
Boxwood cultivars in old gardens in Norway

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Abstract

Som ledd i arbeidet som foregår i regi av Norsk genressurscenter er det foretatt en undersøkelse av buksbom som står igjen i gamle hager i Norge. I tillegg til å avdekke ulike måter å bruke buksbom i hagene, er det funnet forekomster av flere mer eller mindre distinkte former av europabuksbom (*Buxus sempervirens*) og av planter som i det ytre stemmer overens med japanbuksbom (*Buxus microphylla* var. *japonica*). Blant hagene som er undersøkt er det funnet flere eksempler på mer eller mindre bevarte kopier i liten skala av elementer fra store barokkanlegg, og selv i svært små hager kan en fortsatt finne spor etter påvirkning av renessansestilen i bruken av buksbom i klipte figurer og hekker. Men bare i et par tilfeller er det funnet intakte rester av en parterrehage i renessansestil med de originale buksbomplantene fortsatt til stede. Alderen på buksbomplantene som er funnet har bare unntaksvis vært mulig å fastslå direkte ved telling av årringer i stammetverrsnitt. Som oftest har en vært henvist til å anslå alderen ut fra dimensjonene på stammene, alderen på huset og hagen eller fra andre indirekte kilder. Med hensyn på variasjonen som er observert i plantematerialet, er det en tendens til at graden av morfologisk variasjon øker jo eldre hagen er. I de få hagene som kan dateres fra før år 1800 er det funnet flere former av buksbom som ikke synes å være tilstede i yngre hager, og i hager som kan dateres fra perioden 1900-1950, er bare noen få, oftest relativt ensartete former funnet. I det følgende blir hagene og den morfologiske variasjonen som er observert i buksbom beskrevet mer detaljert. Foreløpige resultater fra undersøkelse av buksbommaterialet med amplified fragment length polymorphism (AFLP) gjengis også.

Introduction

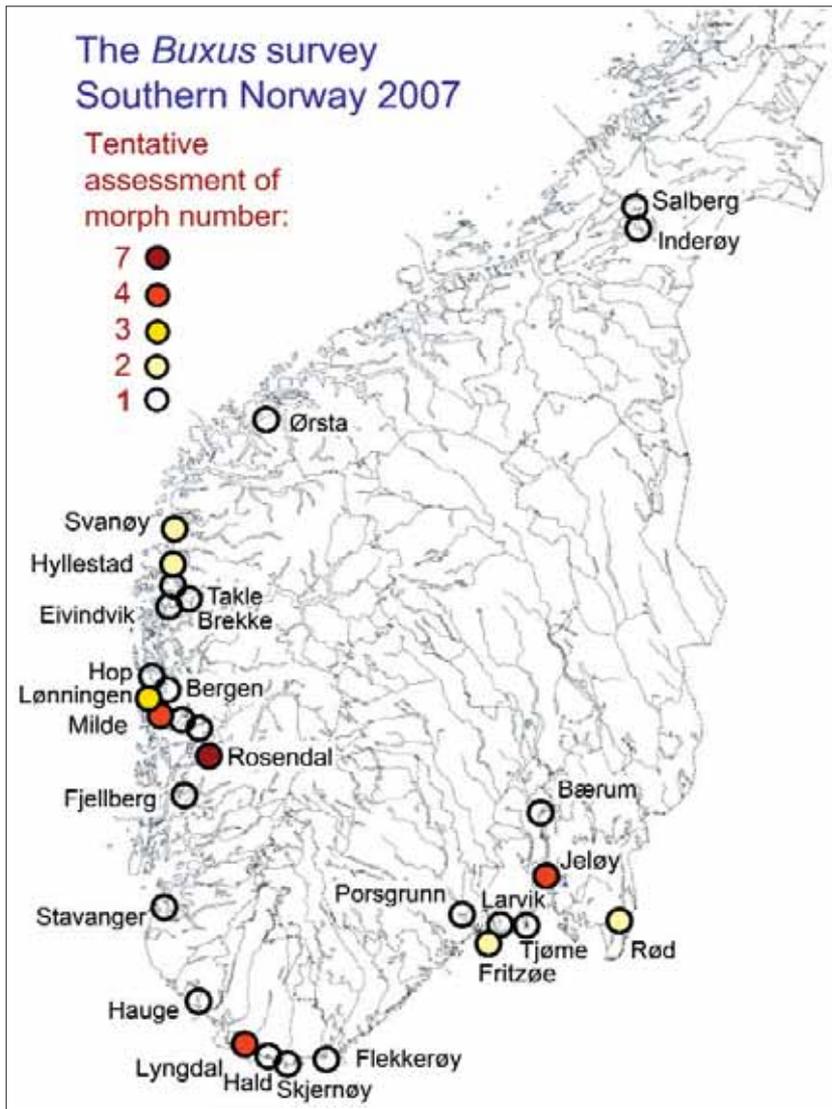
The current use of *Buxus sempervirens* in the gardens of Norway is confined to a zone along the west coast south of ca. 67° N latitude, stretching a few kilometers inland along the fjords and valleys. Only in the climatically favorable districts south of 62° N the species is commonly seen, and only here specimens of more than 80 to 100 years of age were found. Seed set is here also commonly seen, whereas the spontaneous establishment of offspring only rarely occurs, and is limited to the most favourable situations in the vicinity of large specimens of considerable age, and in gardens where the maintenance is not too strict (Lid and Lid 2005; Salvesen unpublished). The current distribution of the species in gardens may thus be described as subatlantic in the sense of Fægri 1960, implying a climatic preference for mild winter temperatures, relatively cool summer temperatures and frequent precipitation.

In recent years several new cultivars, low growing forms in particular, of the Japanese Boxwood (*Buxus microphylla*) have been introduced (Batdorf 2004). In old gardens in Norway, the species is absent except for a few remarkable cases, where specimens of *B. microphylla* var. *japonica* of considerable age have been found and are reported here for the first time.

Although no specific record on the commercial trade with *Buxus* species between Norway and the rest of Europe seems to exist, it is assumed that the material

used in gardens mostly were acquired in the form of selected cultivars purchased at nursery businesses on the European Continent or possibly in Great Britain. The plants observed in old gardens today are either the same specimens as the ones originally imported and planted, or vegetatively produced offspring from such specimens. Seedlings do not seem to have been an option in the production Boxwood plants for horticulture in Norway. It is therefore assumed that it will still be possible to trace back the original cultivar identity of old plants by careful description of the variation observed, and utilization of molecular methods for both elucidating this polymorphism, and making the critical comparisons with named cultivars in reference collections.

During 2007 a survey of extant plant material in old gardens of Norway was conducted as part of the efforts of the National Genetic Resources Council (fig. 1). Material has been collected for documentation in the Herbarium (BG). Largest stem diameter was recorded and in a few cases stem samples were taken, allowing a more accurate determination of plant age (see table 1). Cuttings were sampled for propagation, and rooted specimens of 130 accessions are now included in the collection of 190 accessions cultivated in the Arboretum and Botanical Garden at the University of Bergen, comprising 10 species and 40 named cultivars (mostly of *Buxus sempervirens*) in addition to material still not identified. Leaf samples taken from young shoots of the material collected in Norway and from specific locations



1. - The 2007 survey of old Boxwood (*Buxus sempervirens* and other spp.) in Southern Norway.

on the European Continent are currently being analysed at the Senckenberg Research Institute, Frankfurt am Main, utilising the AFLP technique. Some observations on the use of Boxwood in gardens and the variation found in the material in Norway are reported below.

The renaissance garden and its decline

In 17th and 18th century city maps of Bergen (Harris 1991), several formal gardens are drawn in great detail, indicating the existence of a mixture of quartered parterre gardens and more artistic knot gardens at the houses of merchants and high ranking officials of the city. The situation illustrated in the maps probably is indicative for the gardening style of this time and also of the frequency of gardens existing within other cities of Norway at the same time. Reliable early records of the introduction of the renaissance garden style to Norway

are scanty, but traces can be found back to the later part of the 17th century (Moe *et al.* 2006). This coincides with the first recorded introduction of *Buxus sempervirens* to Western Norway, to the Rosendal Barony in 1666 (Dietze 2000). Probably the garden style and the Common Box (*Buxus sempervirens* L.) both reached Bergen and Western Norway during the same period.

Today these gardens and the original *Buxus* plants are mostly lost, and most Boxwood plants found today are of more recent introductions. Also little remains from the formerly common practice of planting slow growing cultivars of *Buxus sempervirens*, like the Edging Box, 'Suffruticosa', around squared or rectangular flower quarters, which was once strongly advocated by the craftsmen of the renaissance (e.g. Block 1647). Short, closely clipped low hedges of this kind can only be seen in reconstructed gardens like at the former pleasance at Damsgaard in Bergen (Jørgensen and Moe 1995). The material for reconstruction of the garden in this case was brought directly from Italy, and judged from the obvious variation in it, must be seedlings, and not a specific cultivar selected for the purpose. The causes of the absence in today's gardens of closely trimmed Box edgings may be several. First of all, the condemnation of the formal garden style in favour

of the "English" landscape garden style had a strong impact in Norway (Moe 2000a, 2000b; Essen 1997; Bruun 2007). Growing populations in the cities also led to a strong competition for space and an expansion of buildings at the cost of green areas and gardens. More importantly, probably, were the internal problems of the formal style itself, above all its requirement for intensive manual maintenance. Therefore trimmed hedges have been removed or abandoned in many gardens. The Edging Bow in particular, being rather tender, must have faced gardeners with additional problems when winter frosts took its toll. The problem was realized already at the time of introduction of the new garden style. André Mollet (Mollet 1651) thus in Stockholm recommended to use lingonberry (*Vaccinium vitis-idaea*), while Christian Gartner (Gartner 1694) in Trondheim suggested grass or *Allium schoenoprasum* as replacements for *Buxus sempervirens*. Several other taxa have

Taxon	Locality	Latitude (north)	Year	Sept. part	Ann. rings	Girth (mm)	Radius max avg	Increment/yr max avg		
<i>Buxus sempervirens</i>										
Arborescens	VA, Mandal, Hald	58° 2' 8"	2003	Stem, base	62	203	40	32.3	0.65	0,52
Arborescens	VA, Mandal, Hald	58° 2' 8"	2003	Stem, base	62	217	40	34.6	0.65	0,56
Arborescens	Ho, Bergen, Milde	60° 15' 1"	2003	Stem, base	84	305	61	48.6	0.73	0,58
Arborescens	NT, Inderøy, Salberg	63° 51' 1"	2007	Stem, base	67	134	24	21.3	0.36	0.32
Planifolia	Ho, Kvinnherad, Fjelbergoy	59° 44' 19"	2007	Stem, base	65	233	47	37.1	0.72	0.57
Handsworthiensis	Ho, Bergen, Lønningen	60° 17' 17"	2008	Stem, base	84	217	38	34.6	0.45	0.41
Rotundifolia	Ho, Bergen, Lønningen	60° 17' 17"	2008	Stem, base	86	239	45	38.1	0.52	0.44
Pendula	Ho, Bergen, Milde	60° 15' 5"	2008	Branch	60	128	26	20.4	0.43	0.34
Pendula	Ho, Bergen, Milde	60° 15' 5"	2008	Branch	76	232	50	36.9	0.66	0.49
Pendula	Ho, Bergen, Milde	60° 15' 5"	2008	Branch	72	312	68	49.7	0.96	0.70
Suffruticosa	Ho, Bergen, Milde	60° 15' 5"	2007	Branch	62	84	14	13.4	0.23	0.22
Suffruticosa	Ho, Bergen, Milde	60° 15' 5"	2007	Stem, 20 cm	120	175	39	27.9	0.33	0.23
Suffruticosa	Ho, Bergen, Milde	60° 15' 5"	2008	Stem, 20 cm	104	190	42	30.3	0.40	0.29
Suffruticosa	Ho, Bergen, Milde	60° 15' 5"	2008	Stem, 20 cm	108	181	40	28.8	0.37	0.27
<i>Buxus microphylla</i>										
var. <i>japonica</i>	Ho, Kvinnherad, Rosendal	59° 59' 22"	2007	Stem, 30 cm	171	341	94	54.3	0.55	0.32
var. <i>japonica</i>	Ho, Bergen, Milde	60° 15' 5"	2005	Branch	66	114	28	18.2	0.42	0.28
var. <i>japonica</i>	Ho, Bergen, Milde	60° 15' 5"	2008	Branch	114	360	82	57.3	0.72	0.50
var. <i>japonica</i>	Ho, Bergen, Milde	60° 15' 5"	2008	Branch	99	227	55	36.1	0.56	0.37
var. <i>japonica</i>	Ho, Bergen, Milde	60° 15' 5"	2008	Branch	70	193	47	30.7	0.67	0.44
var. <i>japonica</i>	Ho, Bergen, Milde	60° 15' 5"	2008	Branch	68	211	42	33.6	0.62	0.49
var. <i>japonica</i>	Ho, Bergen, Milde	60° 15' 5"	2008	Stem, 40 cm	158	385	96	61.3	0.61	0.39
var. <i>japonica</i> ?	Ho, Bergen, Milde (dead)	60° 15' 5"	2008	Branch	102	178	36	28.3	0.35	0.28

Table 1. - Annual ring data.

been suggested for replacement where *Buxus* spp. are not hardy, like the dwarf form of *Spiraea japonica* used at Hildasholm in Central Sweden in the early 20th century (P. M. Jørgensen, pers. comm.).

Remnants of past Garden Glory

A reminiscence of the former usage of Boxwood for edging in “flower quarters” may still be present in the clipped hedge, cut to some 0.3 to 1 m of height (fig. 2, 3), often seen as a boundary between private grounds and a public area (a road, a square etc.), or around the garden, originally often in combination with a fence to keep sheep or cattle (or people) out. Terrace gardens may often have Boxwood hedges planted on top of the stone walls supporting the soil in steep terrain. A similar use of Box hedges is typically found in church yards, where Box is often planted around family graves and burial places (Brekke church yard, fig. 2). In some cases hedges are planted on both sides of garden walks, guiding visitors along the path and screening other parts

of the garden from disturbance. The double hedges bordering garden walks is still found in a few places, both of quite recent planting and dating back more than 100 years. The oldest and most impressive examples of Boxwood hedges are seen in the old parterre garden in the Rosendal Barony (fig. 6, see below).

By far the most common ornamental use of Boxwood still preserved in old gardens in Norway is the clipping of solitary specimens into spherical shapes like globes, hemispheres or eggs (fig. 4). Often these shaped specimens are placed symmetrically at the corners of a house, at a gate or in a central spot in the garden. Popular places in this respect are next to the flag pole or at a look-out. In some cases, where single or small groups of plants remain, one gets the impression that they are remnants of more extensive Boxwood plantings, and that climatic killing and shearing practices have transformed the specimens surviving into spheres. In a few instances we have come across non-spherical shapes in solitaires, one nice example being at the Røed (Jeløy, Moss, SE. Norway), where two symmetrically placed Boxwood cones planted about 1930 are neatly kept in front of the



2. - Traditional usage of Boxwood as hedges, screening the garden from traffic as here at Takle (above) or enclosing family burial grounds, here at Brekke church yard (below). Inserted: annual shoot of *Buxus sempervirens* from Takle, a morph close to the wild type or 'Arborescens' (Gulen, W. Norway). (Photo PHS).

main building dating from the 18th century. The larger now measures more than 4 m high.

Typically the cultivars present in the material studied

of both hedges and simple topiary figures are close to the wild type of the species or 'Arborescens' (fig. 7a).

In a few instances other selections of the species have



3. - An elegant form of *Buxus sempervirens*, probably the rare cultivar 'Planifolia', planted at the Fjelberg Vicarage in the 1930-ies (Kvinnherad, Hordaland, W. Norway).

been encountered, viz. morphs with variegated leaves and in one case we have come across the once lost *Buxus sempervirens* cultivar 'Planifolia' (fig. 3).

The bordered central circle or ellipse is a quite common garden element still seen in gardens dating from the early decades of the 20th century, where the “medaillon”,



4. - Topiary spheres in small gardens may be more than 100 years old (photo PHS). a-b.) Boxwood “eggs” cut in *Buxus sempervirens* ‘Arborescens’ at the house corners (above, Engjavik i Fusa, Hordaland, W. Norway). (Photo PHS). c-e.) Boxwood spheres trained in *Buxus sempervirens* ‘Arborescens’, remnants of Boxwood edgings of the past? (below, Pleiestftelsen, Bergen W. Norway).

bordered with round stones, shells or a hedge, typically was placed centrally in front of the house. The use of Boxwood in a situation like this is not common, but an interesting example is found at Nygård in Lyngdal (Vest-Agder). All together there seem to be 4 different taxa of *Buxus* present in this circular Boxwood planting, including three different cultivars of *B. sempervirens* (‘Latifolia Maculata’, ‘Arborescens’, and ‘Suffruticosa’) and a modern cultivar of *Buxus microphylla*.

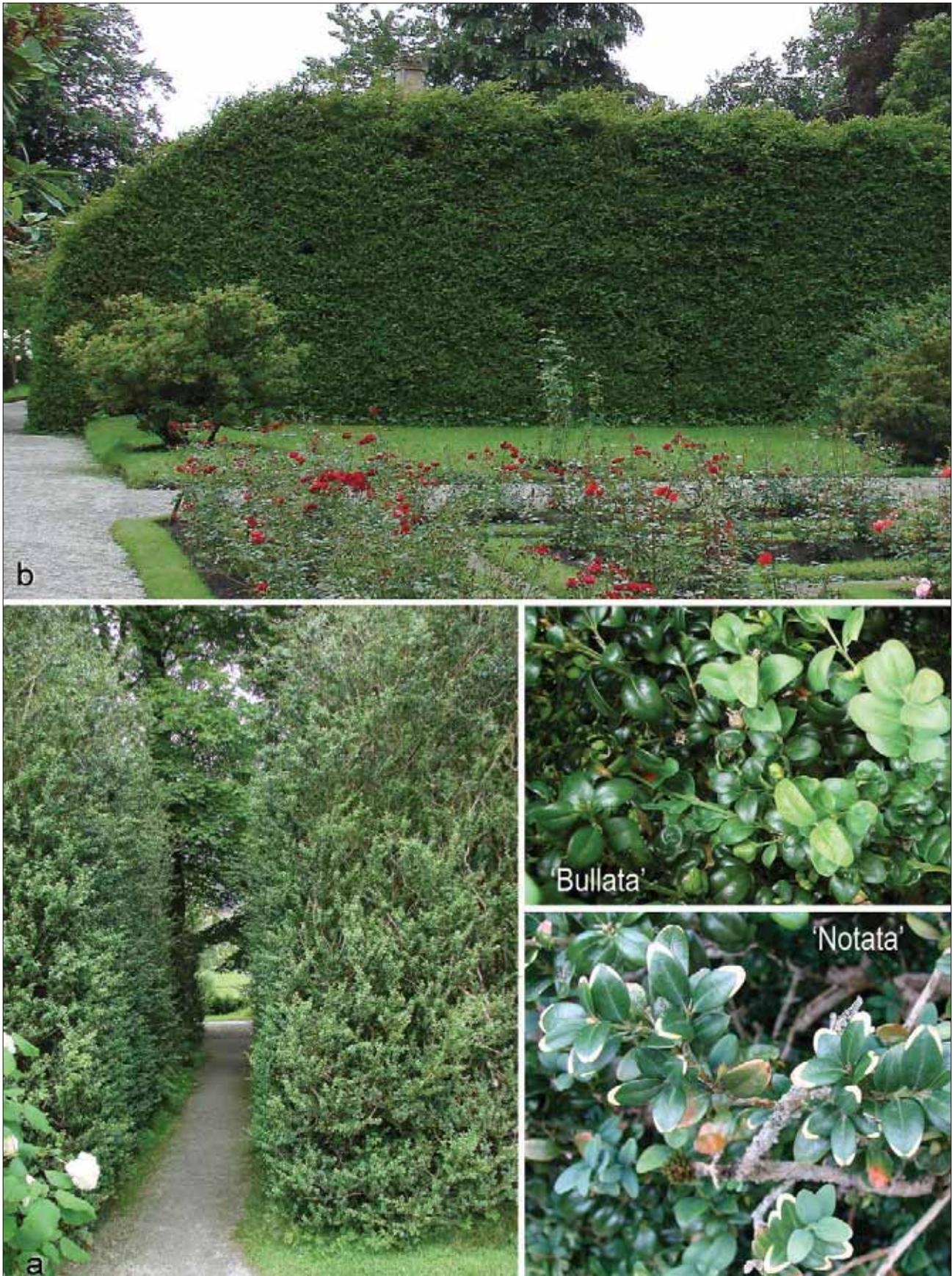
Another element is the garden pavilion, in most cases in the form of a little wooden house. In some cases, however, pavilions were constructed from closely planted trees or shrubs kept shapely by clipping, and often bordered with pleasantly scented flowers. In one location we have found a pavilion made of Boxwood, viz. in the abandoned small park at Lønningen near Bergen Airport, which served as a residence for rich families until 1916 (Larsen 1984). The square “pavilion”



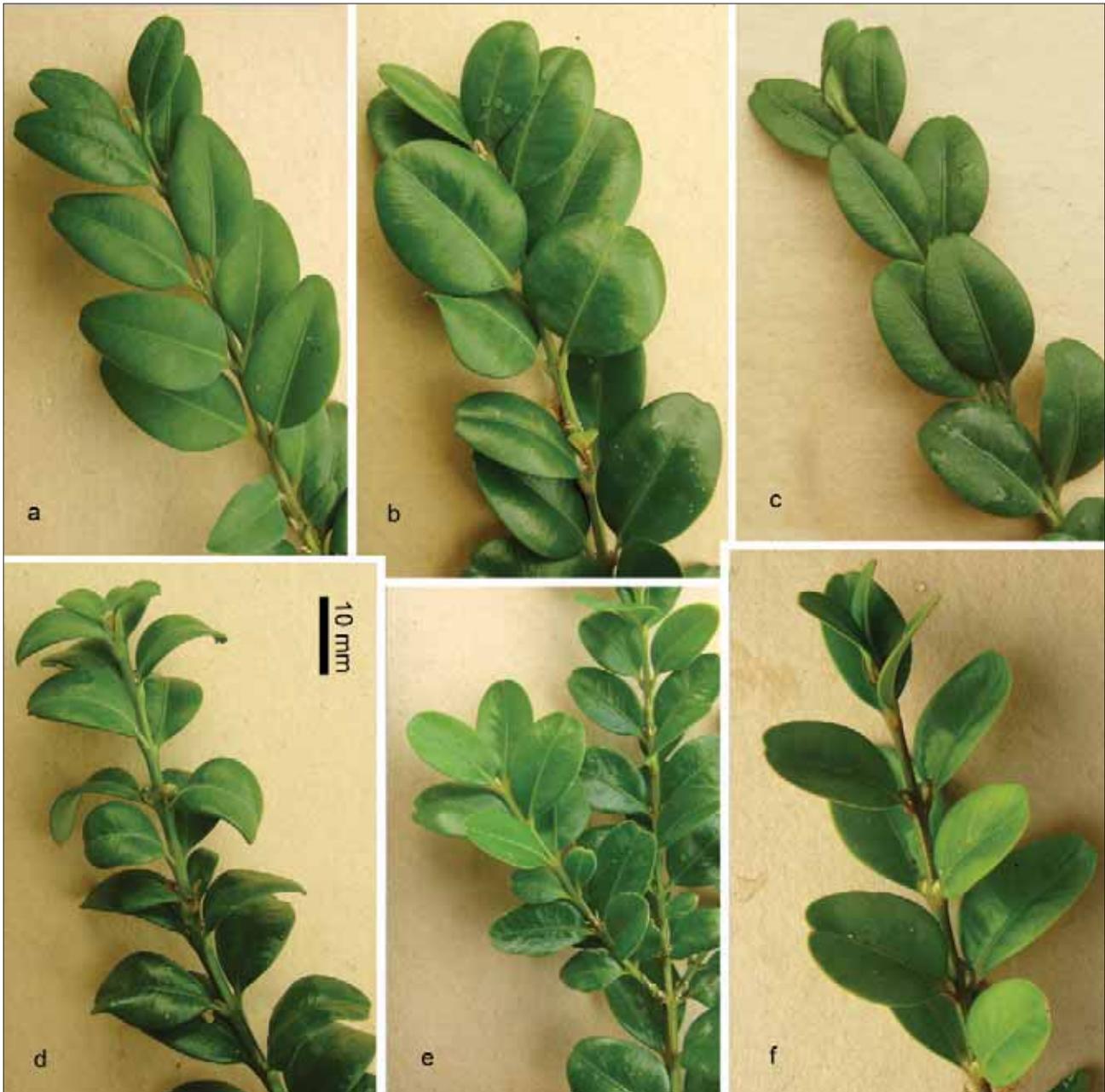
5. - The Rød Estate (Halden, Østfold, Norway) a miniature baroque castle and garden. The large Boxwood shrubs formed by a broad leaved, hardy cultivar close to *Buxus sempervirens* 'Arborescens'. The yellow markings on the leaves are probably caused by the Boxwood mite, *Eurytetranychus buxi*. (Photo PHS).

measuring approximately 3 by 3 meters, is bordered by the *Buxus sempervirens* cultivar 'Rotundifolia' (fig. 7b), today growing to 5.5 meters tall, but originally probably kept lower by clipping. The entrance to the pavilion is flanked by two specimens of a dwarfed *B. sempervirens* morph resembling 'Arborescens', and along both sides of the path leading to it is planted a row on either side of what appears to be the cultivar *B. sempervirens* 'Handsworthiensis' (fig. 7d). The age of the Boxwood pavilion is estimated at about 100 years by counting annual rings in the stems (tab. 1). A case of more elaborate plantings, approaching the mazes or the troyborgs of the Renaissance, is found at the Nesttun church yard, although the Boxwood planting in this case is probably less than 60 years old.

A most interesting garden with extant Boxwood is seen at Rød Estate (Halden, Østfold), a baroque style castle in miniature (fig. 5). The garden is thought to date from before 1700 (Vormeland 1999). Parts of the Boxwood hedges were removed around 1840 (Schnitler 1916), but sizeable Boxwood hedges still existed in 1862 (Schübeler 1862). In 1881 the largest Boxwood stem measured 81 cm in circumference (Schübeler 1888), indicating an age at the time of more than 200 years. When *Buxus* in 1781 was said by Jacob Nicolai Wilse not to thrive at Rød (Witse 1791: 214), it should therefore not be taken to indicate that the species did not exist in the garden. Today trimmed Boxwood hedges are seen along the rose beds on both sides of the central staircase leading out into the garden. More freely



6. - Lavish Boxwood hedge rows at the Rosendal Barony (Kvinnherad, W. Norway). (Photo PHS). a.) *Buxus microphylla* var. *japonica* growing to 4.6 m, overtopping the roof of the gardener's house (above). Here seen from the Castle across the quartered rose garden. Note the chimney visible above the hedge top. b.) Double hedgerows of *Buxus sempervirens* 'Bullata' growing 4.7 m tall (below, left). Mixing with 'Bullata' (right) is a yellow tipped Box, possibly the cultivar 'Notata' (lower right).



7. - Annual shoots and typical leaves on lateral branches of some Boxwoods demonstrated in old gardens in Norway. Bar = 10 mm (Photo PHS). a.) The most common form of *Buxus sempervirens* in old gardens, probably close to the wild type or 'Arborescens', with elongate oval and convex leaves, not very distinctly emarginate at leaf tip (Milde, Bergen, W. Norway). b.) *Buxus sempervirens* 'Rotundifolia' with large, broadly oval to orbicular and convex leaves with a smooth upper surface (Lønningen, Bergen, W. Norway). c.) *Buxus sempervirens* 'Pendula'. Note the olive green colour and convex leaf form, leaf tip distinctly emarginate (Milde Estate, Bergen, W. Norway). d.) *Buxus sempervirens* 'Handsworthiensis' or a close relative. Note the strongly recurving leaves tending to be positioned in four rows along the shoot (Lønningen, Bergen, W. Norway). e.) *Buxus sempervirens* 'Suffruticosa'. Note the fresh green colour and quite flat form of the leaves (Milde Estate, Bergen, W. Norway). f.) *Buxus* aff. *microphylla* var. *japonica*, a morph of uncertain identity. Note the light yellowish green colour and concave form of the leaves (Milde Estate, Bergen, W. Norway).

growing hedges, said to be the originals, are flanking the uppermost terrace in front of the house. The largest specimen holds a stem diameter of ca. 13.5 cm and reaches a height of more than 3 m. Like most of the other specimens seen from Rød, it belongs to a morph with rather broad, emarginate and convex leaves, similar to the morph constituting the famous Boxwood hedges of the Vrams Gunnarstorp Castle in Scania, Southern Sweden, described as *Buxus arborescens* by Linnaeus in

1749 (Linnaeus 1751) and still to be admired there (Lorentzon 1998).

At the Store Milde Estate (Bergen) a small, apparently intact renaissance parterre garden exists (Moe *et al.* 2006). It is today hard to recognize any traces of the original pattern of planting, but historic documents indicate that both "pyramid trees" and "flower quarters" were present here at least until the latter part of the 18th century (Salvesen and Moe 2005; Moe *et al.* 2006). The



8. - Stem cross sections from *Buxus* cultivars. Bar = 10 mm. (Photo PHS). a.) *Buxus sempervirens* 'Pendula', section of a branch on a stem rooted from a fallen old specimen, 72 annual rings counted (Milde Estate, Bergen, W. Norway). b.) *Buxus microphylla* var. *japonica*, section taken ca. 30 cm up from base of a large shrub, 171 annual rings counted (Rosendal Barony, Kvinnherad, Hordaland, W. Norway). c.) *Buxus sempervirens* 'Suffruticosa', section taken ca. 20 cm above ground in a "krumholz-shrub", 120 annual rings counted (Milde Estate, Bergen, W. Norway).

garden in 1851 is depicted in a naturalistic painting as overgrown by trees and shrubs, and in 1915 it was described as a "bewitched fairytale garden" with an overwhelmingly tall and twisted vegetation of Boxwood (Schnitler 1915). Three distinct cultivars of Boxwood have been found in this garden (Salvesen and Moe 2005; Salvesen *et al.* 2009). First of all, *Buxus sempervirens* 'Pendula' with pendulous branches (fig. 7c) originally planted as solitary specimens, and assumed to represent the original pyramid trees. Today most of the remaining specimens have put up secondary stems from branches rooting at a distance from the original main stem. Secondly, one finds several specimens of *B. sempervirens* 'Suffruticosa' (fig. 7e), as it seems originally planted along the borders of the rectangular parterre, and probably originally kept as low, trimmed hedges. Finally, a rather strongly growing form of *Buxus microphylla* var. *japonica* (fig. 7f) is found. The identity of this form in particular has been challenging to elucidate, but the identity of all three cultivars have recently been confirmed by the monographer of the genus, Dr. Lynn R. Batdorf (personal communication in e-mail, October 1 2008). The var. *japonica* specimens were probably once cut into spherical shapes, and possibly planted at the corners and entrances to the parterre, but they may also be the result of an attempt to repair or improve the hedges in the parterre by introducing a more hardy species into the garden.

Magnificent Boxwood plantings are also seen in the garden at the Rosendal Barony (fig. 6). The Barony castle was built to the Danish nobleman, Ludvig Rosenkrantz and his wife, Karen Mowatt during the 1660-ies. According to a painting by Hans Sager dated ca. 1700, a renaissance style garden was established on

a flat terrace constructed at the west facing wall of the castle, laid out in 16 "quarters" and surrounded by a whitewashed wall. The accounts of expenditures on the castle gardens from this time indicate that the plants introduced were a mixture of ornamentals and useful species (Fægri 2000). Preserved in the archives is a receipt for the purchase of "Buchsbaum" dated 1666 (Dietze 2000), indicating strongly that *Buxus sempervirens* was among the earliest introductions to the garden. Today the lay-out of the garden has been changed, and in the four enlarged quarters now seen, the Edging Box is not used. However, along the western border and in the northern section of the former parterre one finds large specimens of Boxwood, some of which one would like to think may stem from the original introductions.

To the west, exquisite examples of both a single and a double hedge partly closing into a tunnel more than 4.5 m high, is seen (fig. 6a). The main cultivar here is a form of *Buxus microphylla* var. *japonica* with yellowish green leaves, corresponding closely to the morph of the same species described from Milde in every detail, including its vigour. Possibly these hedges originally were planted as low bordering rows along the walkway. Today, however, a veritable screening wall between the gardener's house and the parterre garden is formed. A stem section from a specimen in this hedge counted 171 annual rings, and by extrapolation, the thickest stem may be more than 200 years old. Mixed into the northern end of the hedge, two or three additional, more low growing cultivars are found, including several specimens referred to 'Suffruticosa' and one possibly referable to 'Arborescens', but apparently not planted in any strict pattern. One gets the impression that these may be more

recent additions, possibly once having been moved from other locations in the garden.

Another splendid Boxwood hedge is seen in the middle part of the northern section of the parterre at Rosendal, where a narrow walkway leads from the surrounding park into the renaissance garden, bordered by two hedges also exceeding 4.5 m in height and nearly closing over the path. These hedges mainly feature a cultivar resembling 'Bullata', but which have very glossy, dark green leaves reminiscent of the now rare 'Latifolia' (see Batdorf 2004). Mixed into this hedge a few specimens of plants resembling 'Notata' has been found. In total as many as six or seven different cultivars seem to be preserved in the Rosendal Barony garden.

Annual stem growth estimates and plant age

To determine the exact age of large specimens of *Buxus* spp. is not easy. Often the growth is skewed and the oldest wood damaged and decayed, so the stems are hollow. The outer wood on the other hand has proven too hard for the successful use of an ordinary hand-held increment auger. Thus the only practicable method available to us has been to estimate the annual radial growth rate from cross sections taken from smaller stems and branches obtained without damaging the historic specimens in question (fig. 8). From such data we have calculated the age extrapolated to the largest stem measured, based on the maximum radial increment rate and an average growth rate based on the mean radius of a circle with a circumference corresponding to that of the sampled stem section (table 1).

In 'Arborescens' maximum radial increments of 0.65-0.73 mm/yr are observed along the largest radius in favourable localities (tab. 1), while the rate at a northern location is measured at only 0.36 mm/yr (Salberg in tab. 1). Increment rates calculated for the average radius are less variable, 0.52-0.58 (0.32) mm/yr respectively. In the only sample of 'Planifolia' seen, similar rates are observed (max 0.73, average 0.58 mm/yr). In samples taken from 'Handsworthiensis' and 'Rotundifolia', slightly lower rates are recorded (maxima 0.45 and 0.52, averages 0.41 and 0.44 mm/yr, resp.). In the cultivar 'Pendula' (fig. 8a) highly variable increments are recorded (max 0.96-0.43, average 0.70-0.34 mm/yr). Due to the peculiar habit of the specimens, with branches bending down and rooting when touching the ground, new stems have formed away from the original central stem. These new secondary stems are very vigorous and produce exceedingly high increments rates. Based on these data, the age of the largest stem, which in 2005 measured 1025 mm in circumference at the base (see Moe *et al.* 2006), can be estimated to range between 170 and 480 years. From historic data on the dimension of the largest stem in this

locality (Schübeler 1875, 1888), annual increments between 0.37 and 0.49 mm/yr have been calculated (Moe 1991, Salvesen and Moe 2005). This would imply a realistic estimate of the annual increment below 0.5 mm/yr for the main stem, and an age estimate of more than 325 years (dating the 'Pendula' plants before AD 1680). In 'Suffruticosa' distinctly lower annual increment rates are observed (fig. 8c, tab. 1), viz. max 0.33 (range 0.40-0.23) mm/yr and average 0.25 (range 0.29-0.22) mm/yr. These data correspond fairly well with the average annual growth rate (0.33 mm/yr on the radius) given by Batdorf (Batdorf 2004, 213), considering that the Norwegian west coast constitutes a far northern extension of the Boxwood's distribution. From the descriptions and measurements given by Raae (Raae 1987) from old Boxwood hedges, probably of 'Suffruticosa', in the Royal gardens at Frederiksborg Castle in Denmark, an average annual increment of about 0.20 mm/yr (max ca. 0.26 mm/yr) can be calculated. These figures fall in the lower range of the observations from Norway, which may indicate an effect of both the drier climate in the Copenhagen area and the higher level of maintenance in the Frederiksborg garden, where the hedges were apparently still trimmed until the late 1980-ies. The largest stem found in the 'Suffruticosa' cultivar in the parterre at Milde in 2005 measured 300 mm in circumference at the base, yielding age estimates ranging from 142 to 244 years. Considering all available evidence, the average value for the three stem sections taken ca. 20 cm above the base (0.26 mm/yr) may seem quite realistic, giving an estimated date for the largest specimen at AD 1805. This falls within the period when captain Johan Frederik Cappe was the owner. According to tradition, he kept the garden well trimmed and maintained (Moe *et al.* 2006).

In *Buxus microphylla* var. *japonica* annual increment rates range between 0.72 and 0.35 mm/yr measured on the largest radius, and between 0.50 and 0.28 mm/yr on the average radius (table 1). In the Rosendal Barony garden it has been possible to obtain sections taken at ca. 30 cm above ground on a large stem (fig. 8b), and in the garden at Milde a corresponding section ca. 40 cm above ground. In these samples 171 and 158 annual rings were counted respectively, giving annual increments of 0.55 and 0.61 mm/yr along the longest radius. The ages of the largest stems existing today may correspondingly be estimated at more than 198 years in Rosendal and 162 years at Milde. Based on these findings it is considered reasonable to assume that the specimens were planted before AD 1820 in Rosendal and AD 1850 at Milde. The admittedly still scanty data gathered so far therefore points to an introduction to Norway well before the earliest recorded cultivation of this taxon in Europe (about 1860 according to Rehder 1940 and about 1890 according to Batdorf 2004). Japanese Boxwoods were reported by western travelers visiting Japan long before

this, e.g. Thunberg in 1775-1776 (Thunberg 1784, Screech 2005) serving for the Dutch East India Company and visiting Japan from the company's "factorij" on Deshima at Nagasaki. If live material were brought to Europe this early, it seems likely that the Dutch East India Company would have been instrumental, holding a monopoly on the trade with the Japanese Empire in the period from 1641 until 1795. It is not known to the present authors if any living specimens resulted from the earliest discoveries. The introduction of living material of *Buxus microphylla* to Europe already during the 18th century cannot be excluded, however, and the news of such an introduction could easily have been picked up through the close trading relations between the Norwegians and the Dutch at that time.

Variation in leaf morphology and habit

The 2007 survey of *Buxus* in Norway indicate that several cultivars are extant in old gardens. Cuttings have been collected from 130 specimens, resulting in rooted plants in all cases, except one. These will be subjected to morphometric and genetic analysis, and included in a reference collection at the Arboretum & Botanical Garden, University of Bergen, where they can be compared with named cultivars.

The determination of the cultivar identity of many of the plants collected is still preliminary and uncertain. Some characteristic cultivars have still been singled out at this early stage, like 'Argentea', 'Handsworthiensis', 'Latifolia Maculata', 'Pendula', 'Planifolia', 'Rotundifolia', and 'Suffruticosa'. Several instances of plants presenting pale, yellowish leaf tips have been observed. This character does not seem constant, and in most cases disappears when cultivated from cuttings. Probably the phenomenon mostly reflects environmental stresses like drought, acid soil or frost (see Batdorf 2004). The true identity of the plants here called 'Pendula' and 'Suffruticosa' has been confirmed by the monographer, Lynn R. Batdorf (in lit. 1. October 2008). The material studied so far indicate that a limited number of cultivars close to 'Arborescens' have been by far the most popular during the last 100 years or so. Typically the leaves are rather narrowly lanceolate and convex (curving downwards along the edges) and are at most only weakly emarginated at the tip (fig. 7a). The plants are rather strong-growing and may attain a height of 3-5 m if not clipped. Further studies and comparisons of the plants resulting from the cuttings under propagation in the experimental garden may, however, reveal distinct morphs in this group.

A problematic case is constituted by the yellowish green leaved morph found in the gardens at the Rosendal Barony and Milde Estate (fig. 7e). Living material

comparable in terms of morphology and age has not been seen by the present authors in cultivation elsewhere in Europe. From the keys and descriptions in current literature (Ohwi 1984; Ohba 1999; Batdorf 2004), and recently confirmed by Batdorf, it belongs to the Japanese taxon *Buxus microphylla* var. *japonica* first described in European taxonomic literature about the middle of the 19th century (see Siebold 1830; Siebold and Zuccarini 1846; Baillon 1859; Mueller of Argau 1863). Siebold in his survey written in Deshima, Japan, in 1827 (Siebold 1830) mentions Boxwoods cultivated in the botanical garden ran by the Dutch there. He also sent home material collected in Japan, and even if we have not succeeded in proving that living *Buxus* plants reached Europe this early, this seems probable. We have, however, seen dried specimens collected by Thunberg in Japan (Hb UPS - Thunb. 927/11 [microfiche]), specimens in hb. G-DC annotated "*Buxus japonica* Müll.-Arg." collected by Heinrich Zollinger (in gardens on Java, where many Japanese plants were grown by the Dutch), and specimens in G-DC supplied by the herbarium in Leiden in 1864, originally probably collected in Japan by P.F.W. Göring, (G-DC 16, 1, 20, no. 17 [microfiche], cp. Mueller of Argau 1863), all corresponding to the same form, but clearly not the same taxon as the plants in question from gardens in Norway. Still, among the varieties recognized within *B. microphylla* in recent treatments of the genus *Buxus* in the flora of Japan (Ohwi 1984; Ohba 1999), only the var. *japonica* corresponds with the plants found in Norwegian gardens in dimensions (plant height, leaf size etc.) and vegetative morphology (leaf form, more or less hairless shoots etc.). The taxonomic affinities of the old plants in the gardens at the Milde Estate and the Rosendal Barony therefore still should be considered uncertain, and will be subjected to further studies.

Molecular variation, an example

A preliminary study under way of the amplified fragment length polymorphism (AFLP) observed in the Boxwoods in the old garden at the Milde Estate (Bergen), indicates that the three morphs found are genetically distinct (Salvesen *et al.* 2009). Shoot length, leaf hairiness, leaf width, leaf curvature, and lamina width-to-length ratio measured on 30 leaves in each individual allowed separation of the morphs in discriminant analysis. In AFLP analyses 7 primer combinations yielded informative data, producing 168 (57%) polymorphic fragments. Based on the AFLP data, the three morphs in neighbour-joining bootstrap analyses formed well supported clades (100% BP) and in a principal coordinate analysis formed distinctly separated and close clusters, indicating that the morphs are

genetically distinct and the individuals of each morph are closely related. The three morphs are the two European *Buxus sempervirens* cultivars 'Pendula' and 'Suffruticosa' and one morph with affinity to the Japanese *B. microphylla* var. *japonica*. The two European cultivars may represent old cultivars introduced during the 17th century as important elements in the construction of the formal renaissance parterre, while the Japanese Boxwood is more difficult to interpret in a garden historic framework. It may have been introduced during the late 18th or the early 19th century, possibly as a remedy to repair or "improve" a garden in dismay.

A larger set of samples collected in Norway and from specific locations on the continent, is currently being analysed at the Senckenberg Research Institute, Frankfurt am Main, utilising the AFLP technique. An example of the results obtained is given in fig. 9. The tree is based on a total of 618 polymorphic fragments obtained by the primer combinations and methods outlined in Salvesen *et al.* 2008. The tree is rooted by a sample of *Buxus balearica* supplied by the Botanical Garden in Modena, Italy, and a sample of an unspecified cultivar of *Buxus microphylla* from Nygård (Lyngdal, Vest-Agder). All the remaining samples belong to *Buxus sempervirens*, and are separated as a group from the two species on a well supported branch (bootstrap value 100%). The over all picture indicates that the seven primer combinations that resolved the variation in the initial study at Milde, also reveal the genetic structure present in the larger sample.

A plant collected at the ruins of Conimbriga in Portugal referred to *Buxus sempervirens* 'Angustifolia' is separated from the rest on a basal branch. At the next node a population sample of 20 seedlings collected in the wild in a pine forest at Col de Luens (Provence, France) branches off. The variability within this sample is – as should be expected in a sexually reproducing and out-crossing population – quite substantial. Only four individuals are close enough to yield bootstrap support higher than 90%. A note should be made here of the cultivar 'Planifolia' found at the Fjellberg vicarage (fig. 3) showing some affinity to the Provence population. 'Planifolia' was considered lost in cultivation until rediscovered in an old garden in Germany in the 1990-ies (Batdorf 2004). Its geographic origin is still uncertain.

Another well supported group is formed by plants referred to 'Suffruticosa'. Within this group, material collected in the Rosendal Barony garden is separated with a 100% bootstrap support from plants collected in the parterre at Versailles and the edgings of rose beds at the Roseraie de l'Hay in Paris. Interestingly, the 'Suffruticosa' plant found in a garden at Nygård in Lyngdal (Vest-Agder, Norway) is quite close to the French material. This result seems to indicate that the

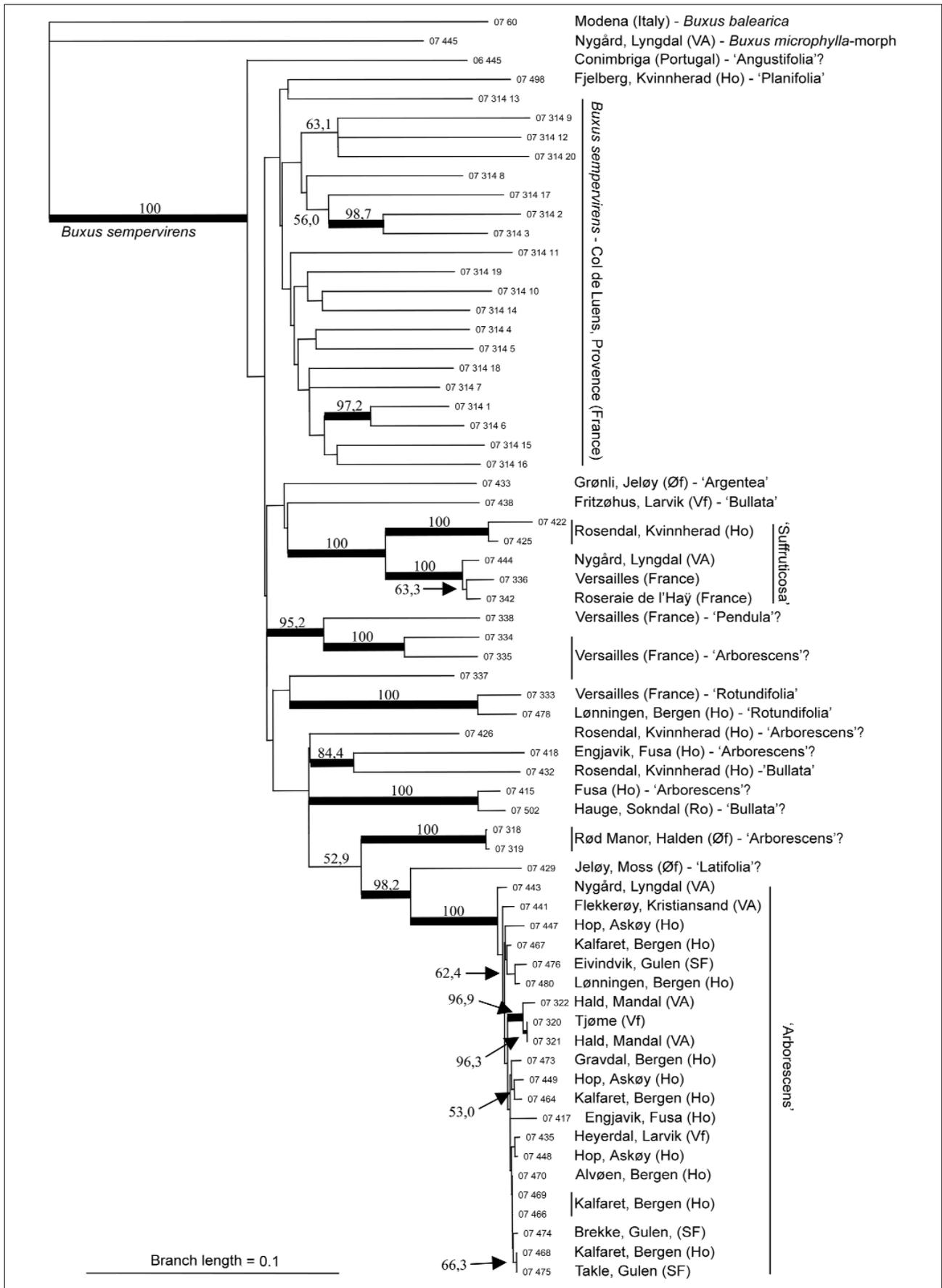
cultivar 'Suffruticosa' circumscribes more than one clone, and that it has reached Norway on more than one occasion. In our further studies, the polymorphism within 'Suffruticosa' will be looked into.

The biggest group in the tree is composed of samples loosely referred to the cultivar 'Arborescens' intermingled with some others. Three samples from Versailles collected from large, tree-shaped plants still extant in the "Bosquet de la Salle de Bal" from 1678-1682 and attributed to André le Nôtre are grouped together. One of these (07.338) was referred to 'Pendula' based on the general habit of the specimen, whereas the two others resembled 'Arborescens'. Another plant (07.337) provisionally identified as 'Arborescens' from the hedges along the terraces in front of the Versailles Castle is grouped with a plant from the Bosquet identified as 'Rotundifolia' (07.333). The latter closely aligns with a specimen of 'Rotundifolia' collected at Lønningen in Bergen (Norway, fig 7b).

Two other cultivars apparently interfering in the analyses, are 'Bullata' and 'Latifolia'. The distinction between these and other cultivars seem to be a matter of some confusion (Batdorf 2004). The plants collected at Rød Manor (Halden, Østfold, fig. 5) provisionally referred to 'Arborescens', may represent a distinct cultivar. They are well separated from the rest of the samples and seem to be virtually identical. The AFLP profile of these plants should be compared with material collected from the garden at Vrams Gunnarstorp in Southern Sweden. At the distal end of the tree a single specimen of a broadleaved morph from Jeløy (Østfold; 07.429) branches off. A characteristic yellow margin of many leaves ("Aureomarginata") disappeared after some weeks in the greenhouse at Milde, but the plant still seem distinct. Closer morphological and genetical comparison of a larger material in culture at Milde that resemble the broadleaved morphs represented in this section of the tree will hopefully reveal some order.

Finally, a well supported group of closely related individuals branches off. Morphologically these samples look very similar, and fit the description of 'Arborescens' (Batdorf 2004). They seem to be clonal offshoots of one successful, fairly common and wide spread cultivar along the coast of Southern Norway (see fig. 2).

The example given above is only one out of several where parts of the total material collected has been analysed. One common feature of the results so far, is that the basal branches of the dendrograms are not well supported, and there are also some discrepancies between the genetic picture generated by the AFLP-analyses and the observations on morphology. Further observations of the plants grown from cuttings will hopefully give more clues. Further AFLP primer combinations as well as alternative molecular



9. - Preliminary result from AFLP-analyses shown as a Neighbour Joining dendrogram based on analyses of seven primer combinations. A sample of *Buxus balearica* (top) and an unspecified cultivar of *B. microphylla* forms a sister group to the samples of *B. sempervirens*. Branch lengths according to Saitou and Nei (1987). See text for details.

approaches will also be tested to improve the resolution and yield a more stable classification that can be compared critically to reference material of named cultivars.

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