Survey of the Great Lakes," by Charles J. Fish; "The Work of the *Carnegie* to Date," by W. J. Peters.

The meetings of the six sections will be held on the mornings of April 25 and 26 and the afternoon of April 25. For each section short business meetings will be followed immediately by progress-reports and scientific papers. The section of geodesy (morning, April 25) will be devoted to progress-reports and recent developments in gravity and geodetic work in Mexico, Canada and the United States as follows: "Gravity-work in Mexico During the Past Year," by Pedro C. Sanchez; "Gravity-comparisons in Europe and America," by A. H. Miller; "The Measurement of Gravity at Sea," by F. E. Wright; "Recent Developments in Time-service Methods," by C. B. Watts; "Recent Developments in Geodetic Instruments," by D. L. Parkhurst; "Geodetic Work in Canada During the Past Year," by Noel Ogilvie; "Geodetic Computations and Investigations," by H. G. Avers; "Accomplishments in Field Geodesy During the Year April, 1928, to April, 1929," by William Bowie. The section of terrestrial magnetism and electricity (morning, April 25) will hear a symposium on physical theories of magnetic and electric phenomena, including the following papers: "The Corpuscular-ray Theory of Aurora," by N. H. Heck; "The Ultra-violet-light Theory of Aurora and Magnetic Storms," by E. O. Hulburt; "The Atmospheric Dynamo-theory of Variations in Earth-currents and Terrestrial Magnetism—A Review," by O. H. Gish; "A Tentative Theory of the Permanent Magnetic Field of the Sun and Earth," by Ross Gunn; "Echo-sounding of the Kennelly-Heaviside Layer," by M. A. Tuve.

The section of oceanography (afternoon, April 25) will hear the following communications: "Oceanography and Meteorology," by Charles F. Brooks; "Oceanography and Littoral Geology," by Douglas W. Johnson; "The Significance of Plankton Investigations," by Charles J. Fish; "Oceanographic Observations in Monterey Bay, California," by Henry B. Bigelow; "Recent Work on the Dynamic Oceanography of the North Atlantic," by C. O. Iselin; "Echo-sounding," by W. E. Parker. Additional oceanographic papers of general interest in this vast field will be presented as indicated above at the general assembly on the afternoon of the following day. The section of volcanology (afternoon, April 25) will hear and discuss the following papers: "Volcanic Oceanic Islands," by H. S. Washington; "Volcanoes of Java and Bali," by E. G. Zies; "The Volcanic History of the San Juan Mountains, Colorado," by E. S. Larsen; "Recent Eruptions of Kilauea," by T. A. Jaggar.

The sections of meteorology and seismology will hold meetings on the morning of April 26. The first will be devoted to the report of the meteorological division of the committee on the physics of the earth, which will include the following: "Introduction," H. H. Kimball; "The Origin and Composition of the Atmosphere," by W. J. Humphreys; "Meteorological Data and Meteorological Changes," by C. F. Marvin and A. J. Henry; "Solar Radiation and its Rôle," by H. H. Kimball; "Meteorology of the Free Atmosphere," by W. R. Gregg; "Dynamic Meteorology," by Edgar W. Woolard and Hurd C. Willett; "Physical Basis of Weather Forecasting," by Carl-Gustaf Rossby and Richard H. Weightman. The scientific program of the section of seismology will include: "Surface-waves," by J. B. Macelwane; "Forces and Movements at the Earthquake-origin," by H. F. Reid; "The Velocity of Surface-waves," by F. Neumann; "The Seismicity of the Arctic as Indicated by Instrumental Data," by E. A. Hodgson; "Earth-vibrations from Dynamite Blasts," by L. D. Leet.

The scientific sessions are open to persons interested in geophysics, whether members of the union or not, and all such are cordially invited to attend. These annual meetings are increasingly interesting each year, not only because of the stimulus afforded the study of problems concerned with geophysics but also by reason of the cooperation of the corresponding geophysical organizations of Canada and Mexico which is making for initiation and coordination of geophysical researches depending upon international and national cooperation.

JNO. A. FLEMING,
General Secretary

SCIENTIFIC APPARATUS AND LABORATORY METHODS

THE IN VIVO CULTIVATION OF INTESTINAL PROTOZOA IN PARASITE-FREE CHICKS

As every one knows, who has attempted experiments with animal parasites in laboratory animals, one of the greatest difficulties is to secure parasite-free animals for infection purposes. During the past two years a number of interesting experiments have been carried on in this laboratory with parasite-free chicks. Chicks offer a number of advantages; they can be obtained at any time of the year; they are free from animal parasites when they hatch from the egg; they are very inexpensive; they can be maintained in the laboratory free from animal parasites without difficulty and at low cost, and they can be inoculated very easily per os or per rectum with material containing animal parasites.

Fowls are known to be infected in nature by a number of intestinal protozoa; these include amebae,

flagellates and coccidia. Among the five hundred or more chicks that we have used in this laboratory only one group of half a dozen have ever become infected with protozoa other than those inoculated into them. This group became infected with coccidia, and it seems evident that greater precautions are necessary to prevent contamination under ordinary laboratory conditions with this type of protozoon than with amebae, flagellates or ciliates.

Besides being parasite free and easily maintained in this condition, chicks are favorable for experimental studies because one can obtain samples from the cecum, where intestinal protozoa seem to be almost entirely localized, without killing the birds or resorting to surgical operation. At first in our experiments chicks were inoculated and then killed at various time intervals. Later it was found that the contents of the cecum are evacuated from time to time and that this material can be distinguished easily from the intestinal contents passed in the form of feces. The fecal material is usually compact and dark in color, whereas the cecal contents are more liquid and yellowish in color. The best way to obtain cecal material seems to be to give the chicks fresh food and water early in the morning and then place them under glass dishes on paper towels. Here they can easily be watched until cecal material is passed. Some of the chicks will not evacuate their cecal contents for several hours, but most of them will deposit the desired material within a few minutes.

The method of procedure followed was usually as follows. The protozoa to be inoculated were obtained either from cultures grown in test-tubes or from fecal material. If from the former, a more concentrated inoculum was sometimes prepared by centrifuging the culture medium and pouring off most of the supernatant fluid. If the trophozoites of protozoa were located in fecal material, this mass was diluted with normal saline solution and passed through cheese-cloth to remove all coarse particles that might otherwise clog the passage through the tube used for inoculation. Protozoan cysts may be secured in large numbers by any of the concentration methods devised for this purpose. A simple method is to stir up the infected fecal material in several liters of water in a tall, narrow cylinder; allow the cysts to settle to the bottom, which requires about thirty minutes, then pour off most of the supernatant fluid, fill the cylinder with water, stir up thoroughly and allow the cysts to settle again. After this has been repeated several times the cysts are well washed and concentrated.

A 5 cc Luer syringe to which was attached a rubber catheter shortened to a length of about 10 cm was used for inoculating material into the chicks. Most of the chicks were about four days old, although older birds were used for studies of age resistance. The amount of inoculum depends on the age (size) of the chick. From 2 to 4 cc of material can be injected into the crop of a four-day-old chick by lubricating the catheter with vaseline, inserting it down the throat with one hand while the bird is held in the other, and then slowly pushing down the plunger of the syringe. Similarly from 1 to 3 cc can be injected into the rectum. The catheter should be inserted about 2 or 3 cm. The anal opening should be held closed with the fingers for a few seconds after the catheter is removed. Material injected into the rectum appears to find its way immediately into the ceca.

The ceca of a four-day-old chick are located about 3 cm from the anus. They are thin-walled sacks about 3 cm long and open into the intestine through small pores. Protozoa inoculated either per os or per rectum very quickly become located in the ceca, although those inoculated by mouth must pass through the stomach, small intestine and large intestine before reaching the ceca and hence not such a large proportion of them actually enter the ceca as of those inoculated per rectum. A sufficient number of experiments were performed to demonstrate that the trophozoites as well as the cysts of many protozoa are able to pass through the stomach and small and large intestine of both young and older chicks and reach the ceca in a viable condition.

The results of introducing intestinal protozoa from man and other animals into chicks have been prepared for publication elsewhere (Hegner, 1929).[1] They indicate that infections can be set up easily in the ceca with a number of species of amebae, flagellates and ciliates. Some of the infections continued for over six months and apparently would have remained indefinitely. Among the protozoa used were *Trichomonas hominis* from the human intestine and *T. buccalis* from the human mouth. These were maintained in chickens for over four months when the experiments were terminated. It thus seems probable that chickens may serve as transmitting agents of human intestinal protozoa.

One of the most interesting results of the experiments was the discovery that the chick may be used as a sort of *in vivo* test-tube for the cultivation of intestinal protozoa. For example, cecal material from a guinea-fowl which was found by the ordinary smear method to contain a very few trichomonads was injected per rectum into chicks. Two days later large numbers of trichomonads, *Chilomastix*, and *Endolimax* amebae were present in cecal material evacuated by the chicks. The trichomonads appeared to

[1] To be published in the *American Journal of Hygiene*.

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.
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> 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 half-