for annual herbs, 15% for perennial herbs, and probably less than 10% for woody composites. They conclude "these general patterns suggest that, small clutch size not withstanding, annual species of the Heliantheae will have, on average, larger reproductive efforts than perennial herbs. Small clutch size in shrubs will be associated with relatively small reproductive risks in time."

In short, Levin and Turner's study demonstrates 'clutch size' differences that are related to geography and growth form. The authors argue that "there is no reason to assume the patterns observed in the Heliantheae are unique to that tribe or the Compositae as a whole", and I echo their hope that their analysis will spark similar analyses of other plant groups. □

Synchrotron radiation at York

from G. V. Marr and I. H. Munro

SEVEN hundred delegates, over two thirds of whom were from outside the UK assembled for the fourth general conference of the European Physical Society.* In this, its tenth year of existence, the EPS took for its theme 'Trends in Physics' and 'Synchrotron Radiation' was one of the eight parallel symposia which formed the basis for a revealing insight into the varied interests of the EPS.

Synchrotron radiation and its applications was introduced and reviewed by S. P. Kapitza (Institute for Physical Problems, Academy of Science, Moscow). This general introduction to synchrotron radiation research was followed by papers on general properties and instrumentation, atoms and molecules, photoemission from solid surfaces using synchrotron and ultraviolet sources, X-ray scattering, X-ray imaging and structural studies.

For the duration of the conference, a large exhibition had been assembled by the Daresbury Laboratory of the UK Science Research Council to describe the nature, generation and exploitation of synchrotron radiation. In addition to providing information concerning the new synchrotron radiation source under construction at Daresbury contributions of material were provided from a number of European laboratories at which facilities are available for synchrotron radiation research. Representatives were present from the laboratories at Bonn and Braunschweig (West Germany), Daresbury (UK), Frascati (Italy), Hamburg (West Germany) and Orsay (France). In addition, the conference was also attended by a group of scientists from laboratories in Moscow, Novosibirsk and Yerevan in the USSR. This group visited the UK under the auspices of the USSR Commission on Synchrotron Radiation with whom in 1977 the UK Science Research Council drew up an agreement for the exchange of information and the holding of joint seminars on synchrotron radiation research.

Reviews and reports were presented at the conference on the following topics: the use of X-ray synchrotron radiation for structural resarch in biology; recent advances in the dynamics of photoselected excited states of molecules and ions; photoemission from solids with synchrotron radiation; elastic scattering and structural applications; synchrotron radiation and X-ray crystallography; X-ray imaging, lithography, microscopy and topography; EXAFS and its use in the study of glass; atomic physics. During the meeting the contributed papers and poster contributions led to discussions of problems associated with the development of new synchrotron radiation sources and of X-ray monochromators; on the soft X-ray and VUV spectroscopy of atoms and molecules, on surface and solid state studies, on the dynamics of protein molecules, on phase transitions in biological systems, the study of clay gels, recrystallisation and grain growth and the structural studies of powdered materials. Techniques were discussed giving rapid recording of data from these very intense X-ray sources which could be used to yield structure refinement with rapidly changing sample environment.

An unusual feature—for a physics conference—was the evident importance of synchrotron radiation research in biology and in biochemistry. This was clearly demonstrated in the use of high resolution X-ray absorption spectroscopy (EXAFS) to elucidate the structure of, for example, polynuclear copper compounds which do not crystallise and of other complex metal containing proteins. Results were given on time resolved X-ray diffraction studies in the millisecond domain for muscle and on high resolution X-ray diffraction data on protein crystals, for example, tyrosyl-tRNA synthetase single crystals. Synchrotron radiation sources are intensely modulated over a wide frequency range enabling the mobility of protein molecules to be observed. Using the technique of time resolved fluorescence polarisation spectroscopy in the ultraviolet region a number of proteins were shown to have widely differing degrees of rotational freedom of a single amino acid residue (trytophan). The measured amplitudes and states of these motions suggested that elementary steps of functionally significant conformational changes take place in the subnanosecond time range.

The meeting revealed to the physics community at large that synchrotron radiation sources have a major contribution to make in an astonishingly wide variety of techniques and fields of scientific endeavour. Contributions indicated that developments such as undulators and the free electron laser will become increasingly important during the next decade. Indeed it is likely that future synchrotron radiation sources will be considerably different from the present generation where the radiated electromagnetic waves are the result of simple centripetal acceleration of high energy electrons confined to move on a circular orbit by a large iron core dipole magnet. The introduction of periodic magnetic structures within a straight section between conventional dipole magnets in a storage ring can result in very different forms of the emitted soft X-ray spectrum. When the vertical magnetic field alternates in direction up and down along the length of the beam orbit traversed by the electron, the oscillating electron emits a sharply peaked electromagnetic radiation spectrum. This peak occurs at a wavelength related to the product of the periodicity of the field with the square of the rest mass energy of the electron and has a width which depends inversely on the number of periods in the undulator. Increases in photon flux of up to one hundred times over that of the normal synchrotron radiation spectrum are predicted for undulator peaks in the soft X-ray region. Results reported at the conference provided details of the spectral features, angular distributions of undulating radiation and polarisation which are in basic agreement with theory, demonstrating that with further development these devices can play a significant part in the next generation of synchrotron sources.

The Synchrotron Radiation Committee of the European Science Foundation, held a two-day workshop during the EPS Conference on the specification and design of a proposed new European Synchrotron Radiation Source. This will form part of a feasibility study to be considered by the European Science Foundation late in 1979 and undulators will represent a significant part of this proposal. □

*Held on 25–29 September at the University of York.

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