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	PAGE		PAGE
<i>The International Geophysical Year—</i>		<i>Preliminary Observations on the</i>	
S. RAMASESHAN	267	<i>Pharmacological Actions of Various</i>	
<i>W.H.O. Report on Radiation Hazard</i> ..	270	<i>Fractions of Nardostachys jatamansi—</i>	
<i>Jets, Wakes and Cavities</i>	271	DC.—B. C. BOSE, S. S. GUPTA, R. VIJAY-	
<i>The Encyclopedia of Chemical Techno-</i>		VARGIYA, A. Q. SAIFI AND J. N. BHAT-	
<i>logy</i>	273	NAGAR	278
<i>Viruses in Search of Disease—N. VEERA-</i>		<i>The Origin of the Aurora</i>	280
RAGHAVAN	274	<i>A New Type Particle Accelerator</i> ..	281
<i>Radiation Controls Titanium Furnace</i> ..	275	<i>Letters to the Editor</i>	282
<i>Ultraviolet Absorption Spectra of Mono-</i>		<i>Reviews</i>	294
<i>substituted Benzenes—C. N. RAMA-</i>		<i>Science Notes and News</i>	299
CHANDRA RAO	276		

THE INTERNATIONAL GEOPHYSICAL YEAR

ERATOSTHENES measured the earth; Cavendish weighed it. These were perhaps the earliest of the great geophysical experiments on which man was to launch upon. Indeed, Gilbert's concept of the earth as a giant magnet, Halley's charting of the trade winds, the ascent of Gay Lussac and Biot in a balloon to investigate the chemical composition of the atmosphere, the discovery by Kennelly and Heaviside of the ionosphere, the detection of the jet stream in the upper atmosphere, Störmer's theory of charged particles from the sun causing the auroræ, the theory of isostasy and Wegener's theory of drifting continents, appear to have been taken from the pages of a fairy tale. This year, scientists of more than 70 nations are joining together to make a concerted effort to get a better knowledge of our planet, the earth. Unlike the two previous attempts in 1882 and 1932 when most of the studies were confined to the polar regions, the

present effort, which is on a **very much larger** scale, will involve not only the poles but the whole earth including the land, the oceans, the atmosphere and the multifarious solar phenomena which have such a great influence on our lives. However, a balanced evaluation of the general programme indicates that the activities to be carried out on and beneath the surface of the earth will be overshadowed by the explorations of the lower and higher atmosphere.

THE GLOBAL ASPECTS OF THE I.G.Y.

The duration of the International Geophysical Year (I.G.Y.) is from the 1st of July 1957 to 31st December 1958, this period having been chosen because of the intense sunspot activity that is expected during it. Extensive observational data are to be collected in the fields of meteorology, glaciology, oceanography, seismology, gravimetry, latitude and longitude

measurements, solar activity, geomagnetism, air-glow, auroral displays, ionospheric behaviour and cosmic ray physics. Effecting a proper correlation between the data in the different disciplines would be one of the most difficult tasks which the organisers of the I.G.Y. have to face. This all-important co-ordination will be attempted at different levels by a series of committees. Apart from the observations to be made in more than 2,000 permanent stations spread round the world, more than 1,000 new observational points have been scheduled. For the distribution of the I.G.Y. stations, clearly defined areas have been selected based on existing scientific conditions. Special emphasis will be put on the arctic and antarctic regions. Measures are being taken to establish a large number of stations in the equatorial belt and the tropic zone where the observational coverage during the past has been insufficient. Four special meridians (80° W., 10° E., 75° E., and 140° E.) have been chosen where a dense net of observation points are being situated. Additional observations from ships and special units have also been envisaged.

In addition to the routine recording of all interesting geophysical data, there will be about 60 "regular world days" when special extensive investigations are scheduled. Whenever any unusual ionospheric, magnetic, auroral or meteoric activity is expected an "alert" will be given and different stations will start making special observations for specified intervals. There will also be six "world meteorological intervals" of ten consecutive days each, during which observations of meteorological interest will be made.

The programmes that are contemplated are so ambitious and the preparations that are being made are so elaborate that it would be impossible to even mention them in a single article like this.

METEOROLOGY AND RELATED SUBJECTS

The meteorological programme of the I.G.Y. stresses the need for the systematic exploration, on a worldwide scale, of the upper troposphere and the stratosphere and it lays down that the investigations should be devoted to large-scale physical, dynamic and thermodynamic processes connected with general circulation. Studies should be particularly directed to elucidate the redistribution in the atmosphere on a planetary scale, of momentum, absolute vorticity, entropy and various forms of energy. Large-scale influence of friction and surface topography, heat and momentum interchanges between the atmosphere and the con-

tinents and the ocean, etc., will also be subjects of study. The programme of observation will consist of the daily routine recording of the synoptic data on land and on board vessels. Each recognised station will make two radio soundings, preferably upto the 10 m.b. level (by balloons), of the pressure, temperature and the humidity and will make four radio-wind observations.

One of the important series of measurements to be made will be those on heat or radiation balance. For these the recognized procedures will be supplemented by the use of radiometers recently developed for measuring the difference between the incoming radiation and that reflected back by the earth's surface.

Nuclear radiation in the atmosphere is to be measured. This would help in determining whether there is any direct correlation between rain and radioactivity. These measurements would also help to identify large masses of air making it possible to draw up on a planetary scale the trajectories of the synoptic air particles. It is hoped that all these meteorological studies may also prove useful in exploring the possibilities of artificial climate control and in the development of the arid regions.

World climate is known to be influenced by the cover of snow and of ice on the earth's surface and the melting of even a fraction of this cover may submerge large portions of dry land. It is well known that the glaciers are retreating and the sea-level is rising. The I.G.Y. programme of glaciological studies includes special seismic methods for estimating the thickness of the ice and the recording of the present glacier topography. To define the geography of the underlying coast is also one of the prime purposes of these studies.

The melting of the polar snows is closely connected with the general circulation of water. A large number of ocean survey vessels will be used for these investigations. Of particular interest will be the study of the shifting boundaries between temperate and polar waters and the transfer of energy across the equator.

GRAVIMETRY AND SEISMOLOGY

Worldwide contributions are expected during the I.G.Y. to the problem of the tides experienced by the solid earth. Under the influence of gravitational forces of the moon and the sun, the earth undergoes tidal movements comparable to those of the sea; the amplitude of the movements being of the order of ± 20 cm. and they can be measured by accurate gravimeters and horizontal pendulums.

A network of well-distributed seismological stations will provide continuous seismic data

all over the world. Data from some of the seismological stations will include microseismic observations which are related to the tides and storm surges in the sea.

It is, however, significant that the suggestion put forward by some eminent seismologists that the earth's interior structure may be studied by exploding atom bombs has been turned down by the Special Committee of the I.G.Y. Programme on the grounds that there was no wish on the part of this body to be associated with a tool of such sinister and diabolical reputation.

Thirty-nine observatories will establish the exact position of certain selected stars during the I.G.Y. It is hoped that these extensive observations will give the exact geographical locations of the observatories, the short period and secular irregularities in the earth's rotation and corrections to the position of the stars given in the nautical almanacs.

SOLAR RESEARCH AND TERRESTRIAL PHENOMENA

It is but natural that considerable effort should be put into solar research during the I.G.Y. Satisfactory international co-operation already exists in solar research. During the I.G.Y. it is proposed to extend the observations made by the different observatories to establish a still closer co-operation between them. The study of the sun will consist of the recording of the sunspots, measurements of the intensity of the magnetic field near their vicinity by Zeeman effect studies, and obtaining also the general magnetic field of the sun, observations of solar flares, a continuous spectroheliograph, coronagraph and solar radio noise records.

The ultraviolet radiations from the sun on entering the earth's atmosphere converts some of the oxygen in it to ozone, and the ozone layer in the atmosphere is of great interest from the point of view of the upper air physicist. Very accurate measurements of the horizontal and vertical distribution of ozone are to be made during the I.G.Y. using spectrographic methods, or by methods based on the observations of lunar eclipses or observation of stars.

Even at night it is found that the upper atmosphere over the whole earth continuously emits a feeble light. This is known as the airglow and it derives its energy from the store accumulated during the day when solar ultraviolet light ionizes and dissociates the atmospheric gases at great heights. The spectrographic studies of the airglow are expected to reveal the mechanisms of dissociation and recombination that are taking place in the upper air.

POLAR AND TROPICAL AURORÆ

An occurrence of an intense flare on the sun's disc is followed almost simultaneously by a short wave radio fade out and a small but sudden disturbance in the earth's magnetic field. These effects are probably caused by the ultraviolet light from the flare reaching the earth. Twenty-seven hours later, there occurs a spectacular aurora visible widely over the earth together with a magnetic storm. The delay in the occurrence of these phenomena is explained as due to their being caused by a stream of material particles ejected by the sun at the time of the flare. This delay also permits the sending of adequate warnings to the different auroral stations. Work on the auroræ will in the main be concentrated around the auroral zone (67° N. and S.). By radar and parallax methods the height of the auroral display will be determined. Progress of an aurora will be continuously recorded by "all sky" cameras. The photographs from these cameras and radar scopes will be compared with those obtained on synchronously paired equipment in both the northern and southern hemispheres.

It is perhaps worthwhile to mention that the displays of the aurora are not confined to the polar regions alone. Indeed bright displays have been noticed in as low latitudes as Bombay and Singapore. But unfortunately no adequate observations of tropical auroræ are available. It would, therefore, be extremely valuable if persons, not necessarily formally associated with the I.G.Y. living in tropical regions, record accurately the form of any unusual luminosity that may be seen in the night sky.

During the I.G.Y., more than 100 new geomagnetic stations will be set up all over the globe which will continuously record the different magnetic elements of the earth. The I.G.Y. rocket measurement of the geomagnetic effects will also contribute to our understanding of the magnetic properties of the earth.

All the tremendous developments that have taken place in electronics after the war will be made use of in the study of the ionosphere. The practical applications to radio propagation will prove a great impetus for many of these investigations. The heights of the different ionospheric layers and their diurnal and long-term oscillatory movements, their fine structure, their absorption, reflecting, double refracting and scattering properties for waves of different wavelengths, will form some of the subjects for extensive investigations. The study of radio echoes as meteors enter the ionosphere will all

be undertaken. Researches in Radioastronomy and Cosmic Ray Physics, which have become so important during the post-war years, will be intensified during the I.G.Y.

ANTARCTIC RESEARCH

The knowledge about the great continent of Antarctica is so meagre but its influence on world climatology is so great that it has been decided to make it the scene of many scientific activities during the I.G.Y. Hidden behind these scientific goals also lie economic and political possibilities. On Antarctica more than twelve nations are establishing about thirty stations equipped with the most modern scientific equipment and these will be able to collect an enormous knowledge about this strange continent. One of these stations is to be situated right on the south pole and another on the magnetic pole.

ROCKET AND SATELLITE PROGRAMME

Scores of rockets are to be sent up to probe the mysteries of the upper air and some of them are expected to reach the auroral regions. U.S.A., Britain, France, Japan, Australia and U.S.S.R. have all joined in what will be one of the most complicated and expensive programmes of the I.G.Y.

But by far the most spectacular of all will be the I.G.Y. satellite programme. Both the U.S.A. and the U.S.S.R. expect to launch small satellites by means of rockets into space during the I.G.Y. The scientific instruments they will carry will send back by radio, atmospheric and cosmic data. The first American satellite will be about 50 cm. in diameter weighing about 10 Kg. travelling at about 28,000 km. p.h. in an elliptic orbit inclined to the equatorial plane of the earth at approximately 40°. It is expected to circle the globe every 90 to 100 minutes. Comparatively little news is available about the Russian satellite except that it may be slightly larger than the American one. It is also likely that the Russians will try to achieve a polar orbit of some kind.

A rather heartening part of the programme is that the geophysicists of U.S.S.R. and U.S.A. have agreed that both their satellites will transmit messages exactly on the same frequency (108 mc.). This will mean that the costly radio tracking equipment present at any one of the "Moonwatch" stations can equally well be used for both the U.S. and U.S.S.R. satellites. The optical track of the satellites will be kept by specially designed Schmidt cameras (mirror diameters 75 cm. f-50 cm.) which have a crystal clock incorporated in them. Precision observations of the tracks with these are expected to yield information about the density of the air, shape of the earth, etc. The programme of measurement by the first U.S. satellite will include the measurement of atmospheric temperature, air density, meteor penetration and surface erosion, the intensity of the U.V. and X-radiations from the sun. If the first satellite is a success a very much more ambitious programme of observation has been planned.

INDIA'S CONTRIBUTION

India, in her own small way, will contribute her share to the I.G.Y. programme. She will be having twelve radio wind and radio sonde stations and about 50 balloon stations for the upper wind studies, three storm detecting units, four radio noise laboratories. Exhaustive studies of the radiation balance will be made at four stations and spectrographic studies of the air-glow will be made at six observatories; eight auroral watch posts have been established. A network of geomagnetic and seismological units are already in existence and many centres of higher learning are co-operating in obtaining cosmic ray data. Himalayan glaciers will be extensively studied and a number of coastal ports will make oceanographic observations. The solar observatory at Kodaikanal will be continuously studying the sun during the I.G.Y. Nainital has been selected as the "Moon-watch" station, its complete astronomical equipment being a gift from the United States of America.

S. RAMASESHAN.

W.H.O. REPORT ON RADIATION HAZARD

THE authoritative report of the study groups on the Effect of Radiation on Human Heredity was published recently by the W.H.O. Headquarters, Geneva. The report declares that all man-made radiation must be regarded as harmful to man from the genetic point of view. Most genetic effects are very closely additive and small amount of radiation received by a large group of individuals can do an appreciable damage to the population as a whole.

The sources are: (1) X-ray tubes and nuclear reactors, and (2) artificial radioactive elements distributed by man in nature. The report outlines certain precautionary measures, and stresses the intelligent use of diagnostic and therapeutic X-rays or radio-isotopes so that their benefits may be at a maximum and any possible long-term genetic hazards are reduced to a minimum.