glands of mosquitoes infected with yellow fever, an animal organism which the members of the American Commission classified as a Protozoan of the order of Coccidiida.

Dr. Henry R. Carter, a distinguished surgeon of the Public Health and Marine-Hospital Service, in a letter dated October 31, 1903, says that while attending the Public Health convention in New Orleans, on December 12, 1902, he visited Professor Beyer's laboratory in Tulane University, with several other physicians, and was shown a number of slides under the microscope. These showed, Professor Beyer told him, sections of the stomach walls, thorax and salivary cells of mosquitoes, with bodies which Professor Beyer claimed were the coccidium, and explained the stages in detail. Dr. Carter says that unquestionably, at that time, Professor Beyer claimed that his slides showed the sexual stages of a coccidium and that he had demonstrated the sexual cycle of a coccidium in the infected *Stygomyia fasciata*.

The proof that the work which Mr. Smith claims to have done in January of this year was all originally done in the summer of last year by the working party of the U. S. Public Health and Marine-Hospital Service is so clear that it is difficult to see how Mr. Smith could set up such a claim. The letter of Dr. Pothier which he prints in his article is contradictory of his claim.

Mr. Smith was consulted in January of this year and corroborated the work already performed. Ratification by a man of his undoubted high scientific knowledge was valuable. Professor Beyer has willingly counseled giving Mr. Smith all due acknowledgment, and has never sought to withhold all that he was entitled to, that is, due recognition of his assistance in demonstrating the life cycle of the parasite.

Mr. Smith has never published any interpretation of the coccidium different from the working party's. It is hard to see, therefore, how he was the first correctly to interpret the discovery when his interpretation was the same as that made by the working party months before.

I ask that you publish this refutation of Mr. Smith's claims in the same manner as his article. This request is made with no wish to provoke a controversy, but solely with a view to correcting an injustice.

I also suggest that a warning note be issued by you against a too hasty conclusion that the animal parasite discovered in infected *Stegomyia fasciata* be accepted as the cause of yellow fever. The working party's report makes no such claim. Surgeon-General Wyman recently issued a letter pointing out that this claim is not made. The value of the discovery of the coccidium lay in the fact that it pointed out a path for future investigation.

H. W. Robinson.

New Orleans,
November 28, 1903.

SHORTER ARTICLES.

THE NEW COSMICAL METEOROLOGY.

With every fresh outburst of large spots on the surface of the sun there is likely to be a sympathetic disturbance in the terrestrial magnetic and electrical fields, a change in the weather conditions of the world, and a recrudescence of popular interest in the subject. Speculation as to the causal connection between this solar action and the terrestrial effect is apt to become extravagant, even going to the length of seeking to identify particular spots on the sun with individual storms on the earth. This procedure overlooks some facts in the chain of events which in reality bind the two phenomena together, and it is the purpose of this paper to present in a somewhat orderly form the sequence as at present understood.

It has been found necessary to include both the sun and the earth in our meteorological research, and properly so, because the atmosphere of the sun is at work in sending energy, and the atmosphere of the earth is receiving energy, each through its process of convection and radiation. By these agencies, a special circulation is sustained in the atmosphere of the sun, and another in that of the earth, and the energy of one passing into the other binds the two together in a single cosmical thermal engine. Solar physics and astrophysics are evidently only other names for meteorology, which embraces all atmos-

pheric phenomena in its scope. The details of the work of the Weather Bureau in this research are being published as rapidly as possible, but as some time must elapse before this will be completed, it may be of interest to

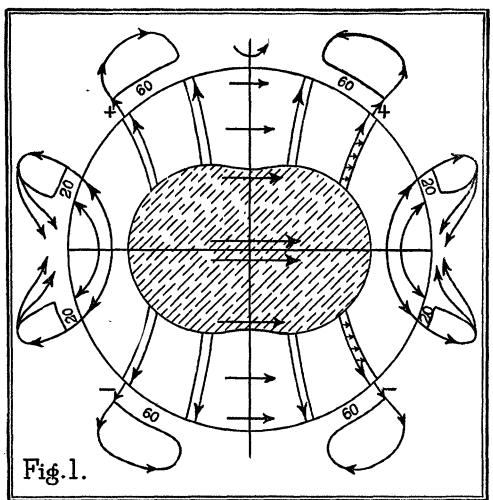

Fig. 1.

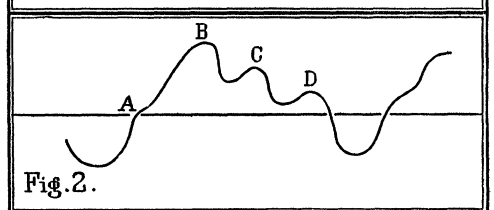

Fig. 2.

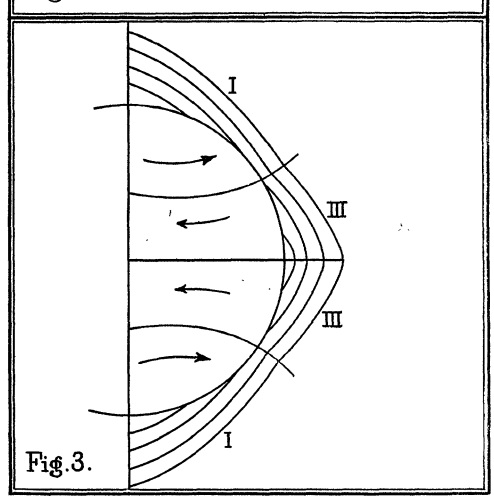

Fig. 3.

make a comprehensive statement of the conclusions that have been reached.

The Circulation of the Sun. (Fig. 1.)—The thermodynamic conditions in the sun suggest a viscous nucleus extending about half its radius from the center, which is surrounded by a gaseous envelope, the sun's proper atmosphere. The nucleus is apparently not spheroidal, but dumbbell in shape, according to the Jacobian ellipsoid of equilibrium, so that the sun is an incipient binary star with two centers of action instead of only one. This result rests upon the following facts: (1) The prominence frequency numbers on the surface have two distinct maxima, which move in opposite directions from the middle latitudes, one from latitude 25° towards the equator, as do the sunspots and faculæ, and the other from latitude 50° towards the poles, in the course of an eleven-year cycle. The cycle begins at minimum with a strong outpouring in middle latitudes, which separates into the two branches mentioned. It is probable that the congested energy of the interior first seeks to escape from the region where the viscous nucleus ends, and that one wave spreads through the gaseous region towards the end of the equator on the surface, while a second wave passes through the nucleus towards the center of the sun. The course of the maxima points, as shown in the *Monthly Weather Review* for January, 1903, favors this explanation. (2) The distribution of the prominences in longitude gives two maxima, located on two opposite meridians of the sun, as if they sprang from two foci. (3) This division of solar activity is also found recorded in the distribution of several other products of solar energy in the period of the solar rotation, which is 26.68 days on the equatorial plane, as in that of the sunspots and the faculæ, in one system of deflecting forces of the terrestrial magnetic field, in the barometric pressures and in the temperatures. That would be a good reason, if it exists, why the sun in its rotation should effect differential impulses throughout the cosmical system.

The periods of rotation of the sun have been determined in the several zones by a discussion of the prominence numbers, and there is retardation from the equator to the poles. This conforms to von Helmholtz's Case II., derived from the general equations of motion,

for discontinuous surfaces of different temperatures sliding past each other with different velocities, and rolling up vortex tubes between them. The layers are warmer around the axis of rotation of the sun, and have slower angular velocities than those more distant from it. The vortex tubes have the shape indicated in Fig. 1, right-handed in the northern hemisphere and left-handed in the southern. If the constituents of rotating matter carry electric charges in their atoms and molecules, this vortex entrainment will produce polarization and a true magnetic field extending outside the sun. The rotation period of the magnetic field near the poles, since it is primarily seated in the nucleus, is the same as that of the surface at the equator, namely, 26.68 days. The earth's normal magnetic field has a component system impressed upon it which is directed from north to south perpendicular to the ecliptic, and these vectors are probably portions of the lines here described as springing from the solar nucleus. Furthermore, all large cooling masses, contracting by their own gravity and rotating on an axis must, in conformity with the equations of motion, set up such a polarized internal structure, and, therefore, all stars are probably magnetic. The earth still possesses a residual magnetism originally produced in this manner, which is gradually fading away as the earth cools, and will become very feeble as the loss of convective heat progresses, somewhat like that of the moon at the present time. The belt systems on the planets Jupiter and Saturn afford examples of rotations with discontinuous surfaces, and minor vortices between them, under this law. The granulated surface of the sun is probably due to this vortex motion, where each granule represents the discharge of a single vortex tube.

The Solar-terrestrial Synchronism. (Fig. 2.)—The eleven-year cyclic period of the sunspot variation gives a curve with one principal maximum and one principal minimum, but this register of the solar action is not so sensitive as that recorded in some of the other elements. The eruptions of the sunspots and the faculæ are confined to the gaseous envelope, and do not directly represent the working of the viscous nucleus. The prominences of higher latitudes, 40° to 80°, produce the same fundamental curve, but there are minor crests superposed upon it, sometimes one on the ascending branch, *A*, and usually two on the descending branch, *C*, *D*. In some of the eleven-year cycles *A* does not appear, and one might count the length of the short period from the three crests, *B*, *C*, *D*, and make it, $11.1 \div 3 = 3.7$ years, as Lockyer has done. I have taken the four crests, *A*, *B*, *C*, *D*, and make the average period, $11.1 \div 4 = 2\frac{3}{4}$ years, as in 'Weather Bulletin' No. 21, page 125. This more sensitive curve registers primarily the action of the solar nucleus, and the minor crests are the recrudescences of a contracting and congesting medium seeking to free itself of supercharged energy. The curve is found to be repeated in a remarkable manner throughout the cosmical system. Thus, we have found, (1) that the periods of rotation in the higher zones of the sun, 50° to 70°, reproduce the curve in a secular variation, and refer its cause, without doubt, to the effects of internal circulation;* (2) that the magnetic field at the earth synchronizes with it;† (3) that the terrestrial temperatures in the tropical zones give the same curve directly, but in the temperate zones they synchronize in an inverted form; while the terrestrial pressures synchronize directly with it in the regions around the Indian Ocean, Australia, South Asia and Africa, but in an inverted form throughout North and South America. This inversion implies that there is a surging of the earth's atmosphere in the process of its general circulation, whereby a portion rises in pressure and temperature while another portion falls. This opens up a new field of meteorological research. A laboratory experiment, by means of cathode rays within a magnetic field, matches the observed distribution of the solar corona, and this is also in harmony with analysis of the sun's physical condition here outlined. The computed system of ordinary magnetic deflecting vectors and of the large magnetic storms which disturb the earth's normal field and fluctuate in

* See *Monthly Weather Review* for October, 1903.

† See *Monthly Weather Review* for July, 1902.

the same curve as the solar circulation, is directed upon the earth in polar curves as if coming from a distant spherical magnet, and not along the radial lines of electromagnetic radiation. It is not easy to account for these disturbances by flights of ions from the sun along the lines of the electromagnetic mechanical pressures. The further the discussion of the cosmical observations is pressed, the more positive becomes the evidence that the sun sustains a strong magnetic field, which responds to a variable magnetization within its nucleus. Radiation from the solar surface has another source of energy, namely, the atomic and molecular vibrations of the constituents of the outer envelope, as the photosphere, and hence much may go on at the surface which is not immediately representative of the state of the nucleus. Thus, the outpouring of heat, light and the ions streaming along the radii of electromagnetic pressure, together with the curved rays seen in the corona, consisting of positive and negative charges of electricity moving about a magnetic field, may take place at a given time in one way, while the nucleus is operating temporarily in another manner. Thus there may be divergences instead of synchronisms between the individual outbursts of spots and prominences on the solar surface as compared with the terrestrial magnetic storms and auroral displays which proceed from the nucleus, without in the least invalidating the claim that in general substantial synchronism exists. When sufficiently long intervals are taken, as a year, or possibly a few months, the conditions of the earth's atmosphere are affected by and vary with the changes in the solar processes. There has been much confusion in scientific writings arising from the failure to distinguish between physical actions at the surface and the interior of the sun, and many unsound criticisms have been published in consequence of it. The problem is complex, but with the growth of reliable data it is becoming yearly more promising of a satisfactory solution, and it is always interesting.

The Circulation of the Earth's Atmosphere. (Fig. 3.)—The meteorological theories of the motions of the atmosphere of the earth are now in a transition state; the old are passing away, and new ones are being constructed. Ferrel's theories of the structure of cyclones and anticyclones, as well as of the general cyclone of the hemisphere, have crumbled under the strain of modern observations. The 'Cloud Report' of the Weather Bureau, 1898, discarded both the Ferrel and the Oberbeck local and general vortices, and indicated a new path of research. The International Meteorological Committee has at last reached the same conclusion. (See 'Reports' for 1902 and 1903.) The problem at present is one of rebuilding in conformity with the facts. The general equations of motions were very briefly discussed by H. von Helmholtz, who introduced into them potential temperatures, in place of the density, and the corresponding constant angular momenta. From these equations arise three distinct cases, one of which was considered somewhat fully by him. The second case has been applied by Emden to solar circulation as above indicated, and the third case has not yet been sufficiently recognized by any one. Case I. shows that there are discontinuous surfaces of separation between layers having different temperatures and velocities, and that in the earth's atmosphere these should extend from about latitude 35° towards the poles, rising higher above the surface with progress poleward. Case III. gives surfaces sloping towards the earth from the equator up to about latitude 35°. This system differs entirely from Ferrel's, which adopted the canal theory of circulation with poleward currents at high elevations. These do not in fact exist, but there is evidence that the surfaces here specified are in conformity with the observed circulations as modified by mixtures. The local cyclones of the temperate zones are built up of counter currents of different temperatures derived from these general conditions, which in low levels near the surface of the ground underflow the eastward drift of the upper strata. The configuration of the isobars of the local cyclones observed on the sea level extends upward two or three miles with diminishing intensity, till absorbed in the system of normal isobars pertaining to the season of the

year. These two sets of isobars have now been separated from each other, and the proof of this statement is positive. (See 'Barometry Report, 1901; *Monthly Weather Review,* January, 1903; and another forthcoming report.) The prevailing stream lines, velocities and temperatures in high levels have been determined for the United States (see 'Cloud Report,' 1898), and are being worked up for the West Indies (report in preparation). The potential temperatures can be computed for both regions from the data in hand, and they are such that the heat of the upper strata of the temperate zones, where there is eastward flow increasing with the height, is above the quantity called for by the adiabatic law. In the tropics, with westward velocities diminishing upward, the heat of the upper strata is probably below the adiabatic quantity, though this remains to be determined. We have had since December, 1902, daily isobars for the United States on the three planes, the sea level, the 3,500-foot, and the 10,000-foot planes, and the result of the intercomparison of their varying configurations throughout the year is in conformity with this analysis. They possess much advantage in practically forecasting the areas of precipitation, the direction of storm tracks, and the rapidity of the propagation of the cyclonic areas over the United States.

Frank H. Bigelow.

Weather Bureau,
November 30, 1903.

Horticultural Varieties of Common Crops.

The improvement of farm crops by breeding and selection has received a marked impetus in recent years, due partly to the success secured by a few pioneer workers in this field, and partly to recent discoveries in the laws of heredity. The present note is written for the purpose of calling attention to a method of improvement that has been applied to ordinary field crops only to a very limited extent, but which offers promise of immediate and marked results. It can be best illustrated by giving actual cases. Dr. A. D. Hopkins, at present connected with the Bureau of Entomology of this department, formerly of the West Virginia Experiment Station, for many years grew timothy for seed. For this purpose the crop is ordinarily sown thinly, so that, during the first harvest year, the plants are sufficiently distinct to permit of the observation of individual plants. Many years' close observation showed that the crop consists of a large number of constantly recurring forms quite easily distinguished. A number of plants, each representing one of these forms, were taken up and separated into as many parts as the nature of the case permitted; in this way each plant became the parent, by divisions, of a large number of plants, all set side by side in a plat. When seed was harvested from these plats it was found that the plants produced from these seeds reproduced faithfully the characters of the original selection. Each original selection, therefore, became the parent of a variety. Several of these varieties are now growing in the grass garden of the Department of Agriculture, where they have been the object of careful observation during the past season. They differ markedly in character of growth, earliness, size, etc. Some of them are evidently far superior to the ordinary timothy as grown by farmers (which is a mixture of superior and inferior varieties), some for seed production, others as hay plants, and others as pasture plants.

In a manner exactly similar, Mr. A. B. Leckenby, director of the Eastern Oregon Experiment Station, has isolated ten varieties of brome grass (*Bromus inermis* Leyss.), as distinct, for instance, as the ordinary varieties of wheat. He has also isolated a larger number of varieties of *Poa pratensis,* differing to a remarkable degree in character of growth, and consequently in agricultural value.

This method of securing new and stable varieties is probably applicable to all unimproved crops that are ordinarily close-fertilized. In the case of cross-fertilized species, a different procedure would be necessary; but if Mendel's law holds in these cases, similar results can be secured even in cross-fertilized species by artificially close-fertilizing the plants. In this case, the plants would immediately split up into a number of stable forms that could be segregated as varieties by isolating them from other forms.

The origin of these varieties which are