Trees, people and bioenergy in Sweden

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25th Session of the International Poplar Commission - 13th to 16th September 2016, Berlin (Germany)

Highlights of the post-conference tour in southern Sweden

Following the 25th Session of the International Poplar Commission in Berlin, my wife Joanne and I joined the post-conference tour in southern Sweden from the 17th to 20th of September 2016. We were the only participants from the North American continent. The travelling troupe of 26 included four hosts from the Swedish University of Agricultural Sciences (SLU) and was international in makeup, with folks from Argentina, Canada, China, India, Italy, Slovenia, Sweden, Ukraine and Uruguay. After a very warm stay in Berlin, it was a pleasure to travel in a cooler climate; and all that time without any rain during the tour.

Travel started in the evening of the 16th of September from Berlin by air to Copenhagen, then by train to Malmö, where we boarded a tour bus the following day. We were joined by Lars Christersson, professor emeritus at SLU; he had been the main mover and shaker of the hybrid poplar movement in Sweden.

Day 1

All Day 1 stops were located along Sweden's west coast, north of Malmö and south of Gothenburg, a region with a fairly mild climate.

- Hybrid poplar

The first stop was at the Swedish Forest Research Institute (Skogforsk) research station Ekebo near Svalöv, a municipality 40 km north of Malmö, where we started with a field trial of various European hybrid poplars (non-aspens), established in 2014. Here we learned that poplars (non-aspens) are not native to Sweden and several trials had been established to determine which hybrids and pure poplar species could survive the climate in southern Sweden. To date, the very best hybrid clone grown in southern Sweden is OP 42 (also known as NE 42), which is an old *Populus maximowiczii* (♀) × *P. trichocarpa* (♂) hybrid (crosses are always listed as female × male), bred by Schreiner and Stout in the twenties of the previous century at the Oxford Paper Company, Pennsylvania (US). Up to 2010, it had been the only clone used in Sweden. Since then 12 new hybrid clones were selected out of 140 tested in three trials in southern Sweden; of these only five proved resistant to *Melampsora larici-populina* leaf rust and *Xanthomonas populi* bacterial canker. After three growing seasons, OP 42, planted at this trial as the reference clone, ranked number three in height of the 15 tested clones (2016 results); the other clones in the top five were all *Populus trichocarpa* × *P. maximowiczii* (TxM) crosses. In general, *Populus deltoides* × *P. nigra* hybrids do not perform well, are unsuitable for the climate and are subject to *Melampsora larici-populina* leaf rust, whereas the *Populus maximowiczii* × *P. trichocarpa* (MxT) hybrid cross, and its reverse TxM, are reasonably well suited to the climate and are resistant to *Melampsora* leaf rust; there was no additional information on the susceptibility of other MxT or TxM hybrids to *Xanthomonas populi* bacterial canker. Of the pure poplar species (non-aspens), *Populus trichocarpa* and *P. maximowiczii* are considered suitable breeding parents for Swedish conditions. *Populus trichocarpa* selections appear to perform well in trial plantations we visited; however, we did not see any *P. maximowiczii* plantations. Hybrid poplar is generally more productive than hybrid aspen.

- Mature hybrid poplar stand

On the way to stop 2, we had an opportunity to visit a mature 24-year old stand of OP 42 (an MxT hybrid cross) near Knutstorp. The stand looked impressive; trees were tall and very straight with small branches. This stand would have compared favourably with similar stands of excellent quality once grown on

British Columbia's southwest coastal alluvial sites. It was planted on old agricultural land with 22 cm dormant cuttings at 1,666 stems per hectare (spha); by age 12 years only 1,044 spha survived. The reason for the high mortality between establishment and age 12 years was not discussed; however, late fall and early spring frosts were mentioned as problems. At age 12 years, 50% of the remaining stems were thinned out; there was no sign of any wind damage, indicating good stand stability. At age 22 years the mean annual increment, or MAI, measured at 30 $m^3ha^{-1}yr^{-1}$, with a mean diameter-at-breast-height, or DBH, of 30.2 cm and a height of 29 m; a very well-balanced stand with a favourable diameter-height (d/h) ratio exceeding 1. Although not specifically mentioned, I assumed the MAI was net of the thinned volume. From my own experience, the stated MAI certainly appeared to be in the ballpark for such a nice and still vigorous stand of hybrid poplar.

A 24-year old stand of OP 42 near Knutstorp.

- Hybrid aspen

Although we did not visit any aspen stands, information received stated that the Swedish Match Company undertook breeding work with aspen from 1940 through 1965 and produced *Populus tremula* × *P. tremuloides*; *P. tremula* is native to Scandinavia. Resulting hybrids showed a high degree of variation within and among families; in general, these outperformed either parent species, a familiar story in poplar hybridization. The very best 20 clones can potentially yield up to 20-25 $m^3ha^{-1}yr^{-1}$ after 20 to 25 years, when planted on fertile soils with good soil preparation and when fenced to prevent predation by ungulates (deer and moose; the latter is called 'elk' in Sweden).

- Hybrid willow

Stop 2 was at Salixenergi Europa AB and Lantmännen SW Seeds in the municipality of Svalöv. Salixenergi's managing director gave us an overview of the company's activities in willow (*Salix* species) cultivation, the development of the willow business in Sweden and Europe, and the willow breeding activities at Lantmännen. The business case for the cultivation of willow for energy is currently not a rosy one. Biologically all goes as planned, but economically this business has severely been impacted by an abundance of alternate fuel sources for energy generation. Sweden is importing garbage from Norway and Italy, which is burned to create energy; both countries pay Sweden to deal with their garbage. On top of that, Sweden also imports waste wood from Norway, which finds its way to incinerators generating electricity; one such plant is located in Enköping, which was on our tour itinerary for Day 3 (more later).

Breeding trials of Lantmännen SW Seeds in the municipality of Svalöv.

Despite the economic challenges posed by these alternate fuel sources, there appears

widespread commitment to continue willow research and development. Both companies are actively involved in growing their respective businesses in the rest of central and northern Europe, where their willow varieties are grown under licence.

We had a chance to look at various Lantmännen breeding trials and noted the enormous genetic variation between clones. Besides yield as one of the main attributes, the form of willow stems is an important selection criterion too. Straight and uniform stems facilitate mechanized harvesting of the biomass; straightness and uniformity are also desired for harvesting, processing and subsequent mechanized planting of a new crop.

- *Populus trichocarpa* & GM aspen trees

The final stop of the day was at Våxtorp, where we saw a breeding orchard for *Populus trichocarpa*; it is the preferred choice of pure poplar species for southern Sweden. Although we did not notice any *P. maximowiczii* trees, this species is the preferred hybridization partner for *P. trichocarpa*.

Highlight was the trial established by Swetree Technologies AB, a plant and forest biotechnology company involved with genetically modifying (aspen) trees for research purposes.

Trial established by Swetree Technologies AB at an old forest nursery site near at Våxtorp. The modified aspen clone is T89, a male hybrid of Populus tremula × P. tremuloides.

This GM-aspen trial is truly unique in Europe. I checked the company's website to find additional information on what the company's objectives are for these GM trees. Their activities include "*Gene mining and Gene identification, proof of concept in GM aspen trees, development of (our) gene technologies, aspen field trials, genetic transformation of most advanced technologies into commercial Eucalyptus clones for customers as well as supporting Eucalyptus field trials*". Traits the company is looking for include "*improved yield*" (smaller landbase requirement), "*improved wood quality*" (various end uses), "*improved performance during drought*" and "*improved water and nutrient use efficiency*" (http://swetree.com/application-areas/biotech-trees/). The original condition of establishment was to cut the trial at age five years, but the company received permission to extend to age seven years, provided it checks for flowering every month. The modified aspen clone is T89, a male hybrid of *Populus tremula* × *P. tremuloides*.

Day 2

This day was our tourist day on Visingsö Island, located in Lake Vättern, the second largest lake in Sweden. According to legend, a giant named Vist created Visingsö by throwing a lump of soil into the lake so that his wife could use it to step over the lake. It is famous for its rich history and large oak plantations, covering 360 hectares, established during the first half of the 19th century. Oak is not native

in this part of the country, but the climate is mild enough for the species to thrive. The island was a favourite hangout for four Swedish kings, who lived and died (in some instances murdered) in the 12th and 13th centuries. Oaks were planted to supply the Swedish navy with wood for construction of warships. Apparently, the manager of these oak plantations presented an invoice to the Swedish Navy several years ago with the message that they were now ready for the Navy to take delivery. No poplars or willows were encountered on this truly leisurely day.

Visingsö Island holds a 360 hectares large oak plantation that was established during the first half of the 19th century.

On the way to the hotel, we visited the Hällskogsbrännan, a vast forest area recovering from a devastating forest fire in July 2014. The fire spread very fast from about 2,800 hectares on the first day to 14,000 hectares the next day. The area has now become a tourist attraction with many trails and even a site with picnic tables amidst the burned trees. A brief walk through charred remains showed reasonably good natural regeneration with aspen (*Populus tremula*) and Scots pine (*Pinus sylvestris*), and there was ample sign of ungulates helping themselves to the regenerating vegetation.

Day 3

On Day 3 we visited several farms growing willow energy crops, irrigated with municipal and residential sewage effluent. The first stop was at the Tillinge-Lundby farm, 10 km west of Enköping, where the farmer grows 90 hectares of short rotation willow energy crops on agricultural land and uses septic tank effluent, collected from farms and private residences in the area, as fertilizer. The effluent is stored in several large ponds. Besides using this on his willow crops, he also provides other willow farms in the area with effluent for their irrigation and fertilization. Clearly visible was the continuous release of gas bubbles (probably methane). The ponds provided a happy habitat for countless ducks.

An overview of the Nynäs farm's willow plantations from the ENA Energi AB district heating plant in Enköping.

Our second stop was at the Nynäs farm near the ENA Energi AB district heating and wastewater treatment plants in Enköping. The farmer grows willow on 76 hectares of his agricultural land and uses drip irrigation to utilize the wastewater treatment plant's effluent, which is rich in nitrogen. Nitrogen gets utilized by the willow before the effluent is returned via the groundwater conduit to nearby Lake Mälaren.

The willow is harvested and utilized in the adjacent ENA Energi AB district heating plant. Here too, the farmer told us of the worrisome economics of these type of energy plantations vis-à-vis the plentiful availability of construction and domestic waste wood for ENA Energi's boilers.

We completed our day with a visit to the adjacent ENA Energi AB district heating plant, where again we learned of the troublesome willow-for-energy economics. The municipality of Enköping, which owns the district heating plant, clearly would like to pay as little as possible for its energy feedstock and construction and domestic waste wood is clearly the cheapest source. However, the municipality also needs to deal with its municipal sewage effluent and must ensure that effluent is released back to the groundwater, and thus Lake Mälaren, with a low nitrogen load; that is where the willow crops deliver. Thus, there is a need for the municipality to spend funds on purchasing willow feedstock to deal with its pollution abatement program, essentially subsidizing willow farming.

These last two stops were repeat visits for me; in 2002 I visited here during the International Poplar Symposium III (IPS III) in Uppsala (Sweden). Fortunately, the vicious mosquitos I encountered then were absent this time.

Day 4

The last day was spent visiting various willow and poplar trials established by researchers and PhD candidates of the Swedish University of Agricultural Sciences (SLU) near Uppsala.

The first stop was in Krusenberg, just south of Uppsala, at a 13-year-old trial with *Populus trichocarpa* × *P. trichocarpa* crosses, adapted to this northern latitude. These resulted from breeding programs at SLU in Uppsala during the 1990's.

The 13-year-old clone trial in Krusenberg with Populus trichocarpa × P. trichocarpa crosses.

The third stop was at a willow field trial on campus grounds, using two different stock types: dormant cuttings vs. billets (comparable to single bud cuttings), and two levels of weed competition: no weeding vs. complete weeding. The take-home message for me was again how critical complete weed control is for successful crop establishment. Good weed control has a much greater impact on crop success than choice of planting stock type.

At the conclusion of the tour, SLU treated us to various indoor presentations, made much more pleasant with the consumption of a fabulous and very rich smörgåstårta (worth checking this out on the Internet), after which we said our goodbyes and dispersed. We had a great tour, with great hosts, after a great conference in Berlin.

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