with the fully matured tissue systems. It should be noted that the incipient vascular tissue can be traced upwards to the region of its inception immediately below the apical meristem. Since the principal initial developments take place in region (2), it is there that experimental treatments must be applied.

The first step is to have unimpeded access to the apical meristem. At first sight this does not appear to be a very feasible undertaking. Indeed, because of the large number of rolled leaves and leaf primordia in the terminal bud and the dense investment of scales, the apices of ferns have not generally commended themselves as providing favourable materials for experimental investigations. Nevertheless, it is a fact of experience that there is little difficulty in removing the scales and leaf primordia from stout shoots of *D. aristata* or *D. filix-mas* and thereby laying bare the apical cone. These operations are carried out by means of small pointed scalpels and

Fig. 4. SOLENOSTELE PRESENT IN THE SHORT AXIS DEVELOPED FROM AN ISOLATED APICAL MERISTEM. ($\times 20$.) (Photos 4-7 by E. Ashby.)

forceps, the material being observed under a binocular microscope. A downward view of a small shoot apex is illustrated diagrammatically in Fig. 1.

To isolate the apical meristem from the adjacent lateral tissues, and to sever the incipient vascular tissue, the following procedure was adopted. The terminal region of a stout shoot, trimmed to a length of about 2-3 cm. and defoliated as already described, was observed under a binocular microscope at a magnification of fifty times. By means of a small, thin-bladed scalpel four vertical cuts were made in such a way as to isolate the apical meristem, on a little square island of tissue, as indicated in Fig. 1. In longitudinal section it will be seen that the isolated apical meristem, together with a thin layer of incipient vascular tissue, is seated distally on a plug of developing medullary parenchyma (Figs. 2 and 3).

The system of incisions described above is obviously only one of many that may be applied. For example, the vertical cuts may be made on the margin of the apical meristem, within the margin, or outside it, so as to include one or more leaf primordia, and so on.

Fig. 5. DICTYOSTELE PRESENT IN THE TERMINAL FOLIAR REGION OF AN AXIS DEVELOPED FROM AN ISOLATED APICAL MERISTEM. ($\times 11$.)

Again, leaf primordia of different ages may be isolated on separate plugs. I have found that isolating by four vertical cuts is simple and least damaging to the apical meristem, but other patterns, for example, by three cuts, are also possible. Radial cuts diverging from the margin of the apical meristem have also been made with interesting results. The procedure can be further varied by cutting more or less deeply into the tissue. In passing, it may be noted that the small size of the meristem precludes the use of a cork borer. The experimental and control plants were planted in moist peat in a cool greenhouse.

The isolated meristem is capable of growth. It develops into a short axis and in the course of four weeks may develop three or four new leaf primordia. In the course of three months, one specimen had developed a compact terminal bud in which fourteen leaf primordia were counted. In relation to the severance of the vascular tissue, the lower region of the axis consists entirely of medullary parenchyma. Higher up, a solenostele is present (Fig. 4). Still higher up, in the region of leaf development, the vascular system becomes dictyostelic (Fig. 5). The new leaves in the materials so far examined show normal

OBITUARIES

Dr. Stanley W. Kemp, F.R.S.

Fig. 6. TRANSVERSE SECTION OF A LATERAL SEGMENT OF AN INCISED SHOOT, SHOWING THE LARGE SOLENOSTELE OF A BUD CONJOINED WITH A MERISTELE OF THE PARENT SHOOT. ($\times 22$.)

phyllotaxis and this is apparently in continuity with that of the parent shoot. Whereas lateral buds develop rapidly on the surrounding segments of the parent shoot, the new terminal axis is devoid of buds.

The lateral segments of the shoot are characterized by the development of very large axillary solenostelic buds (Fig. 6); they are thus in marked contrast to buds on the normal shoot, in which a small, non-medullated protostele is present. Individual undifferentiated meristeles, isolated in lateral plugs as a result of the system of incisions adopted, also show some remarkable and hitherto undescribed developments, such, for example, as the development of solenostelic structure (Fig. 7).

Individual leaf primordia, isolated on plugs, undergo limited development only, and show a tendency to be thrust aside by more strongly growing axillary buds. In contrast to the normal development, in which the foliar conducting system consists of six to eight separate vascular strands disposed horseshoe fashion, the vascular system of an isolated leaf primordium is solenostelic.

Fig. 7. TRANSVERSE SECTION OF A LATERAL SEGMENT OF AN INCISED SHOOT SHOWING THE SOLENOSTELE OF A BUD (TOP) CONJOINED WITH A MERISTELE WHICH HAS BECOME MEDULLATED (CENTRE); THE COMPACT MASS OF TRACHEIDES (BOTTOM) PERTAINS TO A SECOND MERISTELE OF THE PARENT SHOOT. ($\times 30$.)

Thus, by using the technique described, many new and interesting observations have been made. These will be fully described and discussed elsewhere in due course. The answers to some of the questions raised in the opening paragraph are evident from the data submitted.

MARINE biology has suffered a heavy blow through the death on May 16 of Dr. Stanley Wells Kemp, and the loss of a wise and generous friend will be deeply felt by all who were associated with him. He rendered distinguished services to the Irish fisheries, the Zoological Survey of India, the Discovery Committee and the Marine Biological Association, and did much to stimulate marine research in Great Britain and overseas.

Kemp was born on June 14, 1882, the son of Stephen Kemp, and was educated at St. Paul's School and at Trinity College, Dublin. In 1903 he was appointed assistant naturalist in the Fisheries Branch of the Department of Agriculture and Technical Instruction of Ireland. In this post he gained a thorough practical knowledge of marine zoology, especially of the Caridea. He acquired valuable experience in deep-water investigations, and published several papers in the "Scientific Investigations" of the Department. This was followed by a period of fourteen years in India (1910-24), where he was first appointed senior assistant superintendent of the Zoological and Anthropological Section of the Indian Museum (which later became the Zoological Survey of India). Here he specialized in the study of Crustacea and began his "Notes on Decapoda in the Indian Museum", a valuable series of publications which continued until 1925. In 1916 he became first superintendent, under Dr. Annandale, of the Zoological Survey, and it is generally recognized that he and Annandale established an exceptionally high standard of zoological research in India. He accompanied various expeditions to study the fauna in different parts of India, including the expedition to the Abor country in 1911-12 (where he discovered the new genus *Typhloperipatus williamsoni*); and in 1922 he carried out the exploration of the Siju Caves in the Garo Hills. In 1916 he was elected a fellow of the Asiatic Society of Bengal, and in 1918 he brought out the important "Catalogue of Scientific Serial Publications in the Principal Libraries of Calcutta". While on leave in the following year, he took the degree of Sc.D. of Trinity College, Dublin, and visited the principal zoological centres in Europe with the view of establishing a marine biological station in the Andaman Islands.

Kemp was appointed director of research to the Discovery Committee in 1924, and it was under his far-sighted leadership that a well-equipped and many-sided organization was built up. The investigations were to include research on the general biology of whales (for purposes of the rational regulation of the whaling industry) and on other natural resources of the Falkland Islands Dependencies, and they involved an oceanographical survey of Antarctic waters, with attention to many subsidiary matters such as surveying and general collecting. This was an enterprise of a new kind which could be guided only to a limited extent by previous experience; but Kemp's remarkable capacity for organization in detail and his mastery of technical problems overcame all difficulties. Early in 1925 the Marine Biological Station was established at South Georgia, mainly for direct observations on whales. In the same year the *Discovery* (Scott's old ship, refitted for oceanographical research) sailed from England and shortly afterwards there followed the *William*