air. Dust is attracted from warm air to a cold body. If that body is wet, it adheres. By canopies of mosquito-netting over the sick-bed, kept wet with bichloride-of-mercury solution containing glycerine, no dust can pass through the meshes in either direction. The cooled threads attract across the narrow space of the mesh all dust that reaches there. The glycerine and water fix it, and the corrosive sublimate sterilizes it. To keep up the application, two layers of netting are required, — one fixed, the other removable. The outer removable one can at stated times be wrung out of a fresh solution, and put back again. Overlapping folds can allow the passage of food, medicine, etc., to the patient. This provides perfect isolation even in a room occupied by others."

R. Harvey Reed, M.D., Mansfield, O., secretary State Sanitary Association, has known cases where old rags taken and sold from scarlet-fever cases have been used by wipers, and they in turn have communicated the disease to their families. He could give many others if it were necessary, but this fact has long since been established.

D. S. Kellogg, M.D., Plattsburgh, N.Y., believes that the disease may arise *de novo*, and bases his belief on the ground that he has had cases which he cannot *reasonably* determine, after careful investigation, originated from any previously existing case. He says, "I believe scarlet-fever to be communicable, yet last spring my belief received a severe blow. My little boy, aged six, was severely sick with this disease. My baby, aged three, slept across the hall; and my son, aged eight, slept down stairs. The sick boy was kept in a room by himself. Yet his mother and I were constantly going from the sick one to the well ones, and *not either* one of them took the disease. The sick boy 'peeled' so thoroughly that the sheets had to be shaken in order to get rid of the fine flakes of skin. He had many toys that he played with after convalescence set in. I disinfected the room in about six weeks from the beginning of his sickness, and the toys. He and the two other children have played with these toys ever since, have slept in the room for a number of months, and have not had any further scarlet-fever." He does not believe that any thing can be done by the use of remedies to prevent well persons from contracting the fever. He believes that if a person has been exposed to scarlet-fever, the better his physical condition, the better is he able to endure the disease. There are many instances that would make this not seem true.

T. D. Crothers, M.D., Hartford, Conn., says, "In 1868 I traced in an epidemic twenty-one cases to contagion clearly. The communicability was by contact in most cases; in others it was through the near association. In two instances a linen picture-book was the medium of communication of the poison. In several cases it was taken by the clothing of persons who had been nursing such cases. Clothing has retained this infection several weeks when confined in a trunk. Many cases have occurred in a community, and been confined to a single case by means of isolation, quarantine, disinfection, and extreme cleanliness."

William H. Brewer, professor in Sheffield Scientific School of Yale University, New Haven, Conn., in reply to the question whether scarlet-fever ever arises *de novo*, says, "There are insufficient data for a *positive belief*. From the evidence, however, that we have, I say *no*, until better evidence is brought forward that it does arise *de novo*. Quarantine the cases if public opinion will justify: if not, then the first duty of the board is to educate the public as to the facts and the dangers. So soon as the public is ready for it, scarlet-fever will be more rare than the small-pox. But before this can be brought about, there must be a strong public feeling that it is a controllable disease."

W. C. Van Bibber, M.D., Baltimore, Md., thinks that boards of health should endeavor to change the non-sanitary condition of neighborhoods and places; for, although scarlet-fever may not now be fairly numbered among the filth-diseases, yet cleaning and sanitary laws may do good on general principles. Cleaning, segregation, and belladonna internally, ventilation, and increased vigor by increasing the vigor of individuals, should be employed. He says, "I attended Christ Church Charity School, Baltimore, for thirty-six years. The means above mentioned were used where a case of scarlet-fever occurred. The school consisted of thirty-two children. In thirty-six years there was but one death. The disease appeared in the school more than twenty times, and was always kept confined to but few children by means of these precautions. By personal hygiene, continued life in open air, the use of belladonna internally to those exposed, and rubbing the diseased body with disinfectants, much may be done to prevent the spread of the disease. I combine in an oil embrocation (thymol, anise-oil) carbolic and salicylic acids, and camphor.

## DO FORESTS INFLUENCE RAINFALL?

IT is very generally believed that the culture of forests induces an increase in rainfall, and that their destruction diminishes it. A satisfactory explanation of this supposed phenomenon has never, as far as I am aware, been offered; and the only tangible support for the theory appears to consist in a few observations of rainfall in limited areas in central Europe, made before and after reforesting. It seems desirable that the question should be tested by all the evidence at hand, and the theory established or disproved by the facts. We have in this country the material for testing both phases of the theory upon a large scale and in an exhaustive manner.

The prairie region, including Iowa, northern Missouri, southern Minnesota, most of Illinois, and a small part of Indiana, has, during the past thirty years, undergone a great change with respect to its vegetation. This great area of over 100,000 square miles, was, when settlement commenced, mainly grass-covered. It contained no forests. Belts of trees were found along the water-courses, upon the slopes of river-bluffs, and here and there upon the slight elevations. But man has encouraged the growth of trees, and the area of arborescent vegetation has been greatly increased. It is an example of reforesting upon an immense scale, unequalled elsewhere upon the globe. Has the rainfall correspondingly increased?

The early settlers in Ohio found it mainly a forest-covered region. It has been remorselessly cleared. This area of 40,000 square miles does not contain to-day a tithe of the timber-land that it contained fifty years ago. Has the rainfall diminished?

The States of Massachusetts, Rhode Island, and Connecticut, with adjacent parts of New York, New Hampshire, and Maine, — an area of perhaps 25,000 square miles, — were, when Europeans entered them, densely covered with forests. In time these were almost entirely cleared away. In recent years, however, a change in the occupations of the people of this densely settled region, in virtue of which the farms are being abandoned, while the inhabitants are becoming massed in the cities, has allowed an enormous increase in the wooded area of these States. To-day at least half this area is again covered with woods.

If this theory be correct, the rainfall in this region should have diminished from the colonial times down to, say, 1860, while since that date it should have been on the increase. Are these the facts?

We have here three areas of considerable magnitude, in which radical changes in the forest-covering have been made during the present century. Fortunately, also, we have ample records of the rainfall during these periods.

First, however, a word as to the character of the rainfall. Of all current meteorological phenomena, rainfall is the most irregular, both as to time and place. The rainfall of one year may be double or treble that of the year before or the year following. At any one station these fluctuations are ordinarily so great as to thoroughly mask any secular change. It may vary greatly from place to place, even though the distance be small, while the change of the location of a gauge from the ground to the top of a house may make it give very different indications. For these reasons it is apparent that reliable results, in regard to a general increase or decrease of rainfall, are to be obtained only by combining a large number of observations scattered over many years and over the greatest possible variety of conditions. It is a very easy matter to so select stations, and years of observation, as to obtain any pre-arranged result.

If there has taken place a change in the amount of rainfall in any or all of these regions, it must, in the nature of things, have been a progressive one, however disguised by sporadic fluctuations. Moreover, if this increase or decrease in rainfall produces the results claimed for it, making a desert fruitful, or the reverse, it must

be of considerable magnitude, sufficient to be expressed in inches, annually.

In the prairie region I find twenty-four stations at which extended series of rainfall measurements have been made. None which have been used are less than ten years in duration, and they range thence up to forty years. The sum of all these series is four hundred and twenty-eight years. Each of these series was divided into two equal parts, and the total rainfall of each half obtained. On the theory of a progressive increase, the sum of the second half of the series should be greater than that of the first half. The following table exhibits the result. The first column gives the names of the stations; the second, the length of the series; the third, the total rainfall in the first half of each series; the fourth, the same for the second half; and the fifth column, the differences between them, an increase having the plus-sign, a decrease the minus-sign.

**Prairie Region.**

| STATIONS. | YEARS. | AGGREGATE RAINFALL. | | DIFFERENCES. |
|---|---|---|---|---|
| | | 1st half. | 2d half. | |
| Chicago | 22 | 348 | 420 | +72 |
| Athens | 16 | 332 | 299 | −33 |
| Augusta | 18 | 352 | 341 | −11 |
| Dubois | 10 | 221 | 186 | −35 |
| Galesburg | 10 | 175 | 158 | −17 |
| Manchester | 18 | 335 | 325 | −10 |
| Marengo | 16 | 354 | 269 | −85 |
| Ottawa | 14 | 266 | 235 | −31 |
| Peoria | 18 | 322 | 296 | −26 |
| Riley | 14 | 269 | 237 | −32 |
| Sandwich | 12 | 323 | 242 | −81 |
| Winnebago | 14 | 271 | 239 | −32 |
| Wyanet | 10 | 195 | 191 | −4 |
| Springfield | 30 | 704 | 763 | +59 |
| Dubuque | 18 | 293 | 317 | +24 |
| Omaha | 16 | 235 | 318 | +83 |
| Leavenworth | 18 | 367 | 363 | −4 |
| Davenport | 22 | 463 | 406 | −57 |
| La Crosse | 24 | 418 | 412 | −6 |
| Milwaukee | 40 | 611 | 657 | +46 |
| Brookside | 10 | 232 | 250 | +18 |
| Fort Madison | 26 | 569 | 457 | −112 |
| Iowa City | 14 | 306 | 282 | −24 |
| Muscatine | 18 | 414 | 369 | −45 |

The results, as will be seen, have a wide range, some stations showing an increase, while much the larger number show a decrease. Now, although these series overlap one another in all sorts of ways, and do not necessarily refer to the same years, still, under the theory of a progressive change, they may be combined directly without involving error. We may add up columns 1 and 2 and strike a balance, and this balance shows a greater rainfall in the first period by 343 inches. Dividing this by the number of years in the period, 217, it is discovered that on an average each station received per year 1.58 inches more rain during the first period than during the second: in other words, instead of an increase of rainfall being produced by the increase of arborescent vegetation, there has occurred, from some cause, an actual diminution. I should be very slow to argue from this a deleterious action flowing from the increase of forests, but it seems to militate very strongly against a favorable action upon rainfall.

In Ohio the contrary result is to be sought; viz., a decrease in rainfall owing to the destruction of forests. In this State I find twelve stations, with series ranging from ten to forty-eight years each, and an aggregate of two hundred and ninety-four years. The observations have been treated as were those in the prairie region, with results as given in the following table: —

**Ohio.**

| STATIONS. | YEARS. | AGGREGATE RAINFALL. | | DIFFERENCES. |
|---|---|---|---|---|
| | | 1st half. | 2d half. | |
| Cincinnati | 46 | 1044 | 965 | −79 |
| Cleveland | 28 | 513 | 531 | +18 |
| College Hill | 14 | 329 | 319 | −10 |
| Hillsboro' | 16 | 329 | 307 | −22 |
| Hudson | 12 | 203 | 241 | +38 |
| Kelley's Island | 10 | 166 | 159 | −7 |
| Marietta | 48 | 1005 | 1033 | +28 |
| Portsmouth | 26 | 475 | 547 | +72 |
| Steubenville | 40 | 807 | 836 | +29 |
| Toledo | 22 | 412 | 364 | −48 |
| Urbana | 18 | 353 | 333 | −20 |
| Waterville | 14 | 275 | 245 | −30 |

It will be seen that in this case the total rainfall of the first half of the series is slightly greater than that of the second half, the difference being 31 inches, which, divided by the number of years in the first half of the series, shows, that, along with the clearing of the forests, the rainfall has diminished a trifling amount, being 0.21 of an inch less in each year of the second period than the first. It is, of course, unnecessary to add that this change is too small to have any meaning.

In the third area, that of southern New England, there is to be expected a diminution of the rainfall, consequent upon deforesting, which was in progress down to, say, 1860, and, in more recent times, an increase due to reforesting. Prior to 1860, I have eighteen series, ranging in length from ten to forty-six years, with an aggregate of four hundred years. Treated as before, the results shown in the following table are obtained. Summed up, they show that the aggregate rainfall in the second period was greater by 579 inches, or 2.9 inches in each year of the period. Deforesting, in this case, seems to be accompanied by a decided increase in rainfall.

**New England.**

| STATIONS. | YEARS. | AGGREGATE RAINFALL. | | DIFFERENCES. |
|---|---|---|---|---|
| | | 1st half. | 2d half. | |
| Amherst | 24 | 506 | 550 | +44 |
| New Haven | 20 | 456 | 453 | −3 |
| Boston | 34 | 689 | 723 | +34 |
| Cambridge | 20 | 435 | 491 | +56 |
| Lowell | 12 | 267 | 274 | +7 |
| Lunenburgh | 20 | 493 | 544 | +51 |
| New Bedford | 46 | 978 | 958 | −20 |
| Waltham | 10 | 231 | 212 | −19 |
| Worcester | 20 | 435 | 523 | +88 |
| Fort Adams | 12 | 294 | 273 | −21 |
| Providence | 28 | 539 | 613 | +74 |
| Flatbush | 26 | 555 | 555 | 0 |
| Albany | 26 | 527 | 528 | +1 |
| Jamaica | 22 | 402 | 413 | +11 |
| New York | 10 | 211 | 246 | +35 |
| West Point | 20 | 466 | 486 | +20 |
| Brunswick | 30 | 604 | 748 | +144 |
| Gardiner | 20 | 379 | 456 | +77 |

Subsequent to 1860, I have fourteen series, ranging in length from ten to twenty-four years, with an aggregate of two hundred years. The results, presented below, show that the rainfall in the two halves of these series was identical.

| STATIONS. | YEARS. | AGGREGATE RAINFALL. | | DIFFERENCES. |
|---|---|---|---|---|
| | | 1st half. | 2d half. | |
| Amherst | 14 | 318 | 310 | −8 |
| New Haven | 14 | 347 | 348 | +1 |
| Boston | 24 | 597 | 572 | −25 |
| Fort Trumbull | 10 | 241 | 229 | −12 |
| Middletown | 14 | 324 | 338 | +14 |
| Lawrence | 12 | 279 | 265 | −14 |
| Lunenburgh | 14 | 313 | 343 | +30 |
| New Bedford | 14 | 300 | 348 | +48 |
| Providence | 16 | 377 | 393 | +16 |
| Albany | 16 | 328 | 305 | −23 |
| Flatbush | 12 | 234 | 237 | +3 |
| New York | 16 | 373 | 382 | +9 |
| West Point | 10 | 246 | 209 | −37 |
| Gardiner | 14 | 305 | 303 | −2 |

With these results in view, it seems idle to discuss further the influence of forests upon rainfall from the economic point of view, as it is evidently too slight to be of the least practical importance. Man has not yet invented a method of controlling rainfall.

HENRY GANNETT

## THE GERM THEORY AS A SUBJECT OF EDUCATION.

THE time is past when it is necessary to discuss the probability of the 'germ theory' as explaining infectious diseases. This is no longer a theory, but as fully demonstrated as most of the other universally accepted conclusions of science. No one to-day who is competent to form a judgment from a knowledge of the facts, will doubt that many infectious diseases are caused by the growth of microscopic organisms in the body. Of course, no general proof of the parasitic nature of all infectious diseases has been adduced, nor is such general proof possible; but when the causal connection between certain specific bacteria and definite infectious diseases has in many cases been proved by a demonstration so conclusive as to be beyond question, and when such causal connection has been rendered extremely probable in many other cases, indeed in almost every infectious disease, it is only ignorance of the facts that can explain any doubt as to the very general applicability of the theory. It is true that many, perhaps a majority, of practising physicians do not have much sympathy with the conception of the parasitic nature of infection, sometimes indeed treating the whole subject with ridicule. Some are incapable of forming correct judgments, but most of them have not found the time or inclination to study the subject enough to know what facts have been established. At the time when most of the physicians who are now practising were pursuing their studies, the germ theory of disease was scarcely entertained as a theory, and nowhere accepted. Only three or four years ago some of our better medical schools taught their students that the theory was a wild hypothesis, and destined to be exploded like any other visionary speculation. It is not surprising, therefore, that they should still refuse to accept a theory which so revolutionizes the conceptions of disease. But our leading physicians, including professors in better medical schools, are now convinced of the truth of the theory and the great importance of the subject, and medical papers throughout the country are giving more and more space to the subject of bacteriology. The inevitable result of this will be that the next generation of doctors will accept the germ theory as the basis of practice.

This discovery of the parasitic nature of infectious diseases is of more than scientific interest: it is of vast practical value. It has not yet, perhaps, contributed very materially to the methods of treating disease directly, although we may confidently expect great results in the future along this line. There is nothing to prevent direct experiments with germicides upon living bacteria in the laboratory, and we may hope in this way to get a more scientific method of curing infectious diseases, after the theory of their parasitic nature becomes more truly the property of doctors as well as of scientists. Thus far, however, the value of the theory has been rather as the foundation of the science of preventive medicine. Here its importance cannot be overrated, and is only beginning to become realized.

We need do no more than mention the advances made in surgery in the last twenty years, which are due almost solely to the knowledge of septic bacteria. It needs no words to enforce the value of discoveries in this line. Every one appreciates this matter; and the value of antiseptic dressing, which alone makes the difficult operations possible, is almost everywhere recognized, and its use taught in all medical schools.

In other lines than surgery the value of the germ theory is even greater, though at first sight not quite so apparent, since the matter is yet in its infancy. The great advantage which we are to acquire through this theory is not in curing infectious diseases, but in preventing them. Professor Koch, in a recent address to a class of medical students, voiced this fact: "Gentlemen," he said, "you have been hitherto taught only how to cure disease, in the future you will be taught how to prevent disease." We can see in this direction great practical results arising along at least two different lines. The first is by preparing the body to resist the disease, the method of inoculation. The most widespread instance of this method of treatment is of course vaccination for small-pox. Vaccination was discovered, it is true, empirically, and entirely independent of the germ theory; but it finally received its *rationale* through the brilliant work and generalizations of Pasteur. Working in accordance with the same idea of preventing a severe form of a disease by giving the individual previously a mild form, Pasteur has successfully treated splenic-fever and hydrophobia. Others, following in his lead, claim success in a similar treatment of yellow-fever and cholera, although these claims certainly need further verification. But only a beginning has been made in this direction, and it does not seem improbable that we may see a time when many of our most severe epidemics may be as thoroughly subdued by inoculation as small-pox has been by vaccination.

But of much more importance than inoculation is the more natural method of avoiding the diseases. We are now learning to keep the bacteria away from our bodies, either by directly destroying them or by keeping away from the contaminating material. When we know the exact nature of an infectious disease, — what are the habits of the organism which produces it; where they are most likely to be found lurking during epidemics, whether in water, food, clothing, drains, in the air, in the excreta or scales from the skin of the patient; in what conditions they will grow, and what will kill them; how they make their way into the healthy body, whether by food, drink, by breathing, or by contact of infected material with the skin, — in short, when we understand the natural history of an infectious disease, it is usually easy to avoid it. If the disease is taken in drinking-water, it may be avoided or rendered harmless; if in food, the food may be cooked; if from excreta or clothing, they may be easily disinfected by some of the effective germicides; if by contact with the skin, care in handling the infected material, and disinfecting the skin afterward, will usually suffice. As yet we have discovered no way of avoiding contagion which comes to us in the air, but we are just beginning to find out the extremely important fact that the air does not become contaminated with bacteria unless they are allowed to dry. Recent investigations have shown a smaller number of bacteria in the air of a well-kept sewer than in that of a poorly ventilated schoolroom. It is a valuable discovery that this means of infection by breathing — a means which we cannot guard against — is uncommon. The air is not the ordinary mode of transferrence of germs, and would be scarcely at all, if proper precautions were taken to prevent infectious material from drying. Here we immediately get suggestions as to the management of the