The Scottish Rhododendron Society

Yearbook 2009
Proceedings of the 2008 Conference held at RBGE

Editorial

As I put the finishing touches to this publication, the Scottish Rhododendron Society's silver jubilee celebrations at the Royal Botanic Garden, Edinburgh in 2008 seem to be a distant memory. In assembling these Conference Proceedings, I am reminded what an important occasion it was. So many learned people from many aspects of horticulture, all gathered together in the one place.

This book is therefore the culmination of papers submitted by speakers who entertained and educated us on the occasion. It takes the place of the usual SRS Yearbook for 2009. It has been a huge undertaking for me, and appears about nine months later than originally anticipated. I had to put it on hold for a while to catch up with other things. But good things are worth waiting for, and this is one of them.

Sadly, one contributor, Dr Mike Robinson, passed away before I could receive pictures to illustrate his paper.

There is a huge spread of different subjects dealt with. There really is something for everyone. My enormous thanks to all the contributors. I hope you all enjoy reading this, and reliving May 2008.

The Scottish Rhododendron Society is proud to present:

The Proceedings of the 2008 Conference
Hosted by, and in conjunction with
The Royal Botanic Garden, Edinburgh

John Roy

Cover Pictures: Front:
Top: *Rhododendron imperator* by Ken Cox. See page 163
Middle: *Rhododendron valentiniodes* by Steve Hootman. See page 5
Bottom: *Rhododendron racemosum* for miles on the Zhongdian plateau. By Peter Cox & Peter Hutchison. See page 182
Back:
Top: *Rhododendron* 'Lem's Cameo' by David Millais. See page 190
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Introduction

Professor Stephen Blackmore SHM, FRSE
Regius Keeper and Director,
Royal Botanic Garden Edinburgh

Professor Stephen Blackmore addressing delegates at Edinburgh City Chambers

In May 2008 the Scottish Rhododendron Society and the Royal Botanic Garden Edinburgh hosted a highly successful international conference “Rhododendron 2008” celebrating “50 years of modern day Exploration, Conservation and Hybridising”. Delegates from more than twenty countries around the world came together to share their passion and enthusiasm for what is surely one of the most remarkable of flowering plant genera. With over 1000 species, ranging from small shrubs to large trees known from the wild, and an even greater variety of cultivated hybrids, *Rhododendron* is one of the treasures of plant biodiversity.

Little wonder then that exploration for new rhododendrons continues today as conference presentations on Arunachal Pradesh, Tibet and Yunnan proved.

There were presentations by the grand masters of wild collecting: George Argent on Vireya Rhododendrons, and the “Two Peters”, Peter Cox and Peter Hutchison, on their 40 years of expeditions. The keynote lecture by the Two Peters and launch of their wonderfully readable and beautifully illustrated book “Seeds of Adventure” was one of the highlights of the conference. In recent years the exploration of rhododendrons has been transformed from a one way flow to international partnerships. It was a pleasure to see rhododendron experts from China taking part as active participants in a conference in Scotland.

Today, growing attention is paid to the conservation of wild populations of rhododendrons around the world. Plans for a Red Data Book to catalogue the threatened species of rhododendron were announced during the conference. But as presentations in the Scientific and Technical Session revealed, the identity of the plants themselves is complex. Recent studies using molecular biological techniques to compare DNA sequences are gradually unravelling the complex history of hybridisation that has been such a force in the evolutionary diversification of rhododendrons. Their open breeding system makes them perfect candidates for selection and hybridisation. The conference heard exciting presentations on the continuing development of evergreen azaleas and on hybrids developed in Germany and the United States.

An exhibition of rhododendrons in art, visits to gardens across Scotland and a magnificent conference dinner rounded out the programme of this memorable conference. With old friendships renewed and new ones established it is clear that the rhododendron community retains its vitality and continues from strength to strength.

Delegates enjoying the show exhibits at the RBGE

From Bhutan to Vietnam: *Rhododendron* Introductions in the Second Golden Age of Plant Exploration (From 1980 to the present)

Steve Hootman
Rhododendron Species Botanical Garden

As we are all aware, there has been a tremendous amount of new plant material collected in the Sino-Himalayan region over the past 25 years or so. Within the genus *Rhododendron* alone, several dozen taxa, many of them completely unknown to science, have been introduced either as herbarium and/or living material. With the opening of China, portions of Tibet, northeastern India (specifically the floristically rich states of Arunachal Pradesh & Nagaland) and Vietnam to foreign tourists and scientists, a whole new range of species has made its way into scientific collections and our own gardens. Although a great many of these new introductions have come from the classic plant-hunting region of southwestern China and the adjacent eastern Himalaya, many others have been collected in the vast, and, until fairly recently, relatively unexplored "outlying" areas such as the mountains of central China and northern Vietnam. In addition to the great variety of new material, including some species that have yet to be described, we are now blessed with outstanding new forms of many well-known species including such stalwarts as *R. strigillosum*, *R. sinogrande* and *R. irroratum*.

I have arranged this treatise more or less in the same taxonomic/alphabetic order as the subsections are arranged in "*The Encyclopedia of Rhododendron Species*".

Section Choniastrum:

R. hancockii – This has large and fragrant, openly funnel-shaped white flowers with a strong yellow-orange blotch in the throat. Probably not hardy in most climates but should have good tolerance for heat. S Yunnan.

Subsection Argyrophylla:

R. argyrophyllum* ssp. *omeiense – First introduced in 1980, very similar to ssp. *argyrophyllum* but with smaller leaves. Of little merit in the garden. Central Sichuan.

R. coeloneuron – Very large and vigorous shrubs to small trees. The attractive bullate foliage has a dense rufous-brownish indumentum on the lower surface, “rough” green on the upper. The flowers range from white flushed pink to purplish with red-purple flecks, very similar to *R. denudatum* but with a looser, rather lax inflorescence and a narrower, more bullate and convex leaf. S Sichuan, N Guizhou & NE Yunnan.

R. denudatum – This is another very large growing and vigorous new introduction. It is similar to both *R. coeloneuron* and *R. floribundum* and is distinguished from the former in is larger and wider, flattened, rugose foliage and pale lavender to deep rose-lavender flowers with purple spots and a prominent blotch in a much tighter and rounded inflorescence. It is distinguished from the latter by its paler flowers and darker indumentum, the leaves are shiny and dark green compared with the matte green of *R. floribundum*. NE Yunnan, SW Sichuan & W Guizhou.

R*. *haofui – This unusual and still quite rare species has long hanging leaves and pale pink flowers. It differs from other subsect. Argyrophylla in its 18-20 stamens (vs. 10-15). It is difficult to grow well. Guizhou.

R. longipes – Very similar to the species *R. argyrophyllum* but with pale pink to purple flowers, and with narrower leaves and a long narrow apex. These have a thin brownish indumentum beneath. NE Yunnan & Sichuan.

Subsection Falconera:

R. heatheriae – This recently described new species is very close and similar to *R. arizelum* but with a tapering leaf and winged petiole. SE Tibet and adjacent Arunachal Pradesh.

left
Rhododendron sinofalconeri
Picture Steve Hootman

opposite page
Rhododendron species nova
Arunachal Pradesh
Picture John Roy

***R*. *hodgsonii* affinity** – From a single known population in Bhutan this beautiful big-leaf is very similar to *R. hodgsonii* but with a thick red-brown indumentum. The leaves are held very erect compared with the leaves of *R. hodgsonii* and often have a distinctive bi-lobed apex. Bhutan.

R. sinofalconeri – A vigorous and so far quite hardy new introduction. This quickly forms a small tree with large inflorescences of pale to deep yellow flowers. The form from S Yunnan (rounded leaves with a much looser and paler indumentum) is quite different in appearance from the form from N Vietnam (longer elliptic leaves with a denser and deeper colored indumentum).

***R*. *species nova* (“*titapuriense*”)** – A brand new introduction from Arunachal Pradesh, NE India. This forms a massive tree to at least 100 ft. The foliage has a “*mallotum*-like” deep red-brown indumentum.

R*. *species nova – This is another brand new introduction from Arunachal Pradesh, NE India. Morphologically, at least in foliage characteristics, it has been noted that it seems to be most closely related to *R. sinofalconeri*.

Subsection Fortunea:

R. asterochnoum – Forms a large upright shrub or small tree similar to *R. calophytum* but with a thin indumentum on the lower surface of the leaves. The flowers are very similar to those of *R. calophytum* in white to pink with a deep blotch. Sichuan.

R. calophytum* var. *openshawianum – This variety is very similar to var. *calophytum*, differing primarily in being smaller in all of its parts and with fewer flowers per inflorescence. Most forms seen in cultivation have very distinctive shiny and smooth, narrow leaves. S Sichuan.

R. davidii – This forms a large rounded shrub with purplish flowers and smooth leaves. Differs from the probably closely related *R. huianum* in its very small calyx. Sichuan & NE Yunnan.

R. decorum* ssp. *cordatum – Very similar to the type but with rounded cordate leaves resembling those of *R. orbiculare*. Similar flowers to those of ssp. *decorum* – white to pink and fragrant. NE Yunnan

R. glanduliferum - Large and vigorous shrubs somewhat similar to *R. auriculatum* but with much larger leaves. The large fragrant white to pink flowers do not appear until mid-summer (Guizhou) or late summer (NE Yunnan). They are quite large and showy and range in color from white to rose or pink and are fragrant. NE Yunnan and adjacent N Guizhou.

R. huanum – This forms a large rounded shrub or small tree with purple-red to lilac flowers in early spring. Somewhat similar to *R. davidii* but with a large persistent calyx. The new growth is a distinct shiny, olive green with reddish perulae. Sichuan, Yunnan & Guizhou.

R. maoerense – Large shrub or small tree with large pink to white flowers; similar in general appearance to some forms of *R. fortunei*. S China.

R. orbiculare* ssp. *cardiobasis – This is very similar to the type but with longer more elliptic leaves and a much more fastigiate growth habit. I have not seen the flowers. S. China. Older plants in collections are invariably just *R. orbiculare* hybrids.

left
Rhododendron glanduliferum

opposite
Rhododendron platypodum

Pictures Steve Hootman

R*. *platypodum – Probably closely related and similar to *R. orbiculare* but with very thick, leathery foliage and winged petioles. Guangxi (see *R. yuefengense*) and SE Sichuan. Very rare in the wild.

***R*. "*serotinum*"** – This is very similar to *R. hemsleyanum* but with narrower leaves, a more fastigiate habit and larger flowers. The new growth is bright blue-green. S Yunnan and adjacent N Vietnam.

R*. *species nova – A vigorous and very large growing new species with very narrow, smooth foliage and relatively small, white flowers in mid-summer. Resembles a rather poor form of *R. fortunei* ssp. *discolor* but with very distinctive foliage. Guizhou.

R. yuefengense – This new introduction is very similar to *R. platypodum* but seems to be smaller growing and is incredibly disjunct from that species - the "*platypodum*" from Guangxi.

Subsection Grandia:

R. balangense – Forms a large shrub or small tree with whitish indumentum on the undersurface of the leaves. Distinctive short and winged petioles with white to pinkish flowers. May be a stabilized hybrid between *R. watsonii* and a subsection Taliensia. Endemic to Balang Mountain in Sichuan.

R. kesangiae – A fabulous new introduction that forms a small tree with large leaves up to 18 inches in length. The flowers are rose to pink and do not fade to an unsightly color right away as do the flowers of the somewhat similar *R. hodgsonii*. The rounded bud and rough bark readily distinguish it from the smooth-bark and pointed buds of *R. hodgsonii*. Bhutan and adjacent western Arunachal Pradesh (as var. *album* with white flowers).

R. macabeanum (high altitude form) – A surprising recent collection (2003) of this woodland species from the top of Mt. Saramati (c. 12,600 ft.) on the Nagaland border with Burma. Much slower growing and with a darker indumentum than the typical *R. macabeanum*. Should be incredibly hardy for a big-leaf.

Left: *Rhododendron species nova* from North Vietnam
Picture Steve Hootman

Opposite:
Rhododendron flinkii
pink form
Picture John Roy

R*. *species nova – This incredibly vigorous large tree is from N Vietnam where it was collected as *R. protistum* aff. and/or *R. sinogrande* aff. In foliage it is intermediate between the two although it develops its indumentum and flowers at a very young age (for a big-leaf). Cream yellow flowers similar to those of *R. sinogrande* but as early as *R. protistum*. Seems to be quite hardy.

R*. *species nova – This seems to be another brand new introduction from Arunachal Pradesh, NE India; large tree, related to *R. grande*? or perhaps a simply a form of *R. sidereum*.

Subsection Irrorata:

R. gongshanense – This stunning and distinct species forms a large rounded shrub with long narrow leaves, heavily bullate above with a thin indumentum beneath, dark pink flowers in early spring. A bit tender in most regions. NW Yunnan.

R. irroratum* ssp. *pogonostylum – This represents the southern form of this widespread and common species, mostly with pink to reddish flowers, otherwise very similar to the type. S & W Yunnan.

R. irroratum ssp. _yiliangense_ – Recently introduced and renamed (it was known as ssp. *ninguenense*), this is similar to the type but with pale green foliage and yellow flowers. NE Yunnan.

***R. langbienense* – A** new introduction from Vietnam, the name still needs to be verified and very little information available currently

R. tanastylum – Very large shrubs or small trees of the temperate rainforest, red to purple flowers, doubtfully hardy in most climates. E Himalaya to W Yunnan.

Subsection Lanata:

R. flinckii – Similar to *R. lanatum* but with a thinner leaf and a thinner, orange-red indumentum. Seems to be far easier to grow in cultivation. Pink to pale yellow flowers. Bhutan and adjacent Arunachal Pradesh.

R. luciferum/circinnatum– Similar to *R. lanatum* but with larger more pointed leaves and larger stature. Pale yellow flowers. SE Tibet.

Subsection Maculifera:

R. ochraceum – This forms a rounded shrub with foliage superficially similar to *R. griersonianum* and flowers similar to *R. strigillosum*. The flowers appear a few weeks later in the season. Extremely rare in the wild. S Sichuan, NE Yunnan and N Guizhou.

R. oligocarpum – This is very close to *R. maculiferum* but with pink to purple flowers. It forms a medium rounded shrub. Very attractive as the flowers quickly fade to pale pink. Guizhou and Guangxi.

R. sikangense var. _exquisitum_ – This forms a large shrub or small tree with white to pink flowers and a reddish blotch. Very similar to the type. NE Yunnan.

Subsection Neriiflora:

***R. euchroum* – A** dwarf mounding species with a thick brown indumentum. Still quite new in cultivation. Yunnan/Burma border.

R. miniatum – Small compact shrubs with a dense wooly and dark indumentum on the lower leaf surface, crimson flowers with darker nectar pouches. SE Tibet.

R. trilectorum – An interesting and difficult, dwarf mounding alpine shrub with yellow bell flowers. Rather reminiscent of an upright, “tufted” form of *R. forrestii*. Arunachal Pradesh.

Rhododendron trilectorum
Photo Steve Hootman

Subsection Parishia:

There at least two, and possibly three new taxa in this subsection that have been collected recently in northern Vietnam. One is very similar to *R. facetum* but with a much more lax inflorescence that may best be considered a form of that species. Another, with long narrow leaves and obvious stellate indumentum, has been called *R. huidongense* but this is a taxon from S Sichuan. The third has been called “*wallichii*”! but of course, it is not. It has very distinct, rounded elliptic leaves with a remnant of indumentum on the midrib of the lower leaf surface. The hairs are barely stellate however, and this taxon may be best placed within Subsection Maculifera. We will have to await the flowers.

Subsection Taliensia:

R. bhutanense – This forms a compact shrub with a felted grayish to orange-brown indumentum on the underside of the leaves. The flowers are pale to deep pink, somewhat similar to *R. phaeochrysum* var. *agglutinatum*. Bhutan and adjacent Arunachal Pradesh.

R*. *bureavioides – The northern version of *R. bureavii*, differing in its larger flowers and larger leaves that appear sessile on the leaf stems. Sichuan.

***R. clementinae* ssp. *aureodorsale* –** This may actually be more closely related to *R. phaeochrysum*, seems to be far removed from *R. clementinae* (at least in foliar characteristics). SW Shaanxi.

R*. *dignabile – This is very close to *R. beesianum* but with little or no indumentum. White to pink flowers; represents the western extension of that species in SE Tibet.

***R*. *phaeochrysum* "yellow"** – This stunning plant with yellow flowers spotted red hails from the very western end of the large range of this variable species. Should probably be described as a new species or subspecies. SE Tibet.

R. sphaeroblastum **var.** ***wumengense*** – Very similar to var. *sphaeroblastum* but with a thinner and paler indumentum on lower surface of the leaves. Isolated range in NE Yunnan.

Subgenus Pentanthera:

R. eastmanii – A newly described deciduous azalea with fragrant white flowers. SE USA.

R*. *colemanii – Very recently published new species of deciduous azalea native to SE USA, similar in general appearance to *R. alabamense* but much more variable.

Section Pogonanthum:

R. cephalanthum **ssp.** ***platyphyllum*** – Similar to the type but with much larger leaves and slightly larger flowers. Seems to be quite distinct morphologically. N Yunnan.

R. fragrans – This is a dwarf alpine species with white to pink flowers. Very difficult in the garden. Siberia to Mongolia.

R. laudandum **var.** ***temoense*** – A dwarf alpine shrub with white to pale pink flowers and a dense layer of very dark brown scales on the lower side of the glossy leaves. SE Tibet.

Subsection Boothia:

R. boothii – An epiphytic shrub of the temperate rainforest, hairy, leathery foliage and smooth peeling bark, deep yellow flowers, likely to be tender in most regions. Beautiful red-purple new growth with long silver hairs. SE Tibet and adjacent Arunachal Pradesh.

R*. *species nova – This is an unusual taxon that appears to be intermediate between *R. sulfureum* and *R. chrysodoron* with similar yellow flowers in early spring. Known only from the Dulong Valley of NW Yunnan.

Subsection Lapponica:

R. bulu – Upright evergreen shrubs with tiny scaly leaves and pinkish to deep violet flowers. More or less a low elevation form of the widespread and variable *R. nivale*. SE Tibet.

R. tsaii **affinity –** A fine dwarf shrub with pink to purple flowers. Very close to that species but collected on the opposite side of the Yangtze and sharing some

Left
Rhododendron species nova
Boothia subsection

Below
R. kiangsiense

Photos
Steve Hootman

characteristics with *R. hippophaeoides*. SW Sichuan.
ALSO: Several other “species”, mostly variations of the widespread and variable *R. nivale*, have been named recently by Chinese botanists. A few of these have been introduced into the west but have yet to be adequately evaluated.

Subsection Maddenia:

R. excellens – This has very large leaves similar in general appearance to *R. nuttallii*. Very large white fragrant flowers in early summer. A beautiful plant with smooth peeling bark from S Yunnan & N Vietnam. Seems to be hardier than *R. nuttallii*.

R. fleuryi – Very rare new species with unusually shaped flaring tubular flowers. These are white with pink lines on the tube.

Smooth peeling bark. Laos & Vietnam?

R. kiangsiense – Comes from eastern China. Large and fragrant, openly funnel-shaped white flowers. I am still evaluating this introduction.

R. leptocladon – A fantastic and seemingly hardy new introduction from N Vietnam. This species has unusually coloured flowers in mid-spring. They emerge greenish yellow and fade to a rich butter yellow.

R. levinei – This smaller growing species has smooth peeling bark with noticeably small and hairy foliage and fragrant white flowers. Guangdong.

Above and left
Rhododendron excellens

Photos Steve Hootman

Left
Rhododendron changii

Opposite
R. species nova
Subsect. Monantha

Photos Steve Hootman

R*. *liliiflorum – A choice and relatively hardy species that is similar in general appearance to *R. lindleyi* but blooming much later in the season (early summer) and with very attractive smooth and peeling bark. Guizhou and Guangxi.

R*. *pseudociliipes – A smaller growing Maddenia, with small pointed leaves contrasting nicely with the large, single white to flushed pink, slightly fragrant, funnel-shaped flowers. Yunnan/Burma border.

R. valentinianum* aff.** – This hardy species is similar to the typical Forrest collection of *R. valentinianum* from the Salween but much larger in all its parts, yellow flowers. Strikingly bullate and hairy foliage. S Yunnan & N Vietnam. ***R. changii from SE Sichuan is another possibly new taxon that has been included within *R. valentinianum* in the past. It has flowers that are paler and more open in shape appearing earlier in the season.

R. species nova – A very unusual species with a dwarf mounding habit and very slow growing. Tubular funnel-shaped, white flushed pink flowers in mid-spring. Unusual obovate-oblong foliage with a fringe of hairs. Known from a single collection in NE Yunnan. Seems to be quite hardy.

Subsection Monantha:

R. monanthum – An unusual dwarf and epiphytic species from the Yunnan/Burma frontier. Small olive-green leaves with a single to sometimes three, deep yellow, bell-shaped flowers <u>in late autumn</u>. Very slow-growing and fine in a container or hanging basket. This is the first of the entire subsection to be introduced into cultivation.

R*. *kasoense – This is similar to the above but a much more vigorous and larger growing species with slightly larger flowers. From the eastern Himalaya.

R. concinnoides – Very similar to *R. monanthum* but with lavender to purple flowers. From the eastern Himalaya and not introduced until 2005.

R. species nova – Similar to *R. monanthum* but with larger foliage and a distinct whitish waxy coating on the undersides of the leaves. White to cream flowers in early winter. Known only from the Dulong Valley of NW Yunnan.

Subsection Moupinensia:

R. dendrocharis/petrocharis – Both of these very similar species are basically smaller versions of the familiar species *R. moupinense* and they share a similar range and habitat (epiphytic or on rocks). Very large flowers for the size of the foliage and plant, quite hardy and drought tolerant once established. Sichuan to Yunnan and Guizhou.

Subsection Triflora:

R. lateriflorum – Very similar to *R. zaleucum* but with a much less glaucous leaf undersurface. Placed in Subsection Cinnabarina by Chinese botanists. From the Dulong Valley of NW Yunnan.

***ALSO*:** Two new species closely related to *R. yunnanense*(?) that were recently collected in N Guizhou. One has early and small, deep pink flowers and hairy foliage; the other has very glabrous foliage with very few scales and white to pale pink flowers later in the season.

UNPLACED:

R. species nova – collected as *R. arboreum* ssp. *delavayi* affinity in N Vietnam. This has little to do with *R. arboreum* and does not really match up well with anything. Perhaps a link between subsections Arborea and Argyrophylla? Attractively indumented leaves with white to lavender flowers. The bell-shaped flowers have purple nectaries.

Left
R. species nova
Unplaced from
North Vietnam

Photo Steve
Hootman

In addition to these species, numerous new deciduous and evergreen azaleas have been introduced in recent years. These include *R. arunachalense, R. saxicolum,* and others. There has also been a huge increase in the number of taxa of vireyas that have been collected and grown. This subject is worthy of an entire separate lecture and will not be discussed at this time.

Hybrid Zones in Rhododendron Subsection Taliensia

Tobias Marczewski

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Introduction:

The genus *Rhododendron* is widely distributed throughout the world with the exception of Africa and South America, and has a centre of diversity in the Sino-Himalayan region, particularly the eastern Himalaya (Chamberlain et al 1996). It is the largest genus in the family Ericaceae, with over 1000 described species (Chamberlain et al 1996) divided into eight subgenera: *Rhododendron* (Sleumer 1966, Cullen 1980); *Hymenanthes* (Chamberlain 1982); *Azaleastrum, Mumeazalea, Candidastrum, Therorhodion* (Philipson and Philipson 1986); *Tsutsusi* (Chamberlain and Rae 1990); and *Pentanthera* (Kron 1993, Judd and Kron 1995) (all as in Kurashige et al 2001). The resolution of phylogenetic relationships within the genus is generally robust down to the level of subgenera (Kurashige et al 2001, Goetsch et al 2005) but within certain subsections phylogenetic approaches do not yield good results (Hyam 1997). That does not seem too surprising, as many species of *Rhododendron* seem to hybridise quite readily or might have some sort of hybrid ancestry (e.g. Milne et al 1999, 2003; Morimoto et al 2005; Chung et al 2007; Zhang et al 2007).

The subgenus *Hymenanthes* is divided into 24 subsections with 225 species (Chamberlain 1982). Recent work shows that much of the diversity in the subgenus is most likely of recent (<5 million years) origin (Milne 2004). As mentioned before, genetic barriers to gene flow between species also appear to be almost non-existent within this subgenus of *Rhododendron*. Furthermore, extensive hybridisation seems to occur in the wild within certain species complexes (Chamberlain 1982, Milne et al 1999, 2003).

In subsection Taliensia especially problematic species regarding taxonomic status and/or hybridisation behaviour include: *R. aganniphum, R. alutaceum, R. beesianum, R. clementinae, R. phaeochrysum, R. proteoides, R. roxieanum* and *R. traillianum* (Chamberlain 1982, Chamberlain, Milne, Marczewski personal observation); and this is furthermore evidenced by the high number of varieties described for most of the mentioned species:

- *R. agganiphum* : var. *agganniphum*, var. *flavorufum*
- *R. alutaceum* : var. *alutaceum*, var. *iodes*, var. *russotinctum*
- *R. phaeochrysum* : var. *agglutinatum*, var. *levistratum*, var. *phaeochrysum*
- *R. roxieanum* : var. *cucullatum*, var. *oroneastes*, var. *roxieanum*
- *R. traillianum* : var. *dictyotum*, var. *traillianum*

Assuming that hybridisation occurs to a certain extent, it is not surprising that phylogenetic methods, which do not take reticulate evolution into account, fail to resolve relationships below the subgenus level, as they are known to be error prone when hybrids or hybrid ancestry is involved (Rieseberg and Ellstrant 1993, Linder and Rieseberg 2004, Huson and Bryant 2006). Therefore it is desirable to identify hybrids, and determine which methods should be preferred, before further attempts are made to resolve the complex on a phylogenetic basis.

To make further progress in the understanding of the impact that hybridisation, especially homoploid hybrid zones, has on the evolutionary history of organisms, science has to rely on more case studies of present hybrid zones. But despite the overall increment in research effort, mainly annual or perennial herbs have been subject to intensive study (Gross and Rieseberg 2005, Chapman and Burke 2007), probably due to advantages regarding the ease of experimental set-ups. Only fairly recently have scientists begun to include longer-lived woody species as well (e.g. Oak – Dodd and Afzal-Rafi 2004, Lexer et al 2006; Aspen – Lexer et al 2004, 2005). Therefore *Rhododendron*, with a large number of species and weak species barriers, offers the opportunity to investigate population dynamic processes in a group of species that are shrubs or trees. Thus they may be used to explore general questions regarding speciation or species maintenance involving hybridization and could help to elucidate differences that might exist between herbaceous and woody plants.

Aims and Objectives:

The general questions arising are as follows:

- First, what is the general architecture of the hybrid zone? Is there frequent backcrossing involved or is there some sort of gene flow barrier as observed previously in *Rhododendron* (Milne et al 2003).
- Second, are the described varieties hybrids, or of hybrid origin, and if so are they stabilized taxa, or do they only exist through permanent recruitment through ongoing hybridisation? Third, is there introgression between locally hybridising populations and how does that relate to the overall species diversity? Therefore, could introgression through hybridisation, threaten the existence of some rare rhododendrons in the wild? (e.g. see Burgess et al 2005 for introgression in *Morus*).

At present almost all the data on hybridisation among Sino-Himalayan rhododendrons is qualitative, i.e. numerous hybrid combinations have been observed (Chamberlain 1982), and large swarms of hybrids are known to occur, but actual data on genetic composition of hybrid zones is lacking. The project aims to conduct first population genetical work in the above-mentioned species complex in subsection Taliensia to establish methods that can reliably be used to detect hybrids. Furthermore these will be used to get first insights into the population structure of some involved species, with the future possibility to plan projects to investigate ecological factors related to the genetic structure.

Intended Approach:

During my project I will focus on the gathering of quantitative data on a hybrid zone that seems to present a case of a stabilised hybrid population, assuming that *R. roxieanum* var. *cucullatum* is actually of hybrid origin. The second hybrid zone that will be analysed presented itself more in the fashion of a hybrid swarm and involves *R. aganniphum* var. *flavorufum*, which field observations strongly indicate is a hybrid.

R. roxieanum var. *cucullatum* has been chosen because it is most probably a parent of a possible, sympatricly occurring, hybrid that seems identical with *R. alutaceum* var. *iodes*. For that reason it is desirable to know if *R. roxieanum* var. *cucullatum* itself is of hybrid origin before further steps are taken to elucidate the parentage of *R. alutaceum* and relationships in this complex.

R. aganniphum var. *flavorufum* is of interest as it seems to present a completely different case of hybrid zone dynamics, and furthermore the available population samples of the involved *R. phaeochrysum* cover by far the largest area with regard to the overall species range (see Figure 2); therefore allowing a comparison between population diversity.

AFLPs will be used to investigate the population structure and history, as they have been proven to be a powerful technique for detecting hybrids and introgression (e.g. Van Droogenbroeck et al 2006) and have also been previously used successfully in *Rhododendron ferrugineum* to investigate the genetic structure of populations (Wolf et al 2004).

To get a more complete picture of the population dynamics, especially regarding species identity and hybrid history, the aim will be to find a chloroplast marker variable enough to distinguish between haplotypes.

After results from the molecular techniques are obtained, the potential of mass spectrometry of leaf wax hydrocarbons, as described by Chadwick et al (2000), will be explored for detecting hybrids of sampled species. This would allow for testing of a larger number of individuals and will also be valuable information regarding future population studies.

Concrete aims are therefore:

- establish a set of AFLP primers that can distinguish between species to detect hybrids and introgression;
- determine whether species or varieties of the above mentioned complex are of hybrid origin;
- estimate the gene flow/introgression between parent species;
- assess between population differentiation within species (where several population samples could be obtained);
- test sensitivity of leaf wax hydrocarbon chromatography in respect to hybrid detection;
- if the test of the chromatography results in success, test seedlings of known mother plants to determine the proportion of hybrids among offspring.

Sample Collection – Study Area:

Fieldwork China 2007:

From August 24th 2007 to September 25th 2007, a collection trip to south west China (Yunnan and Sichuan provinces) was undertaken. The main aim was to obtain silica dried leaf material from Rhododendron populations of subsection Taliensia containing individuals of uncertain taxonomic status and/or obvious hybrids. During the planning phase Dr. Gao Lianming from the Kunming Institute of Botany (KIB) was of great help and I was accompanied by two of my Supervisors, David Chamberlain and Richard Milne. We were joined by Liu Jie, a Masters student at KIB, who acted as interpreter, and Yang Song, a professional and experienced driver from KIB.

After using the first few days in Kunming to set up everything for the fieldwork and inspecting relevant herbarium specimens, we headed off to Lao Jun Shan Hotel, situated at an altitude of 3800m, where we had scheduled a longer stay to acclimatise to the altitude. This site was chosen by David Chamberlain, based on observations of hybrids made during previous field trips to that area. One downside of the chosen season was that the rhododendrons would not be in flower, leaving us with one character less for the identification of hybrids. But due to the initial guidance of Dr. Chamberlain this was a minor problem, and considering the possible gain of the opportunity to collect seeds this was a reasonable decision.

The site at Lao Jun Shan offered much more than we expected, and we were able to collect samples from various species representing different problems regarding hybridisation and speciation.

We sampled one whole ecological plot of 20 by 20 meters in a grid like fashion, representing a seedling recruitment area in a rhododendron forest, composed of *R. beesianum*, *R. traillianum*, hybrids of the former two, and a few *R. roxieanum* individuals.

On other sites around Lao Jun Shan, population samples were obtained involving *R. clementinae*, *R. roxieanum*, *R. traillianum* and, according to our field observations of special interest, *R. roxieanum* var. *cucullatum*.

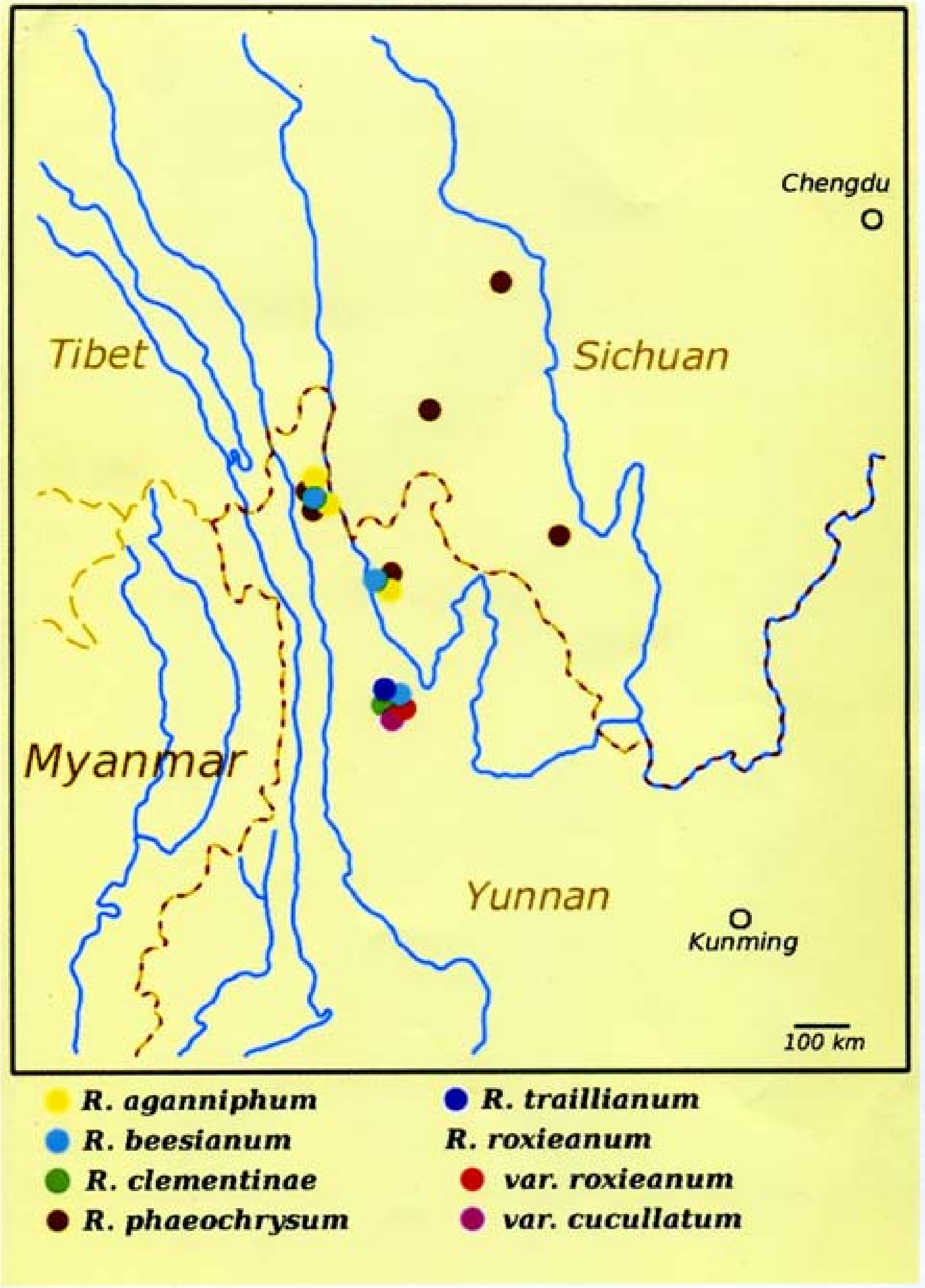
Very much to our disappointment the weather conditions during the flowering season had been very bad, and hardly any plants had managed to set seed; therefore even with careful searching only a few seed pods of any species were collected.

Having completed the work on Lao Jun Shan in one week, we spent a further six days in Yunnan Province collecting mainly different population samples of *R. phaeochrysum* and *R. aganniphum* including the taxonomically equivocal, putative hybrid, *R. aganniphum* var. *flavorufum*. Thereafter, crossing to southern Sichuan Province, we acquired further populations of *R. phaeochrysum*, so that the collection of this species now covers a wide sample of populations throughout the distribution range.

Due to time problems we were not able to collect desired allopatric reference populations of some of the species from Lao Jun Shan (mainly *R. roxieanum* var. *roxieanum* would have been of interest), but overall the collected material is sufficient for the intended work to follow.

Collection locations

(Figure 1)


Chengdu
Tibet
Sichuan
Myanmar
Yunnan
Kunming
100 km
● R. aganniphum
● R. beesianum
● R. clementinae
● R. phaeochrysum
● R. traillianum
R. roxieanum
● var. roxieanum
● var. cucullatum

(Figure 2)

Figure 1. Location of the collection area in China. The species investigated in this study grow mainly on mountain ranges and mountaintops between 3000 and 4500m in north west Yunnan and south east Sichuan province in the eastern part of the Himalaya. Red dots indicate locations of sampled populations.

Figure 2. Shown are the locations of the populations sampled during the fieldwork 2007 in China. Species affiliation is indicated by colour. The habitat fragmentation through the big rivers, flowing actually in deep valleys, is evident (in Yunnan from west to east: Nujiang River, Mekong, Yang Tse Kiang; in Sichuan: Yalong River).

Field Observations 2007:

Most of the samples were collected near Lao Jun Shan, and this area had also the most interesting observations to offer. First of all the above mentioned seedling recruitment site where *Rhododendron traillianum* and *R. beesianum* occur together. This seems to be a very good example of natural primary rhododendron-forest dynamics; *R. traillianum* normally occupies the upper layer, representing most of the top canopy cover (apart from some *Abies delavayi* individuals towering above the canopy) whereas *R. beesianum* grows as an under-story tree preferring more shade. At this special site an old *R. traillianum* tree had toppled over, resulting in an opening of the canopy cover and therefore a space to be invaded by seedlings competing to occupy the space. A considerable number of the young plants, some already exceeding two meters in height, obviously were hybrids; however, none of the adult individuals of either species seemed to be of hybrid origin - possibly a case where hybridisation occurs, but hybrids are then outcompeted in later stages of the recruitment. As my focus for the project is more related to taxonomical questions, the samples from this site will not be investigated. Nonetheless this represents without a doubt a site that has great potential in the future for re-sampling and more so as we discovered several days later an identical situation in another part of the forest, which would allow for comparison.

In the starting phase of the project, preceding the fieldwork, *Rhododendron alutaceum* presented a species of main interest because of its several affinities towards other species. At the site of Lao Jun Shan covering a wide open area around a lake, we observed several individuals that presented characteristics typical for *R. alutaceum* var. *iodes* and they occurred always sympatricly with *R. roxieanum* var. *cucullatum* and *R. traillianum*, exhibiting combined morphological characteristics of both. This strongly suggests a variety of hybrid origin. To complicate matters *R. roxieanum* var. *cucullatum* seems in some morphological characters affliated to *R. clementinae*, which occurs sympatricly, and *R. roxieanum* var. *roxieanum* occurring in proximity to the site. Generally plants that seemed to originate from hybridisation did not occur in too large numbers, mostly five to ten plants or groups of seedlings, compared to the possible parents, but *R. roxieanum* var. *cucullatum* often dominated, bringing up the question what taxonomical status it represents. If it should turn out to be of hybrid origin, it would imply that *R. alutaceum* var. *iodes* is possibly a three way hybrid.

The species we encountered most along our way was *Rhododendron phaeochrysum*, exhibiting an extraordinary morphological character plasticity between, and sometimes within populations. This suggests a considerable amount of meta-population substructure, possibly attributable to the strong habitat fragmentation, which could generally affect the other rhododendron species as well, of which we did not sample this variety of populations.

Acknowledgements

I am truly thankful to my supervisors, Mary Gibby, David Chamberlain and Richard Milne for providing a warm and hearty atmosphere along with offering guidance for my research, making helpful suggestions and always giving support when needed.

Lianming Gao organized a huge part of the fieldwork in 2007, even when it was evident that he couldn't join; and he has always been very kind, offering help regarding Chinese matters.

Financial support for this project has been raised by the Royal Horticultural Society's Rhododendron, Camellia and Magnolia Group.

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Rhododendrons and Primulas, "Excellent Bedfellows"

John Richards, Hexham, UK.

In the context of this august assembly, you may well wonder why I was asked to talk on a genus that is unrelated to *Rhododendron*. I have wondered so myself, and briefly harboured the unworthy suspicion that I had been rostered on behalf of those for whom an undiluted diet of rhodos might prove too indigestible. Having drawn the short straw of Sunday morning after coffee, I might well have been right!

Nevertheless, many of us do tend to associate rhododendrons with primulas. The link may be intangible, even subliminal, and for many gardeners it depends on an idealised perception of a natural plant association, and the romantic notion that this can be recreated in a particular sort of garden. Central to this paradigm has been the concept of 'The Himalayan Glen'. When collections first arrived in the UK from Sikkim and northern India, it was found that these monsoon floras were best suited to sheltered conditions in an Atlantic climate. Over the next century, magnificent facsimiles of 'The Himalayan Glen' were created

Previous page and above
Primulas at Cluny Garden
Opposite: Harewood Hall

All photos in this article by John Richards

at Inverewe, Crarae, Glendoick, Arduaine, Branklyn, Cluny House, Keillour Castle, Brodick, Castle Kennedy, Muncaster, Bodnant, Trellisick, Caerhays and even Biddulph Grange (Staffordshire no less!) (I have listed some of my favourites; you can substitute your own!).

Although every ‘Himalayan Glen’ has its own peculiarities, most depend on rhododendrons and conifers (especially *Abies* species) for their structure, magnolias and camellias for spring glamour, and drifts of primulas for midsummer glory, often abetted by blue meconopsis. In late summer, before the autumn colour provided by acers, sorbus and a host of other small trees, the ‘Himalayan Glen’ often becomes subdued, despite an occasional late fillip provided by roses, lilies and astilbes. Typically, such gardens enjoy a strong supporting cast, characteristically with trilliums, lysichiton, species narcissus and anemones in spring, nomocharis, arisaemas, rodgersias and the like in summer, and colchicums in autumn. However, the genera most closely associated with the ‘Himalayan Glen’ garden are undoubtedly *Rhododendron* and *Primula*.

Many primulas revel in the cool humidity of Atlantic gardens. Likewise, they thrive also in the temperate summer-wet gardens of parts of Norway, New Zealand, Australia and the Pacific coast of north America where rhododendron gardens flourish. Primroses (*Primula vulgaris*) and their relatives and hybrids in spring, and the manifold summer-flowering species and hybrids classified in the *Primula* sections Proliferae (so-called ‘Candelabra’) and Sikkimensis provide sheets of colour in these gardens in the summer. Primulas enjoy the same humidity, shelter, moisture retentive acid soils and even temperatures as rhododendrons. To some extent they dovetail with rhododendrons, because the chief display of rhododondrons tends to come after the primroses and before the summer-flowering primulas. It is not surprising that primulas often dominate the ground cover of rhododendron gardens in ‘Himalayan Glens’.

Interestingly, primulas and rhododendrons have far more in common than a shared taste for growing conditions. Both are very large and varied genera, and as the table below shows, their geographical distribution and centres of diversity show a surprising correspondence. We can assume that both genera probably arose in the Sino-Himalaya and were stimulated to undergo extraordinary levels of speciation there as the mountains grew to spectacular altitudes over the last 20 million years. Of course there are differences. *Primula* has no parallel to the high level of diversification in the tropical mountains of south east Asia exhibited by *Rhododendron* subgenus *Vireya.* Unlike *Rhododendron*, *Primula* underwent a significant secondary diversification in the European Alps, while a similar speciation hot-spot occurred for *Rhododendron* in the south-eastern USA, where no primulas occur. Nevertheless, in regions as disparate as the Caucasus, Japan and the American Rockies, the correspondence between the two genera for levels of local endemism is remarkable.

	Primula	Rhododendron
Estimated number of species	430	850
Percentage of species limited to the Sino-Himalaya	84%	ca. 70%
Percentage of species native to Europe	8%	1%
Percentage of species native to north America	4%	5%
Percentage of species hardy in most of the UK	ca 80%	ca 70%
Percentage of species in cultivation	ca 50%	60%

Primulas associate well with rhododendrons in the garden, and the two genera have similar geographical distributions and centres of diversity. But to what extent do these two genera also associate in nature?

When I was researching pictures for this talk, I looked particularly for examples of primulas and rhododendrons growing together in the wild. The first example I found was actually taken in the French Pyrenees! (*Primula latifolia* and *Rhododendron ferrugineum*). Other such associations occur away from the Sino-Himalayan heartland of both genera. To give three examples *P. luteola* grows with *Rhododendron caucasicum*; *Primula scandinavica*, and the American *P. laurentiana* both occur with *R. lapponicum* on opposing shores of the Atlantic; and *P. prolifera* grows with *R. malayanum* in Sumatra. However, it comes as no surprise that most such associations are found in the Sino-Himalaya. I have found photographs of *Primula bella* growing with *R. saluenense* ssp. *chameunum* on the Beima Shan, *P. calliantha* growing with *R.? trichostomum* in the same area, *P. littledalei* growing under rocks surrounded by *R. nivale*, *P. macrophylla* growing with *R. primuliflorum*, and, in the Ganesh Himal, *P.*

Left: ***Primula latifolia*** **and** ***Rhododendron ferrugineum***

Below: ***Primula bella*** **and** ***Rhododendron saluenense*** **ssp** ***chameunum***

obliqua growing with *R. anthopogon* and *R. lepidotum.* Some primulas grow right under sizeable rhododendrons, for instance the well-known *R. aganniphum* thickets at Tianchi (Zhongdian) harbour both *P. boreiocalliantha* and *P. sonchifolia*. This is unexpected as the drip from rhodo leaves is allelopathically toxic. Plant primulas on the north side of rhododendrons, but never right under them!

However, it is striking that I have been able to find no evidence, either from my own experience,

Primula
boreiocalliantha
and
Rhododendron
aganniphum

other peoples' photographs, or the literature, that primulas in the sections Proliferae or Sikkimensis ever occur in association with rhododendrons in the wild. These large, showy, summer-flowering 'bog' primulas from wet places in the eastern Sino-Himalaya have the greatest impact in the garden, and are the primulas most often seen as mass plantings in rhododendron gardens or 'The Himalayan Glen'. Such gardens thrive in cool, summer-wet conditions, and the rhododendrons themselves provide shade, shelter and humidity. Often a water-retentive leaf-soil accumulates in more level areas, and many 'glens' result from a stream that provides permanently moist (and flood-prone!) sites in the bottom. Such garden sites suit the 'bog' primulas well, but these species rarely inhabit the natural counterparts of these garden facsimiles. This may be because in monsoon climates, soils that support rhododendrons often become dry from the autumn to the late spring.

Instead, in the wild, 'bog' primulas usually occur in locations that never dry up: in flood-plains, water meadows, beside mountain streams, spring fed fens, and even in drainage ditches by roads. These sites are too waterlogged to suit rhododendrons, and if there is shrub cover it will be provided by willows and alders. I have been fortunate to see a number of primula species in the wild that are important components of 'The Himalayan Garden': both the yellow and purple (subsp. *beesiana*) forms of *P. bulleyana*, *P. poissonii*, *P. cockburniana*, *P.*

secundiflora and *P. sikkimensis*. In the wild these never grow in close association with rhododendrons. However, I admit that when the last two species grow together in dense colonies across shallow, rocky mountain streams, the drier streamside banks might well be clothed with *R. phaeochrysum* or *R. adenogynum*.

Top: ***Primula***
sikkimensis **at**
Trømso

Left:
P. bulleyana
Right:
P. bulleyana
ssp. ***beesiana***

In the wild, *Primula bulleyana* is most closely associated with the Yulong Shan. Although the differently coloured subspecies tend to occur at different altitudes, they overlap and are occasionally found growing together. In these circumstances, a rainbow of different colours results, strongly reminiscent of many 'Himalayan Glen' gardens where these so-called *Primula* 'bulleesiana' hybrids often predominate. Other important section Proliferae primulas in the garden are the carmine *P. pulverulenta* (there are pink 'Bartley', and white 'Ness' strains), the yellow *P. prolifera*, the delicate, early, golden and red-tipped *P. chungensis*, and *P. japonica*. *P. cockburniana* usually behaves as a biennial, but it is self-fertile and easy to grow from seed. It is a parent of the sterile, long-lived *P.* 'Ravenglass Vermilion' (probably the same as 'Inverewe') with flowers of an intense scarlet.

Another good, evergreen but long-lived, Proliferae primula is *P. secundiflora*. Mistakenly, this species has been assigned to section Sikkimensis in the past.

Like *Primula secundiflora*, Sikkimensis species have drooping bell-shaped flowers, but they are always deciduous, and the flowers have a mealy face never seen in section Proliferae. Apart from *P. sikkimensis* itself, the species are all Himalayan. By way of contrast, apart from *P. prolifera*, all the Proliferae species are Chinese. *Primula* section Sikkimensis includes the largest and most vigorous of all the 'bog' primulas, the yellow-flowered *P. florindae.* In suitable conditions, this can self-sow to the extent of outcompeting all other primulas, and I would not grow it if you are contemplating a mix of species. *P. sikkimensis* is much better behaved in the garden, while *P. alpicola*, *P. ioessa*, *P. waltonii* and their hybrids add a variety of colours. This group are hardier than the Proliferae primulas, and grow amazingly well in the far north, for instance at Trømso

Opposite page: *Primula pulverulenta* with rhododendrons at Howick Hall
Above: *P. prolifera*

in arctic Norway.

Although the Proliferae and Sikkimensis sections are usually predominant amongst primula plantings in the rhododendron garden, other groups can be important too, especially those that flower earlier, in the spring. Pre-eminent amongst these are the familiar primrose, *Primula vulgaris* and its relatives. The oxlip *P. elatior* is particularly suitable and often naturalises in the rhododendron garden. If this occurs where primroses also grow, attractive hybrid swarms will result. There are dwarfer races of oxlips from the Caucasus, subspecies *pseudoelatior* and *leucophylla*, that are suitable for plantings on a smaller scale. Although oxlips and cowslips, *P. veris*, are invariably yellow (unless hybrid), it is worth bearing in mind that eastern races of the primrose, mostly subspecies *sibthorpii* can be white, pink or purple. Some of these differently coloured plants are vigorous in the informal garden, so that a rainbow of spring colour can be achieved, almost as striking as that of the summer ‘candelabras’.

There are other spring-flowering primulas that are also often used with rhododendrons. Probably the most popular are the ‘drumstick’ primulas, *P. den-*

ticulata. It is important to recognise that when suited these can be seriously invasive, so that it is important to deadhead them after flowering if they are not to take over all your other herbaceous plantings. Also, now that there are such good reds, whites and dark purples to choose from (available from several seed merchants), why stick with the same old drab lilac form we seem to see so often?

Another good spring primula is the brilliantly pink *P. rosea*. This only thrives in seriously wet sites, so it will not grow cheek by jowl with rhodos, but a group looks wonderful by the stream at the bottom of the 'glen'.

Much more esoteric and classy, and as a mass planting subject for association with rhododendrons, perhaps only a serious contender in Highland gardens, are the petiolarid primulas. These demand constant humidity, moisture at the root and shade, but will not tolerate waterlogging. In some gardens they make magnificent companions to rhododendrons and can be used in mass plantings, flowering in the spring. In wetter areas they do better when covered with a frame light during the winter months. Perhaps the most suitable subject for this treatment is the pink *P. gracilipes,* although the blue hybrid between *P. bhutanica* and *P. whitei*, *P.* 'Arduaine', can also be divided to give masses of very early colour.

Above: ***Primula gracilipes***

Right:
P. **'Arduaine'**

Opposite page
P. sonchifolia

Another excellent, vigorous hybrid that so far seems immune to the effects of the cucumber mosaic virus that has affected so many sterile clones is the Taylors' *P.* 'Tantallon', a cross between *P. bhutanica* and *P. nana*. There is also a purple clone, *P. boothii* 'Annapurna autumn' that flowers in October and can be divided to give beds of unseasonal colour.

Perhaps the most glamorous of all is the sky-blue April-flowering *P. sonchifolia* which loves shady banks at the bottom of 'The Himalayan Glen'. Like *P. bhutanica*, *P. nana* and others, this must be propagated from seed on a regular basis if it is to persist. This enables plantings to escape the adverse affects of virus. In most primula species, plants produce either long-styled ('pin') or short-styled ('thrum') flowers and seed is usually set only if a cross is made between the two morphs.

Good plantings of the larger petiolarids, the royal blue *Primula griffithii*, and purple or yellow *P. calderiana* and *P. tanneri* are largely memories of the past, although they continue to flourish at Trømsø, so that we can continue to try to emulate the former feats of the Sherriffs, Knox-Finlays and others who grew these wonderful species amongst their rhododendrons in quantity.

Many other species from the Sino-Himalayan homes of primula and rhododendron have been tried in 'The Himalayan Glen', but few have settled down to be good garden plants. Some grow well from seed, but usually die after flowering, so seed must be saved and the plantings treated as biennial. Section Muscarioides species such as *P. deflexa*, *P. concholoba* and *P. flaccida* are amongst these, although the spectacular summer-flowering *P. vialii*, the 'red-hot poker primula' can be longer-lived when suited. *P. capitata* is a popular alternative, and as an added bonus some forms such as subspecies *sphaerocephala* are autumn-flowering.

For visitors to the Himalayas or China, masses of so-called ‘nivalid’ primulas (section Crystallophlomis) growing amongst alpine snow-melt are one of the great excitements, but it is no surprise that most of these species fail in the garden, where the wet sites they need in growth fail to be frozen in winter. *Primula chionantha* in its various forms can be an exception, settling down well in favoured gardens. *Primula involucrata*, in section Armerina, and its relative *P. zambalensis* can be a success, but again need regular replacement from seed.

Primula chionantha

Except for the specialist, most rhododendron growers who aspire to ‘the Himalayan Glen’ style of planting will rely chiefly on the bog primulas, classified in sections Proliferae and Sikkimensis. The association of these beautiful plants with rhododendrons may be an artificial construct that owes little to wild associations, but there is no doubt that the underplanting of rhododendrons with primulas, meconopsis, nomocharis, lilies and other aristocratic summer-flowering herbs adds dimensions to the garden in both time and space.

Breeding rhododendrons for extreme hardiness

Peter M.A. Tigerstedt, Arboretum Mustila, Finland

Climate at Arboretum Mustila – the cradle of hardy rhododendrons:

We are located at 60°44’ north, which puts us at approximately the same latitude as the south tip of Greenland, midpoint of Hudson Bay, Anchorage in Alaska or at Magadan, north of the Ohotsk Sea in the Siberian far east. Nowhere else in the world can wheat be grown at this latitude where there is a nearly 24 hour day length at mid-summer. Particularly the photoperiodic discrepancy is distorting the “natural adaptation” of many plants introduced from up to 30 degrees further south. This is the case of most introduced woody ornamentals originating in China and elsewhere in the world, for use in central Europe.

We find that the introduced ornamental flora faces critical “bottleneck years” at irregular intervals of about 15 years; times when winter low temperatures sink to close to -40°C, times when frozen ground in April-May causes plant desiccation, times when early summer drought is critical, times when late spring night temperature falls to -10°C and times when first frosts come in mid August. Thus it is clear that “extreme hardiness” is genetically “extreme complexity” – no single gene effect and no single environmental effect!

Mustila is climatically located between two gross climate types; the Siberian continental and the Atlantic maritime climates. The swing from one to the other

The author emasculating
Rhododendron brachycarpum
‘*tigerstedti*’
at Arboretum Mustila, Finland
All photos in this article by Peter Tigerstedt

can be within a few days, even within hours. Clearly the Gulf stream is the prime reason for growing wheat and rhododendrons at this latitude, and further north to about 65°N. Elsewhere in the world permafrost is most common this far north.

At Arboretum Mustila –43.5°C was measured in February 1940. Between October 11, 1941 and April 11, 1942 the temperature was below zero C for 166 days and the average temperature for January was –18.5°C! These were the “Siberian bottlenecks” that sorted planted rhododendrons for hardiness, many having reached heights far above the snow cover. This was for example, when “The Tigerstedtii Group” of *R. brachycarpum* and the “Rudolph Seidel” hybrids, sent to us as raw seed material, were appropriately “naturally selected”. Selection in populations of hundreds of individuals has been the axiom at Mustila.

But we can also experience mild and humid “Atlantic” winter climates that can cause plant dormancy breakage and flushing in late winter with subsequent freezing. This may also cause sudden pest and disease outbreaks with disastrous repercussions. Particularly, plants from continental climates suffer.

Milestones in introducing rhododendrons to Mustila:

A.F. Tigerstedt, my grandfather, a geologist by education, established Arboretum Mustila about 110 years ago. His motive was to survey world tree species to find sources that could produce more valuable wood than the indigenous tree flora. The early introductions were entirely based on climatic maps and seed ordering. Thus for example, Douglas fir was introduced from seeds collected at the Upper Frazer River, Quesnel, B.C. in 1908 and it still represents a provenance never replaced by a more suitable one. That B.C. interior climate seems to be almost identical to ours – swinging between Canadian continental and Pacific maritime. A rough thumb-rule was learned: 100 meters in altitude corresponds to one degree latitude. Later this rule has been applied to collections in the Carpathians, the Caucasus and China; provenances collected to match climates in central Europe must be extrapolated to our conditions by moving roughly 1000 meters higher in altitude, with corresponding restrictions in species distribution.

C. G. Tigerstedt, my father, a botanist by education, enlarged the spectrum of introduced species also to cover woody ornamentals and herbaceous perennials. He established the Mustila commercial plant nurseries, the first price list being from 1933. Early rhododendron species introductions came in 1915

The rhododendron valley at arboretum Mustila, first established nearly 100 years ago.

from Regel & Kesselring Co. in St. Petersburg. A few years later bulk hybrid seed introductions came from the Seidel nurseries in Germany. In 1933 seed was received from Korea under the false name, *Rhododendron chrysanthum*. My father writes (Tigerstedt C. G. 1949): “This fine rhododendron variety has remained firm in a free and sunny nursery, without any shelter, not even snow, also during 1940 - - - A basis for further hybridizations!” This is the source that Cox & Cox (1997) name “perhaps the hardiest of all rhododendrons, having withstood -45°C”. It has been called variously *R. brachycarpum* ssp. *tigerstedtii* Nitzelius, *R. brachycarpum* var. *tigerstedtii* and “Tigerstedt Group”. I venture to call it “clinal variation within *R. brachycarpum*” – a geneticist’s simplistic conception!

In the 1940s there were several exceedingly cold and unusual winters and summers. Many of the approximately 40 rhododendron species introduced to Mustila before the “winter-war” 1939-40 and the 2nd world war succumbed and the arboretum was finally left with the hardiest possible material from several species populations and Seidel bulk hybrids. As particularly hardy species my father in 1949 mentions (latin names as of 1949) *R. brachycarpum* D.Don, *R. caucasicum* Pallas, *R. smirnowii* Traut., *R. degronianum* Carriere, *R. rufum* Batal., *R. przewalskii* Maxim. and *R. catawbiense* Michaux. A number of unusually firm Seidel hybrids, which are presently under special scrutiny by Walter Schmalscheidt in Germany, also came through, virtually without injury.

In 1950 and 1951 Mustila was visited by two persons that injected new rhododendron belief and excitement, namely Wilhelm Kesselring and Dietrich Hobbie. Most of the 1950s was a period of rebuilding after the wars and little new material was introduced but careful observations were taken on plant hardiness and generally on the effects of the unusual photoperiod on material coming from more northerly locations with dark nights. It was found that e.g. *R. przewalskii* had never flowered, probably due to photoperiodic constraints. In the 1960s, ecological genetics, genecology and generally the genetic background of adaptation became the focal point in research, not so much in rhododendrons but especially on introduced conifer species.

Thus in the 1970s, when the author entered the department of Plant Breeding at Helsinki University, my father's comment in 1949 "a basis for further hybridisation" was put into action. The breeding project became a close collaboration between Arboretum Mustila (mother plants), Helsinki University (planning, student assistance and plant nursing) and the Helsinki city gardens (hybrid orchards). The city gardens were prepared to invest considerably in order to establish, what we call, hybrid orchards. About 20,000 bulk hybrids were planted in the orchards 1975-1985. These orchards are now perhaps the most popular public gardens in the Helsinki area – thus it was possible to combine usefulness with pleasure and in doing so to create public interest and appreciation for a rhododendron plant breeding programme. A hybrid orchard of this kind is definitely more dynamic and alive than a conventional garden plantation using cloned cultivars. The reason: great genetic diversity of growth habits, colours and flowering times – biodiversity in front of your eyes! Other city gardens also came to our rescue and 7 hybrid orchards were established around the country. It must be emphasized that hybrid orchards are in a way "hybrid gene pools" that can be used for an unlimited future for new selections, but particularly for new rounds of hybridising. Thus the best in the hybrid orchards was cloned for further comparative trials and for the release of cultivars in the 1990s and almost up to this date when 17 cultivars have been named.

In the meantime, and predominantly due to public acceptance and popularity a new cadre of amateur breeders have set out to continue hybridising (second round) on the basis of our first round results. At present more than 1000 elepidote, 100 lepidote (including *Ledum*) and 50 azalea hybrids have been produced. The problem before us right now is monumental; how to establish large enough hybrid orchards in order to select “the best of the best” remembering that each cross between two species must be represented by tens of plants while each hybrid x hybrid or hybrid x species should be represented by plants in the hundreds to really make effective use of recombination in the second and later filial generations. A small number of individuals at this point is “a training in futility” and a waste of time and energy. Fortunately our first round hybrid orchards have given us plenty of understanding and goodwill. In Finland space for trials is not a problem, but to find economic premises is a much more problematic issue, particularly when the final new cultivar has such a limited usage within a small country. This has made us more and more aware of the importance of joint ventures on largest possible international scale.

Hardiness – an ambiguous concept:

Absolute low temperature tolerance can be measured at dormancy and the physiological background is well known and documented. However this parameter is of little value when evaluating rhododendrons growing in different parts of the world with different thermo- and photoperiods. It becomes even more confusing when considering genetic adaptation to certain original thermo- and photoperiods of the species and different temperature and light regimes at the present location. China’s mountains, at approx. 30-40°N and at 3000-4000m. altitude are certainly grossly different from Mustila at 60°N and 50-70.m above sea level, generally also with a considerably lower effective temperature sun. Even light composition, considering differences in altitude, has been shown to cause unexpected plant responses. In this maze of interactions it appears that only the field result is a reliable measure of hardiness.

Selection in large populations:

Rhododendron brachycarpum tigerstedtii was introduced to arboretum Mustila by planting hundreds of plants. After the 1940s iron winters some 30 were left, some without visible injuries. This then became the maternal basis for our breeding. This is a good example of how to adjust adaptation to marginal conditions using “natural selection” (Tigerstedt 1994). There are many examples of fast, within a generation, adaptation to new environments, particularly in cross pollinating plants. Adaptation may have a population genetic background if plenty of genetic diversity is present in the population. However, it seems to me, that “epigenetics” may also have an effect, as deliberated later.

Complex hardiness is definitely a quantitative trait governed by polygenes, or by co-adapted gene complexes, tightly linked together. Thus in our population-genetic approach to “selection for adaptation” it is obvious that we have to consider large plant numbers (Hill et al. 1998). Thus:

1) Species introductions must be based on hundreds of plants to let natural selection take its toll in the new environment.

2) F1 hybrid populations after crossing two species are generally intermediate. The two combined genomes are still unbroken, genes are “co-adapted” on the chromosomes. Here one can get along with tens of hybrid individuals for evaluation in the first round of hybridising.

3) F2 and later recombinant generations represent a breakdown of co-adapted gene sequences and new recombinant genotypes occur. This is the case both in hybrids of “species x hybrid” and “hybrid x hybrid”. Chance theory tells us that “picking a winner” is mainly a numeric exercise. For practical reasons plant numbers must be restricted to hundreds in rhododendrons considering their space requirements at the time they commence flowering. This is where we coined the concept “hybrid orchard”.

Tailoring growth profiles in breeding:

Growth profiles (Fig.1) were first defined by the author in observing introduced tree species at Arboretum Mustila (Tigerstedt 1990). In the semi-maritime climate type at Mustila freezing injury in woody plants roughly follow following order:

- Continental introductions are damaged by spring frosts due to early flushing.
- Maritime introductions are damaged by autumn frosts due to late growth.
- Alpine introductions are slow growing and generally undamaged at either end.

Several hybrids in the larch and fir families have shown us that hybrids between continental and maritime provenances are intermediate in their growth profiles, thus particularly well adapted to our semi-maritime climate, between the Atlantic and the Siberian. The intermediate inheritance is also proof of a quantitative (polygenic) genetic background in growth rhythms, governed basically by thermo- and photoperiods, but with interaction with light composition due to altitude.

There are regions in the world where semi-maritimity is prevalent. This is where the two climate types (continental and maritime) are close and partly overlap, and where types can alter within days, weeks and years. Here the

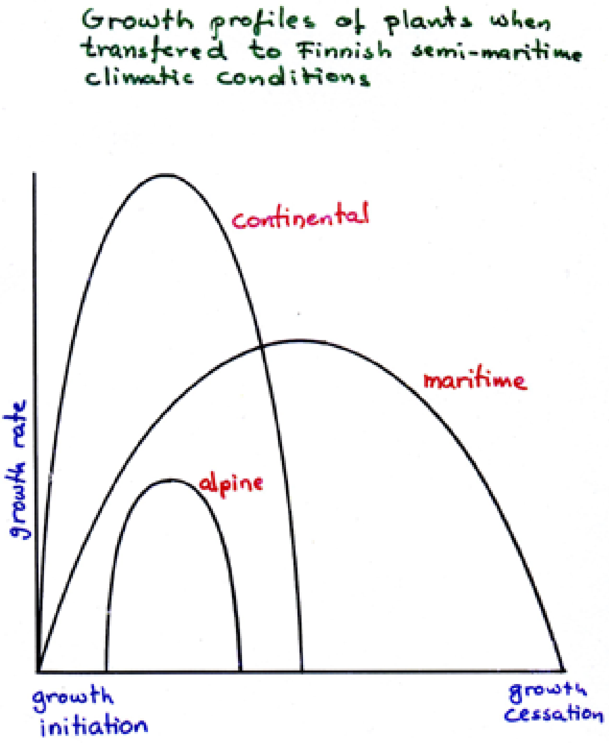

Fig.1. Growth profiles are quantitatively inherited complex traits.

natural flora has to be adapted to wide climatic variation, selection may favour different extremes. From a population genetic point of view, plant populations may be subject of "diversifying selection" giving them wide adaptation. For example provenances of Siberian larch west of the Ural mountains have shown exceptionally wide climatic adaptation due to the fact that this region swings between maritime and continental.

However, the growth profile can be tailored by crossing maritime and continental, a fact that we have approached in rhododendrons. The extra advantage hereby is that one incorporates in the new hybrids genes for "wide adaptation" making them useful over a wider climatic range. An example in continental rhododendron is the *R. brachycarpum tigerstedtii* Group. Cox & Cox (1996) calls it "the world's hardiest rhododendron". It is hardiest in Mustila and in Minnesota, but it freezes year after year at Milde Arboretum on the Norwegian

Atlantic coast and also in many places in New England. However, as we set out to hybridise, using the “brach-tiger” as a maternal parent growing in Mustila, our deliberate goal has been to tailor growth profiles and produce wider climatic adaptation. I believe this has been successful in many, but not all, of our hybrids.

Maternal and epigenetic effects when breeding for hardiness:

My first contention: it is not irrelevant which way you make a cross, reciprocals may be different, particularly concerning sensitivity to photoperiod, thermoperiod and light composition. Extrachromosomal maternal inheritance involves chloroplasts (phosynthesis) and mitochondria (energy metabolism). Chloroplasts are maternally inherited, the exception being conifers. Mitochondria are, as far as I know, invariably inherited maternally through the cytoplasm. Obviously then, a mother with outstanding hardiness will pass it to the progeny due to cytoplasmic maternal effects. There are many molecular genetic studies on chloroplasts and mitochondria now available.

My second contention: C.H. Waddington, at the University of Edinburgh, defined the concept “epigenetic landscape” in 1942 and later, based on his *Drosophila* research (Waddington 1953). Basically it meant that the whole genotype was responsible for the phenotypic expression. The “landscape” describes a ball running down the genetic landscape “canalised” to a certain path. His ideas came close to “acquired trait inheritance”, a concept that was not well taken by geneticists around the world, mainly due to T.D. Lysenko’s politically biased ideas in the USSR. Waddington was a dedicated leftist, as so many evolutionary geneticists after him, and his efforts to reconcile ideas on the inheritance of acquired characters with modern biology at that time was “moderately successful”.

However, there are plenty of examples of probable epigenetic effects, both before and after Waddington. Fast climatic adaptation, after one generation of population transfer to different climate, in Meadow Fescue was documented by Sylvén in Sweden in 1937. McNaughton (1972) found enzymatic thermal adaptation in *Typha* sp. and recently a Norwegian research team (Johnsen et al. 2005) reported striking influence in progeny hardiness after crosses made on the same mother clones of Norway spruce in north and south Norway – it has been called “The Norway effect”.

Finally Pembrey et al. (2005), report on the first unequivocal observations of environmental effects in humans that have been passed to later generations. Particularly "The Norway effect" states that "adaptation (to climate) is influenced by the maternal temperature during zygotic embryogenesis and seed maturation". It suggests a "memory" (genetic) involving DNA-methylation and differential transcription of phytochrome genes?

My conclusion is that maternal and epigenetic effects are most likely in rhododendrons and could be a reason for the superior hardiness in progenies after *R. brachycarpum tigerstedtii* mothers growing at Arboretum Mustila. The Norway spruce experiments carried out in Norway should definitely be followed up by hybridising in rhododendrons. The same clones or cultivars are easily found almost around the globe and should be pollinated with some common batches of pollen.

Enriching the gene pool for hardiness:

We have adopted the concept "hybrid orchard" from the forest geneticists with some adjustments for rhododendrons. The hybrid orchard has two main purposes:

1) To exhibit the full range of variation that one gets in the F1 between species and through recombination in the F2 and later filial generations. Thus it also serves as a plantation for selecting new hybrids for cultivars. It functions as a wide gene pool for hardiness where non-hardy genotypes are eventually "naturally" eliminated or incorporated. We were fortunate to have two extremely cold and irregular winters in the 1980s that screened our hybrid orchards.

2) To serve as a focal breeding orchard for the production of new hybrids. An orchard of this kind can be used by breeders for a long time as a "genetic reserve". Our largest hybrid orchard is located on a pine-mire within the Helsinki city limits. It was established in the 1970s and has become one of the most popular parks in Helsinki. There are information boards telling the public about its purpose as mentioned above. Due to its wide genetic variation, the orchard becomes a dynamic park where growth habits, colours and flowering times vary widely, in fact it is a more interesting park than one based on registered clonal cultivars only.

3) It is a living gene bank and a nucleus for rhododendron biodiversity. The best hybrids in the orchard become candidates for new cultivars and are placed in clone collections, usually each ortet being represented by 3-5 ramets to ensure adequate comparisons. In some cases clones have been incorporated in the hybrid orchards, but more often they are placed in separate plantations.

At the moment we have named 17 new hybrid cultivars and a few more are in the pipeline. We feel that our selection intensity has been high enough, the 17 hybrids having been selected from some 20,000 hybrid plants in the orchards. In our first round azalea project, started in the 1980s, some 15,000 hybrid plants were initially planted in the orchards and first cultivar selections are just now being made. Obviously this first round breeding programme, started in the 1970s (Tigerstedt and Uosukainen 1996) has aroused so much positive interest in rhododendron and rhododendron breeding that the newly established Finnish Rhododendron Club and its members have managed to hybridise a far larger genetic gene pool in the second round now at hand. The problem will be to establish large enough hybrid orchards for this new material. As a German proverb describes: “Vater werden ist nicht schwer - Vater sein dagegen sehr”!

By enriching the gene pool for hardiness, we are now at a stage where hardiness selection has almost unlimited possibilities. Our night dream is to have the new second-round populations spread in hybrid orchards located in different climatic regions. Clearly the outcome of “natural selection” in different regions would favour genetically different individuals and thus the programme would be more effectively utilized.

Fig. 2. Hybrid rhododendron orchard in Helsinki

Fig. 3. Hybrid azalea orchard in Helsinki

Future thoughts:

Gene banks, genetic resources and biodiversity have become counterweights to genetic engineering, cloning and genetic uniformity. Modern registered plant cultivars must be uniform, stable and separable from other cultivars.

Hybrid orchards in rhododendrons (Fig. 2 and 3) are living gene banks that can be the basis for unlimited continuation of breeding programmes. In addition they are examples of biodiversity and can become well appreciated parks for the general public. In fact, the great success of our hybrid orchards has raised the somewhat frivolous idea, that in the face of climatic change and with public acceptance of greater diversity "hybrid swarms" of promising crosses could be launched as "mixed cultivars", a model used to some extent in agriculture (line mixtures) and in forestry (clonal mixtures and species mixtures).

However, is it possible at early stage to reduce the number of plants without sacrificing breeding goals? Can young seedlings be screened? The answer is generally "no way". But there may perhaps be chances to discard whole hybrid families on the basis of poor seed germination and perhaps in the future through molecular marker assisted selection.

In rhododendrons, the great success in the production of hybrids lies with the comparative ease to produce them and in the ease to produce thousands of seeds of a certain cross. A great cadre of skilled amateur breeders can here carry a breeding programme no plant breeding institute can manage – economically! However, the problems come at the evaluation stage, where large numbers are mandatory for "picking the best". Perhaps joint international collaboration is here the solution.

Perhaps also breeding for wide climatic adaptation is a goal and perhaps the "hybrid swarm" approach (Tigerstedt 1977) should be carefully studied at this time of global climatic change.

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Breeding Elepidote Rhododendrons for Resistance to *Phytophthora* Root Rot Disease

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Introduction

Some of the most destructive plant pathogens are grouped in genus *Phytophthora*, a word that literally means 'plant destroyer'. Although they are fungus-like, species of *Phytophthora* are not true fungi and are placed in Kingdom Chromista, which includes algae and diatoms. These pathogens are soil and/or airborne, and collectively their symptoms include root or lower stem rots, damping off of seedlings, and blights of twigs, leaves, and fruits. A rogue's gallery of *Phytophthora* species includes *P. infestans*, which causes potato blight (and famine), and *P. ramorum*, a recently discovered pathogen that threatens many forest trees and can be vectored by ornamental host plants such as rhododendrons (1), thus presenting an economic and ecological threat.

Root rot caused by the soil pathogen *Phytophthora cinnamomi* is a common and fatal disease in many ornamental taxa, including members of genus *Rhododendron* (2, 3). Although professional growers have learned to reduce disease incidence in container culture through the use of suppressive composted bark mixtures (4) or fungicide drenches (5), this ubiquitous pathogen remains a problem for plants grown in native soils. Practically speaking, root rot disease control is a perpetual and challenging issue for nurseries, landscapers, and homeowners who field plant rhododendrons and azaleas, especially where drainage is poor. Furthermore, problems with root rot in container culture may re-emerge with the industry trend towards recycling of irrigation water, because irrigation ponds can be a primary source of inoculum (2).

Genetically conferred host resistance represents an additional, sustainable line of defence against the disease. A number of earlier reports identified sources of root rot resistance among *Rhododendron* taxa. Benson (6) found that a majority (61%) of hybrid evergreen azaleas (subgenus Tsutsusi) exhibited moderate to high levels of resistance to *P. cinnamomi*. Hybrid groups of evergreen azaleas differed in resistance according to their taxonomic origins, so that the so-called Indian hybrids (derived from *R. indicum*) were much more resistant than the Kurume azaleas (derived in part from *R. kaempferi* and *R. kiusianum*). In contrast, resistance among scaly-leaved (subgenus Rhododendron) and non-scaly-leaved (subgenus Hymenanthes) rhododendrons is much less common. A comprehensive survey of hybrids and species from these groups in 1974 listed over 95% of the genotypes as susceptible (7) and a report on more contemporary cultivars found that 77% were susceptible (8). Among rhododendron, there are no taxonomic commonalities among resistant plants, suggesting multiple sources of resistance. The remaining group of horticultural importance – deciduous azaleas (subgenus Pentanthera) – has been evaluated on a limited scale. Two of the five North American and Asian species tested (as seed lots) showed some resistance (7).

Disease resistant rhododendrons and azaleas represent a valuable germplasm pool for breeding new cultivars that are better adapted to challenging conditions. A broader range of resistant hybrids is especially needed in the evergreen scaly and non-scaly rhododendron groups that are highly valued ornamentally but also the most susceptible. Root rot resistant plants would have an immediate benefit towards more sustainable nursery practices and improved consumer confidence, and they might expand new markets for rhododendrons, particularly in the southern U.S. and position the new hybrids for a warming climate. The predominance of azaleas, particularly evergreen azaleas, in the south, and the corresponding reduction in rhododendron culture in that region, suggests that *P. cinnamomi* disease is a key determinant to survival of these plants in warmer climates.

The research described here summarises a decade of work aimed at producing resistant rhododendrons. The focus has been on elepidote, non-scaly-leaved species and hybrids, primarily because this is an important ornamental group that is susceptible as a whole, and also because our goal is to add landscape value to the hardy ornamental elepidotes created by David Leach. To set the level of expectation, it should be stated that there are no disease resistant plants currently ready for introduction from this breeding program. The focus here is on technical and investigative efforts that address the following questions:

1) What are the sources (species and/cultivars) of resistance to *P. cinnamomi*?
2) How well is resistance transmitted to offspring by conventional breeding?
3) What resistant genotypes and breeding methods offer the best avenue for success (a question that is informed by the first two)?

Materials and Methods

A successful breeding program depends on an effective disease screen, that tests whether plants are resistant or susceptible and minimizes the chance of disease 'escapes' (false negatives). The protocol details have been published elsewhere (8) and are summarized briefly here. Rhododendron plants are grown as rooted cuttings in 4 inch tree bands (cultivars and species screens) or as 6-8 month old seedlings in flats (screens of breeding populations) prior to inoculation. The sterile (autoclaved) potting mix is 1/1, peat/perlite, which is very conducive to root rot disease. For inoculum, a single isolate *P. cinnamomi* (#544) is used in most experiments – this was the isolate used in the first report of root rot disease on rhododendrons in 1975 (7). Culture of the fungus, preparation of inoculum, and standardization of dose (10 cfu/plant) follows the procedures of Schmitthenner et al (9). The inoculum is injected just below the surface of the potting media, near the crown of each plant. At that time and thereafter, the pots are watered three times weekly to maintain them near field capacity, and the greenhouse is kept warm, with nightly lows of 20ºC (68 F) and daily highs of 25ºC (76 F).

Included in all experiments are uninoculated controls as well as susceptible checks, known susceptible plants that act as indicators of proper disease conditions. Once shoot symptoms appear, mortality rates are recorded weekly in DAI, days after inoculation. The time course of most experiments is 2.5 – 3 months, depending on the size of the plants (seedlings v.s. rooted cuttings). At the end of an experiment, the roots of surviving plants are washed and rated on a disease scale of 1-5 based on symptoms (1=healthy root, 2=fine root necrosis, 3=coarse root damage, 4=crown rot, 5=dead plant). Rescue of survivors involves repotting them in a composted bark mix and drenching with the fungicide Subdue, conditions which help to suppress the disease.

Identification of Root Rot Resistant Rhododendrons

A list of resistant elepidotes rhododendrons appears in Table 1. This list is a compilation of two studies of *Phytophthora* root rot, a 1974 report (7) that screened 336 cultivars and 198 species from four Rhododendron subgenera, and a 2002 study (8) that tested 51 elepidote cultivars introduced after 1974. Combined, 31 of the 358 elepidote cultivars showed high or moderate resistance, characterized by healthy roots or fine root necrosis, respectively, following inoculation with *P. cinnamomi*. Among species, only 3 resistant elepidotes have been found to date (7). Not all these resistant cultivars and species are suitable for breeding plants that are both disease resistant and cold-hardy, and the plant list in Table 1 represents a subset of 17 cultivars and species with freezing-tolerances suitable for breeding USDA zone 5 hardy plants (H5 on the British scale).

Table 1. Disease resistant cultivars and species found among elepidote rhododendrons (subgenus Hymenanthes)

High Resistance (root score <1.5)*	**Moderate Resistance (root score <2.5)***
Caroline	Anna H. Hall
Disca	Bali
Ingrid Mehlquist	Crete
Normandy	Peter Tigerstedt
Prof. Hugo DeVries	Prize
Red Head	Rocket
Vernus	Samoa
R. hyperythrum	Wilbrit
R. pseudochrysanthum	

* See Materials and Methods for explanation of numerical disease rating scale.

In addition to identifying sources of root rot resistance, these studies have provided other information of value. Root rot disease ratings varied continuously among genotypes, ranging from most resistant (root score =1.3) to most susceptible (root score =5). This continuum of response to infection is characteristic of host defense systems controlled by multiple genes, and the results from *Rhododendron* are similar to those found in other taxa when challenged by *P. cinnamomi* (10, 11). There appears to be no immunity to the disease, since even the most resistant plants show some evidence of infection and necrosis. In some cases, resistance appears to be at best 'partial', since it can be overcome by increasing the level of inoculum (8) or by pre-stressing plants with drought or flooding prior to inoculation (12).

Most elepidote hybrids are produced from interspecific crosses, and the cultivars in Table 1 comprise a diverse array of species. There appear to be no taxonomic commonalities in this resistant group, and it is likely that different resistant genes and defense mechanisms are represented by the various cultivars. However, the two resistant species, *R. hyperythrum* and *R. pseudochrysanthum* present the possibility of shared resistance genes, for although they are taxonomically separated at the subsection level, they occupy a similar range in Taiwan, and hybridize naturally (13).

Gains from Selection and Breeding Values

Some of the resistant cultivars (Table 1) are no longer widely propagated and distributed, having been replaced by varieties that are more popular or more contemporary. The flower color palette of this group is narrow, ranging from white to strong pink (*R.* 'Red Head', the most strongly pigmented, has proven sterile in our breeding program). Therefore, in order to broaden the ornamental array of resistant cultivars, susceptible plants with other flower colors (yellows, reds, purples) will need to be hybridized with one or more parents from the resistant group. The important questions at this stage are 1) how well does the resistant trait transmit from parent to progeny (breeding value)? And 2) how much gain in resistance can be achieved in one breeding generation (gains from selection)?

A recurrent selection method of breeding was used to estimate gain from selection in several populations (Fig. 1).

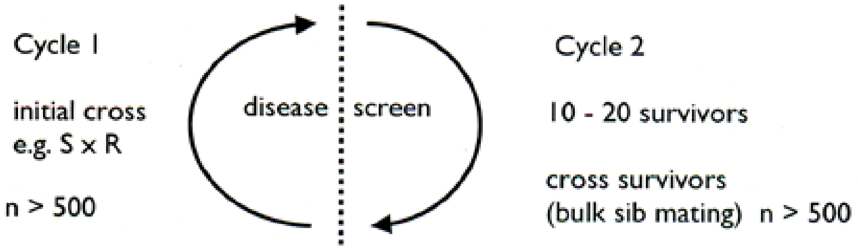

Figure 1. Schematic of method for disease resistance breeding.

A resistant plant is crossed with a susceptible plant in Cycle 1 and seedlings are grown and inoculated. After 8 – 10 weeks of screening, most plants have died, and the remaining survivors are checked for root symptoms, rescuing those with healthy or only slightly diseased roots (i.e. symptoms limited to fine root damage). Survivorship is generally about 2-5% of the starting population size. These survivors are grown on to flowering stage, then a Cycle 2 population is made by collecting pollen from all siblings, physically bulking it, and pollinating the same plants as seed parents. Although not a genuine diallel cross, this bulk mating is akin to making crosses among the surviving progeny in all possible combinations.

Gains in resistance from selection are apparent if the Cycle 2 mean performance is better than the Cycle 1 baseline, i.e. there are more survivors at a given point in time. Increased resistance in Cycle 2 is evidence that 1) the disease screen is working and 2) the resistance trait can be transmitted to progeny (heritable). Results from two breeding experiments are shown below in Fig. 2A and 2B.

Figure 2. Disease progress plots comparing Cycle 1 (C1) and Cycle 2 (C2) generations in two populations. (A) *R.* 'Rio' (susceptible) x *R.* 'Rocket' (moderately resistant) and (B) *R.* 'Janet Blair' (susceptible) x *R.* 'Caroline' (highly resistant).

Resistance in these experiments is measured as a reduced rate of mortality. The cumulative response to inoculation is measured by calculating the area under each disease progress plot. In the first example (2A), a 40% gain in resistance was achieved by using *R.* 'Rocket' as a resistant parent, and a 28% gain resulted from *R.* 'Caroline' as the source of resistance. These results suggest that *R.* 'Rocket' would be a better parent than *R.* 'Caroline' for the purpose of breeding resistant progeny, i.e. the breeding value of *R.* 'Rocket' is higher. This is surprising in view of the fact that prior cultivar screens established *R.* 'Caroline' as highly resistant and *R.* 'Rocket' as moderately resistant (7). However, subsequent studies have substantiated the lower breeding value of *R.* 'Caroline'.

An example of equally resistant genotypes can differ in breeding value is shown below in Figure 3. Open-pollinated seed was collected from *R.* 'Caroline' and *R.* 'Disca', then sown and inoculated with *P. cinnamomi*. Two months post-inoculation, over half the progeny from *R.* 'Caroline' exhibited shoot wilting and necrosis while only a few of the *R.* 'Disca' offspring exhibited disease symptoms.

Figure 3. Differences in breeding value of two resistant parents, *R.* 'Caroline' and *R.* 'Disca'. Photo taken two months after inoculation of open-pollinated (OP) seedlings from each parent with *P. cinnamomi*.

Differences in gains from selection and breeding value in these experiments result in part from the diverse genetic backgrounds of the resistant genotypes. The species composition of the cultivar 'Rocket' is different from either 'Caroline' or 'Disca' (14), and, as noted above, different resistance genes and mechanisms may be involved. The contrast between *R.* 'Caroline' and *R.* 'Disca' is more perplexing because the latter is an offspring of the former (plus *R. fortunei*) and thus would be predicted to share genes for resistance. Unfortunately, it is impossible to predict breeding value in cultivars as genetically complex as interspecific rhododendron hybrids, and their usefulness in resistance breeding must be determined empirically.

Practical Resistance Breeding and the Importance of *R. hyperythrum*

At the present time, the list of resistant plants in Table 1 has been winnowed to four that are being used for the breeding program at the Leach Research Station, including three cultivars – *R.* 'Disca', *R.* 'Ingrid Mehlquist', and *R.* 'Rocket' – and the species *R. hyperythrum*. The cultivars provide an array of plant habits, bloom dates, and flower colors (white to pink) in addition to being disease resistant and cold hardy. However, most of the crosses have *R. hyperythrum* as a parent because we considered it to be the most promising source of resistance for development of commercially grown rhododendrons. Although *R. pseudochrysanthum* would also provide resistance and ornamental traits, we find that it is not as vigorous and easy to grow as *R. hyperythrum* in our climate, and therefore would be less suitable as a production plant in nurseries.

Rhododendron subsection Pontica has always been known for species that contribute key adaptive traits in hybridizing. Surprisingly, *R. hyperythrum* is one that has been underutilized in view of its disease resistance and ability to tolerate both cold and heat (13). This hardy species from Taiwan is one of the few elepidote rhododendrons that can grow in the southern U.S., where cultivation of *Rhododendron* is typically limited to azaleas. Because of its cold hardiness (USDA zone 6/British H5), compact habit, superior foliage, and floriferous displays, it represents an excellent source for introgressing resistance into elepidote hybrids that are also ornamental and cold hardy. Dr. John Thornton, a resident of southern Louisiana and veteran breeder of *R. hyperythrum* hybrids, has established their durability under field conditions normally conducive to root rot disease (www.azaleachapter.com/gulf_south.html and ref. 15).

To learn how to breed using *R. hyperythrum*, a study was conducted to test how much resistance could be obtained in first generation hybrids, and what percentage of *R. hyperythrum* in hybrids is needed to confer good levels of resistance. Crosses were made to generate seedling populations containing 100%, 50%, 25%, 12.5%, and 0% *R. hyperythrum* in their genetic background. At levels below 100%, the susceptible cultivar *R.* 'Calsap' was used as a seed parent. Seedlings were inoculated at the 6 month-old stage and scored for mortality rates over time, as described above. The results are shown in Figure 4.

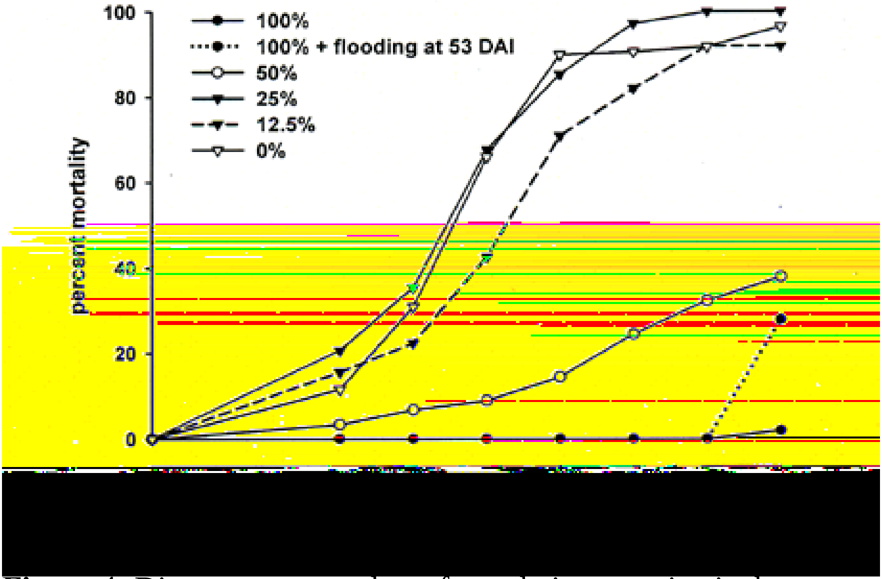

Figure 4. Disease progress plots of populations varying in the percentage of *R. hyperythrum* in their genetic backgrounds.

The results from Fig. 4 indicate that at a genomic level of 50% or higher, *R. hyperythrum* confers considerable resistance while at a 25% or lower there is no significant improvement in resistance compared to the susceptible check (0% level).

Comparisons of areas under the disease progress plots by 60 DAI revealed a 74.5% reduction in mortality (or gain in resistance) at the 50% *R. hyperythrum* level, compared to the 0% level. This is a much higher gain than those observed in earlier experiments (Figs. 2A and 2B), and unlike those studies, the increased resistance was in an unselected Cycle 1 population (i.e. had not been enriched for resistant genotypes). As mentioned earlier, the resistance observed in this experiment is not immunity to disease – given enough disease pressure, such as the buildup of inoculum in pots over time, or additional plant stress, such as flooding treatment (Fig. 4), the resistance observed at the 50 – 100% *R. hyperythrum* levels begins to break down.

By using repeated backcrosses and selection, it is theoretically possible to develop resistant plants that contain only the resistance genes from *R. hyperythrum* and very little else (near-isogenic lines). However, that approach to breeding is impractical and undesirable for ornamental rhododendron breeding. Given the lengthy time from seed to flowering, a backcrossing program would take too long, and it might also generate too much inbreeding and subsequent depression of vigor. Furthermore, a large genetic contribution from *R. hyperythrum* is desirable because it has many ornamental traits to offer in addition to resistance.

A more practical approach (one that has been put into use at the Leach Research Station) is outlined in Figure 5. It starts by making a pollen bulk from several *R. hyperythrum* genotypes (to reduce inbreeding in later generations), and using that species bulk to pollinate hybrids that are known to be good performers in our region. The example in Fig. 5 shows crosses made in the red group of hybrids, and similar numbers of crosses have been made for white, pink, yellow, and purple groups.

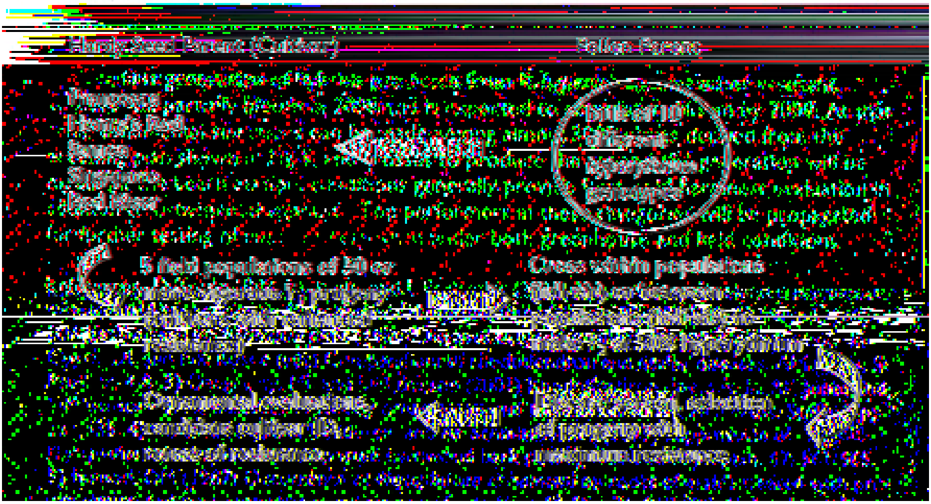

Figure 5. Breeding schematic for producing root rot resistant rhododendrons with red flowers in one or two generations.

The main difference between this breeding scheme and the one outlined in Fig. 1 is that the disease screen is down in Cycle 2, not Cycle 1. Because of the enhanced resistance gained with a 50% *R. hyperythrum* background (Fig. 4), it may be possible to select cultivars from Cycle 1 (F1) generation, providing there is enough flower color saturation and resistance to provide a novel commercial plant. Based on the experience of the first generation Thornton hybrids currently grown in the U.S., they are generally acknowledged by gardeners to be good performers in difficult (hotter) conditions. Full resistance, as well as deeper color saturation and superior foliage, would be found among F2 recombinants, where susceptible plants could be culled by efficiently screening thousands of progeny at the seedling stage.

A Breed of Rhododendrons for the Future?

Current and future ecological constraints present challenging conditions for gardeners and horticulturists. Our recreational pastime and livelihood are under pressure to conform to more sustainable practices that save water, jettison non-renewable resources, reduce chemical use, and minimize landscape alterations by choosing well-adapted plants. Predications of further global warming, changing rainfall patterns, and increased pest and disease problems do not bode well for *Rhododendron*, a genus that is fairly fussy in garden culture to begin with.

This breeding program is a way to address some of these issues by creating disease resistant rhododendrons, ones that may also have increased heat tolerance. Adaptation of these hybrids to current conditions in the southern U.S. would also predict their performance in northern areas that may some day be warmer. Use of root rot resistant hybrids in nursery production would also reduce the need for preventive chemical drenches.

The first generation of hybrids produced from *R. hyperythrum* and other resistant sources will partially bloom in 2008 and is expected to completely bloom in 2009. At that time, ornamental selections can be made among almost 3000 plants derived from the breeding plan shown in Fig. 5, and crosses to produce the second (F2) generation will be made. At the Leach Research Station, conditions generally provide for a cold hardiness evaluation in addition to ornamental appraisal. Top performers in these categories will be propagated for further testing of root rot resistance under both greenhouse and field conditions.

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Propagation of Rhododendrons by Grafting

Alan Clark

Selection of scions showing removal of lower leaves and length reduction.

All photos in this article by Alan Clark

This paper sets out to explain two types of rhododendron grafts.

Understock: *Rhododendron* ‘Cunningham’s White’. This very hardy hybrid is now widely used due to its easy rooting and compatibility with most Subgenus Hymenanthes species and hybrids. Some incompatibility has been noted with some forms of *R. bureavii* and some members of the Falconera and Grandia subsections. These should be grafted on to 4 year old seedlings raised from relevant open pollinated seed.

Terminal cuttings of *Rhododendron* ‘Cunningham’s White’ are taken in early August and are inserted one to a 4 inch pot, so that their leaves are positioned just above compost level. The following spring the terminal bud will produce an upright shoot to which a scion can be grafted during late July through to early September, using the reverse saddle grafting method. Internodal cuttings can also be used for side veneer grafts. Trays can also be used and placed within a simple home made frame within a polythene tunnel. Due to the fact that the scion and understock are the same age, union is usually very rapid.

Rooting medium:

Well soaked standard grade Perlite, mixed with approximately 10% by volume, sieved medium grade moss peat or a suitable lime free compost.

Scion preparation:

Scions should only be collected from healthy plants and preferably without flower buds. Lower leaves should be removed and remaining foliage should be shortened by one third, to reduce water loss.

Types of grafts:

Nurse or cutting graft: This method entails joining two unrooted cuttings and then treated as one cutting.

Reverse saddle and side veneer graft. Experiments have shown that better results are obtained by removing the completed graft and planting in a well drained lime free compost within the frame.

Above: Reverse saddle graft after 9 months

Right: Cutting grafts, root initiation and tying methods

Cutting Grafts:
Right: Understock & scion
Below: Method of grafting side veneer

No artificial heat is used with the methods described above, grafting is normally complete by the following May, when the scion’s terminal bud should be pinched out to induce branch formation.

If inter nodal cuttings and the side veneer method is employed, all the under stock material above the graft union should be removed once the scion is in active growth.

Some species within the subsection Taliensia have been known to “sulk” and may take 12 months before the scion is truly active.

A Practical Approach to Air-layering Rhododendrons and Azaleas

John M. Hammond

Vice-President, Scottish Rhododendron Society,

Some thoughts and suggestions for air-layering old, difficult to root, or storm damaged plants

Introduction and historical perspective:

In many walks of life there is a tendency for new materials, techniques and technology to displace the traditional materials and the time-tested ways of doing things. Gardening and horticulture are no exception to this trend and the "new-fangled" ways of approach often got "short-shift" from the highly skilled Head Gardeners of yesteryear. I recall the late John Basford, Head Gardener for many years at Brodick Castle, and a friend and mentor with a most practical outlook on all manner of horticultural subjects, instructing me on a number of occasions to 'do it the Basford way!' And, viewed in retrospect, his techniques invariably worked.

Many commentators have suggested that air layering does not work, or at best the results are generally poor. I remain unconvinced that some of these commentators have actually carried out air layering themselves, or have done other than trial run, as their comments and approach do not appear to add up to a viable methodology. The results that I have achieved over a number of years have been reasonably good and, given that the methodology is one of the oldest techniques of vegetative propagation, this should not be a surprise.

More than 4000 years ago air laying was successfully tried in China and subsequently became known as 'Chinese layering' as a result of its continued use in that country. Around the start of the eighteenth century the French began referring to it as 'marcottage', but then we can expect the French to be different. In the early 1900's the technique was referred to as 'layering by circumposition' and was said to be 'an ingenious and highly successful plan.' Basically, the plan was 'to a branch that has been tongued or ringed a pot full of soil is fixed. The pot is first split in halves, each half being clasped about the stem and subsequently filled with soil'. Unfortunately, the writer did not explain how the soil was retained in the pot, what maintenance was required and details of how to grow on the layer. Somewhat later the methodology became known as ‘aerial-layering’ and more recently as ‘air-layering’.

Getting the timing right for Air-layering:

Plants can be layered at any time, except during freezing weather or when frosts are forecast. Many of the old-time gardeners carried out their air-layering of rhododendrons and azaleas in late summer or early autumn, however, this probably had more to do with the fact that labour was more readily available at this time of year. The best time to install air layers is in the spring. I usually do this type of work immediately after the plants have flowered, as the majority of the growth season is still to come.

Air-layering techniques:

So let’s begin by discussing the tools and materials required. Very few tools are needed; a pair of clean secateurs, a clean sharp knife and a pair of scissors. Very few materials are required; a supply of damp sphagnum moss, half a bucket of fine or medium chopped bark, a black polythene refuse sack [cleanliness counts, so always use a new bag] and a supply of 6 inch [15cm] long plastic cable ties. And, what you also need plenty of is a commodity that is not often readily available....... patience! Getting prepared is a straightforward process that only takes a few minutes. And, it only takes a few minutes to complete each air-layer once you are familiar with the methodology.

Air layering is a relatively simple process, but in my experience there are a number of pitfalls that need to be avoided if any degree of success is to be achieved. At the outset it is important to choose a branch rather than a twig to layer. I usually select a branch that is 18 to 24 inches [45 to 60 cm] long, is itself branched in two or three places and it also needs to be sturdy enough to support the layering materials. It is preferable to choose a branch that is out of full sun, not only to keep the layer a more even temperature, but to prevent the medium inside the wrapper completely drying out. In overall terms the layering materials need to be as lightweight as practicable. Choosing too small a branch inevitably means that it is under stress throughout the layering process and some form of support is required; it also leads to a very small root-ball that does not have much of a chance in life when the branch is severed and potted on.

Roll out the black polythene sack and, leaving the sack itself unopened, make a number of 10 inch [25 cm] wide double-thickness strips by cutting directly across the sack. Avoid the use of large clear plastic sandwich bags for wrappers, or other clear/translucent plastic material, as excluding light from the wounded branch is extremely important when encouraging roots to start growing. We are aiming to replicate conditions underground and a double thickness black polythene wrapper is ideal in this regard. Mix together, in proportion by volume in a bucket, one third chopped bark to two thirds sphagnum moss, breaking up the sphagnum moss with your hands whilst adding water to the mix until it is relatively wet. Avoid using sphagnum moss by itself as this leads to the plant generating what are termed “water-roots” [fine white roots that are soft and easily broken] as it can be problematic getting these established and thriving in soil at a later stage in the process. It is time to wound the selected branch in the area that the wrapper will be applied. I have experimented with four different types of wound and each has been successful. However, the time-tested method is to cut a 2inch [5cm] long tongue around one third the depth of the branch. It is very important to keep this tongue open throughout its length, otherwise the cut will heal and no roots will be produced. Avoid the use of any type of wood to keep the tongue open, including matchsticks and toothpicks, as this often leads to infection over a long period of time in moist conditions. I find a few strands of sphagnum moss rolled up and inserted along the length of the tongue works well. Some authorities recommend the use of hormone rooting powder but I avoid its use, as it is difficult to gauge whether the correct amount has been applied. Too little powder has no effect at all; too much powder has an adverse effect on rooting, whilst an overdose can lead to rotting and dieback. I find that it is an unnecessary complication and manage well without it.

It is now time to put the wrapper in place. What we are seeking to achieve as the end product is a wrapper that looks like an enlarged Christmas cracker rather than a ball! So bear this in mind as the wrapper is applied. Take a large handful of the sphagnum moss and bark mix [around one litre]; this needs to be wet but not saturated, so wring out any surplus water. Form the mix into a cylinder around the branch then wrap it securely in place with the black polythene to create a tube. Avoid wrapping the mix too tightly as it is important that the mix remains wet, but it is equally important not to leave any large air pockets inside the wrapper once it has been sealed. Fix a plastic cable tie securely about 1.5inches [4cm] from each end of the wrapper, making sure that the wrapper is tightened to the branch. Do not over tighten either end of the wrapper, as it is important not to damage the bark. Open out the ends of the wrapper to look like the ends of a Christmas cracker, as the upright end will act as rain collector.

Some commentators suggest using tape or wire to completely seal the

Black polythene arranged in a “Christmas Cracker”

Photos in this article by John Hammond

wrapper to make it airtight. It is a myth that a completely watertight or airtight seal can be achieved on woody plant material; trying to make it so is a mistake as excessive pressure will cut into and ultimately ‘ring’ the bark. Any ‘ringing’ of the bark is counter-productive and the branch will tend to die slowly, particularly before the layer has formed roots of its own. In practice, the lower end of the wrapper will allow any surplus moisture to gradually drain away over a period. I usually spray a little water into these “rain-collectors” when watering the garden during a particularly dry spell. If the finished product makes the branch a little top-heavy then loosely tie the branch to an adjacent branch for added support.

And, next comes the difficult bit! Leave the air-layers undisturbed for at least two full growing seasons. There are no exceptions to this rule. Some

The two layers on the previous page unwrapped to show successful rooting

old head gardeners recommended leaving layers in place for three seasons. This is where many gardeners tend to fail as their curiosity wins out, they have a look to see whether any progress is being made and they break off the fragile root system before it has had time to mature. No maintenance is required but plenty of willpower is needed. A good indicator to look for in many instances, particularly with deciduous azaleas, is once the air-layer has rooted the plant begins to send out several new branches from its main roots. Somehow the plant seems to know that it is going to loose one or more of its branches. In the case of large rhododendron plants there is nothing to show that rooting has commenced.

After two growth seasons carefully unwrap the black polythene taking care to support the new roots. If the roots are mature then sever the rooted branch about 1 inch [3 cm] below the roots. Carefully tease and spread out the roots, plant in a wide container, positioning the roots of the new plant against one side of the container and make sure the growth is vertical. Get a piece of cane and insert this in the soil so it runs diagonally across the container and secure the main branch of the new plant to it with some twine; much in the same way as you would secure a newly planted young tree with a cross-stake. To minimise the ‘shock’ to the layer, grow it on in medium chopped bark as this is a relatively open medium and is a main component of the “mix” in which the layer rooted. I then place the container in the shaded area of a cool greenhouse for a year. After this additional year’s growing season is over I then lift the plant, or take the container out of the greenhouse, and find a home for the plant in a dappled shade area of the garden, firmly securing the main branch in position with a diagonal cross stake to prevent wind damage to the relatively young rootball. By this stage, and bearing in mind that I tend to root branches that are two or three years old, the new plant itself is now three years old, and the main branch is usually 30 to 36 inches [75 to 90 cm] tall. So, we have propagated a good sized viable plant.

Why use Air-layering?:

Air-layering is a useful technique that can be used to propagate a wide range of both easy and difficult to root woody plants without resorting to specialised equipment or disturbing the parent plant unduly. The end products have cost you virtually nothing other than a minor investment of your time and a major investment of your patience. Many old hybrids are notoriously difficult to root from cuttings, as are Ghent azaleas, and air-layering presents an easy alternative. Over the years many of us have had the unfortunate experience of having large plants blown over on to their side by the wind. Sometimes the root-ball is lifted out of the ground, other times the roots are torn out. Either way, this damage presents a problem, particularly if there appears to be little hope of the plant being viable even if a means could be found to return it to the upright position. Providing that the fallen plant does not present a major hazard and that at least some of the roots are still in the ground, or the root-ball can be back-filled with soil, then it is worth suggesting “Why loose an old friend without attempting to propagate it?”

The technique is particularly useful for propagating a replacement for an elderly upright plant that looks like it may have a limited number of years ahead of it. In instances of this type it is suggested that three or four air-layers are attempted, each on a different branch, so there is an increased chance of a successful result.

In conclusion:

Even the most able nurserymen, with a lifetime in the trade, experience an inexplicable level of propagation failures from time to time. So, it should not be surprising that the gardener must expect to have a significant number of losses along the way. The point to be made here is that you should not be overly concerned if a particular approach to propagation seems somewhat inconsistent when you first have a go. By all means review your way of approach and your results, but don't let this get in the way; there is more to be gained by moving on.

After almost thirty years with a hands-on interest in propagation I am still learning, my success rate is still slowly improving and I am gradually able to successfully propagate an increasing range of both species and cultivars using a variety of methods. There is no substitute for getting your hands dirty and gaining some hands-on experience. If you do not have a go you have no opportunity of getting it right first time, second time, or at all. Air-layering is a particular easy methodology. The cost is almost negligible, just a few basic tools are needed and a few ordinary materials that most gardeners have lying around. It goes without saying that difficult to root plants can be difficult to find at a garden centre, or can be costly at a specialist nursery. One word of warning! Difficult to root plants are often sought after by knowledgeable individuals, including some who have little, if any, respect for other people's property. Layers not only grow roots, some have a tendency to grow legs as well, so make sure your layers don't get the opportunity to walk. Every successful layer provides another plant for the garden, or a plant to exchange with a friend, or a plant to be auctioned at a future meeting of your favourite gardening organisation. All it takes is a little of your time, so get out there and have a go.

Maddenia Rhododendrons of California

Chip Lima

***Rhododendron* ‘Mi Amor’**
All pictures in this article by Chip Lima

Coastal California has a moderate Mediterranean climate which allows an enormous variation of plants to thrive in a multitude of microclimates. There are no fewer than 12 recognized microclimates in Northern California, an area half the size of the UK, and some of these are particularly wet. The wetter areas are protected from the heat and drought of the interior USA by the Coastal Hills and by the Sierra Nevada Mountains to the east. Along the coast, the cold Humboldt sea current rises to the surface of the ocean and the cold moist maritime air accumulates and condenses into summer fog. This acts like an air-conditioner for the region, and brings with it water as fog drip to an area that would have no measurable summer rain from May to September. Rhododendrons grow well in the north coastal locations and in areas where the summer fog spills into the interior of the state through gaps in the mountains. (1)

In 1880 Joseph Hooker contributed the first *Rhododendron maddenii* to the rhododendron collection at the Strybing Arboretum from collections in the UK. The craze for growing azaleas and rhododendrons was increased with the Panama-Pacific Exposition in San Francisco in 1915. Immediately after the Exposition, John McLaren created the Rhododendron Dell in Golden Gate Park where he planted recently imported rhododendrons from Europe and Japan. Other collections of rhododendrons were located at the University of California at Berkeley just prior to 1945, and in 1961 Ernest Shoefer began the Mendocino Coast Botanical Garden at Fort Bragg. (2)

Over the next 70 years success with growing Maddenia and Vireya rhododendrons has been slightly limited by severe arctic cold spells, periods of drought, an increase in thrip insects and the epidemic of *Phytophthora ramorum*. Otherwise, they are still well suited to growing in the coastal fog belt.

A comprehensive collection of most Maddenia species can be found growing in California. Many of the species are easy to confuse with one another because superficially they are similar, especially in the *ciliicalyx* aggregate. Another cause for confusion is the continued use of obsolete specific names, especially within *Rhododendron maddenii* including “calophyllum”, “polyandrum”, ssp. *crassum*, “odoriferum”, “brachysiphon”, “chapaense” and “manipurense”. However, when each of these plants is seen in flower and fully grown, you understand why some people would prefer to split rather than lump these plants based on appearance. Certainly these selections are valid in horticulture, but in the wild and taxonomically, they are likely to be part of an evolving and varied species.

Not only are selections of *Rhododendron maddenii* distinct in their appearance, they also vary widely in their chromosome numbers within the species, and it is likely that it needs to be sorted out with DNA studies. It has been published that the earliest flowering individuals of a series of rhododendrons are those which are diploid and that polyploidy often causes later bloom times. In cultivation, polyploid hybrids most often flower later. Later flowering allows the flowers to escape damage by frost, thus later flowering polyploids may be able to survive higher altitudes. It has been found that within the species *R. maddenii*, the chromosome numbers are higher from collections originating at higher altitudes. (4) (5) (7)

Outstanding among the Californian collections are many species rarely seen in the UK and also those species, which appear to differ from the specimens represented in the UK. *Rhododendron burmanicum* is sometimes represented in the UK by what is known as the "Cox hybrid" which has a deep yellow corolla. Generally the corolla is cream to pale yellow in the true species. *R. carneum* is noteable for the dense silver scales on the leaf undersides as grown in California, and the pink striped corolla. *R. ciliatum* is variable, with deep pink to white flowers and most noticeable is the bright red calyx when grown in full sun in California. *R. cuffeanum* may be a cultivated form of *R. formosum*. *R. dendricola* is separated from *R. taronense* in California and is usually represented by Evan's form. *R. parryae* is prevalent in old collections and looks very different from the selections at RBGE, most noticeably because of the rugose leaves and the buds which appear sunken and covered by the leaves which have very short petioles. *R. valentinianum* is sometimes represented by hybrids rather than the species.

Also imported from Europe, along with the species were many Maddenia hybrids developed previous to 1940 including: *Rhododendron* 'Lady Alice Fitzwilliam', *R.* 'Cilpinense', *R.* 'Countess of Haddington', *R.* 'Fosterianum', *R.* 'Princess Alice', and *R.* 'Sesterianum'. Californians soon created their own hybrids. With the large selection of species some of the new hybrids include species from outside the subsection Maddenia, especially *R. chrysodoron*, *R. cinnabarinum*, *R. edgeworthii*, *R. leucapsis*, *R. moupinense* and *R. yunnanense*. The earliest of the hybridizers was Dr. Bowman in Fort Bragg. He corresponded with British rhododendron collectors to start his collection. By 1930 azalea hybrids were created by the Nuccio family in the Pasadena area. Soon Fran and Maury Sumner were adding to the selection of hybrids in San Francisco and Aptos, and Fleurette and Jack Evans were crossing Maddenia and also *R. cinnabarinum* with *R. maddenii* in Oakland. In the 1960's and onwards, the most prolific hybridizer was Bob Scott of Kensington. Many of the Californian hybrids remain undescribed and are unregistered, confusing the nomenclature. (2)

The far south of California is well known for growing great azaleas, and with frost protection, grow a selection of Vireya rhododendrons. Unfortunately, the lack of summer rainfall and the quality of the irrigation water complicates the cultivation of many rhododendrons, including subsection Maddenia. However, the Mildred Methias Garden and private growers successfully cultivate many of the more heat tolerant species and hybrids as far south as San Diego and the Los Angeles area. The more successful area for growing subsection Maddenia is further north, starting around the Monterey Bay Area, where there is a wetter, moderate climate with frequent summer fog.

On Monterey Bay in the town of Aptos, Fran and Maury Sumner planted a rhododendron garden in a valley of redwood and coastal live oak trees, well situated to catch the fog and protected from severe cold. They named this garden Monte Toyon. Acres of land were closely planted with species and hybrids. This was a place to evaluate their own hybrids. They also had a smaller patch of land in San Francisco.

Above: Fran & Maury Sumner
Right: *Rhododendron* 'Owen Pearce'

The most outstanding of their hybrids is *Rhododendron* 'Mi Amor', grown since 1961. It received an Award of Merit from the RHS in 1975 and a gold medal from the ARS. *R.* 'Mi Amor' is still one of the most popular selling Maddenia hybrids in California. The large flowers measure 125mm x 125 – 150mm, have reflexed corolla lobes, are white with a yellow throat and are fragrant. Some would say the scent is not pleasant. The leaves are 130mm x 30mm and are deeply veined. The plant grows quickly to 2m in 10 years. With regular pinching out of the new growing tips the plant can be kept more compact and lower. Some of their other hybrids include *R.* 'Owen Pearce', (*R.* 'Saffron Queen' x *R. burmanicum*), which is a very reliable good grower and remains compact, grows to 1.2m in 10 years. It flowers late enough to miss any frosts, but it is a little frost tender. The large flowers are 50mm wide and are brilliant green in bud turning to yellow green. *R.* 'My Lady', (*R.* 'Fosterianum' selfed), is especially compact and covers itself with white flowers much like an azalea. The flowers are noticeably flat and thick in texture, but are not fragrant. As with many of the Maddenia hybrids, when grown outside in bright light, the flowers can be pink striped on the reverse and yellow throated but when grown indoors they are perfectly white. *R.* 'My Lady' rarely grows more than a metre tall and the leaves are small, glossy, bullate and deep green. *R.* 'Martha Wright', (*R. burmanicum* x *R.* 'Fragrantissimum'), is often grown indoors in the UK for its fragrance, which to some is a mixture of lemon and nutmeg. The plant is not densely covered with its bullate leaves, and grows upright to 1.2m. *R.* 'My Guy', (*R.* 'Owen Pearce' x *R.* 'Mi Amor'), is an upright growing shrub to 1.2m in 10 years. The large 125mm x 70mm flowers are frilled, palest yellow with pink markings in clusters of 5 to 13 per truss. The fragrance is slight. Many other hybrids remain un-named at Monte Toyon but have found their way into other gardens which result in many undocumented hybrids, some worthy of naming such as the deep yellow cross of *R. burmanicum* x *R. dalhousiae*.

Some other enthusiasts of Maddenia rhododendrons in the Monterey Bay Chapter include Mike McCullough, who is now the chairman of the group, Nancy Ledyard who has grown many of her own un-named hybrids and Alan Korth who had bred many successful elepidote hybrids and deciduous azaleas. Dave Hixson grew *R. edgeworthii* x *R. ciliicalyx* ARS 81-738 seed lot and named a selection *R.* 'Fragrantissimum Improved'. This has turned out to be a

Opposite Page:
Rhododendron
‘My Lady’

Right:
Nancy Ledyard &
Alan Korth

Below:
***R.* ‘Alfred Martin’**

very successful compact, short, floriferous plant for gardens, but it is not derived from *R.* ‘Fragrantissimum’ and it does not have the same intense fragrance. It is still a great improvement on the floppy almost vine like *R.* ‘Fragrantissimum’.

Moving further north to Oakland and the Lakeshore Chapter of the ARS there are several notable creators of hybrid Maddenia. Fleurette and John Paul (Jack) Evans made some terrific selections of species. One of the most popular Maddenia when in bloom is *R. dendricola* Taronense Group Evan’s form because it has one of the best and most intense fragrances of all. The flowers open in succession over many months. This shrub also grows only to about 1.2m tall and 1.5m wide in 10 years, however it is not very cold hardy, only to -5 Celsius for old wood and the flower buds no more than to –3° Celsius. Another frost tender selection of a species by the Evans’ is *R. nuttallii* ‘John Paul Evans’, which has deep purple metallic peeling bark and new growth. The flower is more upright with a yellow throat but it is less pleasantly scented, like paperwhite narcissus to some. A very unusual hybrid between *R. veitchianum* and *R.* 'Else Frye' was named for Paul Molinari. It has outstanding foliage with deeply veined very ciliate leaves which catch dew and fog readily. The flower is fragrant but ordinary and the shrub is very leggy, and can be grown like a shrubby climber. Another hybrid which has stood the test of time and proved it is tough is *R.* 'Alfred Martin', (*R. edgeworthii* (*bullatum*) x *R.* 'Else Frye'). It has leaves similar to *R. edgeworthii* which are bullate, shiny and with a thick indumentum on new leaves and on the underside of old leaves. The flowers are 70mm across, white with pink stripes and fragrant.

William Moyles is well known for his work establishing the Vireya garden at Lake Merrit and his years of work running the vireya seed list, but he has also created several hybrids in subsect. Maddenia. Possibly his best hybrid is *R.* 'Donatella', which is *R.* 'My Lady' x (*R. burmanicum* x *R. chrysodoron*). It has large, deep yellow, flat, open flowers with contrasting red bud scales. It is also a good compact grower with deeply veined shiny dark green leaves. Another great selection is called *R.* 'The Winner', as it combines the red striped outer flower of *R. dalhousiae* var. *rhabdotum* with the light yellow flower of *R.* 'Saffron Prince' and has a very large flower. Bred for compact growth and heavy flowering are *R.* 'Taos', (*R. carneum* x *R.* 'Harry Tagg') which is pinkish purple, and *R.* 'Capuccino', (*R.* 'Winter Lights' selfed) F2, which is cream coloured with yellow buds and throat.

Another East Bay hybridist is Howard Kerrigan, who created some of the most fragrant hybrids. *R.* 'Heaven Scent', which is *R.* 'Fragrantissimum' x *R. burmanicum*, is strongly scented of sweet nutmeg, creamy yellow flowers are freely produced, and the plant is robust to 1.2m in 10 years. Unfortunately its name has been used and registered for a deciduous azalea. *R.* 'Mysterious Maddenii' has caused confusion because the parentage was not available, but it is now known to be *R. parryae* x *R. taronense*. This is an unusual plant in that it prefers full sun and has branches which flop and build upon themselves making a well shaped shrub which will cascade down over a wall. The intensely fragrant flowers are mostly white tinged pink and are large, to 150mm wide. Also, it develops beautiful peeling bark on its main trunks, as does its parent *R. parryae*. *R.* 'Virginia Stewart' is *R.* 'Countess of Haddington' x *R. nuttallii* and it is unusual in that it has large foliage similar to *R. nuttallii* on a relatively low spreading plant. It also has intensely fragrant flowers which are white blush pink and yellow. The flowers are slightly smaller than some *R. nuttallii* hybrids in great profusion. Roy Hudson's name sake is a cross between *R. burmanicum* and *R. nuttallii*. The flowers are particularly frilled, white with a yellow throat and strongly fragrant. Multiple flower buds are produced, so it flowers heavily. It grows to 1.2m in 10 years.

Two other hybrids worth mentioning are *R.* 'Charles Phillips' and *R.* 'Ruth Wakefield Peck'. *R.* 'Charles Phillips', bred by Phillips and Connelly of Oakland is noteable for the way it covers itself with pink buds and white flowers on a very tall shrub to 3.7m in 10 years. The pollen parent was *R.* 'Fragrantissimun' but the female parent is unknown. *R.* 'Ruth Wakefield Peck' is a new hybrid soon to be registered by John Koelsch of San Francisco. It is another cross between *R. burmanicum* and *R.* 'Mi Amor' but stands out from the rest because the pink tinged buds open up deep yellow tinged pink. The plant is very upright to 2m in 10 years with deeply rugose leaves typical of *R. nuttallii* hybrids.

The most prolific breeder of subsection Maddenia hybrids was Bob Scott of Kensington, who at one time managed what is now the Asian section of the UC Berkeley Botanical Garden. With the intention to produce more compact heavily flowering hybrids he introduced the species *Rhododendron moupinense* into many of his crosses and created some very complex hybrids now referred to as Maddenia complex. Another goal was stronger flower colour, to which he added *R. xanthostephanum* to the yellow breeding line and created his own complex pink hybrid involving many species including *R. moupinense* 'Dark Rose'. After Bob's death, some of his crosses were named and registered by Paul Molinari of Enjoy Rhododendrons Nursery in Occidental.

Of the yellow hybrids there are three which stand out. *Rhododendron* 'Joy Ridge' is a cross between *R.* 'Rose Scott' x (*R. burmanicum* x *R. chrysodoron*).

Left:
Rhododendron
'Rose Scott'

It has beautiful large flowers which are a blend of yellow with touches of pink, and the resting flower buds are red. The shrub has dark green shiny leaves and is a vigorous compact grower which prefers shade in California. *R.* 'Butterhorn' is a cross between *R.* 'El Dorado' and *R. dalhousiae* var. *rhabdotum*. It too has large deep butter yellow flowers in a pendulous truss, very hairy attractive leaves and grows strongly. It is late flowering, in May in California and later in the UK. The darkest yellow hybrid is *R.* 'Meadowgold', a hybrid between *R. burmanicum* and *R.* 'Lemon Mist'. It is so deep yellow it has been said the flowers look plastic. The short shrub is only 80cm after 10 years and covers itself with blooms. Unfortunately, *R.* 'Meadowgold' is difficult to root from cuttings.

Left:
Rhododendron
'Meadow
Gold'

Below:
Rhododendron
'Saffron
Meadow'

Other yellows include *Rhododendron* 'Saffron Meadow' which is probably Bob's best yellow. It is spreading and only 80cm tall after 10 years. The leaves are very dark green and are a perfect background for the deep yellow flowers with prominent brown anthers. *R.* 'Lemon Mist' is so low and dense it is like a rock garden plant, growing no higher than 80cm in 10 years. The new growth is covered in hairs and scales and looks like it is dusted

with cinnamon. The small flowers are produced in profusion and are medium yellow. It is a cross between *R. xanthostephanum* and *R. leucapsis*, so is not a Maddenia hybrid. A later hybrid is *R.* ‘Amber Moon’, which is a complex *R. burmanicum* hybrid crossed with a complex *R. moupinense* hybrid. The flowers are a mix of amber and butter yellow fairly early in the season. The shrub is low and dense and can get leaf scorch unless it is in shade. (slide 56,58,61)

More than once hybridizers have tried for a red lepidote. Bob Scott nearly achieved this with his hybrids *Rhododendron* ‘Vuna’, *R.* ‘Heartthrob’, *R.* ‘Taveuni’ and *R.* ‘Cherryfields’. *R.* ‘Vuna’ is the deepest coloured, starting as a maroon black flower bud and opening deep rose red fading to rose with a red eye. It has a light sweet fragrance detectable indoors. The shiny small foliage and

Top: *Rhododendron* ‘Lemon Mist’

Left: *R.* ‘Vuna’

Rhododendron
‘Taveuni’

the peeling stems look similar to a more compact version of *R. moupinense*. Its parentage is complex: [(*R.* ‘Rose Scott’ x (*R. burmanicum* UCBG x *R. moupinense* ‘Rose’)] x [(*R. johnstoneanum* x *R. cubittii*) x *R. chrysodoron*)] x [(*R. johnstoneanum* x *R. cubittii*) x *R. chrysodoron*)] x *R.* ‘Scott’s Valentine’.

Rhododendron ‘Heartthrob’ is the same complex hybrid crossed with *R.* ‘Else Frye’. The flower colour is rosy pink with a red eye. *R.* ‘Taveuni’ is peach with a deeper red orange eye. It is the following cross: [(*R. burmanicum* x (*R. johnstoneanum* x *R. dalhousiae*)] x *R.* ‘Alfred Martin’. *R.* ‘Cherryfields’ is another rose red hybrid. These four hybrids are all low and compact and prefer afternoon shade in California, but not in the UK.

Some of Bob’s other hybrids include *Rhododendron* ‘Scott’s Valentine’, *R.* ‘Sabrina Adler’, *R.* ‘Rose Scott’, and *R.* ‘Smiley’. All of these are reliable landscaping plants in Northern California and are various shades of pink. *R.* ‘Smiley’ is fragrant, particularly dwarf and compact while *R.* ‘Scott’s Valentine’ will grow to 1.5m and is compact, has small leaves and red bark.

Oddly after producing so many complex crosses, a simple cross between two species produced one of Bob Scott’s most beautiful hybrids, *Rhododendron* ‘Apricot Perfection’. It is the cross between *R. burmanicum* and *R. moupinense*. It is compact but will grow vigorously to 1m tall and wide in 10 years. The frilly flowers are freely produced and the colour is apricot peach with a red eye.

Moving further north, Sebastopol is where Parker Smith gardens. One of his hybrids is called *Rhododendron* ‘Winter Peach’. It is *R. chrysodoron* open pollinated. Its name is self explanatory. Another gardener named Parle made an unusual cross, *R. ciliatum* var. *bergii* x *R. nuttallii* Sinonuttallii Group, called

R. ‘Parlevous’.

Fort Bragg and Mendocino are about 200 miles to the north, and this is another centre for subsection Maddenia hybridising. Eleanor and Bruce Philp ran Trillium Lane Nursery in Fort Bragg, and although Eleanor does not hybridise rhododendrons, she is a talented photographer shd B έ ons $ he°B έ odo Ȯ ъ

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called *R.* 'Humboldt Sunrise' with yellow, pink and apricot tones and a carnation scent. The leaves can be yellow green and the plant is wider that tall. Another hybrid from Druecker is *R.* 'Conchita'. It has very frilly deep pink flowers and is a cross between *R. ciliicalyx* and *R. moupinense*.

If there was to be a new winner of the best subsection Maddenia hybrid it would likely be *Rhododendron* 'Patricia Marie'. This hybrid by Braafadt and Granston is a cross between *R. nuttallii* and (*R. dalhousiae* x *R. lindleyi*). While very similar to *R.* 'Mi Amor', it is better in several ways. The fragrance is sweet and strong and never musky. The plant is shorter and the leaves are slightly smaller so it fits into smaller gardens better. The flowers have a pink strip on the outside of the flower similar to *R. dalhousiae* var. *rhabdotum*. It was only registered in 1997 by Singing Tree Nursery in McKinleyville, but it is sure to become very popular.

Also at Singing Tree Nursery, Don Wallace has crossed (*Rhododendron* 'Pink Trumpets' x *R.* 'Alice Eastwood') x *R. maddenii* ssp. *polyandrum* 'Pink' to create *R.* 'Heavenly Trumpets'. It has been a long time since hybrids between *R. maddenii* and *R. cinnabarinum* were grown because of the increase in powdery mildew. However, this hybrid seems immune to the disease and has beautiful long pink fragrant trumpets and red tinted new foliage. Don is also growing several new very dwarf varieties. These are *R.* 'Julian Bramley' with apricot yellow, spicy fragrant flowers and *R.* 'Sister of Mira Monte' with fragrant pink flowers. Both of these hybrids get no taller than 80cm and have very fuzzy attractive leaves. Don produces thousands of subsection Maddenia hybrids by growing them in the ground in open fields in full sun very near to the Pacific Ocean. Conditions here include occasional frosts, the wind off the ocean and full sunlight and so the rhododendrons grow more compact than usual. Plants which thrive here have to be tough and so are better varieties for general planting.

The hybrids of one hundred years ago gave pleasure to thousands of gardeners, but the new hybrids open many more doors into today's gardens. With increased cold hardiness, and the ever warming climate these rhododendrons are destined to be more popular because of their smaller size, fragrance and year round interest. Subsection Maddenia hybrids have come a long way from the ubiquitous white flowered, fuzzy leaved leggy hybrids of years ago. There are many plant shapes, flower colours, fragrances, foliage types and degrees of cold hardiness to choose from. Myself and others are continuing to create new hybrids, including crossing blue lepidotes with fragrant subsection Maddenia species and hybrids. There is renewed interest in healthier *R. maddenii* x *R. cinnabarinum* hybrids, and also more compact hybrids with year round interesting leaves and coloured peeling bark. I am sure you will see more of these showing up at garden centres.

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Towards a Rhododendron Red List

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Assessing the conservation status of plants in the wild is a vital component of biodiversity conservation planning. One of the current targets of the Global Strategy for Plant Conservation (GSPC) agreed by Parties to the Convention on Biological Diversity in 2002 is "*A preliminary assessment of the conservation status of all known plant species at national, regional and international levels*". This target, GSPC Target 2, is very important as a baseline for implementation of other GSPC targets relating for example to *in situ* and *ex situ* conservation of plant species.

Since 1963 when Sir Peter Scott first established the Red Listing system, the IUCN Red List Categories have been widely acknowledged as the international standard for species conservation assessment.

Initially a set of five categories of threat was adopted: Endangered, Vulnerable, Rare, Indeterminate, and Not Threatened:

In 1994, these were replaced by a new objective system of categorisation which, in a modified form, remains the IUCN Red List system used today. Relatively few plant species have been assessed with the current IUCN Red List categories and criteria and increasing the rate of plant Red Listing remains a global priority. Developing a Red List of rhododendrons will be a significant contribution towards a global plant assessment.

Background data:

The first comprehensive global list of threatened plant species was published by IUCN in 1998 using the pre-1994 Red List Categories (Walter and Gillett, 1998). The list included 33,798 taxa as globally threatened, a figure considered to represent the "tip of the iceberg". Gaps in either taxonomic knowledge or on-the-ground fieldwork were cited as reasons for the list being incomplete as well as exclusion of species for which the full distribution was unrecorded.

Also in 1998, *The World List of Threatened Trees* was published (Oldfield et al, 1998). This publication summarised the results of a three-year project to evaluate the conservation status of tree species worldwide. Over 10,000 tree species were assessed using the 1994 IUCN Red List Categories and Criteria. In total 7,388 were considered to be globally threatened. The species information compiled was subsequently added to the IUCN Red List which is now available online at www.iucnredlist.org.

At present there are 8447 plant species recorded as threatened in the 2007 IUCN Red List. Progress in red listing for plants is widely acknowledged to be unimpressive. Problems include the perception that the current IUCN Red List categories and criteria are complicated and difficult to apply; the requirement for relatively extensive supporting documentation; and lack of motivation when many countries have their own national red lists using different categories of threat. Currently 5643 of the plants included as threatened in the 2007 IUCN Red List are tree species, the majority of which are derived from *The World List of Threatened Trees.* Of these 1002 tree species are Critically Endangered.

The 1997 IUCN Red List of Threatened Plants (Walter and Gillett, 1998) included 63 *Rhododendron* taxa. Twelve species were included in The World List of Threatened Trees and the 2007 IUCN Red List includes ten taxa of conservation concern and one listed as Low Risk (Least Concern). Many more species are known to be under threat in the wild, and are included for example in national Red Lists (see Table 1). The need for a comprehensive review of the conservation status of rhododendrons in the wild is pressing. The task is now being undertaken by Botanic Gardens Conservation International (BGCI) working with the IUCN/SSC Global Tree Specialist Group and in association with the Royal Botanic Gardens, Edinburgh.

Assessments of other woody plant groups:

The IUCN/SSC Global Tree Specialist Group has been actively involved in undertaking assessments of the conservation status of tree species since its establishment in 2003. The Secretariat of the Group is hosted by BGCI providing a direct link between the collection of data on species in the wild and their status in *ex situ* collections. The advantage of such a link is that BGCI and its members can help to select priority groups of trees (for example those of ornamental as well as ecological value) to be assessed using the IUCN categories and criteria, can help with the assessments and directly utilise the resulting data in conservation planning. In addition to promoting and implementing red listing, the second function of the Global Tree Specialist Group is to provide advice to the Global Trees Campaign a joint initiative of BGCI and Fauna & Flora International (FFI) that aims to conserve the world’s most threatened tree species and the habitats where they occur.

The Global Tree Specialist Group has undertaken global evaluations of the conservation status of selected genera: *Magnolia*, *Quercus* and *Acer* as well as regional evaluations for the trees of the Caucasus, Central Asia, Ethiopia and Eritrea and parts of Central America. The Red List of Magnoliaceae (Cicuzza et al, 2007) was published in April 2007 following an extensive data-gathering and consultation exercise. The Red List identifies 131 species of Magnoliaceae as threatened – over half the known taxa in the family. Of these, 89 are listed as Critically Endangered and Endangered.

The Red List of Oaks has recently been published (Oldfeld & Eastwood, 2007). The assessment includes 207 species leaving around 300 for future evaluations. 29 species are currently considered to be Critically Endangered or Endangered.

The Red List of Acers will be published later this year. 140 taxa were assessed at a workshop in 2007 using the IUCN Red List Categories and Criteria of which six were recorded as Critically Endangered and 13 as Endangered.

Methodology for preparing the Rhododendron Red List:

The starting point for a full generic assessment of the conservation status of plant species needs to be a robust taxonomic checklist. For the rhododendron project, a checklist of accepted names has been provided by the Royal Botanic Gardens, Edinburgh. This includes 1,043 taxa. The list of names has been added into a copy of the Species Information Service (SIS) database as provided by IUCN. This database provides the data fields to store the documentation requirements necessary for each taxon for inclusion in the IUCN Red List.

A rough breakdown of taxon numbers by countries which have the greatest diversity is provided in Table 1. This is based on the list of names provided by Royal Botanic Gardens, Edinburgh and does not include subspecies and varieties counted separately. Information from various national red lists as indicated in the Table has been added to the SIS database to guide the IUCN Red Listing process. Preliminary assessments for Chinese *Rhododendron* spp. have for example been recorded by China Species Information Service of the Chinese Academy of Science and transferred into the SIS database; 394 taxa have been assessed and the categories and criteria will be verified during the global evaluation.

Table 1. Rhododendron diversity and threat status by country

Country	No. of species	Information on national threat status and rarity
China	472	394 species are listed as threatened by China Species Information Service (CSIS) http://www.chinabiodiversity.com/. 276 of these are endemic to China.
Indonesia	139	
Papua New Guinea	78	
Myanmar	72	
India	60	Various spp. considered Rare and Threatened by Botanical Survey of India
Malaysia	45	12 taxa considered rare or uncommon by Soepadmo, 2002
Japan	38	24 taxa included in the 1997 Red List of Japanese Vascular Plants
Bhutan	31	
Viet Nam	26	
Philippines	20	
Taiwan	20	
USA	20	17 species recorded in NatureServe Explorer (NatureServe, 2008), of which 4 potentially qualify as globally threatened according to IUCN Categories and Criteria: *Rhododendron chapmanii*, *R. eastmanii*, *R. flammeum* and *R. austrinum*.
Nepal	17	
Georgia	17	2 species recorded as Vulnerable in a Global Trees Specialist Group Workshop (Eastwood, 2005): *Rhododendron smirnowii* and *R. ungernii*
Russian Federation	14	

The application of the Red List Categories and Criteria to other *Rhododendron* spp. will be undertaken by members of the Global Tree Specialist Group and other appropriate experts. A workshop will be held in Singapore in July 2008 to facilitate this process.

The current IUCN Red List Categories (IUCN, 2001) are, in summary as follows:

- **EXTINCT (EX) -** A taxon is Extinct when there is no reasonable doubt that the last individual has died.
- **EXTINCT IN THE WILD (EW) -** A taxon is Extinct in the Wild when it is known only to survive in cultivation, in captivity or as a naturalized population (or populations) well outside the past range.
- **CRITICALLY ENDANGERED (CR) -** A taxon is Critically Endangered when the best available evidence indicates that it meets any of five defined criteria for Critically Endangered and it is therefore considered to be facing an extremely high risk of extinction in the wild.
- **ENDANGERED (EN) -** A taxon is Endangered when the best available evidence indicates that it meets any of the five criteria for Endangered and it is therefore considered to be facing a very high risk of extinction in the wild.
- **VULNERABLE (VU) -** A taxon is Vulnerable when the best available evidence indicates that it meets any of the five criteria for Vulnerable and it is therefore considered to be facing a high risk of extinction in the wild.
- **NEAR THREATENED (NT) -** A taxon is Near Threatened when it has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future.

The criteria for applying the categories relate to rate of decline of populations, past, ongoing or predicted (Criterion A); restricted area of distribution and condition of the habitat (Criterion B); small population size (Criteria C and D) and quantitative analysis showing probability of extinction (Criterion E). The criteria are further qualified by a series of subcriteria. The Red Listing criteria are quantitative but, “the absence of high-quality data should not deter attempts at applying the criteria, as methods involving estimation, inference and projection are emphasised as being acceptable throughout”. (IUCN, 2001).

Distribution data have been particularly useful in assigning the IUCN Red List Categories and Criteria for plant species. In the 1998 global evaluation of tree species, 56 percent of globally threatened trees were considered to be threatened because of a limited geographical range and declining habitat. A further 22 percent were assigned categories in the basis of the rate of population decline generally inferred from the rate of loss of appropriate habitat (Oldfield & Lusty, 1998).

The methodology followed in the developing the Red List of Magnoliaceae has proved to be effective and as far as possible will be followed for Rhododendron Red Listing. The approach taken was to undertake an analysis of the distribution of each species compared against potential distribution cover based on forest cover mapping (Cicuzza et al, 2007). The species distribution information was compiled from published sources including regional and monographic floras, national Red Data Books and on-line herbarium specimen databases. For species where precise locality data were not available, information on the political units (country, province, district) and altitude range (minimum and maximum altitude) were used to define the maximum potential range.

A map of global forest cover obtained from satellite remote sensing imagery was used to define the potential distributional range of each species using the Moderate Resolution Imaging Spectroradiometer (MODIS) Vegetation Continuous Fields (VCF) product (Hansen *et al.,* 2003). For each species considered, a single potential distribution map was generated using ArcView 9.1 Geographic Information System (GIS) (ESRI, http://www.esri.com/) software by combining data on distribution and forest cover. Information on the rate of forest habitat loss was derived from statistics for change in national forest cover, obtained from the Global Forest Resources Assessment (GFRA) produced by the FAO (2006). IUCN Guidelines for using the Red List criteria refer to ‘continuing decline’ as ‘a recent, current or projected future decline, which is liable to continue unless remedial measures are taken’ (IUCN,2001). In assessing the magnolias it was considered that the criterion of ‘continuing decline’ was met if the area of forest cover was recorded as declining in the latest GFRA, as well as in previous assessments dating back to 1990.

In addition to the spatial analysis, workshops were held to apply the IUCN categories and criteria for the species considered in the *Magnolia* evaluation. This allowed information on actual threats to be noted, such as harvesting of particular species for medicinal products; field observations to be recorded; and discussions on taxonomy and nomenclature to take place.

For the global rhododendron assessment, distribution maps will be prepared for species of limited range based on monographs and other literature as recommended by Dr George Argent and Dr David Chamberlain. A list of key references to be followed in undertaking the Red List assessment is given at the end of this article. In addition, Marion Mackay a member of the GTSG based at the Institute of Natural Resources, Massey University, New Zealand and her research student Ahmed Fayaz, are currently helping with an initial literature review.

Planning for conservation action:

Workshops to assess the conservation status of species undertaken by the IUCN/SSC Global Tree Specialist Group have also been used to define priorities for conservation action, both *in situ* and *ex situ*. BGCI has subsequently undertaken comprehensive surveys of *ex situ* collections of magnolias and oaks as a basis for identifying gaps in and for planning restoration action for Critically Endangered and Endangered species. Information was requested form BGCI members and other key gardens on species held in the collections, including data on the origin and verification of material, related conservation and recovery programmes, methods of and expertise in cultivation and propagation. Information is stored in BGCI's PlantSearch database.

Through the Global Trees Campaign, BGCI and FFI are supporting a range of projects for globally threatened oak and *Magnolia* spp. Initially projects were undertaken for five target *Magnolia* spp. identified as priorities at a *Magnolia* red listing workshop held in Kunming, China in 2004. One project, for example, undertaken by the Kunming Botanic garden working with FFI is reinforcing the wild population of *M. sinica*, reduced to just 10 individuals in the wild, with saplings found in various nurseries during project surveys. Additional projects have been identified through discussions in China, Colombia and Cuba with the goal of ensuring that Critically Endangered species do not become needlessly extinct.

In general, IUCN cautions that the category of threat applied to a species using the Red List system does not in itself determine priorities for action. It suggests that other factors such as costs, logistics, chances of success and other biological characteristics of the species need to be taken into account (IUCN, 2001). Degree of threat does however clearly have an impact in prioritisation of species for conservation action and the process of applying the categories and criteria helps to define the conservation action required. If the species is identified as Endangered due to restricted range and declining and fragmented habitat, for example, habitat conservation and restoration may be inferred as an appropriate response. If the species is Endangered due to population decline caused by levels of exploitation, management of harvesting should be considered at least part of the solution. Where population numbers have been reduced to critically low numbers, assisted propagation and regeneration may be the only option.

In addition to helping to define species conservation actions, Red List information supports various assessments of the state of ecosystems worldwide. It is used to help identify Biodiversity Hotspots as defined by Conservation International; Important Plant Areas, as defined by Plantlife International (and recognised in Target 5 of the GSPC) and was used in the Millennium Ecosystem Assessment. Red list information is also used to define High Conservation Value forests, initially defined by the Forest Stewardship Council and red list information specifically for tree species is used in the GFRA produced by FAO.

Information on the conservation status of individual tree species is valuable for conserving both the species and for supporting habitat conservation. Conservation action is becoming ever more pressing at a time of rapid global change. It is hoped that the assessments for woody species undertaken by BGCI with the IUCN Global Tree Specialist Group, with associated species mapping, can be used for monitoring the impacts of climate change. This is particularly appropriate for groups that have a wide global distribution and are also well represented in botanic gardens around the world. As the true scale of the threats to wild plants becomes apparent, the role of botanic gardens in *ex situ* conservation is likely to become increasingly important as an insurance policy providing options for future translocation and restoration. Some of the Critically Endangered tree species reduced to less than 50 individuals in the wild, are likely to go extinct regardless of the changing climate, unless immediate conservation action is taken. In the longer term, there is more hope of saving Endangered and Vulnerable species if action is planned now that takes into account the impacts of climate change. The *Rhododendron* Red List assessment will draw attention to the conservation needs of this charismatic group of plants and provide a baseline for conservation monitoring and action.

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Acknowledgments:

Dr Adrian Newton (Vice Chair of the IUCN/SSC Global Tree Specialist Group) is thanked for his role in developing and guiding the mapping of tree species as part of the conservation assessment process. Dr George Argent and Dr David Chamberlain are thanked for their advice on the taxonomic literature and support for the Rhododendron Red List assessment in general.

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What's New in Evergreen Azaleas

Donald W. Hyatt

The Author's Garden

Photos in this article by Donald Hyatt

Abstract:

Popular trends in evergreen azalea hybridizing are examined including improved winter hardiness, better foliage, dwarf plant habit, unusual flower forms and colours, and extended blooming seasons. Current approaches in breeding for the elusive yellow evergreen azalea are presented. Flower colour inheritance and polyploidy issues are discussed in relation to underlying factors that can create obstacles when breeding for specific goals.

Introduction:

The evergreen azaleas, members of the *Rhododendron* subgenus *Tsutsusi*, section Tsutsusi, are native to regions of eastern Asia including Japan, China, Korea, Burma, and Thailand. They are often referred to as Japanese azaleas, but this may not be an accurate characterisation. The geographic centre for this section is probably in China, and only 14 of approximately 60 species are Japanese. [4][14] However, evergreen azalea hybridizing and selection has been going on in Japan for centuries. The popular hybrid *R.* 'Azuma-kagami' (*R.* 'Pink Pearl') is estimated to be at least 300 years old.[10]

The late Dr. August E. Kehr (**right**) lamented that evergreen azaleas were not well known in most horticultural circles. He said evergreen azaleas were not appreciated, nor have they been well classified, and this has led to confusion about these wonderful plants. Furthermore, their potential has not been explored. Kehr estimated that 90% of the available evergreen azaleas came from just four species: *R. simsii*, *R. indicum*, *R. kiusianum*, and *R. kaempferi*. [14]

History:

Confusion about evergreen azaleas probably started with the early Belgian Indian hybrids, also known as Belgian Indicas. Describing these florist azaleas as “Indicas” is really inappropriate since they are not hybrids of the Japanese species, *Rhododendron indicum*, but descendents of the tender Chinese species, *R. simsii*. Some early Belgian Indian azaleas imported to the southeastern United States led to the Southern Indian hybrids. Although generally hardier than their ancestors, neither group is suitable for colder climates.

Originally, many early evergreen azaleas were incorrectly identified as species including plants like *Rhododendron* ‘Mucronatum’ and *R.* ‘Indicum Roseum.’ Azaleas like *R.* ‘Amoenum’ were classified as forms of *R. obtusum*, but that species designation is not valid. Those azaleas are primarily hybrids of two other Japanese species, *R. kiusianum* and *R. kaempferi.*[10][14] In the Kirishima Mountains on Kyushu, Japan, the natural ranges for *R. kiusianum* and *R. kaempferi* are in close proximity, and researchers have documented hybridization and introgression between these two species.[15][16]

Early Kurume collections imported from Japan included the famed “Wilson 50” sent to the Arnold Arboretum by E. H. Wilson in 1917, and cultivars introduced by the Domoto Brothers after the Panama Pacific Exhibition in 1915. Many were the same plants. In 1929, R. Kent Beattie at the U.S. Department of Agriculture imported another 127 Japanese azaleas including 60 Kurumes. Only 11 Beattie Kurumes were duplicates of the Wilson or Domoto azaleas.[10][17]

The Beattie Kurumes have generally been overlooked, and there has been some confusion about names, too. For instance, Wilson #11 (*Rhododendron* 'Takasago') was the same plant marketed by the Domoto Brothers as *R.* 'Cherryblossom.' However, a Beattie introduction (PI #77086) was also called *R.* 'Cherryblossom' but it was the Japanese variety *R.* 'Ogi-kasane (**above**).' It is similar to Wilson #11, but the flowers are pale lavender pink rather than yellowish pink. *R.* 'Ogi-kasane' is one of this author's favorite evergreen azaleas, but rarely seen in the trade.

Developing Hardier Hybrids:

The small flowered Kurumes were hardy and popular landscape plants. However, people wanted evergreen azaleas with larger blossoms like the Southern Indians that would succeed in colder climates.

In 1929, Benjamin Yoe Morrison began his monumental azalea hybridising program while at the U.S. Plant Exploration and Introduction Station in Glenn Dale, Maryland. Morrison raised an amazing 75,000 evergreen azalea seedlings, and eventually selected 454 Glenn Dale hybrids.[17] As the first Director of the United States National Arboretum in Washington, D.C., Morrison began planting his best seedlings there on a 30-acre hillside called Mount Hamilton. Starting in 1947, he set out an estimated 15,000 plants representing approximately 1,200 selections including the named Glenn Dales.[3] Unnamed seedlings may be better than some named Glenn Dales, but it is unlikely those will ever be introduced.

The popular clone *Rhododendron* 'Ben Morrison' is often considered a Glenn Dale azalea. However, it was not named by Morrison but by another

Director of the Arboretum, Dr. John L. Creech. There has been much speculation about the origin of *R.* 'Ben Morrison.'[20] Some feel it is a sister of *R.* 'Surprise,' or perhaps an unnamed seedling. Others believe is a sport of a Glenn Dale, possibly *R.* 'Luna.' However, there is confusion about which plant is actually *R.* 'Luna.'

In 1926, Pennsylvania nurseryman Joe Gable also started hybridising evergreen azaleas. He crossed hardy species like *Rhododendron kaempferi* and *R. poukhanense* (*R. yedoense* var. *poukhanense*) with available cultivars and created many hardy hybrids. Incidentally, the change from *R. poukhanense* to *R. yedoense* for the species name of this hardy Korean azalea seems unfortunate and confusing. *R. yedoense* var. *yedoense* is a double-flowered oddity unknown in the wild.

The late-blooming Satsuki azaleas were derived primarily from *Rhododendron indicum*.[10] B.Y. Morrison brought the first major collections of Satsuki azaleas to the U.S. from Japan, including 53 hybrids in 1938 and 1939. Additional Satsukis were introduced in subsequent years, including 387 clones released in 1978 and 1979 by Brookside Gardens in Maryland.

Above: *Rhododendron* 'Fukihiku'
Right: *R.* 'Tokoharu'
Below: *R.* 'Itten'

John Creech shared Morrison's admiration for evergreen azaleas, and from 1955 to 1980 made at least 5 collecting trips to Japan. In 1983, the U.S. National Arboretum released 33 of Creech's new Kurumes, but these are only now gaining popularity. The Creech introductions are exquisite. *Rhododendron* 'Fukihiko' and *R.* 'Tokoharu' have striped flowers, and *R.* 'Itten' is white with lavender border. There has also been some confusion about these plants. *R.* 'Wakaebisu' has delicate single white flowers brushed with red, but there was already a familiar hose-in-hose salmon Satsuki with the same name.

Although considerable hybridising in the United States has been conducted at government facilities and commercial nurseries, significant contributions have been made by amateur hobbyists. Robert Gartrell, a chemist by profession, started hybridising evergreen azaleas in the early 1940’s and continued for nearly 30 years. One of his goals was to produce hardier Satsuki-type azaleas that could survive in northern New Jersey. He made nearly 1,500 crosses and raised approximately 25,000 azaleas, finally registering 69 Robin Hill hybrids.[26]

Scientific Considerations - Flower Colour Inheritance:

Before discussing current trends in hybridising, it is important to consider some science behind flower colour inheritance and sterility. Attaining a hybridiser’s goal is not always easy, but by understanding the genetics involved, one can make informed decisions.

For instance, nearly 30 years ago this author crossed the orange-red species, *Rhododendron nakaharae* with a white *R. kiusianum*. Expecting compact hybrids in shades of coral, pink, or white, he was shocked that every seedling was purple! Obviously, azalea flower color inheritance was more complicated than imagined. The dominance of purple color in azalea hybridizing is well documented. Joe Gable took 17 years to reach his goal, *R.* ‘Rose Greely,’ a hardy white azalea.[17]

The research by J. Heursel and W. Horn on evergreen azalea flower colour inheritance is very helpful in understanding those results.[11] These researchers analysed seedlings from thousands of crosses, establishing the existence of six gene pairs controlling flower colour.

They identified the gene **W** (or **w**) that produces anthocyanin, but the pigment can take several forms depending upon the action of other genes. Plants homozygous **(WW)** or herterozygous **(Ww)** for the dominant trait produced anthocyanin. The recessive gene **w** is for no anthocyanin, so a plant homozygous (**ww**) will have white flowers.

The gene **O** (or **o**) controls oxidation of the anthocyanin molecule, and **P** (or **p**) controls methylation. Depending upon the actions of those genes, different anthocyanin pigments with different colours are possible:

Genotype	Anthocyanin Pigment	Color
WWOOPP or **WwOoPp**	malvidin	purple
WWOOpp or **WwOopp**	delphinidin	blue
WWooPP or **WwooPp**	peonidin	carmine
WWoopp or **Wwoopp**	cyanidin	geranium lake

The researchers identified two genes involved in the production of water soluble flavenols. These pigments can give an ivory or greenish yellow cast to certain flowers. Gene **Q** (or **q**) controls flavenol production, but there was a secondary gene **M** (or **m**) that controls methylation of the flavenol. The researchers also observed that flavenols seemed to intensify the purple color of anthocyanin pigments.

Flavenols are different from the water insoluble carotenoids, pigments responsible for the deep yellow colors in deciduous azaleas. Carotenoids are contained in specialized protoplasmic bodies (plastids), and not dissolved in the sap.[23]

The sixth gene pair, **G** (or **g**), controls the glycosidation of anthocyanin but it does not influence flower color.

These details helped explain why the cross (*R. nakaharae* x white *R. kiusianum*) produced nothing but purple flowered azaleas in the F1 generation (**left**). White *R. kiusianum* probably had the genotype **wwOOPP.** Homozygous for the recessive trait (**ww**), it is essentially a purple azalea that cannot produce pigment.

The orange-red *R. nakaharae* probably had the genotype **WWoopp**. Without the presence of either the dominant **O** or **P** genes, the colour was not purple but light orange-red, cyanidin. When crossed with the white *R. kiusianum,* the seedlings now had the likely genotype **WwOoPp**. This causes production of the purple pigment, malvadin.

Left: *Rhododendron* 'Leopold-Astrid
Below: *R.* 'Girard's Fuchsia'
Below Left: *R.* 'Sandy Dandy'

John Weagle of Nova Scotia made that same cross, but then wisely crossed his best siblings for an F2 generation. That reshuffled the genes, so he got a broad range of colours on dwarf plants.[27]

Flavenols could be responsible for some other unexpected hybridising results. Joe Klimavicz crossed the tender bicolour *Rhododendron* 'Leopold-Astrid' with the hardy reddish purple, *R.* 'Girard's Fuchsia.' Instead of the hardy bicolour he sought, Joe got many buff-coloured seedlings including *R.* 'Sandy Dandy.' The brilliant purple of *R.* 'Girard's Fuchsia' could be caused by flavenols intensifying the anthocyanin. When the purple pigment was not expressed in certain seedlings, perhaps the yellowish flavenols became more noticeable.

Flower Sterility:

Certain structural problems in evergreen azalea flowers can cause sterility, which is often frustrating when trying to breed for specific goals. Some azaleas are sterile because flowers lack essential reproductive parts, such as anthers or pistils. Doubles like *Rhododendron* 'Balsaminiflorum' and *R. yedoense* var. *yedoense* have neither pollen nor pistil, and are of little use in hybridizing.

Some double flowers have occasional stamens tucked among the petals, or stray anthers with viable pollen attached to petals. Many doubles will not accept pollen, but others have normal pistils and will set seed.

Flowers that are hose-in-hose, or having the appearance of a corolla nested within another corolla, are usually female sterile. Occasionally, a hose-in-hose plant will produce a chance seedpod. One such pod from *Rhododendron* ‘H. H. Hume’ produced *R.* ‘Ring’s True.’

Polyploidy Concerns:

Most evergreen azaleas are naturally diploid (2n = 26), although there are some naturally occurring tetraploid evergreen azaleas like *Rhododendron* ‘Banka’ and *R.* ‘Taihei’. Other azaleas have been artificially converted to polyploids using various scientific methods.[9][12][13]

Tetraploids are promising in certain breeding efforts, but can also cause difficulties. For instance, a tetraploid crossed with a diploid produces triploids, which are sterile. The tender azalea *Rhododendron* ‘Redwings’ is triploid, which explains why it has not been crossed with hardier forms.[12]

Tetraploid azaleas are usually solid colours which could cause problems when breeding for bicolours. Bicolour flowers like *Rhododendron* ‘Leopold-Astrid’ have two tissue types: the white centre is diploid but the contrasting red edge is tetraploid.[8]

Hybridizing Goals–Hardiness:

A major hybridizing goal has been to improve hardiness of evergreen azaleas, but achieving that goal is not always straightforward. The two hardiest species known to date are *Rhododendron yedoense* var. *poukhanense* and

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fertile in both directions. Obviously heterozygous for anthocyanin pigment, other colours can appear in primary crosses. Schroeder's blush pink, *R.* 'Eliza Hyatt,' is (*R.* 'Elsie Lee' x *R.* 'Robin Hill Frosty'). The cross (*R.* 'Elsie Lee' x *R. kiusianum*) produced a very hardy pale pink, *R.* 'Al's Picotee.'

Foliage Retention and Leaf Colour:

Since the flowering season lasts but a short time, people are interested in the year-round landscape effect of garden plants. There are many different leaf types in evergreen azaleas, and this offers many options for developing unusual foliage forms.

Azaleas with persistent, glossy evergreen winter foliage like *Rhododendron* 'Glacier' and *R.* 'Dreamsicle' are preferred to plants with sparse winter foliage like *R.* 'Corsage.' *R.* 'Johanna' has burgundy winter foliage, and one of its descendents, Hachmann's *R.* 'Marushka' (**below**) now holds the standard for foliage quality. In addition, some azaleas can provide a brilliant autumn display if the leaves that are shed prior to winter turn bright red or gold.

There are azaleas with variegated leaves like *Rhododendron* 'Red Lustre' and *R.* 'Girard's Silver Sword,' but that characteristic may not be passed to their hybrids. *R. stenopetalum* 'Linearifolium' with its long, narrow leaves does offer potential as a parent for new leaf forms.

Another interesting but very tender azalea is *Rhododendron* 'Little John', a sport of *R.* 'Formosum'. *R.* 'Little John' has striking reddish purple foliage throughout the year, but has not passed that characteristic to any progeny so far. Perhaps it is a chimera.

Dwarf and Compact Plant Habits:

Some evergreen azaleas like *Rhododendron* 'Dream' and *R.* 'Corsage' become huge, so they are unsuitable for small gardens. Plants of modest stature that do not require constant pruning are preferred by most homeowners. The surprisingly hardy Back Acres hybrid, *R.* 'Bouffant' (*R.* 'Dream' x *R.* 'Gunrei'), is a compact plant with large flowers of soft pink. George Ring's *R.* 'Fairfax' is another excellent compact hybrid with huge flowers of pale pink and white.

Dwarf azaleas are useful in hybridising, but commercial nurseries rarely grow many due to the time required to produce a marketable plant. Ring's dwarf *Rhododendron kiusianum* was only 20cm tall (8in) after 25 years. Other slow growing azaleas include the Beltsville Dwarfs, *R.* 'Leprechaun' and *R.* 'White Elf', and many Satsukis including *R.* 'Kazan' (*R.* 'Rukizon').

Above:
Rhododendron
'Dream'
Right: *R.*
'Bouffant'
Below: *R.*
'Leprechaun'

"Witch's brooms", or extreme dwarf sports of larger growing azaleas, can result from different causes including fungal infection and mutation. *Rhododendron* 'Stiletto' is a witch's broom of *R.* 'Silver Sword,' and *R.* 'Young Dorothy' a diminutive of *R.* 'Dorothy Layman.' Unless the dwarf character is a genetic mutation, such plants may not be useful to hybridisers.

Rhododendron nakaharae and *R. kiusianum* are popular parents for reducing the stature of modern hybrids. Glendoick's *R.* 'Panda' is a primary *R. kiusianum* hybrid. *R.* 'Squirrel' is a primary hybrid of *R. nakaharae*. Crosses using these are producing some excellent compact hybrids.[6]

Double Flower Forms:

There are many flower forms in evergreen azaleas, but doubles are extremely popular. *Rhododendron* ‘Anna Kehr’, *R.* ‘Secret Wish’ (**below**), and *R.* ‘Sandra’s Green Ice’ are all known for very high petal counts. *R.* ‘Caitlin Marie’ is a deep pink double from (*R.* ‘Elsie Lee’ x *R.* ‘Satellite’).

Hybridisers are seeking a hardy azalea that looks like *Rhododendron* ‘Leopold-Astrid’ or *R.* ‘Cabaret,’ but those are far too tender. Bob Stewart’s *R.* ‘Ashley Ruth’ has semi-double white flowers shading to a rose pink at the edge. Harry Weiskittel’s *R.* ‘Marshy Point Fancy Pants’ has blush-white flowers bordered in purplish-red, and it has glossy dark green leaves.

Petaloid and Spider forms:

An azalea flower form becoming popular in the United States is the strap-petal, or “spider” type, where the corolla is separated into distinct petals. The popular lavender spider, *Rhododendron* ‘Koromo-shikibu’ (**below**) has been used frequently in hybridizing.

A hybrid of *Rhododendron* ‘Koromo-shikibu’ developed by Dave Wagner was introduced by this author as *R.* ‘Wagner’s White Spider.’ It has airy, delicate blossoms of pure white. *R.* ‘Tina’s Whorled’ is a slightly deeper, reddish purple version of *R.* ‘Koromo-shikibu’. *R.* ‘Walter’s Pinwheel’ (*R. nakaharae* ‘Mt. Seven Star’ x *R.* ‘Koromo-shikibu’) has strap-like petals in pinkish lavender on a compact, mounding habit. Other spider types include the reddish-orange *R.* ‘Polypetalum,’ and several Satsukis including *R.* ‘Shiryu-no-homare,’ a purple with unusual curled foliage.

An interesting note about *Rhododendron* ‘Koromo-shikibu’ is that the plant collected in Japan and introduced as *R.* ‘Koromo Shikibu’ by R. Kent Beatty in 1928 (PI #77142) was described as a Kurume with “white corolla tipped with purple.”[10][17] That is certainly not what we grow today under that name. The familiar *R.* ‘Koromo-shikibu’ is considered a selection of *R. stenopetalum* (*R. macrosepalum*).

Strap-petal hybrids can arise when neither parent shows that tendency. The author’s cross, (*Rhododendron nakaharae* x *R.* ‘Anna Kehr’) produced the desired compact double pink, *R.* ‘Ginny Grina.’ It also produced a plant with red petaloid flowers, *R.* ‘Cardinal’s Crest.’

Striped and Bordered Flowers:

Some evergreen azaleas have flowers with stripes or sectors of contrasting color that can add significant horticultural interest. This tendency is common

-+*xs* □*‘HKeVPUWKVVPs*□ *R.*

Flower Colour:

Some nurserymen are still looking for the perfect red azalea, one with compact habit, large flowers, superb foliage, and rock hardiness. *Rhododendron* 'Ward's Ruby' and *R.* 'Redwings' are too tender for colder gardens. *R.* 'Stewartstonian' and *R.* 'Girard's Hot Shot' have too much orange in the red. *R.* 'Hino-crimson' (**right**) and *R.* 'Hershey's Red' are the most popular reds in the U.S., but *R.* 'Vuyk's Scarlet' and *R.* 'Johanna' are gaining in popularity. Some very deep reds being used in breeding today include *R.* 'Midnight Flare' and *R.* 'Karafune'.

In the landscape, some people prefer more delicate shades rather than intense colors. Both *Rhododendron* 'Nancy of Robinhill' and *R.* 'Betty Anne Voss' are excellent pale pinks. Dr. Sandra McDonald has released several blush pinks including *R.* 'Pink Cherub', *R.* 'Blushing Angel', and *R.* 'Venus's Baby.'

The Quest for the Yellow Evergreen Azalea:

One unrealized goal in hybridizing is the quest for a yellow evergreen azalea. There are a number of evergreen azaleas with flowers of light cream to pale greenish yellow. Some are arguably as deep as *Rhododendron keiskei*, although nothing has approached the yellows found in deciduous azaleas. Some yellowish evergreen azaleas include the Kurume *R.* 'Mizu-no-yamabuki' and Robin Hills, *R.* 'Olga Niblett' and *R.* 'Bob White.'

The evergreen azalea with probably the strongest yellow color to date is *Rhododendron* 'Melba's Dream' (**left**). Supposedly a cross of *R.* 'Lois' with a yellow Exbury azalea, it has small flowers of an unmistakable yellow hue. The long-lasting blossoms are strange in that the petals have hairs on the edges, similar to sepals. It is not an easy grower, though, and its use as a parent is questionable.

Dr. August Kehr ("Augie") was convinced it was possible to produce an evergreen azalea with strong yellow color.[1][19] Although he pursued that goal for many years, he passed away before achieving his goal. He has, however, left us a rich legacy. Kehr's *Rhododendron* 'Cream Ruffles' was an early cream, but *R.* 'Kehr's Moonbeam' (578-8A x *R.* 'Green Glow') was his last, and probably best, greenish yellow. Waldman's *R.* 'Green Glow' [(*R.* 'Eri' x *R.* 'Glacier') x *R.* 'Anna Kehr'] is a double greenish white. It came from seed this author sent to the ARS Exchange.

Kehr acknowledged that since evergreen azaleas contain only flavenols, hybrids that merely concentrate those pigments will never be deep enough to be called yellow. He felt it necessary to introduce the stronger yellow carotenoid pigments from another source, such as wide crosses between yellow deciduous azaleas and evergreen azaleas.

Dr. Robert L. Pryor at the U.S. Agricultural Research Service in Beltsville, Maryland, experimented with such deciduous and evergreen azalea crosses for nearly 10 years. [22] He used diploid Mollis hybrids for one parent and various Kurume and *Rhododendron kaempferi* cultivars for the other. Pryor ended up with many albino seedlings that eventually died, but he raised hundreds of hybrids with varying degrees of persistent foliage, although none were strong yellow. He did observe that persistent foliage seemed linked to the maternal parent.

Work by Ureshino and others at Kyushu University had similar results. In the cross [(*R. kiusianum* x *R. eriocarpum*) x *R. japonicum* var. *flavum*], the resultant seedlings were albinos, presumably due to genetic incompatibilities. [25] In another experiment, Kobayashi and others observed that crosses of evergreen azaleas onto *R. japonicum* did not develop properly because pollen tubes encountered structural problems and never reached the ovaries. Crosses in the other direction, however, appeared to be successful.[16]

Augie Kehr maintained that it was necessary to use a tetraploid evergreen azalea as one parent, preferably a hybrid that did not have any tendency for purple color, and cross that with a tetraploid yellow deciduous azalea. The resulting plants would be allotetraploids. With a full complement of genes from each parent, plants should be more vigorous. He recommended avoiding orange deciduous azaleas since that could introduce anthocyanin pigments.[19]

Kehr used yellow *Rhododendron calendulaceum* for the deciduous parent since it was tetraploid. We now know there are many other tetraploid yellow deciduous azaleas including *R. austrinum* and *R. luteum*.[12] Kehr converted several evergreen azaleas to tetraploids so he could pursue his hybridizing goal. *R.* 'Cream Ruffles-Tetra' (**below**) is one example.

Kehr made several crosses with one of Pryor's seedlings, (75-305). He called it *Rhododendron* 'Pryor Yellow.' Although a sickly plant that defied propagation attempts, *R.* 'Pryor Yellow' had light yellow flowers and was fertile. The plant eventually died, but some of Kehr's seedlings still exist. Eight have strong cream to light yellow color. Although many have lost tags, (*R.* 'Banka' x *R.* 'Pryor Yellow') and (*R.* 'Gunka' x *R.* 'Pryor Yellow') are excellent and may be useful parents.

Santamour and Dumuth backcrossed evergreen and deciduous azalea hybrids for multiple generations.[19] There was evidence of carotenes in several of the "yellowest" seedlings, with heaviest concentrations in the blotch region. This could imply that breeders should seek azaleas with expanded blotch areas in their quest for yellow. Marshy Point's *Rhododendron* 'Pam Corckran' (**right**) has a blotch that extends to at least 75% of the corolla. It may prove useful in developing azaleas with expanded blotch areas, ones that could help concentrate those carotenoid pigments for yellow colour.

Extending the Season of Bloom:

Perhaps one of the most prominent successes for any amateur hybridizer is the story of Robert E. (“Buddy”) Lee, the Louisiana hybridizer who developed the Encore® azaleas. William R. Brown at the Louisiana Agricultural Experiment Station had experimented with everblooming azaleas using *Rhododendron oldhamii* and other fall blooming azaleas.[2] Pursuing that same line, Buddy Lee has now succeeded in creating a race of everblooming azaleas for southern gardens.

Buddy (**right**) used *Rhododendron oldhamii* ‘Fourth of July,’ which tends to throw off-season flowers, and crossed that with other azaleas to produce his Encore® hybrids. They are reliable rebloomers in climates where summers are warm and the growing season is long, and very popular throughout the southern United States. Unfortunately, they do not generally re-bloom in northern gardens with shorter growing seasons. Encore® Autumn Rouge (*R.* ‘Conlea’) (**below**), a deep rose pink with double flowers, is one of the better performers in the suburbs of Washington, D.C.

There are other azaleas that rebloom in northern gardens, like *Rhododendron* ‘Opal’ and *R. kaempferi* ‘Indian Summer’. Northern hybridizers might try these as parents for repeat bloom.

There is another very interesting plant derived from *R.* ‘Mucronatum’ by the late Dr. Marion B. Matlack of Virginia. This azalea blooms on the new wood, as soon as the flower buds are formed. Its large white blossoms start opening in August and continue until terminated by a freeze, hence the name, *R.* ‘August to Frost.’ The plant is hardy, but unopened buds are usually killed during the winter so there is no spring bloom. *R.* ‘August to Frost’ has thrown several sports including a purple selection and a white with red blotch similar to *R.* ‘Sekidera’.

Solving Problems:

One serious problem that needs to be addressed is petal blight (*Ovulinia*). Finding a way to stop this destructive disease is important, not just for evergreen azaleas but for all members of the genus. Early blooming and late blooming varieties may miss the worst of the petal blight season, but losing any flowers to petal blight is of serious concern.

Sprays are successful to an extent but there are a few plants that seem immune to the disease. One plant is the previously mentioned yellow evergreen azalea, *Rhododendron* ‘Melba’s Dream.’ Its small petals are unique with the obvious hairs on the margins, reminding one of a calyx or a leaf. Since petal blight does not attack foliage or sepals of azaleas, perhaps these strange petals have some property akin to leaf tissue that makes them immune. Another plant immune to petal blight is *R.* ‘Cojuho.’ It similarly has hairs on the edge of its narrow petals.

Conclusion:

Although evergreen azaleas are probably the most commercially successful members of the genus *Rhododendron*, they still have much unrealized potential. It should be possible to develop new varieties with greater hardiness, better plant habits, distinctive foliage, and flowers with new forms and different colours. It is also important to find ways to preserve existing species and cultivars so they are more readily available to researchers, hybridisers, and gardeners.

Acknowledgements:

I want to thank Donald H. Voss for his editorial suggestions and other assistance during the preparation this article. I also want to thank Dr. Sandra McDonald for copies of her personal correspondence with Dr. August E. Kehr. I thank Ms. Barbara Bullock, Curator of Azaleas at the U.S. National Arboretum, for details on plant introductions. I thank Kenneth Cox and John Weagle for providing publication drafts referencing their respective azalea hybridising programmes.

In addition, I gratefully appreciate those who provided images for the digital presentation in Edinburgh, especially Carolyn Beck, Buck Clagett, Kenneth

Cox, Holger Hachmann, Tijs Huisman, Joe Klimavicz, William C. Miller III, Dr. Hartwig Schepker, Bob Stelloh, Don Voss, John Weagle, and Harry Weiskittel.

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Plant Conservation (including *Rhododendron* Habitat Protection) on the Yulong Xue Shan, Yunnan, China

Xu Kun and David Paterson: Project Managers

Abstract:

The development of Lijiang Alpine Botanic Garden and the Jade Dragon Field Station, by the Royal Botanic Garden Edinburgh and its sister institute, the Kunming Institute of Botany, is discussed in relation to plant and habitat conservation activity that aims to bring about more sustainable land management through capacity building projects involving the indigenous communities of the Yulong Xue Shan (Jade Dragon Snow Mountain) in Yunnan Province, SW China. Reference is made to the genus *Rhododendron.*

The Jade Dragon Field Station is a biological research station constructed and operated jointly by the Kunming Institute of Botany and the Royal Botanic Garden Edinburgh with a local partner, the Lijiang Alpine Economic Plant Research Institute of Yunnan Agricultural University. The primary purpose of the Jade Dragon Field Station is the conservation of threatened plants and habitats through capacity building projects that aim to bring about more sustainable land management practices. Whilst *Rhododendron* habitats feature within this conservation work, the genus is not specifically targeted. The Jade Dragon Field Station is recognized by the Chinese and UK governments as a Joint Scientific Laboratory.

The Jade Dragon Field Station is located within the developing Lijiang Alpine Botanic Garden on the southern slopes of the Yulong Xue Shan in the north west of China's Yunnan Province. Lijiang Alpine Botanic Garden lies approximately 20 km north of the ancient town of Lijiang and the Jade Dragon Field Station is located in the mid-reaches of the garden at an elevation of 3,200m on a col, known locally by the Naxi name of Ha Li Gu, which loosely translates to 'windy gap'. The development of the station and the garden are running concurrently although the former has progressed slightly more rapidly. The proposal to build a new botanic garden and field station near Lijiang was discussed and debated widely in China and the UK. Through the efforts and support of the Chinese Academy of Sciences, the Yunnan Provincial Government and the authorities of the Lijiang Prefecture a parcel of land in the region of 400ha was secured. To facilitate the change of use of what was formerly common land, the indigenous peoples from the neighbouring villages agreed to accept a compensation payment and to work in support of the project. As a result of very significant personal involvement from Sir Anthony Galsworthy, the then British Ambassador to China, support was also secured from the UK Foreign and Commonwealth Office. A number of commercial sponsors including BP Amoco, BHP Billiton and British Airways pledged commercial assistance for the project. The support of the local community and inputs from scientists, horticulturists, politicians, diplomats and business leaders in China and the UK has proved invaluable in securing the necessary information, permissions and resources to allow work on the garden and field station to commence.

On May 18th 2001 on the lower slopes of the Yulong Xue Shan, a stone laying ceremony took place to mark the commencement of Lijiang Alpine Botanic Garden. The early scientific work of the garden is concentrating on the conservation of threatened plants and their habitats through various degrees of horticultural intervention. The main focus of this conservation activity is to determine successful propagation and cultivation methods and through this work secure the recovery and survival of threatened species. At least some of the plants targeted for this conservation activity have yet to be cultivated in significant numbers by the world's botanic gardens but despite this, the chance of successfully growing these plants is high. This is mainly because much of the cultivation is carried out in-situ and where ex-situ cultivation is practiced it is done in close proximity and within a similar habitat and set of conditions to those that the plants enjoy in the wild. Another important factor that will ensure the successful cultivation of these plants is the use of local skill and knowledge through the employment of labour from the neighbouring villages.

This early work provides an insight into the overall and long-term vision for Lijiang Alpine Botanic Garden and the Jade Dragon Field Station. Plant conservation is high on the list of priorities and it is planned that this will be achieved by working closely with the local population to draw on their expertise, be that in the search for rare plants or their subsequent cultivation. The conservation strategies that are being developed extend beyond the protection of individual species, although this does form part of the work, to include populations, niches and micro-habitats and in a few cases the entire habitat. The latter present fairly serious challenges not in the least because large tracts of land have to be protected and controlled. Where plants are being harvested and used by the local people the vision is to bring about the sustainable use of plant material. There are many examples of plants that are being collected directly from the wild and because of over harvesting of this natural resource there are a number of species facing possible extinction on the Yulong Xue Shan (and indeed throughout many other parts of the Hengduan Shan Range of which the Yulong Mountain constitutes part). An example of a rhododendron species that is under pressure from over collecting on the Yulong Xue Shan can be found in *R. uvarifolium*. Although not a gregarious species and at times difficult to locate in mixed forest *R. uvarifolium* cannot be described as endangered but on the Yulong Mountain it has become locally threatened due to the practice of harvesting the flowers in the springtime. The flowers are prized by the girls of the Naxi and Yi Minority Nationalities and are worn as adornments in the hair or head-dresses of young maidens especially on market days or other social gatherings where there is a likelihood of meeting a suitor. This seemingly innocent pastime has significantly reduced the seed set of *R. uvarifolium* with a consequence that there are fewer young plants within parts of the forest.

In some cases the population diminution of some species has reached a critical stage and reintroduction programmes may need to be initiated to re-establish sufficiently robust populations to ensure the survival of the worst affected taxa. An over riding priority that runs through much of the conservation activity of the Jade Dragon Field Station lies in the area of capacity building within the local communities. It is fundamental to the successful development of Lijiang Alpine Botanic Garden that the local communities are given the capacity to work on the Yulong Xue Shan in a more sustainable way. The garden and field station can play a very significant role in this respect especially through research and the subsequent provision of guidance on traditional practices that have gradually become non-sustainable. Simple examples where this approach can work include the introduction of in-situ cultivation programmes where the local people are assisted in ‘gardening the mountain’ by tending and monitoring wild plants for harvest rather than simply removing them from their natural habitats without thought for the consequences of these actions. This is just one example of a capacity building project that will halt the non-sustainable management of wild land through horticultural intervention without the complete removal of either the mountain dwellers themselves or indeed their traditional activities or, as some would suggest, the translocation of endangered plants to safe sites such as private collections and the botanic gardens of the developed world.

In addition, the vision for the conservation of the flora (and fauna) of the Yulong Xue Shan includes the provision of alternative means of employment. The Yulong Xue Shan has been a place of great excitement and exploration for many generations of botanists including those impressively robust early scientific explorers who are now so often referred to by the somewhat disparaging term ‘plant hunter’. We owe much of our scientific understanding of genera such as *Rhododendron, Primula, Meconopsis*, to name but a few, to these field botanists and the beauty of the gardens of the west will be forever indebted to their efforts. However, the Yulong Mountain is also the sole means of support for many families that live on her flanks and these people have benefited little from activities and attentions of western botanists. The development of the Lijiang Alpine Botanic Garden and the Jade Dragon Field Station will attempt to address this issue. The largest settlement on the mountain is the Yulong Village with a population of 670 people and in total there are just under 500 families living in six villages on the mountain massif. With a local population of around 2,000 people, the Yulong Xue Shan is hard pressed to provide food, fuel and shelter for these people let alone provide a source of income. The great influx of tourists to the area does create opportunities for income generation but this also places the land under tremendous pressure. The development of the Lijiang Alpine Botanic Garden and the Jade Dragon Field Station is creating an opportunity for sustainable tourism from which the local population can secure long-term employment on the mountain but in a way that both promotes and facilitates the protection of the environment. The more families that become dependent on the garden either directly through employment or indirectly through advice and assistance on the introduction of sustainable land management practices, the more likely that the Yulong Xue Shan will continue to be a world recognised biodiversity hotspot.

All the activities and developments within the Lijiang Alpine Botanic Garden and Jade Dragon Field Station are driven by the importance of plants and the role that they play in securing a future for humanity. The plants of the Yulong Xue Shan are many and varied and *Rhododendron* forms an important part. There is an immense wealth of plant biodiversity that is both unique and incredibly beautiful but also very fragile. The plants are under pressure and many are facing extinction. The plants need to be cared for if they are to survive the rapid changes that are taking place on the Yulong Xue Shan and of course in many other parts of the Hengduan Range, within China as a whole and throughout our world. Fundamental to caring for plants is an ability to recognise them and provide them with an agreed and accepted name. It is also necessary to find the plants, a task that can present the field worker with many difficulties and challenges and the proverbial needle in a haystack springs to mind when one considers the diminutive size of many of the plants in contrast with the immensity of the search area.

In dealing with the issue of finding the plants (and in completing the search, then being in a position to make a claim about an individual species' conservation status) it is necessary to understand the scale of the mountain. By Himalayan standard the Yulong Mountain is compact but nevertheless comprises thirteen peaks, harbours China's lowest altitude glacier, stretches northwards from Lijiang for some 35 kilometres and is over 20 kilometres wide in places. Some describe the Yulong Xue Shan as a small mountain range but it is more accurately described as a mountain massif. In common with other mountains throughout the Hengduan Range, the vegetation on the Yulong Xue Shan is characterised by zonation. However, in addition to the vegetation bands there are a number of distinct habitats both within and in some cases, across the zones. An ability to recognise these zones and habitats will increase the likelihood of being able to locate rare plants. In the widest sense the vegetation on the Yulong Xue Shan can be described as occurring in forest, shrub, scrub meadow and alpine habitats. All but the meadows can, in certain locations, be dominated by *Rhododendron* and all are under various levels of environmental pressure. The nature of these broad habitat types can vary considerably depending on factors such as aspect, exposure, altitude and the presence of linear features such as ravines, streams and paths. The nature and extent of soil accumulation is also of great significance on this limestone mountain since it is only where a degree of organic material builds up that acid loving plants such as *Rhododendron* can be found in any significant populations.

In conservation terms it is the extent of anthropogenic influence on the Yulong Mountain that determines the nature and quality of vegetation cover and this is increasing including the oblique factors that are driving climate change. All of the habitat types are under pressure and the vegetation cover of the Yulong Mountain is subject to varying degrees of change. The rapidity of some of the changes has resulted in a marked contrast between the project zone (Lijiang Alpine Botanic Garden, the Jade Dragon Field Station and other areas influenced by the Kunming Institute of Botany and Royal Botanic Garden partnership) and neighbouring land.

Two examples of threatened habitats that harbour *Rhododendron* on the Yulong Xue Shan lead us to the conclusion that intervention is required and provide justification for the conservation activities of the Lijiang Alpine Botanic Garden and Jade Dragon Field Station. The forests, which are the most threatened habitats on the mountain, fall into three broad categories, evergreen broadleaf, deciduous broadleaf and coniferous woodland. Evergreen broadleaf forest is dominated by oak (*Quercus aquifolioides*) with an under-storey of *Rhododendron racemosum* whereas the deciduous forest is usually mixed species and is generally richer in *Rhododendron* species. Many areas of evergreen broadleaf forest have been cleared of tree cover with a resultant loss of the under-storey and field layer. The second example of species loss from a threatened habitat can be found in the dwarf vegetation zone. Both the shrub and dwarf vegetation can occur as *Rhododendron* in pure stands or as mixed populations. Populations of *Rhododendron fastigiatum* growing in wind blasted heath-land communities appear to be vulnerable to climate change, especially lack of hydrating and insulating winter snow cover. Although neither of the species mentioned can in any way be described as rare, it is interesting to note that some of the most robust population forming *Rhododendron* species are slowly losing their dominance of vegetation cover on the Yulong Xue Shan.

In dealing very briefly with the issue of plant names, the Lijiang Alpine Botanic Garden and Jade Dragon Field Station have the benefit and support of the Kunming Institute of Botany and the Royal Botanic Garden Edinburgh, both significant contributors to the Flora of China project. Through the great efforts of the Flora of China committee and research groups it is now possible to compare like with like and at a more detailed level it is possible to determine how vulnerable a species has become, not only on the Yulong Mountain, but throughout its range in China.

Conclusion:

The plants and habitats that form the vegetation cover of Yulong Xue Shan are facing many challenges and some species loss is inevitable. The process of attrition can however be slowed and possible even halted. The people who depend most on the mountain and its systems can benefit from the development of Lijiang Alpine Botanic Garden and the Jade Dragon Field Station. Some of the benefits are already being recognised by the indigenous peoples of the mountain and the relationship between farmer and botanist is growing in trust and reliance. Much has been achieved in the first seven years of the project and both plans and finances are in place to ensure the next seven years are equally successful.

Rhododendrons at the Royal Botanic Garden Edinburgh

David Knott

Rhododendrons in the Living Collection:

The Living Collection of the Royal Botanic Garden Edinburgh [RBGE] is spread across 4 gardens; the Indoor and Outdoor Living collections in Edinburgh at Inverleith, Benmore Botanic Garden near Dunoon, Dawyck Botanic Garden near Peebles and Logan Botanic Garden near Stranraer. Each garden has a significantly different climate that allows a wide range of plants including rhododendrons to be grown; Dawyck is the coldest, Logan the mildest, Benmore the wettest and Edinburgh is the driest.

Within the Living Collection of RBGE, the rhododendron collection currently, as of May 2008, comprises 657 species, 1,300 taxa, 3984 accessions, 7,259 plant records and 10,869 plants.

Edinburgh has an average rainfall of 636mm with an absolute maximum temperature of 29.6C recorded in August 1990 [in the last 10 years 27.4C has been recorded in July 2006] and an absolute minimum temperature of -15.5C recorded in January 1982 [in the last ten years -8.1C has been recorded in December 2001]. Currently there are 297 species growing indoors and 269 species currently growing outdoor including subsections Fulva, Lapponica, Neriiflora, Pentanthera, Triflora and Saluenensia.

Above:
Rhododendron rex* ssp. *fictolacteum
in the wild

Photos in this article courtesy of RBGE

Benmore has an average rainfall of 2600mm with an absolute maximum temperature of 29.6C recorded in July 1983 and an absolute minimum temperature of -13.9C recorded in January 1983. Currently 299 species are cultivated at Benmore from the following subsections: Arborea, Campanulata, Thomsonia, Barbata, Grandia and Falconera.

Dawyck has an average rainfall of 1000mm with an absolute maximum temperature of 29.8C recorded in July 2003 and an absolute minimum temperature of -19.8C recorded in December 1995. At Dawyck 108 species are grown in subsections Taliensia and Fortunea.

Logan has an average rainfall of 1000mm with an absolute maximum temperature of 27.7C recorded July 2006 and an absolute minimum temperature of -10.5C recorded in December 1996. Currently 77 species are grown in subsections Maddenia and Edgeworthia.

However, none of these collections would ever have been possible without the work of the intrepid plant collectors during the early 1900’s who introduced many of the plants that are still in cultivation today. Since then these introductions have been maintained through the vision and stewardship of generations of

***Rhododendron macabeanum* KW 7724**

garden staff at each garden.

Isaac Bailey Balfour Regius Keeper [Director] of RBGE from 1888 until 1922 was instrumental in ensuring that George Forrest was sent to China in 1904 and it was perhaps this partnership and the new plant material, both herbarium and living, subsequently introduced by Forrest that was going to determine the direction that the herbarium and Garden would take for the next 100 years.

During Sir William Wright Smith's term as Regius Keeper [1922-1956] and Roland Cooper's term as Curator [1934-1950] what is now Benmore Botanic Garden was acquired in 1929, as space for the cultivation of many of the new species of rhododendron introduced from China by George Forrest was required. They were succeeded by Harold Fletcher [Regius Keeper 1956-70] and Edward Kemp [Curator 1950-1972] and during their term Logan was acquired in 1969 thus allowing a wide range of the more tender temperate species, including rhododendrons to be cultivated outdoors. Between 1970 and 1987 Douglas Henderson was Regius Keeper and Richard Shaw was Curator [1972-1987] and during their term Dawyck was acquired in 1978 and its cool temperate climate allowed a further range of plants, including rhododendrons, to be cultivated.

Among the plant collectors from this era George Forrest stands out as having introduced the greatest number of rhododendrons into cultivation at RBGE. These were mostly from south west China and in particular from Yunnan Province, during seven expeditions between 1904 and 1932. Currently within the Living Collection some 216 rhododendron accessions still carry his collector's number, including; *R. roxieanum* var. *oreonastes* F24, *R. beesianum* F10195, *R. wardii* F25534, *R. fulvum* F18310 and *R. balfourianum* F16811. Within the archive of RBGE, images taken by Forrest still exist of the spectacular scenery in Yunnan and rhododendrons in their natural habitat.

Frank Kingdon Ward was from the era, and he collected in upper Burma [Myanmar] and north west Yunnan between 1913 and 1956 during the course of some 18 expeditions. Currently within the Living Collection there are 193 accessions that were introduced by Kingdon Ward and these include *Rhododendron* aff. *faucium* KW 5732, *R. macabeanum* KW 7724, *R. johnstoneanum* KW 7732 and *R. cerasinum* KW 11011.

Joseph Rock was active in Yunnan, Sichuan and Gansu provinces from 1923 until 1949 latterly setting up home near Lijiang, where RBGE is currently involved in the creation a field station at the base of the Yulong Xue Shan or Jade Dragon Snow Mountains. Currently within the Living Collection there are 193 accessions still surviving with Rock numbers including; *Rhododendron vernicosum* R4012, *R. floccigerum* R18465 (**left**), *R. fletcherianum* R22302 and *R. russatum* R 18462.

Ernest Wilson was principally active in Sichuan Province between 1899 and 1911 and although Sichuan is not a Rhododendron 'hotspot' he introduced many fine plants and currently within the Living Collection there are 38 Rhododendron accessions including; *R. arygyrophyllum* W1210, *R. searsiae* W1343, *R. strigillosum* W1341, *R. augustinii* subsp. *augustinii* W1271 (**right**) and *R.davidsonianum* W1271.

Frank Ludlow and George Sherriff were active in Bhutan and southern Tibet between 1932 and 1949 and currently there are 18 rhododendron accessions including *R. thomsonii* L&S 2847 and *R. tsariense* var. *tsariense* L&S 2766 in the Living Collection.

Reginald Farrer perhaps better known for his interest in alpine plants accompanied Euan Cox of Glendoick to upper Burma [Myanmar] and western

Yunnan in 1919, and from this expedition a plant of *Rhododendron mallotum* F815 still exists in the Living Collection and it is only in recent years that this plant has been recollected from its type locality.

It is only in the last 30 years that access to many of the areas within China mentioned above has again been possible and the 1981 Sino-British Expedition to the Cangshan [SBEC] mountain range above the town of Dali in south west China was to prove to be the first in a number of expeditions. These not only allowed such areas to be re-explored allow-

Above: *Rhododendron tsariense* var. *tsariense* L&S 2766
Below: *R.wardii* FED 367

ing many rhododendrons to be re-introduced and many new rhododendrons to be introduced to cultivation for the first time. An example of the former is *Rhododendron sinogrande* SBEC 0104, and perhaps more importantly it allowed taxonomists and horticulturists to study rhododendrons in their native habitat including the hybridization of species which can today be seen in *R. lacteum* x *R. taliense* SBEC 0546 within the Living Collection.

Amongst the taxonomists was Dr David Chamberlain of the RBGE. A member of the 1981 SBEC expedition, David was to travel to China many times on fieldwork and lead the 1991 Chengdu Edinburgh Expedition [CEE] to western Sichuan and the 1995 Forestry Commission, Edinburgh Expedition to Dequen in North West Yunnan. Amongst the plants introduced on the first expedition were: *Rhododendron sutchuenense* CEE 172 which has recently started to flower in cultivation and *R. souliei* CEE 571, and on the latter expedition *R.wardii* FED 367.

The RBGE has had a long taxonomic and horticultural interest in the genus *Rhododendron* and in recent years this culminated in what has been referred to as the ‘Edinburgh Revision’. Started in 1972 by James Cullen and David Chamberlain, the subgenus Rhododendron was completed in 1980 and the subgenus Hymenanthes was completed in 1982.

RBGE has also had a long history with the introduction and cultivation of the Vireya subsection; they are principally montane plants growing at high altitudes in the south west Asian Archipelago from New Guinea in the east to the Philippines in the north and Sumatra in the North West. In the 1960’s Bill Burtt and Paddy Woods collected in the Malay peninsula, and since 1977 George Argent has led many expeditions to south Asia with the resultant introduction of many new species many of which have been introduced into cultivation and their eventual display in the Montane Tropic display glasshouse at RBGE (**opposite page**).

In the late 1970’s Curator Richard Shaw started to renovate and rearrange the rhododendron collection in the garden at Inverleith to reflect the taxonomic work being undertaken in the garden by grouping and planting species within each subsection together. This work started at the north side of the Rock Garden with the *Rhododendron* subsections Cinnabarina, Triflora, Heliolepida, which in turn link with the Saluenensia and Lapponica subsections in the Rock Garden. In the Copse, subsections Glischra, Neriiflora, Fortunea and Pontica were planted and in the area immediately around the Peat Walls and Conifer Walk, the subsections Thomsonia and Taliensia were planted.

Since the 1980's RBGE has had a Collection Policy to determine which groups of plants are grown and where within the Living Collection to take full advantage of the varying climatic conditions across the four gardens. With rhododendrons the aim is to match the cultural conditions required for each subsection or individual species to each garden e.g. subsection Grandia at Benmore, subsection Taliensia at Dawyck, subsection Maddenia at Logan and subsection Vireya – under glass at Edinburgh. A representative collection from as many subsections as possible is grown outdoors at Edinburgh.

Current and future challenges facing the cultivation of rhododendrons within the Living Collection of RBGE include changes in rainfall patterns, temperature extremes and problems with pests and diseases.

Changes in rainfall patterns due to climate change/oscillation are now being experienced at all four gardens and have included in the last 12 months; at Inverleith a very dry April/May 2007 with less than 10mm of rain being recorded and at Benmore between November 2007 and March 2008 a very wet winter with over 1500mm being recorded. Possible solutions to these rainfall extremes is to ensure that the subsections/species are matched to individual gardens, at Inverleith consider the installation of irrigation and at Benmore ensure drainage channels are kept clear and where necessary new plantings are mound planted.

Temperature extremes have in recent years seen higher summer temperatures with lower winter temperatures becoming almost a distant memory. The higher spring/summer temperatures coupled with reduced rainfall have undoubtedly stressed many already vulnerable older plants.

The main pest encountered affecting rhododendrons at all four gardens but particularly at Inverleith in the last 10 years, has been *Chloropulvinaria floccifera*, Cottony Camellia/Taxus Scale. The most obvious sign that the pest is present is the disfiguring and weakening sooty mould on the upper surfaces of the leaves with, on the undersides, the varying stages of the pest found at different times of year. The main methods of control have been cultural by increasing air movement and improving the vigour of the plants by spraying both foliar feed and targeted chemical application.

In the last 5 years even more potentially damaging diseases, *Phytophthora ramorum* and *P. kernoviae* have been found in gardens particularly on the west coast of Britain. Being a notifable plant disease the control measures are extremely draconian and at the time of this presentation several of the rhododendron gardens of Cornwall and western Scotland have been particularly badly hit. At the time of this conference it is difficult to ascertain what long term impact this disease will have.

The different climatic challenges and recent disease outbreaks facing us have perhaps reinforced the need for us all to work more closely together in the future, to successfully cultivate rhododendrons, to share knowledge and information.

American Azaleas

L. Clarence Towe, EdD

While the botanical names and numbers of species of American azaleas have changed over the years, it is now generally recognised that there are 16 distinct species in North America.

[Note: there is scientific evidence to show that a recently discovered tetraploid species will increase the number to 17 species upon its publication in 2008.]

While centred in the United States one eastern species crosses northward into Canada and one species is found in a small area south of the border in northwestern Mexico. In the past, several authorities attempted to lump American azaleas (hereafter azaleas) into alliances by correlating biochemical analyses with morphological characteristics. Due to different approaches and interpretations of data, these attempts failed to conclusively resolve the many relationships that exist between the species. The group approach used here is not an attempt to revisit alliances or to add further layers of taxonomy, but is intended to present the species in a practical manner. The groups are based on geographical isolation in one instance, on lack of fragrance in another, and on fragrance or similar colours in others. The descriptions are composites as noted by several authorities and on personal observations of readily observable characteristics across the ranges of the species. Within each group the species are listed in order of time of bloom.

In keeping with international rules of plant nomenclature, the names of several species were changed several years ago, to refer to them as they were first referenced in early literature. While this gives credit where due, it has led to some confusion and several species are still referred to by their old names. *Rhododendron speciosum* was changed to *R. flammeum*, a very descriptive name for the bright orange and red flowers of this lowland species. The change, however, has led to some confusion as the common name of *R. calendulaceum* is Flame azalea. *Rhododendron nudiflorum*, a name any azalea would aspire to, was changed to tongue-twisting *R. periclymenoides*, and *R. roseum*, a perfectly descriptive name, was changed to *R. prinophyllum*, which sounds much like

R. prunifolium. *Rhododendron bakeri* was changed to *R. cumberlandense* to reflect its Cumberland Plateau range in the southern Appalachian Mountains.

Within the species, many botanical varieties (var.) and forms (f.) were recognised at one time but most of these infraspecies names were dropped, as the species became better understood. Rules of plant nomenclature invalidated some infraspecies names still in use today, which creates a problem in referencing them in an acceptable manner. One taxonomist suggests parentheses as a means to describe plants with unique qualities but which may be invalid from a taxonomic standpoint. For example *R. arborescens* (var. *georgiana*) will be used here to denote the late-blooming southern form of *R. arborescens.*

The range maps presented are approximations and in any area azaleas have uneven distributions. Some large areas within a range may be devoid of azaleas while other areas may be heavily populated. In actuality it is likely that all ranges are larger than depicted on the distribution maps. Hardiness within each species is also variable and hardiness zones should be used only as guides. For example, plants from the southern end of the range of *Rhododendron viscosum*, which spreads from the Gulf of Mexico into New England, are not as hardy as plants from the northern end of the range.

In discussing azaleas a few botanical terms can be helpful to develop a better understanding of how they are divided into species. The primary species indicators are bloom time, flower colour and fragrance, leaf shape and texture, and the presence or absence of small hairs on new stems, leaves, bud scales and flower parts. These hairs may be slender, unicellular hairs or thick, multicellular hairs. Multicellular hairs are usually tipped with sticky or non-sticky knob-like glands. A plant part lacking hairs or having only a few scattered hairs is referred to as being glabrous, and pubescent if covered with hairs. Leaves covered with a waxy white, gray, or blue powder are said to be glaucous and a plant that spreads by underground runners is stolonifereous. Leaf shapes can be elliptical (widest in the centre) or obovate (widest near the tip).

Group One consists of one species: ***Rhododendron occidentale***.

Western Azalea, *Rhododendron occidentale,* is a geographically isolated species with a range from southern Oregon, across California, and into a small area in northwestern Mexico. It grows at low elevations along the Pacific Ocean coastline to as high as 8,000 feet in coniferous forests on the western slopes of the Sierra Nevada Mountains. In its typical form the relatively small fragrant white, cream or pale pink flowers have yellow blotches. The flower tubes, petal ribs, leaf margins and seed pods are covered with conspicuous glandular hairs, a trait shared with a few east coast species.

Leaves are usually 3 inches or less in length and upper surfaces vary from smooth to very hairy. Growth habit varies from low and stoloniferous to over 30 feet in height, making it our tallest azalea. Scattered among these typical forms are plants with unusually large flowers, frequently to 3 inches and occasionally to 4 inches. The petals are wide and overlapping, with some having crimped or frilled margins and velvety, crêped surfaces. Colours vary from light pink to deep pink to pinkish-red to red, occasionally with red picotee margins, and most have yellow or orange speckles instead of blotches in the throats.

A puzzling aspect of this species is its reluctance to grow and thrive on the east coast. It will grow here for some time but in due course usually declines and dies. Even in areas with microclimates similar to the west coast, it seldom lives more than a few years. One theory is that soil chemistry, rather than climate, restricts its growth on the east coast. Bloom time is from May to August and it is hardy from zones 7 to 9.

Several noted authorities have speculated that *Rhododendron occidentale* may have resulted from the assimilation of two or even three ancestral species into one highly variable species. While leaves are usually 3 inches or less in length, some can be up to 6 inches in length, and the large-flowered forms have either speckles on the upper petals, or large blotches that break up into speckles around the blotch margins. These foliage and flower traits are also found on *R. molle* and *R. japonicum*, located across the Pacific Ocean in eastern China and Japan. Continental drift theories place North America and Asia in close proximity in past millennia, raising the possibility that these similarities may be more than coincidental.

Group Two contains two non-fragrant pink species: ***Rhododendron canadense*** and ***Rhododendron vaseyi***. Unlike other azaleas, which have five anthers, these two species have from seven to ten anthers and are not closely related to each other or to any other azalea species.

Rhodora, *Rhododendron canadense*, is found in low-lying glaciated areas of New Jersey, Pennsylvania, New York, throughout New England and into eastern Canada. The tubeless flowers have from seven to ten anthers. The three upper petals are fused into one speckled petal with three marginal lobes and the two lower petals are narrow and widely splayed. Flower colour ranges from white (rarely) to lavender-pink to vivid pinkish-purple. The glaucous leaves are small and grayish-green with slightly raspy surfaces, though in a few areas plants have been found with smooth, bright green leaves. Rhodora is a low-growing 3 feet plant capable of spreading long distances by underground stolons. Bloom time is from April to May and it is hardy from zones 3 to 6.

Pinkshell Azalea, *Rhododendron vaseyi*, is a reclusive high-elevation species restricted to seven counties in western North Carolina and one county in northeastern Georgia. It prefers rich, damp, well-drained soil and cooler summer temperatures than most species. It is usually found from 4,000 to 6,000 feet above sea level and can languish at lower elevations if summer heat is excessive. It is an open-growing, weakly branched shrub with smooth stems covered with shreddy, gray-brown bark. The flowers have seven anthers, short glabrous tubes and deeply divided petals that appear just before or with the emerging foliage, giving a bare plant the look of being covered with pink butterflies. Flower colour ranges from white (rarely) with green speckles in the throats to light pink to vivid pink with reddish throat speckles. Winter buds are fat and plump, with a shape unlike any other species. Terminal leaves are smooth and narrowly elliptical while leaves on lower limbs are more obovate. If exposed to full sun, leaves can be wine red during most of the year. Fall leaf colour varies from red to yellow, depending on sun exposure and night temperatures. Bloom time in its home range is from early to late May and it is hardy from zones 4 to 7.

Group Three contains three fragrant pink species: ***Rhododendron canescens***, ***Rhododendron periclymenoides***, and ***Rhododendron prinophyllum***.

Piedmont Azalea, *Rhododendron canescens*, is our most common species. It is found primarily in the Deep South and is closely related to its more northern counterparts, *R. periclymenoides* and *R. prinophyllum*. *Rhododendron canescens* is a tall 15 feet non-stoloniferous shrub found in a variety of locations, from damp swamp margins to dry upland ridges. The flowers are typically white to light pink with pink tubes, but bright pink forms can be found. Flower fragrance is sweet to musky sweet. The flower tubes are covered with both glandular and non-glandular hairs. The medium green obovate leaves are usually dull, due to being covered with short, raspy hairs above and with dense, downy hairs below. Floral bud scales have a pearlescent look, which adds to the overall candescent (dusty) look of the plant, and gives rise to one of its more obscure names, ‘Hoary azalea’. Bloom time is from March to early May and it is hardy from zones 6 to 9.

Pinxter Azalea (aka Pinxterbloom Azalea), *Rhododendrdon periclymenoides*, overlaps the northern end of the range of *R. canescens* and extends northward into southern New England. Its growth habit varies from low and stoloniferous, to upright, to 12 feet and it is usually found in fairly dry soil in open hardwood forests. Flower colour varies from pure white (rarely) to pale pink to bright purplish violet, with most flowers having dark pink to strawberry red tubes. Typically the flower tubes are covered with non-glandular hairs in contrast with the glandular hairs of *R. canescens* and *R. prinophyllum*. The flowers occasionally have wide petals but are more often narrow and twisted, giving them a frazzled, jumping-jack look. Fragrance is moderately musky sweet or occasionally lacking. Leaves are generally smooth and semi-glossy on top and from elliptical to obovate in shape. The Pinxter azalea hybridises readily with *R. canescens* to the south and *R. prinophyllum* to the north, creating a huge swath of fragrant pink azaleas inside a triangle from Florida, to Texas, to New Hampshire. Bloom time is from April to May and it is hardy from zones 4 to 8.

Roseshell Azalea, *Rhododendron prinophyllum*, differs in several respects from its two fragrant pink relatives. Its primary range is in the cooler upland and mountainous areas of Virginia and West Virginia, across Pennsylvania and upstate New York, and into New England. Oddly, it has a disjunct range west of the Mississippi River in southern Missouri, Arkansas, and eastern Oklahoma. The plants are usually non-stoloniferous and moderate in height to 8 feet. The flowers have shorter tubes than the two other fragrant pink species, the tubes are covered with moderately sticky glands, and the fragrance is sweet and clove-like. Flower colour varies from pale pink to vivid pink to violet-pink, with many having darker pink elliptical blotches on the upper petals. The petals can be narrow or relatively wide, usually with dark pink to strawberry red tubes. Emerging leaves are coppery in color and have impressed veins, causing them to have lumpy upper surfaces. They are also covered with soft hairs, giving rise to one of its older common names, downy azalea. Due to its preference for the cooler mountains, it has also been called mountain pink azalea in some areas. Bloom time is from May to June and it is hardy from zones 4 to 8.

Group Four contains five fragrant white species: ***Rhododendron alabamense***,_***Rhododendron atlanticum***,_***Rhododendron arborescens***, ***Rhododendron eastmanii*** and ***Rhododendron viscosum***.

Alabama Azalea, *Rhododendron alabamense*, is found primarily in Alabama, but crosses into central Tennessee to the north and is found sporadically across Georgia to the east, in a small area of the Florida panhandle to the south, and west into Mississippi. While the distribution range is fairly large it is not a common species, though in its better forms it is very attractive. It was probably more widely distributed in the past but hybridization with *R. canescens* may have assimilated it into that species complex in many areas. It is found along dry ridges and steep bluffs, as well as in flat, moist, sandy areas. The plants vary from low and stoloniferous, to upright to 12 feet. The flowers have a sweet or musky-sweet scent, frequently with distinct lemon overtones. Flower colour is white to white with yellow blotches, while some are flushed pink. The flower tubes are covered with glandular and non-glandular hairs, making them moderately sticky to the touch. Leaf surfaces vary from semi-glossy to dull, and from dark to medium green in colour. Like its relative *R. arborescens*, many plants of this species have dark green leaves that are glaucous underneath and fragrant when crushed. Bloom time is from late April to early June and it is hardy from zones 6 to 8.

Coastal Azalea, *Rhododendron atlanticum,* is a low-growing species found from Delaware south to Georgia, and up to 200 miles inland in sandy coastal plains along damp ditches, sandy swamp margins, as well as in dry pasture sites. If the soil is loose it will spread by underground stolons, forming large colonies of a single plant. The fragrant flowers are typically white, often flushed pink. Flower tubes are very glandular and can be white or pink, and occasionally plants are found with pale yellow or pale pink flowers. Leaves are usually glaucous gray-green or blue-green, frequently with good substance. Bloom time is from April to May and it is hardy from zones 5 to 8.

Sweet Azalea, *Rhododendron arborescens*, is found along fast moving streams and damp mountain tops from Alabama to Pennsylvania. It is usually tightly stoloniferous and can form dense clumps to 15 feet in height. The fragrant white flowers (rarely light pink or light yellow) often have yellow blotches and are fairly large, frequently exceeding 2 inches in width. Flowers typically have red pistils and filaments, making it one of our most distinct species. Most flowers have white tubes but some have light green or pink tubes. Leaves are smooth and glossy to semi-glossy, and vary in colour from medium to dark green to glaucous blue-green with white undersides. New growth is smooth and hairless, giving rise to its other name, 'smooth azalea'. Crushed or dried leaves and twigs are almost always fragrant. Unlike its relatives, it has granular seeds instead of winged seeds. Bloom time is from May to August and it is hardy from zones 5 to 8.

In the past the 'sweet azalea' has been credited with two botanical varieties. *Rhododendron arborescens* var. *richardsonii* was described as being a low, stoloniferous plant with blue-green foliage. In actuality plants that fit this description are fairly common in the Appalachian Mountains and they appear to be hybrids with low-growing, high-elevation plants of *R. viscosum*. Another form that is not well known is *R. arborescens* var. *georgiana*. This low elevation form, found in Georgia and Alabama, differs from typical *R. arborescens* in several ways. It has dark green leaves that are not fragrant when crushed and the leaves are not glaucous. Another difference is that it blooms in August and September instead of May through July like its upland counterpart. The fragrant flowers have typical red pistils and filaments, seldom with yellow blotches, and the growth habit is non-stoloniferous.

Maywhite Azalea, (aka **Santee Azalea**), *Rhododendron eastmanii,* is found only in South Carolina along streams that drain toward the central part of the state into the Broad River and Santee River drainage basins. For decades, this yellow-blotched fragrant white azalea was thought to be *R. alabamense,* but it differs from the Alabama azalea by its fragrance, flower shape, leaf surface texture, and overall plant appearance.

After *Rhododendron eastmanii* was introduced by Kron and Creel in 1994, some confusion arose as the focus of its status centred on dark glands found on floral bud scale margins. It was later found that this hallmark diagnostic, as found on *R. calendulaceum* and *R. cumberlandense*, were in fact seldom found on *R. eastmanii,* though its overall appearance alone is very sufficient, when compared to other white azaleas, to set it apart as a distinct species.

Swamp Azalea, *Rhododendron viscosum*, covers a large distribution area and when examined across its range is our most variable species. East of the Mississippi River it is found along coastal areas from Mississippi to Florida and up the east coast as far as southern Maine. It is also found 400 miles inland in some high elevation areas in the southern Appalachians. West of the Mississippi River it is found in Missouri, eastern Oklahoma, east Texas and northern

Louisiana. It is seldom seen along fast-moving streams like *R. arborescens*, instead preferring damp ditches, swamp margins, sandy fields as well as dry ridges. Leaf shape varies from small and narrow to large and rounded, and leaf color varies from dull gray-green to glossy dark green, to glaucous gray-green or blue-green . Leaf texture can be raspy or smooth.

Distinct as it is, it still suffers from an identity crisis. It is most often confused with *Rhododendron arborescens*, though the two can be separated by the sense of touch alone. The new stems of *R. viscosum* are slender and hairy while the new stems of *R. arborescens* are larger and smooth. *Rhododendron viscosum* has slender tubes and fragrant white flowers, rarely pink, that are small to medium in size with narrow to medium width petals. Pistils and filaments are typically white in contrast to the red pistils of *R. arborescens*. This species has two other common names, catch-fly azalea and clammy azalea, both attributable to its sticky, glandular tube hairs that easily trap flying insects.

Rhododendron viscosum is frequently referenced as having two botanical varieties. The low-growing high-elevation type *R. viscosum* var. *montanum* resembles its low country counterpart *R. viscosum* var. *aemulans*. Due to the seamless range of plant heights found in this species – from very low to very tall – it is doubtful these epithets meet the taxonomic standard for varietal status. Bloom time is from May to September and it is hardy from zones 4 to 9.

The re-classified dwarf *Rhododendron coryi*, *R. oblongifolium* (Texas Azalea), and *R. serrulatum* (Hammock-sweet Azalea), have been lumped with *R. viscosum*. There are those who insist, however, that *R. serrulatum* is distinct enough to remain at the species level. It is one of the earliest azaleas to leaf out in the spring, much earlier than *R. viscosum*, and the shiny leaves and new stems frequently contain strong red pigmentation. It also has small bud scales that may be very red during the winter months. From a horticultural, if not taxonomic standpoint, it deserves the status of *R. viscosum* var. *serrulatum*.

Group Five contains five yellow, orange, and red species; ***Rhododendron austrinum***, ***Rhododendron flammeum***, ***Rhododendron calendulaceum***, ***Rhododendron cumberlandense***, and ***Rhododendron prunifolium***.

Florida Azalea, *Rhododendron austrinum*, is probably distressed to be lumped with four non-fragrant relatives. It is most closely related to *R. canescens* and when they are not in bloom the two are very difficult to separate. It is found in the Florida panhandle, southern Georgia and Alabama, and southeast Mississippi. This colourful species is early to bloom and easy to grow, making it one of our most popular species. The fragrant yellow, gold, or light orange flowers usually have pink to strawberry red tubes, which may be a result of hybridisation with *R. canescens*. Flower tubes are glandular, as are leaves and new stems. Mature leaves are usually obovate and covered with short, raspy hairs. The growth habit is non-stoloniferous, to 15 feet and it thrives in the sand and heat of its Gulf Coast range. Bloom time is from March to April and it is hardy from zones 6 to 9.

Oconee Azalea, *Rhododendron flammeum*, discovered along the Oconee River in Georgia, is not a well known or widely grown species. It is usually non-stoloniferous and grows 6 to 8 feet tall. It is heat tolerant and exhibits a wide range of bright colours from yellow to orange to red. Flowers emerge with the leaves, which are usually dark green and shiny when young. In the wild it hybridises freely with *R. canescens*, giving rise to vivid pinks, frequently with yellow blotches. *Rhododendron flammeum* is often confused with *R. calendulaceum*, though the former has non-glandular flower tubes in contrast to glandular flower tubes of the latter. Bloom time is from April to early May and it is hardy from zones 6 to 8.

Flame Azalea, *Rhododendron calendulaceum*, is the azalea most frequently associated with the Appalachian Mountains, and many consider it to be our most attractive eastern species. It begins blooming at 800 feet in the upper piedmont of the south and finishes its season at over 6,000 feet in the Appalachian Mountains. It is a tall, non-stoloniferous shrub that can grow to 12 feet. Flower colour varies from yellow to orange to red, with many forms having orange blotches and slight pink overtones. Two-inch flowers are common and some can be found to 3 inches in width. Flower petals vary from narrow with pointed tips to wide and overlapping with rounded tips. Flower tubes are glandular in contrast with its three orange/red relatives. Bloom time is from April to July and it is hardy from zones 5 to 8.

Cumberland Azalea, *Rhododendron cumberlandense*, is another high-elevation orange to red species that is easy to confuse with *R. calendulaceum* and *R. flammeum*. Like *R. flammeum* it has sparse, non-glandular tube hairs but in contrast its leaves are fully expanded when the flowers appear and it blooms several weeks later. It differs from *R. calendulaceum*, which blooms with or just after the leaves have expanded, by having smaller flowers with thinner tubes. Plants are typically low and twiggy, but they can grow to 10 feet. Leaves emerge late in the season and have smooth, semi-glossy to glossy surfaces, frequently glaucous underneath. Along overlap areas between their ranges, *R. cumberlandense* and *R. calendulaceum* have hybridised and the plants are very difficult to identify. Bloom time is from May to July and it is hardy from zones 4 to 8.

Plumleaf Azalea, *Rhododendron prunifolium*, has orange-red to red flowers but is very different from the others in this group. As in *R. arborescens* the leaves and new stems are smooth. The dark green leaves emerge very early in the season and are relatively large. The flower tubes are also glabrous, or nearly so, a unique trait that helps with identification. It is a tall shrub, up to 20 feet or more, and prefers cool ravines and creeksides in its small 11-county range along the Alabama-Georgia border. Due to its late bloom time this species is very stable, though some plants have pinkish or salmon flowers, perhaps indicating past hybridisation with nearby *R. arborescens* (var. *georgiana*). Bloom time is from July to September and it is hardy from zones 6 to 9.

Wild Hybrid Azaleas

On the east coast 13 of the 15 azalea species will hybridise naturally, however due to bloom-times and distribution ranges as they now exist, several species are isolated geographically and have no opportunities to hybridise. As discussed here a hybrid is an azalea resulting from cross-pollination between azaleas of two or more species. The issue of frequency of hybridisation in the wild is controversial. Some suggest that hybridisation is relatively rare while others feel that all azaleas are hybrids. As is the case with most divergent opinions the truth probably lies somewhere between the extremes. *Rhododendron occidentale* is genetically compatible with 13 of the 15 east coast species but its isolated range prevents natural hybridization. Two east coast species, *R. canadense* and *R. vaseyi*, are lumped together taxonomically but are genetically incompatible with each other and with all other American species. Wild hybrids have been verified between numerous species pairs, especially in the Deep South where they are so common. In addition to the following pairs, some hybrids have been identified that involve three and perhaps even four species.

Rhododendron alabamense x *Rhododendron periclymenoides*
Rhododendron alabamense x *Rhododendron canescens*
Rhododendron arborescens x *Rhododendron cumberlandense*
Rhododendron arborescens x *Rhododendron calendulaceum*
Rhododendron arborescens x *Rhododendron periclymenoides*
Rhododendron arborescens x *Rhododendron prinophyllum*
Rhododendron arborescens x *Rhododendron viscosum*
Rhododendron atlanticum x *Rhododendron periclymenoides*
Rhododendron calendulaceum x *Rhododendron canescens*
Rhododendron calendulaceum x *Rhododendron cumberlandense*
Rhododendron calendulaceum x *Rhododendron periclymenoides*
Rhododendron calendulaceum x *Rhododendron prinophyllum*
Rhododendron calendulaceum x *Rhododendron viscosum*
Rhododendron canescens x *Rhododendron atlanticum*
Rhododendron canescens x *Rhododendron austrinum*
Rhododendron canescens x *Rhododendron flammeum*
Rhododendron canescens x *Rhododendron periclymenoides*
Rhododendron prinophyllum x *Rhododendron periclymenoides*

Identifying hybrids in the field is relatively easy, especially between an orange or red species and a pink or white species. The resulting plants frequently have vivid pink flowers with yellow or orange blotches. Hybrids between two fragrant pink species or between two non-fragrant orange or red species can be very difficult to identify. If the diagnostic characteristics of an azalea such as bloom-time, flower colour, flower tube glands, and floral bud scale glands are close to type-form definition, identification is relatively easy. Identification, however, is very difficult in the many azaleas that appear to be species but whose family trees, if available, would reveal intermittent gene exchange with other species.

Evidence of long-term gene exchange can be found in most east coast species, especially in overlap areas between species with large distribution ranges. Like people, azaleas are very adept at concealing their ancestries.

Today we probably have more azalea species than in the past. Several authorities have theorised that the 14 azalea species with five anthers could have speciated through hybridisation from a red similar to *Rhododendron cumberlandense* and a white similar to *R. arborescens*. These changes were probably brought about over the millennia by forces of glaciation. Our present climate is thought to be a warm period between glacial advances. As the last advance began to recede some 16,000 years ago, the azaleas kept their distance but followed the glacial fronts northward and redistributed themselves through the basic seed dispersal mechanisms of wind – probably tornadoes – and water flow. These periodic disturbances, combined with wildfires, deforestation and agricultural practices, undoubtedly presented hybridising opportunities not seen in the species' ranges as they exist today.

In March of 1951, Henry T. Skinner embarked on a journey of epic proportions to study southern azaleas. While his work was primarily descriptive in nature, what he discovered about them is still valid today. Between March 18 and August 12, 1951, he and his cohorts travelled 25,000 miles by car inside a rectangle from Florida to Texas and from Missouri to coastal Virginia, crossing Alabama and Georgia several times. They made collections from 7,360 plants, both species and hybrids, and travelled countless miles by foot. Using perforated cards he indexed data on flower colour, flower blotch, plant growth habit, flower tube hairs, bud scale hairs, and leaf hairs. Perhaps his most important finding was that no species is stable across its range. This suggests and supports other studies, and personal observations, that hybridisation is an ongoing process and that most species show evidence of past or recent gene infiltration from other species. There is hope on the horizon that better ways will be developed to analyse azaleas. Until then perhaps the best way to resolve the issue is to use a slight twist on an old adage – if it looks like a duck it's probably mostly duck.

What can DNA markers tell us about the evolution of *Rhododendron ponticum* and its relatives?

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1. Origin of *Rhododendron ponticum* in the British Isles:

Fig. 1. *Rhododendron ponticum*, as found in Britain, is rarely if ever genetically "pure". Instead, plants tend to contain genetic material from other species that are or have been cultivated in Britain. This makes the plants more variable than those seen in native populations, and might also have increased cold tolerance and invasiveness.

Rhododendron ponticum (Fig. 1) was introduced to the British Isles in 1763, and has since become one of the most troublesome invasive plant species in the country. It occurs as a naturalised alien almost throughout the British Isles, avoiding only calcareous soils (notably the clays of the Cambridge region) and the very coldest regions (high mountains and the far north). It

Fig. 2. A hillside near Beddgelert, Snowdonia, Wales, choked with ***Rhododendron ponticum***. Snowdonia has some of the most aggressively invasive populations of ***R. ponticum*** Britain, and large sums of money are spent on controlling them here.

occurs most abundantly where the soil is acid and the rainfall high, and hence it is highly invasive in regions such as Snowdonia (Fig. 2), Western Scotland and parts of Ireland. Some alien plants in Britain, notably the Oxford ragwort (*Senecio squalidus*), escaped into the wild only once and then spread from a single introduction point. However, most or all naturalised populations of *R. ponticum* appear to result from localised introductions. This is particularly noticeable if one drives around western Scotland. Areas such as Glen Garry and the roadside south of Loch Torridon are choked with dense populations of *R. ponticum*, whereas ten miles down the road no plants are to be found. Near the centre of these naturalised populations is always to be found an estate or garden in which *R. ponticum* is, or was, grown. Hence *R. ponticum* is not a rapid spreader, but once it is fully established its spread can be inexorable, with native competitors excluded by a combination of shading and allelopathy – a process by which *R. ponticum* puts noxious compounds into the soil to inhibit competitors. This also impedes recolonisation by other species after *R. ponticum* has been removed.

As a native, *Rhododendron ponticum* has an unusual disjunct distribution. The main populations occur along the southern coast of the Black Sea, stretching from Bulgaria through northern Turkey into the Caucasus. However, there are also three small areas in the Iberian Peninsular where is occurs, in the Algarve, northern Portugal, and SW Spain not far from Gibraltar. Ironically, the populations in Spain are small and relictual, and it is considered to be an endangered species in the country. There is also a small population in Lebanon. There are also fossils which indicate that during a previous interglacial, *R. ponticum* occurred naturally in W Ireland as a member of the Lusitanian flora.

Using data from molecular (DNA) markers, I aimed to determine which of these wild populations had given rise to the British material. The first step was to obtain material from the main parts of the native distribution, i.e. NE and NW Turkey, SW Spain, and the two areas of Portugal where it occurs. The next and most crucial step was to develop a reliable DNA marker which could distinguish between these populations. For this the RFLP (restriction fragment length polymorphism) technique was used. In a nutshell, this technique produces DNA fragments whose presence and size can be detected using gel electrophoresis and radioactive labelling. Sometimes, slight differences in the DNA can produce fragments that are different sizes, allowing groups of plants to be told apart. In this case, a difference was found between all plants from Turkey, and all those from Spain and Portugal. When British plants were examined, all of them had DNA fragments that matched the Iberian material. Later, a second difference was detected which separated Spanish material from Portuguese material, and in this case most British *R. ponticum* plants matched the Spanish native material. From this, we can state with some confidence that most British invasive populations of *R. ponticum* derive from an introduction from Spain, although there might have been a secondary introduction from Portugal (Milne and Abbott, 2000).

This, however, was not the whole story. How does a plant native to the Mediterranean region perform so well in Britain, even in parts of eastern Scotland, where the climate is so much colder? A clue can be found in the morphology of naturalised British *Rhododendron ponticum* material (Fig. 3). Native populations always have glabrous (hairless) ovaries, very short (<1 mm) calyx lobes, and green to orange corolla flecks (Fig. 3). However, British individuals can have hairy ovaries, longer calyx lobes and deep red corolla flecks (Fig. 3). This indicates hybridisation with other species. The ability of *Rhododendron* to form fertile hybrids is well known to horticulturalists, but also has great evolutionary significance. In this case, it may well be the key to how *R. ponticum* has become such a successful invader in the British Isles.

Two close relatives of *Rhododendron ponticum*, both American, are *R.*

Fig. 3. Morphology of ***Rhododendron ponticum*** flowers.

A: Pure ***R. ponticum*** flower – with glabrous (hairless) ovary, short calyx lobes and corolla flecks green to orange. However, a flower of this type on a UK specimen does not automatically indicate a pure specimen of ***R. ponticum***. It could contain genes of other species that do not affect flower morphology.

B: Hairy ovary in UK material is a sure sign of hybrid ancestry. If the ovary is hairy but all other characters are as in **A**, then the likeliest explanation is that some genes from ***R. catawbiense*** are present.

C: Hairy ovary and long clayx lobes together indicate some genes from ***R. maxmum*** are present.

D: Deep red corolla flecks do not normally occur in subsection Pontica, so this character indicates there may be some ancestry from a species from outside this subsection. Of these the likeliest candidate is ***R. arboreum***, which was involved in creating the Hardy Hybrid cultivars in the 19th century.

maximum and *R. catawbiense*. These were introduced to British gardens in 1736 and 1809 respectively. Both have hairy ovaries and *R. maximum* also has long calyx lobes. Both are known to have far greater cold tolerance than *R. ponticum*, presumably because they are native to more continental climates. This makes them useful for breeding hardiness into *Rhododendron* cultivars, and both were deliberately crossed with *R. ponticum* during the 19th century. However, accidental crossing certainly occurred as well, as it will when any rhododendrons of the same subgenus are grown side by side. These events led to the derivation of the “Hardy Hybrids” – *R. ponticum*-like cultivars that were popular towards the end of the 19th century, and were already being widely planted at this time. Then came the exceptionally harsh winter of 1895, during which gardeners of the time ! i " the ar " o " ʿ Ŏ ꝁ ƀ̦ x̵ ᴀ rq

Fig. 4. Distribution of the species of subsection **Pontica** (colour patches), and of the other members of subgenus ***Hymenanthes*** (dotted line).

(Japan and Korea, extending into Siberia) (Chamberlain, 1982; Milne, 2004; Fig. 4). This unusual distribution, consisting of disconnected regions within the Northern hemisphere, is termed a Tertiary relict distribution, and is shared by a remarkable range of plant genera including planes (*Platanus*), witch hazel (*Hamamelis*), and both sweet and horse chestnuts (*Castanea*, *Aesculus*). This distribution is believed to result from the genera in question having been widespread and abundant throughout the northern Hemisphere during the Tertiary period (i.e. from when dinosaurs died out to the onset of the ice ages; between 65 and 2 million years ago). Most of this period was far warmer than the present, allowing warm temperate to subtropical floras to thrive at high latitude regions including Siberia and Greenland. Furthermore, the Bering Land Bridge connected NE Asia to Alaska until 5 million years ago, and there was a land connection between Greenland and Scotland until 30-40 million years ago, so plants could quite easily move between continents. Then, as the climate began to cool, these warm climate floras were progressively driven southwards, disappearing from areas like central Asia and most of Europe, but hanging on in the areas where they are found today. For more about Tertiary relict floras see Milne and Abbott (2002) and Milne (2006).

To elucidate the evolutionary history of *Rhododenron ponticum* and its relatives, DNA sequences were obtained from each member of subsect. Pontica. Plant chloroplasts contain DNA, and parts of this DNA are very often used to examine relationships between plants, as their inheritance patterns are simpler than those for DNA in the nucleus. Once sequences were available for all species, a phylogenetic analysis was performed. Using sequence data, such analysis determines the most likely pattern of relationships among a group of plants and animals, using the principal that any given change is more likely to have happened just once than to have happened twice or more. The analysis showed that among the three American species, two are each other's closest relatives (*R. catawbiense* and *R. macrophyllum*), but *R. maximum* is not closely related to either. Indeed, when the relationships revealed are compared to the species' distributions, it becomes apparent that the two do not correspond (Fig. 5). Among the four species in the Black Sea region, *R. smirnowii* is related to *R. degronianum* and *R. hyperythrum* of Japan and Taiwan, *R. caucasicum* to *R. aureum* and *R. brachycarpum* of NE Asia, and *R. ponticum* to *R. maximum* of eastern N America, although statistical support for the latter relationship is weak. What this tells us is that these species must have all originated before they became restricted to the current distributions. Had physical separation happened first, then the four species in Turkey would each be one another's' closest relatives.

Far more surprising, however, is how subsection Pontica is related to the remaining sections of subgenus *Hymenanthes*. Current taxonomy indicates that Pontica is but one subgroup within the subgenus; however chloroplast DNA evidence clearly indicates that Pontica is the oldest group in *Hymenanthes*, and that all of the other 23 subsections evolved from one or more species **within** Pontica (Fig. 5). The great majority of SE Asian species form a single evolutionary line that is most closely related to *R. smirnowii* and *R. degronianum* within Pontica. This group includes *R. hyperythrum*, the only member of Pontica in Taiwan, which DNA evidence suggests should be removed from subsection Pontica.

So, in a nutshell, the Pontica rhododendrons evolved first, and then, some time later, one or more Pontica species in SE Asia began to evolve at a vastly accelerated rate, giving rise over a few million years to more than 200 species within the region. The cause of this accelerated evolution is likely to be the uplifting of the Himalayas. This process was initiated by the collision of India

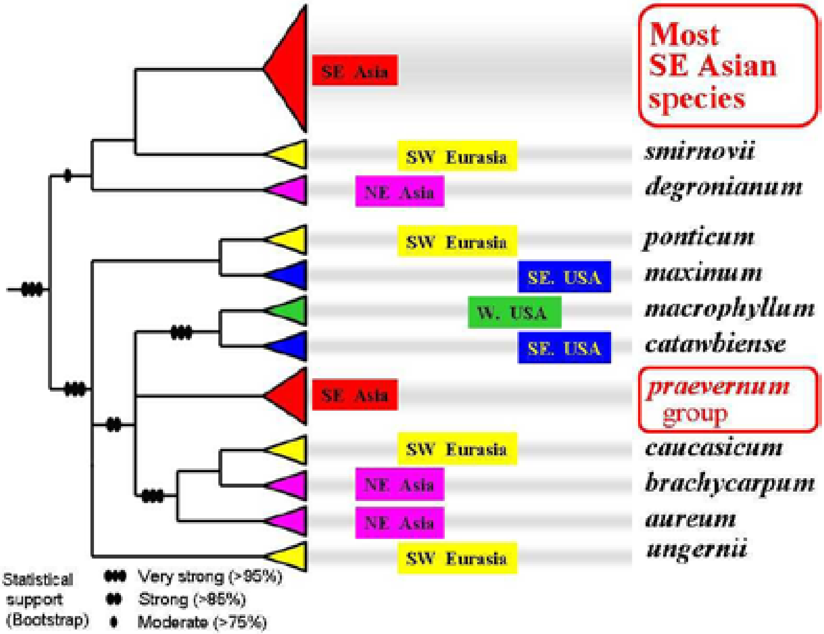

Fig. 5. Relationships of subsection **Pontica** according to cpDNA data. "Most SE Asian species" refers to 60 species examined, covering all but one of the remaining subsections. "The praevernum group" comprises ***R. praevernum, R. insigne***, and ***R. calophytum***. These all occur in SE Asia, but to the northeast of the Hymenanthes centre of diversity there. Statistical support for groupings is generated by various complex methods (bootstrapping, decay analysis and Bayesian posterior support), but these have been greatly simplified here to four levels of confidence.

and southern Asia about 50 million years ago, but may not have happened at a constant rate. Instead, there may have been periods when the mountains rose at an exceptional rate. One such period appears to have been about ten million years ago, and according to molecular data this may have been around the time when rapid speciation was occurring in *Rhododendron*.

Plants that were present on land undergoing such rapid tectonic uplift would have been profoundly affected. First, their habitat would change as its altitude increased, affecting climate, slope and rates of weathering. Moreover, the habitat would be affected differently in different locations, driving evolution of different forms in each place. Moreover, huge ridges and valleys formed, such as are seen today in western China, creating barriers between parts of a species' range, and causing populations on either side to evolve in different directions. Lastly, some species might not have coped with the changes and gone extinct, allowing those that remained, like *Rhododendron*, to occupy their vacant ecological niches. Herbaceous genera like *Gentiana* and *Primula* have similarly exploded into huge numbers of species in the Himalaya, while the likes of *Rheum* and *Saussurea* have undergone a similar process on the Tibet plateau further north.

More recent research has expanded sampling of SE Asian *Hymenanthes* species and produced a surprising result: three SE Asian species (*R. praevernum* (Fig. 6), R. insigne and R. calophytum*) group with species of Pontica according to their cpDNA. A fourth, *R. coriaceum*, appears to have different cpDNA in different specimens. As none of these species has any morphological links with Pontica, the likely explanation is that there was once a Pontica species in SE Asia which hybridised with the ancestors of these species, leaving behind its chloroplast type before going extinct. This hints at hybridisation having played a role in the rapid diversification of *Rhododendron* in SE Asia, as it can provide enhanced genetic variation upon which selection can act to produce new forms, in much the same way that plant breeders can produce a set of hybrids and then select from these the most desirable characteristics.

This example also indicates the need for caution in interpreting molecular data. To blindly transfer the mentioned species into subsection Pontica on the

Fig. 6.
Rhododendron praevernum,
one of 3
SE Asian
species whose
chloroplast
DNA type
unexpectedly
is similar
to that from
members of
subsection
Pontica.

basis of one genetic marker would be counterproductive. Instead, molecular data must be interpreted together with other information to arrive at a classification that is both useful and biologically meaningful.

3. Molecules and taxonomy:

The above data indicates clearly that Pontica is not a natural group, even if *R. hyperythrum* is excluded. A natural group, in this context, is one where it can be said that all species in the group share a common ancestor, which is shared with no species outside the group. In the case of Pontica, the common ancestor of all Pontica species is the common ancestor of all *Hymenanthes* species. If I were designing a taxonomy for the group based solely on cpDNA data, therefore, I would construct a taxonomy very different from that which exists, dividing the genus into two sections represented by the two groupings revealed in Fig. 5.

However, there are several other considerations. Firstly, this does not correspond to morphology. Leaving aside the anomalous *R. hyperythrum*, members of Pontica do share clear morphological traits that are absent in the remainder of the genus. It now appears that these traits were ancestral both to Pontica and subgenus *Hymenanthes*, and were lost in the common ancestor(s) of the species assemblage in SE Asia. Hence Pontica is a meaningful morphological group, from which has arisen other groups with different morphology, a situation not uncommon in nature (the most familiar example being reptiles, from which evolved both mammals and birds). So, breaking up Pontica would serve no useful purpose. However, changing the taxonomic level of the group would make biological sense without much disruption to current classification. At present, *Hymenanthes* contains only one section, Pontica, into which all 24 subsections are placed. However, an altered classification where the subgenus contained two sections, Pontica (containing only subsection Pontica) and a new section (containing the other 23 subsections) might be more appropriate. This would leave section membership unaffected but formalise the important differences in age and geography between subsection Pontica and the rest of the subgenus.

A second cause for caution is that rhododendrons have certainly hybridised a lot during their evolution. Because of this, relationships revealed by chloroplast genetic markers are different from those revealed by nuclear genetic markers. Basically, if species “C” is a hybrid between species “A” and species “B”, then it will end up with a mixture of genetic markers from both species so, depending which genetic marker is examined, it will sometimes seem more closely related to A, and sometimes closer to B. Hence DNA relationships in *Rhododendron* must be interpreted with caution, and substantial changes to taxonomy should only be made when (i) multiple lines of DNA evidence agree, (ii) existing taxonomy is clearly demonstrated to be wrong (as in *R. hyperythrum*), (iii) there is morphological justification for the new taxonomy, and (iv) one can be sure, beyond reasonable doubt, that taxonomy should not have to change again in the future (i.e., that one has got it right!).

4. Patterns of *Rhododendron* hybridisation in nature.

We know that *Rhododendron* species can easily form hybrids in cultivation, and that such hybrids are themselves highly fertile, permitting as it does the development of extravagant cultivated varieties with several wild species as their ancestors. And yet, in the wild, it is possible to find many very closely related *Rhododendron* species growing alongside one another. If these species are so prone to hybridisation, how is it that they are able to remain as separate entities in the wild? Why is it that all the Rhododendrons on any particular mountain in the western Himalaya do not hybridise themselves into one continuous mass of plants?

I first encountered natural *Rhododendron* hybrids in NE Turkey, while collecting material of *R. ponticum*. Here, in mountains such as Tiryal Dag (Figs. 7, 8), occur three other species of subsection Pontica, i.e. *R. caucasicum*, *R. smirnowii* and *R. ungernii*. Each has a distinct ecological range, but there is a lot of overlap. *R. ponticum* is the only species to occur at sea level, but it extends up to around 2000m, becoming confined to dry ridge tops at upper altitudes. *R. caucasicum* is found mainly above 2200m, well above the treeline, but outliers occur in steep-sided valleys shielded from sunlight, as low as 1700m. *R. smirnowii* has an intermediate altitude range, but is mostly found on exposed rocks. *R. ungernii* mostly occurs in shade, and has the narrowest altitude range, 1250-1800 m. Of six hybrids that are possible between these four species, at least five have been found during my visits to NE Turkey. *R. smirnowii* hybridises commonly with *R. ungernii* and infrequently with the other two species, and I found the hybrid between *R. ponticum* and *R. ungernii* (Fig. 7), new to science as a wild plant, in 2000. Many of these hybrids were confirmed using simple molecular markers: genetic markers were detected that are unique to each species, and then the hybrids were shown to contain markers from both putative parent species (Milne et al., 1999).

Fig. 7. Tiryal Dag mountains above Murgul in NE Turkey, where at least five rhododendron hybrids occur, including ***R. smirnowii* x *R. caucasicum*** (main picture), ***R. ponticum* x *R. ungernii*** (inset, top right) and ***R. ponticum* x *R. caucasicum*** (= ***R.* x *sochadzeae***; inset, top left), which forms large populations apparently containing only fertile first generation (F1) hybrids.

One rhododendron hybrid, however, was well known long before my visits, and that is *R.* x *sochadzeae*, which is *R. ponticum* x *R. caucasicum* (Fig. 7). This hybrid forms large populations at altitudes intermediate between those favoured by its parent species (i.e. 1900-2300m, most abundantly in the middle of this range; Milne et al., 2003). Curiously, its populations display little morphological variation between individuals. To understand why this is unusual, it is necessary to briefly examine what normally happens when two highly interfertile plant species form hybrid populations. The process must begin by forming a first generation hybrid (F1). This tends to occur rarely, as even highly interfertile species usually have some mechanisms, such as pollinator choice and an ability of stigmas to favour conspecific pollen, which act to minimise hybrid formation. However, once an F1 is present, every offspring it has will be some form of hybrid – either an F2 (cross between two F1s), or a backcross

(cross between F1 and one of its parent species). Likewise, the offspring of this second generation will all be hybrids of some sort too. Hence if an F1 breeds successfully, a snowball effect can occur with hybrid numbers increasing rapidly. Whether this happens or not will depend on whether the F1 is fit and fertile enough to reproduce, and whether that habitat where it grows will permit hybrids to thrive. The scientific literature clearly indicates that in most cases where large populations of plant hybrids form, the great majority of hybrids are of F2 and later generations, and F1s are a small minority. However, when this is the case, the morphological variation seen among hybrids is dramatic.

Fig. 8. Botanical treasures of Tiryal Dag: ***Rhododendron smirnowii*** and ***R. luteum*** (main picture), ***Epigaea gaultherioides*** and the very rare ***Rhodothamnus sessilifolius***, both **Ericaeae** (insets, top left and top middle), and ***Nonea pulmonarioides*** (**Boraginaceae**; top right), which had not been recorded from this region before I found it in 2000.

The reason for this dramatic variation among hybrids is in their genetics. F1 hybrids always contain exactly one set of chromosomes from each parent. If these chromosomes are sufficiently similar in number, size, arrangement of genes, and these genes' functions, then they will work well together to produce a healthy fertile plant. However, when the times come to produce pollen and ovules, meiosis must occur, and this is actually the first time these chromosomes from different parents come into direct contact, as crossing over occurs and genes from each parent mix together on different chromosomes. Therefore, if a second hybrid generation (F2) is formed, genes from the two parent species will now be mixed together randomly. In an F1 there will be one copy of every gene from each parent. In an F2, there may be none, one or two copies of each gene from each parent, it is purely a matter of chance. It is this which creates dramatic variation between individuals, a phenomenon scientists call "extreme segregation". The progeny will vary greatly in character – a *Rhododendron* grower could observe a similar effect by growing up selfed seed from a known F1 hybrid. When this wide variation is seen in a population of natural hybrids it is clear evidence that many generations of hybrids are present. However, this was not the case in *R.* x *sochadzeae*, which indicated that something unusual was going on.

On a return visit to Turkey in 2000, I examined a large *R.* x *sochadzeae* population on mountain slopes at Tiryal Dag above Murgul (Figs. 7, 8). Pollination experiments confirmed that *R.* x *sochadzeae* hybrids produce copious seed, which germinates readily. Dr Hugh McAllister conducted a chromosome count which eliminated the possibility that it might be a polyploid hybrid species, and both morphological and molecular differences between individuals eliminated the possibility that the large populations were all one clone. Next, I examined the parents and hybrids using molecular markers. Because an F1 contains one complete set of chromosomes from each parent, it can be distinguished from other types of hybrid if enough genetic markers are used. The analysis confirmed that all plants of *R.* x *sochadzeae* from the large population examined were F1s. It seemed that though the F1s produced seed in large quantities, this seed did not naturally recruit adult plants. However, when the same hybrid occurs in outlying populations, hybrids of other generations do occur, and outnumber the F1s. From this only one conclusion is possible: the relative success of F1s and other hybrid classes depends on the habitat on which they grow. The ecology of hybrids likely responds to genetics in the same way as morphology – there is much more variability after the F1 generation. Hence an F1 is likely to thrive on a habitat exactly intermediate between those of its parents, whereas other hybrid generations would perform worse in this habitat, but better in other conditions (Milne et al., 2003).

Fig. 9. Ecological transition in the European Alps, from acidic rocks on the left to limestone on the right. These rocks are the preferred habitats, respectively, of ***Rhododendron ferrugineum*** (Alpenrose, top left) and ***R. hirsutum*** (top right). Where soil derived from the two rock types mixes, hybrids (***R.*** x ***intermedium***; top middle) occur mixed together with both parent species.

These large populations of first generation hybrids have an unexpected evolutionary effect. If all hybrids are F1s, then they will form a barrier between the parent species, because for species to exchange genes, or indeed merge, hybridisation must proceed for many generations, mixing the genes of the parents together. In *R.* x *sochadzeae* this does not happen (at least at Tiryal Dag), so the parent species *R. ponticum* and *R. caucasicum* remain resolutely separate.

Certainly not all *Rhododendron* hybridisation in the wild follows this pattern, but there are at least two similar instances. First, in China, *R.* x *agastum* has recently been shown to comprise hybrids between *R. decorum* and *R. delavayi* (=*R. arboreum* ssp. *delavayi*) or hybrids between *R. decorum* and *R. irro-*

ratum (depending on the locality), and many of these hybrid populations are F1s (Zhang et al., 2007; Zha et al., 2008). It is much easier to mistake a population of F1s for a separate species than it is a population of later generation hybrids, because the F1s all tend to look similar. In the European Alps, the Alpenrose *R. ferrugineum* favours acid soils but its close relative *R. hirsutum* is one of a very few Rhododendrons that grow on basic soils. In sites of intermediate pH, e.g. where soils derived from limestone mix with more acidic soils, the hybrid *R.* x *intermedium* occurs, often mixed together with both parent species (Fig. 9). One such site south of Innsbruck was known to the Austrian botanist Kerner in the 19th century, and he remarked on the morphological consistency of the hybrids (Kerner, 1895). DNA markers showed that at least half of the hybrids present in two hybrid populations were F1s, and that the remaining hybrids were mostly or all backcrosses towards *R. hirsutum* (Milne and Abbott, 2008). This means that, at least in theory, genes can flow from *R. ferrugineum* into *R. hirsutum*, but not the other way around.

These examples hint that subtle differences in habitat tolerance, and their effect on hybrid fitness, may be the key to how *Rhododendron* evolved to contain so many species, and how they are able to co-exist in the wild. However, this also indicates that if their natural habitats are disrupted by human activity these natural barriers to crossing may be removed, leading to increased hybridisation and the risk that pure-bred populations of rare species may disappear.

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Phytophthora ‘A Wake up Call’

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Trengwainton and NT *Phytophthora ramorum* coordinator

The threat to our Historic Plant Collections, posed by Phytophthora ramorum, & P. kernoviae. The need to become proactive rather than reactive, if we are to ensure the survival of our Historic Plant Gene Pool.

The threat to our plant collections from new and existing pests and diseases

Introduction:

It is widely accepted that we are in period of great change which increasingly affects our gardens, plant collections, and the skilled staff who manage them.

A combination of climate change and the growing worldwide movement of plants has already allowed many new pests and disease pathways into the UK. Our plant collections have little evolutionary chance in forming resistance to these aggressive alien species and are therefore at increasing risk. With the added factor of the advanced age of many important plants, we now find ourselves in a race against time to prevent many plant species being lost to cultivation

The recent damage caused by *Phytophthora ramorum* and *P. kernoviae* has highlighted the threat plant diseases pose to our collections and intimately to the significance and conservation of gardens in our care. This situation applies equally to any of the many new plant diseases affecting our gardens now or in future.

For these reasons, we cannot afford to take a passive stance towards plant health, pests and diseases, and should now urgently develop a more robust proactive approach to P&D so that we are prepared for any future impacts.

We should all make sure that the lessons learnt from *Phytophthora ramorum* and *P. kernoviae* and the impact to rhododendrons in particular, should serve as an important wake up call to us all and that as a consequence we leave no room for complacency when our managing important collections. They are dynamic and so we must care for them with this in mind.

For a more detailed article on *Phytophthora ramorum* please refer to this year's RHS Rhododendron, Camellia and Magnolia Group annual year book. (2008)

The National Trust:

The National Trust is a charity formed over 100 years ago to protect places of Historic Interest or Natural Beauty, forever for everyone.

It now manages 1 million acres of countryside, 600 miles of coastline, 240 buildings of historic importance and 200 gardens (the largest garden owner in the world). The NT is funded by membership, donation and paying visitors.

Rhododendrons of the Eastern Himalaya

Kenneth Cox

Rhododendron lopsangianum **in Arunachal Pradesh**
Photo by John Roy

Due to political isolationism and Tibet-China-India tensions through most of the 20th century, Tibet and bordering Arunachal Pradesh were not as thoroughly botanised by the great plant collectors as Yunnan and Sichuan to the East. Frank Kingdon Ward and Ludlow and Sherriff (with Taylor and Elliot) mounted significant expeditions in this area, but left many valleys and ranges unexplored. This has meant considerable potential in areas little or never before explored by western plant hunters which is what attracted me to the area and I have a period of 10 years systematically exploring as many areas of this region as I can, following the older collector routes and getting into virgin territory.

Much of Tibet is high altitude arid plateau. The main Himalayan range places most of Tibet in rain shadow but in the south and east of the country, where the monsoon deluge pierces the Himalayan chain, though valleys and over passes, it gives rise to an extraordinarily rich flora. The extreme nature of the geography, in the Tsangpo gorges and adjacent parts of Arunachal Pradesh as well as in the regions of Tsari on both sides of the border, has given rise to many endemic plant species and many of these have an extremely limited distribution. This paper covers some of the rhododendrons recorded on 9 expeditions to this little-explored region 1995-2005.

TIBET
1995 Tsangpo Gorges region,
1996 Tsangpo Gorges region
1997 Tsangpo Gorges Eastern flank and Zayul
1998 Tsari-Tsangpo divide
1999 Tsari

ARUNACHAL PRADESH
2001 Upper Siyang and Yang Sang
2002 Subansiri/Siyom
2003 Dibang & Tawang
2005 Upper Siang & Yang Sang

The north side of the Doshong La to the west of Namcha Barwa is probably the world's richest habitat for dwarf rhododendrons. The list of species which occur in the steep sided valley above the treeline on this pass includes *R. mekongense, R. charitopes* var. *tsangpoense, R. aganniphum, R. campylocarpum, R. fragariiflorum, R. pumilum, R. nivale, R. calostrotum* ssp. *riparium, R. laudandum* var. *temoense, R. kongboense,* and *R. cephalanthum* Nmaiense. Frank Kingdon Ward was entirely justified in describing the Doshong La as a 'Rhododendron Fairyland'. His favourite species from the Doshong La was the waxy red-flowered *R. forrestii*:

> *'For a minute we just stared at it, drunk with wonder. It lay absolutely flat on the rocks, no part of the plant, not even the corolla, which is considerably larger than the leaf, rising 2 inches above the surface; stems, leaves, and flowers cling as closely as possible to the ground. Some of the mats were 18 inches in diameter, with stems as thick as a man's little finger, and must have been many years old.' (Riddle of the Tsangpo Gorges)*

Left:
***Rhododendron forrestii* in the wild**
Photo by John Roy

Below:
R. cephalanthum
Nmaiense Group

Photo by Ken Cox

R. forrestii, much used in hybridising to raise dwarf red hybrids such as *R.* 'Elizabeth' and *R.* 'Scarlet Wonder', is a taxonomically complex species, perhaps best considered an aggregate or cline. Ward reported finding 3 red entities on the Doshong La which he referred to as 'Scarlet Runner' (the lowest growing), 'Scarlet Pimpernel' (a little taller) and 'Carmelita' (taller still). These were described as *R. repens*, *R. forrestii* var. *tumescens* and *R. chamaethomsonii*. What has since become apparent is that all three are simply variations of a single species and all are best referred to *R. forrestii.* The situation is further complicated by the number of natural hybrids which occur between *R. forrestii* and *R. aganniphum, R. campylocarpum*, *R. parmulatum* and others.

The rhododendrons of Section Pogonanthum, such as *R. primuliflorum* and *R. sargentianum* have daphne-like flowers. The rather hard-to-please *R. kongboense* with aromatic leaves and reddish-pink flowers occurs in this area. *R. laudandum* and its variety *R. laudandum*

Right: Crossing the Doshong La

Below: *Rhododendron imperator*

Photos by Ken Cox

var. *temoense* were introduced by Ward in 1924 but the only surviving seedlings in cultivation do not match the wild herbarium material. These cultivated plants have lavender flowers and a green leaf underside while the herbarium specimens match the wild plants in their usually pure white flowers and leaf undersides densely covered with chocolate-coloured scales. It is now apparent is that the long-cultivated plants are natural hybrids. Seedlings from our 1995 expedition are still scarcely 10cm tall, 6 years later, and we have therefore deduced that in the 1920s no one had the skill or patience to grow this species to maturity. The related *R. cephalanthum* Nmaiense Group, apparently endemic to this area of Tibet, was not, it seems, introduced by either Ward or Ludlow & Sherriff so we were the first to introduce it in 1995. It varies from pale yellow to cream and pink. This has proven to be more amenable to cultivation and is now quite widely distributed.

On the very wet south flanks of the Doshong La, in the sacred land of Pemako, which lies on the politically sensitive Indian border, and in Arunachal Pradesh immediately to the south, two other fine alpine rhododendron species occur. *R. imperator* (which we have resurrected as a species, and it is *R. uniflorum* which should be

Left:
Rhododendron dignabile

Below:
Rhododendrons from
the south Doshong La
R. parmulatum
R. charitopes
ssp. *tsangpoense*
R. cinnabarinum
ssp. *xanthocodon*
Concatenans Group

Photos by Ken Cox

sunk), characterised by its narrow pointed leaves and relatively large purple-pink flowers. This is a popular species for alpine enthusiasts and is good for showing. It is more bud hardy than its close relative *R. pemakoense* which was discovered on the slopes above Pemakochung in the Tsangpo Gorge and which we also found above Dokar on the western range of the Pome valley. Growing amongst the orange form of *R. cinnabarinum*, Kingdon Ward's 'Orange Bill' (now *R. cinnabarinum* ssp. *xanthocodon* Concatenans Group), *R. parmulatum*, a member of Subsection Neriiflora, is endemic to Pemako as far as we know. It was introduced by Ward and also collected by Ludlow & Sherriff, but we found a huge range of colour forms, not hitherto seen in cultivated plants, ranging from pink with almost red rims to pale yellow and almost pure white. This species is fairly easy to please as a garden plant, charming but unfortunately not all that free flowering. We introduced a Ludlow and Sherriff discovery *R. trilectorum* on our 2002 expedition to the Subansiri Divide. This has creamy-pale pink

Right:
Rhododendron lanatoides

Below: *R. miniatum*

Photos by Ken Cox

flowers, tiny leaves and is proving rather hard to please in cultivation so far. Another species here is *R. exasperatum* of subsection Barbata, with deep pink or red flowers. We found it on the Doshong La but it is much more common to the south in Arunachal Pradesh where we have found it in at least 3 valleys. Another species which we located in the wild in Tibet is *R. lanatoides.* This species was only named in 1982, despite having been discovered and introduced by Kingdon Ward, it languished unrecognised in several U.K. gardens. We searched for it in 1995, and found a forest of it in 1996 at the foot of the Tra La. It has very early white flowers and very fine foliage. Closely related is the pale yellow-flowered *R. luciferum* or *R. circinnatum* (almost certainly synonymous in which case the latter takes precedence) which we found in Tsari, S.E. Tibet. It has a very distinctive yellow-brown indumentum on the underside of the leaf. Another species introduced from Tsari for the first time is *R. miniatum*, which we flowered for the first time at Glendoick in 2008. It has waxy red bells and is said to be related to *R. sherriffii* though it would be better placed in subsection Neriiflora we think.

The autumn-flowering subsection Monantha species were discovered by Kingdon Ward et al but never introduced. These should be considered very early rather than late flowering species as the buds open almost as soon as they are formed and take a year to ripen their seed. Yellow *R. monanthum* can flower indoors from July to January and gives a pleasing but not spectacular show. *R. kasoense* makes a bigger plant with slightly larger yellow flowers. The more recently introduced *R. concinnoides* which I collected in the Yang Sang valley, has purple flowers while a new species from the Dulong valley, northwest Yunnan, has white flowers. Whether these can be used to breed a range of autumn flowering hybrids remains to be seen. In common

Above:
Rhododendron kasoense

Right:
R. concinnoides

Photos by Ken Cox

Rhododendron arunachalense
Photo by John Roy

with many other epiphytic rhododendrons, all are easily killed by over-watering and are best planted in raised beds.

Several of our Arunachal Pradesh discoveries are evidently new species but remain as yet unnamed. The most exciting is a giant species over 15m tall with reddish-brown indumentum, which is currently unofficially under the name of ‘R. titapuriense’ which I named after the Pilgrimage of Titapuri where I discovered it. Another interesting plant is the azalea *R. arunachalense* which is the only azalea species from this region. It occurs at very low altitude and should be suitable for growing in the tropics where other rhododendrons are not suitable. We have struggled to keep it alive.

Visiting Tibet and Arunachal Pradesh is still relatively problematic, politically, particularly in the Tsangpo Gorges region. Timing is important: there is a short window in Spring between the snow melt and the onset of the monsoon in June and early July and this, undoubtedly is the best time to go to see the greatest range of plants in flower. The area around Tawang, along the Bhutan border is undoubtedly the most easily accessible place to see plants in this area as you can drive up to high altitude.

Significant new rhododendron introductions from this area from my expeditions include:

R. bulu
R. dignabile
*R. laudandum (*var *temoense)*
R. luciferum or *circinnatum*
R. phaeochrysum yellow form
R. miniatum
R. kasoense
R. trilectorum
R. concinnoides
'R. titapuriense'
R. venator aff.

Other significant discoveries include deep pink *Rhododendron flinckii* and almost red forms of *R. bhutanense.*

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Historic Rhododendrons

Mike Robinson

A survey of the recent work of the RHS Rhododendron Camellia & Magnolia Group

During the past twenty years the Group members have been concerned to raise the profile of less common cultivars in the three genera they cover. To this end a number of collections have been donated to gardens in various parts of England:

RHS Garden, Wisley, Surrey (Battleston Hill):

Rhododendron species recently introduced from the wild, mainly by P.A. and K.N.E. Cox, and by Alan Clark.

Abbotsbury Subtropical Gardens, Dorset:

Rhododendron species from subsections Falconera and Grandia, including most recent introductions.

The Kunming *Camellia reticulata* cultivars and related taxa.

Harcourt Arboretum (University of Oxford):

Recent *Magnolia* x *loebneri* cultivars.

Ramster, Chiddingfold, Surrey:

Hardy hybrid rhododendrons.

It is the last collection and the work that is going into its expansion and revision that concerns us here.

` p N ƙ ri ^

species were among the first introduced to commercial cultivation, following plant exploration in the Caucasus, North America and in the Himalaya, China and Japan. It follows, of course, that many of the early hybrids used these species, and as the new species from the Orient came into cultivation the same species were used to impart more hardiness and later flowering to the new exotics, especially the blood-red *R. arboreum*, in a time when winters in the British Isles were longer and colder than they are today. Many of the earliest hybrids are therefore 'Hardy Hybrids'. However there are very many modern hybrids that have used these species to incorporate hardiness into new cultivars of exotic colour, scent, foliage and growth habit, particularly using *R. yakushimanum*. Such plants are not considered to be 'Hardy Hybrids', so the term needs more precise definition.

Perhaps it should be restricted to hybrids introduced before a certain date, but if so what should the date be? *Rhododendron* 'Zuider Zee' (1936) can certainly be considered a Hardy Hybrid. *R*. 'Nimbus' (*R*. 'Snow Queen' x unknown) is a little more dubious with its high percentage of subsection Fortunea evident in its flowers and foliage. *R*. 'Mother of Pearl' (pre 1925) is certainly a Hardy Hybrid. Dates are therefore an arbitrary cut-off, though anything created after 1945 can certainly be excluded, and the majority of Hardy Hybrids were created before 1918.

What, then are the characteristics of a typical Hardy Hybrid?

- relatively late flowering
- full truss, rounded, or with the built up character inherited from *R. griffithianum*
- foliage usually glabrous, or appearing so
- foliage not liable to wind damage
- growth will come late enough to avoid spring frosts
- will survive sustained periods well below freezing
- flower bud setting on young plants

The plants were judged on flower alone, with little consideration to habit, size or foliage.

The vast majority were produced in Europe between 1850 and 1914, and by a few major nurseries, whose hybrids are still in existence, for example:

- The Seidel family (Grungrabchen near Dresden)
- Ludwig Liebeg (Dresden)
- William Smith (Norbiton Common, Surrey)
- The Waterer dynasty (Knapp Hill & Bagshot, Surrey)
- Slococks (Woking, Surrey)
- Standish & Noble (Bagshot & Ascot)
- Mangles (Littleworth, Surrey)
- Luscombe (Combe Royal, Devon)
- Cunningham (Edinburgh)
- Koster (Boskoop, then USA)
- Van Nes (Boskoop, The Netherlands)
- Van Houtte (nr. Ghent, Belgium)

The Group's collection of Hardy Hybrids has therefore concentrated on cultivars having the characteristics listed previously, and from these nurseries.

The Ramster collection was started at the instigation of the late John Bond when the Group had the opportunity to bulk purchase about 50 varieties of Hardy Hybrids from Sunningdale nurseries. The collection is planted in groups of three on an exposed hillside in the garden. The plants are almost all grafts, some at least on *Rhododendron ponticum* rootstocks, and the intention is to get the collection on to its own roots in time. Most cultivars have grown successfully, but a few suffer from powdery mildews, and *R*. 'Lucy' is so badly affected that it will be discarded, and *R*. 'Letty Edwards' will be moved to another part of the garden.

Subject to the health of the plants, small quantities of propagation material can be made available at cost.

The complete list of the collection as in February 2008 is given below:

• Alice pre 1910	J. Waterer
• Alice Martineau 1931	W.C. Slocock
• America 1902	M. Koster
• Antoon van Welie pre 1940	L.J. Endtz
• Arthur Bedford pre 1935	T. Lowinsky
• Ascot Brilliant 1861	J. Standish
• B. de Bruin pre 1910	Waterer (Knaphill)
• Bagshot Ruby c.1900	Waterer (Bagshot)
• Beauty of Langworth (unregistered) 1932?	W.C. Slocock

Beauty of Littleworth pre 1884	J.H. Mangles
Bernard Crisp 1920	Waterer
Betty Wormald c. 1907	M. Koster
Bluebell c. 1882	Waterer (Knaphill)
Blue Danube c. 1959	Waterer (Knaphill)
Blue Peter 1930	Waterer (Bagshot)
Britannia 1921	C.B. van Nes
Broughtonii pre 1840	Broughton
Butterfly pre 1931	W.C. Slocock
Caractacus pre 1865	Waterer (Knaphill)
Caucasicum Pictum pre 1853	Standish & Noble
Cetawayo pre 1883	Waterer (Knaphill)
Chev. Felix de Sauvage c.1870	C. Sauvage
China (unregistered) 1936	W.C. Slocock
Chionoides pre 1867	J. Standish
Christmas Cheer 1931	Waterer (Knaphill)
Constant Nymph 1931	Waterer (Knaphill)
Corry Koster 1909	M. Koster
Countess of Athlone pre 1923	C.B. van Nes
Countess of Derby 1913	G.H. White
Cunningham’s White c.1830	J. Cunningham
Currieanum pre 1851	Waterer (Knaphill)
Cynthia 1856	Standish & Noble
David pre 1918	T. Seidel
Dawn’s Delight pre 1884	J.H. Mangles
Diane 1920	Koster
Diphole Pink pre 1916	Waterer (Bagshot)
Distinction c.1865	Waterer (Bagshot)
Donald Waterer pre 1896	Waterer (Bagshot)
Dr. A.W. Endtz pre 1933	C.B. van Nes
Doncaster pre 1896	Waterer (Knaphill)
Earl of Athlone pre 1933	C.B. van Nes
Earl of Donoughmore pre 1952	M. Koster
Eileen pre 1850	Waterer (Bagshot)
Everestianum pre 1850	Waterer (Knaphill)
Fastuosum Flore Pleno pre 1846	Francoisi brothers
Faggetter’s Favourite 1931	W.C. Slocock
Frank Galsworthy c.1900	Waterer (Knaphill)
Furnivalls Daughter int. 1926	Waterer (Knaphill)
General D. Eisenhower 1946	Kluis
Goldfort int. 1933	W.C. Slocock
Goldsworthy Crimson 1926	W.C. Slocock
Goldsworthy Orange 1926	W.C. Slocock
Goldsworth Pink 1926	W.C. Slocock

Goldsworth Yellow 1925	W.C. Slocock
Gomer Waterer 1890	Waterer (Bagshot)
Handsworth Scarlet pre 1898	Fisher, Son & Sibray
Harvest Moon pre 1924	Koster
Helen Schiffner 1835	W. Herbert
Hollandia pre 1938	L.J. Endtz
Hugh Koster 1915	M. Koster
Hyperion pre 1924	Waterer (Knaphill)
Jacksonii 1835	W. Herbert
James Burchett 1927	W.C. Slocock
Janet Ward 1974	W.C. Slocock
Jean Marie de Montague pre 1946	van Nes
Jewess pre 1854	L.L. Leibig
John Walter pre 1860	Waterer (Knaphill)
John Waterer pre 1867	Waterer (Bagshot)
Kate Waterer pre 1865	Waterer (Bagshot)
Kluis Sensation pre 1946	A. Kluis
Kluis Triumph pre 1955	A. Kluis
Lady Armstrong int 1860	Waterer (Knaphill)
Lady Annette de Trafford c1864	Waterer (Knaphill)
Lady Clermont pre 1865	Waterer (Knaphill)
Lady Clementine Mitford 1870	Waterer (Knaphill)
Lady Decies 1922	Waterer (Bagshot)
Lady Eleanor Cathcart c1860	Waterer (Knaphill)
Lady Grey Egerton pre 1888	Waterer
Lady Longman pre 1929	G.H. White
Lamplighter 1955	M. Koster
Lavender Girl 1934	W.C. Slocock
Lees Dark Purple pre 1851	J. & C. Lee
Letty Edwards pre 1946	S.R. Clarke
Lord Roberts 1900	Fromow & Son
Louis Pasteur pre 1923	L.J. Endtz
Lucy 1862	C. Noble
Madame de Bruin 1904	M. Koster
Madame Masson 1849	Bertin
Madame Van Houtte 1867	J. Veitch
Marcel Menard pre 1937	M. Koster
Marchioness of Lansdowne 1879	Waterer (Knaphill)
Marie Forte pre 1925	B. Fortie
Marinus Koster pre 1937	M. Koster
Mars 1928	Waterer (Bagshot)
Michael Waterer pre 1865	Waterer (Bagshot)
Midsummer pre 1938	Waterer (Bagshot)
Moser’s Maroon pre 1922	L. de Rothschild

Mother of Pearl pre 1925	Waterer (Bagshot)
Mount Everest 1930	W.C. Slocock
Mrs Anthony Waterer pre 1906	Waterer (Knaphill)
Mrs C.B. van Nes pre 1930	C.B. van Nes
Mrs Charles Pearson c1909	M. Koster
Mrs Davies Evans pre 1915	M. Koster
Mrs E.C. Stirling pre 1906	Waterer (Knaphill)
Mrs Furnival pre 1930	Waterer (Knaphill)
Mrs G.W. Leak 1916	M. Koster
Mrs Helen Koster 1930	M. Koster
Mrs J. (John) Waterer 1857	Waterer (Bagshot)
Mrs J.C. Williams pre 1938	Waterer (Knaphill)
Mrs J.G. Millais pre 1917	Waterer (Knaphill)
Mrs Lindsay Smith c1910	M. Koster
Mrs Lionel de Rothschild 1931	Waterer (Knaphill)
Mrs P.D. Williams 1936	Waterer (Knaphill)
Mrs Philip Martineau pre 1931	Waterer (Knaphill)
Mrs R.S. Holford c1866	Waterer (Knaphill)
Mrs Tom Agnew pre 1870	Waterer (Bagshot)
Mrs A.T. de la Mare pre 1958	C.B. van Nes
Mrs T.H. Lowinsky pre 1917	Waterer (Knaphill)
Mrs W.C. Slocock pre 1929	W.C. Slocock
Mrs W. Watson pre 1911	Waterer (Knaphill)
Mrs William Agnew pre 1870	Waterer (Bagshot)
Nimbus 1935	Waterer (Knaphill)
Nova Zembla 1902	M. Koster
Old Port pre 1865	Waterer (Knaphill)
Olga c1962	Slocock Nurseries
Pelopidas pre 1865	Waterer (Bagshot)
Peter Koster 1909	M. Koster
Picotee pre 1935	Waterer (Knaphill)
Pink Pearl pre 1892	Waterer (Bagshot)
Pink Perfection pre 1928	R. Gill & Sons
Prince Camille de Rohan pre 1854	J. Verschaffelt
Prince of Wales pre 1872	Waterer (Bagshot)
Princess Mary of Cambridge pre 1865	Waterer (Bagshot)
Professor Hugo de Vries pre 1914	L.J. Endtz
Professor J.H. Zayer pre 1958	L.J. Edntz
Prometheus pre 1885	C. Noble
Purple Splendour pre 1900	Waterer (Knaphill)
Royal Purple pre 1942	White
Rainbow c1928	W.C. Slocock
Russellianum 1831	Russell
Sappho pre 1867	Waterer (Knaphill)

Sigismund Rucker pre 1890	Waterer (Knaphill)
Snow Queen 1926	E. Loder
Snowflake pre 1862	Waterer (Knaphill)
Souvenir of Dr. S. Endtz pre 1922	L.J. Endtz
Souvenir of Anthony Waterer pre 1958	Waterer (Knaphill)
Souvenir of W.C. Slocock pre 1928	W.C. Slocock
Speculator pre 1850	Standish & Noble
Spitfire 1946	A. Kluis
Starfish pre 1911	Waterer (Bagshot)
Susan pre 1933	J.C. Williams
Sweet Simplicity pre 1922	Waterer (Bagshot)
The Bride 1850	Standish & Noble
The Queen pre 1866	C. Noble
Trilby pre 1930	C.B. van Nes
Unique pre 1934	W.C. Slocock
Unknown Warrior pre 1922	C.B. van Nes
Warrior c1865	Waterer (Bagshot)
White Swan pre 1937	Waterer (Bagshot)
Wilgens Ruby 1951	A.C. van Wilgen
Windlesham Scarlet 1968	W. Fromow & Sons
Windsor Lad pre 1940	Waterer (Knaphill)
Zuider Zee 1936	M. Koster

There are, of course, so many Hardy Hybrids that the collection cannot be comprehensive, and decisions will have to be made in the future as to how the collection should be expanded. There is little point in adding plants that are widely commercially available, such as *Rhododendron* ‘Pink Pearl’. The future aim may well be to collect mainly named British hybrids no longer readily available, produced before 1920.

Much of the more recent work of the Group has been to find and rescue old hybrids. This job has been made somewhat urgent by modern programmes of removing the invasive *Rhododendron ponticum* from many wild areas of Britain and Ireland. Unfortunately most contractors are not able, or do not have the time, to distinguish between *R. ponticum* itself and the old hybrids which so often made up the planting in estates, which have since become derelict and made over to development, or set aside for recreation. The problem is exacerbated by the common practice of nurseries to sell hybrids grafted on the *R. ponticum* rootstock. It is very common (as, for example, at Woburn Abbey) to find vast plants of *R. ponticum* with a few shoots of the original hybrid visible in the centre of the tangle. Nevertheless contact with local conservation groups has allowed the Group to propagate a fair number of hybrids before they were grubbed out to return an area to native flora (whatever that is).

The greatest step forward in locating historically interesting hybrids, however, has been the study of the rhododendron planting at Lord Lansdowne's property Bowood House, near Calne in Wiltshire. The rhododendron woodland there is an essential stopping off point for anyone remotely interested in the history of rhododendron cultivation in the UK. The gardeners at Bowood must have been very thorough and farsighted, as there is very little sign of *Rhododendron ponticum* rootstock of significant planting before the present Lord Landsdowne's father put in his collection (mainly species) commencing in the 1950's. The first period of creation seems to have been in the 1850's, with many old hybrids, not seen elsewhere, dating from that period. Standish & Noble and Waterer are well represented, with taxa such as *R*. 'Pictum' (Waterer pre 1839), *R.* 'Speculator' (Standish pre 1850), and *R*. 'Album Elegans' (perhaps a selection of *R. catawbiense* by Waterer before 1847) especially good. This was followed by a second planting in about 1900. From this *R*. 'Mum' (Waterer 1897) and *R*. 'Lady Hartington' (*R. griffithianum* hybrid, unregistered) are outstanding. Subsequent planting of Hardy Hybrids followed the two main thrusts, producing a superb collection in fine fettle today.

The Group has also been concerned to identify and propagate more modern rhododendrons that are of a high standard but not readily available, either because the raisers have never released them, or because they are not considered suitable for modern gardens. Of course, as there are many hundreds such selection by Group members has necessarily been subjective, and the short list below is my own private choice!

However I do believe that it includes important varieties worthy of cultivation in UK conditions and perhaps elsewhere:

R. 'Dragonfly'

(*R. facetum x R. auriculatum*) Rothschild 1936
A small tree or large shrub with rapid growth. Roots easily. Pink flowers slightly scented in late June and early July. Foliage like *R. auriculatum*.

R. 'Intrepid' FCC

(*R*. 'Beau Brummell *x R. kyawii*) Rothschild 1941
Eventually a large but dense shrub. Good matt foliage well retained. Blood red flowers in late June.

R. ‘Mahomet’ AM

(*R. dichroanthum x R*. ‘Tally Ho’) Rothschild 1945
Compact growth similar to *R. dichroanthum*. Intense deep orange-red flowers in late June.

R. ‘Impi’ AM

(*R. sanguineum* ssp. *didymum x R.* ‘Moser’s Maroon) Rothschild 1945
Compact but open growth. Roots easily. Intensely dark blood red flowers in June.

R. ‘Polar Cap’ AM

(*R*. ‘Red Cap’ x *R*. ‘Polar Bear’) Urlwin-Smith 1962
Eventually a medium shrub with much more dense growth than R. ‘Polar Bear’. Pink flowers with shades of salmon in July. Unscented.

R. ‘Biscuit Box’ AM

(*R. fortunei* ssp. *discolor x R. elliottii*) Hanger 1950
Slow growing compact shrub. Yellow flowers with pink shades, slightly scented. Maroon young growth.

R. ‘Royal Windsor’ AM

(*R*. ‘Jutland’ x *R*. ‘Royal Blood’) Windsor 1975
A large shrub with matt foliage. Pure red glowing flowers in a superbly shaped truss in mid June.

R. ‘Seamew’ AM

(*R*. ‘Loderi’ x *R. sutchuenense*) Loder pre 1920
Seagull group. Large shrub. Foliage intermediate between parents. Flowers strongly scented in March/April.

R. ‘Southern Cross’ AM

(*R. fortunei* ssp. *discolor* x *R*. ‘Lodauric Iceburg’) George Hydon 1965
Slow growing open but eventually large shrub. Intensely fragrant flowers white shaded pink in late June.

R. ‘Yol’

Hybrid of *R. wardii* Mayers no date
Slow growing compact shrub, very similar to *R. wardii* but with a striking chocolate blotch.

R. sutchuenense* x *R. ririei Ramsden, Muncaster pre 1930
An outstanding small spreading tree with long hanging foliage and large flowers intermediate in colour between the two parents. March.

R. arboreum* (?) x *R. grande
Collected in Arunachal Pradesh under L&S1208, and at one time thought to be a form of *R. arboreum* (*R. 'kingianum'*). Deep pink/red flowers in mid season, with foliage reminiscent of *R. grande*, but broader. Seems to be relatively compact.

It is to be hoped that the Group will continue to preserve these and other outstanding hybrids for posterity.

Travels with our Plants

Peter Hutchison, Peter Cox

Presentation to Rhododendron Conference. A synopsis.

Peter Hutchison on the roof of the world, Nepal 1986
All photos in this article by Peter Cox and Peter Hutchison

At the Conference a selection was taken from the travels over a period of some 45 years by Peter Cox and Peter Hutchison in search of plants, to coincide with the publication of their joint book ‘Seeds of Adventure’. A particular emphasis of their collecting had been on rhododendrons, but a wide variety of trees, shrubs and herbaceous material had been brought back, including much that was rare or not in cultivation. As the presentation was based on geographical areas rather than any chronology, and excluded several trips, it was thought more useful for the Proceedings to set out the full series of expeditions on a chronological basis. Only occasional plants are mentioned but the full data, with many illustrations, can be found in the book.

Above: *Rhododendron smirnowii* in northeast Turkey

The first trip had been in 1962 to north east Turkey where the five indigenous species of *Rhododendron* had been collected and some fine lilies had been seen including the recently described *Lilium ciliatum.* Three years later, accompanied by Patricia Cox, they made a pioneering trip into the part of the Assam Himalayas now known as Arunachal Pradesh. In spite of travel restrictions they found and introduced three new species of *Rhododendron* including *R. subansiriense.* The first introductions of *Ilex nothofagifolia* and *Schefflera impressa* were made along with a botanically important collection of *Agapetes spp.*

The ultimate objective at that time was to collect in China, which had been closed to foreigners for many years. This was achieved in 1981, shortly after the end of the Cultural Revolution. A ground-breaking joint venture with the Kunming Institute of Botany resulted in the first major field trip with the Chinese as partners involving six weeks camping in the Cang Shan.

It was a first for the Chinese as well as the British and substantial collections of both herbarium and living material were divided equally. Although much of the territory had been collected by Forrest and Delavay, two world wars and a long interval resulted in much being lost to cultivation and many choice plants

Right:
Rhododendron sinogrande
SBEC 0104

were reintroduced including *Rhododendron lacteum* , *R. sinogrande, R. cyanocarpum* with the true *Pleione forrestii*.

An excursion to the Milke Danda in 1985 with Donald Maxwell MacDonald gave an opportunity to collect many of the classic plants of the eastern Himalayas and the following year a trip led by Roy Lancaster brought us back to China. It involved both the edge of the Tibetan plain in northern Sichuan (The Red Grasslands) and the Jade Dragon mountain by Lijiang which is now becoming a major tourist destination but at that time was newly released from controlled areas. Many good plants were seen but perhaps the most choice was the reintroduction of the scarlet poppywort, *Meconopsis punicea*, which had been a special objective for Peter Cox.

Bhutan in 1988 provided an opportunity to see some of the finest untouched forest and rhododendron country in the Himalayas, and a peaceful interlude before landing in China again at the time of the Tienanmen Square uprising the following year. Although the main action took place in Beijing, our base in Chengdu was the scene of very active student demonstrations and for once our hosts were only too keen to get us out into the hills. After a short excursion to Mount Omei we went further north in Sichuan through Wolong and up over the Mongbi pass towards Barkam and Huanglong, then down the Min river. A great variety of rhododendrons were seen on this extensive journey but *R. dendrocharis* was a particularly welcome introduction, good forms of the colourful *R. orbiculare* and *R. augustinii* provided an antidote to the generally pallid flowers of the hardy northeners such as *R. watsonii, R. balangense, R. galactinum* and the like. But a strong performer of the trip was herbaceous flora, with a great

Above: Kargupu, the highest mountain in Yunnan.
Below: *Rhododendron racemosum* Zhongdian plateau

Above: *Rhododendron roxieanum* var. *oreonastes*,
northwest Yunnan
Below: *Rhododendron vernicosum* in northern Sichuan

variety of fine species of *Primula*.

1990 saw Peter Cox back in China among early snow in the Gongga Shan and Kanding area, up on the Hailuagou glacier and down the Dadu river. Two years later they were both in Yunnan seeing the great Zhongdian plateau in full flower with *Rhododendron racemosum* wall to wall and many other species. They worked their way up visiting Big Snow Mountain and over Bei Ma Shan to the Mekong river. *Primula* and *Iris* species were plentiful but the most notable shrub was perhaps the yellow *Daphne aurantiaca.* That autumn Peter Cox was back in China on the Salween-Mekong Divide and again in 1994, working the high ridges among such rarities as *Rhodendron proteoides.*

They had worked a lot of territory in western Yunnan and north and west Sichuan but much of the ground to the south and east of there had been little explored, even during the great journeys of the early twentieth century. So in

1995 a journey with a group of enthusiasts through southern Sichuan and over the Yangtze into north-east Yunnan proved to be very rewarding in terms of collections. *Rhododendron ochraceum* was successfully found and the new *R. valentinianum ssp. oblongilobatum* (now *R. valentinioides*), also the surprisingly hardy *R. sinofalconeri.* Some interesting *Sorbus* were collected along with a new *Schefflera sp.* and a good variety of less-known smaller trees.

Tibet had so far escaped attention and in 1996 Peter Cox fulfilled a long-held ambition to go to Pemako, Kingdon Ward's 'Promised Land'. A sequence of high passes were traversed, in sequence the Putrang La, Doshong La, Temo La and Pa La which produced a great variety of rhododendrons including some rare endemics. There was also an abundance of primulas, meconopsis and other endemics flowering on meadows and screes; too numerous to mention apart from the fabled blue-flowered *Chionocharis hookeri,* the *Eritrichium* of the Tibetan Alps. Two years later passes overlooking the Tsari valley of Tibet were visited where again the alpines were a superb feature although a yellow flowered form of what appears to be *Rhododendron phaeochrysum* excited much attention.

The southern province of Guizhou had never been visited so in 1999 they undertook what turned out to be a slightly bizarre trip with relatively poor collecting results, although the fine *Rhododendron platypodum* was introduced for the first time. Potentially rewarding areas were noted for future visits (one was undertaken in 2009).

Opposite page: Top
Keith Rushforth collecting on the edge!
Bottom
***Rhododendron wardii*, northwest Yunnan**

This page:
"Smokey Joe" at the Salween River

The Salween river is hemmed in to the west by the Gaoligong Shan which separates China from Burma (now Myanmar) and to the east by the great dividing range from the Mekong. The area contains some of the richest temperate flora in the world. This was the objective of two trips in 1997 and 2000, stopping up the length of the river and then making excursions on foot west up to the Nam Wa pass into the Dulong valley and north on the old route to Tibet. These trips were not included in the Conference presentation but a full account of the extensive collections can be found in ‘Seeds of Adventure’.

The final trip referred to briefly in the lecture was a return in 2002 to the territory first visited by the authors thirty-seven years earlier, the Subansiri Division of Arunachal Pradesh in Assam. Beyond the few populated valleys the dense subtropical and temperate forest was still largely intact which made for difficult going but the climax of the trip was an arduous ascent from the Subansiri River over the divide into the Mechuka Valley. It was very much new territory and produced some interesting introductions including *R. trilectorum, R. ludlowii* and *R. boothii.*

Taktsang or Tiger's Nest Monastery

The Good, the Bad and the Ugly: a review of American hybrids in Britain

David Millais

Millais Nurseries (www.rhododendrons.co.uk) are one of the leading UK growers of specialist rhododendrons, currently growing around 800 different varieties every year from alpine dwarfs to big leaved specimens. They are sold to keen gardeners visiting our nurseries and gardens, by mail order throughout Europe, and to specialist plant centres from Cornwall to Scotland.

The nursery was started in 1970 by Ted Millais whose interest in the genus was instilled by his uncle J G Millais, the author of the 2 volume series "Rhododendrons" published in 1918 and 1924. During the 1970's Ted corresponded with several Americans on both East and West coasts, and received some of their latest hybrids. However, it was the advent of tissue culture which accelerated the introduction of new plant material. Millais Nurseries was the first UK nursery to import young plants from Briggs Nursery in Washington State during the early 1980's and we also bought from Clays Nurseries in British Columbia. For 20 years, about 10-15 new varieties were tried every year; a process speeded up after I spent a season working at Briggs in 1989.

We soon found that we were selling new varieties after growing them for 3 years without really knowing how they would perform in the UK, and so we planted our trials garden with a view that we could assess the first batch of plants before re-ordering. All too often I regret we found that the wonderful flowers shown in the catalogues and in the ARS journals failed to live up to expectations, though we certainly gained some excellent new material along the way. Most varieties obtained from America originated from the Pacific north west, as this is the region of America most similar to UK conditions. Plants were also trialled from the east coast, but these rarely produced any worthwhile plants.

So why have there been so many plants which should have grown better in the UK?

Climate:

Seattle is on average 2°C warmer than London and has 240mm more rain per year, though this falls mainly in the winter. Perhaps more importantly for rhododendrons, the climate of Seattle means that growth starts earlier in the spring with the distinct advantage of no frosts in May. This is followed by a longer growing season with more hours of summer sunshine to ripen and harden the wood.

Comparison of weather in London and Seattle

	London	**Seattle**
Sunshine hours per day January	1	1
Sunshine hours per day July	7	10
Rain in January	76mm	130mm
Rain in July	50mm	26mm
Rain per year	600mm	840mm
Temperature in January	1-7ºC	2-8ºC
Temperature in July	11-22ºC	12-24ºC
Date of last frost	25th May	1st May
Latitude	51ºN	47 ºN

Whilst the table above shows there are differences in temperature and rainfall between the 2 locations, there would be even greater differences between Seattle and the Cascade mountains, or between London and Scotland, so really the climates are fairly similar other than the dates of the last frosts.

Breeding:

While working in Washington, I was amazed at the enthusiasm of members within ARS Chapters and their quest to breed new varieties. Sometimes this showed as individuals crossing their 2 favourite plants to breed an even better one. Others preferred to obtain seed from the ARS seed exchange and select from those seedlings, while some Chapters set challenges with a specification for members to try and breed the perfect plant. All highly laudable and great fun for all involved. However, the trouble comes later when too many of these offspring are labelled and promoted within the trade, especially if they have not been properly assessed first. The registration of worthy plants should be encouraged, but The RHS Rhododendron Register is growing by about 300 new varieties per year partly because too many unworthy seedlings are named after every member of the breeder's family!

Competitions:

Competitions should be encouraged and are a sure sign of a healthy membership within any rhododendron group. They help to publicise the wonders of rhododendrons to members of the public, and help everyone learn new names that they may not have come across before. Unfortunately not every winning truss makes a worthy garden plant. Too often the most amazing new truss is put into production because everyone loved it on the show bench, when in fact the plant does not offer any favours for 11 months of the year.

Awards:

Some of our buying decisions were made on the strength of awards made by the ARS. It would appear these awards were made purely on the strength of flowers on the show bench. One of the worst plants that we tried was *Rhododendron* 'Trude Webster', which I believe was the first recipient of the ARS Superior Plant Award. After 3 years we lifted them from the open ground when they were 50-60cm high only to find they had root-balls the size of tennis balls. They were only fit for the bonfire. I am pleased to hear the ARS has not used this award for many years and has developed the regional Proven Performers list.

Commerce:

The pressure for new varieties is ever present. The press clamour for something new to write about, so breeders and nurseries have an interest to market new varieties every year. With a breeding programme taking at least 10 years from making the cross to the launch of a new variety, there is reason to launch as soon as possible to recover some costs and fulfil demand. However, proper trialling prior to a launch is essential to ensure good performance in a number of different situations.

Assessment of plants the UK:

Evergreen Azaleas:

Certainly some Gable and Glenn Dales have found their way over here, but few have got really established. This is partly due to established UK varieties and partly due to cheap imports from Holland which arrive simply named for example as “Azalea Red”. Any new introduction therefore has to be particularly special. A problem with the Glenn Dales has been the lack of wood ripening during our cooler summers, so some have not proved fully hardy for our winters. For special mention I highly rate the *Rhododendron nakaharae* hybrids bred by the Hills, for example *R.* ‘Alexander’ and *R.* ‘Pink Pancake’ which extend the season well into June and July. Also good is *R.* ‘Elsie Lee’, bred by Shammarello with its interesting large double lilac flowers, unlike anything else previously available.

Deciduous Azaleas:

Again the UK has plenty of good varieties, so new varieties must excel in different ways. The “Lights” series from Minnesota certainly offer something different than the average Knaphill or Exbury type azalea. The smaller flower is reminiscent of some of the Ghent types, and they have proved hardy and floriferous. However, propagation is more difficult than many, and although claiming to be scented, I have always found them lacking in that department. Other small flowered varieties, bred by Mezitt and Weston on the east coast, have not caught on commercially in the

Above:
Rhododendron
‘Arneson’s Gem’

Right:
***R.* ‘Mount St Helens’**

All photos in this article by
David Millais

UK. The small flowering *Rhododendron prinophyllum* type hybrids such as *R.* 'Pink and Sweet' and *R.* 'Weston's Innocence' have a lovely scent in early June in our trials garden, but fairly insignificant flowers which fail to compare with the best of Denny Pratt's late flowering varieties. From Oregon, Ivan and Robertha Arneson's programme of improving the Knaphill and Exbury type of large flowered azaleas has not gone un-noticed, and *R.* 'Arneson's Gem' with its golden yellow flowers is probably the best known over here. Commercially, the two best American azaleas in the UK are *R.* 'Chetco' (Slonecker) and *R.* 'Mount St Helens'(Girard). Partly this is due to the ready availability of micropropagated material, but it does reflect the size and quality of their respective flowers, plus the attractive scent of *R.* 'Mount St Helens'.

Small leaved Rhododendrons:

When working at Briggs Nurseries, I was amazed at the number of *Rhododendron* 'PJM' type plants which were shipped over to the East coast where I understand they are used extensively for hedging purposes. There is almost certainly an opportunity in the UK for similar hedge plantings but that market has not developed and *R.* 'PJM' is quite a rarity. The early flowering clear pink *R.* 'Cliff Garland' is slowly gaining its rightful status as a replacement for *R.* 'Olive', but like the other early varieties such as *R.* 'Northern Starburst' and *R.* 'Weston's Pink Diamond' they will never be commercially significant as they flower too early for garden centres to stock them. The most successful of this section is therefore *R.* 'Dora Amateis' with its pure white flowers smothering the foliage in late April, and *R.* 'Ramapo' with its bright mauve flowers followed by attractive silvery new summer growth.

East Coast Hardy Hybrids:

Although our nursery is in Southern England, it is situated in one of the worst frost pockets possible, being 200 metres directly below Hindhead. We do need to grow hardy varieties which are not too susceptible to frost damage. In an attempt to try hardier varieties we tried some east coast plants from America in 1990. Most of these proved a total disaster! Again the pictures of Leach's 'world' series looked good in the catalogues, but we rarely got the plants to grow. They made poor roots in containers or in the open ground and often needed staking upright, they scorched with crinkly leaves as if they had too much fertilizer, and they ended up leggy and unmarketable. A few that we managed to grow on flowered sparsely and were uninteresting. About the only east coast plant which still has a place in the UK is *Rhododendron* 'Scintillation', though most are probably imported from Holland anyway.

Review of West Coast Breeder’s varieties:

Warren Berg:

Warren and my father trekked together in the Himalayas several times, and Warren kindly sent my father cuttings of his iconic dwarfs *Rhododendron* ‘Ginny Gee’, *R.* ‘Patty Bee’ and *R.* ‘Wee Bee’ in the latter half of the 1980’s. By using *R. keiskei* ‘Yaku Fairy’ as a parent, Warren had bred tough, neat and floriferous little plants which rapidly became, and have remained the best selling dwarfs in the UK, and which can be found in all the best UK Garden Centres. If there is any disappointment it is the way the market has changed the perception of the plant from being a sought-after new variety in 1990, to being a staple commodity item 15 years later, but it does show the quality of the breeding. Warren’s other hybrids are equally well bred but appeal more to the collector. His interest in choice species is reflected in his beautiful yak hybrid *R.* ‘Golfer’ with its excellent foliage and beautiful flowers.

Halfdan Lem:

All his hybrids have fantastic features, but all also have their drawbacks! Whilst a lovely flower, we have found *Rhododendron* ‘Isabel Pierce’ leggy in habit, partly because she

Above:
Rhododendron
‘Lem’s Cameo’

Right:
***R.* ‘Lem’s Monarch**

Left:
Rhododendron
'Lem's Tangerine'

Below:
***R.* 'Moonwax'**

sheds her lower leaves earlier than most. His namesake *R.* 'Halfdan Lem' is a lovely red with good strong branches, but fades out to pink when planted in sun. In shadier places it can be prone to powdery mildew some years. The flowers of *R.* 'Lem's Cameo' make it so striking that one American catalogue described it as "The plant rhodoholics would kill for when first introduced". Perhaps a bit extreme even for America! The plant really does need the best conditions available to thrive properly. I find it better with a heavier dose of fertilizer than normal, but too much can scorch the leaves. The huge pink trusses of *R.* 'Lem's Monarch' ensures it remains one of my favourite flowers but the leaves are prone to pestalotia fungal leaf spotting, which in severe cases can defoliate the plant. Finally *R.* 'Lem's Tangerine' is one of the brightest oranges on offer, but is prone to late spring frost bark split, and can be a little wobbly in the ground.

Loyd Newcomb:

I think *Rhododendron* 'Moonwax' has some lovely silky pinky yellow flowers, but is on the leggy side. *R.* 'Newcomb's Sweetheart' is a beautiful pale pink with an interesting reddish eye and makes a worthy and more manageable replacement for *R.* 'Pink Pearl'. On the downside, it can be a bit wobbly

Right:
Rhododendron
‘Pride’n Joy’

Below left:
***R.* ‘Apricot**
Fantasy’

Below right:
***R.* ‘Papaya Punch’**

and so is best out of strong winds. *R.* ‘Pride’n Joy’ is a first rate yellow with good substance and really nice silky flowers, set above deep glossy foliage.

Ned Brockenbrough:

Everyone who sees *Rhododendron* ‘Apricot Fantasy’ admires its unusual apricot flowers with large calyces, giving an almost double flowered appearance. There is nothing else quite like it, so we can probably forgive it becoming a little leggy in later years. *R.* ‘Horizon Monarch’ remains another of my favourites. It has wonderful yellow flowers, but unlike so many other yellows which can be weak growing, this has thick, vigorous fast growing branches with deep green glossy foliage, making it a real winner. *R.* ‘Nancy Evans’ has become one of the most popular yellows in British garden centres. It is a good red in bud, opening to an orangey yellow before fading paler. However, like so many other yellows, it does need to be planted where there is good drainage to prevent root rot. *R.* ‘Papaya Punch’ is a nice apricot yellow colour but has proved less successful, and less attractive with matt green foliage.

Hjalmar Larson:

The red buds of *Rhododendron* ‘Bergie Larson’ contrasting with the orangey yellow flowers makes a fine low growing plant. *R.* ‘Karen Triplett’ is another good satin textured yellow with particularly shiny leaves which open with an attractive reddish sheen. However, *R.* ‘Hazel Fisher’ and *R.* ‘Mary Drennan’ proved very poor with muddy yellow flowers and awful foliage. *R.* ‘Rosy Dream’ is a yak hybrid which suffers dreadful chlorosis. For some reason, Americans have bred few decent yak hybrids; perhaps it is to do with the size of their gardens.

Frank Fujioka:

Rhododendron ‘Silver Skies’ is that decent yak hybrid! Here you can really see the yak parentage, and it is more vigorous and has excellent indumentum and nice glossy foliage. This is the type of quality foliage plant for which Frank would like to

Above:
Rhododendron
‘Bergie Larson’

Right:
***R.* ‘Karen Triplett’**

be known, so I do not know why he named either *R.* 'Elsie Watson' which fails to improve on other readily available purple hardy hybrids, or *R.* 'Midnight Mystique' which is a poor growing outcaste with reddish foliage and disgusting pinky purple flowers.

Jim Barlup:

So far two of Jim's plants are note-worthy. *Rhododendron* 'Coral Mist' is a pleasant cream with pink edging, but I am not so keen on its foliage. *R.* 'Mindy's Love' has wonderful glowing yellow flowers with good glossy foliage, and does seem to have a future in the UK.

Other Breeders:

We now reach the list of less well known West Coast breeders and their mixed bag of offerings. Surprisingly, some of the worst performers have been bred by rhododendron nurseries. Harold Greer's *R.* 'Sugar Pink' carries a nice flower, but the plant self destructs at 5 years old when all the branches flop to the floor. (Perhaps he thinks it is the perfect nurseryman's plant!). *R.* 'Trude Webster' needs no more mention. *R.* 'September Song' is attractive, and makes a warmer orange than *R.* 'Olga' with rounder and paler leaves. From Whitney came *R.* 'Simmon's Classic', a yellow which never really matched its description and was prone to mildew. From Elliot we tried *R.* 'Naselle' which has a wonderful two tone truss of salmon pink and cream, and *R.* 'Swamp Beauty' is a gorgeous late flowering pink with a maroon centre, but has proved one of the leggiest plants we have ever grown. From Markeeta, *R.* 'Markeeta's Prize' is a first rate large growing red with huge flowers, but does need some shade to prevent the blooms fading to pink. Mossman bred *R.* ‘Taurus’ which has to be one of the best reds available. It has wonderful dark red buds all winter which then open in early May with a deep red long lasting flower.

So after nearly 20 years of importing new American varieties, we have certainly found some good ones which are performing well in our trials garden and remain firm favourites amongst staff and visitors, but we have also had our fair share of rubbish which has found its way onto the bonfire. We will continue to grow those which perform well, but we need plants which are properly suited to the UK climate with its late spring frosts, and our summers which may not ripen soft wood in time for winter. To achieve better suited plants typically means we are now growing more locally bred varieties from Britain and Europe with the toughness we need.

Opposite Page: Top:
Rhodoendron
‘Mindy’s Love’

Below:
***R.* ‘Naselle’**

This page:
***R.* ‘Swamp Beauty’**

Rhododendron Hybridising in Germany over the past 50 years

Dr. Hartwig Schepker

Botanic Garden and Rhododendron-Park, Bremen & German Rhododendron Society

Introduction

Germany has a long tradition of rhododendron cultivation and breeding. The first rhododendrons were introduced more than 200 years ago. The breeding of rhododendrons started shortly after, resulting today in a broad range of German cultivars including all major groups of rhododendrons and azaleas.

Hybridising in Germany in the 19th and early 20th century was mainly marked by the Seidel cultivars. For many decades the Seidel Nursery originating in Dresden has been the most successful source for new cultivars. Walter Schmalscheidt's excellent book "Rhododendron-Züchtung in Deutschland" (2002) which summarises all hybridising results until 1930 lists 310 Seidel cultivars alone. Many of those do not exist anymore or are very rare. But some Seidel cultivars are still around in today's production lists and valued especially due to their winter hardiness. Because of this feature the old Seidel cultivars played an important role in the hybridising history of the last five decades. Other well known German rhododendron breeders in the first part of the 20th century include Georg und Werner Arends from Wuppertal, who were concentrating on Japanese Azaleas (e.g. the Arendsii- and Aronense-Hybrids, see Schmalscheidt 1991).

Whereas in the first 100 years it has been mainly a job of professional plant growers, hybridising of rhododendrons in the last fifty years has been a mixture of the work of professionals and amateurs. Less than a handful of gardeners have made the creation of new cultivars an important and economically valuable part of their daily work. Many plant enthusiasts have been and still are hybridising rhododendrons on a small scale besides their regular job as a gardener or even more often as an amateur gardener. These enthusiasts rarely publish their results and this complicates the task of reporting on German hybridising in the last fifty years.

The result of rhododendron hybridising on a national scale is nevertheless amazing. Currently the total number of German cultivars lies somewhere between 1,500 and 2,000, approximately 5-7 % of the registered cultivars and groups listed in the 2nd Edition of the Rhododendron Register and Checklist. Many of the cultivars that have gained international reputation have been raised within the last fifty years. The time span between 1950/60 and today has been the main period of hybridising rhododendrons in Germany. Approximately more than two thirds of the total number of German rhododendron cultivars has been raised in this period.

The following compilation contains some of the most well known hybridisers whose cultivars have been widely distributed in Europe and some hybridisers mostly known in Germany only. Of course there are many more German hybridisers whose cultivars have been distributed on a more local scale. Valuable sources for more information are the books of Schmalscheidt (1991, 2002) and the publications of the German Rhododendron Society (i.e. Yearbook until 2005 and its successor “Rhododendron und Immergrüne” since 2006). The website of the German Rhododendron Society (www.rhodo.org) contains valuable information about German rhododendron breeders and nurseries.

Dietrich Gerhard Hobbie: the grand old man of German hybridising

Probably the most well known and influential hybridiser in Germany has been Dietrich Gerhard Hobbie (1899-1985) from Linswege in north western Germany. According to his own notes he has made more than 1,500 different crosses, using many well-known and valuable selections of wild species like *Rhododendron wardii* LST 5679, Kingdon Ward’s 9629 of *R. repens* (*R. forrestii* Repens Group) and *R. ciliatum* from the Sherriff expedition as well as the FCC form of *R. yakushimanum*. Later on he crossed his hybrids with each other and did backcrosses as well. At one point about 100.000 seedlings were growing in the woods of Linswege where now one of the largest and finest Rhododendron-Parks in Germany is located. Hobbie started hybridising in 1937 by crossing *R. williamsianum* and *R. forrestii* Repens Group with the red flowering *R.* ‘Britannia’. This was the beginning of a series of crosses that resulted in Hobbie’s famous “Repens” and “Williamsianum” hybrids and many more.

Hobbie crossed many different large flowering hybrids with *Rhododendron forrestii* Repens Group. One extremely successful cross in terms of named offspring has been the one with *R.* ‘Essex Scarlet’. Many clones were named from this cross (e.g. ‘Elisabeth Hobbie’, ‘Baden-Baden’ or ‘Mannheim’), most of which are very hard to tell apart. The most important cultivar in economical terms has been *R*. ‘Scarlet Wonder’ which is still propagated each year in huge numbers. Hobbie’s “Repens” rhododendrons have become very popular plants especially in the 1970’s and 80’s. In Northern Germany almost every garden displays a “Repens” rhododendron. They make beautiful plants in front of houses and are very useful for hedges! Old plants can easily reach more than two metres in size (height and width).

To produce his famous “Williamsianum” hybrids, Hobbie used red flowering hybrids like *Rhododendron* ‘Dr. V.H. Rutgers’, *R*. ‘Doncaster’ or *R*. ‘Louis Pasteur’. The most popular cultivars are the very hardy *R*. ‘August Lamken’ and *R*. ‘Gartendirektor Glocker’. These “Williamsianum” hybrids grow up to 2 metres and more; the largest in the Bremen Rhododendron-Park already reached 2.50 m. in height and even more in width. They are all early flowering. In Northern Germany they start at

Above:
Rhododendron
‘Scarlet Wonder’

Right:
***R*. ‘Gartendirektor**
Rieger’

All photos in this
article by Hartwig
Schepker

the end of April and last until the mid of May, making them vulnerable to late frosts. Many of Hobbie's "Williamsianum" hybrids have beautiful copper or bronze coloured new shoots.

There are also some crème coloured "Williamsianum" hybrids, for example the results of the cross of *Rhododendron williamsianum* with the cream-yellow large-flowered hybrid *R.* 'Adriaan Koster': the 1971 introduction *R.* 'Elfenbein' and its sister clone *R.* 'Gartendirektor Rieger' which is sometimes sold as *R.* 'Dr. Rieger' in Britain. The actual hybridiser has been Hans Robenek – for almost 40 years the head gardener in Hobbie's nursery.

Later on in his career as a hybridiser Hobbie also worked like many others with *Rhododendron yakushimanum*, e.g. crossing the FCC form with *R. wardii* LST 5679, producing well known clones like *R.* 'Flava' (Syn.: *R.* 'Volker'). Hobbie crossed *R. wardii* also with large flowered hybrids, producing some of the first German *R. wardii* hybrids with improved winter hardiness: examples are *R.* 'Breslau' (using the hardy Seidel-Hybrid *R.* 'Von Oheimb-Woislowitz'), *R.* 'Nippon' (*R. wardii* x *R.* 'Seidel Nr. 100') or *R.* 'Herzas' (*R.* 'Mrs. R.S. Holford' x *R. wardii*).

Hobbie liked the idea of remaking successful crosses and with this he produced huge numbers of saleable seedlings with similar characteristics. Unfortunately he didn't care for the resulting differences in genetic terms, so there were dozens of clones that were sold as *R.* 'Flava' and the likes.

Hobbie's head gardener: Hans Robenek

In the Hobbie nursery many more species than the usual suspects were used for hybridising. Dietrich Hobbie made most of the crosses involving the already mentioned species, but many crosses with species like *Rhododendron viscidifolium*, *R. haematodes* or *R. orbiculare* were made by Hans Robenek (1920-2005), the head gardener who worked on an independent breeding programme during his almost forty years at the Hobbie Nursery. Robenek was a species man. He used to have a very extensive collection of species in his garden, some directly originating from collections by Ludlow, Sherriff & Taylor. Robenek worked mainly with species, either crossing two species or crossing one with a hybrid. This is not a spectacular method, but he did the crossings with species that were in the 1960s-70s either rather unknown in Germany or had a bad reputation. The most well-known Robenek-Hybrid *R.* 'Viscy' evolved from a cross with a "bad" species: *R. viscidifolium* x *R.* 'Diane', a *R. campylocarpum*

Left:
Rhododendron
'Viscy'

Below:
***R.* 'Rexima'**

hybrid of Koster.

Another example of Robenek's legacy during his time at the Hobbie Nursery is *Rhododendron* 'Inamorata', not to be confused with Rothschild's *R.* 'Inamorata'. It is the same cross, but Robenek used the *R. wardii* clone LST 5679 and a comparatively hardy type of *R. fortunei* ssp. *discolor* producing with this combination a hardier form than the Rothschild cross. In honour of Lionel de Rothschild it was given the same name, a very unfortunate decision for all those who care for unambiguous nomenclature. The differences between these two *R.* 'Inamorata' are obvious, the Robenek's *R.* 'Inamorata' is hardier than Rothschild's cross and it is flowering very late, in June sometimes even extending into July.

After his retirement Hans Robenek continued to cross with species in his own nursery producing, for example the very good yellow *Rhododendron wardii* hybrid *R.* 'Walter Schmalscheidt', named after one of the foremost German rhododendron experts, by using different forms of *R. wardii*. *R.* 'Rexima', the cross betweeen a 'mastiff' and a 'pinscher', as it was described in the yearbook of the German Rhododendron Society (Schwirz 1996), is in botanical terms the cross between *R. yakushimanum* 'Hanano-Ego' (which is itself a selection from a cross of two wild *R. yakushimanum* origins by D.G. Hobbie) x *R. rex*. A beautiful foliage plant with leaves similar to *R. rex* but with the indumentum of *R. yakushimanum* and a perfect truss of white flowers with a dark red blotch. In German nurseries it is easier to please than the Danish equivalent *R.* 'Great Dane', the reverse cross of Jens Birck from Denmark.

Robenek died in 2005, valuable accounts about Robenek's hybrids have been published by Schwirz (1996) and by Dixon in the 2006 yearbook of "Rhododendrons with Camellias and Magnolias".

Hybridising for the landscaper and the garden centre market: Wilhelm Bruns

Early in the 1950's the German rhododendron production range consisted mainly of Dutch and British hybrids and of Cultivars raised by Seidel and Hobbie. At that time Wilhelm Bruns was in charge for what is now Germany's largest nursery, the Johann Bruns Nurseries in Bad Zwischenahn. Some of his customers, especially landscape architects, told Wilhelm Bruns that they need new colours for the gardens, especially pastel colours. With this in mind Wilhelm Bruns started his first crosses in 1952. To inherit the pastel colour he used especially *Rhododendron* 'Goldsworth Orange' and crossed it with species like *R. makinoi*, *R. insigne* or *R. dichroanthum* ssp. *scyphocalyx*. On the other hand he combined *R.* 'Goldsworth Orange' with Dutch hybrids like *R.* 'Prof. J.H. Zaaijer', *R.* 'Prof. F. Bettex' or *R.* 'Van Weerden Poelman'. *R.* 'Gloria' (*R.* 'Professor F. Bettex' (s) x *R.* 'Goldsworth Orange') is one of the examples from this "pastel" period.

Wilhelm Bruns obviously had a good nose for promising developments that raised a lot of publicity. He named some of his first hybrids *Rhododendron* 'Diana' and *R.* 'Silvia'. 'Silvia' is the first name of the Swedish Queen, a German by birth. *R.* 'Diana' has been a real winner during the Diana Memorial Day in 2007. British Garden Centres packed their shelves full of Bruns *R.* 'Diana'. There are many hybrids named *R.* 'Diana' in the International Register and Checklist but only the Bruns *R.* 'Diana' combined the right name with a compact, attractive, hardy and easy to please garden plant.

Bruns also heavily used *Rhododendron makinoi* and *R. insigne* in other crosses because they had a reputation of performing well in the less rhododendron suitable growing situations in southern Germany. Today the favourites of

Left:
Rhododendron
'Brun's Diana'

Below:
***R.* 'Berenike'**

the garden centres supplied with plants by the Bruns Nursery are especially *R*. 'Rosa Perle' and *R*. 'Bruns Diamant', both compact *R*. *makinoi* hybrids that produce many flower buds from a young age.

Due to good contacts to the office of the German Federal President, some of the Wilhelm Bruns crosses from the 1960's were named after the wives of the Federal President, the German equivalent of the "First Lady". Examples are *Rhododendron* 'Marianne von Weizsäcker', a hybrid originating from crossing *R*. 'Kluis Triumph' with *R*. *insigne* and *R*. 'Christiane Herzog' (*R*. *insigne* x *R*. 'Blue Ensign').

All these hybrids have been put on the market as the so-called "Gristeder Neuheiten", meaning "Rhododendron novelties of Gristede". Gristede is the village near Bad Zwischenahn where the Bruns Rhododendron-Park is located. This has become a brand name. Later in the 1960's Wilhelm Bruns also jumped on the *Rhododendron yakushimanum* train and crossed it with hybrids like *R*. 'Louis Pasteur', *R*. 'Catharine van Tol' or *R*. 'Doncaster'. They are not very spectacular but until today hybrids like *R*. 'Bad Zwischenahn', *R*. 'Colibri' or *R*. 'Lorelei' were widely grown in Germany because of the heavy marketing through the Bruns Nursery.

After handing over the business to his son in the mid 1980's Wilhelm Bruns, at the age of 72, started his second period of rhododendron hybridising. When looking for new mates he tried several species. *R*. 'Silberpfeil' involves *R*. *rex* and *R*. *smirnowii*, and is a strong grower producing large leaves with a whitish indumentum and huge silvery new shoots. Especially successful were his crosses with *R*. *bureavii*, *R*. 'Hansel' and *R*. 'Fantastica' resulting in many new "Gristeder Neuheiten" like *R*. 'Aureolin', *R*. 'Kranich' or *R*. 'Berenike'. These new hybrids have an extremely large calyx, creating a beautiful hose-in-hose-effect. Wilhelm Bruns has also used *R*. 'Dopey' because of the many different species involved in this Waterer hybrid. It includes ancestors like *R*. *facetum* and *R*. *yakushimanum* as well as *R*. *dichroanthum* and *R*. *griersonianum*. He crossed it with *R*. 'Nova Zembla' receiving the new hybrids *R*. 'Feuerkelch' and *R*. 'Antaris' and the newest German "First Lady" *R*. 'Eva Maria Köhler'.

Many of these second period hybrids are now due to be introduced into horticulture. Through the large distribution network of garden centre chains these novelties will gain a wide distribution. This kind of big sale with thousands of plants per cultivar means that besides compactness and winter hardiness, plant characteristics like easy propagation, easy cultivation and high numbers of flower buds on young 2-3 year old plants are getting more and more important. These characteristics often decide whether or not a promising new Bruns hybrid will be introduced. And - another goal of rhododendron hybridising at Bruns - at least one more feature other than the flower has to be provided, such as attractive leaves or colourful new shoots.

Hybridizing for the "rhodoholics": Hans Hachmann

There is no other German in the past fifty years who has created so many new hybrids as Hans Hachmann. Approximately 450 new hybrids have been named and introduced into horticulture by him. In the early 1950's he started with his first crosses. At that time the cultivation of rhododendrons was not highly regarded in his father's fruit tree nursery, the real money was made with other plants. For almost 20 years hybridising was more a hobby than a profession for him. This has to be seen in a historical context: at those times, i.e. the 1950s and

Left:
Rhododendron
‘Maharani’

Below:
***R.* ‘Fantastica’**

60s, rhododendrons in Germany were “fancy stuff for a few”, not that popular like today. Hachmann helped to change this attitude.

Like many others Hans Hachmann had to endure many disappointments before enjoying the first results that were good enough to be introduced. In the middle of the 1970’s he started to display his first crossings and many of this “first period cultivars” are still around, e.g. *Rhododendron* ‘Kokardia’ or *R*. ‘Maharani’. Hans Hachmann was not only interested in the larger hybrids, from the start of his hybridiser career he worked with all groups of rhododendrons, including species, the compact growing lepidotes and Japanese and deciduous azaleas.

In the beginning he was looking for some “real red” rhododendrons without the bluish shade, of course combined with sufficient winter hardiness. He crossed *Rhododendron* ‘Nova Zembla’ with *R*. ‘Mars’ and named a couple of seedlings from this combination. *R*. ‘Hachmanns Feuerschein’ is the best one of this cross and it is still widely available.

Hachmann was also aiming at yellow cultivars. He used *Rhododendron wardii* and crossed it with Seidel hybrids like *R*. 'Omega'. These Seidel cultivars are very hardy, they survived the extreme cold winters in eastern Germany at the end of the 19th century. One popular result when introduced was *R*. 'Marina', however today it has been replaced with other yellow Hachmann hybrids.

Like many other breeders in the rhododendron world Hans Hachmann also used *Rhododendron yakushimanum* and he will be definitely remembered especially for his results in this field. Examples from his first breeding phase are *R*. 'Polaris', *R*. 'Morgenrot' and *R*. 'Silberwolke'. *R*. 'Fantastica' has long replaced *R*. 'Morgenrot', but *R*. 'Polaris' (*R*. *yakushimanum* 'Koichiro Wada' x *R*. 'Omega') is still offered 30 years after its introduction.

During the first twenty years of his career Hachmann established his own simple hybridising philosophy: Make as many combinations as possible! He believed in the enormous potential of the natural diversity within the genus and so he repeatedly crossed and re-crossed his best hybrids either with each other or with other introductions, species or hybrids from other breeders, always looking for better hybrids which were healthier and tougher than the older ones or showing something exceptional and new.

The realisation of this concept needs lots of time and lots of space, the input of work is enormous. The following rough approach demonstrates the immense extent of his breeding work. Over the years Hachmann made an average of about 100 crosses per year. These results in about 25,000 seedlings per year of which about 5,000 are planted on the testing fields. The fifth year is the most important selection year since at that point most of the 5,000 seedlings have set flowers. A very strict selection results in 50-60 clones that are chosen for the ongoing cultivation. These plants are tested for another 5-10 years. Important criteria in this period are winter hardiness and the response of the customers in the display garden where the unnamed crosses are presented. At the end of this procedure one (a "bad year") to ten new cultivars (a successful year) are released.

With so many successful introductions in the late 1970s, Hachmann changed his business attitude: breeding and growing rhododendron was not a hobby anymore, it became the most important part of his business. The following second phase of Hachmann's hybridising career between the mid 1970s and 2003 can be called the "period of improvement and targeting customer's taste". On the one hand Hachmann constantly improved his early hybrids that were already established but not 100% perfect by hybridising them with other Hachmann hybrids or with carefully picked cultivars of other breeders. On the other hand he listened carefully to the comments and ideas of his customers and defined new hybridising goals. From this point on he served a growing market of rhododendron enthusiasts in Germany and abroad and established his well-deserved reputation as one of the most well known rhododendron specialists.

Hachmann's early *Rhododendron wardii* hybrids like *R*. 'Marina', which were quite hardy but still showing the loose habit of *R*. *wardii*, were replaced by other "improved" cultivars, growing more compact and with better flower quality. The unnamed result of *R. wardii* x *R*. 'Alice Street' has been crossed with *R*. 'Marina' to produce *R*. 'Goldkrone' and *R*. 'Graf Lennart'. *R*. 'Goldkrone' is very free flowering and good for climates with cool summer; *R*. 'Graf Lennart' is also free flowering but earlier than its sister seedling.

Other examples for "improvement" are the following: *Rhododendron* 'Nicoline', *R*. 'Hachmanns Feuerschein', *R*. 'Blinklicht' and *R*. 'Lagerfeuer' have all been red Hachmann hybrids of the first generation (resulting from the cross *R*. 'Nova Zembla' x *R*. 'Mars'), but the red colour became often bluish at the end of the flowering period, a tribute to *R*. 'Nova Zembla'. *R*. 'Erato' has been the second generation "red". It is a cross from 1976 with *R*. 'Oratorium' x *R*. Hachmanns Feuerschein', introduced 1988, with *R*. 'Oratorium' itself a cross between *R*. 'Hachmanns Feuerschein' x *R*. 'Thunderstorm'. *R*. 'Erato' holds its colour consistently over the whole flowering period without the bluish tone. This cross illustrates Hachmann's practice of repeatedly re-crossing his best hybrids with the occasional introduction of older, less hardy but proven varieties. But this was not the end of the line. *R*. 'Erato' itself was crossed in 1984 with *R*. 'Double Date', producing *R*. 'Rabatz' (introduced 2001), the red colour even more shining and clearer than in the other red Hachmann hybrids.

Of course there have also been more *Rhododendron yakushimanum* hybrids in this second phase. One of the best ones ever introduced is *R*. 'Fantastica' from 1983, resulting from a cross Hans Hachmann performed already in 1968: *R*. 'Mars' x *R*. *yakushimanum* 'Koichiro Wada'. There are many sister seedlings named from this cross, but there is a broad agreement that this is the best one.

Orange-yellow and orange-red hybrids were much sought after in the 1970's and 80's. Hans Hachmann used different hybrids (e.g. an unnamed cross between *R*. 'Omega' X *R*. *wardii* offering an orange tone) to serve this goal as a response to the remarks of his customers. A couple of well-known hybrids brought new colours into the horticultural business in the 1980’s: *R*. ‘Brasilia’ from 1982, *R*. ‘Amaretto’ (1987), *R*. ‘Balalaika’ from 1988 and *R*. ‘Mancando’ (1985).

A whole group of hybrids with very dark blotches or spots evolved in these years as well. The number of hybrids of this very popular group is enormous. There are many white ones with large flares on the upper lobe or deep violet flowers with dark blotches. Examples include *Rhododendron* ‘Polarnacht’, *R*. ‘Azurro’, *R*. ‘Bergensiana’, *R*. ‘Sapporo’, *R*. ‘Kabarett’ and *R*. ‘Eruption’. *R*. ‘Kabarett’ is a good example of a purposeful cross to increase the effect of a prominent feature, in this case the contrasting flare. Hachmann crossed *R*. ‘Hyperion’ with his own hybrid *R*. ‘Hachmann’s Diadem’. The prominence of the *R*. ‘Hyperion’ flare has been combined with the much better habit of *R*. ‘Hachmann’s Diadem’. Hachmann thereby increased the effect of a prominent feature while improving the straggly habit of the female partner.

Hachmann also created new deciduous azaleas. Some examples are *Rhododendron* ‘Goldpracht’, *R*. ‘Csárdás’, *R*. ‘Limetta’ and *R*. ‘Sunny Boy’. He also improved the existing range of Japanese azaleas by introducing novelties like *R*. ‘Friedoline’, ‘*R*. ‘Gabriele’, *R*. ‘Kirstin’, *R*. ‘Schneeperle’ or *R*. ‘Schneesturm’. *R*. ‘Maruschka’ is a real winner because of its excellent dark shining winter foliage.

Hachmann also worked with different species, mostly crossing them with hybrids:

- *R*. ‘Winterpurpur’ = *R*. ‘Mardi Gras’ x *R*. *oreodoxa* var. *fargesii* (a cross from 1985, introduction 2001);
- *R*. ‘Caramba’ = *R*. ‘Kokardia’ x *R*. *calophytum* (1979, 1995);
- *R*. ‘Kontiki’ = *R*. ‘Ovation’ (Nagel) x *williamsianum*;
- *R*. ‘Azurella’ = *R*. ‘Sacko’ x *R*. *calostrotum* ssp. *riparioides* (1990, 2001).

2004 marked the beginning of the third phase in the history of rhododendron hybridising in the Hachmann Nursery. The newly published catalogue presented rhododendrons of two Hachmanns. The first hybrids of Holger Hachmann, who started his hybridising career 1989/1990, were introduced next to established and new hybrids of Hans Hachmann.

Hans Hachmann introduced *Rhododendron* ‘Eliska’ with curious and unusually shaped flowers and *R*. ‘Goldsprenkel’, which added a new chocolate flavour to the *R*. *wardii* taste. New cultivars with prominent flares were *R*.

'Albarello' and the late flowering *R*. 'Junifair'. *R*. 'September-Flair', a customers favourite, is one of a whole series of autumn flowering hybrids created by Hans Hachmann. A cold August and a warm September causes the opening of almost all flower buds in September and October and this cultivar might flower for 5-6 weeks.

Holger Hachmann's first hybrids included *Rhododendron* 'Piccobello' with deep foliage and striking flowers, definitely one of the best of this colour, and *R*. 'Haithabu', which is a cross between *R*. 'Walküre' and Hobbie's *R*. 'Germania'. *R*. 'Haithabu' represents a group of rhododendrons with very large flower trusses, producing trusses of almost 20 cm in diameter with leaves much greener than the popular *R*. 'Germania'.

But that year was also a sad one for the Hachmann family and the whole rhododendron community. Hans Hachmann died unexpectedly at the age of 74 in March 2004.

Until his death Hans Hachmann had made 4,947 crosses, producing about 5 million seedlings, resulting in one million decisions of thumb up or down. And this finally resulted in about 450 named varieties. Without doubt he has been the most prolific and effective hybridizer of modern times.

Wolfgang Reich's "backyard hybridising": looking for the small rhododendron

Only a few rhododendron enthusiasts in Germany know Wolfgang Reich, but nevertheless some of his crosses have made their way into the international rhododendron world. Reich is a good example of an amateur gardener successfully crossing rhododendrons. He is a 78-year-old former teacher, a private rhododendron enthusiast who made his first crosses thirty years ago in 1978. He has only a small garden in Alfeld near Hanover with the wrong soil, shell limestone with a pH of 8.4. So he concentrated on cultivating those plants he could realistically care for under these conditions without changing the whole landscape around his property: small growing lepidotes. Everything starts in his basement where Reich is growing all his plants under artificial lights until they are big enough to be moved outside.

This is the birthplace of a cross that has been thought impossible. Reich didn't want to accept that elepidotes and lepidotes don't fit together, so he tried a cross between *Rhododendron yakushimanum* (as the seed bearing plant) and *R. dauricum*. Contrary to the common knowledge and without any tricks five seedlings finally evolved from this "impossible" cross and one of them – a seedling showing more *R. yakushimanum* influence than *R. dauricum* - was finally named *R.* 'Impossible'. It is a cultivar very hard to root, a bad grower and not very attractive with an early flower often hit by late frosts. But it is something special and worth growing in specialists' collections.

Probably Reich's most well known lepidote cultivar is *Rhododendron* 'Frosthexe', a cross from 1979 involving *R. anthopogon* and *R. lapponicum.* It is a good performer in cold climates, successfully growing in Finland and Canada and surviving the cold winters in the north. Winter hardiness is -26 °C and even fully exposed flowers have withstood late frosts in the second half of April with -7 °C without being harmed.

Opposite page: *Rhododendron* 'Piccobello'
Above: *R.* 'Frosthexe'

Reich is currently aiming at double flowers. He often uses the "April" series from the US. *Rhododendron* 'Jonas Reich' is one example of a cross with

R. dendrocharis. Anyone interested in more of his work should read the article in the American Rhododendron Society’s Journal of Spring 2002 (Reich 2002).

Heinz Bohlken and his “blue” yaks:

One of the latest additions to the broad range of German cultivars are the “blue yaks” of Heinz Bohlken, a nurseryman from Bad Zwischenahn who like so many others obviously couldn’t resist experimenting with *Rhododendron yakushimanum.*

In 1985 Bohlken crossed his own unnamed hybrid of *Rhododendron yakushimanum* and *R*. ‘Old Port’ with *R*. ‘Azurro’, a Hachmann hybrid with very deep colour and almost black flare. He received several good and very hardy seedlings with different shades of blue. Some of these

Above:
***Rhododendron* ‘Bohlken’s Lupinenberg’**

Right:
***R.* ‘Bohlken’s Snow Fire’**

Opposite page:
Inkarho rhododendrons

have been in cultivation for a few years now. In the beginning the darkest form was called *R*. 'Yaku-Blue', but its official name now is *R*. 'Bohlken's Lupinenberg'. Another hybrid of this cross with a slightly brighter blue colour is *R*. 'Husky'. Bohlken also produced a very good new yellow *R*. *yakushimanum* hybrid, called *R*. 'Bohlken's Laura', a cross between Hachmann's *R*. 'Fantasica' and one of the first *R*. *wardii* hybrids of Hachmann: R. 'Marina'. A very promising new white *R*. *yakushimanum* hybrid is *R*. 'Bohlken's Snow Fire', which is *R*. *yakushimanum* FCC crossed with *R*. 'Hachmann's Diadem', introduced in 2002. All of these Bohlken "yaks" are very hardy and full of flower buds at an early age and will surely become more and more popular. A couple of new hybrids will be introduced in 2010 at the next "RHODO" in Westerstede.

Go beyond the limits: the Inkarho story:

The nurseryman Johann Wieting from Westerstede together with Hans Hachmann has been the driving force behind the "Inkarho" project, a breeding programme that aimed at creating new rootstocks. Inkarho means "**In**teressengemeinschaft **ka**lktoleranter **Rho**dodendron-Unterlagen", a consortium of German growers looking for lime-tolerant rhododendrons. Wieting has been an outstanding rhododendron grower and hybridiser, but, compared to Hachmann and others, on a much smaller scale. One of his better known hybrids is *Rhododendron* 'Hille', a very early flowering cross between *R*. *irroratum* 'Polka Dot' and the *R*. 'Graf Lennart' which can be used for forcing.

The aim of the Inkarho project, which started in 1980, was to find new rootstocks enabling the cultivation of rhododendrons on soils with higher pH. Crosses were made between a compact growing form of *Rhododendron fortunei* and *R*. 'Cunningham's White'. The resulting seedlings were first tested in the laboratory, being treated with high concentrations of calcium. The surviving ones were expected to tolerate higher pH also under realistic conditions. The surviving seedlings were later tested under field conditions, where they were grown in soils with pH 5.5 to 7.0. Finally, after almost 20 years of research, a couple of clones were picked and used either as rootstocks or new cultivars. Many well known hybrids are now available on the new rootstocks and these so called "Inkarho-Rhododendrons" can be grown satisfactorily at relatively high pH levels (pH 6.0 - 6.5) and under certain conditions, i.e. by adding composted bark material, even higher than that. They are also tolerant of relatively heavy soils. "Inkarho-Rhododendrons" are nevertheless still rhododendrons, and like the all the others they like well aerated, not waterlogged soils. But undoubtedly they are an important breakthrough for near neutral soils.

***Rhododendron* ‘Inkarho-Dufthecke’**

The influence of the Inkarho rootstocks on vitality and lifespan of the grafted varieties is enormous. The differences in growth and root system between *Rhododendron* ‘Cunningham’s White’ and one of the new rootstocks “Rh. 10” are obvious (fig x). The grafted cultivars grow much better, a result of the better developed root system.

Some of the selected clones couldn’t be used as rootstocks due to intolerances with certain grafted cultivars, but they proved to be very valuable as hedges. There are now two cultivars that are heavily marketed as an alternative to *Rhododendron* ‘Cunningham’s White’ for a hedge plant. *R*. ‘Inkarho-Dufthecke’ and *R*. ‘Inkarho-Lila-Dufthecke’ are both very strong growers with a slight odour.

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President's Afterword

This has been the final stage of the conference held at the Royal Botanic Garden in Edinburgh in May 2008 to celebrate the Silver Jubilee of the Scottish Rhododendron Society. This publication is a compendium of the papers presented at the conference and I am sure that it will be a very useful reference work.

Every delegate that I spoke to during the Conference expressed the view that it was useful and well run and I should like to pass their thanks to all who were involved with the organising and running of the event; I hesitate to pick out anybody in particular but I have to put John Hammond in the frame as without his drive and determination I very much doubt we would have got out of the starting blocks.

I would like to take this opportunity to thank all delegates, from whatever part of the world you came, whether you presented a paper or were part of the appreciative audience, without you, there would not have been a Conference.

Finally, without the efforts of our Publications sub-committee and in particular our Editor, John Roy, who has collated the Conference Papers, this publication would not have happened and I should like to thank them for all their hard work.

David N. Starck

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The views expressed in this publication are not necessarily those of the SRS committee. The committee, however, support the right to freedom of speech.

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