the character of the environment should be fully described, along with the published figures. The readings of unsheltered instruments are actually only the temperatures of the thermometers themselves, but they approximately represent the surface temperature of both the vegetation upon which they rest and of the fruit in the immediate vicinity, and not the temperature of the air. The heat lost by an unsheltered thermometer, especially on clear nights, is greater in a more or less degree than that indicated by a sheltered instrument close by.

During a research in the Wisconsin cranberry marshes minimum thermometers exposed in the open invariably read lower in clear weather than sheltered instruments; and over dense vegetation on clear nights differences ranging from 4 to 9 degrees (F.) were observed.

During a research in the orchards in the Carolina Mountain region minimum thermometers fastened to shelters 5 feet 6 inches above the ground usually read during cloudy weather about the same as thermometers within the shelters at the same height, but in clear weather the unsheltered instruments always read lower, but seldom more than 3 degrees (F); the differences not being as great as in the cranberry marshes because the instruments were farther away from the ground and in sections usually where the vegetation was not so dense. The differences were smaller when fresh to strong winds prevailed.

THE COMPARISON OF THE INDICATIONS OF SOME HOUSE THERMOMETERS IN WINTER. RESULTS OF OBSERVATIONS.[1]

By HENRY I. BALDWIN.

(Saranac Lake, N. Y., May 3, 1920.)

SYNOPSIS.

In the comparison of 197 outdoor household thermometers with a sling psychrometer at temperatures ranging from 0° to −30° F., it was found that there was a mean error of 3.2° F. as compared with the psychrometer, the amount of error increasing with decrease in temperature. Of the number tested 120 gave a reading too high, and 68 a reading too low, while 9 were correct at the observed temperature. The greatest error found was 30° F.

It is a common occurrence in a small mountain community that whenever the mercury drops considerably below zero on a still winter morning many conflicting reports are circulated regarding the temperature. There are various popular explanations for these discrepancies, including a vague idea that some parts of a town are colder than others, but there exists little definite knowledge on the subject. It was with a view of ascertaining more definitely the cause of these variations that the following observations were made. It was originally planned to make a complete thermometer census of the village of Saranac Lake, N. Y., under a wide range of temperature conditions, but this was found to be impracticable in the available time. The author fully realizes the limitations of the above observations, owing to the many factors not considered, but hopes that the results may be of some interest if not of much practical value.

Observations were made between 7:15 and 8 a. m., it having previously been determined that no appreciable rise in temperature occurred during that period. The weather conditions were chosen as nearly the same on the different days as possible, cloudless and still mornings being selected. The temperature reading with which the readings of the household thermometers were compared was obtained by taking the mean of three readings of a Green's No. 150 sling psychrometer whirled near the house thermometer. In the following results the readings of this psychrometer are referred to by concession as "standard," and it is assumed that no variation occurred in the instrument during the observations.

To insure this the psychrometer was kept as much as possible at a uniformly low temperature. As the exposure of the thermometers tested differed in nearly every case, and but a few were attached to trees, or objects separated from heated houses, little comparison can be made among them. However, the observations made close to, and applying to one thermometer only, are sufficient for our purposes of showing the errors of individual thermometers. It must, of course, be understood that the arbitrary corrections applied to the different thermometers in the tables hold true only for that particular temperature at which they were checked.

About twice as many thermometers read too high as too low, and it was noticed that it was generally the cheaper alcohol thermometers which read too low, while the majority of the mercurial thermometers read too high. The mean variation from the standard of the 197 thermometers tested was found to be 3.23° F., the error increasing from 2.21° at 0° F. to 4.18° at −28° F. Incidentally some of the series of observations illustrated very well the variations of temperature due to topographic conditions, and shows that these variations are independent of differences in thermometers. In figure 1 the readings of the sling thermometer are plotted beside

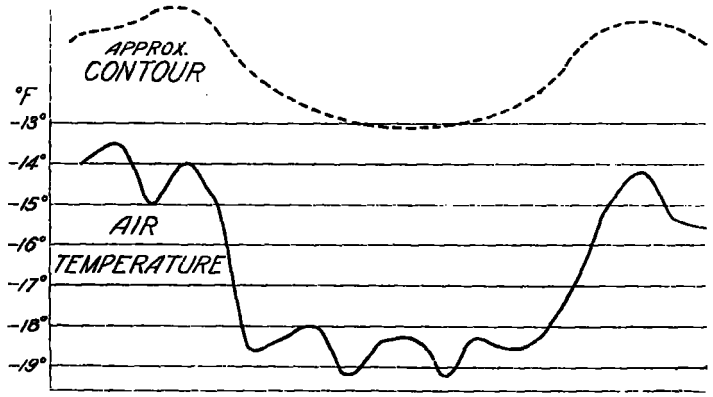

FIG. 1.—Valley profile and corresponding air temperatures near the ground at about sunrise on clear, quiet winter mornings. Saranac Lake, N. Y., winter of 1919–20.

an approximate profile of the ground covered in the observations, and demonstrate the effect of topography on the distribution of surface temperatures at about sunrise on clear, quiet, winter mornings.[1]

Errors in thermometers arise chiefly from three causes: First, from the contraction of the glass and change in the thermometer fluid with age; second, from the differential expansion of the scale and the glass (where the scale is not marked on the glass); and, third, from faulty exposure and ventilation.

The occurrence of minus errors in alcohol thermometers can be explained by the instability of alcohol as a thermometer fluid. It evaporates readily, and hence thermometers are filled at a low temperature, causing a high pressure to be developed when heated. Alcohol is hard to obtain in uniform quality, and has a tendency to form other compounds. However, the coefficient of expansion of alcohol is about 6 times that of mercury,

[1] The detailed tables and numerical summaries of the numerical departures are on file at the central office of the Weather Bureau, Washington, D. C.

which makes inappreciable any errors arising from change in the freezing point with the aging of the glass. This together with its low freezing point makes alcohol valuable for low-temperature thermometers, but great care must be exercised in their manufacture if they are to be at all accurate. Thus alcohol thermometers are liable to read too low because of age, especially if exposed to direct sunlight, which causes a change in the nature of the alcohol or the contained compounds.

The reason for the greater number of mercury thermometers reading too high is doubtless the contraction of the glass with age. While the scale is not marked on the glass in most cheap thermometers, the aging of the glass operates in the same manner in lifting the freezing mark, assuming that the thermometer is rigidly attached to the scale. If the scale slips, another irregular error will, of course, be introduced. It has been found that a thermometer graduated the day it is filled will read 1.5° higher a week later; if not graduated for one and a half years after filling, it will still read 0.5° too high in 6 years. Subjecting a thermometer to a low temperature, as −40° F., also appears slightly to raise the freezing point.

Other errors in thermometers result from faulty exposure and ventilation. A thermometer hung against the wall of a house, for instance, does not show the exact air temperature in cold weather, being influenced by conduction and radiation from the heated house. It is therefore better to hang a thermometer on a porch post, or support it at a distance from a window, than to fasten it directly to the wall.

During clear nights, especially during the winter in the middle and higher latitudes, it is observed that in calm weather the valleys are colder than the surrounding hills up to a certain altitude. The cause of this phenomenon is the nocturnal radiation from the surface of the earth into space. A deep snow cover intensifies the effect. The resulting cooling of the ground cools the adjacent layer of air, and since cold air is heavier than warm, the coldest layers lie nearest the ground in calm weather. Where the surface is not level, it follows that these cold layers of air flow down into the hollows, thus making them colder on still winter nights than the inclosing uplands.

CONCLUSIONS.

(1) The average outdoor household thermometer is about 3° (F.) in error at low temperatures.

(2) Most thermometers read too high. Alcohol thermometers read too low.

(3) The amount of error increases with extremes of temperature.

(4) The variations in the reports of low temperatures in a mountain community are due to—

(*a*) Faulty construction, calibration, and exposure of the thermometer, and its age.

(*b*) Topographical factors affecting the location of the thermometer.

Condensed table of mean deviations from the standard thermometer.

Number of observations.	Mean standard temperature.	Mean error.	Number of observations.	Mean standard temperature.	Mean error.
23	−1.2	2.2	19	−22.5	3.7
44	−10.1	2.9	23	−27.0	3.8
64	−15.9	3.1	24	−28.1	4.2

TEMPERATURE AND RELATIVE HUMIDITY IN COLD STORAGE PLANTS FOR EGGS AND CANDY.

By OWEN T. LAY, Observer.

[U. S. Weather Bureau, Chicago, Ill. Jan. 8, 1921.]

SYNOPSIS

An account of the writer's experience in an investigation of aqueous vapor in its relation to certain cold storage problems. Following are some of the points discussed:

1. The temperature should be kept low for eggs and moderate for most kinds of candy.
2. The relative humidity should be comparatively high for eggs and low for candy.
3. The sling psychrometer was found to be the most practicable method of finding the relative humidity in different parts of the storage rooms.
4. The demand for such work has steadily increased in Chicago.
5. The probability that there is a latent field for such specialized work in other commercial centers.

Early in 1918 the writer was requested by the manager of one of the largest and most modern cold storage plants in Chicago to assist in an investigation of aqueous vapor in its relation to certain cold storage problems, especially in the storage of eggs.

In order to preserve eggs fresh successfully it is of course necessary for them to be so handled that the life germ (in those that are fertile) is kept dormant, this generally being accomplished by providing a uniform temperature slightly above their freezing point, which is near 28° but varies somewhat with the time of year when laid; and at the same time, keeping the air in the storage room pure, with just the right amount of well diffused water vapor. If the relative humidity is too low the interior moisture of the egg will escape, resulting in a loss in weight and a product that must be placed on the market at a loss as "shrunken;" while, on the other hand, if a high relative humidity obtains for any considerable period mold will form on the cases, fillers, and eggs and affect the flavor seriously.

Throughout the first season, closing in January, 1919, humidity inspections were made biweekly in eight rooms, containing approximately 20,000 cases each, it being found that in these heavily insulated rooms which were kept sealed almost constantly, the temperature could be held within 0.5° of the desired degree and the relative humidity held quite constant, although tending to increase gradually as the season advanced. To combat this increase varying quantities of unslaked lime were introduced and at times calcium chloride boxes were used in conjunction with electric fans. However, it was learned that the arbitrary standard of about 88 per cent for the relative humidity was too high, this percentage having been thought about right by many experienced cold storage men; hence, readjustment to a lower percentage was found advisable for the second season, which extended from May, 1919, to January, 1920.

During the second season 14 rooms in the same plant, containing about 250,000 cases, were inspected weekly. Through study of the data gathered during the preceding season, much more desirable results were secured; while, during the third season, closing with January, 1921, the work was expanded to include four storage houses, with about 600,000 cases of eggs and 10,000,000 pounds of candy. The candy included chocolate creams, chocolate nut bars, caramels, hard candies, etc., two ozone machines being used occasionally in keeping the air clean. Most kinds of candy keep best in a dry room, with moderate temperature.

Thanks to the zealous care of those in charge of the mechanical side of the cold storage houses, the practical