tion. These surprising disclosures led to an examination of a number of text-books, etc., on sound, from which it appeared that only rarely was there any reference to the true theory of the fork; even the Britannica supports the view of the psychologist. So a note on the subject may not be superfluous.

The theory of the fork is due to Chladni's researches of a century ago. He had found that a horizontal straight uniform bar could vibrate when supported at points about 0.22 of its length from the ends; obviously portions each side of these nodal points must at any instant be moving in opposite directions. Then he bent the bar a little and found that the nodes had moved toward the center, and when the fork-shape with long parallel prongs was reached, the nodes were near the base of the prongs. Assuming the prongs vertical, when they separated the intermediate part near the bends would of course rise a minute distance. In any practical case the center portion is loaded by the stem which will therefore move up and down and deliver regular blows to a sounding board or resonance box on which it may be placed. Such an effect can not be accounted for by the crude theory that prompted this note.

It will help to clear thinking to recall the curious fork shown by the Standard Scientific Co. at the exhibit of apparatus at the Bureau of Standards about a year ago. This had a relatively large hole near the upper end of the stem, the effect of which was to make the pitch much lower than that of a similar fork unperforated.

In this connection it may be added that measures I made some years ago showed that a Koenig's fork of the middle octave on its box, when vibrating at an average amplitude, expended its energy at the rate of about one millionth of a horse power or less than a thousandth of a watt; of course only a small part of this produces sound and only a very minute fraction of this part could reach the ear of any one of the hundred who could hear the fork.

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SPECIAL ARTICLES

THE RELATION OF SOIL FERTILITY TO VITAMINE CONTENT OF GRAIN[1]

THIS study was undertaken at the suggestion of Professor F. J. Alway, who has made a study of the relation of phosphate-hungry peat soils to the grain produced on them,[2] at Golden Valley, Minn.

Burning of the peat rendered mineral matter more available to the plant and increased the yield. It also increased the amount of phosphoric acid in the grain and, as we shall show, increased the vitamine. Two experiments were made, one with barley grown on untreated and on burned peat, and another on oats grown on peat soil as contrasted with ordinary mineral soil. The barley grown on untreated peat yielded 7.4 bushels per acre and the grain contained 0.5 per cent. P_2O_5 in the dry matter, or 17.9 per cent. in the ash, whereas the barley grown on burned peat yielded 42.6 bushels per acre and contained 1.06 per cent. P_2O_5 in the dry matter and 35.5 per cent. in the ash. The oats grown on untreated peat soil contained 0.52 per cent. P_2O_5 in the dry matter and 17.9 per cent. in the ash. The oats grown on ordinary mineral soil in the same locality contained 1.1 per cent. P_2O_5 in the dry matter and 32.4 per cent. in the ash. It was at first attempted to determine the vitamine content of these grains by the quantity necessary to prevent or cure polyneuritis in pigeons. It was very difficult, however, to feed these grains quantitatively to these pigeons, and they all died of polyneuritis before the end of the experiment.

The next attempt was to feed the whole grains quantitatively to white rats, but this method failed also.

The next method was to grind the grains and mix them to the extent of 5 per cent. in a

1 Contribution from the laboratory of physiological chemistry, University of Minnesota Medical School.

2 F. J. Alway, "A phosphate-hungry peat soil," *Journal of the American Peat Society*, Vol. 8, 1920.

basic ration made of 10 per cent. pure casein, 6 per cent. sea salt and 84 per cent. white flour. The rats were allowed to eat this *ad libitum* and were supplied with ordinary tap water in addition. At the end of the thirty-second day butter fat was added to the ration to the extent of 1 gram per rat per day. The experiment lasted 65 days. In the above experiment, two rats, both males and weighing 65 grams each, and of the same litter, were taken and fed this diet. At the end of the 65 days the rat getting the barley with 0.5 per cent. P_2O_5 weighed 108 grams, whereas the one getting barley containing 1.06 per cent. P_2O_5 weighed 117 grams. This difference of 9 grams is small, and yet, owing to the exact manner in which the experiment was performed and the fact that the rats were of the same sex, size and litter, this small difference is significant.

In the experiment with oats two female rats of the same litter were taken. These rats were practically the same weight. In fact they were of exactly the same weight (55 grams) on the second day of the experiment. At the end of 65 days the rat receiving oats with 0.53 per cent. P_2O_5 weighed 86 grams and the rat receiving oats containing 1.1 per cent. P_2O_5 weighed 97 grams. It may be remarked that the experiments with female rats are not always quite as uniform as those with male rats, but these female rats showed no peculiarities in the growth curves. These experiments are in harmony with those of a number of workers and show that the vitamine content of *milled grains* is proportional to the content in P_2O_5. In the case of milled grains, however, the variation in P_2O_5 is due to its partial removal in milling, whereas in experiments recorded in the present paper the variation is due to the amount of available phosphoric acid in the soil. Since butter fat was fed uniformly throughout the last half of the experiment, the difference in growth of the rats is due to difference in vitamine *B*.

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MOLD HYPHÆ IN SUGAR AND SOIL COMPARED WITH ROOT HAIRS

To compare sugar with soil as a place for growing molds may at first sight be revolutionary, but to one who has studied molds in soil, the first glimpse of a moldy sample of sugar under the microscope compels the comparison put forward in the title of this paper. Mold hyphæ as seen in foods such as sugar and in soil strikingly resemble root-hairs as they develop in earth. Hyphæ of fungi and root-hairs are analogous structures. Both belong to the vegetative phase of a plant's life cycle. Both are turgid, thin-walled cells. The elongating hypha pushes itself between sugar crystals or between soil particles in the same fashion as the elongating root-hair progresses in the soil. The elongating hypha, like the root-hair, is a feeding and growing portion of a plant, which is submerged in a substratum. The hyphal tip, as is commonly understood of the apex of a root-hair, follows between the sugar crystals or soil particles along the path offering the fewest obstacles. Such a path or course is at best winding, irregular, now wide and again extremely narrow. The mold hypha under suitable conditions grows between the faces of the sugar crystals or soil particles. As would the root-hair, it forces its way into a narrow passage, its shape conforming to the space discovered. There may be a bulge on one surface of the hypha and a flattened area on the opposite surface, all depending on the space available for expansion. Attracted by the films of water and available solutes adhering to the sugar crystal or to the soil particle, the mold hypha grows over the face of a particle, conforming to the irregularities in the surface of the object.

It is impossible to separate these bits of mold hyphæ from the respective sugar crystals or soil particles in conjunction with which they are growing. It is commonly known that a separation of soil particles from root hairs, which are much grosser units than segments of mold hyphæ, is impossible without injury to the root-hairs.