Cool IncRNAs respond to cold

As a literature curator at TAIR, I see all kinds of papers on all kinds of different topics coming through. Recently I noticed a couple of papers in Nature Communications describing long non-coding RNAs and their role in cold tolerance and vernalization response. Since many of you are currently experiencing cold winter weather, this seemed like an appropriate topic to cover in December’s blog post.

Thousands of long non-coding (Inc) RNAs with wide ranging roles in plant development and stress response have been found in Arabidopsis thaliana (Refs 11, 12, 19-28 in Zhao, et al). However, IncRNAs involved in the cold response have so far been limited to the FLOWERING LOCUS C (FLC) regulators COO LAIR, COL DAIR, and COLD WRAP (Refs 29, 30, 31, 32, 33 in Zhao, et al).

Both recent Nature Communications papers used a genome-wide sequencing approach comparing cold-treated Arabidopsis plants with plants grown under normal temperatures. Transcription Start Site (TSS)-sequencing identified a cluster of transcription factors that promote cold tolerance (C-repeat/dehydration-responsive element binding factors; CBFs) as the most cold-responsive region on the genome. In this region located between CBF3 and CBF1, Kindgren et al. (2018) were intrigued to find a cold-responsive IncRNA, transcribed on the antisense strand and named it SVALKA (SVK; “cool” in Swedish). A cryptic IncRNA overlapping the CBF1 gene on the antisense strand was produced as a result of RNAPII read-through transcription of SVALKA. As a result of RNAPII collision, expression and timing of CBF1 is tightly controlled for maximum freezing tolerance with minimum fitness costs.

In the second paper, Zhao et al. (2018) identified IncRNAs involved in cold tolerance using high-depth strand-specific RNA sequencing (ssRNA-seq) of cDNA libraries of Arabidopsis plants grown under cold stress and under normal conditions. A natural antisense transcript (NAT) IncRNA transcribed from the antisense strand of the cold-responsive MAF4 gene was renamed MAS (MADS AFFECTING FLOWERING 4 Antisense RNA). MAF4 is a FLC family member involved in prevention of precocious vernalization response.

It is expected that more cold response IncRNAs will be discovered in the near future because of an increased focus on the effects of climate change (Kindgren, et al. 2018). As we learn more about the complex mechanisms underlying cold response in plants the question arises: to what extent will climate change affect cold response and vernalization in crops?
