Prumnopitys andina, the Chilean plum yew, is a species introduced to cultivation in the mid-nineteenth century but still rarely found and little known. Above is a typical old-growth tree in the Alto Biobío in Chile, its natural habitat where its survival is endangered (see pages 24 to 45).

Tree of the Year: *Prumnopitys andina*

MARTIN GARDNER, TOM CHRISTIAN and DAN LUSCOMBE

Introduction

Surprisingly perhaps, the dramatic and varied landscapes of Chile are home to only nine conifer species. Seven of these also occur across the Andes into neighbouring Argentina where they inhabit a narrow band of temperate rainforest. All but the shrubby *Lepidothamnus fonkii* have been successfully cultivated out of doors in temperate parts of the world, with *Araucaria araucana* and *Fitzroya cupressoides* being the most notable. Cultivated trees of *Prumnopitys andina* from the historical introductions are mostly confined to specialist collections and not surprisingly, for these we have no provenance data. More recent introductions through the International Conifer Conservation Programme (ICCP) working with Bedgebury National Pinetum, has greatly helped to broaden the genetic base of trees in cultivation. The hope is that this genetic resource can play a meaningful role in the restoration of depleted natural populations if this ever becomes necessary.

Prumnopitys is a relatively small genus of only nine species with a distribution around the Pacific Rim including eastern Australia, Costa Rica, New Caledonia, New Zealand, and in South America from Venezuela along the Andes to Bolivia (Farjon, 2010). Southern Chile represents a disjunction (separation) in the distribution of the genus with a gap of some 1,900 km between *Prumnopitys exigua* in Bolivia and *P. andina* in the northern part of its range in Chile.

The genus *Prumnopitys* differs from *Podocarpus* in having its lateral shoots arranged in two ranks (not spreading all around) and its large seed is entirely surrounded by a fleshy covering (epimatium) and lacks the swollen fleshy receptacle that is often red in *Podocarpus*. (Page, 1990).

Prumnopitys andina was first described in 1847 by the German botanist and zoologist Eduard Friedrich Poeppig (1798–1868) as *Podocarpus andinus*. Fourteen years later, in 1861, Rudolph Amandus Philippi (1808–1904), the father of Chilean botany, described what he thought to be a different species and named it *Prumnopitys elegans,* alas this turned out to be the same species. *Prumnopitys andina* is endemic to Chile where it is known by the common names of 'Lleuque' or 'Uva de Cordillera', the latter meaning grape of the mountains on account of its sweet-tasting, grape-like cones. Its English common name, Chilean plum yew, relates to its foliage superficially resembling that of the common European yew, *Taxus baccata* and its female cones resembling those of the true plum-yews, *Cephalotaxus*. Indeed, to the less aware, *P. andina* is often confused in cultivation with *Taxus baccata* and the foliage is sometimes confused with *Saxegothaea conspicua* even in Chile. In recent years, numerous plants distributed by an Irish nursery labelled as *Saxegothaea* have proved to be *Prumnopitys andina.*

Description

Prumnopitys andina (Poepp. ex Endl.) de Laub., Blumea 24: 189 (17 May 1978).
Synonyms
Podocarpus andinus Poepp. ex Endl., Syn. Conif. 219 (1847, 'andina').
Nageia andina (Poepp. ex Endl.) F.Muell, Select. Pl. ed. 2: 138 (Dec. 1876).
Stachycarpus andinus (Poepp. [ex Endl.]) Tiegh., Bull. Soc. Bot. France 38: 173 (1891).
Prumnopitys elegans Phil., Linnaea 30: 731 (Mar. 1861 ['1860']).
Prumnopitys andina subsp *blijdensteinii* Silba, J. Int. Conifer Preserv. Soc. 9(1): 33 (2002).
Note: The above taxon was described using a plant that was distributed to a number of collections in the 1990s under the name of *Pseudotaxus chienii* (W. C. Cheng) W. C. Cheng.

Evergreen tree 10–20 m tall, crown broadly pyramidal or rounded, dioecious (sometime monoecious). Usually multi-stemmed, 0.5–1 m, bark smooth, grey. Branches forming whorls. Leaves 1–2.5 × 0.15–0.2 cm, simple, alternate, almost stalkless, linear or slightly sickle-shaped, with an abruptly projecting point. Male-cones up to 25, borne in spikes, each subtended by a leaf-like linear-lance-shaped bract, November–December. Female-cones grouped along a scaly shoot, 1–3 × 2–3 cm, globose, green ripening yellow, January to March (Southern Hemisphere).

Distribution

Prior to 1998, standard references for the flora of Chile considered *Prumnopitys andina* to be endemic to Chile (Rodríguez, 1983, Marticorena & Rodríguez, 1995). Covas, (1998) cited *P. andina* as having an Argentinean distribution based on a herbarium specimen collected in 1936 by Cabrera (no. 3675) apparently from near the Río Aluminé in the province of Neuquén. However, recently this specimen has been re-examined at the La Plata Herbarium, Argentina, only to find that the location label details relate to Ñuble, Recinto, which is located in Chile. Tortorelli (1956) lists *P. andina* as occurring in Cañadón Reigolil (Province Neuquén), Argentina, which is very close to the Chilean border. Local botanists and foresters have not been able to confirm the occurrence of *P. andina* at this location, saying that the conifer *Saxegothaea conspicua*, which is not uncommon in the area, is often mistaken for *P. andina* (Gardner, 2013). The distribution of *P. andina* is mainly in the Andes from Region VII (Province Linares, 35° 52') to Region IX (Province Malleco, 39° 30'S) (Hechenleitner 2005). There is a small population on the eastern slopes of the Coastal Cordillera in Region IX and two closely located sites in the Central Depression Region IX (Province Malleco, 38° 20'S). The latter locations were discovered in 2005 and 2017 respectively by staff from RBG Edinburgh and the Universidad de Austral Valdivia. These are significant discoveries because

Natural distribution of *Prumnopitys andina* **in Chile.**

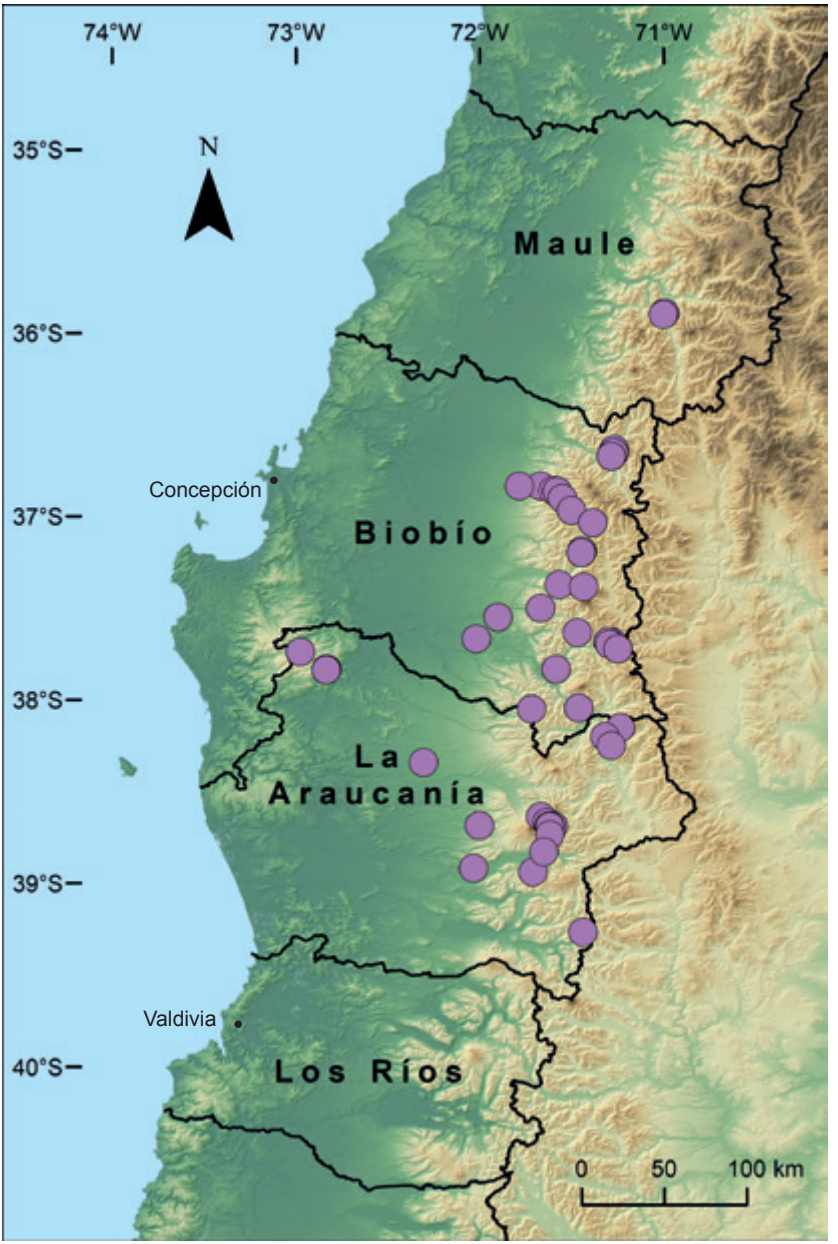

illustration © Vanezza Morales

Locations and approximate sizes of the main populations of *Prumnopitys andina* in Chile.

Region	Province	Location	Altitude (metres)	No. of individuals
VII [Maule]	Linares	Corral de Salas	900 – 1000	75 – 100
VIII [Biobío]	Biobío	Fundo Los Ciervos (Río Polcura)	800 – 900	*ca*. 2000
VIII [Biobío]	Biobío	Alto Biobío	900 – 1000	*ca* 2000
VIII [Biobío]	Biobío	El Abanico (Estero Quillailebu)	850 – 900	75 – 100
VIII [Biobío]	Biobío	Fundo Los Lleuques		
VIII [Biobío]	Ñuble	San Fabián de Alico	670 – 930	900 – 1000
VIII [Biobío]	Ñuble	R. N. Ñuble (Río Diguillan)	900 – 950	100 – 150
IX [Araucanía]	Malleco	P. N. Conguillo (Laguna Verde)	9050 – 1000	25 – 40
IX [Araucanía]	Cautín	Fundo Santa Rosa	750 – 770	200 – 300
IX [Araucanía	Cautín	Reigolil to Maite	500 – 800	*ca*. 5000
IX [Araucanía	Malleco	Fundo El Porvenir & Santa Eugenia	350 – 400	100 – 200
IX [Araucanía]	Malleco	Los Alpes (Fundo Los Lleuques)	*ca*. 1000	*ca*. 30

they represent the only populations in Chile's Central Depression which lies between the Andes and the Coastal Cordillera. For a complete list of locations see table above.

The relatively small group of trees at the entrance to Parque Nacional Conguillio are likely to be cultivated and may have originated from the natural population on the forested slopes leading down to Laguna Verde inside the National Park. This readily accessible location is frequently the source of cultivated plants today.

Habitat

The main distribution of *Prumnopitys andina* is confined to the Chilean precordillera especially in the Mediterranean zone of Central Chile where the rainfall varies from 2,000 to 3,000 mm. It favours riparian habitats and therefore is mostly found in valley bottoms close to large rivers fed by the Andes. The substrates here are very well-drained and derived from volcanic material. Trees usually occur in well-defined populations which are scattered and associated

with a wide range of sclerophyllous trees and shrubs which characteristically have hard, thick, leathery leaves. Typical tree species associated with *P. andina* include: *Aextoxicon punctatum*, *Austrocedrus chilensis, Gevuina avellana, Laurelia sempervirens*, *Maytenus boaria, Nothofagus obliqua* and *Quillaja saponari*a.

The soils of the Andes and the coastal mountains of Chile are largely comprised of volcanic (metamorphic) schist and glacial rock, and are often poor in Nitrogen and Phosphorus, in fact much lower than other temperate conifer forests around the world (Veblen, et al., 2006). Although *Prumnopitys andina* is adapted to damp and valley-bottom habitats (Turner & Cernusak, 2011) and to withstanding periodic flooding when riverside habitats are subject to inundation due to rivers bursting their banks, it is adverse to anaerobic, water-logged soils. Having said this, we have observed some trees surviving in soils which are poorly drained. One such site, at Fundo los Lleuques (Province of Ñuble), has areas with Ñadi vegetation which is permanently water-logged and is characterized by the presence of *Nothofagus antarctica* and *Escallonia virgata*.

Conservation

Vulnerable B2ab(ii, iii, iv, v) (Gardner, 2013).

Despite a cessation in logging operations in of native forest in Chile, which historically contributed to some of the most extensive clearances of forests anywhere in the temperate world, habitat degradation still prevails today (Hechenleitner, 2005). Historical land–use changes have resulted in a highly fragmented landscape in which many native habitats have been reduced and become more isolated. Even though the total population of mature individuals of *Prumnopitys andina* is estimated to be about 10,000 with at least three populations having more than 2,000 trees, it is still one of five Chilean conifers species listed by IUCN as being threatened (Hechenleitner, 2005). The threat assessment of Vulnerable is based on field work carried out over a three year period by staff from the RBGE in collaboration with researchers from the Universidad Austral de Chile, Valdivia (UACh). Its main threat is artificial flooding of Andean valleys as a result of damming mountain rivers in order to produce hydro-electric power. Important populations have already been lost or severely depleted as a result of this activity. Incredibly, the San Fabian de Alico valley has UNESCO Biosphere Reserve status as it forms part of the 'Corredor Biológico Nevados de Chillán Laguna del Laja' and yet there are advanced plans to flood the valley with a loss of 1,000 old growth trees. The Chilean government have passed a law which allows hydro-electric schemes to be developed in UNESCO sites. *P. andina* is further threatened by a lack of regeneration in a number of populations due to livestock eating the fleshy cones; this is further exacerbated by the delayed germination of this species at 'fruit-fall'. Grazing of seedlings and small plants is also a problem. Afforestation using *Pinus radiata* in the only location in the Coastal

Prumnopitys andina growing with *Austrocedrus chilensis* in the San Fabián de Alico valley, Chile.

Cordillera has in the last 15 years reduced the population by 50% to an area of less than 500 m² (Hechenleitner et al., 2005), this population is also suffering from livestock grazing.

Uses

Although the wood of *Prumnopitys andina*, which is yellowish in colour, is used for making furniture and in construction, it is not as sought after as other timber trees that are native to the Chilean temperate rainforests. The sweet-tasting fleshy cones are consumed by local people and are sometimes used for making marmalade.

Introduction to cultivation

The precise date of introduction to cultivation outside of Chile and by whom is not known to the authors. The earliest reference we can find to it is cultivation is 1857 (Anon, 1857) when Hugh Low & Co., Clapton Nursery in London were offering plants for 15 shillings each or 12 for 120 shillings. The very cold winter of 1859/1860 was a good test for the relative hardiness of the new tree introductions to cultivation and prompted gardeners to comment on their trees of *Prumnopitys andina* (Anon, 1860). It was proving to be relatively hardy but these reports were also an indication of its introduction date to cultivation which was likely to have been at least in the mid-1850s, if not earlier. Plants

were also being offered for sale by William Reid Nurseries (Reid, 1861), New York in 1861 for $1.00 each. An early documented introduction to cultivation in the British Isles was in 1860 by the highly accomplished Victorian plant explorer Richard Pearce working for the plant nursery Veitch & Sons of Exeter and London (Veitch, 1881). This is often mistaken as the original date of introduction. According to an entry in *The Gardeners' Chronicle* (1863), under the title of 'New Plants', Pearce describes the trees he collected from as being "pyramidal evergreen 40 to 50 feet high, with a dark glossy green foliage and much the appearance of *Abies douglasii*" now of course known as *Pseudotsuga menziesii*—the Douglas-fir. As so often is the case with historical horticultural introductions, there is rarely a precise provenance given for the collection. In the same article Pearce's collection is said to have been made from 5,000 to 6,000 ft. (1,500–1,800 m). Having surveyed all extant populations of this species we have never observed it growing above 1,250 m above sea-level. This location is called Los Lleuques close to Pinto on the road to Termas de Chillán (Province of Ñuble). Either Pearce's altitudinal range is erroneous (easily forgiven considering the challenges at that time for accurately recording altitudes) or the population he collected from is no longer extant. Certainly this area of Chile was accessible for exploration during the time of Pearce's visits to Chile. The leading botanists of the day, Rodulfo Amando Philippi and his son Federico Enrique Philippi, often visited Termas de Chillán especially in the 1860s and 1870s. One can't help concluding that the location name of Los Lleuques, which is the most widely used Chilean common name for this conifer, attracted Pearce to the area in order to make the collections from *Prumnopitys andina*.

By the turn of the nineteenth century *P. andina* was relatively widely cultivated in Britain and Ireland and to a very limited extent on the European Continent in Denmark and Western France (Hansen, 1892). In the RHS Report of The Conifer Conference, Dunn (1892) listed three of the largest specimens cultivated in the UK as being Castlewellan, County Down (3.5 m), Tortworth Gardens, Gloucestershire (5 m, 25 years old) and Poltalloch Gardens, Argyll (4 m). The Conifer Conference Report of 1893 (Chittenden) detailed (under the name *Prumnopitys elegans*) 21 gardens in Britain and Ireland growing *P. andina* with a tree at Kilmacurragh listed as being 12.5 m, and those at Poltalloch (Bute & Argyll), Fota (Ireland) and Castlewellan (N. Ireland), all 10 m tall. Curiously, in the 1972 *Conifers in the British Isles* (Mitchell, 1972) *P. andina* was scarcely mentioned, even for those gardens mentioned as having trees (some notable) in the 1932 report by Chittenden—many of these still exist today.

Cultivation

Compared with Britain and Ireland, *Prumnopitys andina* is rarely cultivated elsewhere—the BGCI plant collections database lists 27 sites in eight countries. Certainly there are very few examples of large trees outside of

Vanezza Morales and Tom Christian collecting cones from a tree in San Fabián de Alico valley in Chile.

Britain and Ireland. Frédéric Tournay notes that for France "It is very rare but the species is certainly under recorded in public gardens because people often mistake it for *Taxus*". Here we detail some of the trees being cultivated in countries around the World:

Britain and Ireland Of the *ca.* 50 notable trees cultivated in Britain and Ireland, some of the largest specimens were most likely planted in the late nineteenth century, and not surprisingly no field data is available for these. Most records have been accessed from The Tree Register of the British Isles (TROBI) database and where possible we have endeavoured to update those which have not been seen since 2014. Several specimens on the database are no longer alive. These include the large tree at Tregrehan (Cornwall) which according to the owner Tom Hudson came down in a gale in the mid-1980s, and another one growing at a 60 degree angle finally came down (with the help of a large *Thuja plicata* falling on it) in about 2008. Both were thought to have been planted in the late 1880s by Jovey Carlyon, the then owner of Tregrehan. Neville Evans, Curator Bicton Park Botanical Gardens, recalls that their Champion Tree, which in 1968 was recorded as being 21.5 m tall, died and was felled in *ca.* 2014. The tree at Tullock Castle, Dingwall was crushed by a falling beech in 2015. The most recent loss was December 2017 when heavy snow damaged the large tree at Batsford Arboretum (Gloucestershire). According to Matt Hall, the Garden's Curator, it was so badly damaged that it had to be removed.

A selection of the larger trees of *Prumnopitys andina* cultivated in Britain and Ireland. *RBG Kew accession number **RBG Edinburgh accession number

SITE	County	TROBI No.	Height (metres)	Girth (metres)	Year seen
ENGLAND					
Beachamwell	Norfolk	193184	6.00	0.69	2009
Beaufront Castle	Northumberland	194718	6.00	0.94	2009
Bedgebury National Pinetum	Kent	49880	12.00	1.27	2015
Bitton (St Mary's Church)	Gloucestershire	228989	9.00	0.60	2014
Bowood House	Wiltshire	241721	8.50	0.50	2016
Cambridge University BG	Cambridgeshire	228570	7.00	1.02	2014
Cambridge University BG	Cambridgeshire	79702	10.00	1.40	2014
Chelmsford	Essex	187476	12.00	1.79	2008
Cowdary Hall	West Sussex	70023	14.85	2.70	2018
Cowdary Hall	West Sussex	70024	14.42	2.70	2018
Deene Park	Northamptonshire	79725	8.00	1.15	2009
Eastnor Castle	Herefordshire	146914	11.00		2018
Exeter University	Devon	138366	11.00		2013
Endsleigh	Devon	17658	16.00	1.65	2006
Fletcher Moss Park	Lancashire	159181	8.00	1.50	2015
Fontridge Manor	East Sussex	17656	9.50	59.00	2009
Lamellen	Cornwall	79713	8.00	1.30	2016
Leicester University BG	Leicestershire	161214	8.00	0.72	2015
Midhurst Methodist Church	West Sussex	51345	8.20		2018
Pampisford Hall	Cambridgeshire	79721	15.00	1.25	2011
Pampisford Hall	Cambridgeshire	79722	15.00	1.36	2011
Pax Hill	Hampshire	17660	12.00	1.04	2002
Reading University	Berkshire	161664	12.00	1.42	2016
RBG Kew	Greater London	19691319 1*	12.00	1.50	2016
Royal Holloway College	Surrey	125856	12.00	1.98	2000

A nine metres tall female tree at St Mary's Church, Bitton, Gloucestershire (TROBI 228989).

SITE	County	TROBI No.	Height (metres)	Girth (metres)	Year seen
Saint Roch's Arboretum	West Sussex	208123	13.00	0.84	2015
Stanmer Park	East Sussex	38643	17.00	1.38	2018
Stephens House & Garden	Greater London	146319	9.00	1.35	2014
Thursley Parish Church	Surrey	151375	13.00	2.07	2018
Writtle Agricultural College	Essex	249917	12.00	0.90	2017
IRELAND					
Aravon School (Old Conna House)	County Dublin	151793	12.00	1.29	2003
Ashbourne House	County Cork	79715	16.50	1.41	2002
Avondale Forest Park	County Wicklow	152961	15.50	2.14	2000
Birr Castle	County Offaly	8986	19.00	1.55	2013
Castle Forbes	County Longford	152962	14.00	1.66	2000
Castlewellan National Arboretum	County Down	8974	13.50	1.48	2000
Delgany	County Wicklow	176197	11.00	1.27	2005

SITE	County	TROBI No.	Height (metres)	Girth (metres)	Year seen
Dunloe Castle Hotel	County Kerry	152963	11.50	1.51	2000
Glasnevin National BG	County Dublin	79705	17.00	1.49	2018
Glasnevin National BG	County Dublin	79706	14.00	1.66	2018
Howth Castle	County Howth	225433	17.00	1.34	2012
Huntington Castle	Country Carlow	15930	15.50	1.38	2000
Mount Usher Gardens	County Wicklow		17.00	2.16	2015
Rostrevor House	County Down	152964	16.00	1.39	2015
Trinity BG Dartry	County Dublin		8.00	0.90	2011
SCOTLAND					
Burnside Estate	Forfar	179632	10.00	2.00	2015
Dunira (Comrie)	Perth and Kinross	234920	6.00	1.37	2015
RBG Edinburgh	Midlothian	19698199A**	8.00	1.40	2018
RBG Edinburgh	Midlothian	19698199C**	9.00	1.00	2018
WALES					
Bodnant Gardens	Conway	239957	8.00	0.98	2016
Leighton Hall	Powys	192618	11.00		2009
Roath Park	Glamorgan	17657	16.00	2.81	2015
Treborth Botanic Garden	Gwynedd	240150	10.00	0.57	2016

Interestingly there are very few records of significant trees of *Prumnopitys andina* cultivated in Scotland considering the country's unprecedented tree planting tradition. Of the three trees recorded by TROBI (see table, pp. 32–34) the only significant trees are at Burnside (Forfar) and the Royal Botanic Garden Edinburgh (RBGE) at the Inverleith site. RBGE have several trees which are all male and likely to be clonal. The tallest tree (19698199A) at 9 m, started to produce female cones on one of its branches in 1999. The majority of 1968/1969 RBGE accession numbers are 'made up numbers' applied at the time to existing material, and certainly the size of this tree suggests an earlier planting date.

Not surprisingly, the relatively wet and mild climate of the island of Ireland is ideal for cultivating *P. andina*. The 18 m tall tree at Birr Castle is now probably the Champion Tree for the species, closely followed by those at Howth

The two old growth trees with their smooth bark (inset), at Cowdray Park, West Sussex.

Castle (17 m), Glasnevin National Botanic Gardens (16 m) and Ashbourne House (16.5 m). England has many large trees, but not all are associated with private estates and gardens. For example, the Parish Churches of Midhurst, West Sussex, and Thursley, Surrey, have notable trees. Not far from Midhurst there are two closely planted trees on the side of the road leading to Cowdray Hall. At 17 m tall the latter are very impressive and join the trees at Bedgebury National Pinetum and Fletcher's Moss in being some of the tallest of this species in cultivation.

In their survey of conifers in cultivation, Shaw & Hird (2014) list 70 sites, however, most of these relate to plants in the International Conifer Conservation Programme's network of 'safe sites' which have been planted since 1992. Today the network has 511 plants in 80 sites planted throughout the British Isles and Ireland. If RBGE's gardens are included in the count then this figure increases to *ca*. 650 plants. The purpose of this network is to help broaden the genetic base of conifers such as *P. andina* in the hope that this material can one day be used to help restore depleted native populations. Unlike the heritage trees of *P. andina* in cultivation, the ICCP trees are documented with precise provenance data. Seed collections have been made from all known populations in Chile. Some of the significant plantings are those at Bedgebury with 98 plants and Kilmun Arboretum (Argyll and Bute) where 52 plants have been planted which represent a single accession. The largest number of individual

Left, a hedge of *Prumnopitys andina* planted in 2008 which contains 103 plants collected from four populations in Chile. This is at the Royal Botanic Garden in Edinburgh.

Opposite, Two female trees of *Prumnopitys andina* growing at Chèvreloup National Arboretum in France.

trees has been planted in hedges. Such hedges have the potential of storing relatively large amounts of genetic material (Gardner et al., 2018). At RBG Edinburgh's Inverleith site, there is one hedge with 100 plants and the other with 37 plants. In addition there are three external sites where hedges have been planted—Oxford Botanic Garden, Harcourt Arboretum (131 plants) and in Northern Ireland, Ballyedmond Garden (37 plants) and Mount Stewart Garden (58 plants). In total these hedges hold 372 plants and as we compile this account 10,000 more seeds, collected from ten native populations, have just been sown at RBG Edinburgh—hopefully there will be many more opportunities for planting further hedges!

Chile Although Chilean native trees species are often cultivated in parks, public gardens and used in other public spaces such as streets, *Prumnopitys andina* is rarely grown. Mauricio Cano knows of two 6 m trees in the main square of La Unión (Region Los Lagos) which produce copious amounts of female cones each year. Likewise in the small town of Cunco (Region Araucanía) there are several trees in the main square. Antonio Lara reports of it being used as a street tree in the town of Villarrica (Region Araucanía) and according to Paulina Hechenleitner there are several street trees in Frutillar Bajo (Region Los Lagos).

Belgium Abraham Rammeloo reports of a vigorous tree in Arboretum Kalmthout which was planted in 2008 and now measures 4 m tall and with

a circumference of 18 cm. According to Hans Nickmans there are two trees in Arboretum Bokrijk. One of these (19930693), which is female, produces copious amounts of cones and measures 5 to 6 m tall. It was received from Hillier Nurseries Sons (Winchester) in 1990. The second (19990783) is male and about 5 m tall, was purchased in 1998 from Esveld nurseries, Holland as *Pseudotaxus chienii* (see note under description).

France Frédéric Tournay knows of a tree growing at Jardin botanique de l'Université de Strasbourg planted in 1990 and now measures 3.5 m tall. Thierry Lamant and Frédéric Tournay note the that following gardens have trees: Arboretum de Chèvreloup (two, female); Jardin Dominique Alexandre Godron, Nancy (planted 1968, 3 m, dbh 0.97 m, male); Jardin botanique du Montet (now Jean-Marie Pelt), Villers-les-Nancy (planted 1968, 6.5 m, dbh 1.25 m, male); Jardin des Plantes, Paris (*ca.* 5 m, male); Jardin public de Guingamp, Côtes d'Armor (8 m, female); Jardin du théâtre Max Jacob, Quimper (8–10 m); Parc du Thabor in Rennes, Ille-et-Vilaine (3 m, female) and in the Arboretum national des Barres (Loire). Jean Hoch mentions an old specimen growing in Arboretum de Jouéou, which is also known as Arboretum Henri Gaussen (Haute–Garonne).

Germany Veit Martin Dörken confirms two small trees at the Botanischer Garten der Universität Konstanz. Both are of garden origin, one (146610) 40 cm tall and the other (107910) at 1.2 m. At Botanische Gärten der Universität,

photographs © Martin Gardner

Cornelia Löhne reports of one individual planted in 1993 which measures 2 m tall with a 20 cm DBH. Wolfgang Stuppy, Scientific Curator of Botanischer Garten Ruhr Universitat Bochum speaks of seven in the Garden, two are struggling due to excess wet soils but the others look very healthy and range in height from 1.2 to 3 m.

Spain Francisco Garin reports of three plants in Jardín Botánico de Iturraran, (Provincia de Guipúzcoa). These trees, which are now between 2–3 m tall, were planted in October 2008 having come from Rein & Mak Bulk nursery in Boskoop who had obtained them from the online Chilean seed supplier Chileflora.com. Miguel Vizcay notes that there are several small plants being grown in private gardens in NW Spain. According to Silvia Villegas, Curator of horticulture at Real Jardín Botánico de Madrid, the *ca.* 6 m high plant died in 2017.

Canada Douglas Justice, reports of a flourishing tree growing in the Alpine Garden at the University of British Columbia Botanical Garden, Vancouver which is 2.5 m tall. It was collected by Dan Hinkley in 2003, collected from Parque Nacional Conguillio.

USA *Prumnopitys andina* is rare in cultivation in the USA. Raymond Larson has reported of several small trees growing in University of Washington Botanic Garden. According to Raymond the Garden received plants from the

photograph © Martin Gardner

Opposite, mature male cones (left) and developing female cones (right) on cultivated trees at RBG Edinburgh.
Right, mature female cones at San Fabián de Alico in Chile.

Golden Gate Park in San Francisco in 1946 with three of these being planted out in the Arboretum in 1962 alas, the last tree died in 1992. However, they currently have ten trees, planted in various years from 1996 to 2010, the tallest being 5.5 and 7 metres. These can be traced back to having been collected from the entrance to Parque Nacional Conguillio including those purchased from Cistus Nursery in 2010 with an Eric Hammond collecting number ECEH 00107—he collected for Heronswood Nursery of Kingston, Washington in 2004. The tallest trees are now about 4 m tall. Bret Hall confirms that University of California, Santa Cruz Arboretum has clones planted since the 1960s and 80s which are now about 4 m tall. San Francisco Botanical Garden also have three trees; Mona Bourell reports that two of these (20100274A & C) are of known wild origin.

New Zealand Cliff Lawrence reports that *P. andina* was once offered for sale by some of the more imaginative New Zealand nurseries, but it now appears to be absent from most catalogues. He adds that it grows 'well but slow' on his farm near New Plymouth. On the North Island, a large tree is recorded from Park Island Cemetery, Napier, which has grown to *ca.* 8 m since being planted in the 1960s from seed obtained from Adelaide Botanic Gardens. At Clive & Nicki Higgie's Paloma Gardens near Whanganui a tree obtained in 2004 from Cedar Lodge Nursery, New Plymouth, is now *ca.* 4 m tall and has produced male cones, but it has struggled due to intense summer droughts. The Landcare Research organisation's online database of herbarium specimens includes only a few records of *P. andina*. The oldest (1964) being a cultivated specimen from Christchurch Botanic Gardens and the most recent (2007) being an 8–9 m male tree at the T. E. Adams Arboretum near Greendale, Christchurch. On South Island, a tree thought to have been planted in the late nineteenth century at Larnach Castle, Dunedin, achieved an estimated height of 12 m. It thrived in

a sheltered position against the castle wall before it was removed in the late 1960s as part of a programme to conserve the building. Two replacements have been planted since this time and these are reported to be thriving.

Australia *Prumnopitys andina* has been cultivated in Australia since the late 1800s — there are two herbarium specimens in the National Herbarium Victoria (MEL) collected from Port Arthur, Tasmania in 1893. The tallest tree Alistair Watt recalls is in Geelong Botanic Gardens (Victoria) which was planted in the mid-late nineteenth century and is now 20 m tall with a 4.25 m diameter just below the fork. Cuttings taken in 1988 from this tree have now grown into a tree 6–7 m tall at Alistair's' garden at his Otway Ridge Arboretum (Victoria).

Propagation

Over a period of 26 years the International Conifer Conservation Programme (ICCP) has planted *P. andina* extensively throughout Britain and Ireland using material from threatened populations collected in Chile. The establishment of this species in cultivation has not been without its problems owing to the difficulty of germinating seed and establishing plants, especially in sites which have not formerly been planted with *P. andina*. In response to these difficulties the ICCP and Bedgebury National Pinetum have collaborated with Forest Research at Alice Holt Research Station (Surrey) in order increase the percentage of seed germination and shorten the period over which this happens (Gosling, 2005).

There have been several germination methods employed and these have given rise to varying degrees of success. The collection of cones should take place from native populations during January to March and in our experience there have always been copious amounts of cones available. If the cones are collected when the epimatium is still hard and green then these are best stored in plastic bags for two to three weeks in cool conditions as this will soften the epimatium and make its removal easier. Although this is not a pleasant task, due to the viscous nature of the pulp, the removal of the seed from the fleshy epimatium (seed coat) is thought to be essential due to the presence of potential chemical germination inhibitors. Gosling et al., (2005) recommends that the extracted seeds should be washed and agitated in running water at about 15 °C for 12 hours, again this carried out as a precaution against the presence of chemical germination inhibitors. Seeds were mixed with moist peat and sand and incubated. After five and seven months the seeds were cracked using a vice and the excised embryos were germinated on moist filter paper (Gosling, 2005). Using this method most accessions have about 50% of viable seeds and after about six months almost 66% of viable seeds are capable of producing a seedling (Gosling, 2005). At RBG Edinburgh de-pulped seed which was mixed with shredded sphagnum moss and stored in a fridge at a temperature of between 10–15 °C for two to three months, germinated after

A 20 m tree of *Prumnopitys andina* at Geelong Botanic Gardens, Victoria, Australia.

about 12 months. However, the same treatment can result in germination taking anything from 20 days to three years (Hechenleitner, 2005) or no germination occurred. There is also some evidence from research carried out at RBG Edinburgh that if the seed is mixed with rotting fruit the ethylene from the fruit can enhance germination (Hecheleitner, 2005). *Prumnopitys andina* can be easily vegetatively propagated by taking 5 cm long, semi–ripe cuttings (with a heel) in autumn and applying a hormone rooting powder. Placed under mist or a plastic cover with a bottom heat of 18 °C, rooting takes two to three months and 100% success rate can be expected (Hechenleitner, 2005). Cutting-raised plants are potted into 3 L airpots one year after they have rooted and seed-raised plants are potted into the same size pots one year after they have germinated and are ready for planting two years later.

Cultivation

We estimate that the mortality rate of trees planted in ICCP sites over a period of 25 years is about 50%. It is clear that poor health (in the form of yellowing of leaves) and mortality is related to poorly drained sites but also in sites that had not previously been planted with *Prumnopitys andina*. The latter led to the hypothesis that the beneficial mycorrhizal fungi that play such a key role in the health of conifers, is either absent or unavailable in some sites. Research carried out to better understand the associated beneficial mycorrhizal fungi which enhances growth (Melchizedek, 2015), concluded that *P. andina* is a difficult host for arbuscular mycorrhizal fungi and therefore plants struggle to form a symbiotic relationship (known as mutualistic symbiosis). This was especially so in the organic-rich and mineral-rich clayey loam soils of Britain. However as a pot-grown plant under cover in a cold glasshouse or netlon tunnel there has been almost a 100% survival rate as long at the compost is free-draining. The exception to this was when pots of *P. andina* on open-mesh staging were directly beneath a leaking pain of glass. All these plants died which shows just how sensitive this species is to excess water. There is still a lot more research needed in order to understand the cause of the range of unfavourable health conditions and symptoms in *P. andina*.

Like most conifers species, *Prumnopitys andina* is adverse to waterlogged soils however; it will survive seasonal inundation as long as the soil is freely drained. There is no better site to illustrate the aversion to excessive amounts of water than Benmore Botanic Garden (Argyll & Bute). Here, even on the steep slopes of the Chilean Rainforest hillside, *P. andina* failed to become established. Curator Peter Baxter confirms that of the 80 trees planted at Benmore since the early 1990s the mortality rate has been about 60%. He goes on to say that plants can grow healthily for three or four years, sometimes reaching a height of 1.25 m and then suddenly deteriorating and dying. The recent high annual rainfall of 3 m occurs through much of the year; the sheer volume often means that the soils are unable to shed excess water!

High mortality rates have also been experienced at Bedgebury National Pinetum, where although the annual rainfall is much lower (820 mm), the open slope, where the trees were planted, had poorly drained pockets which resulted in a loss of 50–60%. However, in the main pinetum of Bedgebury, where the drainage is better, recent plantings (19 plants) have grown very well with the tallest being *ca.* 4.2 m (planted spring 2006). Even at Picton Castle Gardens (Pembrokeshire), which has proved to be an outstanding site for ICCP conifers, the now 5 m trees (planted in 1996) are showing some signs of stress due continuous rain in 2017. Although well drained soils are the best sites for *P. andina*, we have observed young trees thriving on the heavy clay soils such as those at Batsford Arboretum (Gloucestershire). Perhaps the difference with this site, in comparison with those on the west coast of Scotland, is the annual rainfall is much less and the soils are able to dry out during the summers when there are longer periods without rainfall. The growth rates of trees planted at Batsford Arboretum are good—three trees have attained a height of 3.55 m in 12 years.

Other than water-logged soils, *Prumnopitys andina* has a broad tolerance of climates and edaphic conditions. Not only does it grow on acid soils but it will also survive alkaline substrates, including thin chalky soils. The best evidence of the latter is the thriving 17 m tall tree at Stanmer Park in East Sussex. It can also tolerate cold temperatures. One of the coldest sites with ICCP plants is the Whitmuir Estate, Selkirk. Typically the Scottish Borders can be very cold and this site has seen winter temperatures of -10 °C. Teyl de Bordes, the estate manager, goes on to say that plants have survived damage caused by cold, drying easterly winds, often lasting for several weeks. Several pants have reached a height of over 2 m after seven years in the ground.

A model site for *P. andina* has proved to be Eastnor Castle (Herefordshire) which already has an established tree now measuring 11 m tall (see table, p. 32). The 12 ICCP trees planted since 2012 have shown excellent growth rates. The average is 2.1 m, with one tree, planted in 2014, now 2.45 m tall. A site like Eastnor is ideal because of its relatively moderate annual average rainfall (690 mm), freely drained soils on gentle slopes and high levels of summer sunshine hours.

It is also important to note that *P. andina* is an extremely shade tolerant conifer species—it will even withstand the same levels of shade that *Taxus baccata* can tolerate.

Pest and Disease

Although *Prumnopitys andina* is generally free of pests, according to Melchizedek (2015) it is seriously affected by a range of ill-health conditions and symptoms. In particular a carbohydrate slime disease is present on many of the older trees in cultivation and has also been observed by the authors in the population at Fundo El Porvenir (see table, p. 27).

photograph © Ormungandr Melchizedek

Bacterial infection on a cultivated tree at Royal Botanic Garden Edinburgh.

Acknowledgements

We would like to express our warm thanks to those who provided information regarding the cultivation of *Prumnopitys andina*: Antonio Lara Aguilar, Peter Baxter, Mona Bourell, Koen Camelbeke, Mauricio Cano, Gail Church, Glyn Church, Robert Cubey, Teyl de Bordes, Philippe de Spoelberch, Ron Determann, Veit Martin Dörken, Alan Elliott, Neville Evans, Gonzalo Nieto Feliner, Eric La Fountaine, Julian Gaisford-St Lawrence, Francisco Garin, Martin Grantham, Brett Hall, Matthew Hall, Paulina Hechenleitner, William Hinchliffe, Jean Hoch, Tom Hudson, Chad Husby, Matthew Jebb, Doug Justice, Thierry Lamant, Raymond Larson, Cliff Lawrence, Cornelia Löhne, Neil McCheyne, Sian Mitchell, Hans Nickmans, Ormungandr Melchizedek, Arven Pépinière, Abraham Rammeloo, István Rácz, Alexander Durdin Robertson, Brendan Ross, Elisabeth Ryelandt, Connor Smith, Wolfgang Stuppy, Alex Summers, Fergus Thompson, Frédéric Tournay, Miguel Vizcay, Alistair Watt, Oliver Whalley. We wish to also thank Vanezza Morales for preparing the distribution map.

References

Anon, (1972). *Conifers in the British Isles*. Proceedings of the third Conifer Conference arranged by the Royal Horticultural Society held in London, 5 to 8 October 1970. RHS, London.

Anon (1857). *The Gardeners' Chronicle and Agricultural Gazette* 14: 226, 250.

Anon (1860). *The Gardeners' Chronicle and Agricultural Gazette* 386.

Chittenden, F. J. (ed.) (1932). *Conifers in cultivation*: *The report of the Conifer Conference held by the Royal Horticultural Society Nov. 10–12*, 1931. Royal Horticultural Society, London.

Covas, G. (1995). *Flora Fanerogámica Argentina. Fascículo 4*. 23 pp. CONICET.

Dunn, M. (1892). Statistics of Conifers in the Counties of England, Scotland and Ireland. In: Wilkes, W. & Weathers, J. (1892) Report on the Conifer Conference. *Journal of the Royal Horticultural Society* 14 pp. 481–567

Escobar, L. (1999). Lleuque. *Prumnopitys andina* (Poepp. ex Endl.) de Laub. Ficha Forestal. *Chile Forest*: 276.
Farjon, A. (2010). A Handbook of the World's Conifers. Brill.
Gardner, M. F., P. Hechenleitner Vega & J. Hepp Castillo (2015). *Plants from the Woods and Forests of Chile.* Royal Botanic Gardens, Edinburgh.
Gardner, M. F. (2013). *Prumnopitys andina*, from the website, Threatened Conifers of the World http://threatenedconifers.rbge.org.uk/taxa/details/106. [Downloaded on 7 January 2018.]
Gardner, M. F., Christian, T. C. Hinchliffe, W. & R. Cubey. (2018) Conservation Hedges: Modern Day Arks. *Sibbaldia*, 16, (in press).
Gosling, P. G., Ives, L. M., Cunningham, V. J., Hechenleitner Vega, P., Brownless, P., Thomas, P. & Martínez, C. (2005). Preliminary Advice on Fruit Handling, Seed Pretreatment and 'Germination' of Embryos of *Prumnopitys andina*. *Sibbaldia.* 3: 41–50
Hansen (1892). Pinetum Danicum. *Journal of the Royal Horticultural Society* 14:257–480 *Journal of the Royal Horticultural Society* 14:481–567.
Hechenleitner, P., Gardner, M., Thomas, P., Echeverría, C., Escobar, B., Brownless, P. and Martínez, C. (2005). *Plantas amenazadas del Centro-Sur de Chile. Distribución, Conservación y Propagación.* Universidad Austral de Chile y Real Jardín Botánico de Edimburgo, Santiago.
Hechenleitner, P. Gardner, M. F. Escobar, B. & Cabello, Á. (2006). *Prumnopitys andina* (Poepp. ex Endl.) de Laub. Lleuque, Lleuqui, Uva de cordillera. Familia: Podocarpaceae, In: Las especies arbóreas de los bosques templados de Chile y Argentina. Autoecología. C. Donoso (ed.). Marisa Cuneo Ediciones, Valdivia, Chile. pp. 109–115.
Marticorena, C. and Rodríguez, R. (1995). *Flora de Chile: Pteridophyta — Gymnospermae. Vol.1.* Universidad de Concepción.
Melchizedek, O. (2015). *To better understand the mortality of* Prumnopitys andina *in cultivation by investigating the associated mycorrhizal fungi*. BSc (Hons) year 4 Horticulture with Plantsmanship. RBG Edinburgh, Edinburgh.
Mill, R. R. & Quinn, C. J. (2001). *Prumnopitys andina* reinstated as the correct name for Lleuque, the Chilean conifer recently renamed *P. spicata* (Podocarpaceae). *Taxon* 50(4): 1143–1154.
Mitchell, A.F. (1972) Conifer statistics. In: *Conifers in the British Isles. Proceedings of the third Conifer Conference arranged by the Royal Horticultural Society held in London, 5 to 8 October 1970*, pp. 123–285
Molloy, B. P. J. & Muñoz-Schick, M. (1999). The correct name for the Chilean conifer Lleuque (Podocarpaceae). *New Zealand Journal of Botany*. 37(2): 189–193.
Page, C. N. (1990) Coniferophytina. In: *The Families and Genera of Vascular Plants . Vol. 1. Pteridophytes and Gymnosperms* (eds Kramer KU, Green PS), pp. 282–361. Springer–Verlag, Berlin.
Reid, W. (1861). Catalogue for 1861 of fruit and ornamental trees, flowering shrubs etc. p.20. New York.
Rodríguez, R. R., Matthei, O. & Quezada, M. (1983). *Flora Arbórea de Chile*. Universidad de Concepción, Concepción (Chile).
Rodríguez, R. (1988). Lleuque. *Prumnopitys andina* (Poepp. ex Endl.) de Laub. Ficha Coleccionable. *Chile Forest* 148: 33–34.
Shaw, K. & Hird, A. (2014). *Global Survey of Ex situ Conifer Collections*. BGCI. Richmond. UK
Serra, M.T., Gajardo, R. & Cabello, A. (1986). *Prumnopitys andina* (Poepp. ex Endl.) de Laub. Programa de protección y recuperación de la flora nativa de Chile. Ficha técnica de especies amenazadas. Corporacion Nacional Forestal, Santiago.
Tortorelli, A. L. (1956). *Madras Bosques Argentinos*. ACME, Buenos Ayres.
Turner, B. L., Cernusak, L. A. (eds), 2011. Ecology of the Podocarpaceae in Tropical Forests. *Smithsonian Contributions to Botany*, Volume 95. Smithsonian Institution Scholarly Press, Washington, D.C., USA. 207 p.
Veblen, T. T., Armesto, J. J., Burns, B. R., Kitzberger, T., Lara, A., Leon, B., Young, K. R., (2006). *Ecosystems of the World 6: Coniferous forests*, In: The Coniferous Forests of South America. Elsevier, Philadelphia US.
Veitch, J. (1881). *A manual of the Coniferae*. James Veitch & Sons. London.