

observer, Mr. L. C. Root, who first called my attention to the injurious consequences of the needless disturbance of bees during their winter sleep. And every farmer boy knows how unwholesome it is to be suddenly aroused from a deep sleep to immediately participate in the active duties of the day. How comforting to the rising generation that the doctors now say, the process of awakening should be a gradual one !!! Hibernation differs widely in different animals. While possessing the same general characteristics, yet in no two is it exactly alike and we must not expect the honey bee, which differs so much from everything else of the animal kind, to conform in every particular to the already observed conditions of hibernation. In some animals, hibernation is very profound, in others not. I have already given an illustration of the latter. A hibernating bat, in a pneumatometer, consumed but one seventy-second part as much oxygen as one awake. The bat, may be said to belong to the former class. In some animals, before the period of hibernation, a large amount of fat is stored in the body; this hydro-carbonaceous deposit serves as a store of heat and force during that period. In this class of profound hibernators, the total loss of weight is sometimes 40 per cent or fully as much as usually sustained in starvation. Another class of hibernating animals store their chief supply of food outside of the body and awake at intervals to partake of it. The marmot, hedgehog, squirrels, dormice, etc., belong to this class. To this class, we must assign the honey bee, the honey being the stored supply of heat and force. Some of this class have a partial dependence upon the fat of the body, but it is not asserted that this is the case with the honey bee. Some bee philosophers, however, maintain that bees kept on a short allowance through the fall and supplied later for winter, do not usually come through so well. There is also a small school of physiologists who assert that all carbonaceous food, must first be converted into a dipose tissue before it can be useful for the production of heat and force. This applies *equally as well* to the honey of the bee as to the quarts of oil consumed by the Esquimaux. According to Dr. Hall, the hedgehog in a temperature varying from 45° to 50°, awakes to eat at intervals of two or three days, depending upon this slight difference in temperature. The dormouse which sometimes hibernates in bee-hives, awakes daily in moderate temperatures. Dr. Reeves says, lower temperature begins at the surface of the body and gradually approaches the center. This central part as Dr. Hall, Spallanzani and others have proven, remains permanently at a higher temperature. In hibernation, as at other times, a

swarm or cluster of bees must be taken as a unit. Bearing this in mind, it is, as we should expect, that the center of a hibernating cluster is formed of a higher temperature than the outside, as Doolittle, Tinker and others have noted. Most bee-keepers have noticed on suddenly dividing a cluster of bees in cold weather that the outside bees are somewhat lethargic, while those inside are lively and apt to fly out and sting, while if any of these half awake outside bees fly they appear not to have control of their movements and fall to the ground.

The heat of reptiles is from four to fifteen degrees F above the heat of their medium, while the heat of individual insects is from two to ten degrees more than that of the air. Therefore it cannot be said that reptiles or solitary insects hibernate as warm blooded mammalia do. The same may be said of the individual bee. It is only when aggregated in clusters that a high and independent temperature is maintained. Hibernation must not be confounded with torpidity. The *American Encyclopedia* says: "The torpor produced by extreme cold is very different from true hibernation." And again in another edition "Extreme cold will arouse a hibernating animal from its lethargy, and speedily kill it." We all know that cold arouses bees. These then appear to be some of the leading characteristics of hibernation: An activity similar to but less than in sleep, with diminished respiration, but increased muscular irritability. Lower temperature, lowest at the surface of the body, diminished need for food and when stored outside of the body partaken of only at intervals of awakening, loss of voluntary motion, but continuance of involuntary motion. As bees possess so many of the conditions of hibernation it seems reasonable to conclude that they hibernate. The material for this article was gathered ten years ago this winter and in consulting authorities Dr. Hall was found to be practically the beginning and the end. The other articles were largely a restatement of his work, and every succeeding writer must do the same until further investigations are made. The Rev. W. F. Clarke is entitled to great credit for the ability with which he has presented and defended his views of the hibernation of the honey bee. When he first applied the word hibernation to this insect he was greeted with a storm of ridicule, and his would-be critics, even up to the latest, have too often relied on their own conception of what hibernation is rather than the knowledge they have obtained by consulting the standard authorities on this subject. In his replies Mr. Clarke's inexhaustible fund of