the size of peas, if any of the gangue of the powdered ore remains floating on the top of the metal and is not slagged and absorbed by the litharge. As soon as the ring of slag closes over the metal remove the scorifier, let it get cold, then break it, and by pounding separate the slag from the button of metal.

Put a dry bone-ash cupel, weighing about the same as the button of metal obtained from the scorification, in the muffle, let it get red hot, then drop in the clean button and close the muffle until the metal has liquefied, then open it partly.

Lead under such slags off into litharge, the latter carrying with it all base metals and impurities. It is absorbed almost as soon as formed (if the muffle is properly heated) into the porous bone-ash cupel. The button gradually decreases in size, and as it gets small it must be watched, so that when the last of the lead passes off into slag and the silver (if any is present) "brightens" or assumes the luster and color of the pure metal, the cupel may be removed to avoid loss by volatilization. If the ore contained any silver a small bead of that metal will be found in the cupel; if none the cupel will be empty. Sometimes, in poor ores, the bead will be almost microscopic, so that the cupel must be carefully examined before setting it aside. Weigh the bead if found on a fine balance and multiply the weight in grains by 291,600, the result being grains of silver (with possibly a little gold) in a ton of the ore. Error may arise from the presence of silver in the test lead, so that it is always best to test it for that metal (by scorification and cupellation as above). If it is found to contain silver, and a purer sample cannot be readily procured, determine by duplicate tests as accurately as possible the amount present, and make proper allowance for this in calculating other assays in which the lead is used.

Good scorifiers and cupels can be obtained from any dealer in chemical apparatus, etc. In some instances a large French clay or even Hessian crucible with a hole knocked in the bottom can be made to serve as a good muffle for such tests instead of the clay pipe. In this case the side of the crucible becomes the bottom of the muffle, and if a little dry sand or bone-ash is spread over it, it can be made level enough to support the scorifier without tipping.

Under favorable conditions such tests can be made in an hour or an hour and a half.

RURAL DRAINAGE AND DISEASE.

BY H. C. HOVEY.

It has been estimated that more than half the deaths occurring in cities are due to preventable causes. The vital statistics of farming regions are not so easily obtained, but statements of responsible physicians, having each a large country practice, in widely separated portions of the United States, prove the importance of judicious sanitary measures in rural as well as municipal localities. One observes that "one-third of the autumnal sickness of this region might be prevented by systematic drainage of farm lands, without detriment to their agricultural value." Says another, "about fifty per cent of our sickness might be obviated by suitable sanitary precautions." All agree that a large proportion of the maladies coming under their notice are attributable to the insidious poison emanating from decomposing animal and vegetable matter.

The purest country air is less pure than is commonly supposed; a fact demonstrated to visitors of Mammoth Cave, who, on emerging after breathing for several hours the air of the cave, which is almost absolutely free from noxious gases, find the outer air laden with oppressive odors, and depressing in its influence on the system.

Miasmatic exhalations arise from every swamp, and wayside pool, from the decaying forest leaves, and many other objects that are hardly thought of as prejudicial to good health. This particular form of the evil reaches its minimum in hilly regions, where the tilted strata supply natural drainage; while its maximum is found in such extensive areas as exist in Indiana, Illinois, and other portions of the West, where vast deposits of alluvial and lacustral soil cover nearly level sedimentary beds, allowing but very sluggish removal of marshy accumulations.

The cultivation of the surface soil, and the drainage made for agricultural purposes, have gradually redeemed large tracts of wet land in the regions mentioned; yet much remains to be done, and it is gratifying to see that steps are being taken by some of the States embracing prairies and broad river bottoms, to investigate the relation between the hydrographical features of the country and the prevalence of malaria and zymotic diseases.

State and local health commissions are instituted with authority to collect vital and sanitary statistics, and to have charge of public measures for removing the causes of disease from all parts of the State; omitting, however, two very important links from the chain of a perfect organization; namely, police power to enforce good health laws in rural districts, and means to defray expenses of straightening crooked streams, to increase the velocity of the current, digging canals to relieve wet lands from overflow, and doing other things that might cost a considerable sum of money, but would add largely to the reputation of the State for salubrity, and thus bring a rich reward.

The first annual report of the Health Commission of one of our largest and most populous interior States has lately appeared, full of facts as to the deficient sewerage of cities, and its almost utter neglect in smaller towns and villages, and in rural localities; also showing the inevitable connection between these causes and the prevalence of forms of sickness that might be entirely avoided by a comparatively small outlay. And what is true of Indiana would also be found to be true of other States similarly situated as to a lack of natural drainage.

Look at the still more level State of Illinois, with its vast prairies and fertile bottoms. The sewage of all the cities is emptied into the adjacent streams, which have usually a sluggish flow, and it is hardly asked whither the reeking mass is distributed.

Often this seems to be the only available mode of getting rid of it, all experiments looking toward other methods meeting with but slight success. It is to be hoped that some apparatus like the "garbage destructor and carbonizer" described in a late number of the SCIENTIFIC AMERICAN, will be introduced into all large cities for the consumption of refuse without sending it down some stream to contaminate the surrounding country.

About ten years ago the course of the Chicago River was artificially reversed, so that instead of running as it had done for ages into Lake Michigan it emptied itself and its accumulation of street filth and offal into the Illinois River, coursing completely across the State. The beneficial result to the city was very great; but for 150 miles down the Illinois River loud complaints were made of a marked increase of zymotic diseases, and a remarkable mortality among the fish in that stream seemed to prove that the water had been poisoned. The fact is worth noting, in passing, that the fish appeared to grow used to the changed condition of affairs; but during the past winter the ice bound water not being properly oxygenated for a long time, many fish died, while others in immense numbers congregated below the dam at Henry, where the constant agitation of the falling water would favor aeration. And at the same time there was an alarming prevalence of diphtheria at Peoria and other places along the river.

This illustration shows the importance of State regulation of general drainage, so that what is borne away as a nuisance from one locality shall not be cast as an offensive burden on another.

But suppose all to have been done that can be effected by public health organizations, much will remain to be accomplished by individual effort, in response to appeals to an enlightened instinct of self-preservation.

Many farmers, otherwise well informed, do not seem to realize the fact that gases arising from stables, pigpens, and out-houses may poison the pure country air as effectually as the atmosphere in cities may be spoiled for breathing by the same effluvia spreading from neglected alleys or cesspools. And the thrifty wives of farmers, who, forgetful of cleanliness, saturate the door yard with wash water and kitchen sewage through all the winter months, should be taught that when that ground sours and festers under the summer sun, the heat will ripen the germs of disease as surely as it will ripen the grain in the harvest field.

Maladies mysteriously affecting families residing in what are regarded as healthy localities, are often explainable on opening the cellar door, whence an intolerable odor of decaying vegetables proceeds; or on lifting a board in the kitchen floor, beneath which is a shallow pool of standing water; or on observing that the well is so situated as to drain into itself some of the substances that are thrown away as utterly unfit to be retained in proximity to human beings.

The latter point is one very frequently overlooked. For example, a certain Western city, finely located and attractive, gained the reputation of being an exceedingly unhealthy spot, and was of course much retarded in its prosperity by that fact. Finally it was noticed that underlying the city, at a depth of about twelve feet, is a stratum of impervious blue clay, above which lies an extensive quicksand, affording an abundant water supply by means of numerous wells, and into that same quicksand all the vaults and cesspools of the place were also dug, thus mixing their foul contents with the drinking water that every one used! The amount of sickness was materially diminished by the proper attention being given to this one point. Every careful farmer will see that the compost heap, and other refuse stored as food for the roots of grasses and vegetables, shall be at such a distance from the house and well as not to contaminate the air and the water essential to the preservation of life and health.

In closing, I may mention a curious illustration, given in a paper by Prof. E. T. Cox, on the "Influence of Geology on Local Diseases," showing what has actually been done by rural drainage to eradicate a dreaded malady that used to prevail extensively in Kentucky and Indiana, known as "milk sickness," because, first attacking cattle, it was communicated to human beings through the milk, butter, and beef of the infected animals. Many a brave pioneer lost his life by this malady, which almost always proved fatal; and recovery was usually lingering and imperfect. At first it was supposed that the cattle had eaten some poisonous plant; but every suspected grass and weed proved harmless on scientific examination. Then it was held that mineral poisons must lurk in the springs and brooks; but hundreds of samples were analyzed without detecting the presence of the enemy. At last an investigation of the clay shales, soft rocks formed from ancient mud beds, and which are microscopic in an eminent degree, revealed the secret. These formations abound in every infected locality, and it now seems clear that they exhale some sort of miasma, when saturated with water, that originated or aggravated the disease, just as other kinds of malaria bring on chills and fever. Proceeding on this discovery, thorough drainage of the wet lands adjacent to the shale beds dried them sufficiently to terminate the conditions favorable to the spread of milk sickness, so that it has now almost entirely disappeared from regions that once were cursed by that plague.

The opinion is now established that a large proportion of diseases are of germ origin; and the obvious mode of prevention is the destruction of the germs or their timely removal.

VACCINATION IN SMALLPOX.

Jenner's great discovery of vaccination for prevention of smallpox has not been wanting in opposition, and a few persons are still so stupid as to object to vaccination. These people, who refuse to be vaccinated themselves or allow their children to be, endanger not merely their own lives, but the lives of their neighbors. They furnish the fuel on which the flames feed, and render epidemics of smallpox possible. If vaccination were universal it would be as difficult to get up a smallpox pestilence as it is to start a great fire in those cities where all the buildings are practically fireproof.

While the efficacy of previous vaccination with good virus is well known to be a preventive, the uses of vaccination after the disease has been contracted are less understood. Some years ago a Virginia physician, Dr. Alban S. Payne, conceived the idea of vaccinating a smallpox patient with the kine-pock. It took at once. The next day he repeated the vaccination, and that also took effect. And what was the effect upon the smallpox of having another similar disease in the system at the same time? The eruption was less extensive, but few pustules appeared, no scars were left, and in a surprisingly short time (three or four days) the patient was able to be about the room. In hundreds of cases where the system of daily vaccination was practiced by Dr. Payne, the duration of the disease was shortened, and *no deaths occurred*. Why, one would ask, is not this simple precaution always taken, if by its means life may be saved, pitting prevented, and suffering diminished? We should be glad to hear from other practitioners who have tried the method above described.

Institute of Mining Engineers.

The American Institute of Mining Engineers met at Staunton, Va., May 30. The members present included President William Metcalf, of Pittsburg, Penn.; Dr. R. W. Raymond, of the School of Mines, Columbia College, New York; Dr. Thomas Egleston, of the School of Mines, New York; Dr. Dudley, chemist of the Pennsylvania Railroad Company; Professor P. Frazer, of Philadelphia; Dr. T. Sterry Hunt, of Montreal; J. A. and J. T. Burton, of Troy, N. Y.; W. P. Ward, of Savannah, Ga.; and F. S. Witherbee, of New York.

In his annual address President Metcalf spoke of the advance of science and its results, and of the education of engineers. Special stress was laid upon the continuous study of the higher mathematics and practical observation as means of self education and professional success. A paper by J. H. Mackintosh, on "The Electrolytic Determination of Copper," was read by Prof. Egleston, and discussed by several members. Dr. Frazer read a paper on "The New Geological Map of Chester Co., Pa."

The opening paper of the second day was by Professor Egleston on "The Ore-Knob Copper Process," employed at the mines of the Ore-Knob Copper Company in North Carolina. The belief was expressed that a great amount of copper lay dormant in the South, which, if properly worked, would be as profitable as the lake copper. Major Hotchkiss, of Virginia, thanked Professor Egleston for drawing attention to the copper deposits of the South. Very few persons are aware of the great wealth in this mineral with which this State abounds. Forty years ago Richard Taylor made explorations and reported on this class of ore. The only difficulty in its development then was the lack of transportation facilities. That objection does not now exist, and this industry may be expected to be seen coming prominently to the front.

A paper prepared by F. H. Williams, of St. Louis, Mo., on "A Volumetric Method of Estimating Manganese in Pig Iron and Steel," was read by the secretary. It was an adaptation of the known processes. In connection with it was presented a paper on "Manganese Determinations in Steel," prepared by William Kent, of Pittsburg, Pa. These papers were discussed by Drs. Drown, Sharpless, and Dudley. In reference to the subject of steel rails letters were read from Richard Akerman, of Stockholm, Sweden, and C. P. Sandberg, of London, England. The latter showed a preference for the mechanical over the chemical tests of steel rails, though he recognized the full importance of both. Considerable discussion ensued upon this subject, the principal participants being Drs. Raymond and Dudley.

At the afternoon session Dr. Sharpless, of Boston, made a statement with reference to the black band iron ores of West Virginia. F. P. Dewey, of Tennessee, read a paper on "Rich Hill Iron Ores." O. J. Heinerich, of Drifton, Pa., explained the practical working of the ammonia soda process, and Stuart M. Buck, of Virginia, read a paper "On the Hard Splint Coal of the Kanawha." After an explanation of the geology of the valley by Major Hotchkiss, the institute adjourned.

At the night session Professor Frazer, of Philadelphia, read a paper on "Observations on some of the Ores of the Upper James River." This was followed by Major Hotchkiss in a description of the topography and geology of the Virginia Valley.

The programme for June 1 was devoted to an excursion over the Shenandoah Valley road to the Luray Cavern, with an examination of the rich mineral deposits of the valley.