THE RHODODENDRON PHENOLOGY PROJECT at Royal Botanic Garden Edinburgh (RBGE)

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1. Summary

This project, piloted in 2007 and formally begun in 2008, monitors the flowering curves, leafing and capsule-dehiscence of a wide variety of rhododendron species in order to:

- detect climate-change impacts on rhododendrons
- determine the phenological variability of rhododendrons
- identify any phenologically functional groupings

The data collected in this project, and in a pre-existing RBGE phenological project, already indicate that:

- rhododendrons display unusually high variations in their annual flowering and leafing patterns, not only between species but also within species
- their flowering dates are strongly influenced by the air temperatures in the weeks immediately before flowering
- for *R. ponticum*, springtime warming of 1ºC causes the date of flowering to advance by about 12.5 days

2. Method

Each week since April 2007, members of the Rhododendron Phenology Team (all volunteers) have followed a set route around the Inverleith site, observing 141 accessions that represent 47 species. The stages of flowering and leafing of each accession are recorded on a nine- and three-point scale respectively (see Fig. 1, below, for four examples). Daily RBGE meteorological observations made on site will be used in conjunction with the team's observations to investigate the potential effects of climate change on rhododendron phenology. Table 1 shows the range of rhododendron taxa covered by the project.

Table 1 The taxonomic scope of the Rhododendron Phenology Project

Subgenus	Section	Subsection	Species monitored	No. of plants monitored
Hymenanthes	Ponticum	Fortunea	*R. decorum*	4
			R. calophytum	3
			R. praevernum	4
		Auriculata	*R. auriculatum*	1
		Grandia	*R. macabeanum*	3
		Falconera		0
		Williamsiana		0
		Campylocarpa		0
		Maculifera	*R. strigillosum*	5
			R. 'annwheiense'	3
		Selensia		0
		Glischra		0
		Venatora		0
		Irrorata	*R. irroratum*	2
			R. anthosphaerum	3
		Pontica	*R. degronianum* ssp *yakushimanum*	4
			R. ponticum	4
		Argyrophylla		0
		Arborea	*R. lanigerum*	3
			R. arboreum	7
		Taliensia	*R. adenogynum*	3
		Fulva		0
		Lanata		0
		Campanulata	*R. campanulatum*	3
			R. wallichii	3
		Griersoniana		0
		Parishia		0
		Barbata	*R. barbatum*	3
		Neriiflora	*R. forrestii*	3
			R. neriiflorum	3
		Fulgensia		0
		Thomsonia	*R. meddianum*	1
Tsutsusi	Tsutsusi			0
	Brachycalyx		*R. reticulatum*	3
			R. wadanum	4
Pentanthera	Rhodora		*R. canadense*	3
	Sciadorhodion		*R. schlippenbachii*	3
	Viscidula			0
	Pentanthera	Pentanthera	*R. luteum*	3
			R. calendulaceum	3
		Sinensia		0
Therorhodion				0
Azaleastrum	Azaleastrum		*R. leptothrium*	1
	Choniastrum			0
Candidastrum				0
Mumeazalea			*R. semibarbatum*	3
Rhododendron	Rhododendron	Edgworthia		0
		Maddenia	*R. fletcherianum*	1
			R. lilliflorum	1
			R. 'praecox'	3
		Moupinensia		0
		Monantha		0
		Triflora	*R. siderophyllum*	3
			R. yunnanense	3
			R. augustinii	3
			R. lutescens	3
		Scabrifolia	*R. racemosum*	3
		Heliolepida		0
		Carolinina		0
		Lapponica	*R. hippophaeoides*	5
			R. russatum	3
		Rhododendron	*R. ferrugineum*	3
		Rhodorastra	*R. dauricum*	2
			R. mucronulatum	4
		Saluenensia	*R. calostrotum*	3
		Fragariflora		0
		Uniflora		0
		Cinnabarina	*R. cinnabarinum* ssp *xanthocodon*	5
		Tephropepla		0
		Virgata		0
		Micrantha		0
		Boothia		0
		Camelliiflora		0
		Glauca		0
		Campylogyna		0
		Genestierianа		0
		Lepidota	*R. lepidotum*	3
		Baileya		0
		Trichoclada		0
		Afoharica		0
		Ledum	*R. tomentosum*	3
	Pogonanthum		*R. collettianum*	1
			R. trichostomum	1

3. Initial findings

1. Different species flower at very different times of the year. Indeed at RBGE at least one species can be found in flower in any week of the year.

2. Rhododendrons have a well-defined main flowering curve (Figs. 2 and 3) with, in some cases, a second flowering later in the year (see *R. racemosum* 1932.1028 in Fig. 2 [second flowering only shown] and *R. ferrugineum,* Fig. 3, middle panel).

3. There can be considerable variation in phenological behaviour between members of the same species, even when growing in the same bed (and therefore environment) (Fig. 3). Individual plants within a species (e.g. *R. ferrugineum)* display peak flowering dates that differ by up to 14 days (Fig. 3). However *R.reticulatum* (not shown here) provides an even more striking example of phenological variability. Three co-accessions (1975.2245 B) are being monitored. One individual flowers five weeks before leafing while another flowers four weeks after leafing, a phenological difference of 63 days. The question arises: what advantages does such variation confer on *R. reticulatum* and is there even greater variation in the wild?

4. The first flowering dates (FFDs) in the last five years for three *R. ponticum* accessions show a striking correlation with the average temperature for April-May, indicating that the species is sensitive to temperature changes (Fig. 4). From the two graphs in Fig. 4 the sensitivity is seen to cause about 12.5 days' advancement of the FFD for every 1ºC rise in temperature.

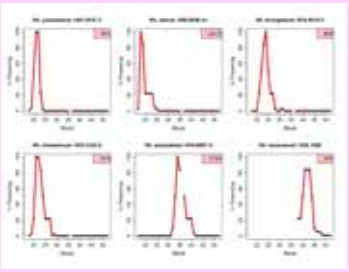

Fig. 2 Flowering curves, of different shapes, for six species, with peak flowering dates between May and October

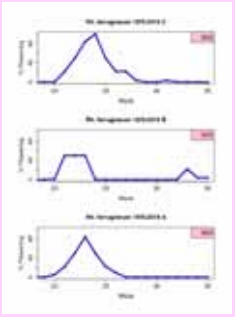

Fig. 3 Three *R. ferrugineum* co-accessions with strongly contrasting flowering curves

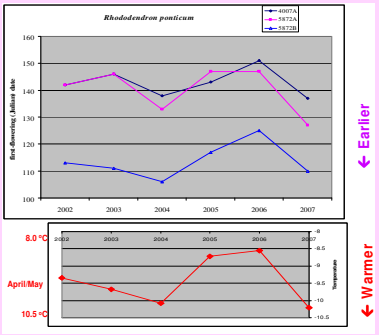

Fig. 4 FFDs for three *R. ponticum* accessions in 2002 to 2007 (blue, black and pink lines). Average April-May temperatures (red). Note: early flowering in the warm years, 2004 and 2007, and late flowering in 2006.

4. The future

Rhododendrons are being affected adversely by damage to their environment. In the Sikkim Himalaya fragile ecological systems are being threatened by a rising human population and its demands for fuel, farmland, civil engineering works and increased tourism (Singh et al., 2003. *Current Science*, **85**, 602-606). Such developments place rhododendron species under considerable pressure.

Another threat is climate change, to which plant communities can respond in three ways: through plasticity, micro-evolution and migration or change of range. Our results indicate that rhododendrons have high plasticity (about 12.5 days/ºC) and high phenological variability (up to 63 days). Thus they may be able to produce viable seed under a wider range of climatic conditions, perhaps enabling them to adapt to climate change. On the other hand individual rhododendron clones can be long-lived (>100 yrs) and slow to colonise new regions (Pornon and Doche, 1995. *J. Veg. Sci.*, **6**, 265-272). Consequently the future for natural rhododendron communities remains uncertain without active and well-planned conservation measures.

Fig. 1a Members of the team at work

Fig. 1b *R. 'praecox'*, past its peak flowering, with ⅓ to ⅔ of flowers "gone over" (recorded as "2↓")

Fig. 1c *R. mucronulatum* at peak flowering (recorded as "P")

Fig. 1d Leaf-buds extending (recorded as "E")

Fig. 1e Leaf-tips diverging (recorded as "D")