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## *Thuja* ×*soeegaardii* (Cupressaceae) – a new name for an old hybrid

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**Abstract:** *Thuja* ×*soeegaardii*, a hybrid of *Th. plicata* Donn ex D. Don and *Th. standishii* (Gordon) Carrière, is described as a new nothospecies from the Kórnik Arboretum, Poland, based on plants obtained in 1988 from the Botanical Garden in Gothenburg, Sweden. The hybrid was found for the first time at the Hørsholm Arboretum, Denmark, in 1938, among seedlings grown from seeds collected from *Thuja standishii*. Plants grown from rooted scions of this hybrid were planted in several places within the Hørsholm Arboretum. Soon, the hybrid plants were gifted to the Botanical Gardens in Copenhagen and Gothenburg as well to the Poulsen's Plant Nursery in Kvistgård. In 1967 seedlings were sent from Kvistgård to the National Arboretum in Washington, where one of them developed into a particularly showy, lush and vigorous plant characterized by a dense, narrow, conical crown. The offspring obtained from rooted scions turned out to be very drought and wind-resistant, especially suitable for the formation of tall hedges and windbreak screens. This plant, now very widespread in cultivation, especially in the United States, goes by the name of *Thuja* 'Green Giant'. In terms of morphology, many features of *Th. ×soeegaardii* are intermediate as compared to the parent species. From the *Th. plicata*, it differs by the following characteristics: leaves not or only weakly shining above, lateral leaves with inwardly curved (not straight) apices, the apical part of lower central leaves thickened and slightly bent from the stem (not appressed), glands on central leaves only weakly visible, central leaves of primary shoots acuminate (not long acuminate) and seed wings sparsely papillose in the upper part (only rarely smooth). From *Th. standishii*, it can be distinguished by the less glaucous upper leaf surface, the less protruding apical part of lower central leaves, at least faintly visible glands on central leaves, acuminate (not acute) central leaves of primary shoots and less distinctly papillose upper part of seed wings.

**Keywords:** *Thuja* 'Green Giant', Hørsholm Arboretum, Bent Søegaard, allopatric hybridization

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### Introduction

The spontaneous crossing of plants in botanical gardens and arboreta is a frequent phenomenon. Hybrids arising here are sometimes interesting and valuable as potential crops, however, they often

remain unrecognized and, when used in scientific research, may lead to erroneous conclusions. Within the genus *Thuja*, such “garden hybrids” often arise between *Th. occidentalis* L. and *Th. plicata* Donn ex D. Don (Zieliński et al., 2019) and also, though much less frequently, between *Th. plicata* and *Th. standishii*

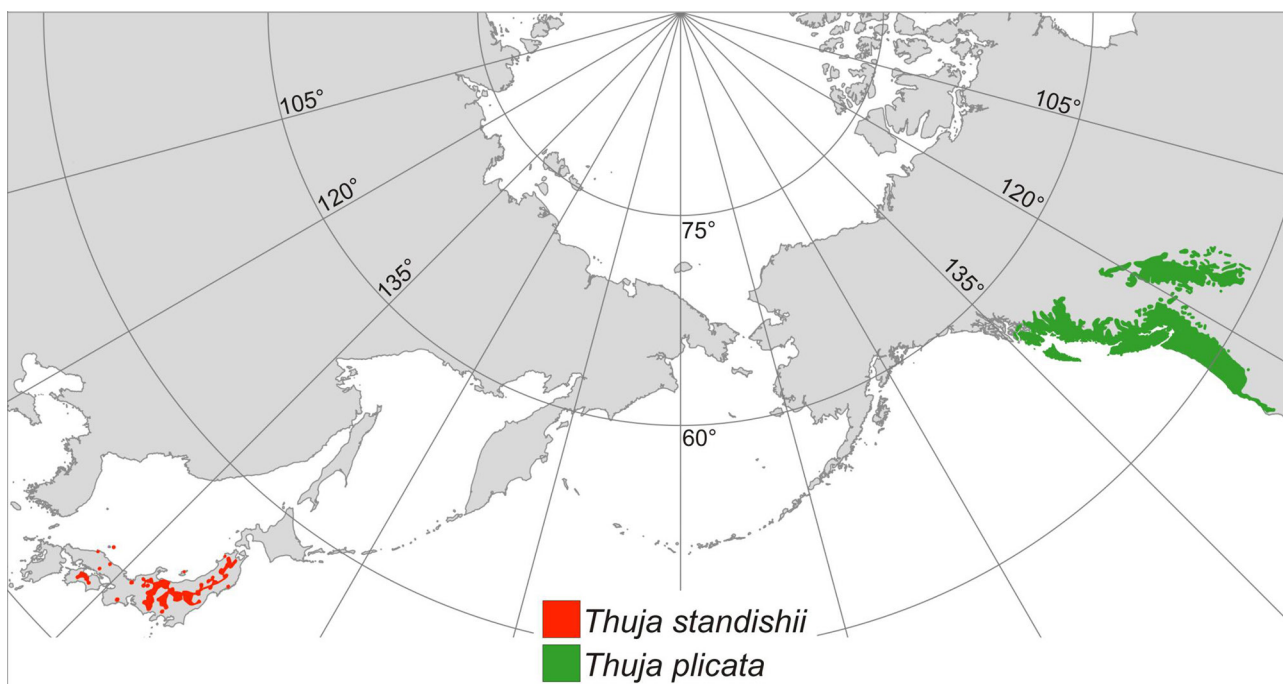


Fig. 1. The geographical distribution of *Thuja plicata* and *Th. standishii*. The map compilation was based on Little (1971), and Worth (2019)



Fig. 2. The largest, almost 35-year-old specimen of *Thuja plicata* × *standishii* in the Kórnik Arboretum. The other Kórnik specimens of this hybrid have similar silhouettes, heavily hanging lateral branchlets and relatively thin, shallowly fissured bark; autumn 2021 (photo by P. Kosiński)



Fig. 3. The bark of *Thuja plicata* × *standishii*, the trunk fragment of the tree from Fig. 2. Very similar bark is found in its twice older maternal tree in the Gothenburg Botanical Garden; see: Fig. 10 (photo by P. Kosiński)

(Gordon) Carrière (Søegaard, 1965). In nature, both species are geographically isolated; the native range of *Th. plicata* encompasses the Pacific Northwest of North America, whereas that of *Th. standishii* is limited to southern Japan (Fig. 1). In Europe, the former is one of the most frequently grown alien tree species, while the latter is found only in more significant dendrological collections.

For over 30 years, several arborvitaes showing the features of *Thuja plicata* and *Th. standishii* have been growing in the Kórnik Arboretum. They were brought to Kórnik in 1988, in the form of scions, from the Botanical Garden in Gothenburg by Professor Władysław Bugała, then the director of the Kórnik Arboretum. Four individuals bred from them are currently 12–14 m tall trees, with a trunk perimeter up to 100 cm at breast height (Fig. 2). They are very similar to each other, having narrow, conical crowns; lateral branches extending horizontally and then slightly upturned; lateral leafy shoots hanging heavily from the side branches and relatively thin, shallowly fissured, greyish-brown bark peeling off in thin narrow strips (Fig. 3).

*Thuja plicata* and *Th. standishii* are closely related species. Their distinction is relatively easy, especially when dealing with live plants or freshly collected shoots. However, recognizing their hybrids requires a good knowledge of the parent species. As is most often the case, hybrids inherit the parents' traits to a varying degree. One of the aims of this study was thus to find a set of diagnostic characteristics that would enable distinguishing hybrid specimens from

parent species. In its original "initial" form, *Thuja plicata* × *standishii* is rarely cultivated. However, several cultivars of hybrid origin are very popular and commercially available, and therefore placing them within the new nothospecies seems practical.

## Material and methods

The morphological description of *Thuja plicata* × *standishii* specimens was based on several adult trees (with cones and seeds) growing in the Kórnik Arboretum. We decided that this was adequate material for such studies because the most relevant literature concerning this hybrid (Søegaard, 1969, The Arboretum in Hørsholm), together with correspondence and photographs from the Botanical Garden in Gothenburg, clearly showed that the Kórnik plants were clones of the first hybrid specimen found at the Hørsholm Arboretum, Denmark, in 1938. For comparison of the examined hybrids with the parent species, i.e. *Th. plicata* and *Th. standishii*, we used authenticated specimens of these arborvitaes growing in Polish botanical gardens and arboreta, supplemented with material from herbaria.

## Results and discussion

Essential features of *Thuja plicata*, *Th. standishii* and their hybrids are collated in Table 1. Due to the different age of the compared specimens, we omitted

Table 1. Main differences among *Thuja plicata*, *Th. standishii* and their hybrids

Features	<i>Th. plicata</i>	<i>Th. plicata</i> × <i>standishii</i>	<i>Th. standishii</i>
Terminal branchlets			
Upper leaf surface	shining above, not glaucous	not or weakly shining, slightly glaucous	not shining above, often glaucous,
Apical part of the central lower-leaves	acuminate, ± appressed, with short but distinct translucent mucro at the apex (use lens!), stems feel slightly prickly when moving the finger from their apex to their base (Fig. 4A)	acute or subacuminate, usually without mucro at apex somewhat thickened, ± bent from the shoot axis, the stems feel ± rough (not prickly) when moving the finger from their apex to their base (Fig. 4B)	obtuse, thickened (slightly fleshy), strongly bent from the shoot axis (as viewed from the side), the stems feel distinctly rough when moving the finger from their apex to their base (Fig. 4C)
Glands on leaves	distinct, visible	faintly visible	embedded within leaves, thus not visible
Apex of the lateral leaves	straight (sometimes indistinctly incurved)	slightly incurved	distinctly incurved
Primary shoots			
Leaf length	(8–)10–12(–13) mm	7–9(–10) mm	4–5 mm
Apical part of the central lower-leaves	long acuminate; distinctly mucronate, free part flat, dagger-like, ± parallel to the stem axis (Fig. 5A)	acuminate, their apical part ± bent from the stem axis (Fig. 5B)	subacuminate, distinctly thickened and strongly bent from the stem axis (Fig. 5C)
Cones			
Length	10–16(–18) mm (Fig. 6A)	11–15 mm (Fig. 6B)	7–12(–14) mm (Fig. 6C)
Upper part of seed wings	smooth, not papillose (Fig. 7A)	sparsely papillose, rarely smooth (Fig. 7B)	distinctly papillose (Fig. 7C)

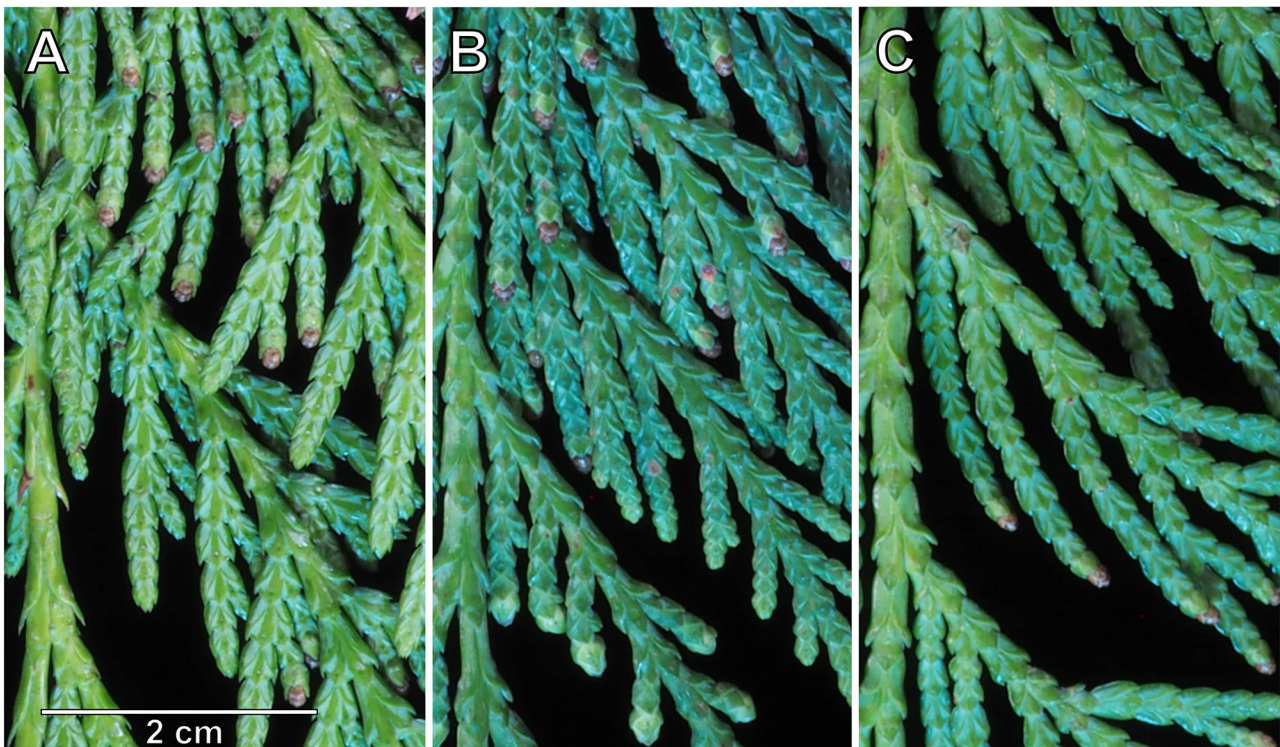


Fig. 4. Leafy branchlets of *Thuja plicata* (A), *Th. plicata* × *standishii* (B) and *Th. standishii* (C); view from above (photo by P. Kosiński)

here the differences in the bark structure as this is significantly dependent on the age of the trees.

The story of *Thuja plicata* × *standishii* begins from a peculiar tree growing for more than 80 years in the Hørsholm Arboretum. The plant was the subject of study by Bent Søgaard, a phytopathologist and long-time director of this Arboretum. It was found in 1938, amongst seedlings grown from seeds harvested a year earlier from *Th. standishii* cultivated in the Forest Botanical Garden at Charlottenlund, north of Copenhagen (Søgaard, 1969). This particular plant was distinguished by its healthy appearance and lush growth.



Fig. 5. Leaves on primary stems of *Thuja plicata* (A), *Th. plicata* × *standishii* (B) and *Th. standishii* (C); lateral view (photo by P. Kosiński)

Carl Syrach-Larsen (1898–1979) was the director of the Forest Botanical Garden in Charlottenlund and the founder and first director of the Hørsholm Arboretum. He is internationally recognized for his outstanding work on *Larix* and the use of hybrids and seed selection in forestry (Ostenfeld & Larsen, 1930). In 1942, he drew attention to this *Thuja* plant, finding it worthy of further observation (Søgaard, 1969). In 1948, six years later, it was shown that it was a hybrid between *Thuja plicata* and *Th. standishii*. Søgaard (1969) demonstrated that the formation of



Fig. 6. Cones of *Thuja plicata* (A), *Th. plicata* × *standishii* (B) and *Th. standishii* (C) (photo by P. Kosiński)

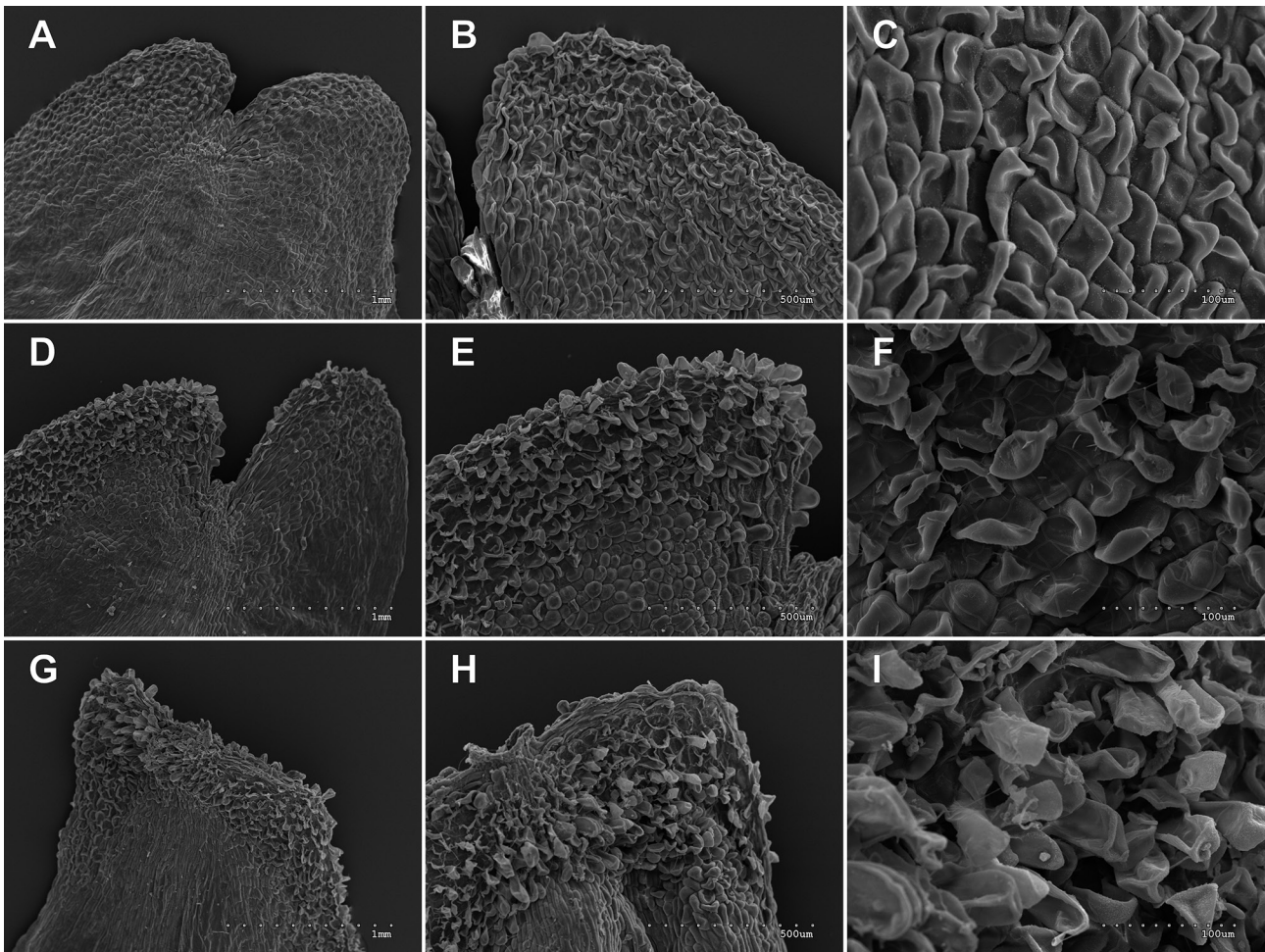


Fig. 7. SEM photographs of the upper part of seed wing: *Thuja plicata* (A–C), *Th. plicata* × *standishii* (D–F) and *Th. standishii* (G–I) (photo by D. Tomaszewski)

such a hybrid in Charlottenlund was fully possible as the mother specimen of *Th. standishii* grew there close to *Th. plicata*, from which the pollen presumably came.

This hybrid (Fig. 8), marked with the administrative number V. 1625, turned out to be entirely resistant to *Didymascella thujina* (Durand) Marie, a parasitic fungus especially attacking seedlings and young plants of *Thuja plicata*. This knowledge gave Søegaard (1969) the impetus to investigate the nature of resistance in *Thuja*. Furthermore, he wrote: “The main object of this work was to find control methods of this disease either by finding genetically resistant factors in *Thuja* or to counteract the fungus by other means” (Søegaard, 1969).

As a result of these studies involving countless two-way crosses and seedling inoculations, Søegaard demonstrated that *Thuja plicata* was not resistant to *Didymascella thujina* as it is homozygous recessive for this trait. He found that hybrids of *Th. plicata* × *standishii* were not affected by this fungus because they inherited the dominant gene determining their health from the mother *Th. standishii*, which was the

dominant homozygote for resistance to this fungal infection.

In the inventory of trees and shrubs cultivated at the Hørsholm Arboretum ([https://ign.ku.dk/arboretum-hoersholm/trees\\_bushes\\_arboretum](https://ign.ku.dk/arboretum-hoersholm/trees_bushes_arboretum)), the first spontaneous hybrid of *Thuja plicata* and *Th. standishii* was listed under the number S 259-38, 468-1925 as *Th. standishii* × *plicata*, i.e., in “non-alphabetical order”, possibly to indicate that the first of these species was the mother plant. In the column specifying the origin of this hybrid, it was written: “from seeds”. In 1951, over 150 individuals (under the same number and registered in the same manner) were planted in the Arboretum. However, this time it was indicated that the plants came from rooted scions, which were undoubtedly obtained from the first maternal hybrid. And again, in 1977, a dozen or so hybrid specimens were planted at Hørsholm, but this time with the notation that they originated from seeds obtained by artificial crossing. In this case, they were named “*Thuja plicata* × *standishii*”, which is supposed to indicate that the maternal parent might be the first of the two mentioned species.

According to Søgaard's (1969) account, the *Thuja* specimen in Hørsholm had been vegetatively propagated before its hybrid origin was known. And thus, even before 1948, its clone had already been planted in the Forest Botanical Garden in Charlottenlund. It might also have been introduced into the Botanical Garden in Copenhagen and from there in 1952 to the Gothenburg Botanical Garden (Figs 9, 10). In 1988, scions from the latter garden were received by the Kórnik Arboretum.

We can follow another thread in the story of *Thuja plicata* × *standishii* hybrid. This refers to Poulsen's Plant Nursery in Kvistgård, 15 km from Hørsholm. In 1967, the U.S. National Arboretum in Washington received a package containing young plants of *Th. occidentalis* 'Giganteoides' (a cultivar selected in Kvistgård) and seedlings of *Th. plicata* × *standishii* (Martin & Tripp, 1997) from this nursery.

Nothing is known concerning the origin of the seedlings mentioned above. They probably were not particularly notable, so in Kvistgård, they had not been provided with a separate cultivar name. The

exceptional value of one of them soon revealed itself in the National Arboretum. Its rooted shoots grew into showy plants with a dense, compact, narrow, conical crown. Soon they were made available to many eager and enthusiastic growers in the USA. They proved to be resistant to drought as well as strong wind. They were perfect for preparing dense, high rows and windproof screens more valuable than plants previously used for such purposes, e.g., *Cupressus* × *leylandii* A.B.Jacks. & Dallim. [× *Cupressocyparis leylandii* (A.B.Jacks. & Dallim.) Dallim.]. They were distributed at first under the erroneous name *Th. occidentalis* 'Giganteoides' and as time passed, under the informal name 'Green Giant' (Martin &



Fig. 8. The first specimen of *Thuja plicata* × *standishii* found at the Hørsholm Arboretum in 1938, marked with the number V. 1625. It was vegetatively propagated and used in later backcrosses. Photograph taken in 1960 (Søgaard 1969)

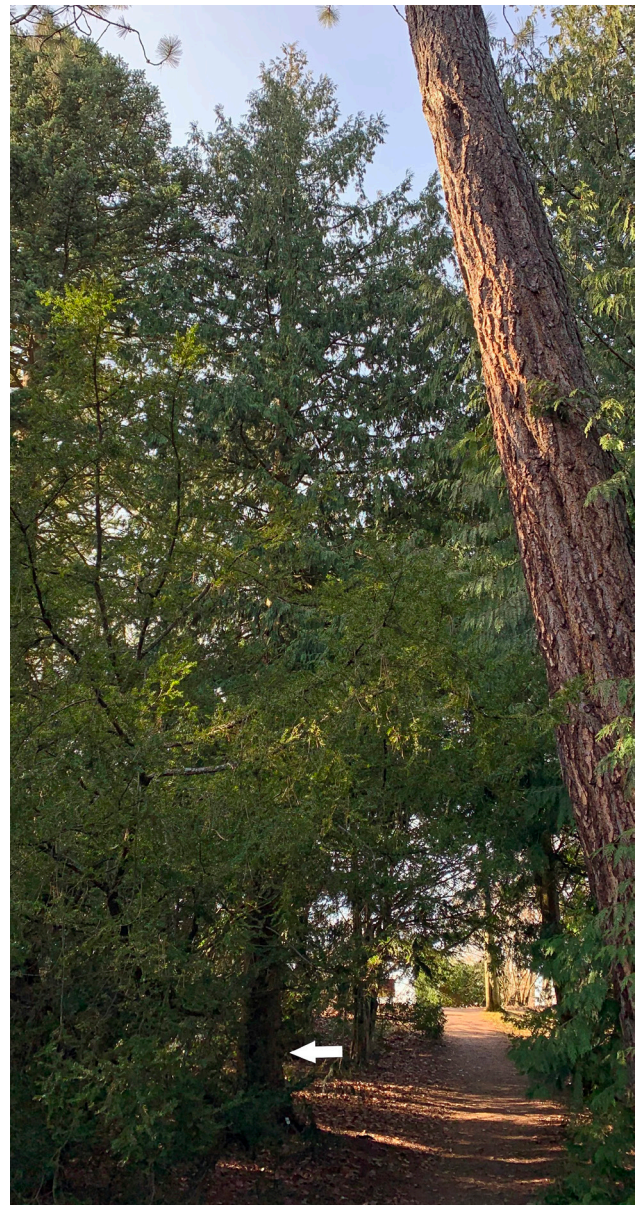


Fig. 9. *Thuja plicata* × *standishii* (marked with an arrow) in the Botanical Garden in Gothenburg, Sweden – the mother plant of the Kórnik hybrid specimens (photo by K. Kainulainen)

Tripp, 1997). This cultivar is obviously connected to Poulsen's Nursery in Kvistgård. However, the view that *Th. plicata* × *standishii* hybrids were developed for the first time at Poulsen's Nursery in the mid-1930s due to intentional crossing, as is commonly stated in American horticultural literature (e.g., Martin & Tripp, 1997; Green Giant, 2017), is completely unfounded.

The Hørsholm Arboretum and Poulsen's Nursery in Kvistgård, only a dozen or so kilometres apart, have probably cooperated. It is highly probable that the *Thuja plicata* × *standishii* hybrid came to Kvistgård from the Hørsholm Arboretum, in the early 1950s, after research begun by Søegaard, when this hybrid was intensively propagated. The seedlings sent to the National Arboretum in Washington in 1967 may have come from seeds produced by then already mature specimens of the hybrid growing in Poulsen's Nursery.

Possibly, the most beautiful specimens were selected in Kvistgård for shipment to Washington. However, one cannot expect or predict that among them, there might be a specimen that would give rise to such a valuable variety as 'Green Giant'. Its distinct form was noticed only after a few years in the National Arboretum. This shows that the variety was selected not in Kvistgård but at the National Arboretum

in Washington. The hybrid *Thuja plicata* × *standishii*, in its original "initial" form, is generally grown as a dendrological curiosity, mainly in arboreta and botanical gardens. However, interest in the 'Green Giant' cultivar is increasing, especially in the United States. Published opinions about its unique features are encouragingly superlative. In Europe, this cultivar has been, so far, practically unknown. Within the last few decades, in the United States, several new patented cultivars similar to 'Green Giant' have appeared on the market, such as 'Steeplechase', 'Green Splendor', 'Virginian'<sup>TM</sup>, 'Junior Giant'. Some of them are clearly vegetative mutations of 'Green Giant'. Others were selected from its seedlings or intentionally crossed. For practical reasons, it would be useful to group all individuals and cultivars showing the features of hybrids formed with the participation of *Thuja plicata*



Fig. 10. *Thuja plicata* × *standishii*, the bark of the tree from Fig. 9; see: Fig. 3 (photo by K. Kainulainen)



Fig. 11. *Thuja ×soeegaardii*, a specimen selected as the type of this nothospecies. Kórnik Arboretum. Sect. XXXVI, inv. no. 53972, autumn 2021 (photo by P. Kosiński)



Fig. 12. A holotype, a herbarium specimen collected from the tree (see: Fig. 10) representing the type of *Thuja x soeegaardii*, KOR 55807 (digitized in the Institute of Dendrology PAS, Kórnik; accessible at: <https://rcin.org.pl/dlibra/publication/267417>)



and *Th. standishii* within a separate nothospecies with the name proposed below.

***Thuja* × *soeegaardii* J.Zieliński & P.Kosiński, nothosp. nova** (Figs 11–12), the hybrid between *Thuja plicata* Donn ex D.Don and *Th. standishii* (Gordon) Carrière.

Holotype: Poland. The Kórnik Arboretum, sect. XXXVI, inv. no. 53972; 12.07.2021, coll. Jerzy Zieliński; KOR 55807 (Fig. 12); isotype KOR 55808.

From *Th. plicata*, it differs by the following characters: leaves not or only weakly shining above, lateral leaves with inwardly curved (not straight) apices, apical part of the central lower leaves slightly bent from the shoot axis (not appressed), glands on central leaves only weakly visible, and leaves of primary shoots acuminate (not long acuminate). From *Th. standishii*, it can be distinguished by the less glaucous upper leaf surface, the apical part of abaxial central leaves only slightly bent from the shoot axis, glands on central leaves ± visible, and leaves of primary shoots acuminate (not subacuminate).

The epithet commemorates Bent Frederik Søegaard (1919–1998), the Danish forester-phytopathologist, director of the largest Danish Arboretum (Hørsholm) from 1968 to 1990. His scientific research covered problems related to the resistance of forest trees to fungal diseases, especially *Thuja* species. For many years, the hybrid described above was an important focus of his studies.

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