belong to two or three different species. Both trophozoites and cysts of the *Chilomastix* were present. The *Endolimax* amebae appeared to belong to two different species, and both trophozoites and cysts were present in abundance. On the third day the trophozoites of a large *Endamoeba* were found; these became abundant on the fourth day and cysts were present on the ninth day. It is evident that conditions in the ceca of these four-day-old chicks were particularly favorable for the growth and reproduction of these protozoa and that the specimens of *Chilomastix, Endolimax* and *Endamoeba* would not have been discovered by the examination of the cecal material from the guinea-fowl by the smear method. Protozoa not observed in the ceca of the duck, goose and screech-owl were likewise discovered in the cecal material evacuated by chicks that had been inoculated with material from these hosts. These results were not due to the accidental infection of the chicks in the laboratory, since control chicks of the same brood that were kept in neighboring cages and were fed from the same food supply remained uninfected.

This work indicates that protozoa too few in number to be found in smears made from the cecal contents of birds such as guinea-fowls, ducks and geese grow and multiply so rapidly when inoculated into parasite-free chicks that they can not only be demonstrated without difficulty but can be secured in sufficient numbers to prepare permanent slides for the detailed study of their morphology. Data already obtained by the use of fecal material from other animals inoculated into chicks suggest that this method of cultivating intestinal protozoa *in vivo* in chicks can be extended to include species from other types of animals, especially mammals. If this proves to be true it will be a relatively simple matter to make an accurate survey of the intestinal protozoa of any particular species of host.

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SPECIAL ARTICLES

IS THE TWELVE-HOUR VARIATION IN ATMOSPHERIC PRESSURE AN ELECTRIC PHENOMENON?

HANN, in his "Lehrbuch der Meteorologie," p. 177, says (translation by present writer):

> No other meteorological element has so regular a daily period as the atmospheric pressure; and this in spite of the fact that the amplitude of this daily variation is relatively small, ranging from two or three millimeters in the tropics to a few tenths of a millimeter at 60° latitude. The daily period is double; the atmospheric pressure reaches twice daily a maximum and twice a minimum, and, where the daily atmospheric pressure is least disturbed, both maxima and minima are very much alike. This is very different from the daily range of other meteorological elements, and suggests the ebb and flow of the sea, for which reason these waves have been called atmospheric tides. In spite of their resemblance in form, an important difference in the two phenomena appears in that the "atmospheric ebb and flow" follows the sun and occurs according to true local time, and that no lunar influence is perceptible in it. Accordingly, it can not be a gravitation phenomenon, since in that case the lunar period would be much more strongly marked than that of the sun.
>
> The phenomenon has, accordingly, a much greater theoretical interest than the daily periods of the other meteorological elements, which, although much less simple and locally much more variable, yet can be definitely shown to depend upon the conditions of insolation. Practically, on the contrary, the daily barometric variation, on account of its minuteness, is of little significance and can scarcely be related to any consequences, while the daily period of temperature, for example, is regarded as of great importance and occupies a very conspicuous place in the domain of meteorology.

A remarkable characteristic of the semi-diurnal barometric variation is the regularity of the occurrence of the maxima and minima and their uniformity in time of day in all latitudes. While the amplitude of these waves may vary greatly with latitude, with elevation and with location, whether over the sea or over the land, the local times of maxima and minima are very constant. This is true also for the different periods of the year, though the amplitude of variation is everywhere greatest at the equinoxes and least at the solstices. In tropical regions the influence of the weather, whether rain or wind, except the great whirling storms, has little effect upon the semi-diurnal barometric fluctuations.

The many differences between this phenomenon and the other meteorological phenomena seem to point to some agency which does not affect the other meteorological elements, but no such agency has hitherto been discovered. It is well understood that the barometric height varies with the temperature and with the moisture content of the air, but these variations, while they must necessarily have a twenty-four-hour period, are very irregular at any single location and vary greatly, both in time and amplitude, at different places. Accordingly, while the two variations are always superposed, the semi-diurnal variation possesses much more the character of a regular sine wave than does the twenty-four-hour variation. For this reason the many attempts to separate the barometric wave by means of harmonic analysis into a daily and a halfdaily wave have failed, and no one knows the true form of either component.

The results of one attempt to analyze the daily barometric wave into harmonic components, made by W. J. Bennett, were published[1] in 1906. Bennett used the mean daily variation of the barometer at Washington, D. C., for fourteen years, and attempted to analyze the resulting curve into four harmonic components, one of which had a twenty-four-hour period, one a twelve-hour period, and the other two had shorter periods and small amplitudes. His results are given for the whole year and for the months of January and July. The three sets of curves are very similar, and the July curves are chosen for consideration in this paper. The experimental curve and the twenty-four-hour and twelve-hour theoretical curves are shown in Fig. 1. The experimental curve is given by the continuous line and the two theoretical curves by the dashed lines.

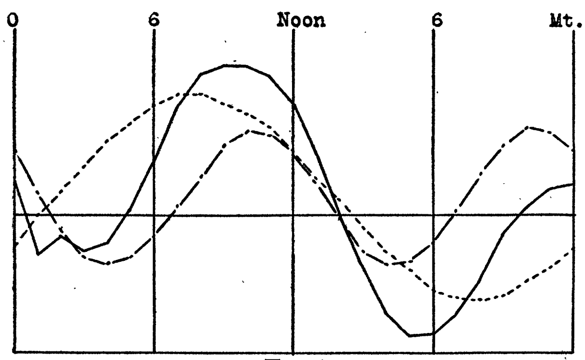

FIG. 1

That these two curves together do not make up the barometric curve may be seen by subtracting the twelve-hour curve from the observed barometric curve and observing the difference between the resultant twenty-four-hour curve and the theoretical twenty-four-hour curve given in Fig. 1. This difference is shown in Fig. 2, where the continuous line shows the computed twenty-four-hour curve and the dashed line shows the curve given by subtracting the computed twelve-hour curve from the barometric curve.

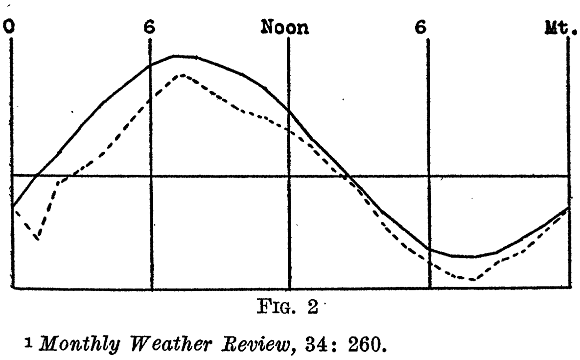

FIG. 2

[1] *Monthly Weather Review*, 34: 260.

In a paper[2] read before the American Physical Society at the Pomona meeting, June 15, 1928, and in a footnote on page 65 of SCIENCE of July 20, 1928, is described a method of proving that the surface charge of the earth undergoes a daily variation at a given place, so that the earth becomes most electropositive to insulated bodies above its surface at from ten to eleven A. M., and most electronegative to such bodies at about seven or eight P. M. This phenomenon may be shown by removing one pair of diagonal quadrants from an ordinary quadrant electrometer, putting the metallic needle suspension into electrical contact with the remaining pair of quadrants and insulating the system thus formed of the needle and quadrants inside a grounded metal case with no battery or artificial charge in its vicinity. If such system be discharged to earth and allowed to stand, the electrometer needle will go through a double diurnal deflection, having its neutral points at about seven A. M. and three P. M. Since the electrometer needle will be repelled by the quadrants when they are both charged alike relative to the earth, one of the semi-diurnal deflections will occur when they are thus positively charged and one when they are negatively charged.

Fig. 3 shows the mean daily deflection for twenty days in May, 1928, of two electrometers set up in this way upon the same pier and recording photographically upon the same drum. The two electrometers were of different size, different construction and different sensitivity. The daily deflections were closely proportional to the sensitivities of the respective instruments, and their average daily magnitude was greater than was produced by charging the instruments up to 150 volts.

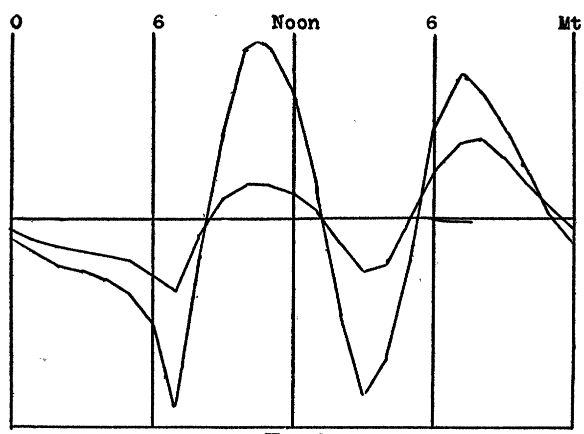

FIG. 3

The results of this and other similar experiments show that *any unelectrified, insulated body near the*

[2] Abstract in *Phys. Rev.*, 32: 325. August, 1928.

earth, even if inside a closed hollow conductor, will be attracted twice daily by the electric charge of the earth, and it has seemed possible that the semi-diurnal variation in barometric pressure may be due in some manner to this attraction. To test this surmise the diurnal variation in barometric pressure as shown by the microbarograph was measured and recorded for the same twenty days for which the electrometer deflections were recorded. The curve given by the barometric variations is compared with the mean of the two electrometer curves in Fig. 4, where the continuous line shows the barometric variation and the dashed curve shows the mean of the daily variations of the two electrometers.

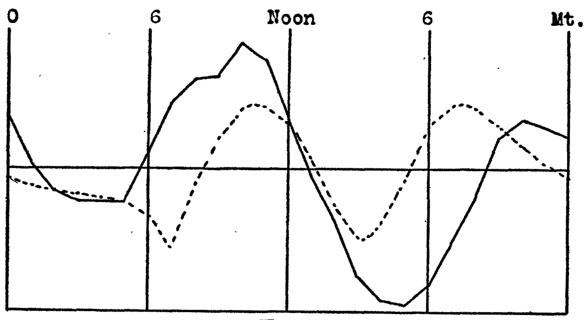

FIG. 4

It will be seen that neither of the experimental curves given in this figure is a sine curve, but the electrometer curve is more nearly one than is the barometer curve. It is also quite as regular on successive days as is the barometer curve, and Fig. 3 shows that its periodicity is the same for the two electrometers. If the semi-diurnal variation in barometric pressure is due to the same cause as the semi-diurnal electrometer deflection, and if it be subtracted from the total barometric variation, it should leave a twenty-four-hour curve due to the various disturbances which depend upon solar radiation and other possible disturbances. When this is done, the dashed curve in Fig. 5 is given. The continuous curve in the same figure is the same as the dashed curve in

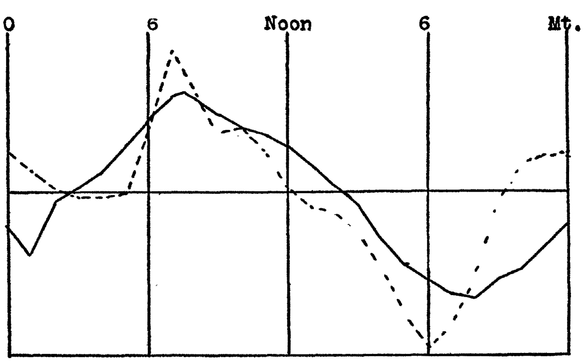

FIG. 5

Fig. 2, *viz.*, the curve given by subtracting Bennett's theoretical twelve-hour curve from his total barometric curve. Both curves indicate a similar form for the twenty-four-hour curve, that is, a maximum about seven A. M. and a minimum from six to eight P. M.

No one knows what form this curve should take. The daily range of air temperature at any given place is very irregular, and as it is always different at different altitudes above the ground, no one knows at what height its variations agree most closely with the twenty-four-hour barometric range.

One thing which seems certain about the semi-diurnal barometric variation is that it is caused in some manner by solar influence. This is shown by both its daily and seasonal variations. Also, the semi-diurnal electrometer deflection must be due to the sun, as it has both a daily and a seasonal variation, being of greatest amplitude at the equinoxes and least at the solstices. In this respect it agrees closely with the semi-diurnal barometric curve. On page 603 of Arrenhius's "Kosmischen Physik" is given a table showing the mean daily amplitude for each month of the year of the twelve-hour wave of barometric variation for each of eight European stations. The average monthly range of variation for these eight stations is shown in the continuous curve in Fig. 6. The dashed curve gives the mean daily range of electrometer deflection due to the variation of the surface charge of the earth at Palo Alto for the different months of 1927.[3]

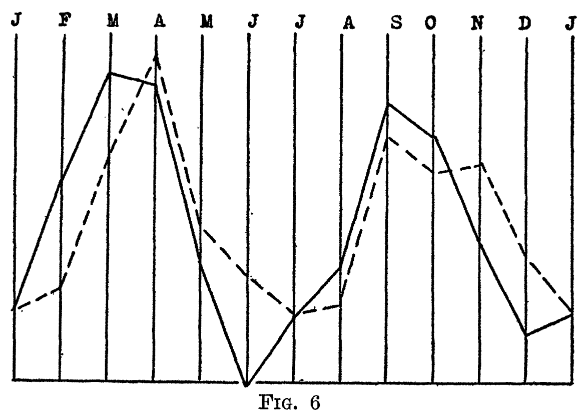

FIG. 6

There seems to be no reasonable doubt that the cause of the electropositive condition on the day side of the earth and the electronegative condition on the night side are due to the electrostatic induction of the sun's negative charge.

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JANUARY 8, 1929

[3] Bulletin of the Terrestrial Electric Observatory of Fernando Sanford, vol. 5, p. 8.