contributors provided support for relationships between solar variations and the pattern taken by the general circulation.

It became abundantly clear how large a number of investigators are patiently accumulating evidence of the amplitude, character, effects and especially the dating of climatic fluctuations all over the world. Speculations regarding the causes abound; supporters of each of the popular theories—solar variation, atmospheric turbidity, carbon dioxide, ozone, variations in the Earth's orbital elements—find their several gods alternately set up and cast down. Workers in one field find themselves unable to judge the validity of the evidence from other disciplines;

in this regard, the sessions and the informal discussion resulting from personal encounters between different kinds of specialists are for many a real help. A great deal of enjoyment is had by all, and those who are tempted to advocate simple explanations are repeatedly reminded of the complexity of the problems they so hopefully seek to solve. It now seems almost certain that no one simple panacea is in any way adequate to explain the intriguing patterns of climatic fluctuation to which the evidence points. Almost all the many processes involved seem likely to play some essential part, small or large. The forthcoming volume of papers will provide welcome reading.

GORDON MANLEY

EXPERIMENTAL TAXONOMY OF FLOWERING PLANTS

A SYMPOSIUM on the experimental taxonomy of flowering plants was held at the Linnean Society on March 3. The chair at the morning session was taken by the president, Prof. C. F. A. Pantin, and at the afternoon session by Dr. W. G. Templeman.

In a brief introduction, Prof. D. H. Valentine said that the symposium should provide a good illustration of both the coherence and the wide range of experimental taxonomy. In the papers to be heard, groups at all levels, from the local population to the genus, would be treated, and the problems would be approached from a variety of points of view—genetical, ecological and taxonomic.

Dr. A. D. Bradshaw, of the University College of North Wales, Bangor, then gave his paper on "Evolution within Plant Species in Relation to Soil Mineral Factors". He pointed out that while a considerable amount is known about evolution in relation to climatic and biotic factors, soil factors have, comparatively, been neglected. This is surprising, as an examination of the differences between closely related species shows that they often possess markedly different soil preferences, which indicates that soil factors must play an important part in evolution. Experiments have been done in sand cultures on a number of common species, especially *Festuca ovina* and *Trifolium repens*. The fescues used were all of the 28-chromosome type, and selected tillers were grown in a range of solutions with varying concentrations of calcium. Populations from chalk and peat soils showed a markedly different response to growth; and an experiment on samples from base-rich and base-poor soils from the Breckland showed a similar difference, although the populations were morphologically identical. *Trifolium repens* gave the same kind of response in relation to variation in both calcium and phosphate concentrations, but the phosphate and calcium responses were not parallel. It would appear that populations of both species are physiologically differentiated in relation to their mineral nutrition; and such differentiation cannot be neglected in considering the evolutionary processes in these and other common species.

In the discussion on this paper, it was pointed out that much information of a similar kind was available for cultivated plants, notably rice, but that a great deal of it was inaccessible or not widely known.

The second paper, on "Interspecific Hybridization as an Evolutionary Stimulus in *Oenothera*", was given by Dr. P. H. Raven, of the Rancho Santa Ana Botanic Garden, California. Dr. Raven first described *O.*

brevipes and *O. clavaeformis*, a pair of annual species which occur in arid areas in western North America. The species differ in a number of morphological characters (habit, flower colour, etc.), in habitat, and also in their floral biology. In one, the flowers open at about sunrise, in the other, in the late afternoon, and they are pollinated by different but closely related species of bees, which are highly specific to these flowers. Geographically, the species have a rather broad area of overlap, and natural hybrids are sometimes formed (the species are occasionally visited by insects other than the bees mentioned above). Both species have 14 chromosomes; 7 bivalents are formed in most cells, though occasionally rings of 4 or 6 chromosomes are observed; fertility is high. In the hybrids the multivalents are more frequent, larger rings or chains of up to 12 chromosomes being recorded; fertility is low, and only 5–15 per cent of good pollen is formed. Although most of the hybrids between the particular pair of populations studied appeared to be F_1 's, other populations can be found (taxonomically of subspecific status) which are probably of hybrid origin. It would appear that occasional hybridization of the kind described may well play an important part in increasing the number of evolutionary pathways available, especially in areas such as this, in which considerable climatic changes have been occurring. In general, it may be said that the retention of the ability to hybridize and to form stable recombinant phenotypes may be regarded as a significant part of the adaptive system in higher plants. There was a short but active discussion of this paper, in which the evolution of pollinating mechanisms and the part played by chromosome interchanges in the genus were discussed.

The final paper in the morning session was given by Dr. N. W. Simmonds, of the John Innes Institute, on "Classification and Nomenclature in Bananas and Potatoes". Dr. Simmonds dealt with bananas first. He pointed out that we now had a good knowledge of the probable course of evolution in the group. The cultivated bananas had arisen from the diploid species *Musa acuminata* and *M. balbisiana* as a result of polyploidy and hybridization, and consisted of a group of sterile, parthenocarpic clones, mainly triploid in constitution. In the potatoes, the cultivated plants probably originated from wild diploid species, as yet not certainly identified, which had developed into the cultivated tetraploid species *Solanum andigenum*; and this in turn, introduced into Europe as a small sample some four hundred years ago, had given rise

to *S. tuberosum*. This resembled the banana in being clonally propagated, but was unlike it in being sexually fertile. In both groups, it is practically impossible to apply the normal nomenclatural rules in any useful way. The banana now comprises six groups of sterile clonal cultivars which are not species in any reasonable meaning of the word; and to attempt to apply the Linnean names *M. paradisiaca* and *M. sapientum*, which represent two of these cultivars, would merely lead to confusion. In potatoes, many of the described species with Latin names refer to single clones, others to an arbitrary selection of plants from continuously varying populations; further difficulties arise in the identification of the Linnean type. In both groups, the best procedure is to discard the Latin nomenclature below the generic level, and apply the *Code for Cultivated Plants*. Rates of evolution in crop plants are high, and crops change; and this must be recognized by an appropriate flexibility of nomenclature. In the discussion, sympathy was expressed with Dr. Simmonds's view of the problem; nomenclatural divisions should resemble a neat fence rather than a barbed-wire entanglement.

In the first paper of the afternoon session, Dr. J. R. Ellis, of the Galton Laboratory, University College, London, spoke on "*Fragaria-Potentilla* Intergeneric Hybridization and Evolution in *Fragaria*". He first reviewed briefly the cytology and distribution of the genus *Fragaria*, and the preliminary experiments on hybridization in this group by Mangelsdorf and by J. K. Jones. Dr. Ellis then described in detail his own experiments, in which he used as seed parent both the garden strawberry, *Fragaria grandiflora* ($2n = 56$), and the artificial allopolyploid *F. vesca-grandiflora* ($2n = 70$). When *Potentilla erecta* ($2n = 28$) was used as pollen parent, hybrid seedlings were produced, but none survived to maturity; but with *P. fruticosa* ($2n = 14$) and *P. palustris* ($2n = 42$) as pollen parents not only did many hybrid seeds germinate but also a number of seedlings grew to maturity. There was great variation in the vigour of the hybrids, which were sterile, and all resembled their *Fragaria* more than their *Potentilla* parent; fertile amphiploids, which may be of value in strawberry breeding, have not yet been obtained. Studies of meiosis in the hybrids have been useful, as they have thrown light on the homologies of the genomes comprising the garden strawberry. Dr. Ellis also suggested that the wild species *Duchesnea indica* might be a *Fragaria-Potentilla* amphiploid. In the discussion on this paper, the bearing of Dr. Ellis's results on the taxonomy of *Potentilla* and its allied genera was referred to, as well as the cytological phenomenon of double non-reduction, observed in both *Fragaria* and *Solanum*.

The final paper, on "The Experimental Taxonomy of *Anthoxanthum* L.", was given in two parts. Dr. M. Borrell, of the Welsh Plant Breeding Station, Aberystwyth, spoke first, on the genetic aspects. In Europe and the Mediterranean, three main groups can be recognized: the arctic-alpine perennial diploid *A. alpinum*, the Mediterranean annual diploids *A. puelii* and *A. aristatum*, and the widely distributed tetraploid *A. odoratum*. Although the latter resembles *A. alpinum* very closely, it also possesses certain features, such as leaf pubescence, which occur in the Mediterranean diploids. *A. odoratum* hybridizes readily with the Mediterranean diploids, *A. alpinum* only with difficulty. However, a sterile diploid hybrid between *A. puelii* and *A. alpinum* was obtained, and from this a tetraploid plant was made

by colchicine treatment. This plant is a vigorous perennial, is reasonably like *A. odoratum*, and is fairly fertile. It is also moderately self-fertile and can be inbred, unlike the very self-incompatible natural tetraploid. It seems reasonable to suppose that *A. odoratum* arose from a cross similar to that made artificially, though not necessarily from exactly the same parents.

Dr. K. Jones, of the Royal Botanic Gardens, Kew, then spoke about the cytological aspects of the problem. Natural populations of *A. odoratum* have invariably been found to be composed entirely of interchange heterozygotes. Some bivalents are always formed, but quadrivalents are common, and up to 10 chromosomes may be associated in a ring. These facts can be related to the probable mode of origin of the species. The artificial F_1 hybrid *A. alpinum* $\times$ *A. puelii* (described by Dr. Borrell) is a complex interchange heterozygote in which pairing varies from 5 bivalents to 1 bivalent and a ring of eight. The artificial amphidiploids derived from this hybrid are thus polyploid interchange heterozygotes, and, in the plants which have been studied, disjunction is not always regular. As a result of selection, the fully fertile natural tetraploid has developed in which there is regular disjunction and self-incompatibility. *A. odoratum* has thus become a stable and permanent interchange heterozygote.

A general discussion on all the papers was opened by Prof. Irene Manton, of the University of Leeds. After referring to a number of specific points, she raised the general question of the time scale of evolution, pointing out that in many of the groups discussed some fairly precise statements had been made which, if followed up, could give more exact information about the speed at which evolutionary adjustments happened than had hitherto been available. Thus it seemed certain that the physiological adjustments to soil described by Dr. Bradshaw must in some cases have occurred rapidly, since one example involved a disused quarry the age of which could be precisely determined. Evolution in *Oenothera*, described by Dr. Raven, seemed to be related to recent changes in the climate of western North America. In bananas, where parthenocarpy was a significant character, artificial selection by man must have been involved in the original Malayan habitat which could perhaps be roughly assessed in years; a significant part of the evolution of the cultivated potato as we know it to-day must have taken place in historical time. Recent advances in the experimental approach to evolution would now justify closer attention to the question of timing than would have been possible a few years ago, and it was strongly recommended that this attention should be given. In the discussion several speakers endorsed the view that certain sorts of evolutionary adjustment can occur surprisingly rapidly. Prof. G. L. Stebbins pointed out that the first stages in the evolution of the potato had not been quite so rapid as Prof. Manton had suggested, as the crop had a very long history in South America. He agreed with Prof. Manton as to the difficulty and complexity of the problem. The rate at which chromosome changes occurred often seemed to show little correlation with rate of change in the gene complexes which controlled morphological and physiological characters, and the causes of both kinds of change were still obscure. More accurate and detailed knowledge of the history of Tertiary floras might eventually provide a basis for firm conclusions.

D. H. VALENTINE