author of the "new" experiment was totally ignorant. The present publication does not lay claim to any profound scientific knowledge or pretend to herald any new discoveries. It is a catalogue of the species of birds known to occur in Michigan, compiled from various published and unpublished data, with notes on localities and other items. There are 332 species recorded. Abstracts are given of bird and game laws, and a bibliography of over 200 references adds to the value of the whole. The illustrations, mostly taken from Coues's "Key to North American Birds," will prove of great assistance to those using the Bulletin in the state. J. F. J.

LIQUID AND SOLID AIR.

BY JOHN S. MCKAY, PACKER INSTITUTE, BROOKLYN, N. Y.

THE physical state, or condition, of a body is entirely incidental and never dependent upon any inherent property. The same substance may be solid in one zone and liquid or gaseous in another. According to the kinetic theory, the different states of matter are only different modes of molecular motion and any change of state is the result of the absorption or liberation of energy. By the addition of sufficient heat energy all solids and liquids become gases, and by withdrawing such energy all gases may be reduced to the liquid or solid state. It is probable that at the temperature of absolute zero (–273°C.) there would be neither solid nor fluid, but that if matter still continued to manifest itself to our senses, it would be in a different physical form from anything now known. It is certain that there could be no gases at that temperature, since molecular motion is essential to the idea of gaseity. From recent experiments it seems probable that all gases, under ordinary atmospheric pressure, would become liquid or solid before reaching absolute zero. It is a well-known fact that after a gas has been cooled below its critical temperature it may be reduced to the liquid state by the aid of external pressure. Until a few years ago oxygen, hydrogen, nitrogen, air, and a few other gases had never been reduced to their critical temperatures and hence could not be liquefied. Air had been compressed until it was denser than water without any trace of liquefaction. And so these gases were called permanent or incoercible gases. But in 1879 Cailletet of Paris and Pictet of Geneva, working independently and by somewhat different methods, succeeded in reaching the critical temperature of some of these gases and by great pressure reduced them to the liquid form. Since then all known gases have been liquefied and the old distinction of permanent and coercible gases has been effaced.

The critical temperature, or absolute boiling point, of these gases is very low, being –140°C. for oxygen, –146° C. for nitrogen, and –240° C. for hydrogen. This low temperature is obtained by evaporating in vacuo liquid NO, CO_2, SO_2, or some other substance whose critical temperature is comparatively high and which is therefore easily liquefied. As yet hydrogen has been liquefied only in small quantities by allowing it to expand suddenly when at a low temperature and highly compressed. In some remarkable experiments before the Royal Society of London during the past year Prof. Dewar made use of liquid ethylene to secure the low temperature necessary to liquefy air and oxygen. By means of three concentric vessels, the outer one containing liquid nitrous oxide and the next one liquid ethylene, both being connected with powerful vacuum pumps to increase the evaporation, he secured so low a temperature in the inner vessel that oxygen, nitrogen and air were liquefied in large quantities with comparatively little pressure. By causing a vacuum to act upon a large tube containing liquid oxygen, a temperature of –210° C. was produced. A small empty test-tube inserted into the boiling oxygen was so cold that the air of the room at ordinary pressure condensed and trickled down its sides. By evaporating liquid nitrogen in a vacuum, a temperature of –225° C. was reached, at which point nitrogen became solid.

Liquid oxygen when first formed is milky in appearance, owing to the presence of some impurity which may be removed by passing it through ordinary filter paper. When pure it is of a pale blue color, which, however, is not due, as some have thought, to the presence of liquid ozone, which is of a dark blue color. Liquid oxygen is a non-conductor of electricity but is strongly magnetic. It may be lifted from a cup by presenting the poles of a strong electro magnet. It seems to have very slight chemical activity, since it will extinguish a lighted match and has no action on a piece of phosphorus dropped into it. It is well known that the A and B lines of the solar spectrum are due to oxygen, and, from recent experiments on the top of Mount Blanc, it is thought that they are largely if not wholly due to the oxygen in the earth's atmosphere. Prof. Dewar showed that these lines come out very strong when liquid oxygen is interposed in the path of the rays from an electric lamp.

Liquid air is at first somewhat opalescent, owing probably to solid particles of carbon dioxide. It may be cleared by filtering or by standing for a few minutes, when the particles rise and disappear. When any of these liquefied gases are placed in an ordinary glass vessel they boil vigorously and soon disappear owing to the heat obtained from the vessel and surrounding objects. In a vessel made of rock salt they take the spheroidal form and last much longer, but Prof. Dewar found that they could be kept longest in vessels with double walls with high vacua between them. A small bulb filled with liquid air and protected by a vacuum would require an hour and a half to boil away, five times as long as it could be kept in an ordinary vessel. Liquid air has the same high insulating power as oxygen but is less magnetic. Its magnetic power is evidently due to the oxygen, since liquid nitrogen is not magnetic. When the oxygen is attracted by a magnet it draws the inert nitrogen along with it without being separated, but if a sponge or ball of cotton be saturated with liquid oxygen and presented to a magnet the liquid will be drawn out of the meshes and cling to the magnet until it evaporates. The normal boiling point of nitrogen is about eight degrees below that of oxygen, so that the two substances may be separated by distillation, the nitrogan boiling off first and leaving the oxygen. But when air is being liquefied the nitrogen does not come down first, as might be expected, but the two condense together at a temperature about midway between their respective boiling points.

All the liquefied gases except oxygen and hydrogen have been frozen by self-evaporation in a vacuum. By evaporating liquid air in a vessel surrounded by liquid oxygen, Prof. Dewar succeeded in reducing the air to a clear, transparent solid. It has not yet been determined whether the oxygen of the mixture is really frozen or merely entangled among the particles of solid nitrogen in some such way as rose water in cold cream, or water in the solid gelatin of calves' foot jelly. Although pure oxygen has never been frozen it is possible that when mixed with nitrogen its freezing point is raised so that the two solidify together.

One of the interesting things connected with these recent experiments in the liquefaction of gases is the fact that it enables us to produce a lower temperature than ever before. We are slowly creeping down toward the absolute zero and the possible solution of the mysteries connected with the nature and constitution of matter. Is it not possible that we may yet be able to separate matter from energy and thus form some conception of matter pure and simple? When the molecules cease to vibrate what would be the state or condition of matter? Would it still manifest itself to the senses? If so, what properties would it retain, what new ones acquire?

FUNGI PARASITIC INDICATE KINSHIP.

BY BYRON D. HALSTED, RUTGERS COLLEGE, NEW BRUNSWICK N. J.

It is difficult in a short title to express the leading thought of this paper. Possibly it may be expressed as follows: Fungi, when strictly parasitic, as a rule, infest either a single species, or, if more than one, the hosts are not distantly related. It is therefore to these species that have a wider range than a single sort of host that attention is called at this time. Please bear in mind that the word "strictly" is employed in the statement of the proposition. Therefore it may be possible to draw something of a conclusion from instances when a fungus grows with almost equal ease upon a wide range of substances. But this is a matter of secondary importance at the present time. For our purpose a fungus may be considered strictly parasitic when it attacks what appears to be perfectly healthy tissue, as the leaf or stem of a plant in the full flush of its vitality. Let some instances be cited to make the fact emphatic. Three years ago there was an outbreak of trouble in a Jersey cranberry bog. The leaves, blossoms and young stems became distorted with numerous minute galls, due to a microscopic fungus (*Synchytrium Vaccinii*, Th.). The cranberry being a bog plant is under water for a part of the year and the shore plants bordering the bog are likewise submerged for some time as well. The fungus discharges its spores into the water, and they are carried to all parts of the bog and the overflowed neighboring land during the spring floods. During the investigation of the cranberry gall trouble the shore plants came under notice, and it was found that several kinds of them were attacked in a way similar to the cranberry. Two interesting facts were obtained in the investigation; first, that the cranberry gall fungus attacked the shore plants up to a certain well-defined line. If the shrub was low it would bear galls throughout, but a high one had them only upon the lower leaves and branches. In short the gall fungus attacked those parts only that were under water at the time of the floods when the spores were being disseminated in the water. The second interesting fact was that all of the shore plants showing signs of infection were all members of the same family (*encaciae*) with the cranberry. The hosts among themselves are widely different in general appearance, and it was remarkable how dissimilar were the galls upon these various species. Upon the white alder, for example, the galls were large and hairy; while upon the wintergreen and sheep laurel they were smooth. But without going into the details of minute structure there seems no doubt that all forms are of the same species, and while the water must have been well charged with the germs and bathed for days or weeks the entire vegetation of the submerged shore, none but the members of the heath family were affected.

The demonstration is quite complete that the presence of this fungus indicates kinship among the host plants. So strong is this that should a new host be found for this gall fungus the first thought would be that the victim is a member of the heath family of plants.

Similar instances might be mentioned in connection with other fungi, and that almost without number. In the case of fungi attacking fruit the circumstances are somewhat different and this sends us back to the word "strictly" in the original proposition. It may be contended with considerable show of reason that a fruit, particularly if it is nearing maturity, is not altogether alive, but instead, having become the receptacle of various substances to facilitate the dissemination of the maturing seeds within, is passing from the condition of a highly vitalized portion of the plant to a passive condition that will soon be on the verge of decay. This being the case, it is not exceptional to the rule when it is found that a mould that grows upon the tomato may thrive equally well upon the peach or plum. The soft tissue in each case is similar and the fungus does not need to overcome the resisting force, peculiar to each species, that is associated with the living portions of the plant. Should the fungus in question grow also upon the otherwise healthy foliage, of the tomato, peach and plum, the question would be different. It would be a true parasite that was able and willing to flourish upon the fresh products of life, namely, the fruit. The leaf fungi, as a matter of fact, are widely different from those of the peach and plum, and those of the cherry and plum, for example, are often identical; and the hosts are within the same small group.

Passing to a small group of closely related plants; namely, the cucurbits, it is interesting to note how wide spread some of the fungi are preying upon the species. Thus the water melon is frequently badly affected with an anthracnose, which growing in the rind of the maturing fruit causes it to become full of decayed pits. The muskmelon suffers from the same fungus but the texture of the skin of its fruit is so different that the decay might be considered as not the same as the one of the watermelon. A third member of the same family, namely the cucumber, is not exempt from the same enemy, as the accompanying engraving will indicate. This illustration is from a photograph of one of a bushel or more of equally bad specimens met with at a market place. The cucumber being of a softer texture is much more quickly destroyed than the muskmelon or watermelon.

This anthracnose (*Colletstrichum lagenarum* (Pass) E and H.) thrives upon the foliage of the three named hosts causing a leaf blight. It is a true parasite and assists in indicating the close kinship of the hosts.

—"Our Own Birds," by Wm. L. Bailey, published by J. B. Lippincott Company, is an excellent manual for those who wish to become familiar with the common birds of this country. It contains a number of half-tone full-page illustrations, with others in the text.