Autumn yellowing of the Nordic mountain birch in relation to climate at Kola Peninsula (Russia) and along the Pasvik river west of Kola

E. Shutova[1], O. Makarova[2], E. Haraldsson[3], N. Berlina[4], T. Filimonova[5], P.E. Aspholm[3], S.R. Karlsen[6], K.A. Høgda[6], F.E. Wielgolaski[7]

1 Kandalaksha zapovednik, ul. Lineinaya 35, 184040 Kandalaksha, Murmansk region, Russia
2 Pasvik zapovednik, 184404 Rajakoski, Petsengskyi district, Murmansk region, Russia
3 Svanhovd Environmental Centre, Planteforsk, 9924 Svanvik, Norway
4 Lapland zapovednik, per. Zeleny 8, Montsegorsk, Murmansk region, Russia
5 Polar-Alpine Botanical Garden-Institute, 184230 Kirovsk, Murmansk region, Russia
6 NORUT IT, P.O.B. 6434 Science Park, 9294 Tromsø, Norway
7 Biological Institute, University of Oslo, P.O.B.1045 Blindern, 0316 Oslo, Norway

Introduction

Russian nature reserves ("zapovedniks") have collected terrestrial phenological plant data, in most cases systematically, almost since establishment (Lapland 1930, Kandalaksha 1932 with phenology since 1960 and the Polar-Alpine Botanical Garden-Institute (PABGI) since 1931, with phenology since 1964, all at the Kola Peninsula). In addition terrestrial phenological data have been collected at the Pasvik nature reserve nearly since establishment (1992), and at Svanhovd Environmental Centre in Finnmark, Norway since 1993, both along the river Pasvik (Fig. 1 and Tab.1). Phenological spectra are published for 19 plant species at the 5 sites (all north of 67° N in the vegetation zones taiga and tundra) in the period 1994-2000 (Makarova et al. 2001). The data have a high value in climate change studies because of continuous observations through many years on the same places and by the same method. In this presentation it is concentrated on the time for first yellowing of Nordic mountain birch leaves.

Figure 1. The positions of the phenological stations (circle) and meteorological stations (triangle) used in this study.

Climate

The northern location causes presence of polar days with midnight sun and polar nights. In general, climate of the Kola Peninsula is moderate arctic-atlantic with highest precipitation through July-October and lowest through March-April (Atlas 1971). The territory of the northern part of Kola Peninsula, however, including the river Pasvik area, belongs to the atlantic, sub-arctic zone (Aleksov 1956). In some cases there is a distance between meteorological and phenological observations (Fig. 1). For temperatures, see Tab. 1.

Table 1. Mean July and January temperature.

Place	Meter a.s.l.	July °C	January °C
Svanhovd	35-60	12.4	-13.5
Pasvik reserve	53	13.8	-13.3
Lapland reserve	128	13.8	
PABGI (Kirovsk)	319	12.7	-12.7
Kandalaksha res.	not > 5	14.4	-12.8

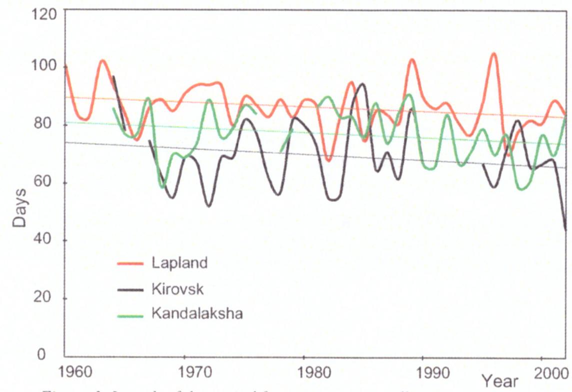

Figure 3. Length of the period from greening to yellowing.

Birch yellowing

Lapland nature reserve has the longest time series with 60 years of data during the 74 years time period 1930-2003. At this site birch show a linear trend of about 8 days earlier start of autumn leaf yellowing in that period (Tab. 2). In the period 1960-2003 leaf yellowing at the same station was about 6 days earlier in Lapland and between 5 and 6 days earlier at Kandalaksha nature reserve

The time trend of leaf yellowing through the last 10 years was more uncertain due to strong variation in the phenophase at the different stations in various years (Fig. 2). In some years the yellowing was relatively late at the Lapland natural reserve (observing the first general yellowing, which normally occurs a few days later than the first yellow leaves observed at the other sites), while it was very early the last years at Pasvik natural reserve. This was particularly the case in 2002 and maybe due to rust disease attacks, causing yellowing of leaves. However, even in this 10 year period, in most cases there was a tendency of earlier yellowing. The length of the period from bud burst (greening) to yellowing was also generally becoming shorter through the second half of the 20th century (Fig. 3) in spite of no trends in the temperature sum between the phases. That means slightly higher mean temperatures through the years in the period.

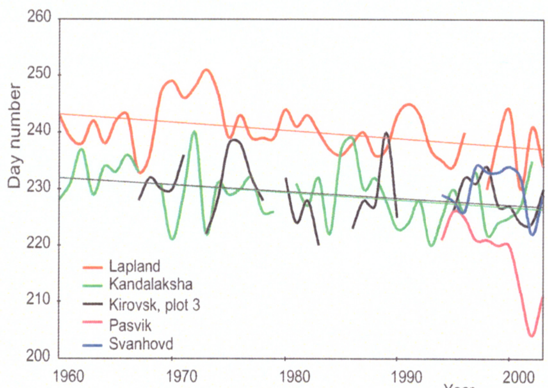

Figure 2. Date of beginning of yellowing of leaves of Betula *sp. during the time period 1960 to 2003.*

Climate change and plant phenology

Climate change through the last decades (IPCC 2001) is generally found to give earlier flowering and longer growing seasons of plants in most of the northern Hemisphere (refs. in e.g. van Vliet et al. 2003). However, in many mountains of Norway and in northern, continental Fennoscandia and in parts of Kola Peninsula an opposite tendency is observed (Høgda et al. 2001, Kozlov and Berlina 2002).

In the present study a significant positive correlation is found between the date of first birch leaf yellowing and the first day of continued decreasing temperature in August (r = 0.6-0.7) at two Kola Peninsula sites after 1964. There is no increment in the correlation coefficient by summing the temperature differences of days below 15° C or 12° C and the real temperature in the period of decreasing temperature before leaf colours in correlations with the date of first yellowing. It is observed that the global radiation was also very low in the days before the first autumn colours of these leaves. This fits well with older phytotron observations that birch plants from northern regions (70° N) need high light intensities and night temperatures above 13° C to develop normally (Håbjørg 1972a, b). Northern ecotypes of birch are also found to have earlier dormancy in fall than more southerly ones (Myking 1999, Ovaska et al. in press). Sometimes it is stressed that the photoperiod plays a more important role than temperature in late-season phenology of plants at high latitudes (Barnes et al. 1998). However, more studies are necessary to see if this is the case also for the Nordic mountain birch.

Table 2. Changes in the phenophase beginning of yellowing of leaves of Betula *sp. Linear trend in day/year.*

Period	Lapland	Kandalaksha	Kirovsk	Pasvik	Svanhovd
1930-2003	-0.13 [1)]				
1960-2003	-0.14 [1)]	-0.13 [2)]	-0.12 [3)]		
1994-2003	0.14 [1)]	0.33 [2)]	-0.48 [3)]	-1.90	-0.07

1) Missing years: 1933, 1943-45 1947-49, 1953-58, 1997
2) Missing years: 1968, 1980, and 2003
3) Missing years: 1960-64, 1966, 1972, 1979, 1984-85, 1991, 1993-94
4) Missing years: 1960-63, 1966, 1980, 1985, and 1993-94

References

Turn the page.

The research is sponsored by the PhenoClim project.
http://project.itek.norut.no/phenology/

Poster presentation for the Bjerknes Centenary Open Science Conference "Climate Change in High Latitudes", Bergen, Norway 1-3 September 2004.

References

Aleksov, B.M. 1956. Climatic classification (Klimaticheskaya klassipfikatshiya; in Russian).

Atlas of Murmansk region. 1971. (Atlas Murmanskoi oblasti; in Russian).

Barnes, B.V., Zak, D.R., Denton, S.R. and Spurr, S.H. 1998. Forest tree variation. In: Forest Ecology, pp. 63-93, John Wiley, New York.

Beidman, I.N. 1974. Method for investigations of plant phenology and plant associations. (Metodika izucheniya fenologii rastenii i rastitelnyih soobshestv; in Russian). Novosibirsk. Science (Nauka). 154 pp.

Håbjørg, A. 1972a. Effects of photoperiod and temperature on growth and development of three latitudinal and three altitudinal populations of Betula pubescens Ehrh. Meld. NLH 51 (2): 1-27.

Håbjørg, A. 1972b. Effects of light quality, light intensity and night temperature on growth and development of three latitudinal populations of Betula pubescens Ehrh. Meld. NLH 51 (26): 1-17.

Høgda, K.A., Karlsen, S.R. and Solheim, I. 2001. Climatic change impact on growing season in Fennoscandia studied by time series of NOAA AVHRR NDVI data. Proc. IGARSS 2001, Sydney, Australia, ISBN 0-7803-7033-3, pp. 1-3.

IPCC. 2001. Summary for policymakers; An Assessment of the Intergovernmental Panel on Climate Change. In: Watson, R.T. and the Core Writing Team (Eds.) Climate change 2001, Synthesis report pp. 1-34. Cambridge Univ. Press, UK and USA.

Kozlov, M.V. and Berlina, N.G. 2002. Decline in the length of the summer season on the Kola Peninsula, Russia. Clim. Change 54: 387-398.

Makarova, O.A., Pokhilko, A.A. and Kushel, J.A. 2001. Phenological monitoring of plants at Kola 1994-2000. (Sesonnaya zhizn prirodyi Kolskogo severa; in Russian). State Committee on Environment Protection. Murmansk. 68pp.

Myking, T. 1999. Winter dormancy release and budburst in Betula pendula Roth. And B. pubescens ecotypes. Phyton (Austria) 39: 139-146.

Ovaska, J., Nilsen, J., Wielgolaski, F.E., Kauhanen, H., Partanen, R., Neuvonen, S., Kapari, L., Skre, O. and Laine, K. In press. Phenology and performance of mountain birch provenances in transplant gardens: latitudinal, altitudinal and oceanity-continentality gradients. In: Wielgolaski, F.E. (Ed.) Plant ecology, herbivory and human impact in Nordic mountain birch forests. Ecol. Stud. Vol. 180. Springer, Germany.

Vliet, A.J.H. van, De Groot, R.S., Bellens, Y., Braun, P., Bruegger, R., Bruns, E., Clevers, J., Estreguil, S., Flechsig, M., Jeanneret, F., Maggi, M., Martens, P., Menne, B., Menzel, A. and Sparks, T. 2003. The European phenology network. Int. J. Biometeorol. 47: 202-212.