



False Polygonaceae smut: increasing knowledge about *Sphacelotheca polygони-serrulati* Maire in Australia

Tanja M. Schuster^{1,2}, Val Stajsic² and Gregory M. Bonito³

- ¹ BioSciences 3 (formerly The School of Botany), The University of Melbourne, Parkville, Melbourne, VIC 3010, Australia; e-mail: tanja.schuster@unimelb.edu.au
- ² National Herbarium of Victoria, Royal Botanic Gardens Victoria, Birdwood Avenue, Melbourne, VIC 3004, Australia
- ³ Department of Plant, Soil and Microbial Sciences, Michigan State University, East Lansing, MI 48824, U.S.A.

Introduction

The study of interactions between fungi and plants is important because fungi are both significant plant mutualists and disease agents. In the buckwheat family, Polygonaceae, examples of beneficial interactions include ectomycorrhizal fungal symbionts on roots of *Bistorta vivipara* (L.) Delarbre (Mühlmann *et al.* 2008) and arbuscular mycorrhizae on *Fagopyrum* Mill. (Likar *et al.* 2008). These root-associated fungi are known to benefit plant partners through increased nutrient, mineral and water up-take in exchange for carbohydrates (Wang & Qiu 2006).

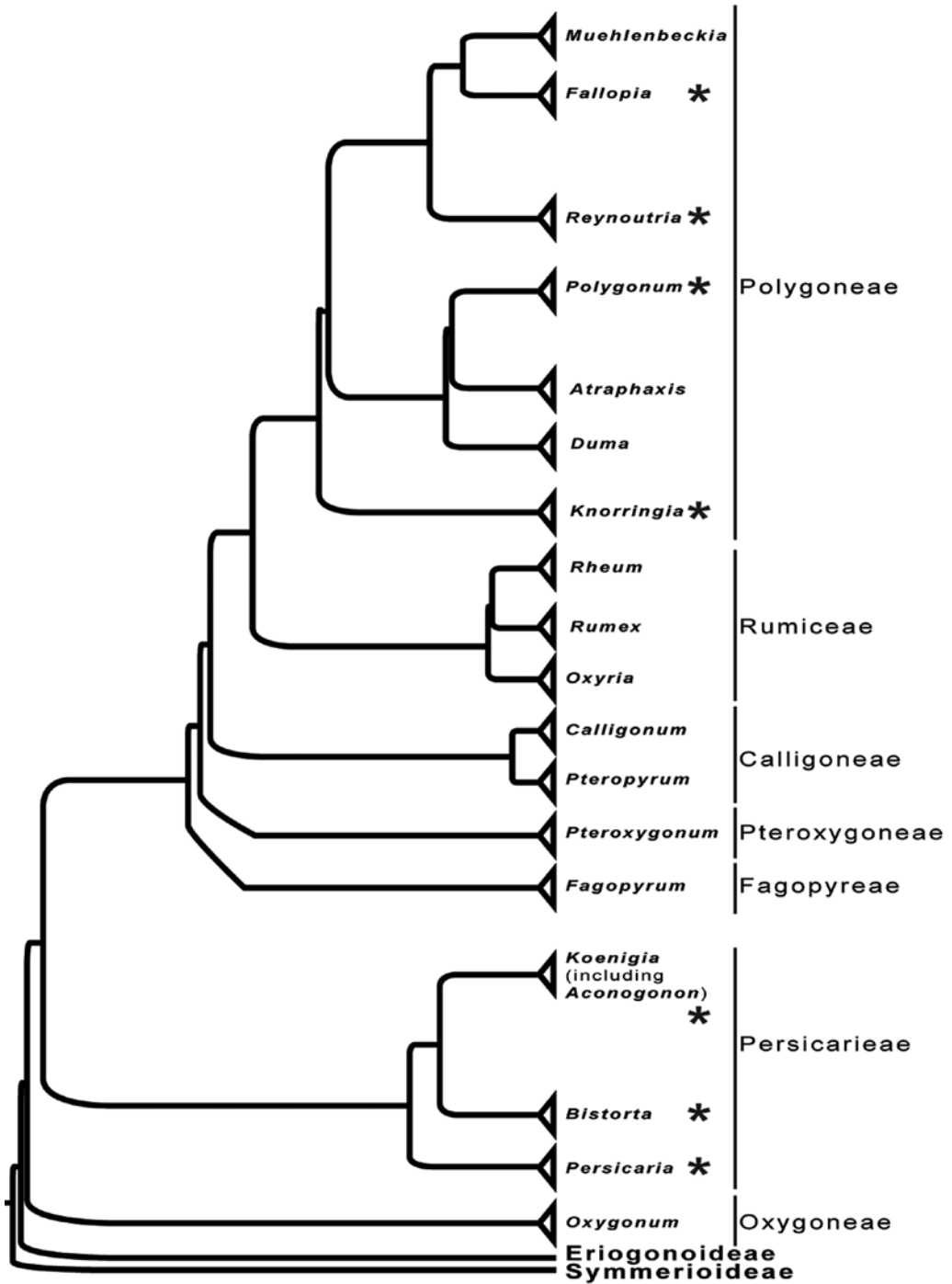
However, some Polygonaceae clades, including Fagopyreae, Persicarieae, Polygoneae, and Rumiceae (Fig. 1), are parasitised by rust and false smut fungi belonging to the Pucciniomycotina (Microbotryaceae) and the distantly related Ustilaginomycotina (*Entyloma* de Bary, *Melanopsichium* G. Beck, and *Thecaphora* Fingerh.) (Vánky 1994; Vánky & Oberwinkler 1994; McKenzie 1998; Vánky 2002; Kemler *et al.* 2006; Piątek *et al.* 2012; Vasighzadeh *et al.* 2014; Klenke & Scholler 2015). False smuts were split from *Ustilago* (true smuts), which use monocots such as Poaceae as hosts, based on morphological (Langdon & Fullerton 1978; Blanz & Gottschalk 1984) and molecular data (Aime *et al.* 2014). This parasitism could have an application in controlling invasive plant species, since fungal leaf endophytes from *Persicaria amphibia* (L.) Delarbre may

Abstract

We report the first record of *Sphacelotheca polygони-serrulati* Maire on live *Persicaria decipiens* (R.Br.) K.L.Wilson flowers and also on some herbarium collections for the Australian Capital Territory (ACT) and the state of Victoria, dating as far back as 1956. Our determination is based on molecular, macro-, and micro-morphological spore ornamentation characters. We also clarify phylogenetic relationships of Polygonaceae hosts with regard to *Sphacelotheca* and related mycoparasites. Our findings show the importance of living and herbarium collections as data sources for increasing our knowledge about interactions of plants and fungi.

Key words: anther smut, Caryophyllales, Microbotryaceae, plant parasite, teliospore ornamentation, urban biodiversity

Figure 1. Cladogram of Polygonoideae (modified from Schuster *et al.* 2015) marking the position of *Polygonum* and genera split from *Polygonum* s.l. with asterisks. Polygonaceae tribes are indicated by bars to the right of the tree.



PCR products with exonuclease and arctic phosphatase and amplicons were Sanger sequenced bidirectionally on an AB3730xl analyser (Macrogen, Korea). Sequences were trimmed and assembled using GENIOUS v.7.0.6. (Biomatters, 2014) and sequence identity was assessed using the BLAST algorithm (Altschul *et al.* 1997) and GENBANK database (<http://www.ncbi.nlm.nih.gov/genbank>). Resulting sequences from our smut samples have been deposited in GENBANK with the accession numbers: KP311405 (ITS), KP311345 (LSU) for *T.M. Schuster TMS14-30A* and KP311404 (ITS), KP311344 (LSU) for *V. Stajsic 7254*.

Sequence Analysis

Newly generated sequences and related sequences downloaded from GENBANK were aligned using MUSCLE (Edgar 2004). For the ITS region 20 ingroup and two outgroup taxa were included in the analysis. For the LSU region 33 ingroup and one outgroup taxon were included. Due to an incomplete overlap of sampled taxa between the two datasets, we analysed them independently. Maximum Likelihood (ML) analyses were run on the CIPRES Science Gateway v.3.3. computer cluster (Miller *et al.* 2010) using RAXML-HPC2 v.8.0.24. (Stamatakis 2006). Options selected for the RAXML analyses were a GTR GAMMA model and a GTRCAT model for 1000 rapid Bootstrap searches. Tree files were exported and edited with FIGTREE v.1.4.1 (Rambaut 2014). Clade support values in text and Figs. 6 & 7 are shown as percent bootstrap support from the ML analyses.

Results

Specimens on which *Sphacelotheca* was found

Host: *Persicaria decipiens*. AUSTRALIAN CAPITAL TERRITORY. Junction of Brindabella and Lee Creek Road, 14.iv.1966, *N.T. Burbidge 7611* (MEL 1551940B). VICTORIA. Mead, xii.1956, *R. Schier s.n.* (MEL 2385252A); Captain Cook National Park. W side of Thurra River, NNE of Cape Everard, 11.xii.1969, *A.C. Beaglehole 32310[A]* & *E.W. Finck* (MEL 2385254A); Murray Valley. Kanyapella Wildlife Reserve, near Echuca, 13.x.1990, *E.A. Chesterfield 2680[A]* & *N. Disken* (MEL 2385253A); South Yarra. Royal Botanic Gardens Melbourne. Ornamental Lake, on E side of Long Island, 31.x. 2014, *V. Stajsic 7254* & *L. Hancock* (MEL 2383469A); Royal Botanic Gardens

Melbourne. Long Island, 9.xi.2014, *T.M. Schuster TMS14-30A* (MEL 2385255A); South Yarra. Royal Botanic Gardens Melbourne. Ornamental Lake, on E side of Long Island, 11.xi.2014, *V. Stajsic 7259* (MEL 2383475A, BRIP, VPRI); South Yarra. Royal Botanic Gardens Melbourne. Ornamental Lake. A-Gate Wetlands, 24.xi.2014, *V. Stajsic 7332* (MEL 2387398A, DAR).

Morphology

Examination with a stereo microscope revealed peridia and columellae on host plant ovaries with a powdery brown, slightly purple-tinted spore mass (Fig. 3). In addition, some teliospores were catenate when not fully developed and connected by disjunctors, later becoming solitary and usually with attached disjunctors, they lacked polar caps, and spores were mostly spherical or subspherical, 8–12(–15) × 8–12 μm, and had a sculpted surface.

Scanning Electron Microscope imaging showed conspicuous disjunctors and reticulate ornamentation of the teliospores (Fig. 4 & 5). Interspaces between the reticulations, with shallow muri, were irregularly shaped and sized, and some had 1–few warts. Subspherical, torus-shaped spores were occasionally catenate (Fig. 4).

Phylogenetic Analysis

The ITS alignment consisted of 679 characters including 344 that were constant and 98 that were parsimony-informative, whereas the LSU alignment included 889 characters of which 799 were constant and 38 were parsimony informative. The Akaike information criterion indicated that GTR+I+Γ was the most appropriate nucleotide substitution model for ML analyses. The ITS (Fig. 6) and LSU (Fig. 7) ML topologies were congruent with each other and place our samples in a well-supported clade composed of other *Sphacelotheca* isolates, and distinct from *Microbotryum*. In addition, *Liroa* is distinct from *Microbotryum* in our analyses.

Discussion

New records of *Sphacelotheca polygona-serrulati* in Australia

Our molecular (Figs. 6 & 7) and morphological results corroborate each other and show that the fungus infecting flowers of *Persicaria decipiens* at the RBGV is the

polygoni-serrulati also occurs on other species of *Persicaria* outside of Australia (e.g., *P. barbata*, *P. hydropiper*, *P. maculosa*, and *P. pulchra* (Blume) Soják). We found an additional specimen of *P. decipiens* from the ACT infected with *S. polygoni-serrulati*, which is the first report for this territory, and a further three Victorian specimens, with the earliest specimen dating to 1956. None of the other species of *Persicaria* examined at MEL were parasitised by *Sphacelotheca*, but a search of *Persicaria* material at other Australian herbaria may yield additional records. Since *S. polygoni-serrulati* has previously been recorded from Western Australia, South Australia, New South Wales, Tasmania, and northern New Zealand (Vánky & Shivas 2008; McKenzie & Vánky 2001), it is not unexpected that this species occurs in the ACT and Victoria, and it is surprising that it has been overlooked so far. On the other hand, a search of the VPRI collections yielded only a single 1893 specimen from Launceston, Tasmania, *L. Rodway* 3109 (VPRI; Jacky Edwards pers. comm. 2014; Vánky & Shivas 2008). This might indicate reluctance by botanists to collect clearly diseased plant material for accessioning into herbaria, which might skew the distributional data for pathogenic fungi.

Microbotryaceae and host plant phylogeny

With regard to Microbotryaceae phylogeny, Kemler *et al.*'s (2006) results showed that *Liroa* and *Sphacelotheca* may actually be nested in a monophyletic *Microbotryum*, though clade support values varied considerably depending on alignment method chosen. In our ML analyses, the LSU data show that *Sphacelotheca* (98% bootstrap support) and *Microbotryum* (95% bootstrap support) form well-supported, separate clades (Figs. 6 & 7). ITS data suggest that accessions of *S. polygoni-serrulati* form a distinct clade, though there is no support for this relationship. *Liroa* is not included in *Microbotryum* in either analysis and may be sister to *Sphacelotheca* (ITS) or sister to both (LSU), but further studies are needed to determine this relationship.

Kemler *et al.* (2006, 2009) also showed that affinity of *Microbotryum* for Polygonaceae has likely arisen multiple times across the evolutionary history of these groups and that Persicarieae may have been the first eudicot lineage parasitised by these false smuts. Since this lineage infects all constituent genera of Persicarieae (Fig. 1), it may have co-evolved with the ancestor of

Persicarieae. Kemler *et al.* (2006, 2009) also showed that another *Microbotryum* lineage that uses additional eudicot families also parasitises Polygonaceae (*Fallopia* Adans. s.s. and *Polygonum* L. s.s.), Persicarieae (*Persicaria* only), and Rumiceae (*Oxyria* Hill and *Rumex* L.). These authors and Oberwinkler (2012) suggested that evolutionary trends in host plant preference of species of *Microbotryum* infecting Caryophyllaceae is narrowly specific, but that it is broad for Polygonaceae. This might actually not be the case and may have been determined by using an obsolete taxonomic concept of *Polygonum* (in the broad sense; Fig. 1). Based on molecular and morphological characters, *Polygonum* s.l. is not a monophyletic group and *Bistorta*, *Fallopia*, *Koenigia* sensu Schuster and Reveal (including *Aconogonon*), *Persicaria*, and *Reynoutria* are monophyletic genera that are not closely related to *Polygonum* s.s. (e.g., Sanchez *et al.* 2009; Schuster *et al.* 2015). Hence, species of *Microbotryum* and *Sphacelotheca* may actually be more host specific than previously thought, at least at the generic level. For example, *M. bistortarum* (DC.) Vánky parasitises both *Bistorta officinalis* (L.) Delarbre and *B. vivipara* (L.) Delarbre, and *M. bosniacum* parasitises *Koenigia alpina* and *K. songarica* (Schrenk ex Fisch. & C.A.Mey.) T.M.Schust. & Reveal (Chlebicki 2006). Both *Bistorta* and *Koenigia* sensu Schuster and Reveal lack detailed phylogenies, and are most speciose in temperate Asia where false smut fungi diversity is also great (Chlebicki 2006). Researchers sampling for molecular phylogenies of these plant groups should keep an eye out for associated false smut fungi, whose diversity is likely also understudied.

A co-evolutionary study of false smuts and their plant hosts will be necessary to settle the taxonomic questions raised here, and to understand the evolutionary history of both lineages. This would be a complex undertaking, since it will require careful sampling of both the plant hosts and species of *Bauerago*, *Liroa*, *Melanospichium*, *Microbotryum*, *Sphacelotheca*, *Zundeliomyces* and other members of Microbotryales (Chlebicki 2006; Kemler *et al.* 2006, 2009). In conclusion, our findings show that it is still possible to discover new and even fairly conspicuous organisms in urban environments and points to the importance of maintaining green spaces in densely populated areas for biodiversity research and conservation.

Acknowledgments

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Spp. No. (50 total)	Fungi	Polygonaceae clade	Polygonaceae host species (currently accepted name)	Synonym used in publication	Publication	Collection location (fungus)
5.	<i>Microbotryum bosniacum</i> (G.Beck) Vánky	Persicarieae	<i>Aconogonon ochreatum</i> var. <i>laxmannii</i> (Lepech.) Tzvelev [likely <i>Koenigia</i>]	<i>Polygonum laxmannii</i> Lepech.	Vánky 1998	N/A
	<i>Microbotryum bosniacum</i> (G.Beck) Vánky	Persicarieae	<i>Koenigia alpina</i> (All.) T.M.Schust. & Reveal	<i>Polygonum alpinum</i> All.	Kemler et al. 2006	Italy
	<i>Microbotryum bosniacum</i> (G.Beck) Vánky	Persicarieae	<i>Koenigia coriara</i> (Grig.) T.M.Schust. & Reveal	<i>Polygonum bucharicum</i> Grig., <i>Polygonum coriarium</i> Grig.	Vánky 1998	N/A
	<i>Microbotryum bosniacum</i> (G.Beck) Vánky	Persicarieae	<i>Koenigia davisiae</i> (W.H.Brewer ex A.Gray) T.M.Schust. & Reveal	<i>Polygonum newberryi</i> Small	Vánky 1998	North America
	<i>Microbotryum bosniacum</i> (G.Beck) Vánky	Persicarieae	<i>Koenigia songarica</i> (Schrenk) T.M.Schust. & Reveal	<i>Polygonum songaricum</i> Schrenk	Vánky 1998	N/A
	<i>Microbotryum bosniacum</i> (G.Beck) Vánky	Persicarieae	<i>Koenigia tripterocarpa</i> (A.Gray) T.M.Schust. & Reveal	<i>Polygonum tripterocarpaceum</i> A.Gray	Vánky 2013	N/A
	<i>Microbotryum bosniacum</i> (G.Beck) Vánky	Persicarieae	<i>Persicaria punctata</i> (Elliott) Small	<i>Polygonum punctatum</i> Elliott	Vánky 2013	N/A
6.	<i>Microbotryum cilinode</i> (Savile) Vánky	Polygoneae	<i>Fallopia cilinodis</i> (Michx.) Holub	<i>Bilderdykia cilinodis</i> (Michx.) Greene, <i>Polygonum cilinode</i> Michx.	Vánky 1998	North America
7.	<i>Microbotryum cordae</i> (Liro) G.Deml & Prillinger	Persicarieae	<i>Koenigia campanulata</i> (Hook.f.) T.M.Schust & Reveal	<i>Polygonum campanulatum</i> Hook.f.	Vánky 2013	N/A
	<i>Microbotryum cordae</i> (Liro) G.Deml & Prillinger	Persicarieae	<i>Persicaria bungeana</i> (Turcz.) Nakai	<i>Polygonum bungeanum</i> Turcz.	Vánky 2013	China
	<i>Microbotryum cordae</i> (Liro) G.Deml & Prillinger	Persicarieae	<i>Persicaria caespitosa</i> (Blume) Nakai	<i>Polygonum caespitosum</i> Blume	Vánky 2013	N/A
	<i>Microbotryum cordae</i> (Liro) G.Deml & Prillinger	Persicarieae	<i>Persicaria foliosa</i> (H.Lindb.) Kitag.	<i>Polygonum foliosum</i> H.Lindb.	Vánky 1994	Finland
	<i>Microbotryum cordae</i> (Liro) G.Deml & Prillinger	Persicarieae	<i>Persicaria hydropiper</i> (L.) Spach	<i>Polygonum hydropiper</i> L.	Kemler et al. 2006	Germany
	<i>Microbotryum cordae</i> (Liro) G.Deml & Prillinger	Persicarieae	<i>Persicaria hydropiperoides</i> (Michx.) Small	<i>Polygonum hydropiperoides</i> Michx.	Vánky & Oberwinkler 1994	N/A
	<i>Microbotryum cordae</i> (Liro) G.Deml & Prillinger	Persicarieae	<i>Persicaria maculosa</i> A.Gray	<i>Polygonum persicaria</i> L.	Vánky & Oberwinkler 1994	Germany
	<i>Microbotryum cordae</i> (Liro) G.Deml & Prillinger	Persicarieae	<i>Persicaria minor</i> (Huds.) Opiz	<i>Polygonum minus</i> Huds.	Vánky & Oberwinkler 1994	Finland
	<i>Microbotryum cordae</i> (Liro) G.Deml & Prillinger	Persicarieae	<i>Persicaria mitis</i> (Schrank) Holub	<i>Polygonum mite</i> Schrank	Vánky & Oberwinkler 1994	Italy

Spp. No. (50 total)	Fungi	Polygonaceae clade	Polygonaceae host species (currently accepted name)	Synonym used in publication	Publication	Collection location (fungus)
	<i>Microbotryum cordae</i> (Liro) G.Deml & Prillinger	Persicarieae	<i>Persicaria posumbu</i> (Buch.-Ham. ex D.Don) H.Gross	<i>Polygonum posumbu</i> Buch.-Ham. ex D.Don	Ványky 2013	N/A
	<i>Microbotryum cordae</i> (Liro) G.Deml & Prillinger	Persicarieae	<i>Persicaria punctata</i> (Elliott) Small	<i>Polygonum punctatum</i> Elliott	Ványky & Oberwinkler 1994	N/A
	<i>Microbotryum cordae</i> (Liro) G.Deml & Prillinger	Persicarieae	<i>Persicaria roseoviridis</i> Kitag.	<i>Polygonum roseoviride</i> (Kitag.) S.X.Li & Y.L.Chang	Ványky 2013	N/A
	<i>Microbotryum cordae</i> (Liro) G.Deml & Prillinger	Persicarieae	<i>Persicaria viscosa</i> (Buch.-Ham. ex D.Don) H.Gross ex Nakai	<i>Polygonum viscosum</i> Buch.-Ham. ex D. Don	Ványky 2013	N/A
8.	<i>Microbotryum coronatum</i> (Liro) Ványky	Rumiceae	<i>Rumex britannica</i> L.		Ványky 1998	North America
9.	<i>Microbotryum dehiscens</i> (L.Ling) Ványky	Persicarieae	<i>Bistorta officinalis</i> (L.) Delarbre	<i>Polygonum nitens</i> (Fisch. & C.A.Mey.) Petrov ex Kom.	Chlebicki 2006	Kazakhstan
	<i>Microbotryum dehiscens</i> (L.Ling) Ványky	Persicarieae	<i>Bistorta vivipara</i> (L.) Delarbre	<i>Polygonum viviparum</i> L.	Ványky 1998	N/A
	<i>Microbotryum dehiscens</i> (L.Ling) Ványky	Persicarieae	<i>Persicaria amplexicaulis</i> (D.Don) Ronse Decr. [misidentified <i>Bistorta sinomontana</i> (Sam.) Miyam.?]]	<i>Polygonum amplexicaule</i> D.Don	Ványky 1998	India
10.	<i>Microbotryum dumosum</i> (Ványky & Oberw.) Ványky	Rumiceae	<i>Rumex dumosus</i> A.Cunn. ex Meisn.		Ványky 1998	Australia
	<i>Microbotryum dumosum</i> (Ványky & Oberw.) Ványky	Rumiceae	<i>Rumex obtusifolius</i> L.		Ványky & Shivas 2008	Australia
	<i>Microbotryum dumosum</i> (Ványky & Oberw.) Ványky	Rumiceae	<i>Rumex pulcher</i> L.		Ványky & Shivas 2008	Australia
	<i>Microbotryum dumosum</i> (Ványky & Oberw.) Ványky	Rumiceae	<i>Rumex tenax</i> Rch.f.		Ványky & Shivas 2008	Australia
11.	<i>Microbotryum filamenticola</i> (L.Ling) Ványky	Persicarieae	<i>Persicaria japonica</i> (Meisn.) Nakai	<i>Polygonum japonicum</i> Meisn.	Ványky 1998	China
12.	<i>Microbotryum goeppertianum</i> (J.Schroet.) Ványky	Rumiceae	<i>Rumex acetosa</i> L.		Ványky 1998	Poland
	<i>Microbotryum goeppertianum</i> (J.Schroet.) Ványky	Rumiceae	<i>Rumex alpestris</i> Jacq.		Ványky 1998	N/A
	<i>Microbotryum goeppertianum</i> (J.Schroet.) Ványky	Rumiceae	<i>Rumex scutatus</i> L.		Ványky 1998	N/A
	<i>Microbotryum goeppertianum</i> (J.Schroet.) Ványky	Rumiceae	<i>Rumex thyrsoflorus</i> Fingerh.		Ványky 1998	N/A
13.	<i>Microbotryum himalense</i> (Kakish & Y.Ono)	Persicarieae	<i>Bistorta officinalis</i> (L.) Delarbre	<i>Polygonum bistorta</i> L.	Ványky 1998	Nepal
	<i>Microbotryum himalense</i> (Kakish & Y.Ono)	Persicarieae	<i>Bistorta suffulta</i> (Maxim.) Greene ex H. Gross	<i>Polygonum suffultaum</i> Maxim.	Ványky 2013	N/A

Spp. No. (50 total)	Fungi	Polygonaceae clade	Polygonaceae host species (currently accepted name)	Synonym used in publication	Publication	Collection location (fungus)
14.	<i>Microbotryum koenigiae</i> (Rostr.) Vánky	Persicarieae	<i>Koenigia islandica</i> L.		Vánky 1998	Greenland
	<i>Microbotryum koenigiae</i> (Rostr.) Vánky	Persicarieae	<i>Koenigia pilosa</i> Maxim.		Vánky 2013	N/A
15.	<i>Microbotryum kuehneanum</i> (R.Wolff) Vánky	Rumiceae	<i>Rumex acetosa</i> L.		Ainsworth & Sampson 1950	England
	<i>Microbotryum kuehneanum</i> (R.Wolff) Vánky	Rumiceae	<i>Rumex acetosella</i> L.		Almaraz et al. 2002; Vánky 1998	Germany, North America, Spain
	<i>Microbotryum kuehneanum</i> (R.Wolff) Vánky	Rumiceae	<i>Rumex alpestris</i> Jacq.	<i>Rumex arifolius</i> All.	Vánky 1998	N/A
	<i>Microbotryum kuehneanum</i> (R.Wolff) Vánky	Rumiceae	<i>Rumex crispus</i> L.		Ainsworth & Sampson 1950	England
	<i>Microbotryum kuehneanum</i> (R.Wolff) Vánky	Rumiceae	<i>Rumex hastatulus</i> Baldwin		Vánky 2013	N/A
	<i>Microbotryum kuehneanum</i> (R.Wolff) Vánky	Rumiceae	<i>Rumex tuberosus</i> L.		Vánky 2013	N/A
16.	<i>Microbotryum longisetum</i> (Vánky & Oberw.) Vánky	Persicarieae	<i>Persicaria longiseta</i> (Bruijn) Kitag.	<i>Polygonum longisetum</i> Bruijn	Vánky 1998	Taiwan
17.	<i>Microbotryum marginale</i> (DC.) Vánky	Persicarieae	<i>Bistorta officinalis</i> (L.) Delarbre	<i>Polygonum bistorta</i> L., <i>Polygonum nitens</i> (Fisch. & C.A.Mey.) Petrov ex Kom.	Kemler et al. 2009; Vánky 1998; Vánky 2013	France, Poland, Switzerland
	<i>Microbotryum marginale</i> (DC.) Vánky	Persicarieae	<i>Bistorta bistortoides</i> (Pursh) Small	<i>Polygonum bistortoides</i> Pursh	Vánky 2013	N/A
	<i>Microbotryum marginale</i> (DC.) Vánky	Persicarieae	<i>Bistorta carnea</i> (K.Koch) Kom. ex Tzvelev	<i>Polygonum carneum</i> K.Koch	Vánky 2013	N/A
	<i>Microbotryum marginale</i> (DC.) Vánky	Persicarieae	<i>Bistorta elliptica</i> (Willd. ex Spreng.) D.F. Murray & Elven	<i>Polygonum ellipticum</i> Willd. ex Spreng.	Vánky 2013	N/A
18.	<i>Microbotryum moelleri</i> (Bref.) Vánky	Persicarieae	<i>Persicaria hispida</i> (Kunth) M.Gómez	<i>Polygonum hispidum</i> Kunth	Vánky 2013	Brazil
19.	<i>Microbotryum nepalense</i> (Liro) Vánky	Persicarieae	<i>Persicaria nepalensis</i> (Meisn.) H.Gross	<i>Polygonum alatum</i> Buch.-Ham. ex D.Don	Kemler et al. 2006; Vánky 1998	India, China
20.	<i>Microbotryum ocrearum</i> (Berk.) Vánky	Persicarieae	<i>Koenigia campanulata</i> (Hook.f.) T.M.Schust. & Reveal	<i>Polygonum campanulatum</i> Hook.f.	Vánky 1998	China
21.	<i>Microbotryum parlatorei</i> (A.A.Fisch.Waldh.) Vánky	Rumiceae	<i>Rumex acetosella</i> L.		Fischer 1953	North America
	<i>Microbotryum parlatorei</i> (A.A.Fisch.Waldh.) Vánky	Rumiceae	<i>Rumex alpinus</i> L.		Vánky 1998	N/A
	<i>Microbotryum parlatorei</i> (A.A.Fisch.Waldh.) Vánky	Rumiceae	<i>Rumex altissimus</i> Alph. Wood		Vánky 1998	N/A

Spp. No. (50 total)	Fungi	Polygonaceae clade	Polygonaceae host species (currently accepted name)	Synonym used in publication	Publication	Collection location (fungus)
	<i>Microbotryum parlatorei</i> (A.A.Fisch.Waldh.) Vánky	Rumiceae	<i>Rumex britannica</i> L.		Fischer 1953	North America
	<i>Microbotryum parlatorei</i> (A.A.Fisch.Waldh.) Vánky	Rumiceae	<i>Rumex crispus</i> L.		Vánky 1998	N/A
	<i>Microbotryum parlatorei</i> (A.A.Fisch.Waldh.) Vánky	Rumiceae	<i>Rumex dentatus</i> L.		Vánky 1998	N/A
	<i>Microbotryum parlatorei</i> (A.A.Fisch.Waldh.) Vánky	Rumiceae	<i>Rumex hastatulus</i> Baldwin		Fischer 1953	North America
	<i>Microbotryum parlatorei</i> (A.A.Fisch.Waldh.) Vánky	Rumiceae	<i>Rumex longifolius</i> DC.		Vánky 1998	Norway
	<i>Microbotryum parlatorei</i> (A.A.Fisch.Waldh.) Vánky	Rumiceae	<i>Rumex maritimus</i> L.		Kemler et al. 2006	Germany
	<i>Microbotryum parlatorei</i> (A.A.Fisch.Waldh.) Vánky	Rumiceae	<i>Rumex mexicanus</i> Meisn.		Vánky 1998	N/A
	<i>Microbotryum parlatorei</i> (A.A.Fisch.Waldh.) Vánky	Rumiceae	<i>Rumex obtusifolius</i> L.		Vánky & Shivas 2008	Australia
	<i>Microbotryum parlatorei</i> (A.A.Fisch.Waldh.) Vánky	Rumiceae	<i>Rumex palustris</i> Sm.		Vánky 1998	N/A
22.	<i>Microbotryum paucireticulatum</i> Vánky	Persicarieae	<i>Persicaria orientalis</i> (L.) Spach	<i>Polygonum orientale</i> L.	Vánky 2013	India
23.	<i>Microbotryum picaceum</i> (Lagerh. & Liro) Vánky	Persicarieae	<i>Koenigia forrestii</i> (Diels) Měsíček & Soják		Vánky 1998	N/A
	<i>Microbotryum picaceum</i> (Lagerh. & Liro) Vánky	Persicarieae	<i>Koenigia islandica</i> L.		Vánky 1998	Norway
24.	<i>Microbotryum piperi</i> (G.P.Clinton) Vánky	Persicarieae	<i>Koenigia alpina</i> (All.) T.M.Schust. & Reveal	<i>Polygonum alpinum</i> All., <i>Polygonum undulatum</i> P.J. Bergius	Vánky 1998; Chlebicki 2006	Italy, Kazakhstan
	<i>Microbotryum piperi</i> (G.P.Clinton) Vánky	Persicarieae	<i>Koenigia davisiae</i> (W.H.Brewer ex A.Gray) T.M.Schust. & Reveal	<i>Polygonum davisiae</i> W.H.Brewer ex A.Gray	Vánky 1998	North America
	<i>Microbotryum piperi</i> (G.P.Clinton) Vánky	Persicarieae	<i>Koenigia phytolaccifolia</i> (Meisn. ex Small) T.M.Schust. & Reveal	<i>Polygonum phytolaccaefolium</i> Meisn.	Vánky 1998	North America
	<i>Microbotryum piperi</i> (G.P.Clinton) Vánky	Persicarieae	<i>Koenigia rumicifolia</i> (Royle ex Bab.) T.M.Schust. & Reveal	<i>Polygonum rumicifolium</i> Royle ex Bab.	Vánky 2013	N/A
	<i>Microbotryum piperi</i> (G.P.Clinton) Vánky	Persicarieae	<i>Koenigia songarica</i> (Schrenk) T.M.Schust. & Reveal	<i>Polygonum songoricum</i> Schrenk	Vánky 1998	N/A
	<i>Microbotryum piperi</i> (G.P.Clinton) Vánky	Persicarieae	<i>Koenigia tripterocarpa</i> (A.Gray) T.M.Schust. & Reveal	<i>Polygonum tripterocarpum</i> A.Gray	Vánky 2013	N/A
25.	<i>Microbotryum polygoni-alati</i> (Thirum. & M.S.Pavgi) Vánky	Persicarieae	<i>Persicaria nepalensis</i> (Meisn.) H.Gross	<i>Polygonum alatum</i> (Buch.-Ham. ex D.Don	Vánky 1998	India

Spp. No. (50 total)	Fungi	Polygonaceae clade	Polygonaceae host species (currently accepted name)	Synonym used in publication	Publication	Collection location (fungus)
26.	<i>Microbotryum prostratum</i> (Vánky & Oberw.) Vánky	Persicarieae	<i>Persicaria prostrata</i> (R.Br.) Soják	<i>Polygonum prostratum</i> R.Br.	Vánky 1998	Australia
	<i>Microbotryum prostratum</i> (Vánky & Oberw.) Vánky	Persicarieae	<i>Persicaria subsessilis</i> (R.Br.) K.L.Wilson	<i>Polygonum subsessile</i> R.Br.	Vánky 2013	N/A
27.	<i>Microbotryum pustulatum</i> (DC.) R. Bauer & Oberw.	Persicarieae	<i>Bistorta officinalis</i> (L.) Delarbre	<i>Polygonum bistorta</i> L., <i>Polygonum nitens</i> (Fisch. & C.A.Mey.) Petrov ex Kom.	Kemler et al. 2006; Vánky 2013	France, Germany, Switzerland
	<i>Microbotryum pustulatum</i> (DC.) R. Bauer & Oberw.	Persicarieae	<i>Bistorta carnea</i> (K.Koch) Kom. ex Tzvelev	<i>Polygonum carneum</i> K.Koch	Vánky 2013	N/A
	<i>Microbotryum pustulatum</i> (DC.) R. Bauer & Oberw.	Persicarieae	<i>Bistorta elliptica</i> (Willd. ex Spreng.) D.F. Murray & Elven	<i>Polygonum ellipticum</i> Willd. ex Spreng.	Vánky 2013	N/A
	<i>Microbotryum pustulatum</i> (DC.) R. Bauer & Oberw.	Persicarieae	<i>Bistorta vivipara</i> (L.) Delarbre	<i>Polygonum viviparum</i> L.	Vánky 1998	Norway
28.	<i>Microbotryum radians</i> (Vánky & Oberw.) Vánky	Persicarieae	<i>Persicaria careyi</i> (Olney) Greene	<i>Polygonum careyi</i> Olney	Vánky 1998	North America
29.	<i>Microbotryum reticulatum</i> (Liro) R.Bauer & Oberw.	Persicarieae	<i>Persicaria amphibia</i> (L.) Delarbre	<i>Polygonum amphibium</i> L., <i>Polygonum coccineum</i> Muhl. ex Willd.	Fischer 1953	North America
	<i>Microbotryum reticulatum</i> (Liro) R.Bauer & Oberw.	Persicarieae	<i>Persicaria longiseta</i> (Brujin) Kitag.	<i>Polygonum blumei</i> Meisn. ex Miq.	Vánky 2013	N/A
	<i>Microbotryum reticulatum</i> (Liro) R.Bauer & Oberw.	Persicarieae	<i>Persicaria careyi</i> (Olney) Greene	<i>Polygonum careyi</i> Olney	Fischer 1953	North America
	<i>Microbotryum reticulatum</i> (Liro) R.Bauer & Oberw.	Persicarieae	<i>Persicaria lapathifolia</i> (L.) Delarbre	<i>Polygonum lapathifolium</i> L.	Kemler et al. 2006	Austria, Bulgaria, Switzerland
	<i>Microbotryum reticulatum</i> (Liro) R.Bauer & Oberw.	Persicarieae	<i>Persicaria pennsylvanica</i> (L.) M.Gómez	<i>Polygonum pennsylvanicum</i> L.	Fischer 1953	North America
	<i>Microbotryum reticulatum</i> (Liro) R.Bauer & Oberw.	Persicarieae	<i>Persicaria senegalensis</i> (Meisn.) Soják	<i>Polygonum senegalense</i> Meisn.	Vánky 2013	Rwanda
	<i>Microbotryum reticulatum</i> (Liro) R.Bauer & Oberw.	Persicarieae	<i>Persicaria sagittata</i> (L.) H.Gross	<i>Polygonum sagittatum</i> L.	Fischer 1953	North America
	<i>Microbotryum reticulatum</i> (Liro) R.Bauer & Oberw.	Polygoneae	<i>Polygonum aviculare</i> L.		Fischer 1953	North America
30.	<i>Microbotryum rhei</i> (Zundel) Vánky	Rumiceae	<i>Rheum maximowiczii</i> Losinsk.		Vánky 1998	Kazakhstan
	<i>Microbotryum rhei</i> (Zundel) Vánky	Rumiceae	<i>Rheum rhabarbarum</i> L.	<i>Rheum undulatum</i> L., <i>Rheum franzenbachii</i> Münter	Vánky 1998	N/A
	<i>Microbotryum rhei</i> (Zundel) Vánky	Rumiceae	<i>Rheum tataricum</i> L.f.		Vánky 2013	N/A
	<i>Microbotryum rhei</i> (Zundel) Vánky	Rumiceae	<i>Rheum wittrockii</i> C.E. Lundstr.		Vánky 1998	N/A

Spp. No. (50 total)	Fungi	Polygonaceae clade	Polygonaceae host species (currently accepted name)	Synonym used in publication	Publication	Collection location (fungus)
31.	<i>Microbotryum shastense</i> (Zundel) Vánky	Polygonaceae	<i>Polygonum shastense</i> W.H.Brewer	<i>Polygonum shastense</i> W.H.Brewer	Kemler et al. 2006	North America
32.	<i>Microbotryum stewartii</i> (Zundel) Vánky	Rumiceae	<i>Rheum webbianum</i> Royle		Vánky 1998	India
33.	<i>Microbotryum stygium</i> (Liro) Vánky	Rumiceae	<i>Rumex acetosa</i> L.		Kemler et al. 2006	Germany
	<i>Microbotryum stygium</i> (Liro) Vánky	Rumiceae	<i>Rumex alpestris</i> Jacq.	<i>Rumex arifolius</i> All.	Vánky 1998	N/A
	<i>Microbotryum stygium</i> (Liro) Vánky	Rumiceae	<i>Rumex scutatus</i> L.		Vánky 1998	N/A
	<i>Microbotryum stygium</i> (Liro) Vánky	Rumiceae	<i>Rumex thyrsoiflorus</i> Fingerh.		Vánky 1998	N/A
34.	<i>Microbotryum tenuisporum</i> (Cif.) Vánky	Persicarieae	<i>Persicaria acuminata</i> (Kunth) M.Gómez	<i>Polygonum acuminatum</i> Kunth	Vánky 1998	N/A
	<i>Microbotryum tenuisporum</i> (Cif.) Vánky	Persicarieae	<i>Persicaria barbata</i> (L.) H.Hara	<i>Polygonum barbatum</i>	Vánky 1998	N/A
	<i>Microbotryum tenuisporum</i> (Cif.) Vánky	Persicarieae	<i>Persicaria glabra</i> (Willd.) M.Gómez	<i>Polygonum glabrum</i> Willd.	Kemler et al. 2006	India
	<i>Microbotryum tenuisporum</i> (Cif.) Vánky	Persicarieae	<i>Persicaria hydropiper</i> (L.) Spach	<i>Persicaria hydropiper</i> (L.) Spach	Vánky & Shivas 2008	Australia
	<i>Microbotryum tenuisporum</i> (Cif.) Vánky	Persicarieae	<i>Persicaria hydropiperoides</i> (Michx.) Small	<i>Polygonum hydropiperoides</i> Michx.	Vánky 2013	N/A
	<i>Microbotryum tenuisporum</i> (Cif.) Vánky	Persicarieae	<i>Persicaria lapathifolia</i> (L.) Delarbre	<i>Polygonum lapathifolium</i> L., <i>Polygonum lanigerum</i> R. Br.	Vánky 2013	N/A
	<i>Microbotryum tenuisporum</i> (Cif.) Vánky	Persicarieae	<i>Persicaria punctata</i> (Elliott) Small	<i>Polygonum punctatum</i> Elliott	Piepenbring 1996; Vánky & Shivas 2008	Argentina, Costa Rica
35.	<i>Microbotryum tovarae</i> (Saville) Vánky	Persicarieae	<i>Persicaria virginiana</i> (L.) Gaertn.	<i>Polygonum virginianum</i> L.	Vánky 1998	North America
36.	<i>Microbotryum tuberculiforme</i> (Syd. & Syd.) Vánky	Persicarieae	<i>Persicaria chinensis</i> (L.) H.Gross	<i>Polygonum chinense</i> L.	Vánky 2013	N/A
	<i>Microbotryum tuberculiforme</i> (Syd. & Syd.) Vánky	Persicarieae	<i>Persicaria runcinata</i> (Buch.-Ham. ex D.Don) H.Gross	<i>Polygonum runcinatum</i> Buch.-Hamilt. ex D.Don	Kemler et al. 2006	Taiwan
37.	<i>Microbotryum tumeforme</i> (L.Ling) Vánky	Persicarieae	<i>Persicaria chinensis</i> (L.) H.Gross	<i>Polygonum chinense</i> L.	Vánky 1998	India
	<i>Microbotryum tumeforme</i> (L.Ling) Vánky	Rumiceae	<i>Rumex crispus</i> L.	<i>Rumex magellanicus</i> Campd.	Vánky 2013	N/A
38.	<i>Microbotryum vinosum</i> (Tul. & C.Tul.) Denchev	Rumiceae	<i>Oxyria digyna</i> (L.) Hill	<i>Oxyria digyna</i> (L.) Hill	Almaraz et al. 2002	N/A
39.	<i>Microbotryum warmingii</i> (Rostr.) Vánky	Rumiceae	<i>Rumex aquaticus</i> L.		Vánky 1998	N/A
	<i>Microbotryum warmingii</i> (Rostr.) Vánky	Rumiceae	<i>Rumex arcticus</i> Trautv.		Vánky 2013	N/A
	<i>Microbotryum warmingii</i> (Rostr.) Vánky	Rumiceae	<i>Rumex crispus</i> L.		Vánky 1998	Norway
	<i>Microbotryum warmingii</i> (Rostr.) Vánky	Rumiceae	<i>Rumex longifolius</i> DC.		Vánky 1998	N/A

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1.	<i>Sphacelotheca fagopyri</i> Syd., P.Syd. & E.J.Butler	Fagopyreae	<i>Fagopyrum esculentum</i> Moench		Saccardo 1912	India
2.	<i>Sphacelotheca hydropiperis</i> (Schumach.) deBary	Persicarieae	<i>Koenigia nummularifolia</i> (Meisn.) Měsíček & Soják	<i>Polygonum nummularifolium</i> Meisn.	Ványk & Oberwinkler 1994	N/A
	<i>Sphacelotheca hydropiperis</i> (Schumach.) deBary	Persicarieae	<i>Persicaria acuminata</i> (Kunth) M.Gómez	<i>Polygonum acuminatum</i> Kunth	Piepenbring 1996	Costa Rica
	<i>Sphacelotheca hydropiperis</i> (Schumach.) deBary	Persicarieae	<i>Persicaria decipiens</i> (R.Br.) K.L.Wilson	<i>Polygonum serrulatum</i> Lag.	Kakishima & Ono 1993; http://mycoportal.org	India, Pakistan
	<i>Sphacelotheca hydropiperis</i> (Schumach.) deBary	Persicarieae	<i>Persicaria filiformis</i> (Thunb.) Nakai	<i>Polygonum filiforme</i> Thunb.	Ványk & Oberwinkler 1994	Japan
	<i>Sphacelotheca hydropiperis</i> (Schumach.) deBary	Persicarieae	<i>Persicaria hispida</i> (Kunth) M.Gómez	<i>Polygonum hispidum</i> Kunth	Ványk & Oberwinkler 1994	N/A
	<i>Sphacelotheca hydropiperis</i> (Schumach.) deBary [as <i>Sphacelotheca koordersiana</i> (Bref.) Zundel]	Persicarieae	<i>Persicaria hydropiper</i> (L.) Spach	<i>Polygonum hydropiper</i> L.	Piepenbring 1996; Ványk 2002	Costa Rica
	<i>Sphacelotheca hydropiperis</i> (Schumach.) deBary	Persicarieae	<i>Persicaria maculosa</i> A.Gray	<i>Polygonum persicaria</i> L.	Ványk 1994	N/A
	<i>Sphacelotheca hydropiperis</i> (Schumach.) deBary	Persicarieae	<i>Persicaria minor</i> (Huds.) Opiz	<i>Polygonum minus</i> Huds.	Ványk & Oberwinkler 1994	N/A
	<i>Sphacelotheca hydropiperis</i> (Schumach.) deBary	Persicarieae	<i>Persicaria mitis</i> (Schrank) Holub	<i>Polygonum mite</i> Schrank	Ványk & Oberwinkler 1994	N/A
	<i>Sphacelotheca hydropiperis</i> (Schumach.) deBary [as <i>Sphacelotheca borealis</i> (G.P.Clinton) Schellenb.]	Persicarieae	<i>Persicaria posumbu</i> (Buch.-Ham. ex D.Don) H.Gross	<i>Polygonum posumbu</i> Buch.-Ham. ex D.Don	http://mycoportal.org	China
	<i>Sphacelotheca hydropiperis</i> (Schumach.) deBary	Persicarieae	<i>Persicaria punctata</i> (Elliott) Small	<i>Polygonum punctatum</i> Elliott	Piepenbring 1996	Costa Rica
	<i>Sphacelotheca hydropiperis</i> (Schumach.) deBary	Persicarieae	<i>Persicaria sagittata</i> (L.) H.Gross	<i>Polygonum sagittatum</i> L.	Ványk & Oberwinkler 1994	North America
	<i>Sphacelotheca hydropiperis</i> (Schumach.) deBary	Persicarieae	<i>Persicaria sagittifolia</i> (H.Lév. & Vaniot) H.Gross	<i>Polygonum sagittifolium</i> H.Lév. & Vaniot	Ványk & Oberwinkler 1994	N/A
	<i>Sphacelotheca hydropiperis</i> (Schumach.) deBary	Persicarieae	<i>Persicaria strindbergii</i> (J.Schust.) Galasso	<i>Polygonum strindbergii</i> J.Schust.	Ványk & Oberwinkler 1994	N/A
	<i>Sphacelotheca hydropiperis</i> (Schumach.) deBary	Persicarieae	<i>Persicaria thunbergii</i> (Siebold & Zucc.) H.Gross	<i>Polygonum thunbergii</i> Siebold & Zucc.	Ványk & Oberwinkler 1994	N/A
3.	<i>Sphacelotheca koordersiana</i> (Bref.) Zundel	Persicarieae	<i>Persicaria acuminata</i> (Kunth) M.Gómez	<i>Polygonum acuminatum</i> Kunth	Ványk & Oberwinkler 1994	Costa Rica
	<i>Sphacelotheca koordersiana</i> (Bref.) Zundel	Persicarieae	<i>Persicaria barbata</i> (L.) H.Hara	<i>Polygonum barbatum</i> L.	Ványk & Oberwinkler 1994	Java

Spp. No. (50 total)	Fungi	Polygonaceae clade	Polygonaceae host species (currently accepted name)	Synonym used in publication	Publication	Collection location (fungus)
	<i>Sphacelotheca koordersiana</i> (Bref.) Zundel	Persicarieae	<i>Persicaria decipiens</i> (R.Br.) K.L.Wilson	<i>Polygonum salicifolium</i> Brouss. ex Willd.	Vánky & Oberwinkler 1994; McKenzie & Vánky 2001	New Zealand
4.	<i>Sphacelotheca polygoni-serrulati</i> Maire	Persicarieae	<i>Persicaria barbata</i> (L.) H.Hara	<i>Polygonum barbatum</i> L.	Vánky & Oberwinkler 1994	Rwanda
	<i>Sphacelotheca polygoni-serrulati</i> Maire	Persicarieae	<i>Persicaria decipiens</i> (R.Br.) K.L.Wilson	<i>Polygonum serrulatum</i> Lag.	Maire 1917; 2002; Kemler et al. 2009	Algeria, Greece, Spain
	<i>Sphacelotheca polygoni-serrulati</i> Maire	Persicarieae	<i>Persicaria decipiens</i> (R.Br.) K.L.Wilson		Vánky & Shivas 2008; Piątek et al. 2012	Australia, Cameroon
	<i>Sphacelotheca polygoni-serrulati</i> Maire	Persicarieae	<i>Persicaria maculosa</i> Gray	<i>Polygonum persicaria</i> L.	Vánky 1994	Madeira
	<i>Sphacelotheca polygoni-serrulati</i> Maire	Persicarieae	<i>Persicaria pulchra</i> (Blume) Soják	<i>Persicaria pulchra</i> (Blume) Soják	Piątek et al. 2012	Zambia
	<i>Sphacelotheca polygoni-serrulati</i> Maire	Persicarieae	<i>Persicaria setosula</i> (A.Rich.) K.L.Wilson	<i>Polygonum setosulum</i> A.Rich.	Vánky 1994	N/A
5.	<i>Sphacelotheca serrulati-magna</i> Vánky & Oberw.	Persicarieae	<i>Persicaria decipiens</i> (R.Br.) K.L.Wilson	<i>Polygonum salicifolium</i> Brouss. ex Willd.	Vánky & Oberwinkler 1994	Greece
1.	<i>Thecaphora schwarzmaniana</i> Byzova	Rumiceae	<i>Rheum cordatum</i> Losinsk.		Vánky 2013	Kazakhstan
	<i>Thecaphora schwarzmaniana</i> Byzova	Rumiceae	<i>Rheum macrocarpum</i> Losinsk.	<i>Rheum lobatum</i> Litv. ex Losinsk.	Vánky 2013	N/A
	<i>Thecaphora schwarzmaniana</i> Byzova	Rumiceae	<i>Rheum palmatum</i> L.		Vánky 2013	N/A
	<i>Thecaphora schwarzmaniana</i> Byzova	Rumiceae	<i>Rheum ribes</i> L.		Vasighzadeh et al. 2014	Iran
1.	<i>Zundeliomyces polygoni</i> Vánky	Persicarieae	<i>Koenigia alpina</i> (All.) T.M.Schust. & Reveal	<i>Polygonum alpinum</i> All.	Vánky 1987	Kazakhstan