ADVANCES IN WEATHER FORECASTING

THE introduction into short-range forecasting of the methods of exact science, and the development of long-range forecasting, were the two main topics discussed by Dr. R. C. Sutcliffe, director of research in the Meteorological Office, Bracknell, in a paper read before the Royal Society of Arts on April 15.

Weather forecasting concerns the prediction of the behaviour of the atmosphere; an atmosphere which contains at any one time some 50 depressions or anticyclones and perhaps 100,000 showers, of which 2,000 may be thunderstorms. To observe the weather, there are about 7,000 synoptic reporting stations, 4,000 reporting ships and only 700 stations launching balloons to give measurements of the upper air. Of the latter, more like 2,000 are needed: a good investment for 100 million dollars a year. In addition the American meteorological satellites now transmit pictures of the clouds seen from above, while a new idea for obtaining upper air data is to use balloons floating horizontally at a fixed density launched from a few strategic sites.

Now, however complicated the motions of the atmosphere may be, they are determined by the laws of physics, and it might have been expected that weather forecasting would have been approached by the methods of exact science in the same way as astronomy. However, because of the many variables and complicated laws the calculations seemed impossibly complex, and until very recently forecasting remained a skilful art. Even the work of L. F. Richardson forty years ago in showing how to calculate the change in wind and pressure was of no practical value, requiring according to his own estimate 64,000 assistants to keep pace with the changing pattern of the weather.

The introduction of the methods of exact science into short-range forecasting had to await the end of the Second World War. By then, upper air observations had provided a good idea of the three-dimensional structure of the atmosphere; advances were being made in the theory of dynamical meteorology; and the electronic high-speed computer had been invented to replace Richardson's 64,000 assistants. Although work to develop prediction by mathematical calculation started in Britain some five years after that in the United States, by following an independent line Britain's achievement now bears comparison with any country. Dr. Sutcliffe then announced that the method would become routine in the Meteorological Office when a suitable computer was installed later in the year. The system used involves the four available quantities: pressure, temperature, density and the velocity of the air which are related by four laws of fluids, Boyle's and Charles's law and the conservation of mass, energy and momentum. The data from the observing stations are sorted and analysed by the computer, which interpolates values of the required quantities at a regular network of some 1,500 grid points covering a large geographical area and the depth of the troposphere. The computer then does the calculations and prints out the answers from which the forecast charts can be constructed. A comparison of 102 forecasts in 1963 gave correlation coefficients between forecast and actual height changes at 1,000 mb of 0·71 for conventional and 0·80 for numerical methods; root mean square height errors in metres at 200 mb were 68·5 for conventional and 50·7 for numerical methods. Thus the computer is replacing the skilful forecaster, who will now only be required to predict such things as rain or frost or fog—and this probably only for the present.

The second topic, the long-range forecasting for weeks ahead, is much less of a success story. Public distribution of monthly forecasts by the Meteorological Office began last December, and these aim to give a general statement on how the coming month will work out compared with past averages. Even such a general statement, if reliable, would have very great economic value. The methods of short-range forecasting cannot be extended, since there is an energy loss by friction of 10 per cent every day, and there is no accurate way of calculating either this loss or the energy input. At present, long-range forecasting can be at most a skilful art. The art involves investigating the synoptic situations over the northern hemisphere and trying to find the essential factors that make a month wet or dry, warm or cold. Previous years are then examined for the occurrence of these factors, and it is then inferred that the season will continue to progress in the same way as in these past years. Physical factors such as sea surface temperatures, the state of the polar ice or the Continental snow fields, are also taken into account.

The reasons behind the changeableness of the seasons are unknown. Some relate the cause to sunspots, some to volcanic activity, others to meteoric dust. Dr. Sutcliffe ended by airing his own speculations. As the seasons go by and the circulation of the atmosphere responds to the changing heat of the Sun, there is no unique sequence of events; but rather there are many possibilities, and as every year begins differently from every other, so it continues differently and there is never a balanced state, always continuous change. The atmosphere is always hunting towards the seasonal balance but never attaining it.

J. R. PROBERT-JONES

FISHERIES RESEARCH IN JAPAN

SINCE 1929 there has been in Japan a Central Fisheries Experimental Station under the Ministry of Agriculture and Forestry. This station was divided, in 1949, with the view of speeding up research, into eight regional laboratories under the Fisheries Agency of the Ministry. The Tokai Laboratory (the Fisheries Research Institute, Tokyo) claims to be the successor of the former Central Fisheries Experimental Station so far as research on marine biology, fishing technology, propagation of marine life and utilization of marine products are concerned. The area served by the Laboratory is theoretically limited to the seas adjacent to the Tokai Region (that is, the central part of the Pacific Coast of Japan), but its investigations on sardine resources and its oceanographical investigations related to fishing extend into a considerably greater area since the Laboratory is a co-ordination centre for the Laboratories of the Agency.

The Tokai Laboratory, under the directorship of Dr. Takemichi Hidaka, is situated on an approximately three-acre site, on an island of reclaimed land in the estuary of the Sumida River where it enters Tokyo Bay: the Tokyo Wholesale Fish Market is on the opposite bank. Primarily the Laboratory exists for the promotion of Japanese fisheries by investigations and researches into marine resources, and the technical problems of the fishing industry. The second objective is to provide information and

data for establishing administrative policies for Japanese fisheries.

The number of staff of 'scientific officer' class is about twenty-five, and these are grouped into five sections:

Marine Resources Section. The main task of the Section is to carry out biological research into marine resources, and to investigate population dynamics with the view of determining adequate measures for the conservation of those resources under conditions of sustained maximum productivity. Besides the director, Jin-jiro Nakai, the Section has a statistician and a marine biologist. Special investigations are being carried out on 'iwashi' resources, that is, sardine, anchovy, whitebait. Similar investigations are being made on mackerel. Marine plankton and other organisms are also being studied, while investigations of marine mammals include the study of migration, distribution and abundance of fur seals off Japan. The Section possesses an analogue computer for analytical studies on fish populations, including the estimation of population parameters, and investigations of the fluctuations of commercial catches.

Oceanography Section. This Section, with three 'scientific officers' led by Dr. Masao Migita, is concerned with those aspects of oceanography related to fishing in the sea areas adjacent to Japan, and includes investigations on the variations of the cold-water mass off Enshu-nada and the resultant effects on fishing. Work is also being carried out on the chemistry of sea-water and its effects on marine organisms. Water pollution studies have been made to determine rates of diffusion of polluted water in fishing grounds and bio-assays are being made of such water by using the brine shrimp, *Artemia salina*, as an index animal.

Marine Life Propagation Section. A programme of work is in progress under the direction of Dr. Takeshi Kawana, essentially as a pilot study of the feasibility of setting up an abalone hatchery farm. With control of temperature and food, the rate of growth of this shell-fish (much esteemed in east and south-east Asia) can be accelerated, and the crop made a good commercial proposition. Work is also in progress on the oyster, with similar aims. Large quantities of oysters are eaten in Japan, and frequently taken as *hors d'œuvre* just as they are in the West; but it is not uncommon for half a dozen oysters dipped in butter and fried to serve as a fish course for luncheon or dinner.

Another standard article of food in Japan is seaweed. One use is in *O-sembi*, which is made with a rice-flour dough, to which chopped seaweed may be added and disks of the product dipped in soy sauce and baked. Alternatively small rolls of dough are made and a ribbon of seaweed wrapped around and the result dipped and baked as above. Sushi are also eaten widely. These consist of a strip of raw fish wrapped around with vinegared rice and the whole rolled into a cylinder with seaweed around the outside. The collecting of seaweed is, however, an arduous and somewhat hazardous occupation. The fisherman works some distance off-shore in a small open boat and uses a bucket with a glass bottom pushed into the water to assist him in locating the weed. A long pole with prongs on the end is used to 'hook' seaweed that has attained an appropriate stage of growth.

Some years ago the productivity of the Japanese seaweed beds was severely threatened, but was saved by the application of the research work that had been carried out off the Welsh coast by the late Dr. Kathleen M. Drew of the Department of Cryptogamic Botany in the University of Manchester. In 1963 the seaweed fishermen of Kyushu gratefully erected a memorial to Dr. Drew. Warm tribute was paid to her work by Dr. Suto, algologist of the Tokai Laboratory, when he attended the ceremony in Kyushu.

Work is in progress in this Section on the production of weed of commercially usable quality, starting with the sowing of spores of *Porphyra* and following development through, under controlled conditions. This research work, including as it does investigations of the diseases of the laver and their countermeasures, is seen as a preliminary to 'pilot scale' cultivation of edible seaweed. An industry developing in this way could have important consequences in Japan.

Other work followed up in the Section is that of the construction of artificial fish shelters and seaweed grounds. As in many other laboratories throughout the world, work is also being done on the protection of wooden structures from damage by the timber-borer.

Fishing Gear and Methods Section. An experimental tank enables measurements to be made on the behaviour and hydraulic resistance of fishing nets of various designs under working conditions. Investigations can be made on fishing methods. Much work has been carried out under the leadership of the officer-in-charge, Shigene Takayama, on problems arising when nets of man-made fibres are used. The section has an officer staff of four members.

Marine Products Utilization Section. This section has a staff of seven officers, the largest group in the Laboratory. Under the direction of Dr. Hideo Higashi, work has been undertaken for some years on the use of enzymes to break down fish flour material in order to obtain food seasonings. This has led to further investigations into the possibility of breaking down fish by the action of enzymes in such a manner that the full protein content of the starting material can be utilized for the production of a palatable human food substance of high nutritional value. Some success has now been achieved on this 'liquefied fish' as it has been called.

Some two years ago, Dr. Paul Jones of Philadelphia, whose interests lay in the same field of work, visited the Tokai Laboratory and suggested a joint follow-up by the Tokyo and Philadelphia laboratories, with the view of producing a food suitable for weaning babies. Efforts have achieved sufficient success for both sides to have become extremely reticent about the methods adopted. Details are not being published until patents have been granted and, in the meantime, the Tokai Laboratory has appointed Dr. Kiyoshi Saito as its official representative and spokesman for this development.

The fermentation technique is reported to be somewhat tricky. Wrongly adjusted, it can easily lead to the production of harmful substances, or to the production of substances of too small a molecular weight considered too sickly for the Japanese taste. Under ideal conditions, the end-product is claimed to be of higher nutritional value than fish flour and, since in effect it is pre-digested, is easily digested; it has a good content of amino-acids. At present, support is being sought from the United Nations Organization and the United Nations Children's Fund so that work may move on from the laboratory to pilot-plant stage.

The Marine Products Utilization Section has other interests besides 'liquefied fish'. Much work has been done on the biochemistry of food tastes. Researches in similar laboratories elsewhere on the post-mortem changes of fish jelly (kamaboko) and its shelf life, rancidity of fish oils, vitamin A and B content of fish, extraction of vitamin A concentrates from fish liver oil, preparation of foodstuffs for fish culture, all find a counterpart here.

A 1,000-c. cobalt-60 source has been used for investigating the effect of ionizing radiations on marine products. Identifications are also made at the Tokai Laboratory of radioisotopes in fish contaminated as the result of nuclear tests. Studies have been made of the pathway of radioisotopes from the environment into fish.

The Tokai Laboratory has one vessel of 258 tons, constructed in 1955, another of 225 tons dating from 1949 and a wooden vessel of ten tons constructed in 1947. The major scientific research instruments carried by these vessels include 10,000-m echo sounders, wire winches for

up to 5,000 m, a Geiger–Müller counter, X-ray equipment, a geo-electrokinetograph, a graduated thermostatic culture tank, and a large-scale projector for minute organisms.

The *Bulletin of the Tokai Regional Fisheries Research Laboratory* appears about three times a year in Japanese, with English summaries. This journal commenced publication in December 1950.

Most Japanese research organizations are in direct contact with their American equivalents, and the Tokai Laboratory is no exception. Knowledge of European work in fishery, however, is negligible, and what little there is has been obtained through exchanges with the Hull Branch of the Torry Research Station. There has also been an exchange of lists of publications with Aberdeen. The Tokai Laboratory is not an educational establishment so that it does not compete in any way with the Fisheries University a mile or two away (which does exchange literature with the Torry Research Station). Trainees do, however, go after graduation to the Tokai Laboratory from countries of south-east Asia for more advanced work. These attachments are usually for periods of six months, and the number of students involved at any one time is less than ten—in January 1964 it was one, a Filipino.

Three of the staff of the Tokai Laboratory are serving as members of technical committees of the Indo-Pacific Fisheries Council of the Food and Agriculture Organization of the United Nations. There is usually someone from the Laboratory acting as a Food and Agriculture Organization Fishery adviser to the Government of a foreign country.

C. R. S. MANDERS

THE CARNEGIE UNITED KINGDOM TRUST

THE fiftieth annual report of the Carnegie United Kingdom Trust for 1963* contains some quotations from Sir Hector Hetherington's oration on the work of the Trust delivered at Dunfermline on October 3, 1963.

In his address Sir Hector Hetherington described the expenditure of £1·5 million on building up the public library service as the largest, longest and perhaps the most productive of the Trust's endeavours. In the social services, about £375,000 had been expended on building or improving some 2,160 village halls, while more than £1·5 million had been spent on the urban areas, especially on helping the voluntary services to cope with their needs. Support of the Museums Service continued during 1963, and the Government approved a token sum of £10,000 to enable the Treasury to contribute up to half the net cost incurred by local museum authorities in participating in self-help schemes conducted by Area Museum Councils. Schemes of improvement totalling £7,150 were adopted by eight authorities as a result of suggestions in expert reports, and grants for reorganizing 24 museums were paid during 1963. Six new community projects were promised assistance before an allocation of £100,000 was set aside for distribution during 1961–65. From the latter, allocations have been made for schemes at the new towns of Livingston and Basildon, the expanded town of Thetford, and housing estates in redeveloped areas at Edinburgh and Winchester. To qualify for these grants the schemes must concern wholly or mainly new communities, preferably expanding ones and be promoted by a responsible local body, democratically elected and competent to receive grants from charitable funds. The proposed community centre must provide facilities not already existing in the area and be settled on acceptable legal trusts, and the capital cost of the scheme must not exceed £1,000. £1,000 was provided to enable the Highland and Islands Film Guild to acquire film screens and a launching grant of £3,000 went to the National Bureau for Co-operation in Child Care, while the grant for a new Child Welfare Centre in Glasgow, containing a unit to provide special services for the handicapped, was increased to £16,000.

By the end of 1963 about half the £100,000 allocated for youth projects had been committed and during 1963 grants were paid in respect of improvements completed by 85 clubs in England, 14 in Scotland, 9 in Wales and 3 in Northern Ireland. From June 1963, regional youth centres were admitted as eligible to apply for assistance. Pioneering projects supported during the year included £1,250 towards the establishment of a highland outstation at Inverhair Lodge, Lochaber, for pupils of a secondary modern school in Buckhaven, Fife, and £1,500 to enable the Roxburgh Education Committee to develop a field study centre at Scotch Kershope under the management of a specially created voluntary body. A capital grant of £6,000 was also promised to the Greenhouse Trust to enable it to secure tenure of premises for its work in holding together small groups of teenagers in south-east London who are not at home in normal youth clubs. A grant of £4,000 was made to the Paddington Young People's Hostel Association towards the purchase of a hostel, and £3,000 a year for 3 years to the Community Service Volunteers for its work in enabling young people to gain experience of work in hard-pressed projects of social service in Britain.

The Trust's last grant to the Conservation Corps expired at the end of 1963 and the Corps is now independent of Trust subvention. The work output of the Corps has increased from 1,238 man-days in 1959 to 6,300 in 1963, of which 17·1 per cent and 50·6 per cent, respectively, were performed by volunteers from youth groups and employment. Small grants for the purchase of tools were made to some County Naturalists' Trusts and the Trust is providing £16,000 for the development of the first public Nature centre at Brantwood House, Coniston, as well as £5,000 for a permanent field centre at Kindrogan House, eight miles east of Pitlochry. Field study bursaries were awarded to members of 51 local scientific societies and grants totalling £838 were made for 15 projects sponsored by archæological societies in membership of the Council for British Archæology; while seven successful courses in meteorology for amateurs were arranged by the Royal Meteorological Society with the aid of the £500 annual grant from the Trust.

* The Carnegie United Kingdom Trust. 50th Annual Report, 1963. Pp. viii + 72. (Dunfermline, Fife: The Carnegie United Kingdom Trust, 1964.)

CUNEIFORM STUDIES AND THE HISTORY OF CIVILIZATION

THE December issue of the *Proceedings of the American Philosophical Association* (107, No. 6; 1963) includes papers read by five of the most eminent American cuneiformists at the 1963 annual general meeting of the Association. Each of these scholars writes on the subject which forms his own special field of interest, but each has taken pains to present his material in a context of wider philosophical issues.

Prof. J. J. Finkelstein writes on Mesopotamian historiography. He is mainly concerned to show that accurate and unbiased records of historical events are to be found only in the omen literature and that "true historiography"