Psoroma femsjonense (Fr.) Trevis., a misunderstood species possibly extinct from Europe

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Psoroma femsjonense, long considered to be a synonym of *P. hypnorum,* is shown here to represent a distinct, misunderstood species. The collections seen are from the lowlands of southern Sweden, Denmark, Germany, the Czech Republic, and France. In these areas, the species has not been collected since 1945 and may prove to be regionally extinct from these countries. However, a report indicates that the species has recently been collected in high-altitude steppes in Anatolia of NE Turkey. *Psoroma femsjonense* is most similar to *P. tenue* var. *tenue*, known from Antarctica and adjacent areas of the Southern Hemisphere, and obviously has different climatic demands, in addition to having different apothecium margins and paraphyses. In Europe, *P. femsjonense* can be distinguished from *P. hypnorum* by the chestnut-brown thallus, crenulate (but not squamulose) apothecium margins, low perispore verrucae, and the presence of porphyrilic acid methyl ester and pannaric acid in the thallus. *Psoroma tenue* var. *boreale* differs from *P. femsjonense* by the distinct cinnamon-brown colour, strongly glossy thallus, and a predominantly alpine and arctic distribution.

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Introduction

The history of the genus *Psoroma* Ach. ex Michx. started with 'Flora Boreali-Americana' by Michaux (1803), and was continued by Gray (1821), who combined a heterogeneous group of eight species into this genus. One of these was the generic type, *Psoroma hypnorum* (Vahl) S.F. Gray, with a history leading considerably further back in time to the publication of the basionym *Lichen hypnorum* by Vahl (1787), see reproduced illustration by Jørgensen (1999). However, another name, *Lichen multiflorus* Ehrh. is even older and was published from 'Upsaliae' in an exsiccate by Ehrhart (1785). This name has been cited in the early literature and was listed under *Lecanora (Psoroma) hypnorum* by T.M. Fries (1871), but is an invalid name published without an accompanying description. A few years ago, I published a presentation of *Psoroma hypnorum* var. *campestre* (Th. Fr.) Räs. in Scandinavia (Elvebakk 2012). The conclusion was that this taxon is not related to *P. hypnorum* but is instead within the *Psoroma tenue* Henssen complex. It was hoped that the publication could lead to new finds that could make available fresh material for sequencing and contribute to the application of a name at species level. After having studied type material of *Parmelia femsjonensis* Fr. described by E.M. Fries (1825a), I realized that this represented the same taxon and was its valid name. This name was combined as *Psoroma femsjonense* (Fr.) Trevis. by Trevisan (1869), placed into synonomy with *P. hypnorum* by T.M. Fries (1871) and has been neglected ever since. The purpose of the present paper is to discuss its distinction from similar species, provide a modern description and updated nomenclature, including its synonyms, as well as discuss its distribution in Europe, the latest collection seen by me being from 1944.

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Material and Methods

Specimens deposited in the herbaria B, C, S, UPS, and W were studied, and the list of specimens include those already reported by Elvebakk (2012). In microscope sections, iodine reactions were tested by adding IKI to mounts pretreated with KOH (Orange et al. 2010). Perispore structures were studied in water mounts and restricted to spores released from the asci. Ascospore morphology was studied by drawing detailed sketches of c. 80 ascospores from 8 samples and copies of all original drawings have been included with the specimens. Several specimens of related species were studied for comparison, in particular potential *P. hypnorum* samples from within the distribution area of *P. femsjonense*, including heterogeneous samples of the latter from Denmark. Thin-layer chromatography of acetone extracts followed standardized procedures and used solvents A and C (Culberson 1972; Orange et al. 2010). The nomenclature of ascospore structures follows Nordin (1997).

The species

***Psoroma femsjonense* (Fr.) Trevis.**, Lich. Veneta Ser. I, Vol II, Fasc. III–IV: 98 (1869). Figs 1–6.

Parmelia femsjonensis Fr., Stirp. Agri Femsionensis: 33 (1825a). *Lecanora femsionensis* (Fr.) Fr., Stirp. Agri Femsionensis Contin. II: 34 (1825b). *Psoroma hypnorum var. femsjonense* (Fr.) Nyl., Mém. Soc. Imp. Sci. Nat. Cherbourg 3: 176 (1855). *Psoroma hypnorum* f. *femsjonense* (Fr.) Rostr., Bot. Tidsskr. 4: 96 (1870). *Lecanora hypnorum* f. *femsionensis* (Fr.) Th. Fr., Lichenogr. Scand. I: 233 (1871). *Psoroma hypnorum* var. *femsjonense* (Fr.) Räs., Ann. Bot. Soc. Zool.-Bot. Fenn. Vanamo II; 1: 45 (1932). – Type: Sweden, Småland (county of Halland), Femsjö in terra humosa adusta versus lacum Femen, undated, E.M. Fries (UPS L-108325–neotype!, designated by Jørgensen 1978: 26; holotype, designated here).

Lichen multiflorus Ehrh., Plantae Crypt. Linn., (1785), nom. nud.

Pannaria femsjonensis (Fr.) Anzi var. *microphylla* Anzi, Catal. Lich. Sondr. 36 (1860), nom. nud., see Jørgensen (1978).

Pannaria hypnorum var. *campestris* Th. Fr., Lich. Arctoi: 79 (1860). *Lecanora hypnorum* f. *campestris* (Th. Fr.) Th. Fr., Lichenogr. Scand. I: 233 (1871). *Psoroma hypnorum* f. *campestre* (Th. Fr.) Stein (as *campestris*), Kryptog.-Flora Schlesiens 2; 2: 102 (1879). *Psoroma hypnorum* var. *campestre* (Th. Fr.) Räs. (as *campestris*), Ann. Bot. Soc. Zool.-Bot. Fenn. Vanamo 18: 56 (1943). – Type: Sweden, Uppland, Uppsala, Lassbybackar, 9 June 1852, T.M. Fries (UPS, L-012452–lectotype!, designated by Jørgensen 1978: 26).

Etymology: The species is named after the village Femsjö, in the county of Halland, southern Sweden, where both Elias M. Fries, son of the local priest, and his son Th. M. Fries were born.

Description: Thallus squamulose, bipartite, terricolous, forming 2–5 cm wide patches on an indistinct hypothallus. Chlorobiont squamules 0.3–1 mm wide, shallowly and irregularly incised, prostrate to ascending, 0.2–0.25 mm thick; upper surface glabrous, matt, chestnut brown without any reddish hue. Upper cortex 20–25 µm thick, sclerenchymatic, upper third dark brown, below pale brown, paraplectenchymatic, lumina mostly elongate, mostly arranged perpendicularly to the upper surface, 5–10 × 5–7 µm, walls 2–3.5 µm thick. Chlorobiont layer c. 25 µm thick, of *Trebouxia* cells, globose to irregularly subglobose, 8–13 µm diam., chloroplasts mostly angular and nodulose, in one sample instead subglobose and papillose. Medulla 150–180 µm thick; lower cortex absent. Cyanobiont *Nostoc*, in globose, nodulose to coralloid cephalodia, blackish, 0.1–1.5 mm wide,

Figure 1. *Psoroma femsjonense* holotype. Scale bar = 5 mm.

situated on the chlorobiont squamules or directly on the hypothallus between them, very common, covers up to 30 % of the thallus, *Nostoc* cells bluish green, irregularly subglobose to ellipsoid, often angular, 4–6 × 3–4 µm, organized within glomeruli and without visible chain structures.

Apothecia common, substipitate, 1–1.5(–3) mm wide, discs reddish brown to dark brown, concave becoming almost flat; thalline excipulum 0.1–0.2 mm broad, crenulated, mostly with 0.2–0.4 mm wide inrolled lobes, lower sides with ochraceous tomentum. Epithecium intensely red-brown, c. 10 µm thick, hymenium c. 100 µm, hypothecium greyish brown, 50–80 µm, strongly IKI+ blue. Paraphyses simple, septate, terminal cells 1.5–2.5 µm wide, indistinctly swollen. Asci clavate, 70–80 × 20 µm, with 8 spores and with an internal apical structure shown as a distinct tube in moderate IKI concentration, plug-like in stronger concentrations; spores proper citriform to ovoid,

Figure 2. *Psoroma femsjonense* holotype. Scale bar = 5 mm.

rarely regularly ellipsoid, 14–22 × 8–12 µm, perispores of the same shape, densely verrucose with small 0.5 µm wide verrucae when immature, regularly verrucose with mostly low and c. 1.5 µm wide verrucae when mature, almost always with distinct nodulose apical extensions, c. 1 × 2 µm in size, larger and c. 3 × 3 µm in immature spores.

Pycnidia common in some samples, blackish, verruciform, laminal, 0.07–0.1 mm wide, ostiole fissure-like, conidia bacilliform 2.5–3 × 0.5 µm.

Chemistry: Porphyrilic acid methyl ester and pannaric acid in small samples analysed by TLC.

Additional specimens studied. **Czech Republic**. *Vysočina*: Moravia, ad terram humosam adargines silvarum prope Trebitsch (= Třebíč), c. 400 m, H. Suza without year, Kryptogamae exsiccatae Nr. 2451 (B 99548; B94554; W 1921-223). **Denmark**. *Nordjylland*: Læsø. Heder nær Vesterø Havn, July 1907, O. Galløe (C); Ferslev, Mølleholm. Udkanten af hede, jord, J. Branth 397 (C). Jutlandia borealis, ad terram im ericetis, J. Branth without year (H-NYL 30837). **France**. (Dept. Yvelines, St. Quentin-en-Yvelines), ad Parisiis, Trappes

(= near Versailles), 1854, W. Nylander (H-NYL 30847). **Germany**. *Hessen*: Telegraphenberg bei Grünberg, an riesigen Abhängen, March 1873, Hellwig (B); *Mecklenburg-Vorpommern*: an etwas bemooster Erde in den Waldungen bei Rostock, H.G. Floerke; Floerke: Deutsche Lich., fasc, VIII: 159 (B 60 0192567); bei Schwerin, in Kiefernwaldungen, exempto herbario ejusdem, Wüstnei (B 60 0192569); bei Schwerin, Tannen bei Neumühle, am Wege nach Göhren am Rande der Tannen, c. 1860, H. Brockmüller (B 60 0099197); *Nordrhein-Westfalen*: Gipfe des Weinbergs bei Höxter, auf Waldboden am Fuss, 1868, Beckhaus (B 60 0192568); *Thüringen*: Wald hinter Knollbuch, 1906, Th. Reinstein (B 87452); Kilians-Kuppe, auf Waldboden am Fuss, 12 Oct. 1906, Th. Reinstein (B 60 0192573); Fuss der Kilianskuppe bei Wernshausen, 1908, Th. Reinstein, in: Migula, W. Cryptogamae Germaniae, Austriae et Helvetiae exsiccatae, Fasc. 35, Flechten, No. 144. (B 94488); Vorharz bei Nordhausen, Fichtenschonung, 5 Oct. 1908, Zschacke (B). **Sweden**. *Uppland*: Vaksala par., Slafsta, 1871, J. Lagergren (BG; UPS); Danmark socken, VII, SO om stn. Bergsbrunna, ett par st. i skogskanten nära vinkeln mell. gräns. till sekt. VI ö. Järnv., 16 May 1943, G. Degelius (UPS); Bergsbrunna, vejkant, brynet af Allmänningen, 3 May 1944, P. Gelting (C); Upsaliae, W. Nylander 1852 (H-NYL 30843); F. Ehrhardt undated, (W, seen; UPS, not seen); Uppsala, Galgbacken, 18 Aug. 1897, T. Hedlund (S); Järlåsa, 1867, S. Almquist (S); *Västmanland*: Götlunda par. (= socken), Hasta, 1860, O.G. Blomberg (UPS); *Södermanland*: Västermo, Råby, 1871, O.G. Blomberg (UPS); Hölö socken, Åbynäs, Aug. 1911, S. Arnell (UPS); *Västergötland*: Axvall, 12 May 1897, C. Stenholm (BG; S; C); Kinnekulle, Österplana hed, *Saxifraga tridactylites-Cetraria islandica-Cladonia symphycarpia*-soc., 22 and 27 May 1944, N. Albertson (UPS); under rödstensplanet S om kyrkan, i *Sedum rupestre*-busk-lavhed, 10 Aug. 1937, N. Albertson (UPS); i *Avena prat.-Festuca ovina-Dicranum scoparium*-soc. 5 Juli 1938, N. Albertson (UPS); Windmeden (in Sunnersberg parish), 14 April 1866, F. Graewe (UPS); *Dalsland*: Bäcke socken, Björtveten, å öppen jord i torr skogsbacke, 21 Oct. 1917, S. & C. Bergström (S, UPS); Bäcke socken, Björtveten, på jord, 24 Sept 1916, S. Bergström (UPS); *Närke*: Axberg socken, Prästgården, June 1888, K. Kjellmark (S); Dylta bruks station, 7 May 1888, K. Kjellmark (S); *Östergötland*: Winnerstad (= Vinnerstad, just S of Motala) 1851, Th. M. Fries (C, UPS); Furingstad, 1909, P.A. Issén (W 1911-3814); Furingstad, St. Söd, 1909, P.A. Issén (H; UPS); in arenariis supra Högtomta paroeciae Vårdnäs, 1 Sept. 1916, F. Nord (S; UPS); Skinberga, 23 Aug. 1913, P.A. Issén (S); Stenhammar: Lich. Suec. Exs. 158 (without geographical information) (W 1909-13418); *Småland*: Kristvalla, July 1871, E.V. Ekstrand (UPS); *Öland*: Böda socken, strax V om lagunen mell. Torp och Nabbelund, krypande c:a 50 m från den expon. stranden, 16 Sept. 1939, T.E. Hasselrot (S).

Psoroma hypnorum *specimens studied from within the distribution area of P. femsjonense*: **Czech Republic**. *Vysočina*: Moravia occid., Třebíč, supra terram graniticam in Pinetis apricis prope pag. Vladislav, alt. ca. 4–500 m, J. Suza without year, Lichenes bohemoslovakiae Fasc. VI: 155, 1931 (W 1931-8216). **Denmark**. *Nordjylland*: Læsø. Heder nær Vesterø Havn, July 1907, O. Galløe (C); heathland, hede, 18 July 1899, L. Kolderup Rosenvinge (C); Ferslev, Mølleholm. Udkanten af hede, jord, J. Branth 397 (C). *Viborg*: Thy, paa hedejord ved Hansted, 9 Aug. 1902, L. Kolderup Rosenvinge (C). **Germany**. *Mecklenburg/Vorpommern*: Mecklenburg (or possibly 'Meulenburg' on the inner envelope) ex herb. Sommerf., det. Flörke (O L-134475); Sachsen-Anhalt: Harz, Blankenburg, F.W. Sporleder 1920 (B 74768). **Sweden**. *Närke*: Tysslinge par., Garphyttan, 1866, P.J. Hellbom (S –F156167); *Gotland*: Sandön, May 1894, G. Hellsing (S-F156107).

Discussion

Notes related to nomenclature

A challenge when trying to define the basionym, cf. Jørgensen (1978), is that Fries' dissertation appears in three different publications, referred to as E.M. Fries ('1825a'; '1825b' and '1826 [1825, 1826]') here, with complete title page references included. The major titles in the two former editions (E.M. Fries 1825a and 1825b), are identical, however subtitles include different dates, the latter also 'Continuatio II' in addition. The former is dated 25 May 1825 (Fig. 3A), the second 11 June the same year, and the two versions have different names of the species in question, and also different diagnoses. The former takes priority, and in the diagnosis the name was '*P. Femsjonensis*', with a

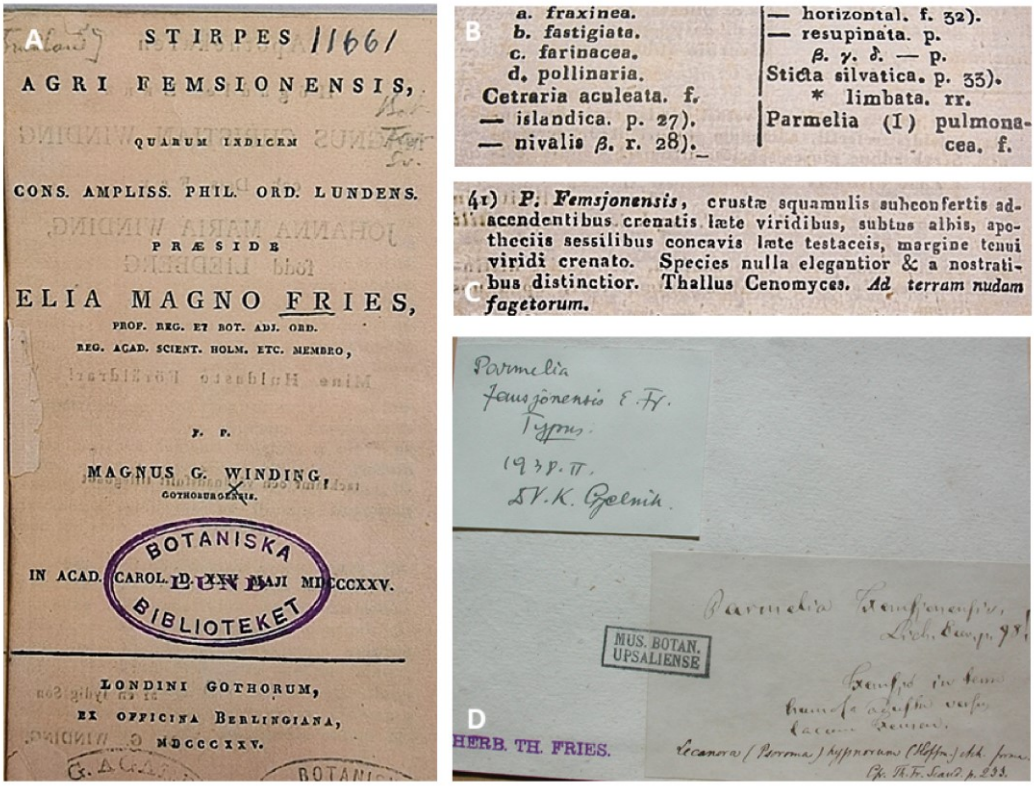

Figure 3. A–C. Publication details from E.M. Fries (1825a). **A**. Cover page showing the publication year 1825. **B**. Details of p. 32 showing that '*P.*' represents *Parmelia*. **C**. Details of p. 34 showing the diagnosis of *P. femsjonensis*. **D**. Annotations on the holotype specimen.

generic position within *Parmelia*, although the epithet was spelled '*Femsionensis*' in an accompanying table. E.M. Fries (1825b) changed the name to '*Lecanora Femsionensis*'.

This shows that the valid basionym is *Parmelia femsjonensis*, whereas the later version should be cited as *Lecanora femsionensis* (Fr.) Fr. E.M. Fries (1826 [1825, 1826]) includes the whole dissertation and is, in the case of *P. femsjonense,* in accordance with E.M. Fries (1825a) with identical page layout. The reference E.M. Fries (1827) was also cited by Jørgensen (1978) when dealing with this species but would refer to one of the separate printed versions of later parts ('Continuatio IV–VI, Continuatio V' cited here) of the dissertation covering other parts than lichens. As there was a suspected disagreement between the name used in the studied version of the thesis (E.M. Fries 1825b) and on the type specimen, the latter was designed as neotype by Jørgensen (1978). However, as shown here, there is agreement between the name used in E.M. Fries (1825a) and the name indicated on the type specimen and the latter is designed here as holotype. This is not affected by the additional notes added on the type specimen by E.M. Fries (reference to a later publication), Th. M. Fries and V. Gyelnik, see Fig. 3D.

We might speculate that E.M. Fries had corrected his spelling of the epithet from the 1825a to his 1825b version, in order to have '*femsionensis*' in agreement with the spelling of this place-name

in the title of his dissertation. However, he described the genus *Femsjonia* later (E.M. Fries 1849), an accepted genus name with quite a number of species. According to Art. 60.6 in the Code, the orginal spelling with j' is not be corrected. Thus, '*femsjonensis*' is accepted here, and '*femsionensis*' is treated as an orthographical variant.

The diagnosis by E.M. Fries (1825a) does not pinpoint any clear differential characters between *P. femsjonense* and *P. hypnorum,* except for the description of apothecium margins as crenate without referring to the squamules typical of the latter. The wording 'thallus Cenomyces' refers to the resemblance with *Cladonia* squamules. As indicated by Figs 1 and 2 and the discussion below, the new species is clearly different from *P. hypnorum*.

The species was combined to species level in *Psoroma* by Trevisan (1869), but this interpretation has never been accepted, and the taxon has remained as a synonym of *P. hypnorum* ever since. *P. femsjonense* does not seem to have been reported under its epithet reliably from any further localities in addition to its type locality but has occasionally been listed as a synonym of *P. hypnorum*. An exception is Räsänen (1932) who reported this taxon, as *Psoroma hypnorum* var. *femsjonense* from Seno Agostini in Chilean Tierra del Fuego. The sample has not been studied, and several alternative interpretations are possible.

The lectotype of *Pannaria hypnorum* var. *campestris* appears heterogeneous. The specimen illustrated as Fig. 5 here is a typical specimen of *Psoroma femsjonense* and has been marked as 'b' on the lectotype. As the remaining specimens, some with partly squamulose margins, have not been examined in a microscope nor tested chemically, a possible second-step lectotypification has been omitted here.

T.M. Fries (1860) provides a short description of this variety, "crusta tenuiore, fusco-virescente, apotheciis minoribus et obscurioribus". His more thorough following description instead referred to a cited exsiccate specimen stated to be intermediate between *Pannaria hypnorum* var. *campestris* and *Parmelia femsjonensis*. *Pannaria hypnorum* f. *campestris* was reported from northern Norway by Norman (1868) as associated with *P. hypnorum* f. *paleacea*. This collection has been studied, and it does not represent *Psoroma femsjonense.* Räsänen (1943) recombined this taxon as *Psoroma hypnorum* var. *campestre,* a combination already made by Nylander (1855), and reported it from Petsamo (now in Russia). I have seen the sample (Petsamo, Maattivuona, Keskijoki. Ad terram muscosam prope cataractum. 29 July 1938, *V. Räsänen,* H) and it represents *P. tenue* var. *boreale,* a taxon which was described much later.

The name *Lichen multiflorus* was introduced in 1785 by Friedrich Ehrhart (1742–1795), a Swiss natural historian and pharmacist who went to Uppsala to study with Linnaeus. The name *Lichen multiflorus* Ehrh. was published in an exsiccate by Ehrhart (1785), without any accompanying description, and is therefore a *nomen nudum,* although the studied W specimen (Fig. 4) clearly represents *Psoroma femsjonense*. Like his generation, Ehrhart had very broad interests, with bryophytes as a speciality, and the genus *Paludella* was described by him, as well as *Betula pubescens* Ehrh. I have searched in vain for possible overlooked descriptions of *L. multiflorus* among numerous writings published by Ehrhart in what appears like a personal journal called 'Beiträge zur Naturkunde', which he published when in Hannover. In one of the articles there (Ehrhart 1790), he included an enumeration of 89 species and five subspecies of lichens from Uppsala, all in the Linnean genus *Lichen*. However, *Lichen multiflorus* was lacking. The name was later included as a synomym of *Lichen brunneus* (= *Protopannaria pezizoides*) by Acharius (1798), and this treatment was followed by a number of authors during the decades to follow, e. g. by Gray (1821). The only critical remark was under the entry '2801. *Lecanora pezizoides*' by 'W.B.' in Hooker (1843) who wrote that an Ehrhart specimen of *Lichen multiflorus* in the Smithian herbarium "appears rather to belong to *L. hypnorum*". In a study dealing specifically with Ehrhart's lichen collections, T.M. Fries

Figure 4. *Psoroma femsjonense*, '*Lichen multiflorum*' specimen at W. Scale bar = 5 mm.

Figure 5. The lectotype of *Pannaria hypnorum* var. *campestris,* specimen 'b'. Scale bar = 5 mm.

(1881) stated that both the UPS and W specimens of *Lichen multiflorus* corresponded to his own taxon *Lecanora hypnorum* var. *campestris*. The conclusion remains that the name *Lichen multiflorus* can be maintained as a *nomen nudum*.

How to distinguish *Psoroma femsjonense* from similar species?

Psoroma femsjonense is normally easily separated from *P. hypnorum* by the flatter apothecia, absence of squamules on the apothecium margins, absence of whitish tomentum on the lower apothecium sides, chestnut brown thallus colour (normally lighter brown in *P. hypnorum*, and sometimes red-brown with a mustard yellow tinge in old herbarium samples), and presence of porphyrilic acid methyl ester and pannaric acid in the thallus (secondary substances absent in *P. hypnorum*). An illustration by Jørgensen (1978) as well as numerous own unpublished spore sketches of *P. hypnorum,* show higher, often hemispherical verrucae, appearing as 'swollen', clearly different from the lower ones of *P. femsjonense* shown as Fig. 6. The apical perispore extensions are higher than the verrucae in *P. femsjonense*, however, in *P. hypnorum* they are even more swollen, in some cases even 'balloon-shaped'.

As indicated by Elvebakk (2012), *Psoroma femsjonense* is clearly the dominant *Psoroma* taxon south of the northern limit of oak in Sweden, a classical phytogeographical concept referred to as 'Limes norrlandicus', whereas *P. hypnorum* appears to be much rarer in this part of the country. Two cited specimens of the latter from the provinces of Närke and Gotland, the latter with distinct squamulose apothecium margins, the former less so, but analyzed as TLC negative. Both collections proved to have very distinct *P. hypnorum* perispores, with large swollen verrucae and very large apical extensions, in some cases balloon-like.

Two specimens from southern Sweden, (Västra Götaland: Norra Ving sn., Axvalla hed, 16 Aug. 1923, G.N. Degelius, UPS¸ and Kinnekulle, Österplana hed, i *P. salicina*-rik *Avena-Festuca-Dicranum* soc. (79), 5 July 1938, N. Albertsson, UPS) have surprisingly been provisionally determined by the present author as the otherwise mostly arctic-alpine taxon *Psoroma tenue* var. *boreale*. These will be restudied for a closer treatment of the latter.

The three C collections from Denmark published as *P. hypnorum* var. *campestre* by Elvebakk (2012) have now been restudied. Two of them represent a mixture of *P. femsjonense* and *P. hypnorum*, and one was redetermined as *P. hypnorum.* The same is the case with an additional collection from Thy in 1902. A total of three localities of *P. femsjonense* are now known from Denmark, including the new one published here, whereas four localities of *P. hypnorum* are listed among the specimens studied. A single sample cited from northern lowlands of Germany has been determined as *P. hypnorum*, although as a deviating form with wide and appressed apothecia, small, suberect and inflated squamules and perispore verrucae and apical extensions more inflated than normally.

Psoroma femsjonense could be confused with *P. tenue* var. *boreale*, which is widely distributed but overlooked in the Northern Hemisphere (see, e.g., Breuss 2012). This taxon has recently been included in *P. cinnamomeum* by Marthinsen et al. (2018), an otherwise austral species previously reported only from a single Northern Hemisphere locality on an islet off Los Angeles (Jørgensen 2001a). Their conclusion is based on a single-marker phylogeny showing closer genetic similarity to the latter species than to *P. tenue*. As the chemistry of *P. cinnamomeum* is different from the one of *P. tenue* var. *boreale,* own conclusions on this taxon will be postponed until a planned study on the group has been finished. However, *P. tenue* var. *boreale* is a distinctly arctic-alpine taxon with uncertain localities in lowlands of southern Fennoscandia where *P. femsjonense* occurs. It can also easily be recognized by its strongly glossy, cinnamon-coloured thallus, including a hue of orange, see e.g. comparative illustrations by Breuss (2012).

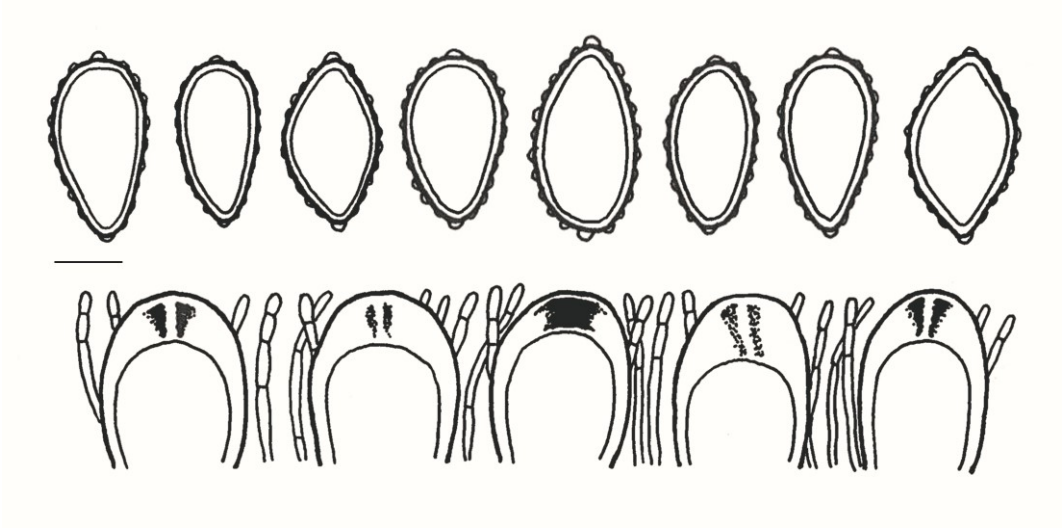

Figure 6. *Psoroma femsjonense*, ascospores, paraphyses and asci with internal apical amyloid structures shown when studied with different IKI concentrations. Scale bar = 10 µm.

Psoroma femsjonense is most similar to the Southern Hemisphere taxon *P. tenue* var. *tenue.* Except for being austral, the latter taxon has a much more polar-alpine distribution, as it occurs in Antarctica and southernmost South America, contrasting the thermophilous lowland occurrences of *P. femsjonense* in Europe. Both taxa have matt thalli with similar brown colours, and morphologically, *Psoroma femsjonense* differs most clearly in its thalline excipulum. In *P. tenue* ssp. *tenue*, apothecia have a narrow, finely crenulated margin, whereas *Psoroma femsjonense* is crenate, with broad, inrolled lobes (Figs 1–2). In the '*Lichen multiflorum'* specimen illustrated as Fig. 4 the apothecium margins have been eroded and look more similar to those of the type specimen only in the protected apothecia. The spores of the two taxa are quite similar. The ascospores are slightly shorter in *P. femsjonense*, however, the paraphyses of the latter are much narrower than the swollen ones of *P. tenue* var. *tenue* (Fig. 6). A key to the known *Psoroma* taxa of Europe, in addition to *P. tenue* var. *tenue* from the Southern Hemisphere, is shown below.

Habitats, distribution pattern and conservation needs

All European samples of *Psoroma femsjonense* are from lowlands. Habitat information indicates that it is a species of dry, open sites, such as heathland in Denmark, dry, open soil in forest margins, roadsides, dry forests and rarely alvar communities in Sweden, and roadsides and pine woodlands in Germany. Several samples include remains of fine, clayey or otherwise fine-textured calcareous soil. The habitat description of the holotype specimen indicates that it was collected from burned soil in beech forest, a process making the soil more minerogenic. Sites like these were kept open by grazing or man-made disturbances in the traditional old agricultural landscape. In 2018, the present author searched in vain for the species in two of its previous localities in Sweden. From Kinnekulle, where several collections are from alvar communities, a sample from 1945 deposited at LD (not seen) is the latest known observation in Europe. However, the exposed, dry ridges there were now extremely eroded by grazing, possibly by the locally very large and introduced fallow deer population and were practically devoid of lichens. At Axvall, where C. Stenholm had collected both

P. femsjonense and *P. paleaceum* in 1897, see Timdal & Tønsberg (2006) for the latter, the oak forest was still open, but the herb vegetation was poorly grazed and much too luxuriant for lichens. Stefan Ekman (pers. comm.) has informed that the sites of *P. femsjonense* in and near Uppsala have now been subjected to changes or have been urbanized. These factors involving changes in land-use have probably operated also in other geographical areas. In addition, air pollution has probably also been very important in central parts of Europe, whereas global warming is considered less threatening as the species is considered thermophilous.

Including the samples reported by Elvebakk (2012), *Psoroma femsjonense* is now known from 27 collections from Sweden, three from Denmark, 9 from Germany, one from the Czech Republic and one from France, the latter made near Versailles by Nylander as early as in 1854. The distribution map of *Psoroma hypnorum* from the British Isles includes quite a number of localities from southernmost parts of England (Seaward 1995) which have all gone extinct. I have not yet seen any of these specimens, but a comparison with the biogeography of the species in the remaining part of Europe indicates that these samples are more likely to represent *P. femsjonense* than *P. hypnorum*, a hypothesis which should be checked.

Strikingly, the report of *Psoroma tenue* from the Anatolia, northeastern Turkey by Kocakaya (2016) illustrates a lichen with brownish apothecium discs, thalline excipuli which are crenate with wave-like outgrowths and without squamules, contrasting brown thalline squamules. The apothecia look exactly like those illustrated from the type specimen of *P. femsjonense.* It was collected in 2014 at 2365 m in steppe just south of the ridge of the Kaçkar mountain chain, where the rain shadow effect from the north is very pronounced, and the specimen is determined as *P. femsjonense* here, hoping that more localities will be discovered.

The youngest samples from Germany were collected during the period 1906–1908. Wirth et al. (2013) writes that all lowland localities of '*Psoroma hypnorum*' in Germany are extinct. Most of these represent *P. femsjonense*, with two exceptions confirmed as *Psoroma hypnorum* here, see the list of studied specimens. One is from northern Germany and originates from Sommerfelt's herbarium. He mainly collected in Norway, although a German locality is indicated on this specimen, obviously sent to Flörke for determination. The second one is from the Hartz Mountains, and may originate from higher altitudes, although such information is lacking. The German Red List of lichens (Wirth et al. 2011) listed *Psoroma hypnorum* as strongly threatened, a conclusion which includes also material now redetermined as *P. femsjonense*. The true status of *P. hypnorum* in Germany is not known as it has been much confused with *P. tenue* var. *boreale*, and the illustration by Wirth et al. (2013) of *Psoroma hypnorum* represents *P. tenue var. boreale.* Breuss (2012) redetermined dozens of *P. hypnorum* samples from the Alps to the latter taxon, but did not include specimens from Germany. No *Psoroma* species were mentioned in the analysis of threatened lichens in Germany by Litterski et al. (2019). *Psoroma femsjonense* should now be considered as candidates for the category regional extinct in a forthcoming Red List edition for Germany. This might also include *P. paleaceum*, regarded as data deficient by Wirth et al. (2011), but as lost in Germany by Wirth et al. (2013).

In Denmark, *Psoroma paleaceum* has not been found since its description in 1831, see Timdal & Tønsberg (2006), and samples previously considered to represent the extinct *P. hypnorum* also include *P. femsjonense*. Both *P. hypnorum, P. femsjonense* and *P. paleaceum* should at present be considered as regionally extinct in Denmark, but these species should still be searched for in suitable habitats. Presently, *P. femsjonense* should also be considered as extinct in Sweden, the country with the highest number of records, although also here one could hope for a rediscovery.

The Red List of lichens of the Czech Republic listed *Psoroma hypnorum* as critically endangered (Liška et al. 2008). Stein (1879) cited *Psoroma hypnorum* f. *campestre* as 'nicht selten'

in hills and lower mountains ('Hgl = Hügelregion' and 'Bg. = Bergregion') of Schlesien. Most of this territory is now within Poland, but I have not seen any samples from this area. In the Czech Republic, both *P. femsjonense* and *P. hypnorum* are reported from the Třebíč area W of Brno, both included in exsiccates and therefore originally probably available as large collections. No national herbarium collections from the Czech Republic nor Poland have been included in the present study. However, the status of *P. hypnorum* in a broad sense as CR in the Czech Republic could be extended to both species. I have also searched in vain for the species during an excursion in dry steppe-like, calcareous landscapes in western parts of the Czech Republic. Open, suitable habitats are still preserved there, and I believe this is the most likely place where the species could be re-found within its previously known distribution area in Europe.

The taxonomy of the *Psoroma tenue* group is planned to be dealt with by the author and coworkers based on samples originating from a large geographical area, including North America and hopefully fresh material from Turkey. For the time being, northeast Turkey is the only place where *P. femsjonense* is known to have survived, as opposed to lowlands in southern Scandinavia and central Europe, where all known populations have gone extinct due to changes in land-use. Dry, grazed habitats probably have been among the most vulnerable landscape elements in this context. The same threat has faced *Psoroma hypnorum*, known from even fewer collections in this lowland area, not to mention *P. paleaceum.*

Identification key

Key to the presently accepted taxa of *Psoroma* in Europe, in addition to *P. tenue* var. *tenue* from the Southern Hemisphere.

1. With porphyrilic acid methyl ester and pannaric acid 2
– Without TLC detectable compounds 4

2. Thallus cinnamon brown (with an orange hue) and strongly glossy . . . . . *P. tenue* var. *boreale*
– Thallus dark brown and moderately glossy 3

3. Excipuli crenulate, paraphyses strongly swollen apically, subantarctic distribution . . . . . *P. tenue* var. *tenue*
– Excipuli crenate, paraphyses moderately swollen apically; dry lowland sites or altitudinal steppes in the Northern Hemisphere . . . . . *P. femsjonense*

4. Apothecium margins squamulose without long, scale-like hairs . . . . . *P. hypnorum*
– Apothecium margins without squamules and with long, scale-like hairs, white when dry . . . . . *P. paleaceum*

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