the eleven members of the executive committee of the association. It brings together the persons who have most to do with the details of society and association affairs, notably with preparations for the society and association meetings. Of paramount importance is the fact that the executive officers of the association are individual members of this conference. The chairman of the Secretaries' Conference for 1933 is Professor Percy E. Brown, of Iowa State College, who is secretary of Section O. The present secretary of this conference is Dr. Mark H. Ingraham, of the University of Wisconsin, associate secretary of the American Mathematical Society.

Secretaries' communications are regarded as somewhat confidential. They are sent only to members of this conference—excepting the secretary of the Academy Conference, who receives them for his information, and sometimes individuals who are not members but who have been asked to aid the conference in some special study. Invitations to the annual secretaries' dinner are sent, by the permanent secretary of the association, to members of this conference (and sometimes to one or two invited guests) who have intimated that they will attend the conference session to which the dinner is supplementary.

The Academy Conference is similar to the Secretaries' Conference in many respects, but its membership is based on geographical distribution and local organizations rather than on representation of the various fields of science. It includes, as *ex-officio* members: (1) The twenty-seven council representatives of the affiliated organizations of the academy group (one representative from each) and (2) three representatives of the association's executive committee. The present chairman is Dr. Howard E. Enders, of Purdue University, Lafayette, Indiana, who represents the Indiana Academy of Science. The secretary is Dr. S. W. Bilsing, of the A. and M. College of Texas, College Station, Texas, who represents the Texas Academy of Science.

Academy communications are conducted like the secretaries' communications, but they are specially notable for the fact that they generally carry brief items of academy news as well as material pertaining to discussions before the conference. They are sent not only to Academy Conference members (and the secretary of the Secretaries' Conference, for his information, as well as to any specially invited guests of the Academy Conference) but also to the president and secretary of each local organization of the affiliated academy group. The Academy Conference has been especially interested for several years in high-school science clubs and the junior academies of science that have recently been organized in several states. It has done much to bring its constituent organizations closer together and closer to the association.

Each of the two conferences is to hold its annual session at Boston, in convocation week, with important topics for discussion, and the American Association will provide a Boston dinner or luncheon for each conference.

BURTON E. LIVINGSTON,
General Secretary, A. A. A. S.

REPORTS

THE WORK OF THE WEATHER BUREAU[1]

THE United States Weather Bureau through its forecasting service probably touches directly the immediate needs of more of the people of the United States than do all other federal services combined, with the single exception of the postal service. The convenience, health and budget of every family in the country are in greater or less degree dependent upon that family's ability to avoid weather hazards, exposure and loss. There is little general realization either of the extent of the personal interest of the whole population in this service or of the magnitude of the organization and the labor involved in serving this universal individual need. The significance in the life of a city, for example, of a single temperature forecast may be seen from the following: With notice of an approaching cold wave greenhouses are closed and boilers fired. Preparations are made at once by heating and lighting plants, whether gas, electric, steam or hot water, to meet the increased demands that will follow. Fire hydrants, exposed mains and general plumbing are protected. Small householders as well as large stockyards drain their mains. Gasoline engines are drained and automobile water-cooling systems are protected by the use of antifreeze solutions. Work in concrete is stopped. Street-railway companies arrange for more heat in their cars. Natural-gas companies turn a larger amount of gas into their mains to provide for increased consumption. Merchants direct their advertising and attention largely to cold weather articles. Oyster dealers increase their reserve stocks. Coal dealers supply partial orders to all customers needing fuel, instead of furnishing full orders to a few, and thus serve all their patrons. Ice factories reduce their output. The dredging of sand and gravel ceases, and iron ore piled for shipment is placed in

[1] Preliminary report of the Special Committee on the Weather Bureau of the Science Advisory Board. Members of the committee are Isaiah Bowman, Karl T. Compton, Charles D. Reed and Robert A. Millikan.

the holds of vessels, to prevent the wet masses from freezing solid. Charity organizations prepare to meet increased demands for food and fuel, and thus minimize suffering among the poor.

Again, the economic value of the agricultural forecasts in the saving of crops such as hay, corn, fruits and vegetables, through the forecasts as to the dangers from rain, drought and frosts, is already of enormous magnitude, and every increase in the reliability of these forecasts runs into large figures when expressed in dollars. In the citrus-fruit districts of California, for example, it is reported that fruit to the value of $14,000,000 was saved by taking advantage of warnings issued by the bureau during one cold wave.

The crop reporting and marketing activities of the Weather Bureau represent a service to the commercial and shipping interests of the country of a magnitude appreciated only by those who are engaged in these activities, but its benefits are felt by every one both in the price and the quality of our foodstuffs.

The railway and transportation companies make continued use of the forecasts in their shipments. Perishable products are protected against temperature extremes by refrigeration or heating, as conditions may require. Frequently shipments of perishable goods are accelerated when it is found possible to carry them to their destination in advance of expected unfavorable temperature conditions. When this can not be accomplished, goods *en route* are run into roundhouses for protection. Not infrequently an advance notice of a cold wave will hold up a contemplated shipment until after the freeze has passed, and if the cold is protracted the companies will refuse to receive consignments of goods likely to be injured by low temperatures. Cattle, as well as fruits and vegetables, are routed to avoid extremes of high or low temperature. These precautions apply in some instances to prospective temperature changes within comparatively narrow limits. Bananas, for example, require very careful handling and must be kept at a temperature of 58° to 65° F. during shipment, because a temperature below 55° chills the fruit sufficiently to cause a deterioration in quality, while a temperature above 65° will produce over-ripening.

In times of floods and other disasters it is the river and flood division of the Weather Bureau which in many instances saves millions of dollars worth of property and human lives by the hundreds through furnishing the basic information as to the precise times before which rescue agencies must do their work in order effectively to salvage property and conduct to places of safety people who are endangered.

The river and flood service is organized with its principal headquarters at the central office of the Weather Bureau in Washington, with subsidiary district centers at advantageous points on the various rivers along which a service is maintained. About 66 district centers are maintained outside of Washington.

Measurements of precipitation in the drainage basins of streams and observations of the height of water on gauges placed at strategic points are collected by telegraph or telephone from about 900 substations and serve as the basis for warnings of floods. A second useful purpose is served on navigable streams in giving notice of boating stages during the low water season.

Flood warnings are indispensable to all river industries, as well as to operations carried on in the lands subject to inundation. Their issue is followed by the removal of stock, harvested crops and other property from bottom lands, and by a general exodus of the inhabitants of the country where overflows endanger human life. Foreknowledge of expected river stages is also of great assistance in determining whether or not it will be advisable to undertake farming operations in the regions subject to overflow.

Knowledge of slight river rises is often of great value, as these frequently permit large freight movements by water. Lumbermen cut a great deal of timber in swamps and along streams during low water in anticipation of higher water to carry out their logs; advance information of coming stages enables them to have everything in readiness to carry out their work without loss of time when the favorable conditions arrive. During rising water those in charge of locks, dams and levees are alert to the need of strengthening and protecting the property under their care; exact forecasting guides their operations as to the time, place and amount of protection, or may save them from expending money and effort in protective measures that will not be required.

The Weather Bureau's service to marine navigation is of scarcely less importance than to internal commerce. Storm warnings are displayed at more than 400 points along the Atlantic, Pacific and Gulf coasts and the shores of the Great Lakes, including every port and harbor of any considerable importance; and so nearly perfect has this service become that for years few storms of marked danger to maritime interests have occurred for which ample warnings have not been issued from 12 to 24 hours in advance. The reports from the West Indies are especially valuable in this connection, in that they enable the bureau to forecast with great accuracy the approach of those destructive hurricanes which, during the period from June to November, are likely to sweep the Gulf and

Atlantic coasts. The sailings of the immense number of vessels engaged in our ocean and lake traffic are largely determined by these warnings, and those displayed for a single hurricane are known to have detained in port on our Atlantic Coast vessels valued with their cargoes at over $30,000,000.

The climatological service of the Weather Bureau is one of the most extraordinary services ever developed anywhere and probably nets the public more per dollar expended than any government service in the world, inasmuch as practically all this work is done by 4,500 unpaid "cooperative" observers to whom the bureau has furnished rain gauges and thermometers, and whom it has inspired, for the mere love of the work, to keep meteorological records and to send in monthly reports. It is the 200 regular observing stations, each presided over by a trained meteorologist and each representing about 15,000 square miles of territory, which furnish the daily data upon which the various forecasts are based, but the demand for detailed knowledge of the climate over this great area has led to the gradual development of the important and interesting climatological service. Under this service, the country is divided into 45 sections, each section covering as a rule a single state, and each having one of the regular observing stations as its section center. Alaska, Hawaii and the West Indian and Caribbean area each constitute a section. The centers collect monthly temperature and precipitation observations from more than 5,000 cooperative and other stations, and each publishes a monthly and an annual summary, giving a large amount of climatological data by months and for the year.

It is mainly these reports upon which the engineer must depend for the data which guide him in his work in irrigation, hydraulic engineering and in the vast task of planning the systems of water supply which serve practically the entire urban population of the United States. The extraordinary skill, resourcefulness and effectiveness of the Weather Bureau in organizing and maintaining this immense service at practically no cost to the taxpayer is deserving of a much larger admixture of commendation and admiration and a much smaller admixture of criticism than it receives in a recent report by a Committee on the Weather Bureau of the American Society of Civil Engineers.[2] This report is well intentioned and contains valuable information, but from the standpoint of the present committee its implications are likely to mislead the reader; first, no doubt, because the engineers' committee was instructed to confine its studies to "the service of the Weather Bureau to engineers," and since this service represents perhaps 2 or 3 per cent. of the total work of the Weather Bureau, it was well-nigh inevitable that both the writer and the reader should lose perspective in appraising the work of the bureau; and second, because the committee did not concern itself with the practical problem of the relation of service rendered to cost to the taxpayer. The report dealt largely with the placement of the instruments and the tabulation of data, but Chief Marvin in his reply has shown that not less than 95 per cent. of the instruments are actually placed as the committee recommended, while the form of tabulation of data is fixed by international usage.

The service of the Weather Bureau to aeronautics, through its aerological division, is of course new, since commercial aviation in the United States is scarcely ten years old, but the willingness of the bureau to move forward as new needs arise is attested by the fact that its aerological division is already its largest service.

As is evident from the foregoing summary of its main activities, the Weather Bureau is rendering to the public a multitude of indispensable services. Every one knows, however, that the accuracy of weather forecasting is far from perfect. Improvement in this accuracy will result in a corresponding enhancement of the value of these services. In recent years there have been developed and tested new methods of forecasting which increase this accuracy, and the remainder of this report deals chiefly with the outline of a practical plan whereby these improvements may be introduced into the United States Weather Service.

Weather forecasting in aid of aviation has developed very rapidly in Europe within the past eight years, and this has been largely responsible for the rapid development of new forecasting techniques which, however, can be applied without change to the improvement not only of aviation forecasts, but also of practically all the forecasting services. For this reason the recommendations of this report deal largely with the problem of the introduction into all the forecasting services of the United States, whether in the Army, Navy, Weather Bureau or commercial aviation, of so-called air-mass analysis methods which merely supplement rather than replace the older methods. These new methods have so demonstrated their effectiveness, both in Europe and in such use of them as has already been made in the United States, that there is the practical certainty that our whole forecasting service can be improved both as to accuracy and in reliability, if the program presented herewith is followed. So great are the interests involved, as shown by the foregoing summary of the

[2] Proceedings of the Society of Civil Engineers for January, April, May, August, September, October, 1933.

services of the Weather Bureau, that the value of the prospective, but definitely realizable, improvements in the general reliability of weather forecasts, of all types are well-nigh certain to be measurable in many millions of dollars and in the saving of a great many human lives. Through the cooperation of the Departments of Agriculture, Commerce, the Army and the Navy these improvements can easily be effected without prohibitive expense, especially since some substantial counterbalancing savings to the taxpayer will be made if the whole meteorological service, including communications, is unified under the chief of the Weather Bureau, reporting as at present directly to an officer of the Cabinet. This will involve placing on the Weather Bureau the responsibility for the transmission of all meteorological data as well as the recording and interpretation of these data. This, of course, is not intended to suggest that the meteorological work of the Army and Navy should be curtailed, since this is recognized as an essential part of these services.

The Weather Bureau serves such a diversity of interests and is of such great importance to all of them that it is clearly imperative that it have the opportunity to serve them all impartially. Subordinating it to any one of them, such, for example, as a hypothetical department of transportation, would inevitably tend to destroy its usefulness to the others. This, of course, means first, that the integrity of the Weather Bureau should be preserved in any event, and second, that the whole meteorological service should be unified under a single responsible control. This consolidation will in itself decrease costs although the expense involved in responding to the demand for an improvement in the forecasting service, so urgently demanded by aviation and also needed by agriculture, commerce and navigation, will somewhat more than absorb the savings. However, the total annual cost of the Weather Bureau service to the people of the United States has never exceeded $4,500,000 and last year's budget was only $3,200,000. In the same year the Government's appropriation to the air mail service alone was $15,000,000 and that for the extension and maintenance of the airways $6,000,000.

(To be concluded)

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A NEW METHOD FOR THE STUDY OF CHROMOSOME REARRANGEMENTS AND THE PLOTTING OF CHROMOSOME MAPS

IT has long been known that in the functioning salivary glands of many dipteran larvae the chromosomes show an elongated and annulated structure. For the past year the writer has been studying such chromosomes, principally by the acetocarmine method, in larvae of *Drosophila melanogaster*. From this study the following conclusions are warranted:

(1) Each of the chromosomes has a definite and constant morphology and is made of segments, each of which has a characteristic pattern of chromatic lines or broader bands, which appear to run around the achromatic matrix. The same chromosomes, or characteristic parts thereof, may easily be recognized in different cells of an individual, or in different individuals of a species. If the position of one or more segments is shifted, by some form of dislocation (translocation, inversion, etc.), the exact morphological point (or points) of breakage can be determined and the segments identified in their new position. This discovery places in our hands, for the first time, a qualitative method of chromosome analysis and once the normal morphology of any given element is known, by studying chromosome rearrangements of known genetic character, we can give morphological positions to gene loci and construct chromosome maps with far greater exactness than has been heretofore possible.

(2) In old larvae, homologous chromosomes undergo a process of somatic synapsis. This union is more than a simple apposition, for the elements pair up line for line in the most exact way and form one apparent structure. If one of the homologues carries an inverted section we get typical inversion figures, such as we would expect in meiosis. If one of the homologues is deficient, at some point, the two mates unite except at the point of deficiency where the normal element usually buckles. Thus we can readily determine exactly how much of the one chromosome is missing. It is probable that the force which causes homologues to unite in salivary glands is the same that operates in meiosis, and while, so far as is known, these specialized chromosomes never divide, we can at least study how aberrant chromosomes unite at synapsis, a fact which should prove of great value to geneticists.

(3) In salivary glands the two arms of the v-shaped autosomes appear as independent elements with no obvious connection between them. As a result, after somatic synapsis, we find six elements in the nucleus, not the haploid number.

(4) The inert region of the X-chromosome does not appear as an organic part of this element, nor does it show in any other as yet recognized form in the nucleus. Likewise, the only part of the Y-chromo-