

like disturbance in the ionosphere such as that suggested by D. F. Martyn⁸.

The meeting provided an excellent opportunity for the bringing together of workers in different branches of this subject, and the Royal Astronomical Society is to be congratulated on choosing such a live subject for discussion. The two most important points which emerged from the discussion were: first, because the wind may change in an important way with height, it is essential to measure the height accurately; and secondly, horizontal movements of irregularities of electron density do not necessarily imply bodily movements of the air.

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PLANT CHROMOSOME-RACES AND THEIR ECOLOGY IN GREAT BRITAIN

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SINCE the "Merton Catalogue"¹ appeared, botanists have had in their hands a list of the chromosome numbers of British flowering plants. It provides a starting point for studying the relations between cytology and various aspects of the flora, such as taxonomic problems, geographical distribution and ecology.

Species may occur with more than one chromosome number, having either a few chromosomes more or less than the normal (aneuploid series), or the numbers are in multiples of each other (polyploid series). Now Darlington² has pointed out that sometimes polyploids occurring within the species are indistinguishable from one another except on the basis of distribution, while others may show size differences of a general character. Therefore, if one considers those species in the British flora containing a polyploid series which taxonomists have not assessed as separate species on morphological grounds, such chromosome-races, as they can be termed, may yield information on the effect of chromosome doubling in relation to plant ecology.

Chromosome-races can consist of autopolyploids which may have originated from relatively homozygous diploids or from hybrids between varieties or subspecies of a diploid species³. Valentine⁴ has discussed the classification and nomenclature of different kinds of polyploid series. Sometimes, as in *Valeriana*, individual chromosome-races within the species recognized cytologically can also be identified by pollen size and stomatal index, which increase with rise in chromosome number. Some of the higher chromosomal types within the species have later flowering. Recently, cytologists have taken precautions to record the habitats of the plant material which they examine, whereas earlier records gave no indication of these.

Some examples can be given which show that there is a relation between chromosome-races and

the ecology of the species. For example, Hancock⁵ found that the three chromosome-races of marsh bedstraw (*Galium palustre*) occupied different habitats. Diploids ($2n = 24$) in Oxford occurred in damp places which dried out in summer. Tetraploids ($2n = 48$) in Devon occupied intermediate habitats, often being submerged in winter and in soil remaining damp in summer. The octoploids ($2n = 96$) in Oxford lived in permanently damp zones and reproduced vegetatively by creeping shoots and roots at the nodes.

In Europe the common whitlow-grass (*Erophila verna*) was found by Winge⁶ to consist of several chromosomal types, with a relation between chromosome number and external form. He divided the collective species into four eco-species, two of which occurred in Britain. These are *E. duplex* ($2n = 30$ to 40), which prefers pastures, gravel-pits and roadsides and is so far recorded only in England, and *E. quadruplex* ($2n = 52$ to 64), which Winge found only in Scotland, growing in low-lying grassland and bogs. It is a much larger plant and perhaps better fitted in competition for light with other species in denser plant associations. In general in *Erophila*, higher chromosome numbers go with larger plants; but the higher chromosome types are handicapped by later flowering and inferior seed setting. No doubt further sampling of the *Erophila* complex in Britain will reveal information as to whether (as seems possible) chromosome number in this species gradually increases northwards.

Lövkvist⁷ in southern Sweden found that there is both a polyploid and an aneuploid series within the species of lady's smock (*Cardamine pratensis*), as in *Erophila*. Plants with different chromosome numbers occur together in meadows, but there is a regional distribution. Plants with lowest numbers ($2n = 30$) occur in the higher drier parts, while lower parts contain the intermediate races ($2n = 56$ to 68). The highest chromosome-races ($2n = 72$ and 76) are near or in water. This suggests that here there is a direct relation between chromosome number and water content of soil among members of the same species in local competition. A plant from the light soil of the former John Innes site at Merton was $2n = 32$ ⁸, while plants from three rather wet situations near Cambridge⁹ were $2n = 56$, indicating that a similar situation probably holds true in Great Britain.

There are two British chromosome-races of parsley piert (*Aphanes arvensis*) according to Walters¹⁰. The diploid (*A. arvensis* s. str. $2n = 16$) is a sexual form indifferent to soil acidity and occurring in forty-three vice-counties¹¹, while the hexaploid, now known as *A. microcarpa* ($2n = 48$), is apomictic and restricted to acid soils; it occurs in thirty-seven vice-counties. Lesser celandine (*Ranunculus ficaria*) occurs in all vice-counties and comprises four chromosome-races, including a sexual diploid ($2n = 16$) producing viable seeds and lacking tubers in the axils of stem leaves, and a tetraploid (var. *bulbifera* $2n = 32$) with these tubers. It rarely has good seed, and reproduces entirely vegetatively by root tubers. According to Turrill¹² these two races probably have an unequal range in Britain: both occur in the counties of Middlesex, Surrey and Buckinghamshire; but only the diploids have been found in parts of Devon and Somerset. Further records of such chromosome-races would be welcome.

Darlington and Mather¹³ have re-emphasized that simple chromosome doubling produces both a genetic change and simultaneously establishes a discon-

tinuity by creating a new form which will not cross with the old. They point out that a single colonizing polyploid individual can produce variation impossible to a solitary diploid, and so when there are sudden opportunities for colonization to occur, as after an ice-age, the new polyploid can step in and quickly acquire a large range from which its diploid parent is excluded. Evidence for this is provided by the two chromosome-races of valerian (*Valeriana officinalis*) studied by Skalinska¹⁴. The tetraploids ($2n = 28$) are limited to southern England south of a line from the Bristol Channel to the Wash, and roughly corresponding to the 62° F. July isotherm, while the octoploids ($2n = 56$) extend as far north as West Inverness. Within their common area, for example, Gloucestershire, the two chromosome-races are ecologically separated, tetraploids being confined to dry, limy or chalky habitats in hilly regions, while octoploids grow at lower altitudes in moist soil, along river sides and on ditch banks. Yet farther north, where octoploids alone occur and have spread after the ice retreated, there are variants which grow in both dry and wet places. In this instance an *old* tetraploid has behaved as a relative diploid.

There are three British chromosome-races of watercress (*Nasturtium officinale*), the species occurring in all vice-counties¹¹. Manton¹⁵ has separated them on morphological as well as cytological grounds. The diploid (*N. officinale* s. str., $2n = 32$) is an annual with bright green leaves while the tetraploid is the perennial winter watercress (*N. microphyllum*, $2n = 64$), recognized by its purplish-brown leaves in cold weather. Recent but still incomplete records of their distribution¹⁶ suggest that the diploid tends to occur more in the western part of Britain while the tetraploid occurs more to the east; both species overlap in midland counties. Perhaps the diploid occurs in areas with higher mean annual rainfall than the tetraploids. On the other hand, the same records for the sterile triploid show an irregular but wider range of distribution from east to west; it may be absent where both parents occur and be present where both are absent. Field studies in Oxford have, however, failed to show ecological preferences between diploids and tetraploids¹².

Many other chromosome-races require investigation. For example, in Britain there are two closely related *Arum* species: *A. neglectum* ($2n = 63$) is a nonaploid confined to the south coast of England, while the common cuckoo-pint (*A. maculatum*, $2n = 56$ and 84) occurs throughout Britain with a sharp delimitation at latitude 56° N. Salisbury¹⁷ has pointed out that probably the different species distribution is due to differences in times of leaf emergence. But we do not as yet know what kinds of distribution the two chromosome-races of *A. maculatum* have in relation to each other.

Investigations have also been made into the cytological relations of closely related species within a genus, members of which can still sometimes hybridize. Thus, Fitzpatrick¹⁸ has established a relation between ploidy and normal habitats among British meadow-grasses (*Glyceria* spp.), all of which are morphologically distinct. The diploid species (*G. declinata*, $2n = 20$) is most drought-tolerant, living in dried-up ponds and cart ruts, while the two tetraploid species (*G. plicata* and *G. fluitans*, $2n = 40$) prefer wetter habitats such as ditches and stream edges. The hexaploid species, *G. maxima* ($2n = 60$), is a typical constituent of reed swamps¹².

The relation between chromosome-races and ecology can also be observed in Pteridophyta. For example, Manton¹⁹ has found that in the common polyploidy fern (*Polypodium vulgare*) the diploid ($2n = 74$) usually occurs on limestone habitats in south-west England and in Yorkshire. This race, known as the variety *serratum*, has its dormant season in summer, putting out new fertile fronds in August or September, while the tetraploid ($2n = 148$) is earlier, producing new leaves in May and June. The hexaploid ($2n = 222$) is a large plant with thicker leaves and has an extended season from summer to autumn; it prefers moister climatic conditions, and is the commonest type in Ireland, Wales and south-west England and the only race on Jersey.

Where there are ecological differences between chromosome-races within a species the general trend becomes clear. Within the species, lower chromosome multiples prefer drier habitats and there is a progressive trend through intermediates to the highest polyploids, which prefer moist or wet habitats. Aneuploidy is not so important in this respect as polyploidy. It remains to be determined how this has come about, the actual physiological relationships involved, and whether the phenomenon is related to a change-over from sexual to apomictic or vegetative methods of reproduction which so often accompany higher polyploidy².

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OBITUARIES

Prof. Cyril Batho

WE regret to record the death of Prof. C. Batho, which occurred at his home in Birmingham on March 23, after an illness which had lasted some months. Prof. Batho retired only last year from the Beale chair of civil engineering in the University of Birmingham, and was afterwards accorded the title of emeritus professor.

Born in Liverpool on June 21, 1885, Dr. Batho was educated at Liverpool College and at the University of Liverpool, where he later spent some time in postgraduate research. He was appointed to a lectureship in civil engineering at McGill University in 1908 and thereafter spent two years in post-graduate study at Berlin and Charlottenburg, returning to McGill University in 1911 as assistant professor. In addition to his work at the University, he acted for a period as an assistant design engineer on the Quebec Bridge.