Fig. 3. POLLEN GRAINS FROM PLANTS OF THE FAMILY COMPOSITAE.
× c. 300

descriptions, including measurements, of a large number of pollens, with eighty plates of excellent photomicrographs of some 750 different kinds¹³. The pollen is separated by mixing the honey with water and centrifuging, after which the pollen is mounted in glycerin-jelly. The pollen grains are then identified and counted and a percentage table is constructed; from this a conclusion may be made as to the source of the honey¹⁵.

Although the dimensions of pollen grains are important characters, it is probable that the shapes and markings are more reliable criteria for diagnosis. These facts are immediately evident when one examines the pollen from closely related plants. For example, pollens from the three common drugs belonging to the Solanaceae (Fig. 2) have the following characters¹⁴: *Atropa belladonna*, sub-spherical, 37–50 μ in diameter, exine with lines of pits radiating from the poles, three furrows, three pores which are about 8 μ in diameter; *Hyoscyamus niger*, sub-spherical, 40–50 μ in diameter, exine with pits in a scattered arrangement, three furrows, three pores which are about 15 μ in diameter; *Datura stramonium*, sub-spherical, 56–80 μ in diameter, exine coarsely granular, no furrows, three pores which are 15–24 μ in diameter.

Similarly with pollen of compositous plants, the important distinguishing features are the presence or absence of cuticular spines, the length and number of the spines when present, the arrangement of any ridges as in *Taraxacum officinale* and other plants of the Cichorieae (Fig. 3, and the accompanying table¹⁴):

Name	Shape	Diameter	Surface	Furrows	Pores	Notes
<i>Artemisia cina</i>	Sub-spherical	20 to 25 μ	Finely granular	3	3	No spines
<i>Grindelia camporum</i>	Sub-spherical	32 to 45 μ	Smooth; spines 2 μ long	3	3	21 spines in the disk
<i>Arnica montana</i>	Sub-spherical	40 to 52 μ	Very finely granular; spines 8 μ long	3	3	16 to 18 spines in the disk
<i>Anthemis nobilis</i>	Sub-spherical	30 to 36 μ	Finely warty; spines 3 μ long	3	3	12 to 13 spines in the disk
<i>Chrysanthemum cinerariaefolium</i>	Sub-spherical	34 to 40 μ	Lines of warts radiating from the poles; spines 4 μ long	3	3	10 to 11 spines in the disk
<i>Taraxacum officinale</i>	Hexagonal-spherical	32 to 40 μ	Smooth; spines 2 μ long	0	3	40 spines in the disk, etc.

The spores of *Lycopodium clavatum*, which are used as a dusting powder, as a vehicle for snuffs or insufflations of penicillin and menthol and also in large quantities in pyrotechnics, have an important use in microscopy to enable one to estimate the weights of materials seen in the field of the microscope¹⁶. The determinations depend upon counting methods based upon the number of lycopodium spores per mgm., which is 94,000¹⁷. This process is possible because lycopodium spores are very uniform in size, easily identified by their shape and markings and are highly resistant to most common mountants and microscopical reagents.

The study of pollen and spores has therefore yielded details of great economic importance. In addition to the elucidation of academic problems, the study has proved of much value to the advance of medicine and to the analyses of peat, honey, drugs, spices and foods, thus providing the foundation for much knowledge of such diverse subjects as peat, hay-fever and pharmacognosy.

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PROGRESS OF CANCER RESEARCH

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THE British Empire Cancer Campaign has awarded the Garton Medal and Prize of £500 to Prof. E. L. Kennaway in recognition of his outstanding contributions to cancer research. Eighteen years after his discovery of the first carcinogenic hydrocarbon (1 : 2 : 5 : 6-dibenzanthracene), investigators are still synthesizing and testing new carcinogenic compounds although these now number more than three hundred; and in fact studies of carcinogens and their mode of action form the largest single group of investigations in progress in the twenty-one centres of research financed, assisted and co-ordinated by the Campaign.

In the accompanying table, the reviewer has attempted a classification of the investigations described in the twenty-third annual report issued by the Campaign approximately according to their numerical occurrence, but of course this arrangement

is no conclusive proof of priority in any sense. Numerous modifying factors should be taken into account in any more precise evaluation. For example, some of the reports of researches are detailed, some highly summarized; some pursued by a single worker, others by a team; one may represent a project barely begun, another may be one of those long-term investigations which can only give results after several years and where, consequently, one year's report reads much the same as that of the previous year; and finally, the type of research which can take advantage of the fertile technique of organic chemistry is bound to attract more attention than others which depend upon less well-developed techniques. Nevertheless, it is obvious that carcinogenesis by chemical compounds, work on X-rays and radium, and chemotherapy form the largest three groups of investigation.

Carcinogens, their mode of action, factors affecting carcinogenesis, metabolites, carcinogenesis by tar and petroleum	15
Radiology, developments in the use of X-rays and radium, action of radiation on tissues and tissue constituents. Biophysics, use of radioactive isotopes	14
Chemotherapy by stilbene derivatives, oestrogens, urethane and other compounds	7
Filterable tumours	5
Cytology	3
<i>In vitro</i> culture	2
Nucleoproteins	2
Histology	1
Social distribution of cancer	1
Genetics	1
Enzymes	1
Transmissible milk factor for mammary cancer in the mouse	1

Apart from laboratory experiments, much clinical investigation has been pursued at practically all centres, and the Clinical Cancer Research Committee presents an elaborate report of nearly 1,500 cases of cancer of the rectum and anus treated statistically under thirty-five different headings dealing with the pathological, surgical and etiological aspects. Three new projects are being launched by the Campaign this year.

At Edinburgh, a pool of experimental animals is being bred, and transplantable tumours are being kept growing in animals for use by other research centres, much like the national collection of type cultures. The Campaign is producing a new journal, the *British Journal of Cancer*, and virus research in relation to cancer is to receive stimulation by a £25,000 grant, which will no doubt also accelerate experimental work with filterable tumours and in related fields such as the transmissible milk factor for mouse carcinoma, nucleoproteins, and ultra-violet microscopy.

Among the latest carcinogenic compounds to be tested at the Oxford centre are some containing sulphur; for example, 4:9-dimethyl-2:3:5:6-dibenzthiophanthrene and 4:7-dimethyl-2:3:5:6-dibenzthionaphthene. Such sulphur-containing carcinogens are no doubt already being used in tracer experiments where radioactive sulphur forms part of the molecule. At the same centre, species differences have been sought in experiments where 9:10-dimethyl-1:2-benzanthracene—to date the most powerful carcinogenic agent known—was tested on mice, rats, rabbits and guinea pigs; but it might perhaps be objected that instead of such sledge-hammer methods the test would have been more sensitive if a less active agent had been used. Some investigator with a sense of humour might try the effect of cancer-producing hydrocarbons upon the crustacean after which the disorder was named so long ago.

Bielschowsky at Sheffield is continuing experiments with one of the most remarkable carcinogens, 2-acetylaminofluorene, which when fed to rats and mice produces cancer in the liver, ductus acusticus, thyroid, blood cells, mammary gland, bladder, stomach and uterus. He has found that 2-aminoanthracene readily produces tumours of the skin in albino rats, and this compound must therefore be classed as one of the simplest carcinogens. The cellular structure of these skin tumours is usually different from that of skin tumours in mice produced by hydrocarbons, and hence different processes must be involved in carcinogenesis by the two types of agent.

Many workers in this field—probably a majority—inclined to the theory that the carcinogen, before it can effect neoplasia, has first to be converted by the tissues to an active derivative, which is the true carcinogen. Proof of this theory is, however, somewhat unconvincing as yet. Indeed, what evidence is available points rather in the opposite direction, since metabolic products of the carcinogens have so far shown very little carcinogenic activity. A metabolite of 2-acetylaminofluorene isolated from rat urine, namely, 2-acetyl-amino-7-hydroxyfluorene, has so far proved inactive as a carcinogen; the metabolite of 3:4-benzpyrene, namely, 8-hydroxy-3:4-benzpyrene, is only very weakly carcinogenic, but if the hydroxyl group is converted to methoxy, the new compound is then strongly carcinogenic. It must be noted that to speak, as some do, of 'methylated metabolite' conveys a little ambiguity, because the methylation takes place in the test-tube, but the metabolite is generated *in vivo*. Moreover, Dickens has tested the carcinogenicity of the 'methylated metabolite' from 9:10-dimethyl-1:2-benzanthracene and finds it (4'-methoxy-9:10-dimethyl-1:2-benzanthracene) inactive.

At Glasgow, Peacock and his colleagues have, among much other work, extended the study of co-carcinogens to gastric cancer. By adding one of these substances, croton oil, to the diet of rats, hyperkeratosis of the stomach, but not cancer, was produced; and even if a weak carcinogen were added to a diet containing an irritant (pepper), tumours were not found at post-mortem. No mention is made of results with a combination of croton oil and weak carcinogen added to the diet, but perhaps such tests are already in progress.

At Leeds, Orr has found that when methylcholanthrene is applied to the skin of mice of the *IF* strain (highly susceptible to skin cancer induced by hydrocarbons, but not liable to spontaneous mammary cancer), cancer of the mamma and pulmonary adenomata were found in every experimental animal. Attempts were made to breed from these mice with induced mammary cancer, to see if the disease was transmissible, unfortunately without success. Work on somewhat similar lines is being pursued at Newcastle by Pybus and Miller, who are following up the extraordinarily interesting discoveries of Strong in the United States. Strong reported that the methylcholanthrene treatment of certain inbred strains of mice induced a greatly increased tendency to carcinoma, particularly of the stomach, which was transmitted to subsequent generations without any further application of the methylcholanthrene.

Advances in radiology have been on several lines, but chiefly in developments of the complicated, but immensely important, task of assessing the distribution of dosage of X-rays and γ -rays in the body of

the patient in three dimensions. By means of small condenser chambers the dosage can now be measured directly in the patient during treatment, and studies are being made of the measurement of the integral dose and of the causes of X-ray sickness. Artificial radioactive substances such as radio-sodium and radio-phosphorus are being used for tracer element experiments and for radiotherapy. At the Strange-ways Laboratory, Cambridge, the action of X-rays, γ -rays and α -rays have been studied in a large variety of materials ranging from inorganic substances, through *in vitro* culture of fibroblasts, to the normal brain of mice and rabbits.

At Leeds, Rudall has examined with X-rays the crystallographic structure of the proteins in the cells of the epidermis before and after cancerization, and finds that the proteins of papilloma tissues induced in rabbits by the Shope virus differ structurally from the proteins of normal skin.

The number of compounds which have been tested for chemotherapy in cancer must now run well into the thousands, and the present situation is that Haddow finds derivatives of 4-aminostilbene the most effective against transplantable tumours in rats; oestrogens are being used for prostatic human cancer and urethane for human leukaemia. It must be noted that all three compounds are also cancer-producing agents; for example, 4-dimethylaminostilbene evokes a wide variety of tumours in the rat, and urethane produces lung adenoma in mice. Oestrogens, while only weakly carcinogenic at the site of administration, produce uterine fibromata in the guinea pig (Lip-schutz) and also facilitate cancer of numerous organs and tissues in mice of strains liable to spontaneous mammary cancer (W. U. Gardener). These findings reinforce Haddow's original theory that carcinogenicity and tumour-inhibitory capacity are closely linked properties of chemical compounds, somewhat in the same way that radiations in different dosages can either produce or inhibit the growth of tumours.

Koller has continued his cytological studies of the mechanism of radiotherapy and comes to the conclusion that the success of the treatment depends largely on the indirect action of the radiation, that is, upon the still healthy tissue forming the tumour bed, rather than a lethal action upon the tumour cells directly.

At the Cancer Research Laboratories of the Hebrew University, Jerusalem, detailed studies are being made of the malignant conversion of normal fibroblasts *in vitro* by the Rous agent, and on the cytology of the different strains of rat sarcomas *in vitro*, which present a great variety of structural peculiarities, although they were obtained by the same agent, namely, benzpyrene.

Prof. and Mrs. Kennaway, continuing their examination of that treasury of information, the Registrar-General's reports on the deaths in Great Britain, have extracted the facts that cancer of the scrotum is about twenty times less common in men of the highest social class than it is in the general population. Thus hygienic habits of cleanliness, and perhaps other conditions common in the wealthiest social strata, could, if spread over society in general, greatly diminish at least one form of cancer.

Cornelia Hoch-Ligeti has been confirming earlier results showing that milk added to the diet of rats receiving butter yellow (dimethylaminoazobenzene) gives considerable protection against the formation of liver tumours. It is therefore possible that dietary deficiencies may partly account for the widespread

occurrence of liver cancer in the Japanese, Chinese, Indian and allied Asiatic races, and particularly the Bantus of South Africa, all of whom have been, until recently, less well nourished than Europeans.

Hieger, after ten years work on carcinogenic substances in human tissues (first discovered by Schabad in Leningrad), concludes that: (a) not only liver but also lung, kidney and muscle contain these substances; (b) human subjects that have died of cancer or of other diseases contain these agents; and (c) that they are to be found in the cholesterol-rich fraction of the tissues and are probably sterols or closely associated compounds.

OBITUARIES

Prof. F. Paschen

PROF. F. PASCHEN died in Potsdam on February 26; he was eighty-two years old. According to his daughter, the extreme cold at the time resulted in his contracting pneumonia, from which he failed to recover.

Paschen was a giant among spectroscopists, and with his passing there closes a chapter in classical spectroscopy which included such other names as those of Lockyer, Kayser and Fowler. It is difficult to realize that fifty-five years have passed since Paschen first began his classical work on the infra-red. Since then a veritable torrent of publication came from his pen, and only ceased with his death. He covered the whole of experimental spectroscopy in a masterly manner, making a succession of important discoveries. Infra-red measurements, precision wave-length determinations, analysis of series, interpretation of hyperfine structures, were all illuminated by him.

He developed the delicate Paschen galvanometer, discovered the Paschen infra-red series in hydrogen, was senior co-discoverer of the Paschen-Back effect in magneto-optics, invented the Paschen hollow cathode discharge and so on. His masterly analysis of the complicated series in the neon spectrum is a classic. Although the analysis of series in spectra was his major interest, yet he realized the value of the hollow cathode for hyperfine structure studies and did a great deal of work in this field too.

It was my good fortune to go to Berlin to study under Paschen in 1931, and he welcomed me as his first (and last) research student from England since 1914. My most vivid recollection is of a man with a dynamic virility, a freshness of mind and a generous nature. He had a profound understanding of most of the techniques of experimental spectroscopy, and it was an inspiration to see the energetic, impulsive manner in which he worked. His eyesight was unusually keen and he missed nothing. Withal he was an engaging *raconteur*, telling his amusing stories about physicists equally well in English and German. The Zeeman pictures he obtained will be surpassed only with difficulty, and he had a fund of knowledge on the use of high-resolution interferometers. He was essentially an exact experimenter, with little use either for gadgets or for those statistical methods which attempt to extract as much as possible out of observational data. In 1931 I showed him a trivial statistical trick I had developed. His smiling comment was: "If measurements on a plate are not self-consistent, smash the plate and take another. This is far better than statistics." A rash procedure