Science Congress to which they should present their own local problems for investigation. In order to widen the scope of the usefulness of the Science Congress it may be deemed desirable to admit within its province the problems of municipal administration which directly concern the health and efficiency of the people.

Under the reformed constitution Indian scientists will be confronted with tremendous problems, and their preparedness to grapple with them on the basis of a common purpose and common understanding, must in a measure constitute the vindication of the general demand for the freedom of the country to progress.

Announcement.

WE have pleasure in informing our numerous readers that Sir Richard Gregory, Editor of *Nature*, will arrive in Bombay on or about January 19th. 1933, by the P. & O. SS. *Mongolia* and will be in India for about a month. He will be accompanied by Lady Gregory and hopes to visit Allahabad, Calcutta, Madras and Bangalore during his short stay in the country. Any communications intended to reach him on arrival should be addressed to Messrs. Macmillan & Co., Ltd., 276, Hornby Road, Bombay, and afterwards to their branches at Calcutta and Madras. We welcome Sir Richard A. Gregory and Lady Gregory to our country.

Effects of Temperature on the Determination of Size of Species.

By Dr. C. C. John, M.A., D.SC., D.I.C.

GRAY (1931) by his experiments on the eggs of *Salmo fario* has shown that the size of the embryo at the end of larval life is smaller at a higher temperature than at a lower. For the eggs of any given species of animals there exists a range of temperature within which the embryo is capable of developing into a normal healthy individual. If the temperature of incubation is raised, the rate of development of a cold-blooded embryo is increased and if the temperature is lowered the rate of development is retarded. Though the rate of growth at a higher temperature is more rapid, the final size at the end of larval life is smaller at a higher temperature than at a lower. This is because a larger proportion of yolk is required for the maintenance of the embryonic tissue at a higher temperature and only a smaller proportion is available for the formation of new tissue. Each of the many processes accompanying development is altered and a "new state of dynamic equilibrium is established" with the increase in temperature. These facts can be extended to a consideration of the development under natural conditions. The temperature of the seas increases as we proceed from the polar to the equatorial regions, so that the larvæ which develop under these different conditions are bound to show differences in size and the same conclusions may be applied to the adults also which develop from these larvæ. If this could be proved it means that individuals of any given species of aquatic animals (invertebrates and cold-blooded vertebrates) living under colder conditions will be larger than individuals of the same species in warmer seas.

The genus Sagitta is well suited for the verification of this fact, because of its occurrence in all the seas of the world under all conditions of temperature and depth, from the Arctic and Antarctic to the Equatorial seas. In a general consideration of the distribution of Sagitta the most disturbing factor is the difference in length of the specimens of any particular species obtained from different localities. For instance *S. enflata** obtained from San Diego region (Michael, 1911) are about 15–21 mm., whereas the specimens collected at Madras are only about 11·5–13 mm. The same kind of difference is also noticed in *S. neglecta*. In fact all the species found to occur both in tropical and temperate seas show differences in length, the tropical form being always smaller in length, compared to those obtained from temperate seas.

There are some species such as *S. lyra*, *S. hæmata*, *S. macrocephala*, *S. elegans* and

* The Sagitta of the Madras coast have been wrongly identified as *S. bipunctata* (Shankara Menon, 1931). I was kindly permitted to re-identify the material and have been able to describe five species *S. enflata*, *S. gardineri*, *S. tenuis*, *S. neglecta* and *S. robusta*. Probably a few more species may be discovered by more systematic method of collection.

S. decipiens, which have been so far recorded only from cold water regions under conditions of temperature varying from 1·1° to 18·6°. Among these *S. lyra* has a total length of 18–48 mm. while the length of *S. elegans* is 21–23 mm. In comparison with these there are some species, which are restricted to the warmer seas (temperature, 21–29°), such as *S. neglecta*, *S. regularis*, *S. betodi*, *S. ferox*, *S. tenuis*, *S. gazelle*, *S. hispida* and *S. pacifica*. All these species are relatively shorter, for example, *S. neglecta* measures about 8–13 mm., *S. tenuis* 5–5·5 mm. and *S. hispida* 5·5–10 mm. Though all the species mentioned above are limited in their range of distribution there are quite a number of others, which show a cosmopolitan distribution, *e.g.*, *S. bipunctata*, *S. hexaptera*, *S. subtilis*, and *S. serratodentata*. *S. hexaptera* has been recorded between 70° N. and 40° S. at temperatures varying from 6° to 29° and *S. bipunctata* between 74° N. and 28° S. at temperatures varying from 0·2° to 31°. Among these two, *S. hexaptera*,[1] especially, gives the best example of the influence of temperature on the determination of the size. The total length of *S. hexaptera* varies from 20–70 mm. Specimens obtained from the Gulf of Naples are about 20–25 mm. long while those obtained from colder regions are considerably longer, reaching upto 70 mm. in length. I was privileged to examine the collection of Sagitta of the "Discovery" expedition and the first thing which impressed me about the whole collection was the comparatively larger size of the specimens. Samples of *S. hexaptera* in this collection measure about 70–80 mm. These large specimens were obtained from regions beyond 40° S. and at depths ranging from 1,800–3,000 metres. The surface temperature in these regions varies from 8°–12°, but temperature at the depth from which these specimens were obtained is very much lower.

Though the data available at present are not sufficient for drawing up a statistical table, the general facts seem to indicate that in the colder regions Sagitta are comparatively long and that increase in temperature is accompanied by a corresponding reduction in size, in other words, the length of any given species of Sagitta in relation to its distribution is inversely proportional to the temperature of the locality from which the specimens are obtained.

For a study of the length of species in relation to temperature more than one factor is to be taken into account. Apart from its surface distribution Sagitta occurs at various lower depths, so that unless the depth of the catch and the temperature of that depth are definitely known it will be difficult to estimate the true relationship between temperature and size. If temperature does really influence the length of the species, then bathymetrical distribution is an important factor. It is one of the simple facts of Oceanography that temperature diminishes with depth, the bottom being always very much colder than the surface. Therefore, if in any locality a species of Sagitta shows vertical distribution the length of individuals obtained from markedly different depths are bound to show differences in length. But very careful systematic study of both Geographical and Bathymetrical distribution are essential before these facts can be definitely established.

Differences in the length of the larvæ may also be noticed in some aquatic forms of the temperate regions which produce two broods in the year. This is clearly seen in Herring (*Clupea harengus*) the common food fish of Europe. The Herring produces two broods, the autumn brood and the spring brood. The eggs of Herring are demersal, *i.e.*, they are laid at the bottom of the sea. They are hatched on the seventh day and the larvæ keep to the bottom for about three or four days till the yolk in the yolk sac is completely absorbed. The larvæ of the spring brood now migrate vertically upwards to the surface and from there to the coast, while the autumn brood behaves in a slightly different way. They never appear to leave the bottom but migrate shorewards without an intermediate journey through midwater. When the larvæ reach the shore the two broods are of different lengths, so that it is difficult to estimate age in relation to length, but it can be shown that at the stage when red blood appears some of the specimens are about 33 mm. and others 35 mm. long. (John, 1932.) This stage has been called the metamorphosing stage. If it is taken for granted that at the time of metamorphosis all the larvæ are of the same age the difference in length can be explained only by the difference in the temperature of the sea water in which the two broods pass their early development. The spring brood undergoes its earlier development through summer while the autumn brood passes this stage through winter.

References.

(1) Gray, J., "The Effects of Temperature on the Development of the Eggs of *Salmo fario*," *British Journal of Experimental Biology*, 1931.

(2) John, C. C., " The Origin of Erythrocytes in Herring," *Proceedings of the Royal Society*, **B 110**, 1932.

(3) Michael, E. L., " Chætognatha of the San Diego Region," *University of California Publications, Zoology*, **8**, 1911.

Agricultural Meteorology.

By Dr. L. A. Ramadas, D.Sc., *Agricultural Meteorologist, Poona.*

THAT weather has a great influence on crops is well known from the earliest times. The farmer has ever watched the skies anxiously for symptoms of coming weather for guidance in planning and prosecuting his farming operations. The experience of past ages has crystallised into popular weather lore handed down from generation to generation; but such information is necessarily empirical and of very local interest. As Sir Napier Shaw said in his opening address on Agricultural Meteorology before the Conference of Empire Meteorologists, Agricultural Section, 1929 (London), " Agricultural Meteorology is what the farmer knows and won't (or can't ?) say ". With the development of Agriculture and Meteorology as more and more exact sciences in recent times, we feel the need to-day of escaping from the limitations imposed by the vagaries of weather on farming and of exploiting with fore-knowledge the results of modern science in artificially improving the growth and yield of crops, in combating the adverse effects of fungi and pests and in protecting crops as far as possible from damage by bad weather either by inventing protective devices or by culturing weather-resisting types. It is the business of the Agricultural Meteorologist not merely to discover exactly " how much sun, how much warmth, how much rain was necessary for a bumper crop " but also to find out whether he can tell the farmer before-hand how much of these elements of weather he may expect in a given season. The State is also an interested party as it wishes to know before-hand, however roughly it may be, what the prospects of agriculture are likely to be and how much land revenue may be expected during a financial year.

Russia was one of the earliest countries to move in this direction and systematic observations of meteorological elements side by side with the growth and yield of different crops were commenced at a large number of experimental stations (the number of stations was 81 in 1912). The United States of America, Canada, Great Britain and most of the European countries have similar organizations for the study of Agricultural Meteorology and its practical applications to farming. The growing interest in the applications of meteorology to agriculture is also shown by the fact that before the War the International Meteorological Committee appointed a special Committee to study meteorology in relation to Agriculture. This Committee is now under the Chairmanship of Dr. Wallen of the Swedish Meteorological Service.

In India the Meteorological Department was instituted in 1875 to combine and extend the work of various provincial meteorological services which had sprung up before that date. The warnings to ships, ports, aeroplanes, etc., the daily weather reports, the monthly weather reports and seasonal forecasts for rainfall issued by the department are based on meteorological observations received by the forecasting centres from about 200 surface observatories. The observations recorded daily at these and a few more observatories for periods ranging upto 50 to 60 years are now available. The Department has also been responsible for technical supervision of rainfall registration at about 3000 stations in India, so that, on the meteorological side, there is available at present a very large mass of accumulated data for correlation with available crop data.

It will be recalled that two years ago, soon after his return from Europe after attending the International Meteorological Conference at Copenhagen and the Conference of Empire Meteorologists in London, at both of which Agricultural Meteorology was one of the subjects for discussion, C. W. B. Normand, Director-General of Observatories in India, placed before the Imperial Council of Agricultural Research a modest scheme on Agricultural Meteorology on the lines of the recommendations made by the Royal Commission on Agriculture in India (*vide* para 577 of their Report, 1928) so that India may fall into line with other nations which had already made a start. The scheme was sympathetically considered by the Council and official sanction was given early last year for giving effect to the scheme for a period of 5 years. Unfortunately the scheme had to be held up owing to the retrenchment campaign of the Government of India in 1931. The Government of India recently reviewed the research schemes sanctioned by the Imperial Council of Agricultural Research, and decided that rather than postpone the scheme of Agricultural Meteorology until the financial situation improves, it should be proceeded with on a reduced scale for a period of three years. The cost of the restricted scheme is roughly half of what was originally sanctioned. The New Branch began functioning in August last at the Meteorological Office, Poona.

The work of the new branch on Agricultural Meteorology will be under two heads: (*a*) Statistical, and (*b*) Experimental or Biological, but these two lines of enquiry are complementary to each other.

The programme of statistical investigation will begin with a critical enquiry of the available data on the area and yield of crops for the various presidencies and districts in India, and proceed, after careful selection, to correlate some of them with the accumulated meteorological data.

It will be one of the aims of the new branch to interpret the needs of the farmer to the weather forecaster and to tell the farmer in what way the