

Distribution, status and ecology of the lichen *Cyphelium notarisii* in Sweden

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Received 5 May 2004, revised version received 21 Jan. 2005, accepted 29 Mar. 2005

Areskoug, V. & Thor, G. 2005: Distribution, status and ecology of the lichen *Cyphelium notarisii* in Sweden. — *Ann. Bot. Fennici* 42: 317–326.

An inventory of the two largest Swedish occurrences of the lichen *Cyphelium notarisii*, situated on Visingsö in Småland and at Kovik on Gotland, respectively, was conducted. A third occurrence on Fårö, Gotland was discovered. A total of 21 localities were visited. Only cultural substrates such as wooden barn walls, fishing sheds and gates were utilised by fertile specimens. The species is mostly found on south- to southwest-facing walls with no shade cover, close to a water-body. The current distribution is greatly reduced compared to the historical range of the species. The major current occurrences are characterised by a high concentration of old wooden structures, which strongly indicates that measures to ensure the viability of the species should be taken at the landscape level, rather than on individual localities. *Cyphelium notarisii* is reported as new to Estonia and Kazakhstan, and *C. tigillare* is reported as new to Gotland, Sweden.

Key words: *Cyphelium notarisii*, lichens, red-listed, substrates, wood

Introduction

Cyphelium notarisii is red-listed as Critically Endangered (CR) in Sweden (Gärdenfors 2005). The species is a crustose lichen of the family Caliciaceae, and it was first described by Tulasne (1852) under the name *Acolium notarisii*. Blomberg and Forssell (1880) subsequently transferred the species to the genus *Cyphelium*. Vainio (1927) placed *Cyphelium notarisii* in its own monotypic genus based on the submuriform spore morphology, referring to the species as *Pseudacolum notarisii*. Weber (1967) claimed *C. notarisii* to be a variety of its relative *Cyphelium tigillare*.

Since 1969 *C. notarisii* has been accepted as a separate species due to its submuriform spores (Tibell 1969). For a comprehensive summary of the species' taxonomy and distribution, see Nilsson (1930) and Tibell (1969, 1971, 1975, 1984). For a morphological description see Tibell (1999). In gross morphology *C. notarisii* is indistinguishable from *C. tigillare*, but differs by the spore shape (Tibell 1999). The thallus has numerous irregular groups of conspicuous, irregular, black multilocular pycnidia. Very similar pycnidia are also present in *C. tigillare* (Tibell 1999), but sterile thalli with abundant pycnidia are often referred to *C. notarisii*. For photographs see e.g. Tibell (1999).

This paper summarises the current and former distribution, status and ecology of the species in Sweden, and the prerequisites for its long-term survival in Sweden are discussed. The paper is based on a degree project at the Swedish University of Agricultural Sciences, Uppsala (Areskoug 2000).

Former status and distribution in Sweden

The distribution range of *Cyphelium notarisii* formerly extended from Skåne (56°N) in the south to Hälsingland (61°N) in the north (Appendix). Most collections were made prior to the end of the 1930s. Only three collections were made during the 1940s (Bohuslän, 1942, Magnusson; Gästrikland, 1942, Ahlner; Västmanland, 1949, Kjellmert), and two during the 1950s (Västmanland, 1950, Kjellmert; Södermanland, 1958, Hasselrot). All old herbarium specimens utilised cultural substrates. During the 1960s, 1970s and a large part of the 1980s no collections were made, and the species was presumed to have disappeared from Sweden (Tibell 1992). It was, however, rediscovered in 1986 on a barn wall in the province of Hälsingland (Ågren 1991, as *C. tigillare*), but that locality was destroyed in 1997 by the removal of the barn (Å. Ågren, pers. comm.). Two localities were subsequently discovered in 1990 on the island Visingsö in the province of Småland (Thor 1993). The species was also discovered in 1994 at Kovik fishing village museum on Gotland by Mats Nordin (pers. comm.).

The rediscovery of the species has led to reinventories on many of its former localities. Three old localities in Skåne and Blekinge were revisited by Ulf Arup and Stefan Ekman in 1991 (Arup *et al.* 1997). They were unable to find the species in its previous localities, but a new site was discovered on Hallands Väderö, Skåne (Arup *et al.* 1997; no apothecia). This is the only known occurrence of *C. notarisii* growing on a naturally occurring substrate (*Juniperus communis*) in Sweden. One additional new locality has subsequently been discovered in eastern Skåne (Arup 1999). In the province of Västmanland, only one old locality could be identified. This site was inventoried, but *C. notarisii* was neither found there, nor in other appropriate habitats in the area

(Hultengren & Danielsson 1996). A finding was made in 1997 on the island of Biskops-Arnö, Uppland, by Svante Hultengren (pers. comm.). Unfortunately, the substrate barn wall was painted over very shortly after the discovery, destroying the occurrence. A second rather nearby locality in Uppland was recently found, but also there, the wall has now been painted over (Foucard 2004). These incidents demonstrate the current vulnerability of the species. A few additional unpublished localities have also been found in northern Uppland and Dalarna by J. Hermansson during the past few years (*see* Appendix).

Status and distribution outside Sweden

The species is widely distributed in North America, Asia and Europe, stretching from 116°W to 86°E and from 39°N to 61°N (Appendix). Collections of *C. notarisii* outside Sweden are sparse, with no more than a single collection from several countries. Few findings of *C. notarisii* have been made in recent years, except in England (Earland-Bennett & Hitch 1997, Dobson 2003). The species was published as new to Spain by Sarrión *et al.* (1999). An occurrence in southern Siberia was published by Nimis (1993). We have, however, seen no Siberian material.

The available collections are insufficient for an accurate analysis of the change in the species' global status. Many historical collections exist from Germany and the United States, but the records are sporadic, and no adequate assessment of the present situation has been made. It is unlikely that the existing herbarium material will ever allow us to obtain certain information about the historical abundance of the species, or draw definite conclusions regarding its population development.

Material and methods

Data on the Swedish distribution was collected from the Swedish Species Information Centre (ArtDatabanken), and by means of personal communication. All specimens of *C. notarisii* from B, BM, CANL, COLO, FH, GB, M, NY, S, UPS, W and the personal herbarium of the author (G.

Thor) were examined in order to determine the historical distribution of *C. notarisii*, in Sweden and globally. The herbarium material is listed in the Appendix. The nomenclature follows Santesson *et al.* (2004). Collections of *C. notarisii* and *C. tigillare* by V. Areskoug and G. Thor (Appendix) will be deposited in UPS.

The two largest remaining occurrences of *C. notarisii* in Sweden (Visingsö, Småland and Kovik fishing museum, Gotland) were revisited, and a third (Fårö, Gotland) was discovered and inventoried. The fieldwork was carried out during September and October 1997. For the purpose of this publication each property unit, often consisting of several structures (barns, fishing sheds, fences), was defined as one locality. This was considered appropriate, as the buildings of a specific property are likely to have a similar maintenance regime and historical usage, and to be exposed to the same threats.

The following parameters were measured or noted on each locality where *C. notarisii* was present:

1. Distance from water (approximated to within 100 m).
2. Distance from dust impregnation source, e.g., gravel road or arable field (approximated to within 10 m).
3. Percentage shade cover of the *C. notarisii* growth.
4. Directional exposure (measured using a handheld compass).
5. Visible traces of paint or char.
6. Material used for roofing.

On each wall where *C. notarisii* occurred, the following observations were made:

1. The total coverage of *C. notarisii* was approximated to the nearest dm².
2. The total lichen cover on the substrate with *C. notarisii* was approximated to the nearest dm².
3. Associate lichen species were sometimes identified.
4. The orientation of the substrate was recorded as horizontal or vertical.
5. The highest and lowest point of thallus growth on the wall was measured to the nearest cm.

6. On each individual wall, specimens of *C. notarisii* were checked for fertility. The highest and lowest point of apothecium occurrence was measured to the nearest cm, and a collection for the purpose of microscopic examination of the spores was usually made.
7. The thickness of the wooden substrate utilised by *C. notarisii* was measured to the nearest 1 mm.
8. The degree of substrate decay was recorded. The following decomposition scale from 1–5 was developed to evaluate the condition of the substrate: (1) new wood free from surface cracks and obvious signs of decay, (2) wood intact, firm, cracks < 1 mm wide, (3) wood of a silver hue, firm, surface fleeced, cracks 1–3 mm wide, (4) wood beginning to soften, cracks 3–5 mm wide, (5) wood in latter stages of decay, cracks > 5 mm wide.

Results

A total coverage of 731.5 dm² was found at the three occurrences inventoried. Herbarium material from Estonia and Kazakhstan, where there are no previous records of the species (e.g. Randlane & Saag 1999) was studied. The collection from Estonia has no apothecia, yet the high abundance of pycnidia suggests that it is a *C. notarisii* specimen (*see* above). Occurrence on natural substrates appears to be more common outside Sweden. The species was collected on bark of the coniferous trees/shrubs *Juniperus* sp., *Larix* sp., *Libocedrus decurrens*, *Pinus flexilis* and *Pinus ponderosa*, but there are also collections from cultural substrates as fence rails, old poles and houses. The morphologically similar *C. tigillare* was encountered on one locality on Gotland, and the species is hereby reported as new to this island (Appendix). This locality can be seen on a map in Hermansson and Hultengren (1999).

Småland, Visingsö

Visingsö is an island in lake Vättern (58°N, 14°E). It extends 14 km north to south and 3 km east to west. Every wooden structure on

the island not recently painted was inventoried. A total of 31 suitable wooden structures in 27 localities were found. The species occurred on a total of 15 wooden structures in 12 localities (Appendix). The localities were scattered within 800 m of the shoreline. A total of 510 dm² of *C. notarisii* growth was found. On eight of the localities, apothecia were observed. Of the 12 localities, eight had no remnants of paint; three showed remnants of traditional Falun red paint and one had a relatively intact coat of Falun red. Falun red paint has been used in much of the Swedish agricultural landscape since 1764 (Thor 1996).

Gotland, Kovik

The only known location on Gotland at the time, Kovik fishing village (57°N, 18°E), was revisited and inventoried. It is an open-air museum consisting of a collection of seventeen traditional boathouses originating from various parts of the area, and moved to Kovik. The museum is located on a spit 3 km south of Klintehamn on the west coast of Gotland. All buildings are within 60 m of the seashore, and fully exposed to sun and wind. A total of 35.5 dm² of *C. notarisii* growth was found. Two of the houses are painted, and *C. notarisii* growth occurred only on the unpainted houses. *Cyphelium notarisii* was found on four of the 17 buildings (22%).

Gotland, Fårö

Fårö, an island located 74 km northeast of Kovik Fishing Museum, constitutes the northernmost part of Gotland. Suitable wooden structures vis-

ible from the main roads on Fårö were inventoried. A total of seven *C. notarisii* localities were found (Appendix). All specimens occurred within 1200 m of the shore line. A total of 186 dm² of *C. notarisii* growth was found. Four localities had been painted with traditional Falun red while the other three had no remnants of paint. On each locality, the species occurred on only one building.

Site conditions and growth habit

All localities inventoried in Sweden occurred within 1200 metres of a major water body (Table 1). A dust source (gravel road, arable field) was found within 10 m of 79% of the localities, and within 100 m of all localities (Table 1). 87% of the walls (20 of 23) of the occurrences had no shade cover. One wall on one locality had a shade cover of 80% (Table 1). The *C. notarisii* growth on this location was visibly enfeebled, displaying a pale thallus and few apothecia. The thickness of the wooden substrata utilised by *C. notarisii* ranged from a value of 0.5 cm up to 21 cm, but the majority of values fell within the 2.0–2.9 cm interval (Table 1). *Pinus sylvestris* was probably the only, or at least by far the most common substrate material. These results are representative of the building material used in the inventoried landscapes. The species appeared to occur mainly on wood in decay stage 4 (Table 1).

Most of the buildings inventoried were 220–450 cm in height (Table 2). The species tended to grow near the ground (Table 2). Apothecia were often formed approximately 10 cm from

Table 1. Summary of results of environmental parameter measurements of visited *C. notarisii* localities in Sweden (Fårö, Kovik fishing museum, and Visingsö).

	Min.	Max.	Median
Distance from water (m)	2	1200	250
Distance to dust source (m)	< 1	100	5
Shade cover (%)	0	80	0
Substrate thickness (cm)	0.5	21	2.0–2.9
Substrate decay stage	2	5	4

Table 2. Summary of thallus and apothecium growth height on substrate wall.

	Min.	Max.	Median
Lowest height of thallus growth (cm)	1	110	19
Highest height of thallus growth (cm)	18	330	160
Lowest height of apothecium presence (excluding sterile specimens) (cm)	5	140	40
Highest point of apothecium presence (cm)	20	280	117

the edge of the thallus.

Cyphelium notarisii was the dominant species in all localities, and the total lichen cover was low (15%). Species found growing in association with *C. notarisii* included mainly common and widespread species occurring on wood in southern Sweden, such as *Hypocenomyce scalaris*, *Lecanora saligna*, *L. varia*, *Thelomma ocellatum*, *Trapeliopsis flexuosa* and *Xylographa vitiligo*. The species *Chaenotheca trichialis*, *Chrysothrix candelaris* and *Lepraria* sp. were observed at sites with a higher shade cover.

The growth orientation in all localities was vertical, although two of them had additional horizontal growth, on a gate and a window, respectively. None of the numerous inventoried buildings with remnants of char or paint other than traditional Falun red supported *C. notarisii* growth. Healthy *C. notarisii* growth occurred under both wood and metal roofing materials.

The most common exposure of the lichen was to the south, southwest, or west. Although unusual, two localities with northern exposures of 350° and 10°, respectively, as well as one with a northeast exposure of 55° were recorded.

Discussion

During the last century the amount of old untreated wooden structures in the Swedish landscape has decreased continuously. Old buildings have fallen into disuse and decay (Lange 1997), while only very few new structures are built with untreated wood. Consequently, the available substrate for *C. notarisii* has been severely reduced, and few areas remain where wooden structures occur in significant amounts. As a result, only a few severely fragmented occurrences of *C. notarisii* remain.

This study indicates that, within Sweden, the species is dependent on sunny localities, displaying signs of reduced vigour when exposed to shade and competition from other lichens. It is possible that the need for sun exposure is temperature dependent. Some of the herbarium specimens collected in North America had been growing with a northern exposure as far north as 50°N. The species can survive extremely cold

winter temperatures, such as those experienced in Alberta, Canada, but cool summer temperatures may be a limiting factor. It is possible that by utilising the sunny walls of wooden buildings the species can extend its northern limit significantly. There is a westerly skew of the exposure values of the localities inventoried on Visingsö. This may be the result of buildings being orientated perpendicular to the main roads, which run southwest to northeast along the coastline. As a result, few walls with due south exposure are available on Visingsö. Several localities where the species grows with a westerly exposure also occur on Gotland, although a southern exposure is more common and appears to allow more vigorous growth. The westerly afternoon sun may warm the substrate significantly more efficiently than the eastern early morning sun.

Our observations suggest that *C. notarisii* may prefer dust-impregnated habitats; a denser, more fertile growth occurs closer to the ground, the species often grows in close association with dust-favoured species such as *Lecanora saligna* and *Thelomma ocellatum*, and a dust source was noted close to all inventoried localities.

There is a strong tendency for the species to occur in coastal areas and lake regions in Sweden. It is possible that close proximity to smaller rivers, streams or ponds may also suffice, as many (but not all) herbarium collections from outside Sweden state the presence of a river or nearby water-body. The abundance of the species in the three investigated areas, and its occurrence on relatively fresh, intact coats of paint, indicate that certain of the occurrences are newly established (about < 7 years), and that local dispersal is not a problem for the species. However, the low number of current localities, the isolation of the remaining localities, and the species' absence from a number of appropriate sites within its range suggest that long-distance dispersal is difficult.

Whether the current localities are relics of the former distribution or represent recent colonization events is unknown. There are no old records from any of the current localities, and none of the old Swedish localities has been identified. No literature is available on the dispersal strategy of the species. Wind is one likely vector since all Swedish localities occur along windy shore-

lines, and the species grows on exposed sites. However, the spores measure $15\text{--}30 \times 8\text{--}15 \mu\text{m}$, which is consistent with calicioid species with limited long-distance dispersal ability (Tibell 1994). It is unlikely that vegetative reproduction occurs in the species, since it does not develop soralia or isidia. Being a calicioid lichen with mazaedium, contact with livestock may help to spread the species from wall to wall and from building to building, but is not a likely vector for long-distance dispersal. Sheep were common in the Fårö localities, and cows were frequent in the Visingsö localities.

Implications for species conservation

The current Swedish localities are limited to a few highly isolated occurrences. The survival of the species is dependent on the swift protection of these occurrences. Three recently discovered localities (one in Hälsingland, two in Uppland) have already been destroyed due to ignorance. At such localities with small populations, local extinctions are most likely. The low number of localities and the low habitat density in large parts of south and central Sweden probably makes it impossible to balance extinctions with colonisations in the long run outside the few remaining major occurrences. This extinction debt will probably be paid in the future (Hanski 2000). As for almost all lichens, the threshold values of isolation and population size that must be exceeded for population persistence are still unknown.

The current occurrences at Visingsö, Kovik and Fårö are characterised by a high concentration of old wooden structures. This may have enabled the species to maintain a presence in the area, and made recolonisation of a wooden structure possible after disturbance events such as painting or replacement of boards. This strongly indicates that measures to ensure the viability of the species should be taken at the landscape level rather than in individual localities. In order to preserve the species, it is not enough that the current occurrences are protected. A continuous supply of suitable habitat (substrate) must be maintained and, if possible, increased at a landscape level over time to allow for the continuation of popula-

tion dynamics. As an implication, all appropriate wooden structures within the occurrences would need to be protected, and guidelines developed for renovations and possible painting of the buildings. The species appears to be capable of re-establishing quite quickly after the application of the Falun red paint. However, care should be taken to apply only thin layers (J. Hermansson unpubl. data). Property owners should be advised against painting all buildings simultaneously, and against the use of char, a substrate of which seems to hinder *C. notarisii* establishment. On the small, remaining localities outside the main occurrences, the removal of decaying/old buildings and the maintenance of buildings in an inappropriate way are serious threats.

There are several seemingly suitable sites throughout Sweden from which *C. notarisii* is absent. Attempts to establish new populations on suitable localities by deliberate dispersal of spores would increase the species' chances of long-term survival in Sweden. Such efforts would also facilitate research into the species habitat requirements and developmental biology, but the introductions must be carefully documented. Our recommendation is that attempts should be made to establish new populations on historical localities where the species has suffered local extinction.

Lichens growing on barn walls are exposed to biocides and fertilizers, which may lead to their disappearance from otherwise suitable substrates (Tibell 1980). Several of the current localities occur within decimetres of cultivated fields and pastures. One barn, which might have been an appropriate substrate, but had been coated in manure during fertilizing of the fields, was observed on Visingsö. A management plan for the current localities should include a consultation with landowners to encourage farming practices that minimize wind-blow during application of fertilizers and biocides. Such measures might include leaving a buffer zone around wooden structures where no chemicals are applied, or the use of applicators with minimal aerial spray.

Acknowledgements

Thanks to J. Hermansson for information on localities in

Uppland and Dalarna, Svante Hultengren for sharing his knowledge of the Biskops Arnö location, Roland Moberg and Anders Nordin for allowing us to publish the locality from Kazakhstan, Mats Nordin and Per Johansson for sharing their knowledge of the Kovik location and Leif Tibell for his review of an earlier version of the manuscript. We would like to acknowledge Uppsala Herbarium for providing access to their facilities and B, BM, CANL, COLO, FH, GB, M, NY, S, UPS and W for the loans of their collections.

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Appendix. Examined specimens. The abbreviation CS and NS in parenthesis before the herbarium abbreviation specifies the collection's occurrence on cultural substrate (wooden structures) or natural substrate (living trees or wood) respectively. The countries are listed in alphabetical order.

Herbarium material of *Cyphelium notarisii*: **Austria.** Austria inferior ad Sepium asseres prope Dreistätten infra montem Hohe Wand, 1920 *Baumgartner 2343* (CS)(B, BM, S); Nieder Österreich, an Zaun, 500 m, 1915 *Baumgartner* (CS)(B). **Canada.** *Alberta:* Bow River Watershed, 11 miles W Calgary, 1¼ miles S Elbow River, 3900 ft, NW29-24-3-W5, 1967 *Bird 18474* (CS)(BM, CANL, COLO, FH, UPS); Mirror, open farm habitat, 52°28'N, 113°00'W, 1991 *Brodo 27876* (NS)(B, M, W); Oldman River Watershed, west facing sandstone exposure, 4450 ft, beside Lyndem Creek, 18 miles west of Claresholm, Porcupine Hills, NE11-12-30-w4, 1966 *Bird & Lakusta 14702* (NS)(CANL); Oldman River Watershed, Montane forest/prairie, 17 miles north of Lundbreck, beside the Oldman River, 49°49'N, 114°12'W, 15-10-2-W5, 4400 ft, prairie with *Pinus flexilis* on sandstone outcrops, 1972 *Bird 28874* (NS)(CANL). *Ontario:* Grey Co., 2.5 mile E of Hwy 26, on Grey Road 22, 44°39'N, 80°38'W, exposed granite outcrop field, 1976 *Bowler & Wong 1930* (CS)(CANL). *Saskatchewan:* N of Klintonel (Swift Current), *Looman 27910* (NS)(COLO). **Czech Republic.** Ěp, 105 m, 1933 *Nádvořník* (NS)(B, M, W). **Estonia.** Kingissepa District, Kõinastu, W of Muhu, 58°38'N, 23°02'E, 1989 *Thor 8106* (no apothecia; CS)(S). **Finland.** *Alandia:* Kumlinge par., Enklinge village, Hermas Museum, 1986 *Thor 6622* (no apothecia; CS)(herb. G. Thor). *Regio aboënsis:* Masku, Ristimäki, 1938 *Ahlner* (CS)(S, UPS); c. 11 km SW Dalsbruk, E part of the island Högsåra, in the village Högsåra, 59°57'N, 22°22'E, 1990 *Thor 9329* (no apothecia; CS)(herb. G. Thor); Korppoo par., the island Jurmo, NW from the chapel, 1989 *Sundin* (CS)(S). *Lapponia:* Locality uncertain, *Nylander* (CS)(BM). **France.** *Gallia:* Hautes Alpes, Ancelle, 1450 m, 1966 *Rondon* (A. Vězda: Lich. Sel. Exs. 479)(CS)(BM, COLO, M); Gallia-Hautes Alpes, Le Casset prope Mon(?)-tier-les-Bains, 1500 m, 1970 *Rondon* (NS)(CANL, COLO, W); Hautes-Alpes, 1350 m, Lärchenwälder um Le Casset bei Monetier-les-Bains, 1978 *Rondon* (NS)(B, BM, COLO, W). **Germany.** *Nordrhein Westfalen:* Greven bei Münster, "Gimbte in Westfalen", 1860 *Lahm* (CS)(B); Greven bei Münster "bei Gimbte", 1857 *Lahm* (CS)(B); Greven bei Münster "bei Gimbte", 1860 *Lahm* (CS)(B). *Sachsen:* Im Sächsischen Erzgebirge um Dresden, Rabenhorst (CS)(M); Berlin, bei Dresden, 1874 *Hübner* (no apothecia; CS)(M); Königsbrück in Sachsen, *Hübner* (CS)(M); Prope Königsbrück, *Schmalz* (M). *Schleswig-Holstein:* Nordfrisische Insel Föhr, 1928 *Erichsen* (CS)(UPS, W); Nordfries Föhr, 1929 *Erichsen* (CS)(BM); Harz Mts., pr. Blankenburg, 1861 *Hampe* (no apothecia; NS)(B). **Hungary.** *Nagykapos:* pr. Ortó, 1933 *Nádvořník* (no apothecia; CS)(B); prope pagum Ómása, in cacumine montis Magaskő, in cote 656, 1939 *Föriss* (NS)(M, W). **Italy.** bei la Thuil e geg. kl. St. Bernhard im Aosta-Tal, an Lärche, 1700 m, 1962 *Schauer* (NS)(M); Sardinien, Gallura, 1983 *Brunnbauer* (W); Val d'Aosta, 1922 *Sbarbaro* (NS)(GB); Courmayeur, Plan Gorret, Abete pr. lo charlet Restaurant, 1924 *Sbarbaro* (NS)(FH). **Kazakhstan.** Vost. Kazakhstanskaja, Mt. Tinkoban, in the forest at the foot, 48°41'N, 86°01'E, 1600 m, 1993 *Moberg & Nordin K25:3* (NS)(UPS). **Poland.** 'Grünberg in Schlesien, comm. B. Stein', 1873 *Hellwig* (CS)(B). **Sweden.** *Skåne:* Brunnby par., Lerhamn, 1929 *Degelius* (CS)(UPS). *Blekinge:* Listerby, Lilla Edet, 1936 *Hedvall* (CS)(GB, S); Ronneby par., Spjälkö, 1934 *Hedvall* (CS)(GB, S). *Öland:* Köping, 1874 *Elmqvist* (CS)(UPS). *Gotland:* Sanda par., Koviks fiskeläge, RN x: 636710 y: 164145, 1995 *Johansson* (CS)(UPS). *Småland:* Visingsö par., the island of Visingsö, the parking place of the ruined castle of Näs, 58°00'N, 14°18'E, 1990 *Thor 9785* (CS)(herb. G. Thor). *Bohuslän:* Stenkyrka par., Åkervik, 1942, Magnusson (CS)(M, UPS). *Östergötland:* Lindöja prope Gransö, 1878 *Hulting* (CS)(GB); Östra Ryd par., 1819 *Petrin* (CS)(UPS). *Närke:* Götlunda par., Nannberga, 1859 *Blomberg* (CS)(UPS); Götlunda, 1860 *Blomberg* (CS)(S, UPS); *ibid.*, 1862 *Blomberg* (CS)(M); *ibid.*, 1869 *Blomberg* (CS)(M, S); Örebro, 1868 *Indebetou* (CS)(UPS); Örebro, 1874 *Hellbom* (CS)(B, GB); Örebro, 1897 *Stenholm* (CS)(UPS); Stora Mellösa par., Ö Valön, Ö om gården, 1932 *Morander* (CS)(UPS). *Södermanland:* Hölö par., Ledarön, W side, opposite Åbykvarn, 1958 *Hasselrot* (CS)(S); Öja, 1872 *Blomberg* (CS)(S, UPS); Västermo, 1875 *Blomberg* (CS)(NY, S, UPS). *Västmanland:* Arboga, St. Sättra, 1945 *Kjellmert* (CS)(NY); Arboga, St. Sättra, 1949 *Kjellmert* (CS)(CANL, GB, S); Arboga, St. Sättra, 1950 *Kjellmert* (CS)(B, BM, GB, S, UPS, W). *Uppland:* Uppsala, 1821 *Indebetou* (CS)(S); Uppsala, 1823, *ex herb. J. Vahl* (CS)(B); Uppsala, 1849 *Fries* (CS)(UPS); Uppsala, 1859 *Fries* (CS)(M); Uppsala, Halmbyboda, 1849 *Floderus* (CS)(UPS); Uppsala, 1870 *Dusén* (CS)(UPS); Uppsala, Kungsängen, 1820 *coll. ignot.* (CS)(UPS); Uppsala, *Torsell* (CS)(UPS); Danmark par., 1938, V om Pinan, *Degelius* (CS)(UPS); Danmark par., between Pinan and Fyris River, 1938 *Ahlner* (CS)(S); Tierp par., Tierp, W about between the route 292 and the railway, 60°20'N, 17°29'E, 1998 *Hermansson 8471* (no apothecia; CS)(UPS). *Dalarna:* Hedemora par., Hedemora, 1879 *Indebetou* (CS)(S, UPS); Hedemora par., Salnarlid, 1885 (CS)(S); By par., 6.0 km ESE By church, Leknäs, at the end of the public road, W of the farm, 65 m, 60°11'N, 16°35'E, 1998 *Hermansson 8531* (no apothecia; CS)(UPS); Gustafs par., Långhag, 6.2 km SSE Gustafs church, 60°23'N, 14°42'E, *Hermansson 10058* (CS)(UPS). *Gästrikland:* Gävle, Strömsbro, NE of the village, 1942 *Ahlner* (CS)(S). *Hälsingland:* Norrala par., Skensta, 15H0d4603, 1986 *Ågren* (no apothecia; CS)(UPS); Söderala par., Östansjö, 3 km S Söderhamn, 61°16'N, 17°02'E, 1989 *Ågren* (CS)(UPS). **Switzerland.** *Valais:* Walliser Alpen, oberhalb von Zermatt, Furri, 1830 m, 1975 *Kalb* (CS)(M); Walliser Alpen, Furri oberhalb Zermatt, 1974 *Kalb* (CS)(B, BM, COLO, W); Wallis, Walliser Alpen, oberhalb von Zermatt, Furri, 1850 m, 1975 *Kalb* (CS)(M); Unter Wallis, Val d'Herens, S of Sion, Arbec, c. 1 km W of Evolène, Coord. C.603.5/106.5, c. 1400 m, meadows with schist outcrops around the village, 1990 *Sipman 30276* (CS)(B); Wallis, Zermatt, Aroleit, 0.5 km SW of Zum See, 1820 m, 1970 *Tibell 4266* (NS)(UPS); Wallis, Zermatt, Aroleit, Blatten, 1730 m, 1970 *Tibell 4251* (CS)(UPS); Wallis, Saastal, Saas-Fee, at the bus stop, 1800 m, 1970 *Tibell 4314* (CS)(UPS). **Ukraine.** Czerniajew (CS)(M, S, UPS). *Krim:* Jalta, Nikitski Botanischer Garten, *Degelius 1938* (NS)(S, UPS).

USA. *Colorado:* Archuleta Co., N slope, Simms Ranch, 2 mile N of Chromo, 8000 ft, 1955 *Shushan* S9888 (NS)(CANL, COLO); Boulder Co., 7.5 mile SW Longmont, just N of Haystack Butte, 5200 ft, 1952 *Shushan* S470A (CS)(B, CANL, COLO, FH, GB, M, NY, UPS); Boulder Co., N slope of ravine, 1955 *Weber & Shushan* (NS)(COLO); Boulder Co., 1958 *Pursell* 3035 (NS)(COLO); Boulder Co., 1967 *Shushan* s1-7513 (NS)(BM); Boulder Co., foothills of Front Range of Rocky Mountains, west base of Steamboat Mountain, c. 3 km NW of Lyons near mouth of North St. Vrain Creek, 1700–1900 m, 1966 *Santesson* I8496 (CS)(UPS); Larimer Co., 40°N, 1935 *Kiener* 3031 (CS)(COLO); Larimer Co., 1954 *Shushan* s2423 (NS)(COLO); Larimer Co., S of Wyoming state line, N Virginia Dale, 41°N, 105°22'W, 7400 ft (2255 m), 1974 *Shushan* S1-76a (NS)(BM, CANL); Turner Co., S edge of Parker, 1964 (CS)(COLO). *Idaho:* Idaho Co., 12 miles W Grangeville, near Pine Bar, along the lower Main Salmon River, 1350 ft, 1990 *Rosentreter* 6647 (CS)(UPS). *Montana:* Rosebud Co., 1965 *Wetmore* 12883 (NS)(COLO). *Nebraska:* Blaine, 42°N, 1952 *Kiener* 28132 (CS)(COLO); Cherry Co., Valentine, 1951 *Kiener* (CS)(COLO); Sioux Co., NW of Crawford, 4800 ft, 43 N°, 1952 *Kiener* 28108 (CS)(CANL, COLO); Keya Paha Co., Niobrara Valley Preserve, 1992 *Ladd* 16564 (CS)(NY); Nance Co., W of Genoa 41°N, 1952 *Kiener* 28060 (CS)(COLO); Sheridan Co., Rushville, 43°N, 1951 *Kiener* (CS)(COLO); Sheridan Co., Rushville, 1952 *Kiener* 28131 (CS)(COLO). *North Dakota:* McKenzie Co., Theodore Roosevelt National Park, N Unit, near Hagen Spring (14 miles SW of Watford City), 2300 ft, Sec. 22, T 148 N R 100w, 1982 *Wetmore* 44590 (NS)(CANL); SW of Rhome, 1964 *Denison* 856 (CS)(CANL); Slope Co., 1976 *Esslinger* 5669 (NS)(COLO); Slope Co., Chalky Buttes, 14 miles N of Bowman, Prairie and rock outcrops on Buttes, 3100 ft, 1978 *Trana* 6383 (CS)(CANL, NY); Stark Co., 8 miles SE of Dickinson Bird Gully, 1978 *Trana* 6420 (CS)(B). *South Dakota:* Custer Co., Black Hills, Anselmo, 42°N, 1952 *Kiener* 28133 (CS)(COLO); Custer Co., along Antelope Ridge Road N of Custeo-Limestone Road, W facing slope, 6200 ft, sec.33, T. 25., R.2E, 1960 *Wetmore* 7100 (NS)(CANL); Custer Co., west-facing hill, 1961 *Wetmore* 10163 (CS)(BM); Custer Co., SW of Hermosa, 0.5 mile W of S.D. 79 on S.D. 36 (18 miles east northeast of Custer), 3400 ft, Sec 1, T.3S., R.7E, 1961 *Wetmore* 10205 (CS)(CANL, M, UPS); Custer Co., along road to Argyle 7 miles NW U.S. 385 (7 miles NW of Hot Springs), 4550 ft, Sec. 20, T.6S., R.5E, 1961 *Wetmore* 10871 (NS)(BM, UPS); Fall River Co., on hill above dam at N end of Angostura Reservoir, 3350 ft, Sec. 20 T. 8S., R.6E, 1960 *Wetmore* 6607 (NS)(M, UPS); Fall River Co., 1953 *Weber* (NS)(COLO); Fall River Co., 1.3 miles SE of Gull school, on road to Cascade Springs, on ridge-top along forest boundary, 4200 ft. Sec. 36, T8S, R.3E., 1961 *Wetmore* 10707 (CS)(BM, CANL); Fall River Co., Black Hills, town of Burdock (25 miles W Hot Springs), hilltop NE town, 3730 ft, Sec. 10, T.7S., R.1E, 1961 *Wetmore* 10672 (NS)(UPS); Turner Co., 1963 *Anderson* 3871 (COLO). *Wyoming:* Crook Co., Black Hills, N facing slope of valley Sec. 25, T. 55 N R. 63W, 1960 *Wetmore* 9962 (NS)(NY); Crook Co., Black Hills, at head of Grand Canyon, 2.5 miles N U.S. 85 (18 miles SW Lead), gentle north facing slope, 6300 ft, Sec. 28 & 21, T.49N., R.60W, 1960 *Wetmore* 9574 (NS)(UPS); Weston Co., N of Flying V. Resort (10 miles N of Newcastle), on N facing ridge, 5500 ft, Sec. 5, T.46N., R.61W., 1961 *Wetmore* 11756 (NS)(M).

Localities from which *Cyphelium notarisii* and *C. tigillare* were recorded during the inventory in 1997.

Cyphelium notarisii: **Sweden.** *Småland,* Visingsö par., the island of Visingsö, S part of the island, 200 m NNW of Näs castle ruin, S of the road, property of the farm Jönsagården, south side of wooden barn, 95 m, 58°00'00"N, 14°17'45"E, 1997 (not collected); *ibid.*, S part of the island, 750 m NE of Näs Castle ruins, W of the road, N of property of Andersagården, S and W side of small wooden barn, 100 m, 58°00'32"N, 14°18'10"E, 1997 *Areskoug* 12 (UPS); *ibid.*, S part of the island, 950 m NNW of Näs castle ruin, west of the road, property of the farm Jönsagården, south and west side of wooden barn, 95 m, 58°00'37"N, 14°17'75"E, 1997 *Thor* 15515 (UPS); *ibid.*, S part of the island, 2.9 km SW of Brahe church, Stigby Village, west of the gravel road, property of the farm Bengtsgården, SW side of wooden shed, 110 m, 58°00'80"N, 14°19'20"E, 1997 *Areskoug* 11 (UPS); *ibid.*, mid-part of the island, 2.3 km SW of Brahe church, N of small gravel road, Tunnerstad property 5:18, SW side of wooden barn, 110 m, 58°01'54"N, 14°19'10"E, 1997 *Areskoug* 10 (no apothecia) (UPS); *ibid.*, mid-part of the island, west shore, 2.2 km ENE of Brahe church, Boat house Museum, boathouse on the beach, on south and west side of south-western corner pillar, 90 m, 58°02'39"N, 14°18'70"E, 1997 *Thor* 15516 (UPS); *ibid.*, mid-part of the island, 2.5 km N of Brahe church, Torp village, W of the road, property of the farm Törsagården, south side of wooden garden shed, on the door, 100 m, 58°03'40"N, 14°20'70"E, 1997 *Areskoug* 4 (UPS); *ibid.*, N part of the island, 5.6 km NE of Brahe church, the area Lyckan, farm N of Sadelmakaregården, west of the road, on SW wall of barn, 90 m, 58°04'89"N, 14°22'30"E, 1997 *Areskoug* 5 (no apothecia) (UPS); *ibid.*, N part of the island, 6.5 km NNE of Brahe church, Erstad village, the farm Kockegården, south of the road, W and E side of wooden shed, high shade cover, 90 m, 58°05'32"N, 14°23'77"E, 1997 (not collected; reported from here as locality 7 by Thor 1993); *ibid.*, N part of the island, 7 km NNE of Brahe church, Erstad village, the farm Svengården, W and S wall of wooden barn, 95 m, 58°05'60"N, 14°24'12"E, 1997 *Areskoug* 8 (no apothecia) (UPS); *ibid.*, N part of the island, 7.2 km NNE of Brahe church, 400 m N of the houses Hospitalen, west of the road, SW and NW wall of wooden barn, 95 m, 58°05'80"N, 14°23'20"E, 1997, *Thor* 15517 (UPS); *ibid.*, N part of the island, 7.5 km NNE of Brahe church, Ed village, the farm Storegården, on south side of wooden barn, 90 m, 58°05'90"N, 14°23'88"E, 1997 *Areskoug* 7 (UPS). *Gotland:* Sanda par., 3.5 km N of Klintehamn, Koviks Fishing Village Museum, on south side of wooden fishing hut, 5 m, 57°25'N, 18°10'E, on east and west side of wooden fishing hut, 1997 *Areskoug* 16 (no apothecia) (UPS); Fårö par., Fårö Island, the village Broa, 50 m from harbour, on wall of wooden house, 5 m, 57°52'N, 18°05'E, 1997, *Areskoug* 17 (UPS); *ibid.*, 2.2 km NE of Fårö church, the farm Hammars (property 1:42), NW of the road, SW side of wooden shed near the road, 15 m, 57°56'N, 19°09'E, 1997 *Areskoug* 22 (no apothecia) (UPS); *ibid.*, 4 km NNW Fårö church, Lauter village, W of the road, SW side of old wooden barn, 5 m, 57°57'N, 19°06'E, 1997 *Areskoug* 19 (UPS); *ibid.*, 4 km NNW Fårö church, Lauter village, E of

the road, SE of mill, SW and NE side of wooden portion of stone mill, 5 m, 57°57'N, 19°06'E, 1997 *Areskoug 20* (UPS); *ibid.*, 7 km NE Fårö church, the farm Ringvida, W side of old wooden barn near the road, 10 m, 57°57'N, 19°13'E, 1997 *Areskoug 23* (UPS); *ibid.*, 5 km NNE of Fårö church, the farm Kåldurivshagen, west of the road, S side of large newer barn wall and door, 10 m, 57°58'N 19°09'E, 1997 *Areskoug 21* (no apothecia) (UPS); *ibid.*, 600 m ENE of Skär village, W wall of large wooden barn behind windmill, 5 m, 57°59'N, 19°19'E, 1997 *Areskoug 24* (UPS).

Cyphelium tigillare: **Sweden**. *Gotland*: Fårö par., Fårö Island, 7 km N of Fårö church, Digerhuvud Nature Reserve, fishing vil-lage, on wooden roof of fishing hut, 45° angle, 5 m, 57°59'N, 19°08'E, 1997 *Areskoug 18* (UPS).