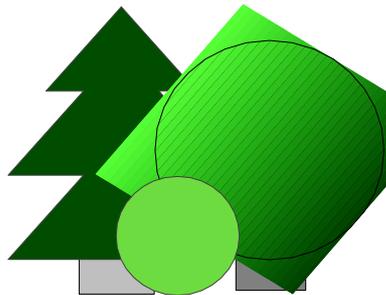

**INTERNATIONAL PHENOLOGICAL GARDENS
IN EUROPE
(IPG)**



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Phenology

Phenology is the study of the seasonal timing of life cycle events in relation to environmental factors. Many phenological spring phases in mid- and high latitudes such as the dates of first flowering and beginning of leafing are driven by temperature. Therefore phenological observations are one of the most sensitive indicators of climate impacts on vegetation in these latitudes. They can help for a better understanding of interactions between atmosphere and biosphere.

It is very probably that the trends of phenological phases will increase in the future due to a global warming. This will have considerable consequences for agriculture, forestry, biodiversity and human health.

International Phenological Gardens in Europe

The International Phenological Gardens (IPG) are a unique network in Europe for the observation of plants. In all gardens genetically identical trees and shrubs are planted in order to make large-scale comparisons among the timing of different developmental stages of plants (phenological phases). During the last 40 years (1959-1998) more than 65.000 observations of 23 plant species with different varieties and provenances have been collected.

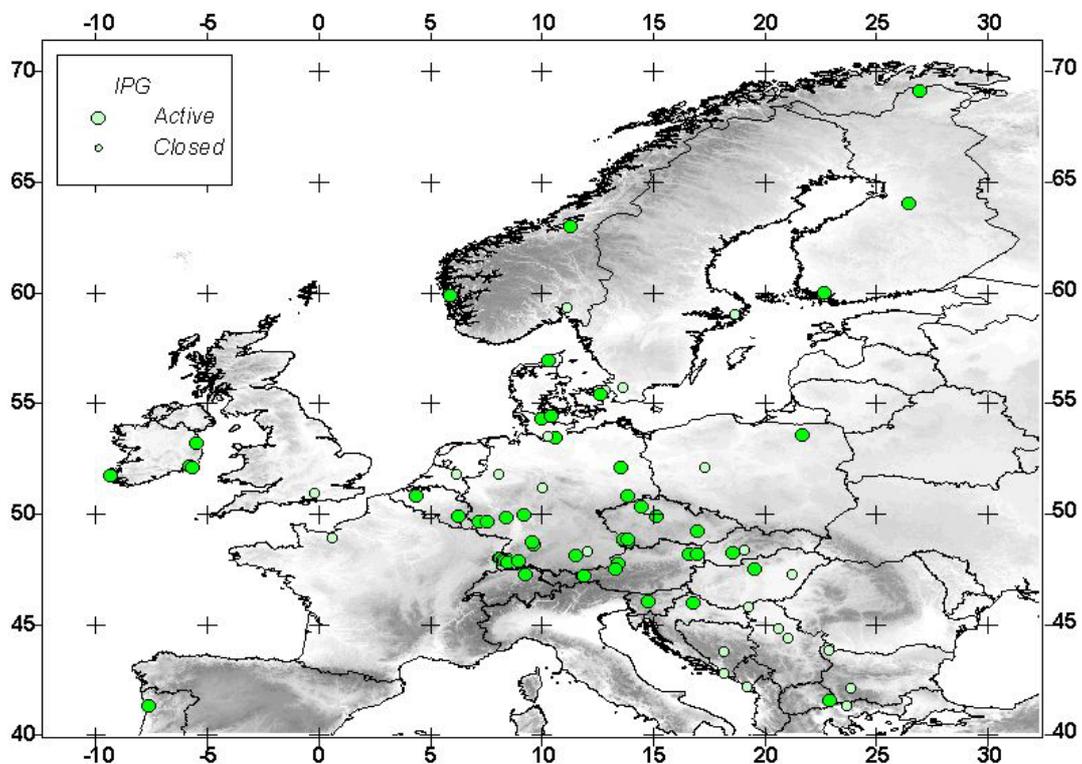


Fig. 1: The network of the International Phenological Gardens (status 2002)

History

The establishing of an international phenological observation programme was decided at the first meeting of the “Agrometeorological Commission” of the WMO in 1953. It was in 1957 when *F. Schnelle* and *E. Volkert* founded the International Phenological Gardens. After several years of preparation, in 1959 the first phenological observations started at Offenbach a.M. (IPG 24). The number of IPGs increased in the following years up to more than 50 IPGs today.

The co-ordination of the network changed several times. From 1973 to 1977 the net was co-ordinated by the Institute of Biometeorology of the University in Munich. Between 1978 and 1995 the German Weather Service was responsible for the gardens.

When in 1996 the Humboldt-University at Berlin took on the coordination and management of the IPGs, 47 IPGs belonged to the network. One of the first tasks of the new management was to find a new parent-garden. In 1997 the young plants were moved from the old parent garden in Hamburg-Grosshansdorf (Federal Research Centre for Forestry and Forest Products) to Ahrensburg nearby Hamburg, where a new site was established at the JORDSAND association. In 2001, the Bavarian State Institute of Forestry took over the propagation of selected species from the IPG programme.

The geographical distribution of the IPGs is shown in figure 1. All active IPGs together with already closed IPGs, which have done observations for more than 10 years, can be seen. The actual network of the International Phenological Gardens ranges across 28 latitudes from Scandinavia to Macedonia and across 37 longitudes from Ireland to Finland in the North and from Portugal to Macedonia in the South.

Use of Phenological Data

The idea of the International Phenological Gardens was to make large-scale and standardized phenological observations. Therefore all IPGs are situated in similar surroundings (mainly plain surface with meadows and some trees), they have a detailed observation-guide and they are professionally looked after by the staff of the institutes, botanical gardens etc. In order to eliminate the hereditary variability, cloned species of all trees and shrubs have been planted in the IPGs. Therefore it was necessary to establish a parent garden doing the vegetative propagation, breeding, and dispatch.

The use of phenological observations is manifold. For scientific investigations, for planning and consulting tasks as well as in daily practice phenological data are required. Examples for the application of phenological data are investigations of the impact of climate changes on plants, the calibration of remotely sensed data, the use of these data in yield-, growth- or hydrological models, the determination of regions with high frost-risks for fruit-tree growing and the monitoring of environmental changes. Since the end of the 1980s the demand for phenological observations increased substantially. Mainly, the rise in air temperature in the previous decades and the clear phenological response by plants led to this increased interest in phenological data.

Perspectives

One task in the next years will be to replace inveterate and ill plants in the phenological gardens. For this the vegetative propagation of plants was intensified. Unfortunately a few plants are extraordinary difficult to propagate, so that some changes in the observation programme were necessary. For this reason now we will concentrate on a new “Standard-Observation-Programme” which includes about 18 plant species.

Also new gardens must be established to fill the gaps in the IPG-network as well as to expand the network to East- and South-Europe.

In spring 2001 two new IPGs were established in Czech Republic and another two IPGs in Germany (Schleswig, Maasholm). At the same time the first “link gardens” were laid out in Germany (Schleswig, Deuselbach, Tharandt). These are gardens in which both the IPG and the GPM¹⁾ assortments are planted. The link between the IPG and GPM programme will continue. In 2003 some new IPGs will be established, for example the first IPG in Spain (Cordoba).

Instructions to Establish an IPG

1. Selection of the site

- it should be typical for the region,
- it should not have any local climate anomalies,
- a climate station should be in the surrounding,
- the site should have no extreme soil-types,
- surrounding with a loose, open formation of plants and partly protected sites like parks or botanical gardens are recommended.

2. Arrangement of the plants

- the geometrical form is unimportant (e.g. arrangement in stripes, fields or several groups are possible),
- the garden must be arranged in a uniform topography,
- same species should be planted in groups,

The distances between the plants of a group are depending on the final height of the plants:

Height of plant (m)	Distance between plants (m)
> 40	6 – 8
> 30 and < 40	5 – 6
> 15 and < 30	4 – 5
< 15	3 – 4

- distance between groups: 5 - 8 m,
- highest plants must be planted in the north of the area, smaller plants should be planted on the southern side (shadowing should be avoided),

¹⁾ www.dow.wau.nl/msa/gpm

- plants should be labelled with their names and IPG-plant number.

3. Required area

The required space depends on the distances between the plants. The total required area results from the sum of the required area of all plants plus a surplus of about 15 percent.

Distance between plants (m)	Required area per plant (m ²)
8	50
7	38
6	28
5	20
4	13
3	7

4. Plants

The original IPG programme, which was fixed in 1957 by *Schnelle* and *Volkert*, the founders of the IPG network, included 23 plant species. Because, some plant species are very difficult to propagate we decided to concentrate now on a subset of plants which will be planted at all new IPGs. Some changes in the programme are still possible.

The new Standard-Observation-Programme consists of 18 plant species, listed below:

No.	IPG-Plant-No.	Plant species	Plants available in
01	1 1 1	<i>Larix decidua</i>	?
02	1 2 2	<i>Picea abies</i> (late)	2003, 2004 new plants
03	1 3 1	<i>Pinus sylvestris</i>	?
04	2 1 1	<i>Betula pubescens</i>	2003
05	2 2 1	<i>Fagus sylvatica</i> (Hardeggen, Germany)	2004 or later
06	2 4 1	<i>Prunus avium</i> (Bov.)	2004 or later
07	2 5 6	<i>Quercus robur</i> (Wolfgang, Germany)	2004 or later
08	2 6 1	<i>Robinia pseudoacacia</i> (USA)	2004 or later
09	2 7 1	<i>Sorbus aucuparia</i>	2004 or later
10	2 8 1	<i>Tilia cordata</i>	2003
11	3 1 1	<i>Ribes alpinum</i>	2003, 2004 new plants
12	3 2 3	<i>Salix acutifolia</i>	2003
13	3 2 4	<i>Salix smithiana</i>	2003
14	3 2 6	<i>Salix viminalis</i>	2003
15	3 3 1	<i>Sambucus nigra</i>	2003, 2004 new plants
16	4 1 1	<i>Corylus avellana</i>	2003
17	4 2 1	<i>Forsythia suspensa</i>	2003
18	4 3 1	<i>Syringa vulgaris</i>	2003

5. Observed phenological phases

In order to obtain comparable data from the observations in the International Phenological Gardens, an agreement on the selection and on the definition of the phenological phases is necessary.

All IPGs are asked to observe following phenological phases:

IPG-No.	Plant species		Phenological Phases							
	Botanical name	English name	BO	M	B	AB	J	F	LV	BF
111	<i>Larix decidua</i>	European larch	x		x	x			x	x
122	<i>Picea abies (late)</i>	Norway spruce		x	x	x				
131	<i>Pinus silvestris</i>	Scotch pine, Fir		x	x	x				
211	<i>Betula pubescens</i>	White birch,	x		x	x			x	x
221	<i>Fagus sylvatica 'H'</i>	Common beech	x		x	x		x	x	x
241	<i>Prunus avium 'B'</i>	Wild cherry	x		x	x		x	x	x
256	<i>Qercus robur 'W'</i>	Common oak	x		x	x	x	x	x	x
261	<i>Robinia pseudoacacia</i>	Common robinia	x		x	x		x	x	x
271	<i>Sorbus aucuparia</i>	Mountain ash	x		x	x	x	x	x	x
281	<i>Tilia cordata</i>	Small-leaved lime	x		x	x		x	x	x
311	<i>Ribes alpinum</i>	Alpine currant	x		x	x	x	x	x	x
323	<i>Salix acutifolia</i>	Pussy willow	x		x	x	x		x	x
324	<i>Salix smithiana</i>	Smith's willow	x		x	x			x	x
326	<i>Salix viminalis</i>	Basket willow	x		x	x			x	x
331	<i>Sambucus nigra</i>	Common elder	x		x	x		x	x	x
411	<i>Corylus avellana</i>	Common Hazel	x		x	x		x	x	x
421	<i>Forsythia suspensa</i>	Forsythia	x		x	x			x	x
431	<i>Syringa vulgaris</i>	Common lilac	x		x	x			x	x

BO Beginning of leaf unfolding

M May shoot

B Beginning of flowering

J St. John's sprouts

F First ripe fruits

LV Autumn colouring

BF Leaf fall

The most important precondition to obtain comparable observation values is the exact definition of the phenological phases which are observed. For this reason all IPG receive a Phenological Observation Guide.

6. Observations

Once a year, usually in December, the observers in the gardens receive the observation sheet for the following year. The observers are asked to do the phenological observations in its garden, to fill out the observation sheet and to send it back when all phenophases are observed. The data are checked and stored in the IPG database at the Humboldt-University. The observation results are published once a year in the newsletter "Arboreta Phaenologica". All participating gardens receive this newsletter free of charge. The data in the database are available for all participating gardens/institutes, which do the phenological observations continuously. Please, note that this is a long-term observation programme. If you are interested in phenological observations and if you decide to join this European network, you should be prepared to do phenological observations for the next decades.

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Further information:

<http://www.agrar.hu-berlin.de/pflanzenbau/agrarmet/ipg.html>