from year to year, although the level of activity can vary markedly in different years. Keay and Ellyett have compared the 1963-65 data with a similar survey with the same radar covering the twelve months from February 1960 to January 1961, and they have found that the 1963 rate can be more than twice that of 1960. This was particularly so during May, June and July, and confirms similar reports from Canada and Sweden.

Because the way the meteor rate changes throughout the day is more or less the same for corresponding months of the different years, Keay and Ellyett agree that the different levels of activity have less to do with changes in the flux of meteoroids entering the atmosphere than with the ability of the atmosphere to produce detectable trains of ionization—in other words, to act as a detector of solid particles. What meteor radars are sensitive to is the electron line density generated by the meteoric particles, and the detector will work best in years when the air density is high in the region of the lower thermosphere where most of the meteoric ionization is produced—roughly between 80 and 110 km. Obviously there is a tendency to blame the Sunspot cycle, but it is by no means sure that this is the whole answer. The effect is more marked in May–July because these are the months when showers which are rich in fainter meteors, such as the Delta Aquarids and the Arietids, are active.

For aficionados, the Christchurch radar operates at 69.5 MHz, higher than might be expected, using crossed dipoles for transmission and reception. The limiting magnitude—the faintest meteor which the radar can detect—is about 8, which for those who consider meteoroids to be solid bodies rather than fluffy clumps of particles corresponds to a radius of about 0.3 mm.

ARCHAEOLOGY

How the Physicist Helps

from a Correspondent

TWENTY years of research on carbon dating were marked in London on December 11 and 12 by a joint meeting of the Royal Society and the British Academy on the impact of the natural sciences on archaeology. Professor W. F. Libby (University of California, Los Angeles) began the meeting by recounting his story of the discovery of radiocarbon, and described the perfection of a suitably sensitive method for detecting its very weak activity. His first measurements of natural radiocarbon were made on enriched samples of methane from the City of Baltimore sewage works. The enlistment of a panel of experts to help him to choose the most suitable samples for testing the potential new dating method shows how amicable cooperation among the disciplines achieves the most fruitful results. His success can be judged by the 30,000 samples dated in the several dozen laboratories now established throughout the world.

With refined measuring techniques came the possibility of testing the basic tenets of the simple theory, and, as with most scientific theories, modification is necessary. In this case, the assumption of a constant concentration of radiocarbon in the biosphere for the past tens of millennia has been demonstrated to be invalid. Dr Briant Bannister (University of Arizona,

Tucson) described how, by cross dating the growth rings of trees, especially the sequoia and bristlecone pine, it has been possible to construct an absolute chronology extending for more than seventy centuries. Besides its usefulness in its own right for archaeological research, this dendochronology provided wood of known age for directly checking the radiocarbon time scale. Careful measurements made in laboratories of the Universities of La Jolla, Pennsylvania and Arizona have demonstrated that the radiocarbon concentration has varied by 1 to 2 per cent during the past 2,000 years and that the deviation progressively increases for the next 5,000 years back in time. This has the effect of foreshortening the carbon-14 time scale and all radiocarbon dates appear younger than historical dates by periods of time increasing to about 750 years at a range of 7,000 years. This effect was confirmed by several speakers who have dated critically chosen objects from Egypt.

Dr V. Bucha (University of California, Los Angeles) explained these past changes by the interaction of the Earth's magnetic field with impinging cosmic rays. The varying field he has measured affected the radiocarbon production in a manner which correctly predicted the results of the radiocarbon calibration scale. Minor fluctuations remaining can be explained in terms of radiations associated with Sunspots. The calibration curve contains some 400 measurements by Professor H. Suess (La Jolla) and slightly fewer by Dr E. Ralph (Pennsylvania) and Professor P. Damon (Arizona), and surely must be the most expensive calibration curve of all time.

Professor H. Godwin (University of Cambridge), who established radiocarbon dating in Britain, showed how it has facilitated the solving of various types of archaeological problems, even though a revision of Mesolithic and Neolithic chronology by the order of a thousand years has been necessary. In Britain radiocarbon dating has been particularly useful in relating cultural changes to geographical, climatic and vegetational changes.

Describing advances in the relatively new method of dating fragments of pottery by thermoluminescence, Dr M. J. Aitken (University of Oxford) modestly claimed an accuracy of only about 5 per cent, which will surely improve as work continues. This is an independent method of dating which might well be used in monitoring the radiocarbon time scale.

Professor D. G. Kendall (University of Cambridge) led the audience through the complex mathematical process of a practical problem of seriating tombs in a cemetery. Information about the presence or absence of certain chronologically significant features within the tombs was all he required to produce a similarity matrix, which was used in the ubiquitous computer for beginning a multi-dimensional scaling procedure leading to the placement of the tombs in correct chronological order. This method could be generalized, he explained, and should be most useful for the archaeologist.

The principal difficulty in making use of such techniques, as Mr H. Barker (British Museum), among others, emphasized, is the need for scientists and archaeologists to collaborate inside and outside the laboratory, and to establish intelligible information exchange. With such communication, the impact of the natural sciences on archaeology would be only just beginning.