Innovations in Maple Sap Collection Systems: Reducing Clogging in 3/16" Tubing

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Natural vacuum created in 3/16" tubing has been a boon for many maple producers in stands wheresufficient grade allows it to function properly. The column of sap moving downhill in 3/16" tubing doesn't readily allow air bubbles to pass, but rather pushes them out of the system, creating a vacuum (Wilmot 2014, Perkins and van den Berg 2018). Unfortunately, several years of use have demonstrated that 3/16" tubing systems can be prone to clogging by microbial masses (Wilmot 2018, Perkins and vanden Berg 2019), especially at fittings (Childs 2019) where the internal diameter is greatly reduced (Figure1). This leads to progressively lower yields over a 2-3 year period, eventually reaching the point where sap yields can be lower than 5/16" tubing without vacuum (Perkins and van den Berg 2019). Solutions to this problem devised so far include either cleaning the tubing annually with a chemical sanitizer or replacement of all fittings in the 3/16" lateral line system every three years (Perkins and van den Berg 2019). An alternative approach using ¼" tubing which might be somewhat less prone to clogging (Wild and Otto 2021) but vacuum might not develop as readily as in 3/16" tubing.

Another possible approach might involve reducing or eliminating the reductions in the internal diameter in and around fittings where clogs develop. This would allow the full internal diameter to be maintained throughout the 3/16" tubing system and therefore greatly reduce the propensity for clogs to develop and to be caught up at fittings.

We first sought to test this using an off-the-shelf solution. John Guest™ push-to-connect fittings that would fit around the outside of 3/16" maple tubing were acquired and a small test setup was made in the field. Within a short time, expansion/contraction due to the wide ambient temperature swings combined with the added weight of sap in the lines resulted in the fittings failing to hold and the tubing came apart. In addition, while these fittings could be used for a long time, they are considerably more expensive as compared to maple fittings. Given this, we sought to design a new type of fitting that would meet the following criteria:

- connect to 3/16" tubing externally,
- not reduce the internal diameter of 3/16" tubing,
- be approximately the same dimensions as standard maple fittings,
- hold securely across the range of

temperatures encountered in the field,

- hold securely when tubing was full of sap,

- be comparable in cost to standard maple fittings, and

- utilize the same type of tools used with standard maple tubing fittings

Several concepts led to various prototypes being designed and constructed at the University of Vermont Proctor Maple Research Center, then later by machinists at UVM Instrumentation and Modeling Facility.Several designs were tested for holding power across a wide temperature range (ambient temperature, refrigerator temperatures, and freezer temperatures). To understand whether and how these prototypes might be commercially made, the involvement of an Progressive Plastics, Inc., an experienced maple injection-molding company, was solicited, and further designs were developed. Several discussions led to the develoment of the fitting shown in Figure 1. The barrel of device has small projections on the hinged plate to securely hold the tubing in place once inserted it is into thefitting and the plate closed. The central barrel of the fitting is slightly tapered inward from the ends of the fitting to the center stop (smaller towards the center, larger towards the ends) to accommodate slight variations in extruded tubing diameter. In use, tubing would be inserted firmly into the end of the fitting until it reaches the stop (by hand or preferably with a tubing tool), then the hinged door on each end closed and latched to hold the tubing in place securely.

This approach is still under evaluation, but current plans are to build a mold to produce test articles for examination by researchers and selected maple producers during the 2024 season. Modifications will then be made based upon feedback from these producers. If testing goes well, full production will commence in time for fittings to be available for the 2025 sap flow season through Middle Valley Maple (https://middlevalleymaple.com/).

Literature Cited

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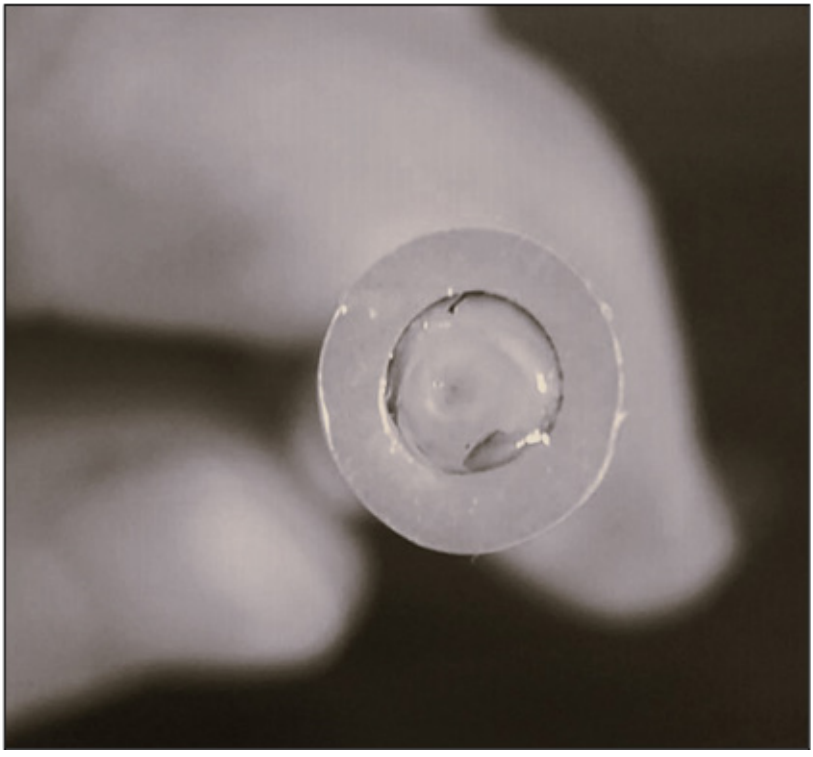

Figure 1 . Microbial clogging in 3/16 maple tubing. Photo credit: Adam Wild, Cornell Maple Program.

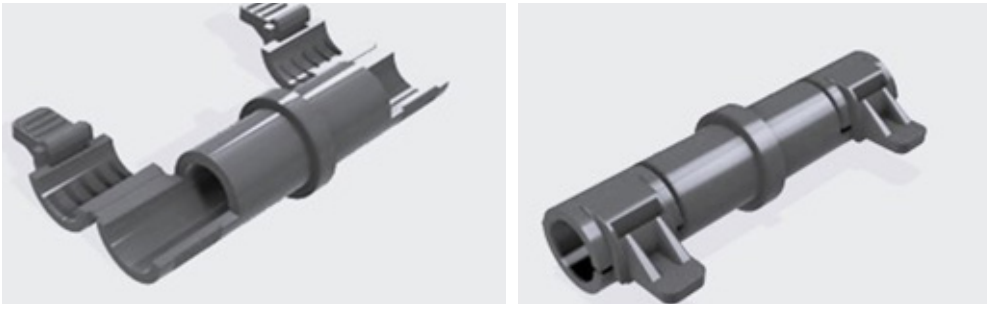

Figure 2. Drawing of an external 3/16" tubing connector designed by UVM and Middle Valley Maple (Williamstown, VT, http://www.middlevalleymaple.com) shown in the open (left) and closed (right) configurations.