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Distribution and limits of evergreen broad-leaved (laurophyllous) species in Switzerland

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Abstract

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The Central European forests are relatively species-poor compared with the analogue vegetation of North America or East Asia. Only few woody, evergreen broad-leaved species were able to recolonize Central Europe after the last glaciation. Nowadays, exotic species are spreading with increasing frequency. Especially evergreen broad-leaved (laurophyllous) species become more and more established in the indigenous vegetation. The process of their introduction and spread, in the context of potential causal factors, are discussed in the following paper.

Key words: Laurophyllous species, evergreen broad-leaved (laurineous) forest, vegetation change, neophytes.

Introduction

Vegetation, its distribution and composition, has always been a matter of change. In the warm tertiary period, camphor- and cinnamon-trees, palms and magnolias occurred even north of the Alps (Heer 1865). But with the glaciation vast spatial displacements have occurred. They have been easier in areas with N–S mountain chains, as e.g. North America and East Asia, where "walking tracks" have been available along the bottom of the mountain-slopes and the intramontane plains. The geological substrate, as an important site factor, has not changed in these areas from north to south. Therefore, a more or less unhindered re-expansion of many species' territory from their glacial refuge towards north has been possible. In temperate regions of North America and East Asia a species-rich woody vegetation has been established after the last glaciation, being able to keep in its composition a lot of the former diversity of the tertiary forests (Küster 1996).

In Europe vegetation history took a different way. The West-East-extended Mediterranean Sea blocked the retreat of thermophilous plants southwards. Only small and scattered remnants were available as refuge-areas during the glaciation at the Mediterranean coast. After the glaciation the West-East oriented mountain chains such as the Pyrenees, the Alps and the Carpathian Mountains as well as the dry area of the Pannonian Plain hindered many species

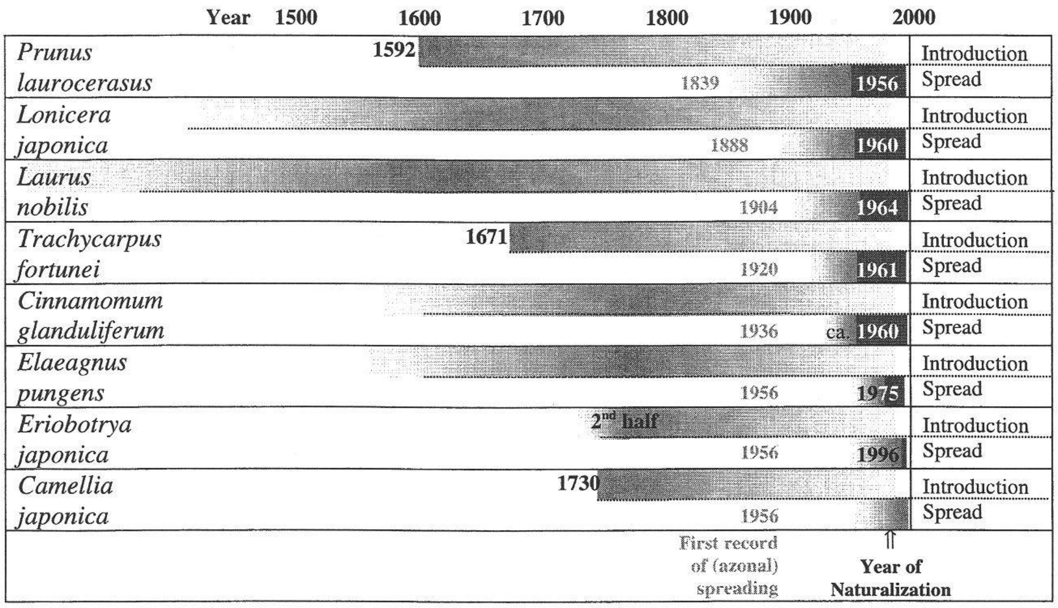

Fig. 1. The asynchronous history of the introduction of exotic laurophyllous species in historical time (upper bars) and their synchronous spreading in the present century (lower bars) first on azonal sites (gardens, gorges etc.), then on zonal forest sites.

to re-expand northwards. Thus, the Central-European flora impoverished more and more from glaciation to glaciation (Straka 1975; Lang 1994) and finally, these changes lead to the disruption of the Eurasian laurel forest belt (Mai 1995). There are only very few evergreen broad-leaved woody species that could successfully re-colonize Central Europe, as e.g. *Ilex aquifolium, Buxus sempervirens* and *Hedera helix* (Pott 1990).

In present-day Europe, laurophyllous tertiary relics exist only in the relative species-poor laurel forests of Macaronesia, as e.g. the Canary Islands and the Azores, in the Lusitanic and Kolchic floristic provinces and in the so-called Mediterranean "Laurocerasus-belt" (Mai 1989). Hence since the last glaciation, the Central-European forests are relatively species poor compared with forests of North America and East Asia (Küster 1996). This might be one motivation for Europeans to enrich their gardens with exotic species. The majority of these species were introduced in the $18^{th}/19^{th}$ century (Figure 1) and cultivated in gardens and parks. Especially southern Switzerland, with its mild insubrian climate, allowed the cultivation of quite a number of warm-temperate species. The old gardens along Lago Maggiore were well-known for the richness of ornamental plants and due to their early (first?) introduction of exotic species also important. Unfortunately, species lists are lacking until the middle of the 19^{th} century (Schmid 1956). Amongst others, also many evergreen broad-leaved, so-called laurophyllous species have been introduced from various regions of the world and successfully cultivated.

Aim and motivation for compiling a separate paper on the occurrence of laurophyllous species in Switzerland

In Series 58 of the 'Fortschritte in der Floristik der Schweizer Flora' (Swiss Floristic Notes) of this volume a selection of the most important floristic notes for many laurophyllous species is given (Bäumler & Palese 1999). These records must not be interpreted as first records of observation. The discussed species have grown already for years as garden escapes in the surrounding forests. Some of them can be considered as naturalized. The list presented in Table 1 comprises a collection of introduced laurophyllous species. It gives a brief description of the taxa according to Griffiths (1994) and first records of observed spreading. Further details can be seen in Walther (1999).

The establishment of exotic laurophyllous species in Swiss forests

In the first half of this century only isolated rather small stands with few individuals of laurophyllous species were reported. They often were restricted to particular azonal sites in southern Switzerland, especially Insubria (Walther 1999). Therefore, most of these species must be seen as only temporarily introduced aliens to the flora. In northern Switzerland there was no evidence for the occurrence of spreading laurophyllous species.

This changed in the second half of this century. More and more reports of laurophyllous species have been published especially for southern Switzerland. So Schmid reported (in Dal Vesco 1950) data of many species of the laurophyllous type, as e.g. *Laurus nobilis*, *Aucuba japonica*, *Prunus laurocerasus*, *Trachycarpus fortunei*, etc., cultivated in gardens and easily spreading. Schmid (1956) adds *Arundinaria japonica*, *Ligustrum lucidum*, *Cinnamomum glanduliferum*, *Eriobotrya japonica*, *Acacia dealbata* and *Camellia japonica*, as garden escapes in the Insubrian area. Even in the description of common forest associations such as Salvio-Fraxinetum taxetosum, evergreen broad-leaved species occurred in such an amount, that Oberdorfer (1964) described it as giving the impression of a "Laurel-summerforest" as known from the oceanic western Europe.

Whereas in relevés of the sixties and seventies the occurrence of laurophyllous plants was restricted to the herb layer (Antonietti 1968, Zuber 1979), they have been capable to grow up, appearing in the eighties in the shrub and lower tree layer (Gianoni et al. 1988) and finally in the nineties with some individuals in the upper tree layer (Walther 1995; Klötzli et al. 1996). Not only the exotic evergreen broad-leaved species have increased in frequency within the last decades. Also indigenous evergreen species as *Daphne laureola*, *Vinca minor*, *Ruscus aculeatus*, *Buxus sempervirens*, *Taxus baccata*, *Hedera helix* and *Ilex aquifolium* have shown the same trend (Carraro et al. 1998).

Today, many forest patches on the southern slope along the Insubrian lakes are dominated by exotic evergreen species. The shrub layer consists of thickets of laurophyllous species and the tree layer equals deciduous evergreen broad-leaved mixed forest as known e.g. from the transition zone from summergreen to evergreen forest in Japan.

For the future successful establishment of exotic species populations in indigenous forest ecosystems, the species must be capable to accomplish all stages of the life cycle, and thus, regenerate independently from the cultivated parent plants in the gardens. Table 2 gives an overview on exotic laurophyllous species, their abundance and capability of fructification and rejuvenation in forest stands outside the garden and park area.

There is no evidence that this transformation from deciduous to some sort of evergreen – deciduous mixed forest, which is also called laurophyllisation (Klötzli & Walther 1999), will be stopped, or even reversed in the near future in the area of southern Switzerland. Neither the vitality of the laurophyllous stands nor the climatic conditions and their trend point to an inversion.

In northern Switzerland, both the frequency and the number of different species of this laurophyllisation process is minor. The spectra of the species as well as the spatial and struc-

Table 1. Brief description of the taxa (from Griffiths 1994) and first records of observed spreading

Species Family Popular name	**Short description of the species** (according to Griffiths 1994)	**Distribution** (Griffiths 1994)	**Records of observed spreading**
Arundinaria Michx. Graminae Bamboo	Culms 2–10 m × 2–7 cm, stout, terete, erect; sheaths glabrescent, usually with coarse dark bristles and auricles; branches many, erect, produced from upper part of culm in its second year. Leaves 10–30 × 2.5–4 cm, tessellate, margins scabrous.	SE US Climatic zone 6 (–23.3 to –17.8°C)	
Phyllostachys Sieb. & Zucc. Graminae Bamboo	Some 80 medium and large bamboo spp., readily recognized by their grooved culms and branching habit. Rhizome running, in colder climates appearing pachymorph. Culms hollow and grooved or flattened on alternate sides, where branches emerge.	China, India, Burma	Some stands with bamboo-species grow outside the garden area; however, rather as a consequence of garden deposits than of natural regeneration (for species determination see e.g. Schmid 1956)
Sinarundinaria Nak. Graminae Bamboo	12+ clumping bamboo. Culms with white powder below nodes; branches many. Leaves tessellate.	China, Himalaya	
Trachycarpus fortunei (Hook.) H. A. Wendl. Palmae Hemp Palm	Trunk to 20 m. Petiole to 1 m, margins sharply dentate; blade to 85 cm long, 1,25 m diameter, circular, divided almost to base; segments semi-rigid, apices drooping. Inflorescence interfoliar, branched 4 times. Bracts 1–4, overlapping brown to white; rachillae stiff, crowded; X and Y flowers similar, cream to yellow, in clusters of 2–3. Fruits spherical to reniform, purple-black, pruinose.	Probably from N Burma, C & E China; naturalized in China and Japan. Climatic zone 9 (–6.6 to –1.2°C)[1)] [1)] resistant to –14°C (cf. Larcher 1980) (note of the author)	Occurrence of exotic palm species growing in the forests of Monte Verità, Ascona, – amongst them also *T. fortunei* – mentioned from the early beginning of this century (compare Rezzonico 1992), subspontaneous occurrence reported by Voigt (1920). On Brissago-Islands (Schröter 1936): "birds pillage fruits of *Trachycarpus fortunei* and drop the woody seeds afterwards; those can easily germinate and thus, "meadows" of young palms can be found at the bottom of trees, used by black-birds (*Turdus merula*) as rest-trees". Since ca. 1975 spreading *T. fortunei* have been observed (Zuber 1979); also in alluvial forests (Klötzli, pers. com.). From ca. 1980 the cultivation in gardens in Zürich has increased and meanwhile, planted individuals survive the recent winters unprotected and develop flowers.

Mahonia aquifolium (Pursh) Nutt. Berberidaceae Oregon Grape	Shrub to 2 m, sparingly branched, suckering freely; stem thin. Leaflets 5–13, to 8 × 4 cm, ovate, with to 12 spiny teeth per side, glossy, dark green turning purple-red in winter. Flowers golden, on erect racemes to 8 cm, 3–4-fascicled. Flowering season: Winter.	America Climatic zone 5 (–28.8 to –23.4°C)	First records of *Mahonia aquifolium* published in Thellung (1919). In southern Switzerland the species is regarded as naturalized (Carraro & Gianoni 1987). In northern Switzerland, a tiny shrub of *Mahonia* was recorded in 1974 (cf. Keller 1975). The plant could live for ten years, presently it has disappeared (Keller 1998). For Zürich, the first observation of garden escapes is dated with 1985 (approx.), with some local installations later on. Due to continuous seed dispersal *M. aquifolium* often escapes in various other areas in northern Switzerland (Landolt 1993). Meanwhile, the species is considered as an often cultivated and in various forests almost completely naturalized evergreen shrub (Landolt 1997).
Cinnamomum Schaeff. Lauraceae	Ca. 250 evergreen tree and shrub species. Wood and bark aromatic. Leaves aromatic, coriaceous, veins usually 3, conspicous, young leaves often red. Flowers inconspicuous, paniculate.	E & SE Asia to Australia Climatic zone of the genus: 9 (–6.6 to –1.2 °C)	
Cinnamomum camphora (L.) Sieb. Camphor tree	Tree to 30 m. Branchlets yellow-brown to black, hairy. Leaves 7.5–10 cm, ovate-lanceolate, narrowly acuminate, glabrous and shining above, whitened beneath. Flowering season: Spring-Summer.	Japan, Taiwan, Malaysia, Tropical Asia.	Berries in demand of birds, which act as dispersal agent for the hardpeeled seeds. Seeds easily germinating and troops of young plants often found at the bottom of a mature camphor tree (Schröter 1936). However, most of the seedlings did not survive in the first half of the century (Rordorf 1942).
Cinnamomum glanduliferum (Wallich.) Meissn.	Tree 20–25 m. Bark smooth[2)]. Branchlets slender, green-brown, glabrous. Leaves to 9 cm, lanceolate elliptic, apex abruptly acuminate, green and shining above, paler, blue green beneath, coriaceous. [2)] only young (< 10 years old) trees (note of the author)	China	Records of camphor tree garden escapes occur in Gianoni et al. (1988) and Walther (1995). Meanwhile, in some patches of forests along Lago Maggiore some individuals of *Cinnamomum glanduliferum* reached the tree layer and develop fruits. Therefore, considered as naturalized (Walther 1999).

Table 1. (Continued)

Species Family / Popular name	**Short description of the species** (according to Griffiths 1994)	**Distribution** (Griffiths 1994)	**Records of observed spreading**
Laurus nobilis L. Lauraceae / True Laurel; Bay Laurel; Sweet Bay; Bay Tree	Small tree or shrub 3–15 m[3]. Young branchelets glabrous. Leaves 5–10 × 2–4 cm, narrowly elliptic to oblong-ovate, often undulate, dark green, glabrous above, glabrous beneath; petiole to 0.8 cm. Flowers to 1 cm diameter, green-yellow, unisexual; perianth 4-parted, Y flowers with at least 12 stamens; X flowers with 2-4 staminodes. Berry to 1,5 cm diameter, subglobose, black. [3] in Insubria found up to 18m high (note of the author)	Mediterranean Climatic zone 8 (–12.2 to –6.7°C)	*Laurus nobilis* stands on rocky sites on the Insubrian lake shores reported by Franzoni (1888). Subspontaneous occurrence mentioned by Bettelini (1904) and reported from Mte S. Zeno (Canonica, pers. com.). Rikli (1907) described shrubforest on rocky, little developed slopes e.g. along Lake Lugano between Gandria and Oria, with *L. nobilis* giving a picture of a naturalized species. Similar observations are given by Chenevard (1910) from Castagnola to Porlezza and for the sottoceneri in general by Jäggli (1924).
Camellia japonica L. Theaceae / Camellia	Shrub or small tree to 15 m. Leaves 5–10.5 cm, broadly elliptic to elliptic-oblong, apex shortly and bluntly acuminate, base cuneate, denticulate or crenulate-denticulate, rigidly coriaceous, glossy above, pale beneath with brown cork-warts. Flowers red; petals to 3 cm, 5–6, oblong-oval to broad ovate or suborbicular, rounded and deeply emarginate; outer filaments 1/2 to 2/3 united. Over 2000 cultivars with varying flower form, colour and markings.	Liu Kiu Island, Japan, Korea, China Climatic zone 7 (–17.7 to –12.3°C)	The non-fleshy, woody fruits not very much in favour of birds. Therefore, the dispersal agent may be missing and only single individuals have succeeded to escape from the gardens. Regeneration below parent plants quite frequently in gardens and parks.
Cotoneaster salicifolius Franch. Rosaceae	Evergreen shrub to 5 m, of graceful habit. Shoots slender. Leaves to 8 cm, elliptic-oblong to ovate-lanceolate, slender-pointed, coriaceous, glossy green, grey-tomentose beneath. Flowers 5 mm diameter, in corymbs to 50 mm diameter, white. Fruits bright red. Flowering season: Summer.	China Climatic zone 6 (–23.3 to –17.8°C)	Landolt (1993) indicates 1950 for the first observation of garden escapes of *Cotoneaster salicifolius* in Zürich. Less frequent as e.g. *C. horizontalis* or *C. divaricata*, but nevertheless at least occasionally found on both sides of the Alps, e.g. in the Zürich forests (cf. Landolt 1997) and along the lake of Como (Carraro, pers. com.).

Eriobotrya japonica (Thunb.) Lindl. Rosaceae Loquat; Japanese Loquat; Japanese Medlar; Nispero	Tree to 7 m. Branches stout, with pale golden, coarse, downy when young. Leaves to 25 cm, broadly oblanceolate to narrow-ovate, apex acuminate, sometimes toothed, deep green, lanate-pubescent above, later glossy, scurfy beneath. Flowers small, white, in erect, crowded pan. Fruits globose to pyriform, to 4 cm diameter, yellow. Flowering season: Autumn-Winter.	China, Japan Climatic zone 7 (–17.7 to –12.3°C)	*Eriobotrya japonica* sporadically spreads into Insubrian forests (Carraro et al. 1998).
Prunus laurocerasus L. Rosaceae Cherry laurel; Laurel Cherry	Evergreen shrub or tree to 6 m[4)]. Leaves to 25 cm, oblong-elliptic, acuminate, glossy and dark green, coriaceous. Flowers white, small, in dense cylindrical racemes to 10 cm. Fruits 8 mm, globose-ovoid, black. Flowering season: Spring. [4)] in Insubria up to 12 m (note of the author)	SE Europe, Asia Minor Climatic zone 7 (–17.7 to –12.3°C)	*Prunus laurocerasus* introduced through Eastern Europe to Central and Western Europe at the end of the 16th century (for Basel the year 1592 is indicated) (Hegi 1995). First record for the dispersal of *P. laurocerasus* is given by Thellung (1919) dated with 1839. Franzoni (1888) reports probably the same location with *P. laurocerasus* cultivated and growing quasi spontaneously in the valley of Ponte Cassarina, in the forests of Cassarate (southern Switzerland), whereas, Chenevard (1910) listed the records with subspontaneous occurrence of *P. laurocerasus* in Muralto and in the valley of Cassarate, but could not find any sites with naturalized individuals. Hegi (1995) mentioned frequent escaping in southern Switzerland and Landolt (1993) estimates the first observation of escaping *P. laurocerasus* in Zürich for approximately 1985. The confirmation is given by Kowarik (1992) reporting that *P. laurocerasus* has been cultivated since 1663, but the first seedlings were not observed in Berlin until 1982. Finally, Landolt (1997) could find *P. laurocerasus* in more than half of the plots in his mapping of the flora of Zürich, rarely with flowers. Meanwhile, the spreading of *P. laurocerasus* is quite frequent in the lower parts of the Swiss Midlands (up to an altitude of approximately 600 m a.s.l), dependent on the vicinity of a seed source (Meduna 1998; Walther & Grundmann (in prep.).
Pyracantha coccinea Roem. Rosaceae Pyracanth; Firethorn; Buisson Ardent.	Shoots downy at first. Leaves 2–4 cm, elliptic to lanceolate. Flowers 8 mm diameter, white, in 3–4 cm corymbs. Fruits 5–6 cm, bright scarlet. Flowering season: Early Summer.	Italy to Asia Minor Climatic zone 6 (–23.3 to –17.8°C)	In the coastal area, at the Lake Garda and near Meran often cultivated for hedging and sometimes e.g. in northern Italy dispersed and escaped (Hegi 1995). *Pyracantha coccinea* occasionally escapes on both sides of the Alps. It is listed e.g. by Landolt (1997) with individuals in the Lehmgrube Binz or Elefantenbachtobel.

Table 1. (Continued)

Species Family Popular name	Short description of the species (according to Griffiths 1994)	Distribution (Griffiths 1994)	Records of observed spreading
Acacia dealbata L. Leguminosae Silver Wattle; Mimosa	Evergreen tree to 30 m. Leaves to 12 cm, bipinnate, silver-green, leaflets 4 × 1 mm, 20–40 pairs. Inflorescence globose, highly fragrant, yellow.	Tasmania, Australia Climatic zone 8 (–12.2 to –6.7°C)	*Acacia dealbata* is rather sensitive to cold northerly winds, but rejuvenates by seeds on sun-exposed warm sites.
Evonymus japonica Thunb. Celastraceae Evergreen Evonymus	Evergreen shrub or small erect tree to 8 m, glabrous; branches rather thick. Leaves to 7 cm, elliptic or ovate, obtusely serrate, glossy above, coriaceous. Flowers small, yellow-green, slender-stalked. Fruits globose, not lobed, to 8 mm long, pink; seeds white, aril orange. Flowering season: Summer.	China, Japan, Korea Climatic zone 7 (–17.7 to –12.3°C)	Very rarely found as garden escapes with very limited spreading capacity (Carraro et al., 1998).
Elaeagnus pungens Thunb. Elaeagnaceae Silver Berry	Evergreen shrub to 4 m, often spiny. Young branches covered in brown scales. Leaves 4–8 cm, tough, oval to oblong, undulate or crispate, lustrous above, dull silvery-white and dotted with brown scales beneath. Flowers fragrant, silvery-white. Fruits brown, becoming red. Flowering season: Autumn.	Japan Climatic zone 7 (–17.7 to –12.3°C)	Rare spreading of the often cultivated plant was reported by Schröter (1936). Further records are given by Zuber (1979) and Gianoni et al. (1988) with increasing abundancy. Meanwhile, mature and fertile *E. pungens* can be found in forest patches on southern slopes along the Insubrian lakes.
Aucuba japonica Thunb. Cornaceae Dwarf Aucuba	Shrub to 4 m. Leaves to 20 cm, elliptic to narrow-ovate, ± serrate. Flowers purple-maroon, Y with cream anther(s), Fruit scarlet. Flowering season: Late Spring.	Distribution of the genus: China, Taiwan, S Japan. Climatic zone 7 (–17.7 to –12.3°C)	Female indivuals introduced to European gardens in 1783, males in 1863 (Hegi 1926). Schmid (1956) reported occasional spreading of *A. japonica* in southern Switzerland. The species regenerates rather easily but has only rarely been seen as garden escapes outside the cultivated area (Walther 1995), probably as a consequence of garden deposits.
Ligustrum lucidum Ait. Oleaceae Chinese Privet; White Wax Tree.	Evergreen shrub or small tree to 10 m. Leaves to 10 cm, ovate-elliptic, long-acuminate. Flowers white, small, in panicles 10–20 cm. Fruits blue-black. Flowering season: Late Summer.	China, Korea, Japan. Climatic zone 7 (–17.7 to –12.3°C)	*Ligustrum lucidum* was introduced to Europe about 1794 (Hegi 1927). Hegi (1927) reports also from garden escapes in Morcote. Further individuals in the Lake Major area are recorded by Gianoni et al. (1988).

Lonicera japonica Thunb. Caprifoliaceae Japanese Honeysuckle; Gold-And-Silver-Flower	Scandent evergreen or semi-evergreen shrub. Branches glandular, patent-pubescent when young. Leaves to 8 × 3 cm, oblong to ovate-elliptic, entire, often incised-sinuate, light green, pubescent or glabrous, ciliate. Flowers paired, intensely fragrant; corolla to 4 cm, white, becoming pink later yellow, bilabiate, soft pubescent outside. Fruit to 7 mm diameter, blue-black. Flowering season: Spring-Summer.	E Asia; naturalized in SE US Climatic zone 4 (–34.4 to –28.9°C)	Earliest records: 1896 at Trevano (near Lugano) and 1914 at Gandria (Thellung 1919). Easily escaping and often naturalized (Thellung 1919).
Lonicera henryi Hemsl. Caprifoliaceae	Scadent evergreen or semi-deciduous shrub. Shoots slender, strigose. Leaves to 9 × 4 cm, oblong-lanceolate to oblong-ovate, deep green above, glossy, ciliate. Flowers usually paired, crowded in panicles, spikes, or heads; corolla to 2 cm, maroon or yellow, bilabiate. Fruits purple-black. Flowering season: Summer.	W China Climatic zone 4 (–34.4 to –28.9°C)	*Lonicera henryi* is considered as only locally naturalized, but often escaping due to continuous seed dispersal in various other areas in northern Switzerland. First observation of garden escapes in the surroundings of Zürich: 1980 (Landolt 1993).
Lonicera pileata Oliv. Caprifoliaceae	Low, often prostrate, evergreen or semi-deciduous shrub. Young shoots purple, pubescent. Leaves to 3 × 1.25 cm, distichous, oblong-lanceolate, dark green or lozenge-shaped, subglabrous, shiny. Flowers in sessile pairs; calyx produces collar covering cupule margin; corolla to 8 mm, yellow-white, funnelform, pubescent. Fruits amethyst, translucent. Flowering season: Spring.	China Climatic zone 5 (–28.8 to –23.4°C)	Same status as *Lonicera henryi*, but first observation is given with the year 1970 (Landolt 1993).

Table 1. (Continued)

Species Family Popular name	**Short description of the species** (according to Griffiths 1994)	**Distribution** (Griffiths 1994)	**Records of observed spreading**
Lonicera nitida Wils. Caprifoliaceae	Densely branched evergreen shrub to 3.5 m. Young shoots erect, purple, setose. Leaves 0.5–1.2 cm, dark green, ovate to rounded, blunt, shiny above, lighter beneath, usually glabrous. Flowers paired; corolla to 1 cm, cream or white. Fruits 6.5 mm diameter, shiny blue purple, transparent. Flowering season: Spring.	SW China. Commonly used for hedging Climatic zone 7 (–17.7 to –12.3°C)	Increasing spontaneous occurrence in the Rheinland (Germany) since 1980 reported by Adolphi (1995). Rarely spreading also in northern Switzerland (Landolt, pers. com.).
Viburnum rhytidophyllum Hemsl. Caprifoliaceae	Evergreen shrub to 6 m. Leaves to 20 cm, ovate-oblong, acute or blunt, shiny and distinctly rugose above, grey to tawny-felted beneath. Flowers dull yellow-white, 6.5 mm diameter, in 7–11-rayed, umbellate trusses to 20.5 cm diameter. Fruits ovoid, red, later black. Flowering season: Spring–Summer.	C & W China Climatic zone 6 (–23.3 to –17.8°C)	Seedlings of *V. rhytidophyllum* are occasionally found in the lower parts of the Swiss Midlands (up to an altitude of approximately 600 m a.s.l), dependent on the vicinity of a seed source (Meduna 1998; Walther & Grundmann (in prep.).
Viburnum tinus L. Caprifoliaceae Laurus tinus	Evergreen shrub to 3.5 m. Leaves to 10 cm, ovate to ovate-oblong, entire, shiny dark green, paler with axillary hair tufts in veins beneath. Flowers pink-brown in bud, opening white to pink-white, 6.5 mm diameter, in convex, terminal cymes to 10 cm diameter. Fruits ovoid, indigo to black. Flowering season: Winter–Spring.	S Europe, N Africa Climatic zone 7 (–17.7 to –12.3°C)	Sporadically found as garden escapes (Carraro, pers. com.)
Pittosporum tobira Ait. Pittosporaceae Tobira; Mock Orange; Japanese Pittosporum	Shrub or small tree to 5 m. Leaves 3–10 cm, obovate, apex rounded, base cuneate, leathery, dark green and glossy, revolute. Inflorescence terminal, umbellate, 5–7.5 cm diameter; flowers orange-blossom-scented, 2,5 cm diameter, cream-white to lemon-yellow. Flowering season: Spring–Early Summer.	China, Japan Climatic zone of the genus: 9 (–6.6 to –1.2°C)	The species regenerates rather easily but has only rarely been seen as garden escapes outside the cultivated area (Walther 1995).

Table 2. Frequency of the occurrence of exotic laurophyllous species in forest stands in southern Switzerland.

Species	Abundance	Fructification	Rejuvenation
Agriophytes			
Laurus nobilis	++	++	++
Lonicera japonica	++	++	++
Elaeagnus pungens	++	++	++
Prunus laurocerasus	++	+	++
Trachycarpus fortunei	++	+	++
Lonicera pileata	++	+	+
Mahonia aquifolium	+	+	+
Pyracantha coccinea	+	+	+
Cotoneaster salicifolius	+	+	+
Cinnamomum glanduliferum	+	+	+
Viburnum tinus	+	+	+
Lonicera henryi	+	+	+
Ligustrum lucidum	+	+	+
Acacia dealbata	+	+	+
Epecophytes			
Aucuba japonica	+	+	–
Lonicera nitida	+	–	–
Camellia japonica	+	–	–
Eriobotrya japonica	+	–	–
Evonymus japonica	+	–	–
Pittosporum tobira	+	–	–
Viburnum rhytidophyllum	+	–	–
Legend:	– = none	+ = sparse	++ = frequent

tural expansion of laurophyllous exotics is smaller than in southern Switzerland. Additionally, the chance of a reversal e.g. due to extreme climate conditions is more likely. The interval between critical climatic events has increased (Figure 2), allowing the exotic species to spread. However, in contrast to the climatic situation of southern Switzerland (cf. Carraro et al. 1998), the chance for the occurrence of critical low temperatures still exists (e.g. events in 1985 and 1987, Figure 2). Such an event would not eliminate the spreaded laurophyllous species, rather they would resprout from stock, initializing a restart of the process.

Interpretation and discussion of Laurophyllisation

In Figure 1 the timetable of the occurrence of laurophyllous species is given from the beginning of their introductions to the period of spread and naturalisation. On two extraordinary characteristics in this context will be focused particularly:

The vast majority of the species is from the same plant functional type, of the evergreen broad-leaved habit. Although introduced into the habitat of deciduous plants, they succeeded to survive as planted individuals for a long time. The second extraordinary fact is the way of

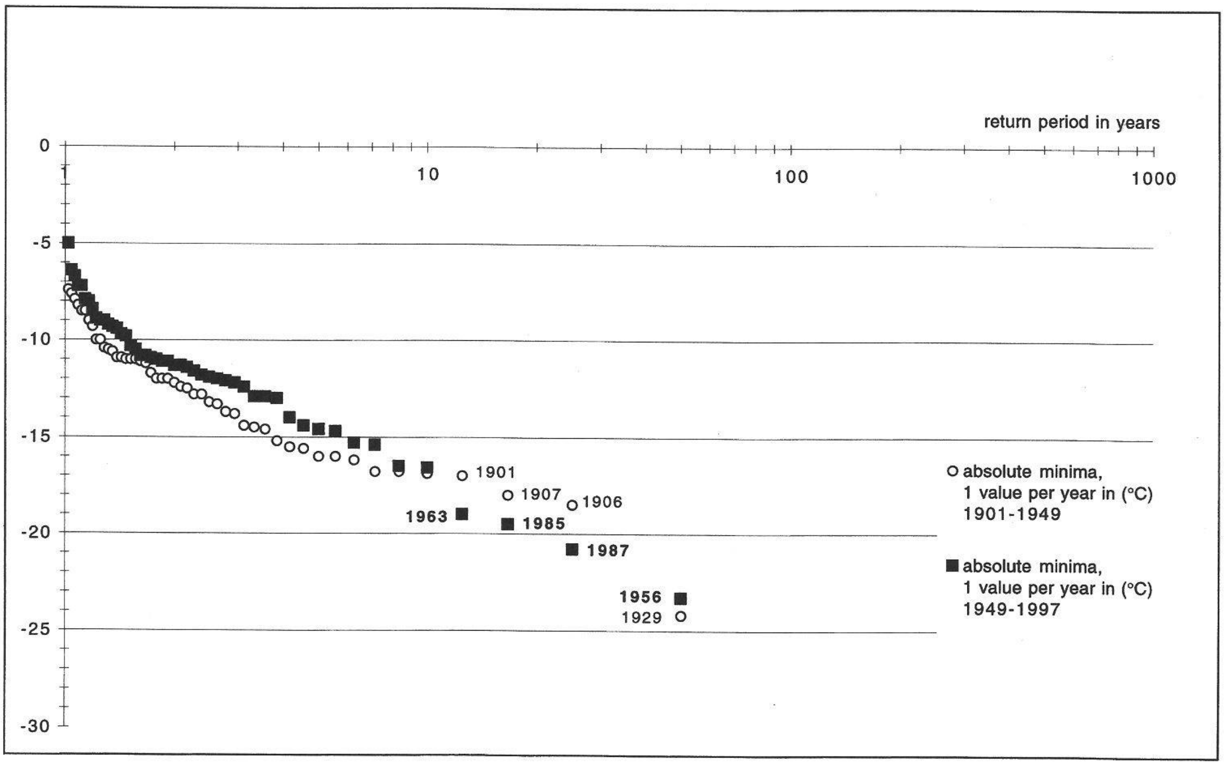

Fig. 2. Return period of lowest temperatures in Zürich in the first and second half of this century (from Carraro et al., unpubl.)

their spreading. Although imported in different centuries, quite a number of laurophyllous species have shown a synchronous pattern of dispersal (Figure 1). In the first half of this century the regeneration under natural conditions was initiated, followed by a simultaneous spreading of a front of laurophyllous species into the forest. The most of the laurophyllous species are dispersed by birds. Therefore, this colonization process proceeds step by step, with the first generation presently being installed in the forest and maturing. Once they are fertile, the next step deeper into the forest can be initiated. Presently the general altitudinal limits are given with 600m altitude on southern slopes and 400m a.s.l. on northern slopes in southern Switzerland (Klötzli et al. 1996). Some places with laurophyllous garden escapes can be found even in higher altitudes, but these stands might be considered as only temporary.

The synchrony of the spreading may lead to the question of a driving external factor, e.g. changing environmental conditions, for the initiation of the process called laurophyllisation. The character of the laurophyllous species considered in this paper is very much determined by its sensitivity to low temperatures. The distribution of many elements of the laurel forest is limited by Winterfrost (Larcher 1978, Woodward 1987, Box 1995). For example, the northern and eastern border of the cultivation area of *Prunus laurocerasus* is substantially influenced by minimum temperatures. The +2.5 °C-isotherm of January builds the borderline of "being frostresistant in cultivation, fruiting and often spreading", the 0 °C-isoline the border to "in cultivation rarely fruiting, often with frost damage" and the –5 °C-isoline gives an absolute limit to "in cultivation not surviving without protection" (Jäger 1975). Limiting temperature values are also known for some genera of the Lauraceae familiy. For *Cinnamomum* and *Persea* the mean annual temperature of 13 °C is given as an indicator for the northern limit of their distribution area (Mai 1995 cit. Hantke 1954 & 1986). Also palms are considered as climate indicators (Mai 1995). According to Larcher (1980) regions with temperature minima lower than –15°C are not supposed to be colonized by fan palms. A last example is given by the indigenous evergreen broad-leaved shrub *Ilex aquifolium* with the coincidence of the northern distribution limit with a mean temperature of the coldest month of –0.5°C (Dahl 1998), and even better with the isoline of the absolute minimum temperature of –12°C in late winter (Walter 1954).

This climatically determined limit of the distribution of laurophyllous species leads to the conclusion, that the increase of exotic evergreen woody species may be mainly influenced by the warmer summer and milder winter temperatures. Beyond that, one must also bear in mind the additional support from the increase in the genetical diversity of the species due to their more frequent cultivation (Landolt 1993; Adolphi 1995; Sukopp & Wurzel 1995; Carraro et al. 1998). Anliker (1954) stated that non-indigenous species, cultivated close to their thermal limit, obviously show greater sensitivity to the variability of the local climate. They are supposed to be ideal climate indicators, especially when cultivated in sufficient number of individuals and species. They are able to indicate and incorporate the advantages and disadvantages of a particular site in a more comprehensive way than any general measuring of climatic elements (Anliker 1954).

In this sense, the reader is kindly invited to focus on the occurrence of exotic, especially evergreen broad-leaved species and help to gather informations on the distribution and limits of laurophyllous species in Switzerland.

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Zusammenfassung

Die mitteleuropäischen Wälder weisen im Vergleich zur nordamerikanischen oder ostasiatischen Gehölzvegetation derselben Vegetationszone eine charakteristische Artenarmut auf. Nur wenigen immergrünen Laubholzarten gelang nach der letzten Eiszeit die Rückwanderung aus ihren Refugialgebieten in die eisfreien Gebiete Mitteleuropas. Daraus resultierende potentielle offene Nischen werden in zunehmendem Maße von exotischen Pflanzen eingenommen. Insbesondere lorbeerblättrige (laurophylle) Arten sind im Begriff, sich in der heimischen Vegetation zu etablieren. Die Einführungs- und Verbreitungsgeschichte der am häufigsten anzutreffenden immergrünen Arten wird im Zusammenhang mit deren möglichen Ursachen diskutiert.

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