NATIONAL MAPLE SYRUP DIGEST

Vol. 10, No. 1 February, 1971

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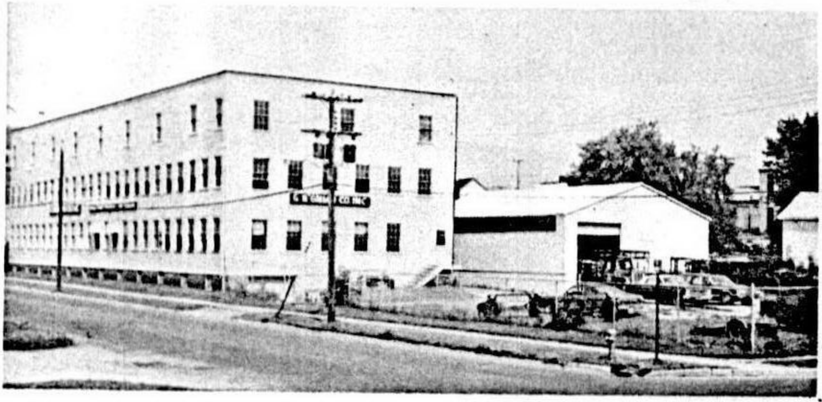

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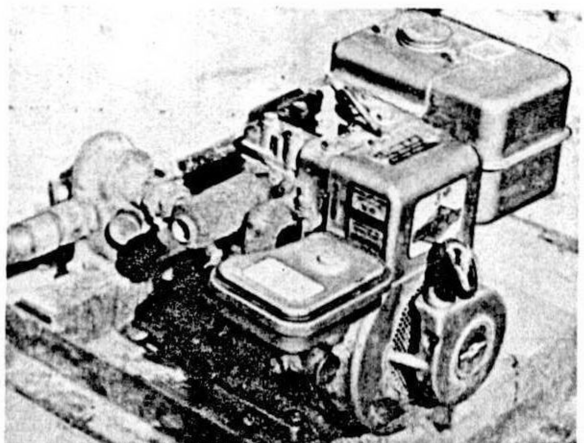

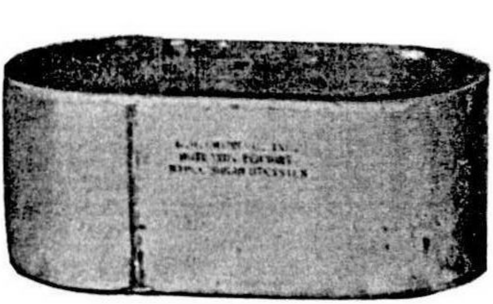

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COVER PICTURE

The cover picture this month is of the sugarhouse at the Proctor Research Farm.

See, Maple Research at The University of Vermont article in this issue.

$ FOR THE DIGEST

NOTICE-BACK ISSUES

The following issues of the Digest have been printed to date;

Vol. 1, No. 1,2,3,4
Vol. 2, No. 1,2,3
Vol. 3, No. 1,2,3,4
Vol. 4, No. 1,2,3,4
Vol. 5, No. 1,2,3,4
Vol. 6, No. 1,2,3,4
Vol. 7, No. 1,2,3,4
Vol. 8, No. 1,2,3,4
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Editorial

Last February, I wrote an editorial asking for contributions. I thought, at the time, I explained the financial situation of the Digest clear enough for everyone to realize just what shape we were in. Apparently I failed, at least to some extent.

At first the returns came back in bunches,but they soon dwindled down to a trickle. During the summer and fall, we averaged about one a day and for the past month a few more than that. This indicates that most of our readers are willing to contribute, but it is an easy thing to neglect to do.

When I totaled the results at the end of our fiscal year (Sept. 1st), I was very disappointed. Our mailing list last year averaged about 6700 in the states, plus about 400 copies that are distributed in Canada, and some extra copies that are sent to extension foresters, Council delegates, etc. From this circulation we received only 1228 contributions for a total of $2850.50. While this is more than we ever received in one year before, it lacked over $400.00 of paying the bills. A little simple arithmetic tells me that less than 18% of our readers responded to our plea for help and a look at the financial report tells me I must be out of my mind to try to keep the Digest going.

At the annual meeting of the National Maple Syrup Council last October, the delegates unanimously agreed that the Digest should be continued. They favored voluntary contributions rather than paid subscriptions, at least for another year. They increased the dues of seven of the larger syrup producing states to build up a reserve to help the Digest if necessary. It might interest you to know that for all the nine years the Digest has been published, it has been entirely on it's own. It hasn't cost the National Council one cent!

Well, that's the situation, folks. As of this writing, I haven't been able to pay the printing bill for the last issue (December). Counting this one, I'm three issues behind on my renumeration for acting as editor, publisher, business manager, accountant, bill collector, newsboy, etc. Since I can't look anywhere else for help, I guess it's up to you folks to bail me out.

A self addressed envelope that requires no postage is included in the center fold. Please use it to either send a contribution or ask to have your name removed from our mailing list if you no longer want the Digest.

If this editorial sounds like a broken record, I'm sorry. I don't like to ask for money any more than you do and would be very happy if this was the last time.It's just something that has to be done. I want to thank you in advance for your cooperation and hope you all have that bumper crop you've been looking for the past five years.

On the lighter side, a very interesting letter was received from Putnam W. Robbins, retired professor of forestry at Michigan State University,in regard to the use of the pellet. With his permission, we are printing his letter immediately following this editorial. In a recent phone conversation, Put made the remark that he would like to hear from anyone who has proof that any maple trees were killed from use of the pellet. Also, has anyone ever drilled ten tapholes in small trees? What were the results?

This might lead to some interesting articles for future publications. With your help, and God willing, the Digest will be continued and we'll bring you the latest in every phase of the maple industry.

PELLETS – – – – Letter to the Editor

Putnam W. Robbins
Box 409, Star Rt. 2
Florence, Wis. 54121

Mr. Lloyd H. Sipple, Ed.
National Maple Syrup Digest
Bainbridge, N. Y. 13733

Dear Lloyd:

I wanted to attend the Pennsylvania meeting of the National Maple Syrup Council, but before we knew the Council meeting dates, had made promises to be elsewhere. Please give me the low down on what took place at the Lukan's Farm Resort during the annual meeting.

Needless to say, I have not been where I could assemble good sound data for a rebuttal on Shigo and Laing's U.S.D.A. Forest Service Research Paper NE-161 of 1970 (condensed version published in December 1970 issue of Maple Syrup Digest).

In the mean time, I shall endeavor to get copies of the cross-sections of tapholes which I had photographed before I retired from Michigan State University. These cross sections were from trees which had received the pills, and they were good sized trees, tapped in the normal manner, <u>not ten holes per tree on ten inch trees.</u> I can then prepare an article for the next Digest.

In my talk to the Ontario Maple Syrup Producers Association last fall, I included a few pages on the report of Shigo and Laing, and I quote, "Last year at the annual meeting of the National Maple Syrup Council, we heard a report on the effects of paraformaldehyde pellets on the wood surrounding the tapholes, by A. L. Shigo and F. M. Laing. Their research paper NE-161 in 1970 also reports their work."

They tapped <u>five</u> trees on the Vermont Proctor Farm and <u>five</u> on the Mitchell Farm near Jericho, Vt. Each tree received <u>ten</u> tapholes making a total of 100 tapholes on ten trees, all in a diameter range of 10 to 18 inches! Did you ever know a producer who put 100 holes in only ten trees? I certainly would have saved a lot of work if I had used only 10 trees instead of 119. Shigo and Laing give no record of maple sap yields from the trees they tapped, nor any record of the bacteria, mold or yeast found in the sap which flowed from the trees tapped.

The trees they tapped ranged in diameter from 25 to 45 centimeters. This is approximately 10 to 18 inches in our language. The photographes in the paper NE-161 are all of small trees showing the damaged and undamaged wood. You producers seldom concentrate on such small trees and when you do, you place only one or two tapholes in them. At Michigan State University, back in 1936-1940, long before we had even developed the tap hole pellets, we killed <u>ten</u> inch sugar maple trees by drilling <u>four</u> tapholes per tree each season for <u>four</u> years! In this study of pellet damage, Shigo and

Laing put ten holes in each tree. They give no record of maple sap yields from the trees tapped, nor any reference as to the amount of the paraformaldehyde pellet remaining in the tapholes after sap flow had stopped.

All photographes in the paper show tapholes sloping toward the center of the tree rather than sloping toward the outside to facilitate drainage.

In my studies at Michigan State University, we used 119 trees from 1953 to 1955 and added 50 more in 1956. At the end of the treatment with paraformaldehyde pellets, six of the large trees were felled and cross sections were made at the tapholes and in two inch intervals above the below the holes. No greater discoloration above or below the holes was noted between the treated and the non-treated holes. I am sorry I do not have the photographs here to show you these sections, but will try to obtain them for the next issue.

Drs. Rudolph and Nyland, in 1969, studied the effects of paraformaldehyde pellets on taphole healing and concluded "the pellets do not have harmful effects on taphole healing."

My best wishes to you for a good maple sap season in 1971.

Sincerely

Putnam W. Robbins

ATTENTION — — All young Vermont maple producers!

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The Vermont Maple Sugarmakers Assoc. is sponsoring the YOUTH MAPLE AWARD to encourage the participation of young folks, both fellows and gals, in the production, processing and marketing of maple products.

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Field Tests of the Reverse Osmosis Unit for Concentrating Maple Sap

J. C. Underwood, J. C. Kissinger, and R. A. Bell
Eastern Utilization Research and Development Division
Agricultural Research Service
United States Department of Agriculture
600 East Mermaid Lane
Philadelphia, Pennsylvania 19118

Laboratory scale studies in 1966-67 (1) showed that the reverse osmosis (RO) process could be used to concentrate maple sap. These experiments demonstarted that (a) maple flavor precursors do not pass through the membrane, (b) up to 75% of the sap water can be efficiently removed at an estimated energy cost of about 1/20 of that for thermal distillation, and (c) the removal of the remainder of the water can be done by the conventional heat process to produce typical maple flavor and color.

Based upon these observations and data, a semi-plant size reverse osmosis concentrator (EUROC, Fig. 1) was constructed for field tests (2). The main objectives of the field tests were to (a) determine the effect of the reverse osmosis on quality of sirup, (b) observe the performance of the EUROC for long periods of continuous operation with maple sap, and (c) determine the cleaning procedures needed to maintain the membranes in efficient operating condition for prolonged use.

In 1968 the first field tests were conducted at the central plant of Lloyd Sipple at Bainbridge, New York (3). Two studies were run. The most important fact to be determined was whether RO-concentrated sap would yield a sirup with full-bodied flavor and no off-flavors when concentrated to standard density sirup by conventional open pan evaporators. This was done by running 500 gallons from a uniformly mixed 4000 gallons of maple sap through the EUROC at 600 psig at a feed rate of 5 gal./min. The treated sap was then boiled to sirup density in the plant's evaporator pans. This sirup had a full-bodied flavor and could not be differentiated from the sirup made from the remainder of the 4000 gallons by the plant's conventional procedure. Then the RO unit was operated for the rest of the abnormally short season as part of the plant's processing procedure. Ten thousand gallons of sap were treated by EUROC at 5 gal./min. and 600 psig, removing 50% of the water from the feed. At no time was there evidence in the finished sirup of any deleterious effect due to the reverse osmosis treatment. One of the important factors that will determine the economic feasibility of reverse osmosis for maple sap concentration is life of the membranes. To protect the membranes in EUROC from deterioration by microorganisms normally present in the raw sap, the feed line is equipped with in-line ultraviolet water sterilizing units. This treatment of the feed minimized the build-up of bacteria, yeasts, or molds in the various lines and pressure vessels of the unit during extended use. Also, when EUROC was shut down more than 24 hours, it was found necessary to drain the sap from the unit, sanitize it with a hypochlorite solution acidified to pH 4.5 with acetic acid, and flush out the excess chlorine with water sterilized by passing it through the ultraviolet feed line purifier (4). Otherwise, an excessive bacterial build-up occurred in the pressure tubes during shut-down.

Second Season, 1969

For the 1969 season, the EUROC was taken to Mountain Meadow Farm, Schellsburg, Pennsylvania to the central plant of B. F. Walters. One change was made in the unit for this, the second year of field tests. Late in 1968 a new membrane module became available. This module is three feet long compared to the one foot length of the older ones. The new type, also, was improved in construction to give increased flux and longer life. For the 1969 tests two of the eight pressure tubes of EUROC were filled with the 3-foot modules. The unit was again test run by EURDD personnel and then operated by plant personnel for the season with weekly check visits. The unit was operated at a speed rate of 6 gal/min. at 550 pounds applied pressure. With the new modules these conditions removed 50% of the water from the feed. During a 4-week period over 50,000 gallons of sap passed through the unit. The first two weeks of the active season the unit worked well.

Then the amount of water being removed began to decrease (flux dropped). The fall in flux continued until only 33% of the feed water was being removed. The selectivity of the membranes remained unchanged as indicated by conductivity and sugar values of the permeate. A pressure tube was opened and the cause of the flux decline was very evident. Slime was depositing on and in the modules. Cleaning by flushing with water and enzymic detergents produced only a temporary small improvement.

The unit was brought to the laboratory at the end of the season and studies made to find a method of preventing and/or removing the slime buildup.

It was observed that the new 3-foot modules were much freer of slime than the old 1-foot ones. As the flux of the 3-foot modules had been determined to be 50% greater than the shorter ones, the flow rate of the feed through the pressure tubes with the longer module had to be greater than with the shorter modules. Increased flow rate might eliminate slime deposition.

The slime seemed to come from the sap; it was not being produced in the pressure tubes. The bacteria counts of the concentrate discharge did not indicate high microorganism activity around the membranes. Trouble did begin when the sap temperature would rise due to warm weather. This indicated a possible increase in polysaccharide production by adventitious microorganisms contaminating the sap. The flux of the modules returned to normal after several periods of inactivity and water flushing of the unit. Various enzymatic treatments did little good.

Work for the 1970 season indicated by these findings was to study the effect of increased feed flow rate on the slime deposition and find the source of the slime.

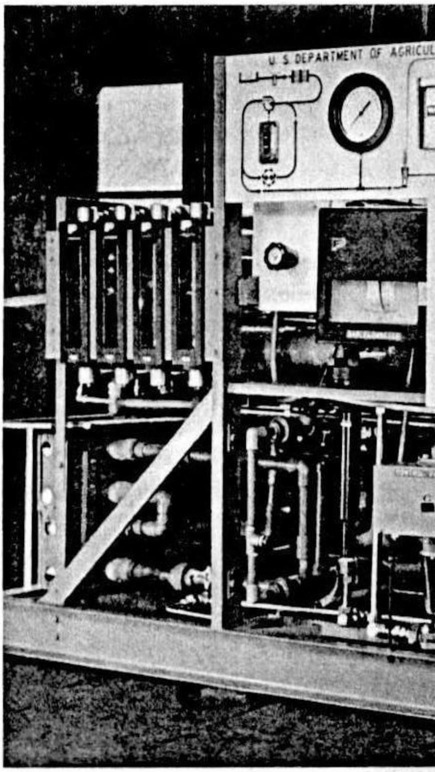
Third Season, 1970

The EUROC was operated again during the 1970 maple season at B. F. Walters' Mountain Meadow Farm, Schellsburg, Pennsylvania. The unit was run at this plant for a second consecutive year because Mr. Walters, being very much interested in the reverse osmosis process, generously furnished a number of the new 3-foot membrane modules for the unit. With the 3-foot modules it was possible to arrange the pressure tubes in a group of four parallel two-tube units connected in series. This gave a balanced, faster flow than the original 8 tubes connected in parallel. For the 1970 season, one thousand square feet of membrane were used. Four hundred square feet were in the form of one-foot modules in the third season of use. The remaining 600 square feet were as 3-foot modules, half new and half in their second season.

The EUROC was installed in the Walters' plant and test-run by EURDD personnel. Then the unit was used by the Walters' plant personnel for the 1970 maple season, a period of six weeks from March 1 to April 11. Temperature, Brix and rate of sap feed, concentrate and permeate were recorded. The unit was run at 450 pounds module pressure at a feed rate of 6 gal/min.

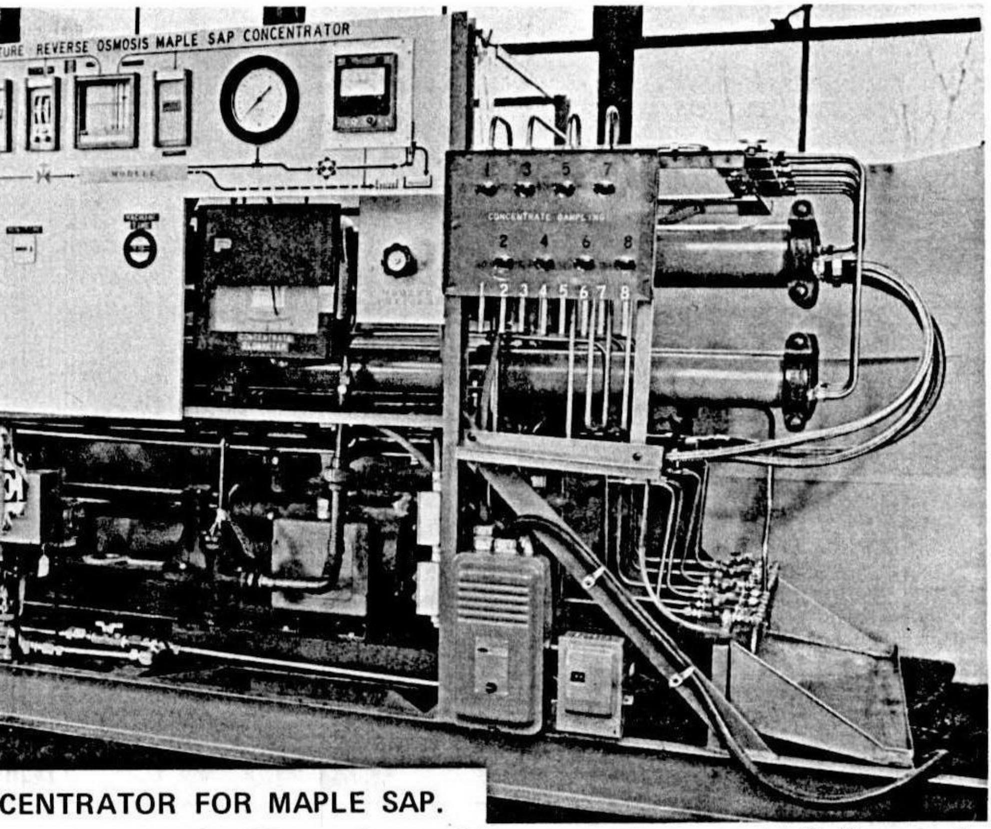
More than 10,000 gallons of maple sap were processed by EUROC during this season. The concentrate was discharged directly into an open pan evaporator for finishing to sirup. The sugar content of the feed averaged 2.1 and ranged from 1.7 to 2.4 Brix. Temperature of the feed was 42 to 52 F. The water removed from the feed averaged 49% and ranged from a high of 67% to a low of 33%. This average degree of removal constituted an efficient operation at the 450 pounds applied pressure used. As the season progressed the cleaning procedure used became less and less effective, and the unit was removing much less than 40% of the feed (a low of 33%) when its operation was stopped. This drop in permeability affected only the rate of water loss. The selectivity regarding sugar rejection remained satisfactory.

The water permeability drop by the membrane again was due primarily to slime deposited on it; and again, this seemed to be a component of the sap and not built up on the membranes by microbial activity in the pressure tubes. If a way of preventing (cleaning is difficult) this slime deposition is not found, the rolled-module configuration of reverse osmosis membrane may not be the best one for the concentration of maple sap. Some of the tube-type units should be tested with sap on a plant size scale. Laboratory studies with one tube-type apparatus have shown that this membrane operates satisfactorily as to flux and selectivity.



THE REVERSE OSMOSIS CON

The EUROC was brought to the laboratory at the close of the 1970 maple season, serviced, and tests run on the unit. The membranes in the various modules, (one and three foot) after standing idle and receiving several intermittent flushings with water, improved in flux. However, several of the pressure tubes



CENTRATOR FOR MAPLE SAP.

containing the older, one-foot modules produced permeate with abnormally high conductivity and sugar values. These were opened and the modules in them tested individually with tap water at 400 psig. A good module will produce permeate from lab tap water (370 micromicromhos conductivity) with a conductivity below 50 micromhos. The tubes containing three-foot modules produced water with C = 25 to 35 micromhos. Many of the one-foot modules gave water above 150 micromhos. These were replaced with modules testing below 70 micromhos.

The reassembled unit was then operated with tap water. When the pressure in the module tubes was raised to 500 and then 600 psi, the conductivity of the permeate from the one-foot modules began to increase again, finally surpassing 150. The increase was found not due to faulty connections. Therefore, it was concluded that the modules must be failing. It could not be determined if the membrane itself had failed or whether the module had broken down, but it can be stated that these three-year old modules are no longer usable.

Tests have shown that when the conductivity of the permeate from lab water reached 75 micromhos too much sugar also passed the membrane from the nor-2-4% sugan maple sap. Thus the life of these particular modules has been three maple seasons, plus the relatively small number of hours of use for laboratory studies (a total of 1475 hours machine running time). However, we cannot say that the life of a new module is three seasons because the three-foot module that has replaced the one-foot type was improved in construction specifically for longer life. Field testing of these must continue if their life is to be determined.

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Maple Research at The University of Vermont

The Proctor Maple Research Farm is a facility of the Vermont Agricultural Experiment Station of the College of Agriculture of the University of Vermont. Established in 1948 as a field laboratory, it is devoted exclusively to the study of the biology of the sugar maple tree and to the development of new techniques for maple sap and syrup production. The laboratory is also used as a classroom to teach tree physiology to biology and forestry students and new research findings to maple specialists and maple producers.

The 200-acre farm in Underhill, Vermont, has a mature sugar bush supporting about 1,400 taps and many acres of young trees. There is a sugarhouse, a classroom and laboratory building, as well as other structures for storage and instruments. The laboratory building is named for C.H. Jones whose pioneering studies, including the useful Rule of 86, at the University of Vermont 70 years ago are the basis of modern maple research. Offices for the staff, another laboratory, and a maple tissue culture bank are located in the University of Vermont campus in Burlington.

Some of the previously published research includes results of a continuing study to understand the sap flow mechanism and its dependence on temperature changes. Identification of high-yielding trees has been a major project since 1944. F. H. Taylor[10], after thousands of individual measurements, reported in 1956 that, compared with others in its population, "a sweet tree is always a sweet tree." This has been amply substantiated since (3,6). More recently we found that high-sugar content is correlated with large sap yield[5]. For 18 years an intensive study of sugar content and volume yields from each of 29 trees showed that the highest sugar content in the sap and the greatest volume yield of sap always occurred in the same trees. A high-sugar-content tree for 18 years averaged 1.0 gallon of syrup per tap compared with 0.3 gallon per year from a low-sugar-content, low-volume tree.

In cooperation with Nelson Griggs[2] of the Vermont Bureau of Industrial Research, we began our first research with plastic tubing in 1954; we have experimented with plastic tubing each year since. From the beginning we knew that any back pressure on the taphole reduced the flow and also that tapholes reabsorbed sap after a flow. The 18-inch drop on a closed and carefully graded system was our solution: it gave a 55 percent increase over buckets. Vacuum pumps were first used in 1961 with somewhat ambiguous results. A test on 36 taps gave greatly increased yields; but on the whole bush, 1,100 taps, no increase was found over gravity lines with the 18-inch drop. We now know that gravity system installed on a slope (without vents) itself produces a vacuum due to the weight of sap, and hence gave as good yields as with a low vacuum pump (less than 15-inch mercury). Recently we found that high vacuum (more than 15-inch mercury) greatly increased yields over gravity (two to four times as much). This research was confirmed by the U. S. Forest Service(9). An important question is whether these high vacuums are extracting larger amounts of normal sap components or new substances which could affect the tree and syrup quality.

In 1970 the bush was divided into four quarters, two on gravity with 18-inch drops and two on high vacuum. Sap samples were collected during each run and analyzed for eight minerals, sucrose, invert sugars, amino acids, and phenol-containing substances. Other samples were evaporated to standard syrup under laboratory conditions. Comparison of the data from 22 runs showed no effect of high-vacuum pumping on the analysis of the sap or the quality of the syrup.

The sugar content and growth rates of pole-sized maple trees vary widely. An important problem has been to determine how to identify potentially superior trees at this stage of growth. Having studied such a stand of young trees for six years, we are reasonably certain that superior trees can be identified with confidence, and that rapid growth can be induced by proper management.

The sugar content of maple sap when measured periodically, as it comes from a tree, is constantly changing around an average figure for that tree; these changes are probably related to temperature. In a project sponsored by the Northeastern Forest Experiment Station, USDA, we studied these changes and found that while it was difficult to relate temperature and sugar and starch content in nature, maple tissue cultures in the laboratory lost 40 percent of their starch in 48 hours when they were cooled from 80^{o} F. to 4^{o} F., thus demonstrating a temperature-sensitive mechanism converting starch to sugar.

Edson(1) in 1910 recognized that the problem of tapholes drying up about 6 weeks after tapping resulted from the growth of microorganisms on the cut surfaces in the taphole. This growth plugs the sap-flow vessels. To control these microorganisms, several disinfectants, including Clorox and alcohol, were used in 1956 and 1958. They prolonged the season and therefore increased yields. After 1962, as a result of the work of Sheneman(7) et al., paraformaldehyde pellets became available and were widely accepted because of their ease of handling and effectiveness.

Recently Shigo et al(8), in the U.S. Forest Service, reported that paraformaldehyde pellets have a serious side effect on the natural disease resistance mechanism in the tree. The tissues in the tree, in the region of the taphole, lose their natural capacity to resist infection, and wood-decaying fungi invade and cause soft rot. We microscopically examined 25 trees; all show PFA-induced changes in the disease-control mechanism in the cells.

The Maple Research staff, in addition to its year-round maple research program, conducts educational meetings for foresters, college students, and maple producers at the Proctor Maple Research Farm, and takes part in the annual county meetings of the Vermont Maple Producers Association.

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Classified

New York Producers

The New York State Maple Producers Assoc. has compiled and printed a bulletin containing all the information necessary for grading syrup under the New York State Grading law. It also contains information on packaging and the correct labeling of all maple products.

A copy of this bulletin was mailed to every maple producer in New York State along with a membership card. The Association directors hope all maple producers will use the card to support the organization that has spent a considerable amount to provide them with this information.

Out of state producers who are interested may obtain a copy by sending their request, along with a large size (No. 9 or 10) stamped, self addressed envelope, to Fred E. Winch, Jr., Fernow Hall, Cornell University, Ithaca, N. Y. 14850.