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Tilletia anthoxanthi, a smut fungus new to Moravia

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Tilletia anthoxanthi was found in Moravia (eastern part of the Czech Republic). It is a rare species and new for this area. The hosts of this fungus are *Anthoxanthum alpinum*, *A. aristatum*, and *A. odoratum*. This smut occurs in Europe, Asia, North America, and Australia (incl. New Zealand).

Key words: *Tilletia anthoxanthi*, *Tilletiales*, smut fungi, Moravia.

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Tilletia anthoxanthi byla nalezena na Moravě. Jedná se o vzácný druh, nový pro tuto oblast. Hostitelé této houby jsou *Anthoxanthum alpinum*, *A. aristatum* a *A. odoratum*. Jmenovaná sněť se vyskytuje v Evropě, Asii, Severní Americe a v Austrálii (včetně Nového Zélandu).

INTRODUCTION

This article deals with a find of the rare smut *Tilletia anthoxanthi*. This fungus was described by A. Blytt (1896: 31). It parasitizes *Anthoxanthum alpinum* in Asia (Kazachstan), *A. aristatum* in New Zealand, and *A. odoratum* in Europe, North America, and Australia (incl. New Zealand).

Approximately 100 species of the genus *Tilletia* are known in the world, all parasitizing members of the family *Poaceae*. Sori are dark brown, either in ovaries as ellipsoid balls (in Europe 75 % of the species) or as streaks in leaves and culms (in Europe 25 % of the species); in both cases causing systemic infection. Some of them are parasites of cereals.

MATERIAL AND METHODS

This work is based on herbarium specimens and literature data. Some herbarium data were taken from the internet databases of BPI (Farr et al.), K (Legon & Henrici), and PDD (McKenzie). Herbarium specimens were not revised.

Data on the distribution of *Tilletia anthoxanthi* are structured as follows: continent, country, region, district (mountain range), municipality, cadastral zone, name of the locality.

Administrative units are set according to internet websites, arranged alphabetically. Coordinates were taken from internet websites or calculated from maps.

The area of Moravia is understood as the Moravian-Silesian Land ("Země Moravskoslezská") which was effective in the periods 1928-1939 and 1945-1948. See the map in Kokeš and Müller (2004: 122).

Abbreviations of herbaria

BP = Hungarian Natural History Museum, Dept. of Botany, Budapest, Hungary
BPI = U. S. National Fungus Collections, Beltsville, United States of America
DAR = Orange Agricultural Institute, Orange, Australia
DBN = National Botanic Gardens, Dublin – Glasnevin, Ireland
HBG = Institute of General Botany, Hamburg, Germany
HUV = Herbarium of *Ustilaginales* by Kálmán Vánky, Tübingen, Germany
CHUR = Natural Bündner Museum, Chur, Switzerland
K = Royal Botanic Gardens, Kew, United Kingdom
KO = Petr Kokeš, Vyškov, Czech Republic
M = Botanical State Collections, München, Germany
NCRI = Bioforsk, Dept. of Plant Health and Plant Protection, Ås, Norway
O = Botanical Garden and Museum, Oslo, Norway
PDD = New Zealand Fungal Herbarium, Landcare Research, Auckland, New Zealand
TROM = University of Tromsø, Dept. of Botany, Tromsø, Norway
WA = University of Warsaw, Institute of Botany, Dept. of Plant Systematics and Geography, Warszawa, Poland

RESULTS AND DISCUSSION

Tilletia anthoxanthi A. Blytt

Description of the Moravian locality

In 2006, the author found *Tilletia anthoxanthi* on *Anthoxanthum odoratum* in the Hrubý Jeseník Mts. The locality is situated on the slope of Mt. Praděd, the highest mountain of Moravia, near the spring of the brook of Sokolí potok. It is located in the cadastral zone of Malá Morávka in the Bruntál district, 0.51 km NE of Mt. Praděd (1487.3 m a. s. l.), 95 m NNW of the stream of the brook of Sokolí potok, in a meadow below a plot of dwarf mountain pine. The coordinates are 50°05'08.3'' N, 17°14'22.9'' E, alt. 1,376.6 m. These values were calculated from the „Základní mapa ČR" map (number 14-24-19) published in 1999 (2nd edition). These maps use the Bessel ellipsoid.

The habitat is a degraded mountain meadow; the host *Anthoxanthum odoratum* and the smut are frequent at this locality. This collection is the first re-

cord of *Tilletia anthoxanthi* in Moravia. The spore sizes of this fungus from the Moravian locality are as follows: 21–28 × 24–31 µm (circa 60 spores measured).

Morphological description

Infected plants have the same appearance as healthy ones. The ear is only imperceptibly changed. Infection is systemic, all ovaries of an inflorescence are usually infected.

Sori globose, grey-purple, 3–4 mm in diameter, mostly concealed between glumes, covered by the pericarp; membrane fragile. Spore mass dark reddish brown, loose, powdery. Spores usually globose, rarely ellipsoidal to somewhat irregular, yellowish, later reddish brown, 20–28 × 24–32 µm; wall 2–3 µm thick, reticulate to slightly cerebriform, interspaces smooth, violet brown; meshes round or angular, usually pentahedral, 3–5.5 µm in diameter; muri 1–3 µm high, at the base usually 1 µm, rarely up to 2 µm wide; crests of the muri sharp or somewhat blunted. Sterile cells globose to ellipsoidal or irregular, 12–14 µm long, yellow-tinted hyaline, wall smooth, 1.5–2.5 µm thick.

The „CMI description" of *Tilletia anthoxanthi* was published by Waller and Mordue (1983: 1) as *T. holci* (incl. *T. anthoxanthi*).

OUTLINE OF THE WORLD DISTRIBUTION

Sori of *Tilletia anthoxanthi* are easily overlooked, and thus this smut may be found at many more localities in the world, since the hosts are distributed worldwide. The list of localities is certainly not complete since I contacted curators from important herbaria only. I used literature data to a small extent only, because many papers are scattered over the whole world and difficult to obtain.

on *Anthoxanthum alpinum*

ASIA

Kazachstan

Almaty:

Zailijskij Alatau Mts. (Azbukina and Karatygin 1995: 120) [43°00' N, 77°00' E]

on *Anthoxanthum aristatum*

AUSTRALIA*

New Zealand

Otago:

Dunedin city, Clark's Junction: leg. V. D. Zotov (20 Jan 1938 in PDD, Vánky and McKenzie 2002: 134) [45°44' S, 170°03' E]

* Understood as the continent, including New Zealand.

on *Anthoxanthum odoratum*

ASIA

Kyrgyzstan

Ysykköl:

Žeti-ögüz distr. (Těrskej Alatau Mts.), on W slope towards the Irdyk river: leg. I. Lichačeva (29 Aug 1949 in Pospělov et al. 1957: 36) [The locality lies c. 18.5 km S of the town of Karakol; 42°19' N, 78°24' E.]

AUSTRALIA

Australia

New South Wales:

Wallace distr. (Snowy Mts.), Mitchell mun., Diggers Creek Lake, alt. 1,490 m: leg. J. Thompson (29 Jan 1977 in DAR, Ványky and Shivas 2008: 148) [The locality lies in the Kosciuszko National Park; 36°22' S, 148°29' E.]

New Zealand

Canterbury:

Ashburton distr., Camp Lake, alt. 670 m: leg. E. McKenzie & K. Ványky (2 Feb 1990 in HUV, PDD, Ványky and McKenzie 2002: 134) [The locality lies in the Hakatere Conservation Park; 43°37' S, 171°04' E.]

Hurunui distr., near the village of Hanmer Springs, Jack's Pass, alt. 880 m: leg. E. McKenzie & K. Ványky (30 Jan 1990 in BPI, HUV, LE, M, PDD, Ványky and McKenzie 2002: 134) [The locality lies c. 5.3 km NNW of the village of Hanmer Springs; 42°29' S, 172°49' E.]

Mackenzie distr., 7 km SE of Mt. Cook, near the village of Mount Cook, near a hermitage: leg. E. McKenzie & K. Ványky (3 Feb 1990 in HUV, PDD, Ványky and McKenzie 2002: 134) [43°44' S, 170°07' E]

Mackenzie distr., 11 km NNE of the village of Lake Pukaki, Pukaki Lake, E shore, Hayman Road, alt. 540 m: leg. E. McKenzie, C. Ványky & K. Ványky (4 Feb 1998 in HUV, PDD, Ványky and McKenzie 2002: 134) [44°05' S, 170°13' E]

Mackenzie distr., 13 km SE of the town of Lake Tekapo, alt. 660 m: leg. E. McKenzie, C. Ványky & K. Ványky (4 Feb 1998 in HUV, PDD, Ványky and McKenzie 2002: 134) [44°06' S, 170°35' E]

Selwyn distr., near Andrew's Shelter: leg. E. McKenzie & K. Ványky (1 Feb 1990 in HUV, PDD, Ványky and McKenzie 2002: 134) [The locality lies in the Arthur's Pass National Park; 42°59‘ S, 171°47‘ E]

Selwyn distr., Waimakariri Gorge Bridge, alt. c. 400 m: leg. G. H. Cunningham (Jan 1927 in PDD, Cunningham 1928: 503) [43°22‘ S, 172°03‘ E]

Waimakariri distr., Bennetts, alt. 250 m: leg. J. C. Neill (Jan 1927 in BPI, HUV, PDD, Ványky and McKenzie 2002: 134) [43°18‘ S, 172°18‘ E]

Otago:

Queenstown-Lakes distr., Arrow River: leg. G. C. M. Latch (17 Apr 1964 in PDD) [45°01‘ S, 168°53‘ E]

EUROPE

Czech Republic

Moravia:

Bruntál distr. (Hrubý Jeseník Mts.), Malá Morávka, Praděd Mt., ENE slope, near the spring of the brook of Sokolí potok, alt. 1,377 m: leg. P. Kokeš (17 Aug 2006 in KO) [50°05' N, 17°14' E]

Ireland

Munster:

Cork distr., Ardnageehy mun., W of Glenville: leg. M. Scannell (23 Aug 1988 in DBN) [Glenville is a suburban neighborhood; 52°03' N, 8°26' W; together with *Claviceps purpurea*]

Ireland is mentioned also by Zundel (1953: 281) who ment another locality which is unknown to me.

Norway

Hordaland distr., Granvin mun.: leg. J. Havås (26 Jul 1895 in O, UPS) [60°34' N, 6°45' E]
Hordaland distr., Odda mun., Røldal: leg. I. Jørstad (28 Jul 1925 in O, UPS) [59°51' N, 6°49' E; together with Claviceps purpurea]
Nordland distr., Røst mun., just W of the village of Røstlandet, Hansøy Østreå: leg. J. Reiersen (in NCRI) [67°30' N, 12°03' E]
Nord-Trøndelag distr., Leksvik mun., Hindrem: leg. H. Bryn (in O, Blytt 1896: 31) [63°40' N, 10°29' E; lectotype]
Nord-Trøndelag distr., Leksvik mun., Vanvikan: leg. H. Bryn (in O, Blytt 1896: 31) [63°33' N, 10°13' E]
Oppland distr., Nord-Aurdal mun.: leg. A. Hagen (24 Jul 1944 in O) [60°59' N, 9°15' E]
Sogn & Fjordane distr., Aurland mun.: leg. I. Jørstad (20 Sep 1923 in BPI, O) [60°52' N, 7°15' E]
Sogn & Fjordane distr., Lærdal mun., Lærdalsøyri: leg. L. Solberg (4 Jul 1926 in O) [61°06' N, 7°29' E]
Sogn & Fjordane distr., Leikanger mun.: leg. I. Jørstad (14 Jul 1926 in O) [61°12' N, 6°47' E]
Sør-Trøndelag distr., Midtre Gauldal mun., near Singsås, Vestre Hinsverk, alt. 225 m: leg. T. Ouren (31 Jul 1959 in O) [62°58' N, 10°42' E]

Poland

Lesser Poland:

Tatran distr., Zakopane mun., Skibówki, alt. 850 m: leg. T. Majewski (5 Aug 1963 in HUV, WA, Majewski 1965: 212) [The former village of Skibówki is now a part of the town of Zakopane; 49°17' N, 19°56' E.]

Romania

Transylvania:

Bihor distr. (Apuseni Mts.), Pietroasa mun., Boga Valley: leg. S. Tóth & K. Vánky (5 Jul 1968 in BP, HUV, Vánky 1985: 130) [The locality lies in the Apuseni Nature Park; in the Bihor Mts.; c. 5.9 km ENE of the village of Pietroasa; 46°36' N, 22°38' E.]

Russia

Smolensk oblast:

Gagarin distr. (Gutněr 1941: 200) [The town of Gagarin was formerly named Gžatsk; 55°33' N, 34°59' E.]

Sweden

Uppland:

Stockholms distr., Norrtälje mun., near Vätö, Lidö: leg. H. Hasselman (Aug 1899 in BPI, HBG, LE, M, O, UPS) [The village of Lidö does no longer exist. It was burned down by the Russian army in 1719, and has apparently never been restored. It seems that the name Lidö was still in use in 1899 although the village disappeared (Constantinescu 2008, in lit.); 59°49' N, 18°55' E.]

Switzerland

Graubünden:

Inn distr. (Rhaetian Alps Mts.), Zernez mun., Schera Mt., WSW slope, near the Alp la Schera hut, alt. 2,090 m: leg. B. Stüssi (Aug 1943 in CHUR, Zogg 1985: 96; Aug 1944 in CHUR, Zogg 1985: 96) [The locality lies in the Swiss National Park; 46°39' N, 10°12' E.]

Ukraine

Ivano-Frankivs'k oblast:

Kosiv distr., near the village of Kosmač, Siglenij Mt.: leg. A. Śleńdziński (13 Jul 1880 in Wróblewski 1915: 123) [The locality is originally mentioned in Polish as Sehleń; it lies c. 4.3 km E of the Kosmač village; 48°20' N, 24°52' E, 859 m.]

United Kingdom

Scotland:

North Ayrshire distr., near the village of West Kilbride: leg. D. A. Boyd (18 Jul 1921 in K) [55°42' N, 4°51' W]
Zundel (1953: 281) records also England but I do not know any locality of Tilletia anthoxanthi from this country.

NORTH AMERICA

Canada

Nova Scotia:

Digby distr., near the town of Digby, near a small cove: leg. G. P. Clinton (29 Aug 1927 in BPI) [44°37' N, 65°45' W]

United States of America

Connecticut:

New Haven distr., East Haven mun., Momauguin area: leg. G. P. Clinton (17 Jul 1909 in BPI) [41°15' N, 72°53' W]
New Haven distr., New Haven mun., Westwille area: leg. G. P. Clinton (14 Jul 1907 in BPI) [41°20' N, 72°58' W]
New Haven distr., Hamden mun., Whitneyville area, Hartford Turnpike, back of the New Hawen Country Club, in a meadow: leg. G. P. Clinton (6 Jul 1902 in BPI); leg. G. L. Zundel & G. P. Clinton (21 Jul 1927 in BPI) [41°21' N, 72°55' W]

Pennsylvania:

Bradford distr., Smithfield mun., East Smithfield, farm of L. A. Harris: leg. G. L. Zundel (6 Jul 1934 in BPI) [41°52' N, 76°38' W]
Lycoming distr., Jordan mun., Unityville, farm of J. E. Neuhart: leg. G. L. Zundel (27 Jun 1933 in BPI) [41°14' N, 76°32' W]
Lycoming distr., Lewis mun., Trout Run, Rose Valley, orchard of Allen Apker: leg. G. L. Zundel (3 Jul 1934 in BPI, PDD) [41°23' N, 77°04' W]
Sullivan distr., Dushore mun.: leg. G. L. Zundel (7 Jul 1934 in BPI) [41°32' N, 76°24' W]
Sullivan distr., Cherry mun., 6 miles E of Forksville, on the top of a mountain: leg. G. L. Zundel, L. White & N. C. Dale (16 Jul 1932 in BPI) [41°29' N, 76°28' W]
Susquehanna distr., Silver Lake mun., Quaker Lake: leg. N. C. Dale (Jul 1935 in BPI) [41°59' N, 75°55' W]
Wyoming distr., Noxen mun., Noxen, orchard of E. G. Engleman: leg. G. L. Zundel (9 Jul 1931 in BPI, 14 Jul 1932 in BPI) [41°25' N, 76°04' W]

Notes on ecology, phenology, distribution and related taxa

Tilletia anthoxanthi has been often collected in valleys of streams, near lakes and fjords, on seacoasts, and in mountains, so it is apparently more frequent at localities with a relatively high air humidity. *Tilletia anthoxanthi* occurs together with *Claviceps purpurea* (Fr.) Tul. at two localities (as mentioned above). *Tilletia anthoxanthi* was collected at altitudes from sea level up to 2,090 m (Alp la Schera hut in the Alps, Switzerland).

According to the collection data, the fungus was collected from 27 June to 20 September, mostly in July and August, in the northern hemisphere; from 20 January to 17 April, mostly in January and February, in the southern hemisphere. This

means that the difference in the mean occurrence period in both hemispheres averages half a year.

Tilletia anthoxanthi is very rare on *Anthoxanthum alpinum* and *A. aristatum*. On *A. odoratum* it occurs: 1. scattered in Europe, more often collected only in Norway; 2. only in two states (Connecticut, Pennsylvania) in the north-eastern part of the USA, and on the peninsula of Nova Scotia in Canada; 3. in Australia (New South Wales), in the eastern regions (Canterbury, Otago) of the South Island of New Zealand.

Anthoxanthum alpinum is known from subalpine meadows in Eurasia. *A. aristatum* is native to the Mediterranean, alien in the rest of the world (scattered). *A. odoratum* (sweet vernal) is a plant with a worldwide distribution (common). Although sweet vernal is widespread in the world, *Tilletia anthoxanthi* was collected rarely, only in three regions more often.

Tilletia anthoxanthi closely resembles *T. holci* (Westend.) J. Schröt. which parasitizes *Holcus lanatus*, and *H. mollis*. *Tilletia anthoxanthi* has smaller meshes (3–5.5 µm as compared with 4–7 µm) on the surface of spores than *T. holci*. The meshes in *T. anthoxanthi* are often incomplete to cerebriform and interspaces lack verrucae while in *T. holci* meshes are reticulate and interspaces verruculose. Phylogenetic studies (Castlebury et al. 2005: 893-894, figs. 3, 4) also show differences between *Tilletia anthoxanthi* and *T. holci*.

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