out the inflowing air? This theory really proves too much; for, if there is this enormous centrifugal effect producing a partial vacuum, how is it possible for moist air to flow in against the centrifugal effect? The theoretical explanation that there is friction at the earth's surface, which breaks up the centrifugal effect at that point, is exceedingly unsatisfactory.

It is given as a proof of this vacuum, that "corks fly from empty bottles." I have searched the tornado literature through and through, and have not found a single well-authenticated case of this phenomenon. The questions naturally arise, "Why were corks *put* in *empty* bottles?" also "Why did not the corks fly from the full bottles?" It is probable that empty bottles and corks were found in a cellar, and the theory could have very easily arisen that they had met with a separation. It would be very interesting to have a confirmation of this fact. It is said that whole houses sometimes burst from the passage of this partial vacuum. We have already advanced an explanation of this.

It should be noted that nearly all pictures of tornado-funnels make them exceedingly circumscribed, perhaps not more than ten feet across at the tip (see Fig. 1). The earliest representation of a tornado-cloud is very different from this, and it is probable that the imagination has had altogether too much to do with all these later pictures. It is to be hoped that wherever possible, in future drawings, there will be given some idea of the size of the funnel. If houses are affected, the funnel should be at least from a hundred to two hundred feet across at the earth. A remarkable evidence of the desire for showing a gyration in a tornado-cloud is to be found in the quotation regarding the Gentry County tornado, from Professor Ferrel's last book, at p. 354. This statement was of an observation in which it was claimed that trees on the north side of the track were thrown to the west and south-west. As shown in Fig. 2, this is exactly the way trees ought to be thrown, if this theory of a gyration is a correct one. This is the only instance, if we grant its authenticity, in which, out of a hundred or a hundred and fifty reports of this phenomenon, trees were ever thrown this way. The evidence of this kind is overwhelmingly in favor of the supposition that there is *no* gyration.

6. ORIGIN IN THE CLOUD REGION.—There can be no doubt that the tornado originates in the cloud region; but to say that this must be from an unstable equilibrium at that point, is a violent assumption. The sun, contrary to theory, undoubtedly heats up a cloud so that there is a steady increase of temperature with height, as shown by balloon observations; but there is no unstable equilibrium, though theory indicates that this should be enormous under these conditions. The tornado frequently arises after sunset, when there is no abnormal heating of the cloud. This transfer of the primitive impulse from the earth to the cloud is very significant, and seems to have been done to avoid a difficulty; which, however, has been increased rather than avoided. The hypothesis that such a disturbance, after starting in the cloud region, is transmitted through friction to the earth's surface, seems a little strained, when we reflect, that, according to computation, it would require more than twenty years for such transmission through a depth of three hundred feet.

7. A PROGRESSIVE MOTION IN THE DRIFT OF THE UPPER CURRENT.—If the general storm motion is in this drift, it certainly seems impossible to ascribe that of the tornado to the same. The tornado moves with a velocity fully double that of the general storm, and it is probable that the centre of its motion is not more than half the height of the former; and, as it is known that the velocity of the current increases rapidly with the height, it is safe to say that the drift at the "power" of the tornado is not more than half that in the case of the general storm. It is also impossible to account for the motion of the tornado for more than a hundred miles, unless it has its own generating force, through the drift of the upper current. If the cloud is about three thousand feet high (not an underestimate), the motion of the upper part will approximate double that of the lower, and, in spite of the utmost centrifugal action, it would in a few minutes be torn apart. The hypothesis that the upper part breaks off, and re-forms itself in front, and afterward communicates its gyrations to the earth through a frictionless medium, must be regarded as one of the most strained that was ever advanced. This would break up the absolutely necessary continuity of the vertical ascending current, and would be fatal to the whole tornado theory.

8. A SIMILARITY BETWEEN THUNDER-STORMS AND TORNADOES.—This view was advanced prominently in 1884, and in the past few years has become a most important factor in all discussions. It demands a notice by itself, which will be given later.

It will be asked, Is not the foregoing a too severe setting-forth of the general weakness of tornado theories? Is not there some good to be gotten out of such theories, even if there are some points not fully settled? I leave the questions where they stand. I have not tried to overdraw the picture. The essential weakness of such theories is a starting from insufficient data and reasoning regarding most complex motions in a region in which we have hardly a dozen reliable records. It may be put down as an undoubted fact that no great advance can be hoped for in such studies, except the abandonment of these theories, until we investigate carefully the region where all these disturbances are developed.

H. A. HAZEN.

ON THE GROUP OF METEORITES RECENTLY DISCOVERED IN BRENHAM TOWNSHIP, KIOWA COUNTY, KAN.[1]

ABOUT four years ago the farmers of Brenham Township ploughed up a number of heavy objects, which they used to weight down haystacks and for other such purposes, as they would have used bowlders. It was discovered in March last that these were not common rocks, but an interesting group of meteorites, numbering over twenty in all, weighing together about 2,000 pounds, and individually from 466 pounds down to one ounce each. They were found embedded at a slight depth in the soil, which here, for about one hundred feet in depth, is formed of a pleistocene marl, originally the bottom of an ancient lake, scattered over a surface over one mile in length; principally, however, in a square of about sixty acres.

What is now Kiowa County, Kan., five years ago formed parts of Edwards and Comanche Counties, and was occupied by large ranges and cattle-ranches. Brenham Township, or Township 27 as it was then called, is in the north-western part of Kiowa County, is covered by a high prairie with some areas of sand-hills,

[1] First announced at the New York Academy of Sciences, April 7, 1890.

and has an altitude of about 220 feet above sea-level. Some drains of the head waters of the Medicine River and its tributaries, farther south, become ravines and valleys; and there a gravel occurs, the *débris* of miocene "Loup Fork" conglomerates. But on the high prairie not a stone of any kind is to be found: hence the ranchmen and settlers were greatly surprised at finding heavy rocks or stones projecting through the prairie sod.

Several years ago, Mr. Davis, a lawyer at Greensburg, identified these as meteorites; and although the farmers had known this for a long time, yet, strange to say, no importance was attached to them until Mrs. Kimberly applied to Professor F. W. Cragin, of Washburn University, in the early part of March. It was not until the 13th of March that Professor Cragin secured four of these masses.

They were nearly all found by being struck by mowing-machines, ploughshares, corn-cultivators, or other farm implements. Over twenty distinct masses have been reported; but it is very evident, from the weight and other facts, that some have been noted several times over.

The history of some of these pieces is quite remarkable. The 35.72-pound piece was found on the Evans place, was lost, and again found in a hole made by some hogs under a barbed-wire fence. The 75-pound mass was used by Mrs. Kimberly to hold down a cellar-door or the cover of a rain-barrel. No. 3 was used to keep down a stable-roof. The 466 pound mass (called by the farmers the "moon meteorite") was covered by only three inches of soil, and broke a ploughshare when it was struck. Apparently none of the masses were buried to a greater depth than five or six inches.

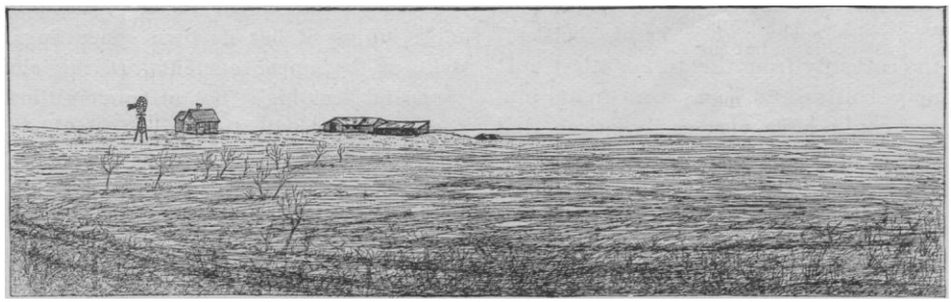

FIG. 1.—PRAIRIE LAND, KIMBERLY FARM.

The 101.5-pound, the 71.5-pound, and the 55-pound masses were found four years ago by a cowboy, when the ranch had not yet been occupied by settlers, and was simply used as a cattle-range. He was unable to move them to the "Green's Stage Station," now Greensburg, eight miles distant, and so buried them in the gulch a mile north-west of the "Francisco Claim." About a year afterward he became ill, and died; but before his death he communicated the burial of the "three strange rocks," as he called them, to two of the settlers, who succeeded in finding them and bringing them to the new town of Greensburg about a year after his death. The 55-pound mass was carried over by a neighbor, who used it to weight down his haystack.

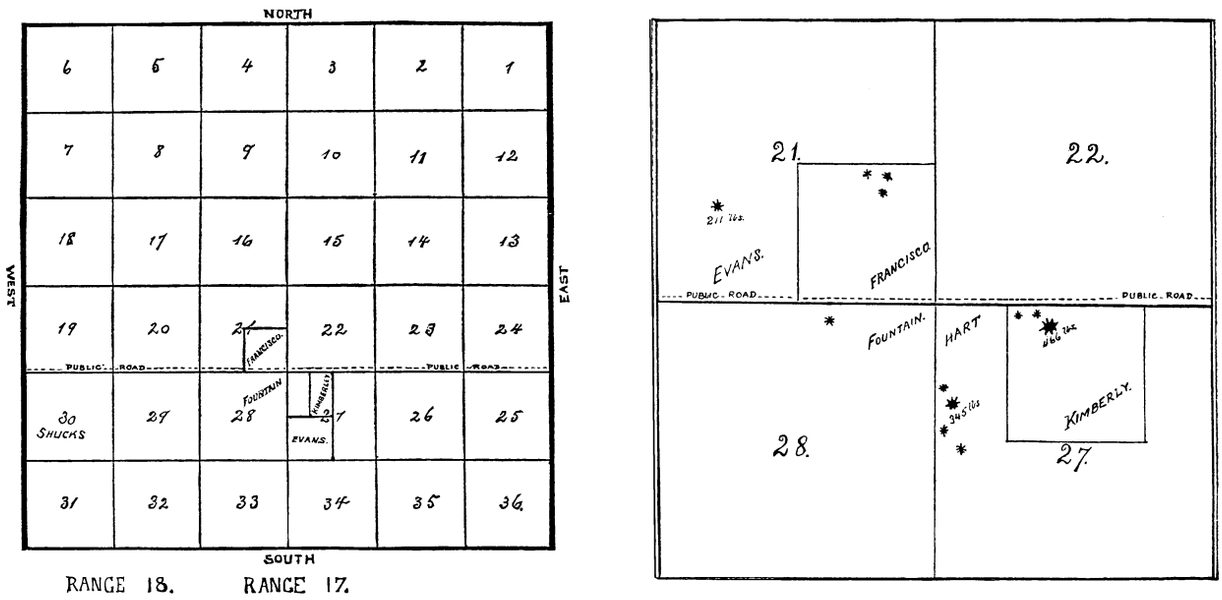

FIG. 2.—TOWN MAP BRENHAM TOWNSHIP.

(The asterisk denotes the spots where meteorites were found.)

The townships are reckoned from the base-line, the 40th parallel; and the ranges, from the 6th principal meridian, which crosses Kansas about longitude 97° 30′ west of Greenwich.

Brenham Township (27) is made up of thirty-six sections, each one mile square, numbering from No. 1 to No. 36. The meteorites seem to have been scattered north-east and south-west, and to have covered an area over one mile in length. Some of the meteorites fell on the east half of the north-west quarter, Section 27, Township 28, Range 17, west of the 6th principal meridian.

Professor Snow of Lawrence, Kan., visited Kiowa County several times, and the last time obtained the 101.5-pound mass in the streets of Greensburg, the county seat, where it had lain for several years in front of a lawyer's real-estate office.

The exterior of all the masses shows the characteristic pitting. The surfaces have all been more or less oxidized by exposure to

the elements, showing that the fall is not recent, and that the original mass was made of crystalline iron as well as of iron filled with crystals of olivine: in other words, the masses show two distinct groups. Of these, the 345-pound and the 75-pound ones are nickeliferous iron of a highly octahedral structure and cleavage, and are caillites, while the others are meteoric iron containing olivine, and belong to the group known as "pallasites."

The largest mass, a pallasite, weighs 466 pounds, or 211.818 kilos. It is thick, slightly flattened, triangular in form, somewhat heart-shaped, and measures through the longest part 61 centimetres, or 24½ inches; across the widest part, 48 centimetres, or 19 inches; and in the thickest part, 37 centimetres, or 14½ inches. It is covered with large indentations measuring $10\times6\times3$ centimetres. The coating is more or less oxidized, but the olivine is perceptible in all parts of the mass.

The dimensions of the 345-pound mass (156.818 kilos) are $60\times37\times29$ centimetres, or $23\frac{3}{4}\times14\frac{1}{2}\times11\frac{1}{2}$ inches. It is slightly arch-shaped, is an iron with many pittings, and shows the characteristic magnetic oxide of iron crust.

The 211-pound mass (95.909 kilos) is somewhat rounded, with a circular depression on one side.

There are two masses weighing 125 pounds (58.863 kilos) and 54.96 pounds (25.084 kilos) respectively.

The 101.5-pound mass (46.136 kilos) is almost round, measuring $35\times26\times27$ centimetres ($13\frac{3}{4}\times10\frac{1}{4}\times10\frac{3}{4}$ inches). The exterior is evenly pitted, and the centre of each pitting is an olivine crystal.

The 75-pound one (34.09 kilos) is an iron, and measures $32\times22\frac{1}{2}\times15$ centimetres ($12\frac{1}{2}\times8\frac{1}{2}\times5\frac{7}{8}$ inches). It is in shape like a pear or ham, covered with large pittings. The crust has been changed somewhat by weathering.

The 71.5-pound mass (32.485 kilos (measures $27\times23\times22$ centimetres ($10\frac{1}{2}\times9\times8\frac{5}{8}$ inches). It is a jagged, irregular square, and shows olivine crystals all over the exterior:

The 60-pound mass (27.272 kilos) measures $36\times21\times17$ centimetres ($14\frac{1}{8}\times8\times6\frac{5}{8}$ inches). It is an elongated, rounded piece, with one large flat side showing large spaces filled with olivine.

The 40-pound mass (18.181 kilos) measures $22\times21\times21\times13$ centimetres ($8\frac{5}{8}\times8\frac{1}{8}\times8\frac{1}{8}\times5\frac{1}{8}$ inches). It is of irregular shape, with one large projecting point.

The 36-pound mass (16.363 kilos) measures $22\times22\times16$ centimetres ($8\frac{1}{2}\times8\frac{1}{2}\times6\frac{1}{4}$ inches). It is a flattened spheroid, containing some olivine, but almost entirely iron, showing large pittings like the 75-pound or the 345-pound masses.

There are also about a dozen small masses weighing 12, 7, 6, 5, 3, and 1 pounds each, and a few weighing only one ounce each. The 211 and 6 pound masses belong to the University of Minnesota; the 125-pound mass, to Harvard University; the 54.96-pound mass, to the University of Kansas; the others are in the collection of the writer.

The specific gravity of the masses is very variable, and was found to be as follows: of the 6-pound mass, 5.17; 40-pound mass, 6.41; 71.5-pound mass, 5.22; 75-pound mass, 7.27; 345-pound mass, about the same density as the 75 pound mass; 466-pound mass, about the same density as the 71.5-pound mass.

The following analyses of the Kiowa meteorite were made by Mr. L. G. Eakins in the laboratory of the United States Geological Survey:—

Iron.		Olivine.		Dark Outer Zone of Olivine.	
	Per Cent.		Per Cent.		Per Cent.
Fe	88.49	SiO_2	40.70	SiO_2	34.14
Ni	10.35	Al_2O_3	tr?	FeO	23.20
Co	.57	Fe_2O_3	.18	NiO	tr
Cu	.03	FeO	10.79	CoO	.03
P	.14	NiO	.02	MnO	.09
S	.08	MnO	.14	MgO	40.19
C	tr	MgO	48.02	S	5.42
Si	tr?		99.85		103.07
	99.66			Less O for S	2.71
					100.36

The specific gravity of the iron freed from olivine was found to be 7.93 at 23.4° Celsius; of the olivine, 3.376 at 23.2°.

The iron is brilliant white, enclosing the troilite, and surrounding the olivine crystals. Occasionally small etched surfaces show delicate figures like that of the Linnville Mountain meteorite.

Troilite exists plentifully in rounded grains from one to five millimetres in diameter, and in thin folia mixed with and surrounding the olivine crystals, as well as running into and filling small spaces in the body of the iron, either as flat plates or rounded masses. Several flat circular plates (crystals?) of graphite two millimetres in diameter were observed.

The olivine crystals are very brilliant, and break out entire, the faces on many of them being distinct enough to measure the angles. The spaces from which they break are highly polished, showing every crystal face with a mirror-like polish; and in the centre there is a coating of a shining black mineral that is jet black in color, and crushes into a jet black powder.

Many of the olivine crystals are in two distinct zones,—the inner half a bright transparent yellow, the outer a dark brown iron-olivine. In reality this dark zone is an intimate mixture of the troilite and the olivine, as the analysis by Mr. Eakins and a microscopical examination of the crystals by Mr. J. S. Diller of the United States Geological Survey fully proved.

This group of meteorites, which has recently come to me for description, possesses more than ordinary interest, on account both of the peculiar composition and structure, and also of the undoubted ethnological relation. It is especially interesting because of its probable connection with the meteoric iron found in the Turner mounds.

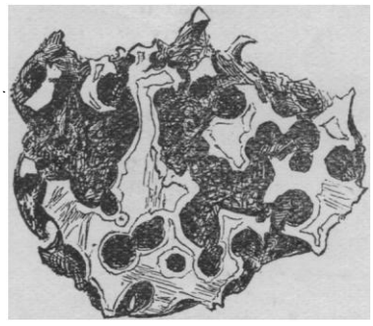

FIG. 3.—SECTION OF METEORIC IRON.

In the spring of 1883, Professor F. W. Putnam found on the altar of mound No. 3 of the Turner group of mounds, in the Little Miami valley, Ohio, several ear-ornaments made of iron, and several others overlaid with iron. With these were also found a number of separate pieces that were thought to be iron. They were covered with cinders, charcoal, pearls (two bushels were found in this group of mounds), and other material, cemented by an oxide of iron, showing that the whole had been subjected to a high temperature. On removing the scale, Dr. Kennicutt found that they were made of iron of meteoric origin.[1] One of the pieces weighed 28 and the other 52 grams.

In the autumn of 1883 a mass was found on the altar of mound No. 4 of this same group, which weighed 767.5 grams (27.25 ounces). Dr. Kennicutt suggested that these were all parts of some larger meteoric mass. The results of the investigation were published in connection with the description of the Atacama meteorites, because in structure they approached more closely to the latter than to those of any other occurrence known of at that time. In the Liberty group of mounds in the same valley, Professor Putnam found a celt five inches long, and in another of the Turner mounds an ornament five inches long and three inches wide, made also of the same meteoric iron.

The Carroll County meteorite was found in 1880, about three-quarters of a mile from Eagle Station, Carroll County, Ky., ten miles from the mouth of the Kentucky River, and about seven miles in a direct line from both the Kentucky and the Ohio Rivers. The distance to the Turner mounds, where Professor Putnam found the meteoric iron and the ornaments made of it, is about sixty miles. The mass, which weighed about 80 pounds, or 36.5 kilos, was rusted on the surface to a depth, in some places, of 10 to 12 milli-

[1] 16th and 17th Reports of the Peabody Museum of Archæology, p. 382.

metres; and deep pits, some 2 centimetres across, are observed in spots where grains of olivine have probably dropped out. The meteorite was largely made up of fine yellow transparent olivine, resembling that of the famous Pallas iron, with a specific gravity of 4.72.

Taking the specific gravity of the iron at 7.6, and that of the olivine at 3.3, we find that the Turner mound meteorite consists of about three parts of olivine to one of iron. Several of the Kiowa masses have about the same constitution. For comparison, see the analyses of the olivine and iron from the Turner mound,[1] here given, and of the Kiowa meteorite, given above.

OLIVINE.	Per Cent.	IRON.	Per Cent.
SiO	40.02	Fe	89.00
FeO	14.06	Ni	10.65
MnO	0.10	Co	0.45
MgO	45.60	Cu	tr
	99.78		100.10

When the Carroll County iron was described by the author in the *American Journal of Science* (vol. xxxiii., March, 1887), it was suggested that the pieces of the meteorite found by Professor Putnam in the Miami mounds had probably been taken from that

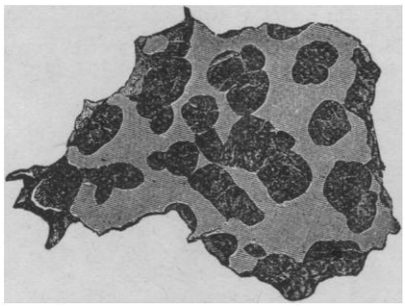

FIG. 4.—TURNER MOUND METEORITE.

mass, since no other olivine meteorite had up to that time been found in North America; while that of Carroll County contained a large percentage of olivine, even greater than the Little Miami specimen. Very little cutting had then been done on the Carroll County mass; and it proved, on being cut, not to be a pallasite, but a brahinite variety of meteorite. In the Little Miami valley meteorite are embedded circular grains or crystals of olivine; whereas that of Carroll County consists of a mass of olivine in which the iron serves as a filling between the crystals. When a section was cut from the Kiowa County material, however, there appeared no doubt as to the identity of this fall with that of the mass from which the ear-rings were made which were found in the mound. In both the Kiowa County and the mound specimens the body of the meteorite is iron, in which are embedded circular masses or crystals of olivine. The fact that in connection with the large Kiowa County masses a number of small portions, weighing from half a pound to six pounds each, were found, makes it very probable that a small mass, weighing perhaps three or four pounds, had been conveyed by the Indians to the Ohio valley. Probably the two ear-rings in the collection of Mr. Warren K. Moorehead, which were recently found by him at Fort Ancient, O., may have been made from a part of the mass weighing 767.5 grams, which is now in the Harvard University collection.

I must here express my indebtedness to Professor F. H. Snow for information, and particularly to Professor Robert Hay for aiding me in procuring many of the meteorites and assisting especially to obtain exact data by visiting the place of finds, and to secure the illustration; as also to Mr. L. G. Eakins for making, and to Professor F. W. Clarke of the United States Geological Survey for his courtesy in having made in the Survey Laboratory, the analyses of the iron and olivine of the Kiowa County meteorite.

GEORGE F. KUNZ.

[1] Kennicutt, 16th and 17th Reports of the Peabody Museum of Archæology, p. 382.

LETTERS TO THE EDITOR.

**** *Correspondents are requested to be as brief as possible. The writer's name is in all cases required as proof of good faith.*

The editor will be glad to publish any queries consonant with the character of the journal.

On request, twenty copies of the number containing his communication will be furnished free to any correspondent.

The International Congress of Geologists.

WILL you kindly permit me to publish my correction of an erroneous statement on p. 461 of the last (May) number of the *American Naturalist?* I fear that it will be quoted by other periodicals, to the injury of those who are quite innocent. The statement is to the effect (1) that the director of the United States Geological Survey, Major Powell, moved that the meeting of the International Congress of Geologists appointed for Philadelphia should be held in Washington; and (2) that the motion was carried in committee by the votes of members of the United States Geological Survey, who were present in such numbers as to constitute a working majority of the committee.

The statement is particularly unfortunate, and unjust to Major Powell, seeing that he was not the mover of the resolution, and that he voted against it, after speaking against it, giving his reasons why he was strenuously opposed to the congress meeting in Washington. As a member of the American committee of arrangements for the congress, I was present at the meeting in Washington at which the voting took place, and can therefore testify to Major Powell's opposition, both then, and afterwards in conversation. Furthermore, I take upon myself the responsibility of the change of the meeting-place of the congress from Philadelphia to Washington, if such a change occurs: for I made the first motion; namely, that the local Philadelphia sub-committee (of which I had been made, against my protest, chairman) be discharged; which motion was carried. After some discussion, the next motion was then made (not by Major Powell), not that the congress should meet in Washington instead of in Philadelphia, but that the secretary of the committee should be instructed to express the sentiment of the committee (that the congress should meet in Washington, and not in Philadelphia) to the secretary of the executive bureau of the congress in London, in which alone power was vested *ad interim* to discuss and decide such points. It was understood, that, if a majority of the American committee should express such a sentiment, the bureau abroad would be pretty sure to order the change of place of meeting. Major Powell opposed such an expression of sentiment, and urged that nothing should be done by the American committee to cause such an action abroad. I myself urged that there were reasons for my belief that a meeting in Philadelphia would be a failure, and gave the reasons; and I stand ready to repeat them, in *Science* or elsewhere, if called upon to do so. What I wish to say here, however, is that Major Powell, instead of advocating the motion and getting it passed by the assistant United States geologists present, opposed it, and would have defeated it if he could. In fact, it was only passed by a vote of seven to three (if I recollect aright), all the other members of the committee abstaining from voting either for or against it. By rule of the committee the secretary was then instructed to obtain by correspondence the votes *pro* or *con* of all absent members, as, until this be done, the chairman of the committee, Dr. Newberry, cannot declare the motion either carried or lost. What the bureau abroad will then do about it, no one knows. My own hope is that the bureau will revoke the order for an American meeting of the congress, and appoint some European capital instead of either Philadelphia or Washington. But, if there must be a meeting next year in America, I trust that the bureau will see the propriety of holding it as usual in the capital of the country, which is also, in our case as in Europe, the chief centre of physical science.

J. P. LESLEY.

Philadelphia, June 7.

Counting Bacteria.

I SHALL feel much obliged if observers who have had experience with the different methods of counting bacteria in water will give their views as to the most reliable method.

M. D. EWELL, M.D.

Chicago, June 2.