

pressure" was forcing water through the larger branches of the root and up the stems. No leaves, and few if any living cells, remained above ground to utilize the water being carried up in the essentially uninjured vessels of the outermost layers of the xylem. The ascending stream of considerable volume was rather quickly chilled and the water frozen soon after it reached a point in the stem slightly above ground. The water, upon being frozen, expanded and ruptured the cortical tissues appearing as the beginning of a short ribbon of ice. The first-formed ice is forced on by the transpiration stream, which freezes as it comes to the surface and is exposed to sub-freezing temperatures.

The ice masses are thin, fragile, and quite flexible, so that extensive ribbons or bands, result. We have observed three-inch wide ice ribbon bands developing to become four or five inches long. Also, I have observed that the ribbons were faintly corrugated and take this as an indication of the fact that the water was frozen and was crystallized somewhat before it had emerged from the tissues of the stem.

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"Frost flowers" in Florida

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Mr. Raymond H. Torrey's note on frost crystals on *Cunila* in northern New Jersey, in the Jan.-Feb. number of TORREYA, reminds me of a similar phenomenon that I observed on the same day about eleven degrees farther south. On the morning of Nov. 27, 1930 (Thanksgiving Day), I went with Dr. John K. Small and Dr. Herman Kurz to Wakulla County, Florida, to show Dr. Small a certain plant he was looking for. In Tallahassee, 18 miles north of the locality to be cited, the weather had been cloudy and rainy most of the month (much more than usual for November), but that day was clear, and there had been a killing frost the night before.

In flat pine woods underlaid by limestone, in the Gulf Hammock region, about half way between Wakulla and St. Mark's, we noticed around a cypress pond, on many dead stems of *Pluchea foetida* (formerly known as *P. bifrons*), a few inches from the ground, delicate excrescences of ice almost exactly like that figured by Mr. Torrey; something that none of us had ever seen

in Florida before, though it may not be infrequent when the right combination of weather conditions occurs.

That this phenomenon is comparatively rare is suggested by the fact that it has been considered worth writing up by several different people in the past, some of whom seem to have just encountered it for the first time. None of the papers on the subject is accessible to me at this writing, but I believe some are earlier than the reference cited by Mr. Torrey. Some of the best accounts are by MacDougal.¹

My last previous experience with "frost flowers," as nearly as I can remember, was nearly 25 years before, in Tuscaloosa County, Alabama. There I found the same sort of crystals, though somewhat differently shaped, exuding from the stems of *Verbesina occidentalis*, on December 5, 1905, a day when there was frost in shady places all day.²

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¹ MacDougal, D. T., Science 22: 351-352. 1893. Bot. Gaz. 19: 120-121. 1894. Bot. Gaz. 27: 69-71. 1899. References supplied by Editor.

² Harper, R. M. Plant World 9: 1906.

Additional notes

For the benefit of our readers and to give evidence of the ancient lineage of this question we quote in part herewith the short article in the *Botanical Gazette* (19: 120-121) by Dr. MacDougal referred to by Dr. Harper. It appears from this that the observations of this phenomenon go back over 100 years.

"Frost Plants.—Prof. Lester F. Ward's observations on the 'frost freaks of the dittany,' in the GAZETTE for April, 1893, occasioned much interest, since the phenomena illustrate one form of the movement of water in the plant stem. I have elsewhere³ made a lengthy review of the literature of the frost plants and take occasion to call attention to the following references which may be accessible to the readers of the GAZETTE. Prof. Ward called my attention to the fact that the frost crystals of *Cunila* and *Helianthemum* were noted by Dr. Darling-ton.⁴ The first observation of frost phenomena recorded is that of Stephen Elliot on the stem of *Conyza bifrons* (now *Pluchea bifrons*).⁵ Sir John Herschel noticed a similar formation on the

³ Quarterly Bulletin of the University of Minnesota 2: 30. 1894.

⁴ Flora Cestricea p. 350. 1837.

⁵ Sketch of the botany of South Carolina and Georgia. p. 322. 1824.



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