motion as is possible for a molecule of a solid reaches a maximum value which can only decrease, whether the amplitude of the oscillation be increased or diminished, and that the only way in which it is possible to increase the mean kinetic energy of this kind of motion is to impart sufficient additional energy to change the motion into one of complete rotation. By such a process, greater freedom of motion is given to the molecules, and a large amount of energy becomes potential. This is regarded as explaining the phenomenon of liquefaction.

It is shown by an extended mathematical discussion of the cohesive forces and resistance to compression, by which molecules hold each other at mean fixed distances, that the mean kinetic energy of the vibration of molecules about their mean positions also has a maximum value which can only be increased by removing them to such mutual distances that the cohesive forces no longer act. In this process a large amount of energy also becomes potential. This is regarded as the rationale of the phenomenon of vaporization.

It is further shown, that, on this theory, it might very readily occur that the specific heat of a liquid should at first decrease, and then increase, as Rowland has proved is the case with water, but that the specific heat could not at last decrease.

The cause of the relatively large specific heat of most liquids is treated. It is shown that the distribution of rotary velocities in free rotation, such as the molecules of a liquid are supposed on this theory to have, is such that the atoms of some small per cent of the molecules in any given mass must be torn asunder. What per cent of the liquid may be thus dissociated will depend upon the temperature and constitution of the liquid; it being smaller for the simpler liquids, and increasing with the temperature. Electrolysis is an evidence of this action. Such dissociation sufficiently accounts for the generally high specific heats of liquids.

There is a general qualitative accordance of the theory with observed specific heats. A further confirmation of the theory is found in the clear explanation it affords of the existence of a critical temperature, above which a vapor is uncondensable by pressure alone; for, when the mean kinetic energy of all the molecules of a liquid acquires a value greater than the maximum possible in a liquid state, the liquid is not only vaporized, but necessarily becomes an uncondensable gas, and remains so.

GERMS AND EPIDEMICS.[1]

AFTER a brief historical sketch showing the idea that certain diseases, and especially marsh-fevers and the plague, are caused by the entrance of minute living organisms into the body, to be a very old one, but one which, until within a few years, has had no experimental proof, some definitions were given of the terms now used in discussion of this subject; and the word 'microdeme,' meaning 'little living thing,' was proposed as a general designation for the minute living particles found in almost all air or water. The microdemes include the *Microphytes*, or minute vegetable organisms, and the *Microzoa*, — the microzomes, the bacteria, microbia, micrococci, etc. There is at present no evidence that any microdemes are derived from any source other than other living organisms, nor that the special microphytes which cause the various processes known as fermentations or putrefactions ever develop into the higher forms of fungi; although this is still an unsettled question, and there is some reason to think that some of the higher fungi may act as ferments.

The prevailing opinion at present is, that there are many different kinds of microphytes, each having special powers, and that each can only propagate its own kind within a certain limited time.

But it is also probable, that by changes in nutriment, temperature, etc., changes in their habits and powers may be produced through natural selection. These changes are so considerable as to cause them to appear to be new species. The germ theory is, that certain diseases are due to the presence and propagation in the system of minute organisms which have no part in its natural economy. The word 'germ,' however, is often erroneously applied to independent organisms which originate outside of the body itself, such as the particles in vaccine lymph which are not microphytes, and can hardly be called independent organisms.

The diseases caused by large and comparatively well-known organisms are called parasitic. Such are some varieties of skin-disease; as ring-worm, or the so-called live spots, the fungus foot of India, and the disease of the ear due to the growth of a peculiar Aspergillus. A new disease of this kind is the so-called actinomycosis, due to a fungus which forms tumors near the angle of the jaw, and which causes death when it becomes generalized.

An account was then given of the organisms found in splenic-fever, relapsing-fever, chicken-cholera, leprosy, etc., and the method of Pasteur for the so-called attenuation of virus was described. This method appears to depend largely on the exposure of the broods of micro-organisms to the influence of oxygen; and recently MM. Nocard and Mollereau have announced that the same can be effected much more rapidly by the use of oxygenated water. The question as to whether Pasteur's inoculation with artificially modified virus will afford permanent protection is still unsettled, for sufficient time has not elapsed to decide it; but there is reason to hope that it will be found to be of great practical benefit.

The effects of microdemes in producing pyaemia and puerperal-fever are well described, and attributed to a poison secreted by them, of the nature of the so-called ptomaines, rather than to their mere mechanical presence. This knowledge is practically applied in what is called antiseptic surgery; and the surgeon now undertakes, without hesitation, operations which, twenty years ago, would have been deemed quite unjustifiable; for he knows, that by insuring that neither through the air nor the water, the sponges nor the instruments, nor in any other way, a single microdeme which has not had its powers of growth and reproduction totally destroyed shall gain admission to the wound, he need have no fear of blood-poisoning.

As regards diphtheria, it is probable that it is due to a common micro-organism, which, under circumstances not yet understood, becomes virulent, as the micro-organisms of common sweet-hay infusion may be transformed into those which cause malignant pustule.

The connection of consumption with a microphyte is still doubtful, though not improbable; and the same may be said with regard to malaria.

A sketch was then given of some of the characteristic phenomena attending the great epidemics. For some, the germ theory appears to afford the best explanation; for others, such as influenza or cerebro-spinal fever, this theory is quite inadequate.

Special attention was called to the many points in

[1] Abstract of a lecture by Dr. J. S. BILLINGS, given in the Saturday course at the U. S. national museum, Washington, Feb. 17.

which our knowledge of these subjects is still fragmentary and imperfect, — points which are to be settled by direct experiment. Such experimental researches are of the highest value; and it is much to be regretted, that while the governments of England, France, and Germany, are employing their leading scientific men in such work, Congress has deliberately stopped a most promising series of investigation of this kind, and has resolved to confine its efforts to paying bills after an epidemic has made its appearance.

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.*

Use of the moxa in Japan.

As I rode behind the naked-backed jinriksha coolies, I noticed along each side of the spine, from the head to the hips, white, irregular scars, about the size of a dime, indicating, as I supposed, some skin-disease, to which they are very subject from their diet and exposure when young. These were the marks left by the *moxa*, a household remedy, probably invented in Japan, — a painful and powerful agent, well known in modern surgery. It is made of the pith of a reed (Artemisia), mixed with powdered charcoal, in a conical form. This is ignited, applied to the skin, and allowed to burn slowly until extinguished. The flesh is severely burned, with the resulting scar alluded to. As if this were not sufficient to expel the 'winds and vapors,' which they and the Chinese believe to be the cause of all diseases, this is combined with acupuncture, the needle passing through the moxa deeply into the tissues, and conveying the heat to the supposed seat of disease. As they employ this every spring as a preventive measure, it is rare to see a coolie without these scars. The accoucheur calls it to his aid, and is directed to burn three cones on the little toe of the right foot to accelerate the operation of nature. Even infants are thus tortured. A child about three years old, suffering from a wasting diarrhoea, who had thus been uselessly tormented, was brought to me; the many wraps having been removed, a simple water dressing and mild opiate brought the little creature round all right in two days. SAMUEL KNEELAND.

The least bittern in Newfoundland.

While on a recent visit to Newfoundland, I examined a mounted specimen of the least bittern (Ardetta exilis) that had been killed in a fresh-water marsh about a mile from St. John's, in the early part of October, 1882. The latitude of St. John's is 47° 33′ N., and it is hardly necessary to add that this species has not previously been recorded from so far north. C. HART MERRIAM, M.D.

Locust Grove, New York.

Science for workingmen.

Your article in the number of SCIENCE for April 20, upon this topic, was timely and suggestive. The example offered by the Baltimore and Ohio railroad is indeed worthy of imitation. But such work, however novel it may be in the east, has been done to a greater or less extent in this state for several years. It may interest your eastern readers, who sometimes think that we westerners must always wait for them in such matters, to know of a few attempts here to do similar work for the working-classes. Three years ago the officers of the St. Louis and San Francisco railroad maintained, with the hearty co-operation of its friends, a course of lectures in at least one important town on its line of road, for the special benefit of the railroad employees.

Two winters ago the Crystal plate-glass company, whose works, situated about thirty miles from this city, bring about them a population of nearly fifteen hundred, arranged a similar course of instruction lectures, which were attended by audiences of six and eight hundred persons.

The president of the St. Joe lead-mines at Bonne Terre, about seventy-five miles south-west of St. Louis, has just begun a like work, and intends to provide a good course of practical lectures, or talks upon science, literature, and travel, for the coming winter.

At Bonne Terre and at Crystal City, reading-rooms and libraries have been opened for all who choose to avail themselves of such opportunities; and at the former place a public reading from some standard author is given every Friday evening. The results attending such efforts to help working men and women have been sufficient to encourage these and other corporations to go on to still better things. The knowledge conveyed, and impulse given to thought and study, are only a part of the good done. A better relation between employers and employed is sure to come from the good feeling which prompts such action, and the grateful appreciation with which it is received.

Washington university is in this matter willing to take the position assumed by Johns Hopkins university in Baltimore, and has some half a dozen or so among its busy professors who are always ready to respond heartily to such calls for help. This institution has, in fact, been the main dependence of the corporations above mentioned in their efforts to do something to entertain and instruct their people.

We have accomplished but little here yet, but it may not be amiss to put ourselves on record as having begun. It helps us, always, to know what others are trying to do. M. S. SNOW.

Washington university, St. Louis, May 2.

Robins, sparrows, and earth-worms.

An amusing bit of impertinence on the part of the immigrant house-sparrow is seen in his habit of stealing earth-worms from our great lumbering, native American robin. As everybody knows, the robin is not a little skilful in extracting earth-worms from their burrows in land covered with short grass, as in pastures, lawns, and yards. The bird quickly detects the worm's head, as the creature lies resting near the mouth of its burrow, and seizes it instantly by a sudden blow with the beak. The head of the worm once firmly grasped, the robin straddles his legs apart, braces himself firmly, and gradually lifts his head to the uttermost, and thus slowly, by what is manifestly a powerful and a fatiguing effort, drags out the resisting worm. Having succeeded in an important enterprise, the bird very naturally pauses for a moment to take breath; and at this critical instant of time a sparrow steps forward, out of a squad of these birds which have been watching the robin's proceedings, quietly takes the worm from the robin's mouth, and incontinently flies away with it, leaving the original possessor in blank amazement. The transaction is well worth seeing for its own sake, and needs but to be looked for, in order to be seen frequently in and about our cities; and it suggests a question which may, perhaps, be profitably studied by the coming generation of naturalists. Indeed, the fact itself is worth putting upon record as a sort of bench-mark to serve as a point of comparison for observers in future years.