only slight traces of carbon dioxide and was obtained from Layng and Crum[2] of the chemistry department of the University of Illinois. It consists of a 35 per cent. aqueous solution of zinc sulphate to which 14 grams of concentrated sulphuric acid are added per liter of solution.

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A SIMPLIFIED PLANKTON BUCKET

MANY users of the old fashioned naturalist's plankton net who may object to its crudeness or who have employed the commoner expedient of tying a glass bottle into a silk net, will appreciate a simple device which serves the same end much more efficiently. There are a number of elaborate plankton buckets described which serve various purposes but none of these are quite simple or inexpensive enough for the ordinary biological teacher or investigator who purposes only a qualitative collection for classroom demonstration or technical use.

The writer uses, both for class work and for his own investigations, conical fine silk nets of number twelve and twenty grade, and a plankton bucket of his own design. While not especially new in principle, the bucket is simpler and more inexpensive than any he has seen or used before. It may be constructed by almost any one. The bucket is made up of four parts: First, there is an inverted and truncated cone with a fairly long threaded tube attached to the truncated end, secondly, there is another cone exactly like the first one but without the tube, which fits closely over the other of the two cones. A threaded ring which screws on the tube of the first cone is the third part. The first cone is dropped *into* the net and its tube is arranged to project below, outside the net. The second cone is then fitted to the first from the *outside* of the net with the silk between the two. The two cones are now clamped together and held tightly by the threaded ring; they lock the device to the apex of the net. The fourth part of the apparatus is the bucket, a simple cylinder closed at one end and threaded at the other to fit the tube of the inner of the two cones. The cylinder is of uniform diameter and may or may not have a flange at its threaded end to give weight to the apparatus. The cylinder is screwed to the tube and the bucket is ready for use at once. All parts are constructed of brass.

The net arranged as above may be used exactly as other rigs, but one needs only to unscrew the cylinder to release the catch, and pour the collected plankton into a bottle for preservation or observation while alive. The writer finds the apparatus a very valuable adjunct to his laboratory classes in which a number of plant and animal plankton organisms lend much interest to the ordinary class routine. In collecting material for investigation the contents of the cylinder may be put directly into fixing reagents in the field and carried home in the best condition.

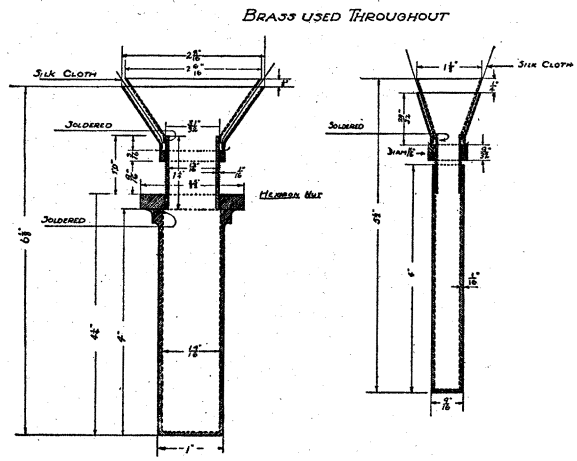

FIG. 1

The whole apparatus is heavy enough to sink easily without extra weights, but does not weigh enough to tear the wet net and it lacks the cumbersomeness of the more elaborate deep-sea apparatus. The diagrams illustrate the dimensions and form of two rigs used by the writer (Fig. 1). Others may be used of course to fit different nets and purposes.

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SPECIAL ARTICLES

OBSERVATIONS ON HEATING HAY IN THE FLOODED REGIONS OF NORTHERN VERMONT

MANY interesting reports of the devastations wrought by the recent floods in Vermont and Massachusetts have been written. Little mention has been made, however, of the effect of the floods upon the tons of feeding stuffs stored on the farms for winter use. The agricultural pursuits of the farmers in the valleys of the Vermont rivers have been confined largely to dairying, most of the flat valley land being used for hay production. In New England the length and severity of the winter season make it imperative that the farmer be well supplied with hay for his stock.

[2]Layng, T. E., and S. A. Crum, "On Examination of Methods of Gas Analysis." Unpublished paper, University of Illinois.

In order to store the hay properly, large barns with deep bays or open sections extending usually from the ground to the roof have been constructed. The recent floods, coming early in November, found practically every barn filled with good meadow hay. The flood waters entered many barns, covering as much as 17 feet of the hay piles. When the flood waters receded, masses of wet hay remained, in which intense heat production soon became evident. This "spontaneous" heating was so severe as to endanger the barns and their contents with fire. One fire attributable to this cause had been reported, and the farmers were deeply concerned for the safety of their buildings.

Studies of the problem of the "spontaneous" heat production in agricultural products have been undertaken in the United States Department of Agriculture.[1] The unusual conditions in Vermont offered exceptional opportunities for further investigation. The facilities of the University of Vermont, including the College of Agriculture and the Extension Service, were generously placed at our disposal and are gratefully acknowledged.

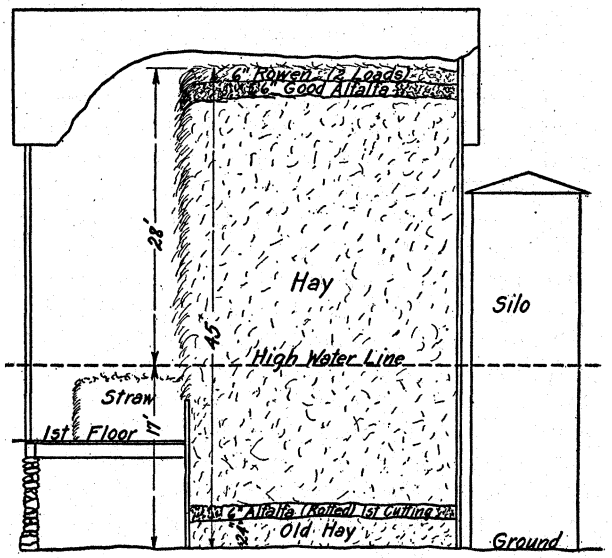
Studies were made of the conditions on 13 farms in Northern Vermont, in the valleys of the Winooski, Lamoille and Mississquoi Rivers. The wetting and heating of the hay at these places were said to be typical of those throughout the entire flooded area. In many cases actively steaming hay had been removed from the barns before our arrival, and many other lots were then being thrown out as rapidly as possible with the limited amount of help available. A brief résumé of the data gathered at the thirteen farms is given below. Eight of the farms are in the valley of the Winooski River, and five are in the valleys of the Lamoille and Mississquoi Rivers.

The floors supporting the hay in a few of the barns consisted only of boards resting directly upon the ground. In the majority of the barns visited, however, the hay was piled above the first-floor level, and the stock was housed in basement stalls beneath. The rising waters entirely covered the stalls and immersed as much as eight feet of the hay piles.

"Spontaneous" heat production had begun in the bottom wet layers of the hay, and the hot gases rising through the stacks led to the production of strong draughts or "flues." The moisture thus carried upward condensed in the cooler parts of the hay or in the air above, wetting the hay in the immediate area. So many of these draughts had existed in some piles as to soak the hay thoroughly. Similar draughts were observed in all heating piles of hay. Temperatures in typical "flues" ranged from 47° to 74° C.

When we arrived the period of most marked heating had passed, and the temperatures were then on the decline. Many piles of hay had shown such marked steaming as to prompt the farmers to remove them immediately to the open. A large number of the men students of the University of Vermont, at Burlington, cheerfully gave their full time and energies to the pitching of the hot hay out of the barns. While forking over the hot material, only one farmer had observed any evidence of charring.

One clear-cut case of "spontaneous" ignition of heating hay occurred on a farm near Middlesex, Vermont. This farm is in a narrow portion of the valley of the Winooski River where the flood waters rose exceptionally high. The barn held about 50 tons of meadow hay and a little alfalfa. The hay had been kept in a bay in the rear of the barn and rested upon boards laid flat on the ground. The contents of the bay at the time of the flood, as shown in the accompanying diagram, considered from the bottom to the top consisted of:



Section through barn at Middlesex, Vt.
Burned by "spontaneous" combustion, November 7, 1927

About 2 feet of last year's (1926) hay.

About 6 inches of first cutting alfalfa (1927) which had rotted somewhat in the field but which was dried before storage in the barn.

About 45 feet of good meadow hay.

About 6 inches of good, second cutting alfalfa (1927).

About 6 inches of rowen on the top.

There was also a small pile of old dry straw on the barn floor.

The flood waters covered 17 feet of the pile of hay and most of the straw. No heating of the hay had been noticed before the flood, but considerable steam-

[1] James, L. H. "Microbial Thermogenesis." I. SCIENCE, LXV, May 20, 1927, 504–6; II. *Jour. Bact.*, XV, February, 1928, 117–41.

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 Missisquoi 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.