

and multiple-ship, detailed studies of the areas of convergence and divergence in the North Central Pacific and North Central Atlantic. These studies, as for all programmes in connexion with the International Geophysical Year, are co-ordinated with those of other nations.

The United States programme in glaciology will encompass detailed studies at points in the northern hemisphere and at stations in the Antarctic, as well as reconnaissance observations in the western United States, Alaska, and portions of the Arctic in co-operation with Denmark and Canada.

During the International Geophysical Year three approaches to obtaining direct upper-atmosphere data will be utilized: launching of large rockets from the ground, firing of smaller rockets from balloons and from aeroplanes, and launching of earth satellites. A total of more than two hundred rockets of different sorts will be launched by the United States for geophysical research purposes.

One of the limitations of the conventional rocket programme is that the rocket does not stay at great heights long enough to permit certain important types of measurements to be made. A single successful flight of a satellite will provide us with more observing time in the very high atmosphere than has been provided by all the ordinary rockets that have been fired.

Present plans call for the first earth satellite to be launched from the east coast of Florida at Cape Canaveral. There will be a three-stage rocket assembly to provide the means of placing the satellite in its orbit. When the satellite has reached a height of 300 miles, the last rocket will impel it into its orbit at a speed of about 18,000 miles per hour. The satellite will then revolve about the Earth in an approximate latitude range of about 40° on either side of the equator. Taking into account such factors as the Earth's rotation and the elliptical orbit of the satellite, its displacement will be about 25° for each revolution. This orbit will permit us to record observations over a broad expanse of the high

atmosphere, while the latitudinal band-width coverage will permit scientists of a large number of nations to make observations and measurements.

The first satellite will be spherical in shape, about 20 in. in diameter, and will weigh approximately 21.5 lb. About half this weight will be required for the satellite itself, the remainder being available for instrumentation. At its closest point to the Earth it will be between some 200–300 miles distant, and at its farthest some 800–1,500 miles. Once placed in its orbit, the satellite becomes in effect a new celestial body. As such, the first problem becomes its acquisition—those preliminary observations which not only establish its existence in orbit but which also provide data for preliminary calculations of its orbit in order that ephemerides may be calculated and issued. These calculations will permit, first, the concentration of ground stations on the preliminary orbit and, second, the subsequent acquisition of more extensive data on the basis of which the various studies can be conducted.

The satellite programme thus affords an unusual opportunity for the acquisition of information about the upper atmosphere. As in other programmes of the International Geophysical Year, this opportunity is a broad one: the nations of the world will not only observe the satellite but will also participate in the scientific programme. The ground-station scientific programme, in particular, calls for extensive international participation in order to secure maximum advantage from the endeavour. Observations by radio or optical instruments will permit the conduct of important experiments relating to the density of the air of the outer atmosphere, the composition of the Earth's crust and various geodetic determinations. Moreover, it is hoped that other nations will be able to place satellites in orbit during the International Geophysical Year, increasing the amount of data thereby attainable and taking advantage of the interests, activities, and observing stations established during 1957–58 by the many participating nations.

PROGRESS OF CANCER RESEARCH

THE investigations described in the 500-page 33rd Annual Report of the British Empire Cancer Campaign covering 1955 can be divided into four categories, namely: (1) radiology, radiotherapy and radiobiology; (2) pathology and morbid histology and clinical themes; (3) carcinogenesis, statistical and demographic studies; (4) biochemical and biological lines such as those on nucleoproteins, cytogenetics, cytochemistry, steroid metabolism, tissue metabolism, viruses, cytotoxic agents, enzymes and hormones. It should scarcely be necessary to reiterate that in this short review only part of the large amount of research can be dealt with, and secondly that in such a wide field any reviewer is limited by his own experience.

The report affords an interesting cross-section of research at many centres into the vexed question of the relation between cigarette-smoking and cancer of the lung. The present position would seem to be summed up in a most interesting paradox: statistically, the case against cigarettes grows more and more convincing at the same time as, experimentally

(at least so far as workers in Britain are concerned), it seems to grow thinner and thinner.

It would seem inescapable in the face of the formidable statistical evidence that cigarette smoke must contain something carcinogenic to the respiratory tract. Yet experimental proof of this is remarkably slow in appearing. At a number of centres the current experiment is to apply, to mouse skin, tar from cigarette smoke made in an apparatus which draws air through the lighted cigarette and condenses the smoke by passage through acetone cooled in a 'Drikold' bath. At none of six research centres have malignant tumours been evoked when the tobacco tar was applied to the mice. (These results are completely at variance with those of Wynder, Graham and Croninger in the United States, who obtained skin tumours in more than half the mice which were painted with tobacco tar.) Neither mice, rats nor hamsters have given positive results; nor have the different fractions from the tobacco tar obtained by separation with solvents shown activity.

It might be suggested that the disagreement with the American reports could depend upon some important difference in the technique of preparation of the tars or in the strain of mice employed for the tests. Since confirmation (or otherwise) of the report of Wynder *et al.* is urgently required, a thorough interchange of information and especially of materials, such as tobacco tars, tar fractions and mouse strains, should be instituted—and perhaps plans for such a liaison are already in process of being devised.

The lung of the rat has been used as the test material in experiments where either tobacco tar, or alternatively powerful carcinogens (benzpyrene, methyl-cholanthrene), were applied directly to the lung after thoracotomy had been performed. In forty-four rats only one carcinoma and seven sarcomas were obtained, indicating that the lung tissue of the rat is resistant to the carcinogenic potency not only of benzpyrene and methyl-cholanthrene but also of tobacco tar; the investigators were aiming at producing lung carcinoma of the type found in man, not at merely inducing sarcoma. None of the tumours was induced by the tobacco tar.

Tobacco tar injected directly into the lungs of thirty-six mice induced a low yield of lung tumour which was not very different from the incidence in the control untreated mice. In another experiment, soot containing nearly 100 parts per million of benzpyrene was used for direct injection into mouse lung. These experiments are not yet concluded; so far, the quantitative incidence of lung cancer could not be described as spectacular. Soot from railway engine funnels contains very little benzpyrene, whereas the soot from diesel engines which are operating slowly contains appreciable amounts of benzpyrene among other hydrocarbons.

The mortality-rates from respiratory cancer in Eire has been the subject of a very interesting investigation into the relation of tuberculosis to lung cancer in that country. Males in rural Eire have a low lung cancer-rate, less than a half of that in rural England. The data quoted afford plenty of material for speculation. For example, why was the Greater London lung cancer-rate (for 1953) 1,710 per million males at ages 45–64 and 4,125 at ages 65–74 years, while the corresponding rates for Dublin remained at 1,650 per million at ages 45–64 and 1,655 at ages 65–74? In 1953 the rate in rural England was 1,140 at ages 45–64 and only rose to 1,665 at ages 65–74 years.

The author states, "A study of the mortality rates per million for respiratory and non-respiratory tuberculosis and cancer from 1893 shows that apart from the disturbances due to the wars the sum of the mortality rates of the two diseases remains constant at 2,500 from the year 1910 onwards. It would appear that the mortality from respiratory tuberculosis has been replaced by that from non-respiratory cancer and that from non-respiratory tuberculosis by respiratory cancer".

Work on the relation of the atmospheric benzpyrene to smoking and lung cancer in Liverpool and nearby rural districts have shown that: "(1) rural death rate from lung cancer increases in proportion with the maximum number of cigarettes which have been smoked habitually per week, (2) Liverpool rates exceed the rural rates by about the same amount in each smoking category, (3) the urban/rural ratio between the death rates among non-smokers is about 9 to 1 and corresponds roughly with the ratio between the concentrations of 3 : 4-benzpyrene, some

other polycyclic hydrocarbons and sulphur dioxide, found in the air of a Liverpool locality and the concentrations found in rural situations in Anglesey and Cheshire".

Stocks and Campbell's report just mentioned is a first-fruit of a major co-operative investigation into the environmental histories of patients dying of cancer of all sorts in North Wales and Liverpool. Data on 12,000 such patients and 19,000 controls are now available. Among other findings based on this series may be mentioned the following: (a) Cancer of the uterine cervix can be related better to early commencement of child-bearing than to numerous progeny. (b) Cancer of the stomach, in rural Wales where it has a high incidence, appears to occur most often in those who have lived for long periods over soil of high organic content. (c) Those with a high intake of beer (but not of milk or tea, the former appearing actually protective) have a raised incidence of most forms of cancer (but not, oddly enough, of gastric cancer).

This kind of survey, which depends for its success on the co-operation of many separate agencies, is one for which the British Empire Cancer Campaign seems particularly fitted. Another activity one would like to see it promoting more vigorously is the investigation of the geographical incidence of cancer, a subject on which even in its simplest aspects a remarkable amount of work remains to be done. There are accounts of only two activities of this type in this year's report. From Hong Kong come reports of investigations of two tumours of importance in that area. Hou describes the post-mortem appearances of infestation with *Clonorchis sinensis*, which he believes to be responsible for 15 per cent of liver cancers in the area. Teoh describes the nasopharyngeal tumours of Chinese, and comes to a firm conclusion that they are squamous carcinomata. In both of these, experimental investigations are under way; in the latter the possibility that incense smoke is the cause is being examined.

In Uganda a Cancer Registry has been set up, and has had the benefit of a visiting statistician. It is hoped to produce reliable statistics at least for one large district around Kampala. So far it has not gone beyond indicating that the true total incidence of cancer in the African is probably not very different from that seen in Europe. It has been possible to confirm roughly beliefs that cancer of the penis, liver, skin (especially Kaposi sarcoma) and uterine cervix are especially common, cancer of the respiratory and alimentary systems and breast relatively rare, and cancer of the testis, tonsil and thyroid apparently absent. Fuller reports from this Registry will be awaited with interest. One piece of work given little space in this Report, which could be a key to the incidence of liver cancer in the tropics, is the *Senecio* alkaloid studies of Schoental and Head.

The Great Ormond Street review of the tumours of childhood continues. This year's instalment is prefaced by some observations on the way in which improved treatment of other diseases is increasing the importance of tumours as a cause of death in early life. Though only 1 per cent of admissions to the hospital are for tumours, they are the cause of death of 17 per cent of cases coming to post-mortem, a figure second only to congenital malformations. Of the tumours nearly a third are intracranial, which are dealt with in some detail this year. The 203 tumours seen in this situation include 174 (86 per

cent) glial and 29 (14 per cent) non-glial—the latter consisting of eighteen meningiomas, six cranio-pharyngiomas, four choroid plexus tumours and one ependymoma. Bodian classifies the glial tumours into (differentiating) medulloblastoma (70 cases), nodular astrocytoma (59), diffuse astrocytoma (25) and subependymal glioma (20). (It may be noted that this makes medulloblastoma the fourth commonest tumour of childhood, or fifth if one includes leukaemia: neuroblastoma, Wilm's tumour and lymphoma stand above it.) Medulloblastoma and diffuse astrocytoma appear to be nearly always fatal. In the case of nodular astrocytoma, subependymal meningioma and subependymal glioma, the prognosis is more encouraging and the results of treatment appear to be improving.

Further details of the study of the effect of treatment of neuroblastoma with vitamin B₁₂ in massive dosage are given. Though only moderately encouraging, with 25 per cent of two-year cures, the genuineness of the effect would appear to be established.

In an experiment on the effect of environmental factors on cancer incidence, fowls were kept in a climatic chamber at constant temperature and humidity, while their siblings were exposed to the ordinary vagaries of climate; the diet was the same in both groups. The result of constant climatic condition was to increase greatly the incidence of cancer, for in the climatic chamber thirteen of nineteen fowls died and were found to have been suffering from adenocarcinoma of the ovary, oviduct, mesentery, alimentary tract, spleen, or liver. During the same period, only one death occurred in the control group (variable climate) and no cancer could be found at post-mortem. The fowls in the constant climate chamber were sexually inactive (that is, ceased egg-laying) for an average of 1.5 months in the three years of the experiment, while the control (variable climate) hens ceased egg-laying for eight months. These experiments suggest that a constant environmental temperature and humidity has a powerful effect on the reproductive cycle, and that in the fowl, cancer of the reproductive system and also of the alimentary tract, the liver and the spleen is facilitated by environmental factors via the endocrine organs.

Electron-microscope studies of the virus-induced Rous sarcoma in the fowl has made possible the first definite morphological identification of this virus. It has been shown to have a diameter of 70 m μ , but is not constantly detectable in all filterable Rous sarcomas. Obviously there are some interesting gaps in our knowledge of this tumour awaiting elucidation. From eight different Rous tumours, the 70-m μ particles were detected in four, and their occurrence varied from one particle-bearing cell in 2,000 cells to one in 50 cells. When the cells of the tumour were disintegrated mechanically so as to liberate the virus, it was found that there was a very close correlation between the sarcoma-producing activity of the tumour of origin and the percentage of cells which contained the 70-m μ particles.

The investigation of the carcinogenic action of cholesterol is continuing; recent reports from the United States have claimed that some oxidation derivatives of cholesterol have a much more powerful carcinogenic potency than the parent sterol. Fieser, Bischoff and collaborators state that solutions in sesame oil of lathosterol, 6-hydroxy- Δ^4 -cholestene-3-one and particularly 6- β -hydroperoxy- Δ^4 -chol-

estene-3-one all produce sarcoma in 30–60 per cent of injected mice.

An interesting example of species differences in sensitiveness to carcinogens has been demonstrated in the reaction of the tissues of the rat and of the guinea pig to 2-acetamidofluorene. The rat develops malignant tumours of the liver, kidney, ureter, bladder, pancreas, acoustic duct, mammary gland, uterus and skin; but feeding the compound to guinea pigs for as long as four years produced no tumours of any kind.

Interesting facts have been discovered in a study of the behaviour of normal and of malignant fibroblasts when these are grown in tissue culture. When the pseudopodia of normal fibroblasts touch each other, adhesions occur and movement ceases. On the contrary, when the pseudopodia of malignant fibroblasts touch, no permanent adhesion takes place; the cell surfaces slide over each other.

Berenblum's early work on co-carcinogens (now termed 'promoters') dealt chiefly with the polycyclic hydrocarbons, for example, benzpyrene or 1 : 2 : 5 : 6-dibenzanthracene, as 'initiators' which were applied in sub-threshold doses to mouse skin and then followed up by promoters, the most effective being croton oil, which behaves like a photographic developer in making visible the preliminary effect of the initiator.

This work has now been extended by other investigators to show that the entirely different compound urethane is a potent initiator for mouse skin and that croton oil is an initiator as well as a promoter. New initiators have been found; for example, one of the most effective is allyl methane sulphonate and also β -propiolactone; furthermore, applied in sub-ulcerative doses, the lactone is a complete carcinogen and produces papilloma and carcinoma. The detergent 'Tween 60' has been found to have promoting activity. The problem of relating chemical structure with carcinogenic potency thus becomes more complex as carcinogens (whether the compound is a complete carcinogen or is only a promoter or an initiator) of widely different structure become known.

Tobacco tar has been tested for co-carcinogenic activity and with positive results. Mouse skin pre-treated (initiation) with benzpyrene developed papillomas when afterwards painted with tobacco tar, showing that the tar had a promoting effect.

In the ever-widening range covered to-day in research into the causes and treatment of cancer, the boundaries of the different fields of work become less distinct, and the physicist works in increasingly closer co-operation with his medical and chemical colleagues. Although the particular sphere of any one worker tends to become narrower, yet he is quick to make the most of the very varied tools available to him. This is well illustrated at one centre by the use of electron microscopy and autoradiography in the study of ultra-thin slices of tissues which contain carbon-14 or sulphur-35. A 1,000-curie cobalt-60 unit for the joint use of chemists, physicists and radiotherapists forms common ground for radiobiological research in another laboratory, and leads to the mutual discussion of other problems which are common to workers attacking the same basic problems from such widely differing approaches.

A considerable number of centres are installing, or have installed, sources of radiation of increasing penetration. Reports from various regions give details of measurements of the depth-dose distributions with 4–15 MeV. linear accelerators, and with

cobalt-60 sources. The effects of the inhomogeneity of body tissues on the dose received in the various tumour sites, and also the relative biological effect of the various qualities of radiations used in radio-therapeutic practice are being investigated.

Methods of calorimetric dosimetry are being perfected to enable an accurate measure of beams of high intensity but short duration, such as are met with when using the linear accelerator. Scintillation dosimetric techniques can now be applied with an energy response constant to ± 10 per cent over the range 20 keV. to 2 MeV.

At the other end of the activity scale, equipment has been constructed for the continuous monitoring of the natural radioactivity of the atmosphere, and regular measurements are being made of the radon content of the air in both hemispheres. Measurements

have also been made of the natural radioactivity of different types of building materials from different parts of the world, and calculations carried out on the doses received at the gonads for both males and females. With the increasing development of radioactive materials, arising from a variety of uses from the luminescence of wrist-watches to the 'fall out' resulting from atomic explosions, the radiation dosage-level of the population as a whole becomes of increasing importance. This is confirmed in this report by the increasing use of radioactive isotopes, not as therapeutic agents, but as diagnostic and research tools, for labelling red blood cells with iron-59, for radiography with thulium-170 and xenon-133, and for diagnostic tests for thyrotoxicosis using iodine-131, to mention but a few of the numerous routine uses.

SCIENCE BY THE UPPER FORM

A SESSION of Section X (Assembly of Corresponding Societies) of the British Association meeting at Sheffield was devoted to a series of papers by sixth-form pupils under the title "Science by the Upper Form". Its object was two-fold: to introduce the young people to the meetings of the Association and to give adult listeners an insight into the work and interests of potential scientists.

The session was popular and attracted the largest audience that the Section enjoyed. The papers covered a wide range, from a consideration of the teaching of the history of science in schools to the mating customs of bullfinches, and from a school astronomical project to observations upon animal life in a stream. They were all indicative of much careful thought, and, where the subject demanded it, close and continuous observation combined with accuracy in recording. The young people were to be congratulated on their timing. None exceeded the limit imposed and some ended with a few minutes in hand.

The session was opened by Anthony E. Hanwell (King Edward VII School, Sheffield), who, under the title "The Value of the History of Science in a Sixth-form Science Course", gave an account of a course involving two periods a week for two years. The course began with the early attempts of man to exploit and adapt himself to his environment, all of which were characterized by the lack of a desire to seek theoretical explanations of the processes used. This was followed by attention to the study of Nature by the early Greek philosophers; to the Roman attitude to such matters; to the general decline in learning in the Dark Ages, and the impact upon European thought and life of the rise of Arabic nationalism and the recovery of the ancient Greek writings.

The course dealt fully with the lives of Copernicus, Tycho Brahe and Kepler, and the far-reaching effects of the work of Newton. Other sections were concerned with the histories of magnetism, electricity and light, to which a considerable amount of time was given; but it was surprising to learn that the history of biology was dealt with only in outline, and that of geology apparently not at all.

The speaker said that he was impressed by the way in which the study of the experiments of the pioneers emphasized the necessity for accurate

observation. This in ordinary class-room work seemed directed mainly toward "obtaining a more accurate answer to a particular experiment, when if the answer were known it is usually possible to surreptitiously modify the observations". He appreciated the necessity for dealing with failures as well as with successes, and concluded that "a history of science course can do much to rectify the errors of undue specialization" by providing the scientist with a broader knowledge of his subject, its aims, its limitations, and its possibilities for good.

In a paper entitled "British Finches", Kenneth R. Hughes, of Chesterfield, gave the results of observations on three of the common species that he had kept under observation. The behaviour of some kept under aviary conditions was found to be identical with that of the wild birds. From accounts of mating displays, nest-making and brood-rearing it appeared that the courting of bullfinches began in mid-April and lasted for about a fortnight. Nest-building began soon after mating and when incubation commenced the cock was rarely seen near the nest, though he shared in the feeding of the young while the hen was sitting on her second clutch. When the birds of the second brood were able to feed themselves the whole family gathered and remained together until spring, changing their summer woodland habitat for gardens and allotments during autumn and winter. In March the flocks separated into pairs and the yearly cycle began again.

Hawfinches next received attention. The courtship was seen to be a vigorous affair in which the female seems almost to be driven to build a nest. The young are reared on insects, and it is only later that they become the enemies of fruit growers and gardeners.

The work is continuing, for Kenneth Hughes has seven other species under observation. He regards finches as suitable for his purpose on account of the ease with which they may be kept under conditions almost natural to them.

Miss Anne Bunting contributed a paper on "Some Little-known and Unpublished Aspects of the Life-History and Habits of *Periplaneta americana* (L.)". Having reared the large American cockroach for a number of years, she had come to the conclusion that the periods of incubation and of growth from incubation to final moult were shorter than is stated