ing was in evidence 24 hours after the waters had receded. The crest of the flood occurred early on Friday morning, November 4, and the barn burned between 4:00 and 5:00 P. M. on Monday, November 7, or about two days after the flood waters receded. On Sunday much heating had been noticed and on Monday a distinctly charred odor was noticed before the fire started. The barn burned to the ground and a silo, close to it, fell over and also was destroyed. It is interesting to note that owing to the contour of the land, the barn and hay stood in about 3 feet of water when the fire broke out.

A number of veteran farmers living close to the Canadian border were visited. Several claimed to have had marked success in stopping "spontaneous" heating of hay by the application of large quantities of salt.

It is unfortunate from the standpoint of the accumulation of scientific data that observations of the heating hay piles were not begun for about six days after the flood waters had receded. Discussions with county agents, agricultural men and farmers revealed that practically every lot of hay which had been wetted had shown excessive heating within a day or two after the flood. The belief had been expressed that the season was too cold for "spontaneous" combustion to occur. However, the general excessive heating and the actual case of "spontaneous" firing of the hay on the farm at Middlesex, Vt., show that the possibility of dangerous heating was not removed. Although the air entering the hay piles was cool, especially at night, and the lower layers of the hay were thoroughly soaked with water, temperatures above 70° C. were recorded on several occasions.

The question of the possibility of botulism appearing among the stock which might be fed the rotted hay was raised by county agents and others. No cases of such poisoning have been reported, and although it is by no means impossible yet the chance of the simultaneous occurrence of all conditions necessary for the growth of this organism in the water-soaked hay is slight.

Summary

The waters of the recent floods in Vermont and Massachusetts reached the haymows of hundreds of barns. Excessive heating set in almost immediately after the flood waters receded, endangering the farm buildings. Observations were made at 13 different farms in the valleys of the Winooski, Lamoille and Mississquoi Rivers. These observations are summarized in the following statements:

1. From half a foot to seventeen feet of the piles were under water.

2. In every pile of wet hay observed some "heating" had taken place, frequently to the point of being considered dangerous.

3. Heat was generated in the bottom layers of the piles and, escaping up through the hay, led to the production of draughts of hot gases or "flues" rising to the surface.

4. The large quantity of moisture carried with the hot gases from the lower layers was condensed on the upper, cooler hay, or in the air above. Many hay piles had been soaked throughout by the falling condensed moisture.

5. While the hot hay was being removed from the barns only one farmer had observed any charred materials.

6. The maximum temperature found (besides one case of fire) was 74° C., though temperatures above 70° were recorded in other places.

7. The most marked evidence of excessive heating was observed (by the farmers) on the second and third days after the recession of the flood waters.

8. One authentic case of "spontaneous" combustion of hay caused by the flood was reported. The outstanding features were:

a. The lower two feet of the pile consisted of old hay from the preceding season (1926).

b. Covering this lower 2-foot section of old hay was a 6-inch layer of first cutting alfalfa.

c. Two feet beneath the top surface of the 42-foot pile was another 6-inch layer of alfalfa (second cutting).

d. This hay pile which fired "spontaneously" was the only one containing even a small quantity of alfalfa.

The urgent need for extensive research upon the problem of the "spontaneous" heating of farm products was emphasized by the lack of scientific knowledge with which to meet the situation.

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THE RELATION OF BORON TO THE GROWTH OF THE TOMATO PLANT

It is surprising to note the prevalence of the old idea that the number of elements essential for normal plant growth is limited to ten. To this list of "preferred" elements, to use the expression of Sommer and Lipman,[1] have been added manganese, zinc, boron and without a doubt several others will be annexed as methods and technic become more and more refined. There is little doubt that in the past, failure to obtain good plant growth in numerous water-culture experi-

[1] Sommer, A. L., and Lipman, C. B., "Evidence on the Indispensable Nature of Zinc and Boron for Higher Green Plants," Plant Physiology *1*: 231–249. 1926.

ments was due to a deficiency of some of the above-mentioned elements so long overlooked. An illustration with regard to boron will serve as an example.

In a series of experiments dealing with certain potassium relations of the tomato plant, it was found impossible to obtain anything that even approximated normal growth in water cultures without the addition of a small quantity of boron. This circumstance was especially interesting since no attempt had been made to purify the ordinary C. P. chemicals used in the solutions. These observations led to a series of experiments dealing with the relation of boron to the growth of the tomato plant. It is believed that some of the results obtained are interesting enough to warrant this brief preliminary paper. Both the appearance of the plants as well as actual measurements and analyses clearly showed boron to be absolutely essential.

Most of these experiments were carried out in the division of plant nutrition at the University of California, with the variety Santa Clara Canner. Some of the experiments have been repeated at the University of Maryland with this same variety and with Marglobe. Boron was supplied as boric acid in a concentration of 0.5 p. p. m. Plants grown in nutrient solution containing this concentration of boron grew normally and produced blossoms. Plants grown in the boron deficient solutions ceased to grow at the end of three or four weeks. In the Maryland experiments the first signs of injury were noticed after nine days. One of the early visible symptoms of boron deficiency is the blackened appearance at the growing point of the stem. New leaves and branches often start growing just below this dead portion and give to the plant a short bushy appearance. Often the leaves grow in length, but not in width. Chemical analysis in the case of the Berkeley experiments showed approximately twice as much total sugars in the leaves of the boron deficient plants as in those from normal plants grown in a similar manner, but in solutions containing boron. The leaves from the boron deficient plants also contain more starch than those from the normal plants. On the other hand, the quantity of total sugars in the stems of the boron deficient plants is only about two thirds of that in the stems of normal plants. The leaves of the boron deficient plants at College Park developed, after 13 days, a distinct purple color, probably anthocyan, which is frequently associated with an excess sugar accumulation. Another very striking characteristic of the boron deficient plants is the extreme brittleness of the leaf petioles. This brittleness is not that characteristic of turgid stems, which break with more or less snap, but it is one that may best be described as similar to the breaking of a piece of cheese.

Both the chemical analysis and later observations on an entirely different variety indicate a failure on the part of the boron deficient plants to remove sugar from their leaves. This seems to be related to a breaking down of the conducting tissues. Microscopic examinations of the petioles and stems made by Professor J. H. Priestley on a few of our plants seem to bear out this view. In the boron deficient plants the phloem was broken down and apparently gave a much more acid reaction than the corresponding regions of the normal plants.

These general conclusions are in agreement with the anatomical studies of Warington[2] on *Vicia Faba* (broad bean) grown in boron deficient solutions. She states, "The vascular bundles in particular are affected, the xylem often appearing unusually remote from the phloem or even broken up into small groups of elements . . . an unusual development of the cambium is chiefly responsible for this abnormal appearance." The phloem is described as becoming compressed or displaced and the xylem itself may degenerate. Frequently the lumen of the tracheides become completely blocked. These conditions of the broad bean seem to be very similar to those occurring in the tomato when grown in boron deficient solutions.

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TRIASSIC VERTEBRATE FOSSILS FROM WYOMING

DURING the past summer the writers, with the able and enthusiastic assistance of Mr. N. H. Brown and his son, Newton, of Lander, Wyoming, added materially to the University of Missouri collections of vertebrate fossils from the Triassic of Wyoming. All the fossils came from the Popo Agie beds of the Chugwater formation, but from several scattered localities. Chief of these are the quarries on Bull Lake Creek and Sage Creek, Fremont County.

The collections include both reptilian and amphibian remains, the latter in much the greater abundance. Among the amphibian materials are two nearly perfect skulls similar in many respects to the specimen from Texas described by Case as *Buttneria perfecta*.[1] There is in addition a considerable part of four other skulls; at least two distinct types of clavicular girdles,

[2] Warington, Katherine, "The Changes induced in the Anatomical Structure of *Vicia Faba* by the Absence of Boron from the Nutrient Solution," *Ann. Bot. 40*: 27–42. 1926.

[1] E. C. Case, "New Reptiles and Stegocephalians from the Upper Triassic of western Texas," Carnegie Inst. Wash. Publication No. 321, pp. 13–25, 1922.