

Tree Pollen Allergy

I. Features of Plant Geography and Pollen Counts

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The distribution of trees and bushes in Sweden (viz. lignoses) of possible allergic importance is presented and comments made on analyses of pollen counts of lignose taxa from different parts of the country. Based on these data, 20 lignose taxa were selected for an allergen panel and used in a multi-centre study covering Sweden with the aim of revealing the pattern of sensitization to these plants among sufferers of springtime hay fever.

Key words: allergy; plant geography; pollen counts; tree pollen seasons.

Accepted for publication 2 June 1984

CLINICAL ASPECTS

A plant geographical survey and analyses of pollen counts of trees and bushes in Sweden are presented which, hopefully, will serve as a useful manual for allergists in clinical practice.

Springtime hay fever caused by tree pollen is very common in Sweden. A newly published study (3) indicates that the prevalence among hospital staffs is more than 10%. Other clinical studies (2, 9, 13) have indicated that allergy to birch pollen predominates. To what extent sensitization to other trees and bushes plays a role in provoking hay fever has not been completely investigated.

The aims of this study are: 1) to select a broad allergen panel containing at least one lignous taxon of all actual botanical families in Sweden and judged to be of allergic interest; 2) to use this allergen panel for skin tests and RAST tests in a multi-centre study on hay fever patients from all parts of Sweden; 3) to analyse the sensitization pattern and degree of cross-reactivity among these patients.

The first paper deals with the selection of the allergen panel based on botanical and plant geographical aspects (8) and on studies of pol-

len data from various parts of Sweden (1, 10). Parts 2 and 3 of this study will be published later.

METHODS

Selection of trees and bushes for the allergen panel

There are somewhat more than 30 plant families with lignose taxa in Scandinavia. The primary objective of this study was to select one lignose taxon of each plant family with possible allergic importance.

Initially excluded were plant families known to be pollinated only by insects and with limited geographical distribution. Further exclusions were made after discussion with the allergen extract manufacturer revealed problems in supplying allergen extracts. This resulted in a final list of 20 taxa. Among these are two taxa, plane and larch, not common in Scandinavia

but considered to be of a certain allergic interest. The selected taxa fall into the following categories:

- A) *Taxa found in the whole study area.* Pollen from these taxa are regularly found in pollen traps, at least in the southern parts of Sweden.
- B) *Taxa growing primarily in southern Sweden, extending in some cases to Limes Norrlandicus.* Pollen from these taxa are also regularly identified in the pollen traps in the southern parts of Sweden.
- C) *Taxa seldom or never found in pollen traps in Sweden.* Pollen from these taxa are not dispersed regionally.

Pollen counts

In many European countries the frequency of air-borne pollen has been registered for several years. Pollen counts have been performed in Stockholm since 1973, and in Göteborg and Malmö since 1975. In Eskilstuna registrations started in 1978 and in Umeå and Östersund in 1979. The geographical locations of the above cities are shown in Fig. 1.

At all six locations the registrations are performed with Burkhard's 7-day-recording volumetric spore traps. These traps simulate normal breathing by sucking in 10 l air/min through a slit the size of a human nostril. The particle content of that air, $14.4 \text{ m}^3/24 \text{ h}$, is deposited on a sticky tape moving 2 mm/h. Twelve transverse strips of this tape, each running for 2 h, provide a 24-h record for analysis. The pollen content/ $\text{m}^3 \text{ air}/24 \text{ h}$ can then be analysed qualitatively and quantitatively using a microscope at about $400 \times$ magnification. Pollen from about 30 frequently occurring taxa are identified, whereas other incidentally occurring pollen are registered as unidentified. The traps are placed on flat roofs 15–30 m above the ground, thus giving a good picture of the average pollen distribution in the region. This method is especially reliable for plants such as trees which shed pollen regionally, i.e. over distances far beyond the local populations. Plants shedding their pollen mainly within the local

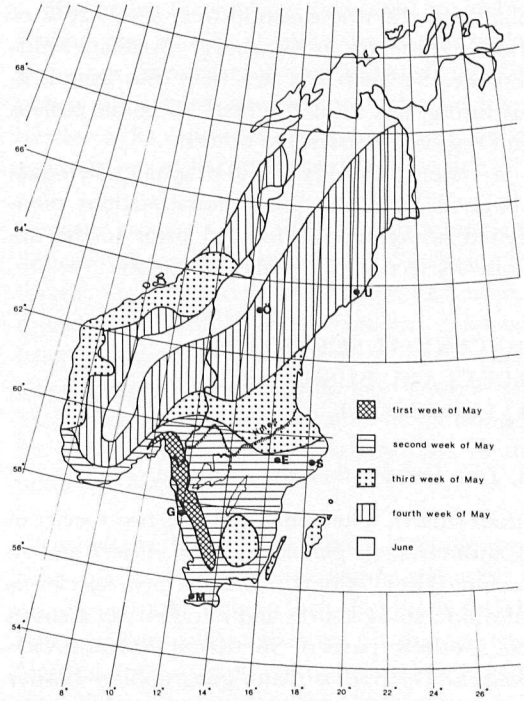


Fig. 1. The mean data of the onset of the birch pollen season (coinciding with the time of foliation) for different parts of Sweden (after Hultén, 8). The map also shows the position of *Limes Norrlandicus* (Limes) through Sweden and the places with pollen registration 1979–1981: M = Malmö, G = Göteborg, E = Eskilstuna, S = Stockholm, Ö = Östersund, U = Umeå. For latitudes and longitudes, see Table 1

populations, for example low bushes and grasses, will obviously be under-represented in pollen traps placed high above the ground.

The size of the area for which the measurements of the pollen trap is valid depends on the topography and the vegetation of the area. For example, one study compared pollen counts from Copenhagen and Malmö (11), and although the pollen traps were 31 km apart, their results were markedly similar. A similar study in Göteborg (6), on the other hand, gave quite contrasting results between two pollen registration stations just 16 km apart. One station, located in eastern Göteborg, was approx. 30 m above ground, the other was approx. 3 m above ground near seashore on the island Lilla Amundön. The pollen traps of the two stations were of the same type used in this study. The pollen amounts registered on the

island for the whole season were about 20% of those registered in Göteborg. Qualitative differences between the two were also found, illustrating the local dispersal of some pollens and regional dispersal of others.

A systematic study of the original pollen data obtained from the six regional stations mentioned above was performed prior to the definitive selection of the allergen panel.

BOTANICAL SURVEY OF TREES AND BUSHES OF ALLERGOLOGICAL INTEREST

A. Taxa found in the whole study area

Alnus (Alder). The genus includes two species in Scandinavia, *A. glutinosa* (Black Alder) and *A. incana* (Grey Alder). The former species is common along shores and in other wet areas in the southern parts of Sweden up to *Limes Norrlandicus* (7), viz. a plant geographical border extending from the district north of Lake Vänern north-eastwards to the lower parts of the river, Dalälven (Fig. 1). Black Alder is replaced in the north by Grey Alder, which is found up to the timberline in the northern Scandinavian mountains. The two species of Alder are closely related and fertile hybrids result where they have contact.

Alder pollen is registered during April in the southern and during May in the northern districts, and is reported from all stations in Sweden.

Betula (Birch). The genus includes three good species in the region, *Betula pendula* (syn. *B. verrucosa*) (European Birch), *B. pubescens* (Downy Birch) and *B. nana* (Dwarf Birch). The last-mentioned species forms low shrubs mainly in the mountains and the northernmost districts of Scandinavia. The two first mentioned species include such ecological races as *B. tortuosa* (Fell Birch), closely related to *B. pubescens*, and constitute the timberline in the Scandinavian mountains. There are also other more or less local forms of birch. *B. pendula* and *B. pubescens* frequently produce spontaneous fertile hybrids.

The pendulous catkin-like inflorescences of *Betula* start shedding their pollen at foliation. Hultén (8) published a map showing the average date of the foliation of *B. pendula* and *B. pubescens* in Scandinavia (Fig. 1). The foliation of *B. tortuosa* in the mountains and in the northernmost parts of Scandinavia (the white parts on the map (Fig. 1)) does not start until June. Birch pollen is registered from all pollen stations in Sweden.

Calluna vulgaris (Heather). The species is distributed throughout Sweden. It forms dwarf bushes or shrubs and was formerly the basis of an extensive form of cattle farming in Sweden, especially in the south-west. The extensive heaths are now to a large extent reforested, but the heather is still common in open woodlands. The pollen is dispersed partly by wind and partly by insects. It is found in low numbers in the pollen traps of Sweden. Heather blossoms from mid-July until the end of August. Pollen of *Empetrum nigrum* (Crowberry) is similar to heather pollen and is sometimes registered in springtime.

Juniperus communis (Common Juniper). The species is common in the whole of Scandinavia and the pollen is registered in great numbers at all pollen stations from mid-April to the end of June, with a peak during the last 2 weeks of May and early June.

Pinus silvestris (Scots Pine). The species includes a series of climatically adapted variations throughout the whole area. *Pinus* pollen is the most common pollen registered at all pollen stations during the last half of May and early June. Other species of *Pinus* are cultivated as ornamentals and also as forest trees.

Populus tremula (Aspen). The species is common throughout Scandinavia as a colonizer after lumbering and at abandoned farm sites. Aspen pollen is registered from all pollen stations in Sweden during April and May. *Populus tremula* is the only wild-growing poplar species in Scandinavia.

Quercus (Oak). The genus includes two very closely related species in Sweden, and fertile hybrids are often found in the western part of Sweden. *Q. petraea* (Sessile Oak) grows mainly in the south-western districts where the climate is influenced by the sea, and *Q. robur* (Pedunculate Oak) grows wild northwards to south-eastern Norway and *Limes Norrlandicus*. Oak trees are, however, cultivated as ornamentals in all agricultural parts of Sweden, even north of this limit.

Pollen of oak is regularly registered in Malmö, Göteborg, Eskilstuna and Stockholm from the middle of May and 4–5 weeks thereafter.

Salix (Willow). This genus is widely distributed in the area and includes a great number of closely related taxaforming hybrid swarms in ecologically disturbed areas. Pollen of willows is reported from all pollen stations in Sweden, although the flowers are at least partly insect-pollinated. The pollen shedding period starts in April and continues until June. In the mountains, some species flower even later.

The willow (*Salix caprea*) is a common species of willow in large parts of Sweden.

B. Taxa, growing primarily in southern Sweden extending in some cases to Limes Norrlandicus

Corylus avellana (Hazel). The species has a distribution similar to that of wild growing oaks (see above). The pollen is regularly registered from the pollen stations in Malmö, Göteborg, Eskilstuna and Stockholm, and is normally dispersed during March and April.

Fagus silvatica (European Beech). The natural distribution is restricted to the region south of a border extending from the south of Norway, through the southern parts of Bohuslän, and eastwards over Jönköping to Oskarshamn. It is still cultivated northwards to Karlstad, Örebro, Köping, Uppsala, i.e. somewhat south of *Limes*

Norrlandicus, and along the sea coast to the middle of Norrland.

The pollen is regularly registered in Malmö around the middle of May. Occasional pollen grains are trapped each year in Göteborg. The pollen of isolated beeches near the northern border of its range is rarely found in the pollen registrations of Eskilstuna and Stockholm.

Fraxinus excelsior (Ash). This tree is a nutrient-demanding species found in rich deciduous forests. It grows in valleys of the agricultural districts south of *Limes Norrlandicus*. The ash belongs to the same plant family as the olive tree (*Olea europea*), which causes hay fever in the Mediterranean area. Small amounts of ash pollen are registered for only a few days in the middle of May.

Ulmus glabra (Wych Elm). This is the only common species of the genus within the area. It occurs naturally only in rich deciduous forests, but is widely cultivated as an ornamental tree. Natural spread from cultivated stands is common. There are two other elms cultivated in parks and along roads within the area, viz. *Ulmus carpinifolia* and *U. hollandica*. The latter is a hybrid between the former and wych elm. The pollen is dispersed by wind from the middle of April up to the time of foliation.

C. Taxa, seldom or never found in pollen traps in Sweden

Acer platanoides (Norway Maple). The only naturally occurring species in the area; common south of *Limes Norrlandicus* and found along the coast, even up to the middle of Norrland. A few other species of the large genus *Acer* are cultivated, at least in the southern districts of Sweden, *A. pseudoplatanus* (Sycamore) and *A. campestre* (Field Maple) are the most common of these. The flowers bloom in May during foliation. The pollen is mainly dispersed by insects and is rarely observed in the pollen analyses.

Aesculus hippocastanum (Horse-Chestnut). The species is cultivated as an ornamental tree, at least as far north as central Sweden. The pollen is dispersed by insects in June but occasional pollen grains may be found in the pollen traps.

Larix (Larch). The genus does not grow naturally in Scandinavia but a few species and hybrids are sometimes cultivated as forest trees or as ornamentals. The pollen is dispersed by wind in May. The genus *Larix* is related to cedars known to be allergenic, especially in Japan.

Ligustrum vulgare (Privet). This bush grows wild along the coast of south-west Norway and the Swedish west coast. It is often cultivated as a hedge plant up to the latitude of Stockholm. It is only rarely allowed to flower in hedges. The privet belongs to the same plant family as the ash. The pollen is dispersed by insects in July.

Myrica gale (Bog Myrtle). This low-growing shrub is common particularly in south-west Sweden and the adjacent parts of Norway. It is distributed at least as far north as the districts of Värmland and Dalarna, and to the north-east, along the coast around the Gulf of Bothnia.

Bog myrtle is pollinated by wind before foliation in May. It occurs only in bogs and swamps; these are often surrounded by dense forests, thus preventing the dispersal of pollen outside the local populations. Though common in the south-west of Sweden, pollen of bog myrtle is never found in the regional pollen trap in Göteborg. It was present, however, in the samples from Lilla Amundön (see p. 603), where the trap was situated near the ground and less than 100 m from a local population of the species.

Platanus (Plane). Plane trees are grown only as ornamentals at a few places in the southernmost part of Sweden. They are, however, very common as park and boulevard trees in Mediterranean countries, where thousands of Scandinavians spend their vacations. The flowering period coincides with foliation in April. Plane tree allergies are observed in areas where the trees are common.

For a few seasons, pollen of plane trees has been registered from the trap in Malmö, where plane trees are grown as ornamentals.

Sambucus nigra (Elder). The bushes are probably not native to Scandinavia but become naturalized from widespread cultivation near farmhouses and villages northwards to *Limes Norrlandicus*. It is rarely cultivated as far north as Jämtland and Ångermanland in central Sweden. The pollen is dispersed mainly by insects during June to July.

Tilia (Lime). The lime, or linden, never forms forests but occurs as solitary trees or in small groups in meadows, groves and rocky steepes. It is common south of *Limes Norrlandicus* and is found along the coast as far as the middle of Norrland. A lime hybrid is often cultivated in parks and along roads and avenues and is probably the most commonly planted street tree in Northern Europe. The hybrid is fertile. Lime pollen is dispersed by insects during June and July. Occasional pollen grains are found each year in the traps of Malmö and Göteborg.

ANALYSIS OF THE POLLEN FREQUENCIES

The atmospheric pollen content has been analysed for 5 years from Malmö, Göteborg and Stockholm and for shorter periods from Eskilstuna, Östersund and Umeå.

Only seven of the 20 pollens selected for the study have been observed in Östersund and Umeå, viz. alder, aspen, birch, common juniper, heather, pine, and willow. Most of the deciduous trees occur only very rarely north of the plant geographic border *Limes Norrlandicus*, except when cultivated in gardens and parks. In such cases, some exposure may occur when people live near these cultivated trees. However, for the population as a whole the risk of sensitization to pollen of these taxa, is probably small, and diminishes as one goes north through the districts of Norrland.

The pollen spectra from Stockholm, Eskilstuna, Göteborg and Malmö have many features in common, but also have distinct differences. Beech pollen is regularly registered in rather

large amounts in Malmö, in small amounts in Göteborg, and only sporadically in Stockholm. Pollen of larch and plane have been registered only in Stockholm and Malmö, respectively, although not annually.

Pine and birch pollen predominate. Pollen counts some years may reach more than 3000/ m^3 air/24 h. Pine and birch pollen levels are commonly 10 times that of alder, and up to 100 times that of hazel. The amount of oak and elm pollen is similar to that of alder.

The pollen of the other deciduous trees are registered in much lower numbers. In practice, this means that pollen of, for example, horse chestnut or maple is only rarely the main cause of a pollen allergy. Even when provocations and skin tests prove a manifest allergy to one or more of these uncommon pollens, the allergy more probably arose from cross-sensitization to another, commoner pollen.

BIRCH POLLEN SEASONS IN SWEDEN 1979–1981

The report on the onset of birch flowering illustrated in Fig. 1 refers to registrations by Hultén (8) and is the mean of a long period of years. In the following, a more detailed picture of the variation of birch flowering will be given.

Birch is the most important allergy-provoking tree in Scandinavia (2). As mentioned above, it also produces more pollen than most trees. One single catkin may contain more than 5 million pollen grains.

Since the beginning of the registration in Malmö and Göteborg in 1975 the intensity of birch flowering has followed an obvious 2-year rhythm in south and south-west Sweden. A corresponding, less obvious rhythm may also be observed at the more northern pollen stations. Similar rhythms are found in several other species of trees and bushes. The underlying cause may be either genetic, or physiological, such that one year of rich flowering and fruiting will be followed by one or several years with more restricted reproduction. Climatic conditions also greatly influence the maturity and condition of the trees at the time they initiate

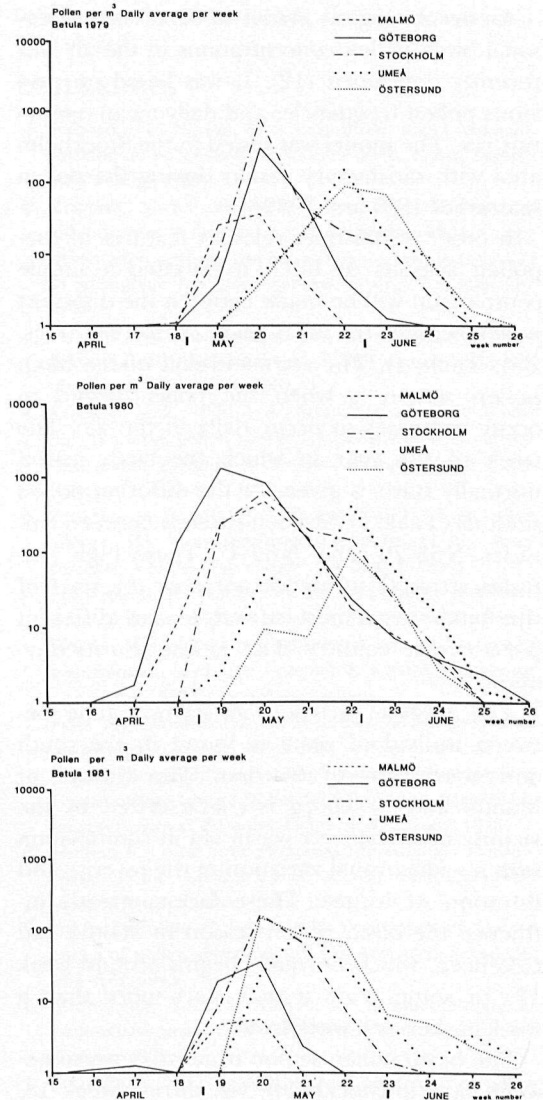


Fig. 2, 3, 4. The birch pollen season in Sweden 1979, 1980 and 1981. Diagrams of the frequency of birch pollen in the air expressed as pollen grain/ m^3 , daily average/week. Burkhard's volumetric spore traps were used in all the five places shown in Fig. 1.

the new generation of flowering buds. Catkin buds are already established by the end of the summer of the previous of the flowering season. The weather conditions on the very day the pollen is shed is, however, critical. This determines how much pollen will circulate in the air sufficiently long enough to be caught in the pollen traps.

number of days with 10 or more pollen grains/ $m^3/24$ h occur in Malmö and Göteborg.

CONCLUDING REMARKS

The final composition of the allergen panel (Table 2) is a slight compromise due to the reasons earlier mentioned. We are, however, convinced that no taxon of major allergic importance has been omitted. It is our opinion that the panel will be useful for elucidating the sensitization pattern of the Swedish population against common trees and bushes. Also it may help answer more specific questions.

Table 2

Tree and bush pollen allergens to be used for skin tests in a multicentre study

Botanical family	English name	Latin name
Aceraceae	Maple	<i>Acer platanoides</i>
Betulaceae	Alder	<i>Alnus glutinosa</i>
	Birch	<i>Betula pendula</i> (syn. <i>verrucosa</i>)
Caprifoliaceae	Elder	<i>Sambucus niger</i>
Corylaceae	Hazel	<i>Corylus avellana</i>
Cupressaceae	Juniper	<i>Juniperus communis</i>
Ericaceae	Heather	<i>Calluna vulgaris</i>
Fagaceae	Beech	<i>Fagus silvatica</i>
	Oak	<i>Quercus robur</i>
Hippocastanaceae	Horse chestnut	<i>Aesculus hippocastanum</i>
Myricaceae	Bog myrtle	<i>Myrica gale</i>
Oleaceae	Ash	<i>Fraxinus exelsior</i>
	Privet	<i>Ligustrum vulgare</i>
Pinaceae	Larch	<i>Larix decidua</i>
	Pine	<i>Pinus silvestris</i>
Platanaceae	Plane	<i>Platanus orientalis</i>
Salicaceae	Aspen	<i>Populus tremula</i>
	Sallow	<i>Salix caprea</i>
Tiliaceae	Lime	<i>Tilia cordata</i>
Ulmaceae	Elm	<i>Ulmus glabra</i>

ACKNOWLEDGEMENTS

The authors are much indebted to Doctors S. Nilsson, Stockholm, G. Boethius, Östersund, L. Rosenhall, Umeå, and B. Victorin, Eskilstuna for permission to use the results of their pollen analysis. The analyses from Göteborg and Malmö were performed by science candidates Margit Fredriksson, Åslög

Dahl and Suzanne Roth-Tedenstig to whom we are likewise much obliged.

REFERENCES

- Engström, I., Nilsson, S. & Strandhede, S.-O.: Sammanfattning av pollensäsongerna 1979–1980. Fisons Sweden AB, Tumba, 1981.
- Eriksson, N. E.: Allergy to pollen from different deciduous trees in Sweden. An investigation with skin tests, provocation tests and the radioallergosorbent test (RAST) in springtime hay fever patients. *Allergy* 33, 299–309, 1978.
- Eriksson, N. E. & Jacobsson, A.: Björkallergi vanligt – björkris i offentliga lokaler en luftförorening. *Läkartidningen* 78, 1073–1074, 1981.
- Eriksson, N. E., Wihl, J. Å., Strandhede, S.-O. & Arrendal, H.: Tree pollen allergy. II. Sensitization to various tree pollen allergens in Sweden. A multi-centre study. *Allergy* 39, 610–617, 1984.
- Eriksson, N. E., Wihl, J. Å. & Arrendal, H.: Tree pollen allergy. III. Cross-sensitization patterns in hay fever patients. A multi-center study. (To be published).
- Fredriksson, M.: Jämförande studier av pollen insamlade från två burkardfällor i Göteborg 1979. (Enskilt arbete i biologi: Morfologisk och systematisk botanik, Botaniska institutionen, Avd. för systematisk botanik, Göteborgs universitet 1981). Unpublished paper.
- Fries, M.: Limes Norrlandicus-studier. En växtgeografisk gränsfråga historiskt belyst och exemplifierad. (Limes Norrlandicus-Studien. Eine pflanzengeographische Grenzenfrage historisch betrachtet und mit Beispiel beleuchtet). *Svensk Botanisk Tidskrift* 42, 51–69, 1948.
- Hultén, E.: Atlas över växternas utbredning i Norden. (Atlas of the distribution of vascular plants in north-western Europe). Stockholm, 1971.
- Juhlin-Dannfelt, C.: About the occurrence of various forms of pollen allergy in Sweden. *Acta Med. Scand.* 26, 563–577, 1948.
- Strandhede, S.-O. & Nilsson, S.: Sammanfattning av pollensäsongerna 1980 och 1981. Fisons Sweden AB, Tumba, 1982.
- Strandhede, S.-O. & Wihl, J. Å.: Comparison of pollen counts in Copenhagen and Malmö. *Grana* 20, 187–189. Uppsala 1982.
- Törnevik, H.: An aerobiological model for operational forecast of pollen concentration in the air. SMHI Reports Meteorology and Climatology, RMK 38. Liber Grafiska AB Stockholm, 1982.
- Zetterström, O., Fagerberg, E. & Wide, L.: An investigation of pollen extracts from different deciduous trees in patients with springtime allergy in Sweden. *Acta Allergol.* 27, 15–21, 1972.

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