

as stated by Tyndal, that spores which resist the temperature of boiling water for several hours, may be killed by repeated boilings for a few minutes at a time?

"The explanation is that spores which resist the first and second boiling have time to begin germinating in the interval, and they then succumb at once, when the liquid is thus boiled."—*Ward*.

"The body of the germ may be so indurated by time and dryness as to resist powerfully the insinuation of water between its constituent molecules. Some are more indurated than others, and require a longer immersion to soften and germinate. For all known germs there exists a period of incubation, during which they prepare themselves for emergence, as the finished organisms which have proved so sensitive to heat. If, during this period, and well within it, the infusion be boiled for even the fraction of a minute, the softened germs which are thus approaching their phase of final development, will be destroyed. Repeating the process of heating every ten or twelve hours, before the least sensible change has occurred in the infusions, each successive heating will destroy the germs thus softened, until through a sufficient number of heatings, the last living germ will disappear."—*Tyndal*.

Query 7.—In causing the death of spores by the application of heat are there other conditions besides a high temperature and a saturated or moist condition of the germs?"

"Denser media are less fatal than thin ones."—*Ward*.

"It was noted that a long exposure to a lower temperature produced the same effect" (as a higher for a shorter time).—*Huxley*.

"There is very strong reason for believing that the influence of temperature on life is greatly modified, first, by the nature of the medium in which the organisms are placed; and secondly, by the length of time during which any given temperature is kept up."—*Huxley*.

"Dr. Roberts, of Manchester, further proves that that there are two factors in the induction of sterilization, the degree of heat on the one hand and the duration of its application on the other. For example, speaking roughly, an exposure of one hour and a half to a heat of 212° appeared to be equivalent to an exposure of fifteen minutes at 228°"—*Huxley*.

From the foregoing answers the following inferences may be drawn:

1. Since it is admitted that wax made from foul-broody combs, rendered in the solar wax extractor, may contain germs of foul brood, and

since to sheet wax it is melted in a water bath and kept at a temperature just above the congealing point, not being heated to more than say 160° in any part of the process, it is highly probable that such sheets may contain live spores of the microbe of foul brood.

2. Since we do not know the death point of the spores of bacillus alvie, our only safe course is to treat them as amongst the most resistant, requiring a temperature of 257° to destroy their vitality.

3. Since denser media are less fatal than thin ones, it follows that to kill spores in honey a higher temperature is required than in water.

4. Since it appears that to kill spores by the process of discontinuous boiling, it is necessary that they become saturated with the water, and since spores in wax in boiling water are not likely to become softened on account of their coating of wax, the only sure way of killing such spores is to subject them to a temperature of 257°, the same as if they were air germs.

5. Since the effect of a long duration of the application of heat is equivalent to a higher temperature for a shorter time, and since it may be difficult to apply a temperature of 257° to wax without injuring it, until definite information is obtained as to the death point of the spores of foul brood, arrangements should be made to keep all wax heated to at least 200° or over for some days, so as to be sure that all spores it might contain are cooked to death before the wax is worked up into foundation.

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Lindsay, 28th Feb., '91.

Science and practice do not always accord, and I am willing to believe that they do not in the present instance. I am not prepared to say that the heat ordinarily required for the boiling of honey or wax will kill the foul brood germs or spores, which may be in them, but I do say that in all my experience, and I have had a good deal, I have never had a case of its return, after submitting them to this heat. I have often taken foul brood honey and put it into a dish, suspending the dish in boiling water, but not allowing any water to get mixed with it. In this way I have rendered unfertile all germs of disease which were in it—at least there were none ever appeared afterward. I have also made similar tests with wax, with the same results. Wax melted in the sun, or at a lower temperature than the boiling point of water (212°) may, per-