MONITORING INSTRUCTIONS OF THE FINNISH NATIONAL PHENOLOGICAL NETWORK

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Finnish Forest Research Institute (Metla)

Muhos Research Unit

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Photo in cover: Eeva Kotilainen

1 FOREWORD

Phenology is a branch of science focusing on the rhythm of biological phenomena and the effect of various factors on this rhythm (Lieth 1974). Phenological observations have been made already before the common era, in China, for example. The scientific study of the development of individual plants was begun in Europe in the early 1700s. In Finland, too, the history of phenological research goes back a long way. Already in 1751, Carl von Linné launched phenological monitoring. Attention was then focused on the point in time when plants burst into leaf and when they flower, and this was done by volunteers (Moberg 1857). The Finnish Society of Sciences and Letters continued these observations in 1846, a few years after the establishing of the Society. This work went on until 1965, after which the Finnish Museum of Natural History took on the responsibility for the observations with volunteers continuing to provide the workforce. Since the 1960s, phenological observations have also been conducted by the Universities of Oulu and Turku, Agrifood Research Finland, and Luonto-Liitto. Observations of natural phenomena in the Finnish Forest Research Institute's (Metla) research area were launched in the 1960s, e.g. leaf bud burst and flowering of plants, arrival of migratory birds and melting of ice cap on lakes or sea. At some of Metla's outposts this monitoring has been on-going for more than 30 years.

In 1985, in connection with a climate convention arranged by the Academy of Finland, Professor Paavo Havas brought up the matter of need to establish a phenological observation network in Finland (Havas 1985). In 1996, Metla launched a project, supported by the Academy of Finland, in which the phenology of forest trees and other forest vegetation began to be monitored via a nationwide observation network in collaboration with universities, state research institutions, and vocational schools and colleges. This monitoring is systematic and focuses on aspects such as leaf bud burst, flowering, ripening of berries, and yellowing of leaves. It was at this point in time that the monitoring of wild berry and mushroom crops, which had been carried on since 1985 at Metla's unit in Joensuu, was included in the project. The monitoring of the seed crops of forest trees was included in 2002. The most common damages affecting trees are also monitored within the observation network.

In 2004 Metla launched a new project entitled "Timing of phenological events in changing climate – research on trees and their seeds, yields of wild berries and mushrooms". This project continues with the work of phenological monitoring relying on the Finnish National Phenological Network. In addition to phenological phenomena, the research focuses on the forest tree seed, wild berry and mushroom yields, and the drawing up of yield forecasts. Models based on the monitoring data are used in studying changes in the timing of phenological phenomena, in making forecasts of wild berry and forest tree seed yields, and the risks of frost damage to forest trees and wild berries. The monitoring of biological damage continues as well. Weather data form the foundation for all of this.

Climate change has attracted increasing interest in phenological research, especially in Europe (Bruns & van Vliet 2003). Long-term observation series tell a lot about the annual variation in the growth of plants and about changing environmental conditions, and in this way phenology provides excellent opportunities for studying climate change and its impacts on forest ecosystems. Metla's nationwide phenological observation network (Kubin et al. 2006) has collected data covering a full decade and the results have been analysed using both data for the whole country (Kotilainen et al. 2007a) and northernmost Finland (Kotilainen et al. 2007b). For example, the point in time when *Betula pubescens* reaches bud burst has advanced by one week in Southern Finland and Central Finland, and by two weeks in the regions of Pohjanmaa-Kainuu and Finnish Lapland during the years 1997-2006. With accumulating observation data, we will eventually get an answer to the question of whether this is an on-going trend or the result of climatic variation.

Moreover, Finland is an active participant in international cooperation in the field of phenology. A project called COST 725 **(Establishing a European Phenological Data Platform for Climatological Applications)** was launched in 2004 with the objective of making phenological observations in Europe uniform (Koch et al. 2005). The purpose is to have the database now being developed to include the phenological observation data of the member states with the help of BBCH coding (Biologische Bundesanstalt, Bundessortenamt and Biologische Bundesanstalt Chemical industry), which has been developed by German research institutions (Meier 2001). This coding system allocates various distinguishing characters to the different phases of development of plants, which can then be used in grouping even large amounts of data in different ways.

Finland has a good and comprehensive nationwide network of research stations. As it is representative of phytogeographically different zones, it enables the study of plant reactions to the predicted climate warming in their natural habitats. With a series of observations covering the past 10 years behind us, it is now time to review the phenological observation instructions. The single biggest change is that as of 2007 onwards observations will be made tree-specifically. This enables more in-depth statistical interpretation of the results and improves their reliability in regard to studying the impacts of climate change.

2 OBSERVATIONS

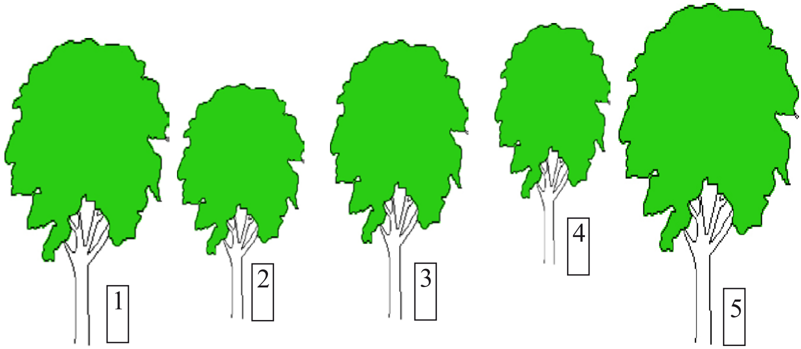
This chapter looks at the instructions applying to the making of the actual observations. The instructions to monitoring of most common damages affecting trees are presented in Chapter 5. In the part dealing with the description of the plants to be observed, we observe the guidelines presented by Hämet-Ahti et al. (1986).

2.1 Selecting the observation site

Special attention should be attached to selecting the observation site. Depending on the situation, one or more tree stands representing mature and mesic or relatively dry forests need to be selected as sites. The locations for phenological observations, berry crops and biological damage observations, should be in the same stand where possible. These locations should be representative of the average conditions of the locality, which excludes locations where the natural phenomena being monitored occur exceptionally early (e.g. a warm south-facing slopes) or exceptionally late (e.g. shady north-facing slopes) with respect to the surroundings. As many observations as possible should be made within the selected forest stand. If the tree species being observed (e.g. Bird-cherry, Rowan, Grey Alder) are not present in the selected stand, these will be selected from other suitable locations in the nearby area. If changes are necessary regarding the observation location or the observation trees, please contact Jorma Pasanen or Jarmo Poikolainen at Metla's Muhos unit.

2.2 Selecting the trees

The selected trees should be healthy and exhibit normal growth, and preferably by of natural origin rather than planted. If the observations are focused on planted trees, a fundamental requirement is that the trees must be of a local origin. The selected trees need to be marked and numbered, e.g. by placing a numbered stake next to each tree to be monitored. **This is important because as of 2007 onwards the observations will be made tree-specifically.** The recommended number of trees to be monitored is five.



2.3 Filling in the form

At the top of the form there are fields for entering the details of who is making the observations and the observation location.

Name of observation location: Local district and locality; e.g. Paimio, Preitilä. Enter the number of the observation location in the top right-hand corner of the observation form.

Name of the person making the observations: Always write the name and telephone number of the person making the observations on the form. Please note! If someone substituting for the regular person makes the observations, the name and contact details of this substitute person must always be provided.

Make the observations weekly on Monday and Thursday throughout the growing period. If the phenomenon to be monitored has not yet occurred, indicate this by inserting the dash character (–) on the form. Note that you need to enter this character alongside each day until the phenomenon has occurred. When the phenomenon does occur, indicate this by entering the plus character (+) and stop monitoring the phenomenon. If the phenomenon you are monitoring occurs between the observation days (between Monday and Thursday), record the actual date if you know it.

Not all of the fields on the form are intended to be filled in; you are required monthly to concentrate on those observations, which are on-going then.

2.4 Submitting and archiving of observation data

Submit the observation data immediately after the occurrence of the phenological phenomenon in question to Metla's Muhos unit. There are three ways of doing this:

1. Over the Internet to **www.metla.fi/metinfo/fenologia/ syotto**; for this you need to be issued a username and a password
2. By fax to **+358 10 211 3701**
3. By phone during office hours **+358 10 211 3712**

Internet users should contact Jouni Karhu (tel. +358 10 211 3752 or +358 50 391 3752) for their username and password.

It is a practice to be recommended that the unit responsible for making the observations record and retains the observation data, e.g. by archiving the field forms, irrespective of the manner in which their data is submitted, so that the data can be checked at a later point in time if necessary. Metla's Muhos unit bears the responsibility for the entire nationwide phenological observation network's database and for its updating.

2.5 Observation field form

The observation field form has undergone reformulation in readiness for observations to made in 2007. The new form is used to enter the phenological data tree-specifically or per block of vegetation.

Plant phenological monitoring 2007

Observation site : **Site no :** **Month :**

Observer : **Tel:**

Observations are made tree-specifically weekly on mondays and thursdays. If the phenomenon to be monitored has not yet occurred, indicate this by inserting the dash character (-). When the phenomenon does occur, indicate this by plus character (+).
Submit the observation data immediately to Metla's Muhos Research Unit by on the internet, phone (010 211 3712) or fax (010 211 3701).

1. *Betula pubescens*	**Tree**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**
Bud burst BBCH07	1																															
	2																															
	3																															
	4																															
	5																															
Onset of male flowering BBCH61	1																															
	2																															
	3																															
	4																															
	5																															
Leaves full-sized BBCH15	1																															
	2																															
	3																															
	4																															
	5																															
Shedding of seeds BBCH89	1																															
	2																															
	3																															
	4																															
	5																															
Leaf colouring BBCH92	1																															
	2																															
	3																															
	4																															
	5																															
Leaf fall BBCH97	1																															
	2																															
	3																															
	4																															
	5																															
2. *Betula pendula*	**Tree**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**
Bud burst BBCH07	1																															
	2																															
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	4																															
	5																															
Onset of male flowering BBCH61	1																															
	2																															
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	4																															
	5																															
Leaves full-sized BBCH15	1																															
	2																															
	3																															
	4																															
	5																															
Shedding of seeds BBCH89	1																															
	2																															
	3																															
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	5																															
Leaf colouring BBCH92	1																															
	2																															
	3																															
	4																															
	5																															
Leaf fall BBCH97	1																															
	2																															
	3																															
	4																															
	5																															
3. *Populus tremula*	**Tree**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**
Leaves full-sized BBCH15	1																															
	2																															
	3																															
	4																															
	5																															
Leaf colouring BBCH92	1																															
	2																															
	3																															
	4																															
	5																															
Leaf fall BBCH97	1																															
	2																															
	3																															
	4																															
	5																															
4. *Sorbus aucuparia*	**Tree**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**
Bud scales opened BBCH07	1																															
	2																															
	3																															
	4																															
	5																															
Leaves opened BBCH13	1																															
	2																															
	3																															
	4																															
	5																															
Leaf colouring BBCH92	1																															
	2																															
	3																															
	4																															
	5																															
Time and abundance of flowering BBCH65	1																															
	2																															
	3																															
	4																															
	5																															
Berries ripe and abundance of berries BBCH86	1																															
	2																															
	3																															
	4																															
	5																															

5. *Prunus padus*	**Tree**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**
Flowering	1																															
BBCH63	2																															
	3																															
	4																															
	5																															
Berries ripe	1																															
BBCH86	2																															
	3																															
	4																															
	5																															
6. *Alnus incana*	**Tree**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**
Onset of male flowering	1																															
BBCH61	2																															
	3																															
	4																															
	5																															
7. *Pinus sylvestris*	**Tree**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**
Onset of height growth	1																															
BBCH30	2																															
	3																															
	4																															
	5																															
End of height growth	1																															
BBCH39	2																															
	3																															
	4																															
	5																															
Onset of male flowering	1																															
BBCH61	2																															
	3																															
	4																															
	5																															
Onset of female flowering	1																															
BBCH61	2																															
	3																															
	4																															
	5																															
Female flowering 100%	1																															
BBCH63	2																															
	3																															
	4																															
	5																															
8. *Picea abies*	**Tree**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**
Onset of height growth	1																															
BBCH30	2																															
	3																															
	4																															
	5																															
End of height growth	1																															
BBCH39	2																															
	3																															
	4																															
	5																															
Onset of male flowering	1																															
BBCH61	2																															
	3																															
	4																															
	5																															
Onset of female flowering	1																															
BBCH61	2																															
	3																															
	4																															
	5																															
Female flowering 100%	1																															
BBCH63	2																															
	3																															
	4																															
	5																															
9. *Juniperis communis*	**Shrub**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**
Onset of male flowering	1																															
BBCH61	2																															
	3																															
	4																															
	5																															
10. *Vaccinium myrtillus*	**Square**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**
Flowering	1																															
BBCH65	2																															
	3																															
	4																															
	5																															
Berries unripe	1																															
BBCH86	2																															
	3																															
	4																															
	5																															
Berries ripe	1																															
BBCH87	2																															
	3																															
	4																															
	5																															
11. *Vaccinium vitis-idaea*	**Square**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**
Flowering	1																															
BBCH65	2																															
	3																															
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Berries unripe	1																															
BBCH86	2																															
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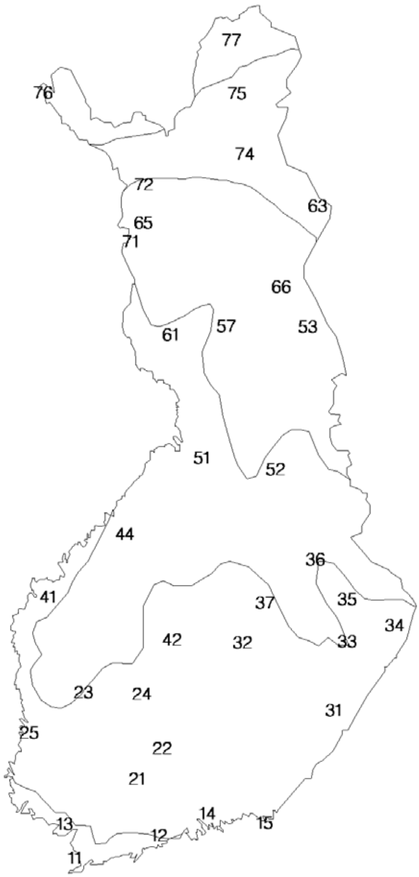
	5																															
Berries ripe	1																															
BBCH87	2																															
	3																															
	4																															
	5																															

3 OBSERVATION NETWORK

The Finnish National Phenological Network covers the entire country and is comprised of 32 active observation sites (in the spring 2007). These sites are located at Metla's field research stations and research areas, at field stations of other research institutions and universities, at some local offices of Metsähallitus and at some vocational schools and colleges.



The observation sites on 1.4.2006 superimposed on a map of phytogeographical zones. The contact details of the persons making the observers are presented on pages 50-56.

Observation site	Location no.	Site	Observer or person in charge
Solböle	Bromarv	11	Thomas Lindblad
Ruotsinkylä	Tuusula	12	Jukka Lehtonen
Preitilä	Paimio	13	Esa Ek
Lapinjärvi	Lapinjärvi	14	Erkki Piiroinen
Ravijoki	Virolahti	15	Esa Punkkinen
Aulanko	Hämeenlinna	21	Merja Kujala
Vesijako	Padasjoki	22	Markku Pastila
Parkano	Parkano	23	Hannu Autio
Vilppula	Vilppula	24	Pertti Niemi
Punkaharju	Punkaharju	31	Hannu Heinonen
Suonenjoki	Suonenjoki	32	Sirpa Kolehmainen
Joensuu	Joensuu	33	Markku Tiainen
Mekrijärvi	Ilomantsi	34	Risto Ikonen
Koli	Lieksa	35	Ismo Hyttinen
Nurmes	Nurmes	36	Veli-Matti Laatikainen
Siilinjärvi	Siilinjärvi	37	Raimo Styhr
Korsholm	Korsholm	41	Karl-Gustav Ingo
Kolkanlahti	Saarijärvi	42	Juha Rauvala
Kannus	Kannus	44	Esa Heino
Muhos	Muhos	51	Jorma Pasanen
Paljakka	Puolanka	52	Ilkka Kemppainen
Oulanka	Kuusamo	53	Juho Palosaari
Kivalo	Rovaniemi	57	Tapani Hänninen
Värriö	Savukoski	63	Teuvo Hietajärvi
Äkäslompolo	Kolari	65	Pasi Tanninen
Salmivaara	Salla	66	Juha Kemppainen
Kolari	Kolari	71	Irma Lantto
Pallasjärvi	Kittilä	72	Eveliina Pääkkölä
Saariselkä	Inari	74	Jouko Kyrö
Muddusjärvi	Inari	75	Heikki Törmänen
Kilpisjärvi	Enontekiö	76	Viktor Mannela
Kevo	Utsjoki	77	Saini Heino

4 MONITORED PLANTS AND PHENOMENA

4.1 Downy birch – *Betula pubescens* Ehrh.

Characteristics

Downy birch is smaller in size than Silver birch and its branches are not so thick. The young shoots of the Downy birch are smooth, hairy, and fairly stiff at the tip. Its leaves are usually ovate or roundish in shape, generally with single serration along the edges, and they lack the elongated tip typical of Silver birch. The leaf blade is at its widest at about midway along its length. When compared to the leaf blade, the petiole is shorter and broader than that of Silver birch. The dormant buds are sticky, and the bark at the butt end of the Downy birch is smooth and light in colour.

Mountain birch (*Betula pubescens* ssp. *cherepanovii* Orlova) is a subspecies of the Downy birch. Where Mountain birch occurs, the observations are recorded alongside Downy birch and this is indicated in writing.

Selecting the trees

The observations are made individually by observing five medium-sized and healthy Downy birch trees. The trees have been marked and numbered. All Downy birch observations are made of the same trees.

Phenomena to be monitored

Bud burst. BBCH07.

Leaves are in this phase when they are emerging from their buds. The leaves are still very small, the leaf blade has not yet opened, and the petiole is not visible. This phenomenon is deemed to have occurred when at least half of the leaves of each observation tree have reached this phase, i.e. when the crowns of birches appear green for the first time when viewed from a distance.

Onset of male flowering. BBCH61.

Male flowering is deemed to have begun when the first tree begins to release pollen. This is when the catkins become heavy and start to hang downwards at the tips of branches. In Southern Finland this usually occurs at the end of April, in Central Finland in mid-May, and in Lapland towards the end of May. The beginning of male flowering can be determined by tapping the branches of birches with a long pole or other equivalent.

Leaves full-sized. BBCH15.

The leaf has reached its full size and does not really grow any bigger. The leaves becomes dark green and thicker, and the foliage of the birch as a whole becomes denser in appearance within a short time. Cross measurements can also be used in connection with this observation by measuring the length and width of a few leaves.

Fig. 1. Male flowering of birch. When the branches are given a tap, the catkins release a distinct puff of pollen. Photos: Eeva Kotilainen

Shedding of seeds. BBCH89.

This phenomenon is deemed to have occurred when the first seeds are observed to be shed by birches. A sheet of plastic or some other suitable material can be spread underneath trees to help in making this observation. In Southern Finland this usually happens already at the end of July or early August; in Northern Finland it happens towards the end of August. The shedding of seeds usually continues well into autumn. If tree-specific shedding of seeds cannot be distinguished, this phenomenon is marked alongside tree no. 1 on the form.

Leaf colouring. BBCH92.

This is the point in time when more than half of the leaves on each observation tree have turned yellow. The discoloration caused by rust fungi is not to be taken as yellowing in the sense meant here. If there is an abundance of birch rust fungi, and this hinders the making of observations, this can be noted down separately. See pictures of birch rust on page 45.

Leaf fall. BBCH97.

The shedding of leaves is deemed to have occurred when more than half of the leaves of each observation tree have been shed.

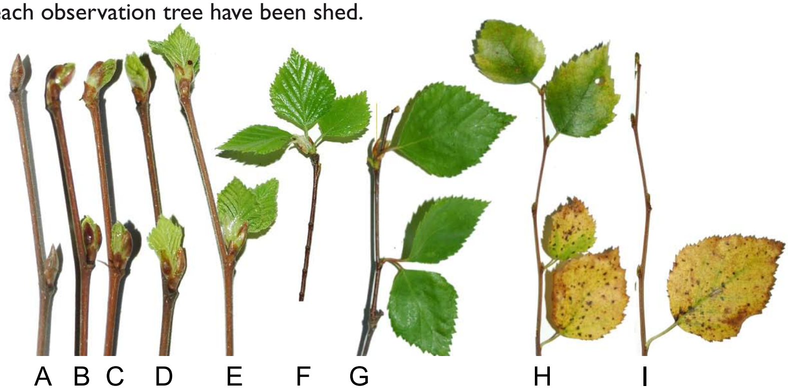


Fig. 2. Bud burst, leaf colouring and leaf fall of Downy birch. Flushing before the phase of bud burst (A-D); bud burst (E); leaves fully out of the bud (F); leaves full-sized (G); leaf colouring (H); and leaf fall (I). Photos: Eeva Kotilainen.

4.2 Silver birch – *Betula pendula* Roth.

Characteristics

Silver birch is bigger in size than Downy birch and its branches are sturdier. The new shoots of Silver birch have small resinous warts and they are hairless. The leaves are triangular or rhomboid and with clearly double-serrated edged. The leaf blade is at its broadest near its base. The winter buds are dry and the bark at the butt end of the tree is often rough and cracked.

The distribution of Silver birch does not extend to Northern Lapland, and so birch observations there are confined to Mountain birch and these are recorded alongside Downy birch.

Selecting the trees

The observations are made individually by observing five medium-sized and healthy Downy birch trees. The trees have been marked and numbered. All Silver birch observations are made of the same trees.

Phenomena to be monitored

Silver birch is monitored regarding the same phenomena as Downy birch, see Section 4.1.

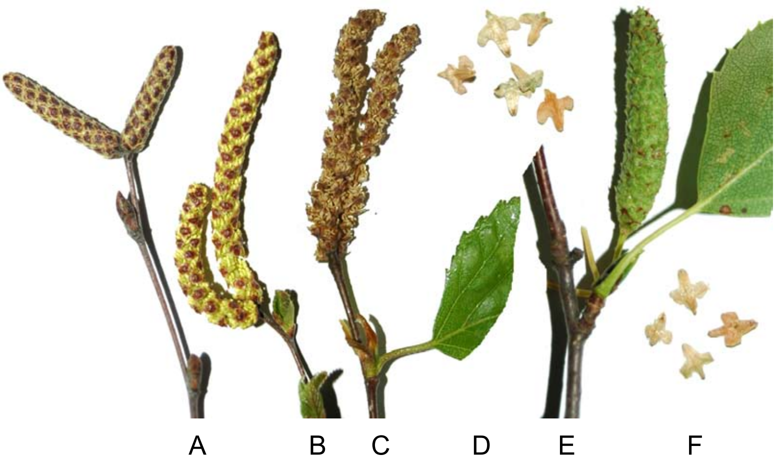


Fig. 3. Various phases in the male flowering of birch, a female catkin, and shed seed. Male catkin before pollen release (A), during pollen release, (B) and after pollen release (C). A female catkin just before the shedding of seeds (E). Seed of Silver birch (D) and Downy birch (F). Photos: Eeva Kotilainen.

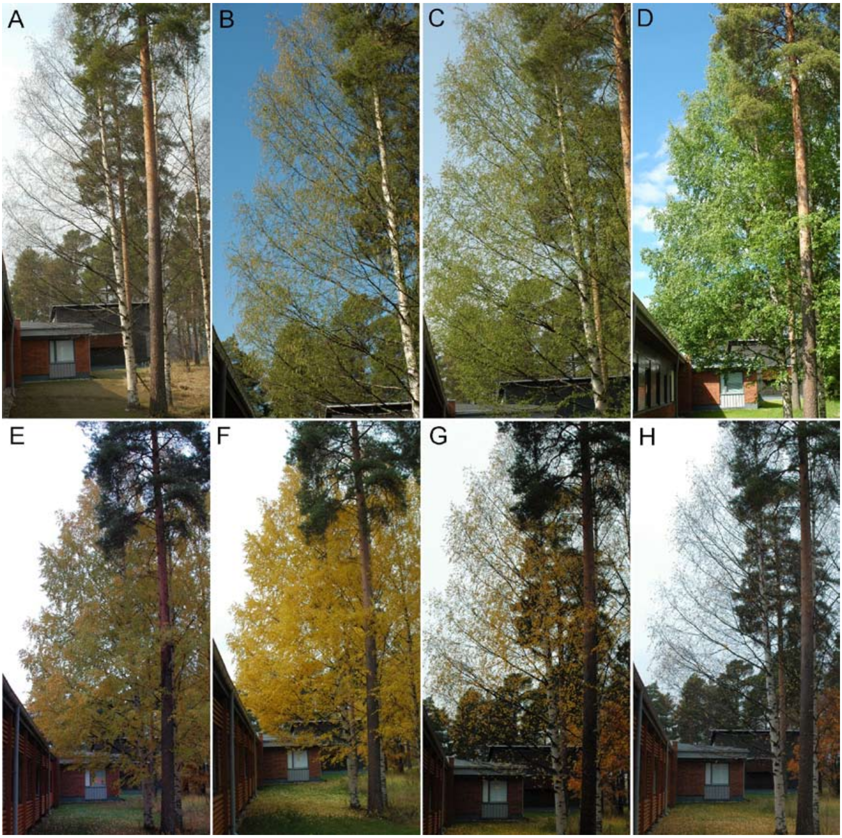


Fig. 4. Various phases in onset of leafing, leaf colouring, and leaf fall of Silver birch. Birch before bud burst (A), bud burst (B); leaves fully out of the bud (C); leaves full-sized (D); leaf colouring (E); leaves fully coloured (F); leaf fall (G); and birch entirely without leaves (H). Photos: Eeva Kotilainen.

4.3 Aspen – *Populus tremula* L.

Characteristics

Aspen is a large tree with grey bark. The buds are hairless and slightly sticky. The leaf petiole is about as long as the leaf blade. The leaf is roundish and wavy-edged or irregularly bluntly serrated.

Selecting the location and the trees

The observations are made individually by observing five medium-sized and healthy Aspen trees. The trees are selected either from an observation stand or from a separate location according to the situation, and they are marked and numbered. It should be noted that adjacent Aspen trees often belong to the same clone; different clones can best be separated in their autumn colours.

Phenomena to be monitored

Leaves full-sized. BBCH15.

The leaf has reached its full size and does not really grow any bigger. Cross measurements can also be used in connection with this observation by measuring the length and width of a few leaves.

Leaf colouring. BBCH92.

This is the point in time when more than half of the leaves on each observation tree have changed colour.

Leaf fall. BBCH97.

The shedding of leaves is deemed to have occurred when more than half of the leaves of each observation tree have been shed.

Fig. 5. Aspen leaves in various phases. Leaves full-sized (A); leaf colouring (B); and leaf fall (C). Photos: Eeva Kotilainen.

4.4 Rowan – *Sorbus aucuparia* L.

Characteristics

Rowan is tree-like or bush-like in form, and its bole is smooth. The leaves are composed of 6-8 pairs of opposite leaflets and terminal leaflet is no bigger than the others. The inflorescence is a broad panicle, the individual flowers are small and white. The berries are red or yellowish-red.

Selecting the location and the trees

The observations are made of five Rowan trees as tree-specific observations. The trees should be selected from an open area, along the forest or field edge, from a yard area, or some other suitable area. The trees should be of such age that they flower. The trees need to be marked and numbered. If five trees cannot be found in the vicinity of the observation location, the observations can be confined to those trees that are in the area. All rowan observations will be made of the same trees.

Phenomena to be monitored

Bud scales opened. BBCH07.

This is the point in time when green leaves have begun to push forth out from the buds, but individual leaves cannot be distinguished as yet. The phenomenon can be deemed to have occurred when more than half of the bud scales of each tree have opened up.

Leaves opened. BBCH13.

More than half of the leaf blades in each observation tree have fully unfolded. The leaves are not yet full-grown at this phase.

Leaf colouring. BBCH92.

More than half of the leaves of each observation tree have changed colour.

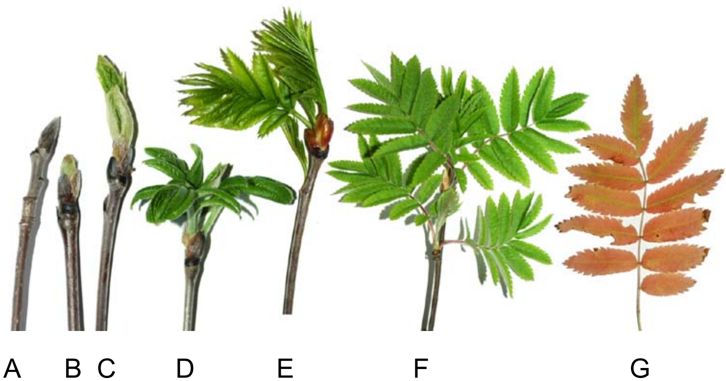


Fig. 6. Onset of leafing and leaf colouring of rowan. Bud before opening (A), bud scales opened (B), intermediate stages before the opening of leaves (C-E), leaves opened (F), and leaf colouring (G). Photos: Eeva Kotilainen.

Time and abundance of flowering. BBCH65.

Flowering is that point in time when more than half of the flowers of each tree have opened up.

This is also the time to estimate the abundance of flowering at the observation location and in its surroundings. This needs to be marked on the observation form alongside the flowering date using the following scale:

1. *No flowering.* There are no inflorescences at all or only very few.
2. *Flowering poor.* There are inflorescences here and there, and the number of flowers in the inflorescences may be small.
3. *Flowering middling.* The trees have inflorescences in general and there is fair number of them.
4. *Flowering abundant.* The trees have inflorescences in general and there is an abundance of them.
5. *Flowering very abundant.* The trees are full of inflorescences.

Fig. 7. Various phases of rowan flowering and development of berries. The flowers begin to open (A-B), time of flowering (C), and all flowers have opened (D). The berries have ripened between the stages E and F. Photos: Eeva Kotilainen.

Berries ripe and abundance of berries. BBCH86.

Berries ripe is that point in time when more than half of the berries on each tree have turned orange in colour.

This is also the time to estimate the abundance of berries at the observation location and in its surroundings. This needs to be marked on the observation form alongside the berry production date using the following scale:

1. *No berries.* There are no berries at all or there are very few berries in individual clusters of berries.
2. *Berry production poor.* The trees have berries here and there, and they are small in number.
3. *Berry production middling.* The trees have berries in general and there is fair number of them.
4. *Berry production abundant.* The trees have berries in general and there is an abundance of them.
5. *Berry production very abundant.* There is such a lot of berries that some of the branches are bent down by the weight of the berries.

Fig. 8. Various phenophases of rowan. Flowering (A), Berries ripe (B), leaf colouring (C), and entire tree coloured (D). Photos: Eeva Kotilainen.

4.5 Bird-cherry – *Prunus padus* L.

Characteristics

The Bird-cherry is bush-like or tree-like in form. The leaves are oval and round or heart-shaped at the base, serrated along the edges, and shiny. The inflorescence is a multi-flowered raceme and the petals are white. The berry is black.

Selecting the location and the trees

The observations are made of five Bird-cherries as tree-specific observations. The trees should be selected from an open area, along the forest or field edge, from a yard area, or some other suitable area. The observation trees should preferably be tree-like rather than bush-like. The trees need to be marked and numbered. If five trees cannot be found in the vicinity of the observation place, the observations can be confined to those trees that are in the area.

Phenomena to be monitored

Flowering. BBCH63.

This is the point in time when more than half of the flowers on each observation tree have opened up.

Berries ripe. BBCH86.

This is the point in time when more than half of the berries on each observation tree are ripe.

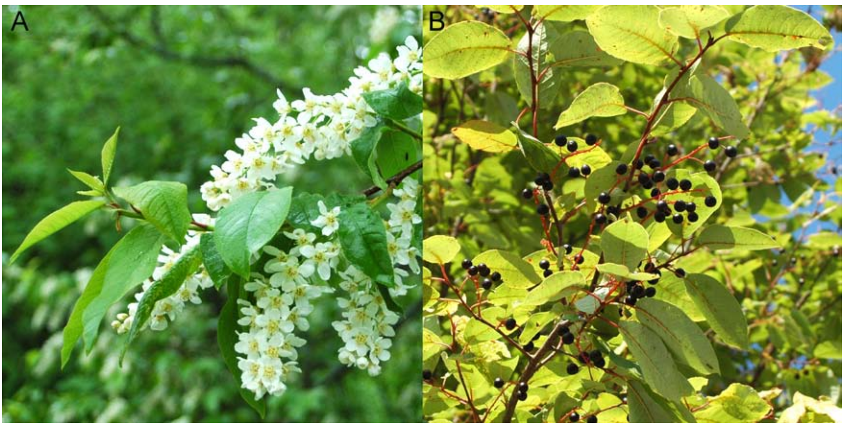


Fig. 9. Flowering and ripening of berries of Bird-cherry. Flowering (A) and the ripening of berries has just been passed (B). Photos: Eeva Kotilainen.

4.6 Grey Alder – *Alnus incana* L.

Characteristics

Grey Alder is a slim-boled tree or a large bush, whose bark is smooth. The young twigs and buds are hairy. The leaf blade is oval or roundish and more sharp-pointed than on the Black Alder. The edge of the leaf is double-serrated and the corners between the veins on the under surface of the leaves are bald. The "cones" are sessile.

Selecting the location and the trees

The observations are made of five Grey Alders as tree-specific observations. The trees are selected from within the observation stand or a suitable nearby place. The trees need to be marked and numbered.

Phenomena to be monitored

Onset of male flowering. BBCH61.

Time when the first trees in sunny places release pollen. This can be tested by tapping the branches with a stick or a pole.

Fig. 10. Male flowering of Grey Alder. Photo: Eeva Kotilainen.

Fig. 11. Male flowering of Grey Alder. Catkins before pollen release (A), during pollen release, (B) and after pollen release (C). Photos: Eeva Kotilainen.

4.7 Scots Pine – *Pinus sylvestris* L.

Characteristics

A broad-crowned conifer. Its needles are stiff, bluish green, and they occur in pairs. The cones are almost sessile, conical in shape and pendant.

Selecting the location and the trees

The trees should be selected from a well-lighted site. The growth observations are made tree-specifically of five numbered young trees, which are about 1.5 metres in height and with normal leaders. The flowering observations are made of five middle-aged pines. Distinguishing the male inflorescences and female inflorescences from each is a fundamental requirement in this observation. If male and female inflorescences are not on the same tree, then a sufficient number of trees needs to be selected to ensure a successful observation.

Phenomena to be monitored

Onset of height growth. BBCH30.

The height growth of Pine begins when the tip of the terminal bud gradually swells and the scales at the tip start to unfurl. The tip of the bud is then lighter in colour (Fig. 12 B).

End of height growth. BBCH39.

Shoot length is measured until no more elongation occurs. The length of the shoot is measured from the base of the bud to the tip of the shoot. The base of the bud is also the point where the new branch whorl is formed.

When growth ceases, the date is marked onto the form. It should be noted that a new terminal bud is formed at the tip of the shoot already before shoot elongation ceases. Sometimes so-called late growth may occur in late summer, but this is not considered to belong to the current year's growth.

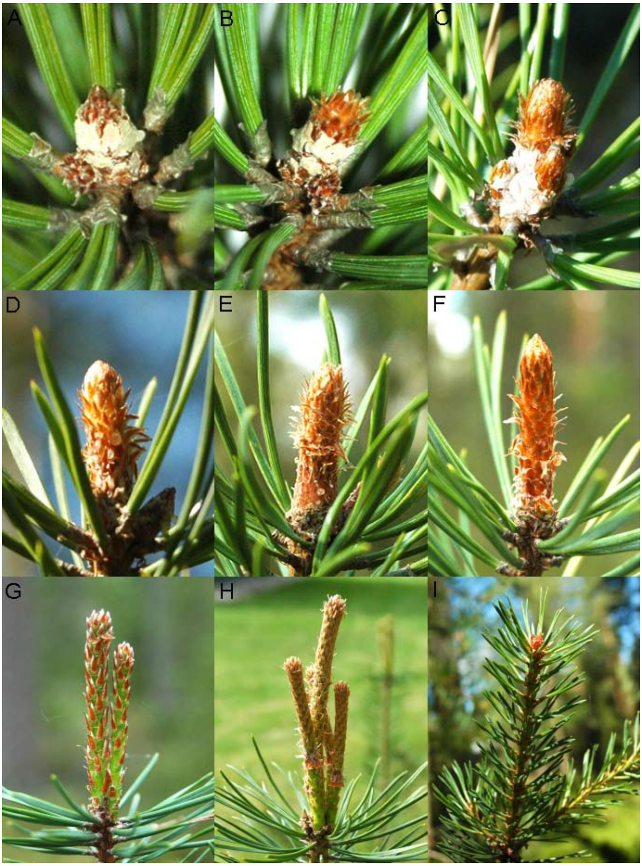


Fig. 12. Height growth of Scots Pine. Bud before onset of growth (A), onset of height growth (B), elongation of the shoot (D-H), and end of height growth (I). Photos: Eeva Kotilainen.

Onset of male flowering. BBCH61.

The point in time when the first trees in sunny places release pollen is marked on the form. This can be tested by tapping the branches with a stick or a pole. The male inflorescences of Scots Pine tend to be most abundant in the lower parts of the crown.

Onset of female flowering. BBCH61.

This is marked on the form when the first observation is made of a female inflorescence that has opened up. The female inflorescences of Scots Pine are concentrated in the top of the crown and binoculars are useful in making this observation.

Female flowering 100%. BBCH63.

The point in time when practically all of the female inflorescences have opened up.

Fig. 13. Flowering of Scots Pine. Male inflorescences before pollen release (A), during pollen release (B), and a female inflorescence (C). Photos: Eeva Kotilainen.

Fig. 14. Male flowering of Scots Pine. Photo: Eeva Kotilainen.

4.8 Norway Spruce – *Picea abies* L.

Characteristics

A conifer with sharp-pointed and angular single needles. The cones are shuttle-like in shape and pendant.

Selecting the location and the trees

The trees are selected from within the observation stand or a suitable nearby place. The growth observations are made tree-specifically of five numbered young trees, which are about 1.5 metres in height and with normal leaders. The flowering observations are made of five middle-aged spruces. Distinguishing the male inflorescences and female inflorescences from each is a fundamental requirement in this observation. If male and female inflorescences are not on the same tree, then a sufficient number of trees needs to be selected to ensure a successful observation.

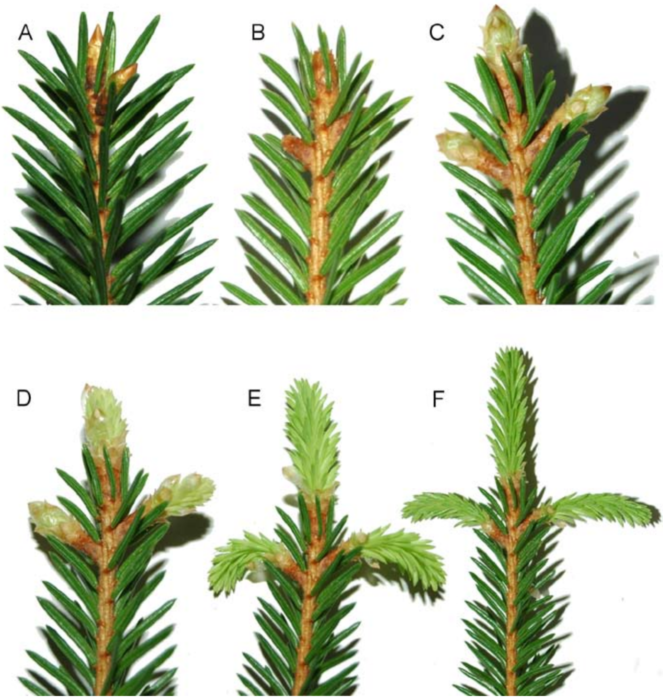


Fig. 15. Onset of height growth in Norway Spruce. Bud before onset of growth (A), onset of height growth (B), and various stages of elongation (C-F). Photos: Eeva Kotilainen.

Phenomena to be monitored

Onset of height growth. BBCH30.

Before the onset of the elongation of the shoot, the terminal bud is sharp and shiny. The height growth begins when terminal bud swells and its scales start to unfurl, then some of the bud scales have already opened up. Light green needles borne by the new shoot begin to appear some time after the onset of elongation.

End of height growth. BBCH39.

Shoot length is measured until no more elongation occurs and this point in time is then marked on the form.

Onset of male flowering. BBCH61.

The point in time when the first trees in sunny places release pollen is marked on the form. This can be tested by tapping the branches with a stick or a pole. The male inflorescences of Norway Spruce tend to be most abundant in the middle and top parts of the crown.

Onset of female flowering. BBCH61.

This is marked on the form when the first observation is made of a female inflorescence that has opened up. Female flowers of Norway Spruce are mostly in the top of the crown.

Female flowering 100%. BBCH63.

The point in time when practically all of the female inflorescences have opened up.

Fig. 16. Flowering of Norway Spruce. Male inflorescences before pollen release (A) and during pollen release (B). Female inflorescence before opening up (C) and after opening up (D). Photos: Eeva Kotilainen.

4.9 Juniper – *Juniperus communis* L.

Characteristics

This is a dioecious conifer with needle-like stiff leaves, which occur three together. The cone is small and spherical, the berries are bluish-black.

Selecting the location and the Juniper bushes

The observations are made of five juniper bushes individually, which have been selected from within the observation stand or from a suitable nearby site.

Phenomena to be monitored

Onset of male flowering. BBCH61.

Flowering is deemed to have begun when the junipers release pollen on a sunny day. This can be verified by tapping the branches of a juniper bush. It should be borne in mind that the male and female inflorescences of junipers are located in different individuals; there are no berries on a juniper bush which produces male inflorescences.

Fig. 17. Flowering of juniper. Male inflorescences before pollen release (A) and during pollen release (B). Photos: Eeva Kotilainen.

4.10 Bilberry – *Vaccinium myrtillus* L.

Characteristics

An upright dwarf shrub, which sheds its leaves for the winter. The leaves are ovate, green and with finely serrated edges. The flowers are solitary, axillary and their corolla is greenish-yellow or reddish in colour. The berry is dark blue.

Selecting the observation site

The observations are made within the observation stand within the same 1 sq. m monitoring squares as when gathering data for berry yield predictions.

Phenomena to be monitored

Flowering. BBCH65.

This is the point in time when more than half of the bilberry flowers within each vegetation monitoring square have opened up.

Berries unripe. BBCH86.

This is the point in time when more than half of the bilberry flowers within each vegetation monitoring square are in the unripe stage. This is when the flowers have been shed and distinct green unripe berries can be seen in these dwarf shrubs.

Berries ripe. BBCH87.

This is the point in time when more than half of the bilberry berries within each vegetation monitoring square are ripe and dark blue in colour.

Fig. 18. Flowering and berry ripening of bilberry. The points in time when the flowers have opened up (A), the berries are still unripe (B), and when the berries are ripe (C). Photos: Eeva Kotilainen.

4.11 Cowberry – *Vaccinium vitis-idaea* L.

Characteristics

An upright dwarf shrub, which is evergreen. The leaves are obovate, obtuse and elongated. The leaves are green from above and inrolled at the margin. The inflorescence is a dense raceme. The corolla is campanulate and white or reddish in colour. The berry is red.

Selecting the observation site

The observations are made within the observation stand within the same 1 sq. m monitoring squares as when gathering data for berry yield predicting.

Phenomena to be monitored

Flowering. BBCH65.

This is the point in time when more than half of the cowberry flowers within a vegetation monitoring square have opened up.

Berries unripe. BBCH86.

This is the point in time when more than half of the berries within each vegetation monitoring square are in the unripe stage. This is when the flowers have been shed and distinct green unripe berries can be seen in these dwarf shrubs.

Berries ripe. BBCH87.

This is the point in time when more than half of the cowberry berries within each vegetation monitoring square are fully ripe and dark red in colour.

Fig. 19. Flowering and berry ripening of cowberry. The points in time when the flowers are still in bud (A), flowering (B), the berries unripe (C), the berries are ripening (D, E), and the berries ripe (F). Photos: Eeva Kotilainen.

5 DAMAGE MONITORING

5.1 Timing of bark beetles' swarming

The timing of bark beetles' swarming is monitored by making observations of boring dust appearing on the surface of spruce and pine logs. Bark beetles swarm in the spring when the air temperature rises high enough. The swarming of shoot borers begins when the air temperature rises above +10 °C, i.e. this usually occurs in mid-April, and the swarming of spruce ambrosia beetles occurs when the temperature rises above +14 °C, i.e. end of April – early May. In northern Finland, swarming occurs about 2-4 weeks later than in southern Finland.

During their swarming period, bark beetles dig in underneath the bark of freshly-felled timber. The beetles attack fresh piles of timber where their entry points are indicated by a variety of boring dust produced by different insect species.

Where possible, it is best to arrange a few piles of freshly-felled pine and spruce pulpwood near the monitoring location for phenological observations. The piles of pine and spruce pulpwood must be far enough away from one another so that bark beetles normally favouring pine timber will not attach piles of spruce or vice versa. The landowner's consent is always needed when setting up the piles of wood! If wood piles cannot be set up for some reason, signs of these insects can be monitored by keeping an eye on the situation in timber storage points along side forest roads. However, then there is always the risk that the timber is hauled away too early.

This form of monitoring involves watching out for the occurrence of boring dust excavated by the insects as they bore into the bark and wood. In the case of spruce, heaps of brown powder is produced by *Ips typographus* and heaps of white dust is produced

Figure 20. A pile of pine and spruce pulpwood set up for monitoring bark beetles. Photos: Eeva Kotilainen.

by *Trypodendron lineatum*. In the case of pine, heaps of brownish powder are produced by pine shoot beetles (*Tomicus* sp.) and heaps of white sawdust are produced by striped ambrosia beetles (*Trypodendron lineatum*). When monitoring, the damage form is used to note down the colour of the heaps of sawdust by marking (-) alongside the observation day if no sawdust heaps are visible, and 1 when they are visible for the first time trees on the pulpwood logs (separately for pine and spruce stacks).

Figure 21. Ips typographus' coarser brown dust and the finer brown dust produced by Pityogenes chalcographus in spruce. Photos: Antti Pouttu.

Figure 22. Brownish dust produced by shoot borers in pine (left) and white dust produced by striped ambrosia beetles (right). Photos: Antti Pouttu.

5.2 Monitoring the most common damages affecting trees

Location and marking of damage on the form: The purpose is to monitor the occurrence of damages and their changes during the observation season. Only new cases of damage are monitored. The occurrence of damage is monitored in those forest stands where the phenological observations are made and along the way leading to the observation locations.

The foremost things to note are the symptoms of damage as early as possible when they begin to appear. The occurrence of each damage in the phenological observation stand will be marked on each observation day using the following scale:

0 = No damage visible

1 = Slight damage occurs (only just visible, in one or few trees)

2 = Damage occurs moderately or in abundance

Damage observations are made always in connection with phenological observations. The occurrence of damage is noted on the damage observation form using the numbering of the above scale.

At the end of the observation season the forms are to be sent by fax or by mail to Metla's Muhos unit addressed to Jorma Pasanen (fax: 010 211 3701; address: Metla, Muhoksen toimintayksikkö, Kirkkosaarentie 7, 91500 Muhos).

Damage forms to be monitored

Scleroderris canker, caused by *Gremmeniella abietina*

The Scleroderris canker occurs in pines of all ages and sometimes in the spruce understoreys of pine stands. However, its worst damage occurs in young pine stands. Usually, the Scleroderris canker kills shoots only from in the lower part of the canopy, but with time it can spread into the entire canopy and can kill entire trees. The symptoms of Scleroderris canker are the brownish discoloration of the most recent set of needles in May, starting from the needle bases (the needles come off easily), the dying of terminal buds, the occurrence of cankers on branches, and the yellow-greenish colour.

Only fresh occurrence of Scleroderris canker during the observation summer is monitored (i.e. the brownish discoloration of the shoots starting in June and the shedding of needles from infected shoots in the late summer).

Figure 23. Pine shoot in June infected by Scleroderris canker. Note: bud dead as well. Photo: Seppo Nevalainen.

Figure 24. Scleroderris canker on pine; fresh infection shows as shoots having turned brown (left). Scleroderris canker on young pine in August – brown needles partly shed from infected shoots (right). Photos: Seppo Nevalainen.

Spruce needle rust, caused by *Chrysomyxa ledi*

Spruce needle rust (with Ledum palustre as the intermediate host) occurs in eastern and northern Finland where *Ledum palustre* (Labrador Tea) also grows on upland mineral soil sites. There is great variation in its occurrence from year to year. Aecia are formed in the infected needles of the newest shoots during July at this stage that these needles turn yellow or appear orange-yellow in colour due to the abundance of released aecidiospores. Infected needles are shed at the end of August. This rust does not kill the infected shoots.

The yellowing of the new set of needles on spruce trees is monitored.

Figure 25. A spruce branch infected by spruce needle rust (with Ledum palustre as the intermediate host) in June. Note: only the new set of needles is infected. Photo: Seppo Nevalainen.

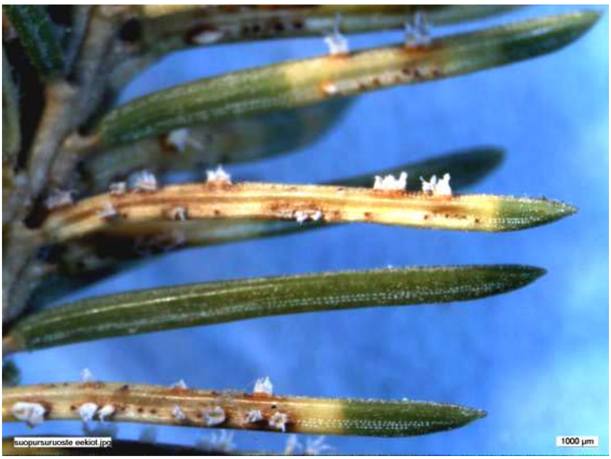


Figure 26. Spruce needle rust (with Ledum palustre as the intermediate host), close-up of aecia on new needles. Photo: Seppo Nevalainen.

Birch rust, caused by *Melampsoridium betulinum*

There is great variability in the occurrence of birch rust from year to year and by region due to weather conditions and the genetic properties of trees. In some years, birch rust can cause the yellowing the foliage of birches already at the end of July – early August. When the rust attacks the leaves, yellow spots and orange-yellow spores appear on the underside of the leaves, at first only on some the leaves.

The premature yellowing of birch foliage by the rust is monitored

Figure 27. Birch rust infection as seen from a distance (left), and a close-up of infected leaves (right) turned yellowed by birch rust. Photos: Seppo Nevalainen.

Pine sawflies: European pine sawfly – *Neodiprion sertifer***;**
Common pine sawfly – *Diprion pini*

Several pine sawflies occur in Finland, but significant damage is caused only by the European pine sawfly and the Common pine sawfly. In southern Finland, the larvae of the European pine sawfly generally hatch in early June from eggs that have over-wintered in pine needles while in northern Finland hatching occurs a few weeks later. The larvae of the European pine sawfly feed only on the older needle sets, but if there are a lot of larvae, they may feed on part of the new set of needles. Usually, only a short stump remains of the needles. These insects cease to feed on needles in early July in southern Finland, but in northern Finland feeding often goes on until August. The damage caused by the European pine sawfly affects forests of all ages, and is most common on dry upland soils and in stands growing in pine mires. Scots pine is targeted by several conifer-favouring sawfly species.

The larvae of the Common pine sawfly hatch in late June – early July. They feed on pine needles until September. The larvae of this species also consume the new set of needles. Cases of large-scale damage caused by the Common pine sawfly are rarer than those caused by the European pine sawfly.

Monitoring focuses on the European pine sawfly's larvae feeding on pine needles. Note! This damage may be difficult to notice in its early stage!

Figure 28. Larvae of the European pine sawfly emerging in southern Finland in early June (left). Following feeding by the larvae, pine needles have become curled in late June (centre). Big European pine sawfly larvae (right). Photos: Antti Pouttu.

Figure 29. Aftermath of feeding by the European pine sawfly. Photo: Antti Pouttu.

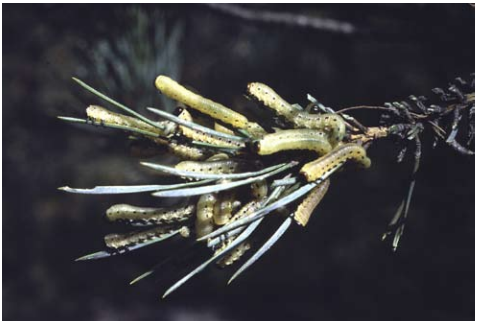


Figure 30. Big larvae of the Common pine sawfly (left) and aftermath of feeding by this insect species (right). Photos: Antti Pouttu.

Frost damage on young Norway spruce

The new shoots of Norway spruce are very susceptible to frost damage in early summer. The new shoots are injured if the air temperature drops below –3°C. Frost damage is manifested in the new shoots as wilting (= the shoots begin to droop) and they turn brown.

The occurrence of frost damage in young Norway spruces is monitored in early summer.

Figure 31. Figure 30. Severe frost damage on Norway Spruce. Photo: Metinfo Forest Damage Information Service.

For more information on the various damage forms, please contact

- Seppo Nevalainen, tel. 010 211 3036; seppo.nevalainen@metla.fi
- Antti Pouttu, tel. 010 211 2576; antti.pouttu@metla.fi

5.3 Damage observation form

Damage monitoring 2007

Observation site : **Site no :** **Month :**

Observer : **Tel:**

Observations of damage are always made in connection with phenological observations. If the phenomenon to be monitored has not yet occurred, indicate this by inserting the dash character (-) and if damage is visible, indicate this by entering number codes 1 - 2. When monitoring the timing of bark beetles' swarming, indicate (-) on the line of right colour alongside the observation day if no boring dust is visible, and 1 when it is visible for the first time.

Scleroderris canker	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
- damage																															
Spruce needle rust	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
- damage																															
Birch rust	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
- damage																															
Pine sawflies	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
- damage																															
Frost damage on young Norway spruce	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
- damage																															
Bark beetles' swarming																															
Pine:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
- White boring dust																															
- Brownish boring dust																															
Spruce:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
- White boring dust																															
- Brown boring dust																															

Damage
- = No damage visible
1 = Slight damage occurs (only just visible, in one or few trees)
2 = Damage occurs moderately or in abundance

Bark beetles' swarming
- = No occurrence
1 = Occurrence of boring dust

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