

## Revision of the *Massarineae* (Pleosporales, Dothideomycetes)

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**Abstract:** We here taxonomically revise the suborder *Massarineae* (Pleosporales, Dothideomycetes, Ascomycota). Sequences of SSU and LSU nrDNA and the translation elongation factor 1-alpha gene (*tef1*) are newly obtained from 106 *Massarineae* taxa that are phylogenetically analysed along with published sequences of 131 taxa in this suborder retrieved from GenBank. We recognise 12 families and five unknown lineages in the *Massarineae*. Among the nine families previously known, the monophyletic status of the *Dictyosporiaceae*, *Didymosphaeriaceae*, *Latoraceae*, *Macrodiplodiopsidaceae*, *Massarinaceae*, *Morosphaeriaceae*, and *Trematosphaeriaceae* was strongly supported with bootstrap support values above 96 %, while the clades of the *Bambusicolaceae* and the *Lentitheciaceae* are moderately supported. Two new families, *Parabambusicolaceae* and *Sulcatissporaceae*, are proposed. The *Parabambusicolaceae* is characterised by depressed globose to hemispherical ascogonia with or without surrounding stromatic tissue, and multi-septate, clavate to fusiform, hyaline ascospores. The *Sulcatissporaceae* is established for *Magnicamarosporium* and *Sulcatisspora* genera nova and *Neobambusicola*. The *Sulcatissporaceae* is characterised by subglobose ascogonia with a short ostiolar neck, trabeculate pseudoparaphyses, clavate asci, broadly fusiform ascospores, and ellipsoid to subglobose conidia with or without striate ornamentation. The genus *Periconia* and its relatives are segregated from the *Massarinaceae* and placed in a resurrected family, the *Periconiaceae*. We have summarised the morphological and ecological features, and clarified the accepted members of each family. Ten new genera, 22 new species, and seven new combinations are described and illustrated. The complete ITS sequences of nrDNA are also provided for all new taxa for use as barcode markers.

**Key words:** Coelomycetes, Freshwater ascomycetes, *Helminthosporium*, Holomorph, Hyphomycetes, *Massarina*, *Periconia*, *Spegazzinia*.

**Taxonomic novelties: New families:** *Parabambusicolaceae* Kaz. Tanaka & K. Hiray., *Sulcatissporaceae* Kaz. Tanaka & K. Hiray.; **New genera:** *Aquastroma* Kaz. Tanaka & K. Hiray., *Clypeoloculus* Kaz. Tanaka & K. Hiray., *Fuscostagonospora* Kaz. Tanaka & K. Hiray., *Gregarithecium* Kaz. Tanaka & K. Hiray., *Magnicamarosporium* Kaz. Tanaka & K. Hiray., *Neophiosphaerella* Kaz. Tanaka & K. Hiray., *Parabambusicola* Kaz. Tanaka & K. Hiray., *Pseudocoleophoma* Kaz. Tanaka & K. Hiray., *Pseudoxylomyces* Kaz. Tanaka & K. Hiray., *Sulcatisspora* Kaz. Tanaka & K. Hiray.; **New species:** *Aquastroma magniostiolata* Kaz. Tanaka & K. Hiray., *Aquilomyces rebunensis* Kaz. Tanaka & K. Hiray., *Clypeoloculus akitaensis* Kaz. Tanaka & K. Hiray., *Clypeoloculus hirosakiensis* Kaz. Tanaka & K. Hiray., *Clypeoloculus microsporus* Kaz. Tanaka & K. Hiray., *Clypeoloculus towadaensis* Kaz. Tanaka & K. Hiray., *Dictyosporium pseudomusae* Kaz. Tanaka, G. Sato & K. Hiray., *Fuscostagonospora sasae* Kaz. Tanaka & K. Hiray., *Gregarithecium curvisporum* Kaz. Tanaka & K. Hiray., *Helminthosporium massarinum* Kaz. Tanaka, K. Hiray. & Shirouzu, *Keissleriella breviasca* Kaz. Tanaka & K. Hiray., *Keissleriella quadriseptata* Kaz. Tanaka & K. Hiray., *Keissleriella yonaguniensis* Kaz. Tanaka & K. Hiray., *Lentithecium pseudocloninum* Kaz. Tanaka & K. Hiray., *Magnicamarosporium irimotense* Kaz. Tanaka & K. Hiray., *Periconia homothallica* Kaz. Tanaka & K. Hiray., *Periconia pseudodigitata* Kaz. Tanaka & K. Hiray., *Pseudocoleophoma calamagrostidis* Kaz. Tanaka & K. Hiray., *Pseudocoleophoma polygonicola* Kaz. Tanaka & K. Hiray., *Stagonospora pseudoperfecta* Kaz. Tanaka & K. Hiray., *Sulcatisspora acerina* Kaz. Tanaka & K. Hiray., *Sulcatisspora berchemiae* Kaz. Tanaka & K. Hiray.; **New combinations:** *Lentithecium cloninum* (Kaz. Tanaka, Sat. Hatak. & Y. Harada) Kaz. Tanaka & K. Hiray., *Neophiosphaerella sasicola* (Nagas. & Y. Otani) Kaz. Tanaka & K. Hiray., *Parabambusicola bambusina* (Teng) Kaz. Tanaka & K. Hiray., *Pseudoxylomyces elegans* (Goh, W.H. Ho, K.D. Hyde & K.M. Tsui) Kaz. Tanaka & K. Hiray., *Setoseptoria arundinacea* (Sowerby) Kaz. Tanaka & K. Hiray., *Setoseptoria magniarundinacea* (Kaz. Tanaka & Y. Harada) Kaz. Tanaka & K. Hiray., *Stagonospora bicolor* (D. Hawksw., W.J. Kaiser & Ndimande) Kaz. Tanaka & K. Hiray.; **Epitypifications (basionyms):** *Phaeosphaeria arundinacea* var. *brevispora* Nagas. & Y. Otani, *Phaeosphaeria sasicola* Nagas. & Y. Otani.

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### INTRODUCTION

The *Pleosporales* is the largest order in the *Dothideomycetes*. Two suborders have been recognised, viz. the *Pleosporineae* and the *Massarineae*, containing more than 19 families that presently still lack subordinal assignment (Hyde *et al.* 2013). One suborder, the *Pleosporineae*, includes many economically important plant pathogens, *Alternaria*, *Bipolaris*, *Didymella*, *Leptosphaeria*, *Parastagonospora*, and *Pyrenophora*, for example, containing huge species diversity (Manamgoda *et al.* 2011, Zhang *et al.* 2012, Woudenberg *et al.* 2013). In this suborder, the phylogenetic relationships within each family, the morphological circumscriptions including those of asexual

morphs, their evolutionary trend as plant pathogens, biogeography, and speciation are well established and documented (Rouxel & Balesdent 2005, Peever 2007, Zhang *et al.* 2009b, Ohm *et al.* 2012, Grandaubert *et al.* 2014). In contrast, for the other suborder, the *Massarineae*, much fundamental information including the taxonomic framework, phylogenetic relationships, biology, and species diversity are poorly understood. The *Massarineae* was originally established by Barr (1979) to accommodate the *Massarinaceae* and the *Arthopyreniaceae*, but this suborder has long been disregarded in the classification of bitunicate ascomycetes (Hawksworth *et al.* 1983, 1995, Barr 1987, Eriksson & Winka 1998, Kirk *et al.* 2008, Lumbsch & Huhndorf 2010).

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The family *Massarinaceae* was established by Munk (1956) to encompass four genera, *Massarina*, *Metasphaeria*, *Pseudotrichia*, and *Trichometasphaeria*. The thin basal peridium and dark tissue (= clypeus) around the ostiole found in the ascomata of these genera were emphasised as familial characters. Although this proposal was accepted by many researchers (Eriksson 1981, Boise 1985), the characters emphasised by Munk (1956) for the family also exist in several other groups of bitunicate ascomycetes, such as *Didymosphaeria* (*Didymosphaeriaceae*), *Salsuginea* (*Salsugineaceae*) and *Rousoella* (*Rousoellaceae*). The *Massarinaceae*, therefore, has been treated as a synonym of the *Pleosporeaceae* (Bose 1961, Luttrell 1973, Von Arx & Müller 1975) or *Lophiostomataceae* (Barr 1987, 1992). Similarly, taxonomic circumscription of the genus *Massarina* has also been repeatedly revised (see Notes in *Massarina*), and as a consequence of a clear taxonomic definition of *Massarina*, the family *Massarinaceae* has been regarded as a natural lineage. Several related genera, e.g., *Aquatichieirospora*, *Dictyosporium*, and *Periconia* (Tsui et al. 2006, Kodsueb et al. 2007, Schoch et al. 2009), have been assigned to the *Massarinaceae* as circumscribed by Eriksson & Hawksworth (2003), and the concept of the family has been revised (Hyde et al. 2013).

In a recent molecular study on the *Pleosporales* (Zhang et al. 2012), the suborder *Massarineae* was resurrected as a sister to the *Pleosporineae*, and was emended to include five families, the *Lentitheciaceae* (Zhang et al. 2009b), *Massarinaceae* (Munk 1956), *Montagnulaceae* (Barr 2001; later synonymised under *Didymosphaeriaceae*, Ariyawansa et al. 2014), *Morosphaeriaceae* (Suetrong et al. 2009), and *Trematosphaeriaceae* (Suetrong et al. 2011b). More recently, the *Bambusicolaceae* (Hyde et al. 2013), *Dictyosporiaceae* (nom. prov., see Liu et al. 2015), *Latoruaceae* and *Macrodiplodiopsidaceae* (Crous et al. 2015a) have been added to the suborder. Most of these families have been recognised from the results of recent molecular studies. Only a few members of each family are currently known, and thus the morphological characteristics and phylogenetic relationships within each family are not fully understood. Consequently, several new genera belonging to the *Massarineae*, such as *Ascorhombispora* (Cai & Hyde 2007b), *Inflatispora* (Zhang et al. 2011), and *Noosia* (Crous et al. 2011a), have been published but their phylogenetic placements at familial level remain obscure (Zhang et al. 2012, Hyde et al. 2013).

Our aims were to reveal the species diversity within the *Massarineae* and to establish a taxonomic framework within this suborder for understanding the relationships among the *Massarineae*. To this end we examined 106 specimens/isolates belonging to this suborder, and analysed their morphology and partial DNA sequences of the small and large subunit nuclear ribosomal DNA (SSU and LSU nrDNA) and the translation elongation factor 1-alpha gene (*tef1*).

## MATERIALS AND METHODS

### Morphological studies

Leaf and twig specimens were collected from various plants in Japan, and deposited in the herbarium of Hirosaki University (HHUF). Measurements of all structures except for ascomata/conidiomata were taken from material mounted in distilled water. India ink or Black-Blue ink in distilled water was added to water

mounts to detect gelatinous sheaths or appendages around spores. To observe the internal structure of strongly melanised spores, 5 % sodium hypochlorite solution (NaClO) was used for the bleaching of spores as described in Eriksson (1989). The position of the primary septum of spores was noted using the decimal system (Shoemaker 1984), and the numbers of spore septa were recorded as “septae of upper hemisphere + the primary septum + septae of lower hemisphere”. To observe sporocarp structure, ascomata/conidiomata were boiled in water for a few minutes, sectioned using a freezing microtome (HM 400R; MICROM, Germany), and mounted in diluted lactophenol cotton blue. Morphology was observed using differential interference and phase contrast microscopy (Olympus BX53, Japan).

Single spore cultures were obtained following the methods of Tubaki (1978). Ninety-nine cultures on 2 % potato-dextrose agar (PDA) or potato-carrot agar (PCA) were prepared from the collections and were deposited in the Japan Collection of Microorganisms (JCM), the National Institute of Agrobiological Sciences, Japan (MAFF), and the CBS-KNAW Fungal Biodiversity Centre (Centraalbureau voor Schimmelcultures; CBS). An additional seven strains were obtained from the CBS culture collection (Table 1). Growth rate and colony characteristics were recorded from cultures grown on PDA within 2 or 4 wk at 20 °C in the dark. Colours were designated according to Rayner (1970). Induction of sexual/asexual sporulation was attempted by culturing isolates on rice straw agar (RSA; Tanaka & Harada 2003a) and/or incubating small pieces of colony in sterilised water (Scheuer 1991). Nomenclatural novelties were deposited in MycoBank (Crous et al. 2004).

### Molecular phylogenetic analysis

A total of 106 isolates were used for DNA extraction (Table 1). DNA from mycelia was extracted using the ISOPLANT Kit (Nippon Gene, Tokyo, Japan) following the manufacturer's instructions. Partial SSU and LSU nrDNA, and *tef1* were sequenced to elucidate phylogenetic relationships of the isolates for considering familial and generic classifications. The complete internally transcribed spacer (ITS) regions of nrDNA were also obtained for use as DNA barcode markers (Schoch et al. 2012), although the sequences were not used for phylogenetic reconstruction (Table 1). Four primer sets, NS1–NS4 (White et al. 1990), LR0R–LR7 (Rehner & Samuels 1994), EF1-983F–EF1-2218R (Rehner & Buckley 2005), and ITS1–ITS4 (White et al. 1990) were used for the amplification of SSU, LSU, *tef1*, and ITS, respectively. DNA fragments were amplified and sequenced following the methods described by Tanaka et al. (2009). Newly obtained sequences have been deposited in GenBank (Table 1). These sequences together with those retrieved from GenBank (Table 2) were aligned by MUSCLE included in the program Molecular Evolutionary Genetic Analysis (MEGA) v. 6 (Tamura et al. 2013) and manually adjusted to optimise the alignment. *Hysterobrevium mori* and *Hysterium pulicare*, both belonging to the *Hysteriales*, were designated as outgroup taxa. The alignments used were deposited in TreeBASE (<http://www.treebase.org>). Phylogenetic analyses were conducted based on maximum likelihood (ML) method. The optimum substitution models for each dataset were estimated by Kakusan4 (Tanabe 2011), based on the Akaike information criterion (AIC; Akaike 1974) for ML analyses. The ML analyses were performed with TreeFinder Mar 2011 (Jobb 2011) based on



**Table 1.** Cultures and GenBank accession numbers of *Massariniae* obtained in this study.

Taxon	Family <sup>1</sup>	Original no.	Culture no.	Specimen no. <sup>2</sup>	GenBank accession no. <sup>3</sup>				Notes <sup>4</sup>
					SSU	LSU	<i>tef1</i>	ITS	
<i>Aquastroma magniostiolata</i>	Par	KT 2485	CBS 139680 = JCM 19429 = MAFF 243824	HHUF 30122 <sup>HT</sup>	AB797220	AB807510	AB808486	LC014540	A
<i>Aquilomyces rebunensis</i>	Mor	KT 732-2	CBS 139684 = JCM 19427 = MAFF 243862	HHUF 27556 <sup>HT</sup>	AB797252	AB807542	AB808518	AB809630	A
<i>Bactrodesmium cubense</i>	IS	–	CBS 680.96 = JCM 14126	–	AB797218	AB807508	AB808484	LC014541	C
<i>Clypeoloculus akitaensis</i>	Mor	KT 788	CBS 139681 = JCM 19424 = MAFF 239467	HHUF 27557 <sup>HT</sup>	AB797253	AB807543	AB808519	AB809631	A
<i>C. hirosakiensis</i>	Mor	KT 1283	CBS 139682 = JCM 19425 = MAFF 243864	HHUF 30144 <sup>HT</sup>	AB797260	AB807550	AB808526	AB809638	A
<i>C. microsporus</i>	Mor	KT 1131	CBS 139683 = JCM 19426 = MAFF 243863	HHUF 30143 <sup>HT</sup>	AB797245	AB807535	AB808510	AB811451	A
<i>C. towadaensis</i>	Mor	KT 1340	CBS 139685 = JCM 19428 = MAFF 243865	HHUF 30145 <sup>HT</sup>	AB797259	AB807549	AB808525	AB809637	A
<i>Dictyosporium</i> aff. <i>bulbosum</i>	Dic	KH 375	JCM 19403 = MAFF 243829	HHUF 30127	AB797224	AB807514	AB808490	LC014542	C
<i>D. aff. heptasporum</i>	Dic	KH 332	JCM 19406 = MAFF 243828	HHUF 30126	AB797223	AB807513	AB808489	LC014543	C
<i>D. bulbosum</i>	Dic	yone 221	MAFF 243835	HHUF 29990	AB797221	AB807511	AB808487	LC014544	C
<i>D. digitatum</i>	Dic	KH 401	JCM 19404 = MAFF 243830	HHUF 30128	AB797225	AB807515	AB808491	LC014545	C
<i>D. digitatum</i>	Dic	KT 2660	JCM 19405 = MAFF 243833	HHUF 30131	AB797228	AB807518	AB808494	LC014546	C
<i>D. digitatum</i>	Dic	yone 280	MAFF 243837	HHUF 30093	AB797222	AB807512	AB808488	LC014547	C
<i>D. hughesii</i>	Dic	KT 1847	JCM 19407 = MAFF 243832	HHUF 30130	AB797227	AB807517	AB808493	LC014548	C
<i>D. pseudomusae</i>	Dic	KH 412	JCM 19408 = MAFF 243831	HHUF 30129 <sup>PT</sup>	AB797226	AB807516	AB808492	LC014549	C
<i>D. pseudomusae</i>	Dic	yone 234	CBS 139686 = JCM 19409 = MAFF 243836	HHUF 30133 <sup>HT</sup>	AB797230	AB807520	AB808496	LC014550	C
<i>D. tetrasporum</i>	Dic	KT 2865	JCM 19410 = MAFF 243834	HHUF 30132	AB797229	AB807519	AB808495	LC014551	C
<i>Fuscostagonospora sasae</i>	IS	KT 1467	CBS 139687 = JCM 13104 = MAFF 239614	HHUF 29106 <sup>HT</sup>	AB797258	AB807548	AB808524	AB809636	A
<i>Gregarithecium curvisporum</i>	Dic	KT 922	CBS 139688 = JCM 19411 = MAFF 243838	HHUF 30134 <sup>HT</sup>	AB797257	AB807547	AB808523	AB809644	A
<i>Helicascus aquaticus</i>	Mor	KT 1544	JCM 19423 = MAFF 243866	HHUF 30146	AB797242	AB807532	AB808507	AB809627	A
<i>H. elaterascus</i>	Mor	KT 2673	MAFF 243867	HHUF 30147	AB797243	AB807533	AB808508	AB809626	A
<i>H. elaterascus</i>	Mor	KT 2682	CBS 139689	HHUF 30451	LC014603	LC014608	LC014613	LC014552	A
<i>H. thalassioideus</i>	Mor	–	CBS 110441 = JCM 14147	–	AB797267	AB807557	AB808533	LC014553	A
<i>H. thalassioideus</i>	Mor	KH 242	JCM 17526 = NBRC 107811	HHUF 30069	AB797268	AB807558	AB808534	LC014554	A
<i>Helminthosporium dalbergiae</i>	Mas	H 4628 (= TS 36)	MAFF 243853	HHUF 27971	AB797231	AB807521	AB808497	LC014555	C
<i>H. magnisporum</i>	Mas	H 4627 (= TS 33)	MAFF 239278	HHUF 27968 <sup>HT</sup>	AB797232	AB807522	AB808498	AB811452	C
<i>H. massarinum</i>	Mas	KT 838	JCM 13094 = MAFF 239604	HHUF 27573 <sup>PT</sup>	AB797233	AB807523	AB808499	AB809628	A
<i>H. massarinum</i>	Mas	KT 1564	CBS 139690 = JCM 13095 = MAFF 239605	HHUF 29089 <sup>HT</sup>	AB797234	AB807524	AB808500	AB809629	A
<i>Helminthosporium</i> sp.	Mas	H 4743 (= TS 68)	MAFF 243856	HHUF 28248	AB797236	AB807526	–	–	C
<i>Helminthosporium</i> sp.	Mas	yone 38	MAFF 243857	HHUF 29740	AB797237	AB807527	AB808502	–	C
<i>Helminthosporium</i> sp.	Mas	yone 63	MAFF 243858	HHUF 29741	AB797238	AB807528	AB808503	–	C

(continued on next page)

Table 1. (Continued).

Taxon	Family <sup>1</sup>	Original no.	Culture no.	Specimen no. <sup>2</sup>	GenBank accession no. <sup>3</sup>				Notes <sup>4</sup>
					SSU	LSU	<i>tef1</i>	ITS	
<i>H. velutinum</i>	Mas	H 4626 (= TS 28)	MAFF 243854	HHUF 27966	AB797240	AB807530	AB808505	LC014556	C
<i>H. velutinum</i>	Mas	H 4739 (= TS 58)	MAFF 243855	HHUF 28243	AB797235	AB807525	AB808501	LC014557	C
<i>H. velutinum</i>	Mas	yone 96	MAFF 243859	HHUF 30140	AB797239	AB807529	AB808504	LC014558	C
<i>Karstenula rhodostoma</i>	Did	–	CBS 691.94	UPS (F-141152) 425947	AB797241	AB807531	AB808506	LC014559	A
<i>Katumotoa bambusicola</i>	Len	KT 1517a	JCM 13131 = MAFF 239641	HHUF 28661 <sup>PT</sup>	AB524454 <sup>1</sup>	AB524595 <sup>1</sup>	AB539108 <sup>2</sup>	LC014560	A
<i>Keissleriella breviasca</i>	Len	KT 540	JCM 19413 = MAFF 239476	HHUF 27715 <sup>PT</sup>	AB797296	AB807586	AB808565	AB811453	A
<i>K. breviasca</i>	Len	KT 581	JCM 19414 = MAFF 243843	HHUF 27717 <sup>PT</sup>	AB797297	AB807587	AB808566	AB811454	A
<i>K. breviasca</i>	Len	KT 649	CBS 139691 = JCM 19415 = MAFF 243844	HHUF 27718 <sup>HT</sup>	AB797298	AB807588	AB808567	AB811455	A
<i>K. culmifida</i>	Len	KT 2308	JCM 19416 = MAFF 243848	HHUF 30135	AB797301	AB807591	AB808570	LC014561	A
<i>K. culmifida</i>	Len	KT 2642	JCM 19417 = MAFF 243849	HHUF 30136	AB797302	AB807592	AB808571	LC014562	A
<i>K. gloeospora</i>	Len	KT 829	MAFF 239474	HHUF 27704	AB797299	AB807589	AB808568	LC014563	A
<i>K. quadriseptata</i>	Len	KT 2292	CBS 139692 = JCM 19418 = MAFF 243850	HHUF 30137 <sup>HT</sup>	AB797303	AB807593	AB808572	AB811456	A
<i>Keissleriella</i> sp.	Len	KT 895	JCM 19420 = MAFF 243845	HHUF 27705	AB797300	AB807590	AB808569	–	A
<i>K. taminensis</i>	Len	KT 571	MAFF 243846	HHUF 27707	AB797305	AB807595	AB808574	LC014564	A
<i>K. taminensis</i>	Len	KT 594	MAFF 243847	HHUF 27709	AB797306	AB807596	–	–	A
<i>K. taminensis</i>	Len	KT 678	MAFF 239475	HHUF 27711	AB797307	AB807597	AB808575	LC014565	A
<i>K. yonaguniensis</i>	Len	KT 2604	CBS 139693 = JCM 19419 = MAFF 243851	HHUF 30138 <sup>HT</sup>	AB797304	AB807594	AB808573	AB811457	A
<i>Lentithecium clioninum</i>	Len	KT 1149A	CBS 139694 = JCM 12703 = MAFF 239293	HHUF 28199 <sup>HT</sup>	AB797250	AB807540	AB808515	LC014566	A
<i>L. clioninum</i>	Len	KT 1220	MAFF 243839	HHUF 28213 <sup>PT</sup>	AB797251	AB807541	AB808516	LC014567	A
<i>L. pseudoclioninum</i>	Len	KT 1111	JCM 19421 = MAFF 243840	HHUF 29053 <sup>PT</sup>	AB797254	AB807544	AB808520	AB809632	A
<i>L. pseudoclioninum</i>	Len	KT 1113	CBS 139695 = JCM 19422 = MAFF 243841	HHUF 29055 <sup>HT</sup>	AB797255	AB807545	AB808521	AB809633	A
<i>Magnicamarosporium iriomotense</i>	Sul	KT 2822	CBS 139696 = JCM 19402 = MAFF 243827	HHUF 30125 <sup>HT</sup>	AB797219	AB807509	AB808485	AB809640	C
<i>Massarina cisti</i>	Mas	–	CBS 266.62 = JCM 14140	ZT (Hütter & Loeffler) <sup>HT</sup>	AB797249	AB807539	AB808514	LC014568	A
<i>M. eburnea</i>	Mas	H 3953	CBS 139697 = JCM 14422	HHUF 26621	AB521718 <sup>3</sup>	AB521735 <sup>3</sup>	AB808517	LC014569	A
<i>Monodictys capensis</i>	IS	HR 1	CBS 134928 = VKM F-4506	HHUF 29712	AB797261	AB807551	AB808527	LC014570	C
<i>Monodictys</i> sp.	Par	JO 10	MAFF 243825	HHUF 30123	AB797262	AB807552	AB808528	–	C
<i>Monodictys</i> sp.	Par	KH 331	MAFF 243826	HHUF 30124	AB797263	AB807553	AB808529	–	C
<i>Morosphaeria ramunculicola</i>	Mor	KH 220	NBRC 107813	HHUF 30070	AB797264	AB807554	AB808530	–	A
<i>M. velatispora</i>	Mor	KH 218	JCM 17529 = NBRC 107814	HHUF 30072	AB797265	AB807555	AB808531	LC014571	A
<i>M. velatispora</i>	Mor	KH 221	JCM 17530 = NBRC 107812	HHUF 30073	AB797266	AB807556	AB808532	LC014572	A
<i>Neokalmusia brevispora</i>	Did	KT 1466	CBS 120248 = JCM 13543 = MAFF 239276	HHUF 28229	AB524459 <sup>1</sup>	AB524600 <sup>1</sup>	AB539112 <sup>1</sup>	LC014573	A
<i>N. brevispora</i>	Did	KT 2313	NBRC 106240	HHUF 30016 <sup>ET</sup>	AB524460 <sup>1</sup>	AB524601 <sup>1</sup>	AB539113 <sup>2</sup>	LC014574	A
<i>N. scabrispora</i>	Did	KT 1023	CBS 120246 = JCM 12851 = MAFF 239517	HHUF 28608	AB524452 <sup>1</sup>	AB524593 <sup>1</sup>	AB539106 <sup>2</sup>	LC014575	A

Table 1. (Continued).

Taxon	Family <sup>1</sup>	Original no.	Culture no.	Specimen no. <sup>2</sup>	GenBank accession no. <sup>3</sup>				Notes <sup>4</sup>
					SSU	LSU	<i>tef1</i>	ITS	
<i>N. scabrispora</i>	Did	KT 2202	NBRC 106237	HHUF 30013	AB524453 <sup>1</sup>	AB524594 <sup>1</sup>	AB539107 <sup>2</sup>	LC014576	A
<i>Neophiosphaerella sasicola</i>	Len	KT 1706	CBS 120247 = JCM 13134 = MAFF 239644	HHUF 29443 <sup>ET</sup>	AB524458 <sup>1</sup>	AB524599 <sup>1</sup>	AB539111 <sup>2</sup>	LC014577	A
<i>Parabambusicola bambusina</i>	Par	H 4321	MAFF 239462	HHUF 26590	<b>AB797246</b>	<b>AB807536</b>	<b>AB808511</b>	<b>LC014578</b>	A
<i>P. bambusina</i>	Par	KH 139	MAFF 243823	HHUF 30121	<b>AB797247</b>	<b>AB807537</b>	<b>AB808512</b>	<b>LC014579</b>	A
<i>P. bambusina</i>	Par	KT 2637	MAFF 243822	HHUF 30120	<b>AB797248</b>	<b>AB807538</b>	<b>AB808513</b>	<b>LC014580</b>	A
<i>Paraphaeosphaeria michotii</i>	Did	KT 2222	MAFF 243861	HHUF 30142	<b>AB797269</b>	<b>AB807559</b>	<b>AB808535</b>	<b>AB809639</b>	A
<i>Periconia byssoides</i>	Per	H 4600 (= TS 29)	MAFF 243872	HHUF 28238	<b>AB797280</b>	<b>AB807570</b>	<b>AB808546</b>	<b>LC014581</b>	C
<i>P. byssoides</i>	Per	H 4432	MAFF 243869	–	<b>AB797279</b>	<b>AB807569</b>	<b>AB808545</b>	<b>LC014582</b>	C
<i>P. byssoides</i>	Per	H 4853 (= TS 60)	MAFF 243873	–	<b>AB797281</b>	<b>AB807571</b>	<b>AB808547</b>	<b>LC014583</b>	C
<i>P. digitata</i>	Per	–	CBS 510.77	–	<b>AB797271</b>	<b>AB807561</b>	<b>AB808537</b>	<b>LC014584</b>	C
<i>P. homothallica</i>	Per	KT 916	CBS 139698 = JCM 13100 = MAFF 239610	HHUF 29105 <sup>HT</sup>	<b>AB797275</b>	<b>AB807565</b>	<b>AB808541</b>	<b>AB809645</b>	A
<i>P. igniaria</i>	Per	–	CBS 379.86	–	<b>AB797276</b>	<b>AB807566</b>	<b>AB808542</b>	<b>LC014585</b>	C
<i>P. igniaria</i>	Per	–	CBS 845.96 = JCM 14142	–	<b>AB797277</b>	<b>AB807567</b>	<b>AB808543</b>	<b>LC014586</b>	C
<i>P. pseudobyssoides</i>	Per	H 4151	MAFF 243868	–	<b>AB797278</b>	<b>AB807568</b>	<b>AB808544</b>	<b>LC014587</b>	C
<i>P. pseudobyssoides</i>	Per	H 4790 (= TS 102)	MAFF 243874	HHUF 28257	<b>AB797270</b>	<b>AB807560</b>	<b>AB808536</b>	<b>LC014588</b>	C
<i>P. pseudodigitata</i>	Per	KT 644	JCM 13164 = MAFF 239674	HHUF 27569 <sup>PT</sup>	<b>AB797272</b>	<b>AB807562</b>	<b>AB808538</b>	<b>LC014589</b>	A
<i>P. pseudodigitata</i>	Per	KT 1195A	JCM 13165 = MAFF 239675	HHUF 29368 <sup>PT</sup>	<b>AB797273</b>	<b>AB807563</b>	<b>AB808539</b>	<b>LC014590</b>	A
<i>P. pseudodigitata</i>	Per	KT 1395	CBS 139699 = JCM 13166 = MAFF 239676	HHUF 29370 <sup>HT</sup>	<b>AB797274</b>	<b>AB807564</b>	<b>AB808540</b>	<b>LC014591</b>	A
<i>Periconia</i> sp.	Per	KT 1820A	MAFF 243870	HHUF 30148	<b>AB797282</b>	<b>AB807572</b>	<b>AB808548</b>	–	C
<i>Periconia</i> sp.	Per	KT 1825	MAFF 243871	HHUF 30149	<b>AB797283</b>	<b>AB807573</b>	<b>AB808549</b>	–	C
<i>Pseudocoleophoma calamagrostidis</i>	Dic	KT 3284	CBS 139700	HHUF 30450 <sup>HT</sup>	<b>LC014604</b>	<b>LC014609</b>	<b>LC014614</b>	<b>LC014592</b>	A
<i>P. polygonicola</i>	Dic	KT 731	CBS 139701 = JCM 19412 = MAFF 239468	HHUF 27558 <sup>HT</sup>	<b>AB797256</b>	<b>AB807546</b>	<b>AB808522</b>	<b>AB809634</b>	A
<i>Setoseptoria arundinacea</i>	Len	KT 552	MAFF 239460	HHUF 27543	<b>AB797284</b>	<b>AB807574</b>	<b>AB808550</b>	<b>LC014594</b>	A
<i>S. arundinacea</i>	Len	KT 600	MAFF 243842	HHUF 27544	<b>AB797285</b>	<b>AB807575</b>	<b>AB808551</b>	<b>LC014595</b>	A
<i>S. magniarundinacea</i>	Len	KT 1174	CBS 139702 = MAFF 239294	HHUF 28293 <sup>HT</sup>	<b>AB797286</b>	<b>AB807576</b>	<b>AB808552</b>	<b>LC014596</b>	A
<i>Spegazzinia deightonii</i>	Did	yone 66	MAFF 243876	HHUF 30150	<b>AB797291</b>	<b>AB807581</b>	<b>AB808557</b>	–	C
<i>S. deightonii</i>	Did	yone 212	MAFF 243877	HHUF 30151	<b>AB797292</b>	<b>AB807582</b>	<b>AB808558</b>	–	C
<i>Spegazzinia</i> sp.	Did	yone 279	MAFF 243878	HHUF 30152	<b>AB797293</b>	<b>AB807583</b>	<b>AB808559</b>	–	C
<i>S. tessartha</i>	Did	SH 287	MAFF 243875	HHUF 27691	<b>AB797294</b>	<b>AB807584</b>	<b>AB808560</b>	–	C
<i>Stagonospora perfecta</i>	Mas	KT 1726A	JCM 13099 = MAFF 239609	HHUF 29095	<b>AB797289</b>	<b>AB807579</b>	<b>AB808555</b>	<b>AB809642</b>	A
<i>S. pseudoperfecta</i>	Mas	KT 889	CBS 120236 = JCM 13097 = MAFF 239607	HHUF 29087 <sup>HT</sup>	<b>AB797287</b>	<b>AB807577</b>	<b>AB808553</b>	<b>AB809641</b>	A
<i>Stagonospora</i> sp.	Mas	KT 903	CBS 120237 = JCM 13098 = MAFF 239608	HHUF 29088	<b>AB797288</b>	<b>AB807578</b>	<b>AB808554</b>	–	A

(continued on next page)



Table 1. (Continued).

Taxon	Family <sup>1</sup>	Original no.	Culture no.	Specimen no. <sup>2</sup>	GenBank accession no. <sup>3</sup>				Notes <sup>4</sup>
					SSU	LSU	tef1	ITS	
<i>S. tainanensis</i>	Mas	KT 1866	MAFF 243860	HHUF 30141	AB797290	AB807580	AB808556	AB809643	A
<i>Sulcatiflora acerina</i>	Sul	KT 2982	CBS 139703	HHUF 30449 <sup>HT</sup>	LC014605	LC014610	LC014615	LC014597	A
<i>S. berchemiae</i>	Sul	KT 1607	CBS 139704 = JCM 13101 = MAFF 239611	HHUF 2909 <sup>HT</sup>	AB797244	AB807534	AB808509	AB809635	A
<i>Tingoldiagio graminicola</i>	Len	KH 68	JCM 16485 = NBRC 106131	HHUF 30009 <sup>HT</sup>	AB521726 <sup>S</sup>	AB521743 <sup>S</sup>	AB808561	LC014598	A
<i>T. graminicola</i>	Len	KH 155	JCM 16486 = NBRC 106132	HHUF 30010 <sup>PT</sup>	AB521728 <sup>S</sup>	AB521745 <sup>S</sup>	AB808562	LC014599	A
<i>T. graminicola</i>	Len	KT 891	MAFF 239472	HHUF 27882 <sup>PT</sup>	AB521727 <sup>S</sup>	AB521744 <sup>S</sup>	AB808563	LC014600	A
<i>Trematosphaeria pertusa</i>	Tre	KT 1496	JCM 19430 = MAFF 243879	HHUF 30153	AB797295	AB807585	AB808564	AB809646	A
<i>T. pertusa</i>	Tre	KT 3314	CBS 139705	HHUF 30452	LC014606	LC014611	LC014616	LC014601	A
<i>T. pertusa</i>	Tre	KT 3315	CBS 139706	HHUF 30453	LC014607	LC014612	LC014617	LC014602	A
<i>Pseudoxylomyces elegans</i>	IS	KT 2887	MAFF 243852	HHUF 30139	AB797308	AB807598	AB808576	LC014593	C

<sup>1</sup> Abbreviation of family names: Bam (*Bambusicolaceae*), Dic (*Dictyosporaceae*), Did (*Didymosphaeriaceae*), IS (*insertae sedis*), Len (*Lentitheciaceae*), Mas (*Massarinaceae*), Mor (*Morosphaeriaceae*), Par (*Paramorosphaeriaceae*), Per (*Periconiaceae*), Sul (*Sulcatifloraceae*), and Tre (*Trematosphaeriaceae*).

<sup>2</sup> Specimen with HT (holotype), PT (paratype), and ET (epitype).

<sup>3</sup> Sequences obtained in this study are shown in bold. Sequences with <sup>1</sup> from Tanaka et al. (2009), <sup>2</sup> from Schoch et al. (2009), and <sup>3</sup> from Hirayama et al. (2010).

<sup>4</sup> Origin of isolates: A, single ascospore; C, single conidium.

the models selected by AIC (separate model among genes and proportional model among codons, HKY85+G for SSU, J2+G for LSU, GTR+G for the first codon of *tef1*, TVM+G for the second codon of *tef1*, and GTR+G for the third codon of *tef1*). Bootstrap proportions (BP) were obtained by 1000 bootstrap replications.

## RESULTS

### Molecular phylogenetic analysis

Approximately 940–1750 bp of SSU, 870–1330 bp of LSU nrDNA, 830–940 bp of *tef1*, and 500–900 bp of ITS sequences were determined for 106 isolates of fungi within the *Massarinaceae*. Analyses of different gene datasets were performed individually, but no topological conflict was observed at familial level with the exception of *Lentitheciaceae*, which was polyphyletic in the *tef1* tree (data not shown). A combined dataset of SSU, LSU, and *tef1* sequences was generated after excluding insertions of several species which corresponded to positions 493–1005 of *Monodictys capensis* (GenBank AB797261) and positions 1286–1651 of *Magnicamarosporium iriomotense* (GenBank AB797219) in the SSU, and positions 836–892 of *Montagnula spartii* (GenBank GU205225) and positions 871–924 of *Hysterium pulicare* (GenBank FJ161201) in the LSU sequences. The combined dataset consisted of 243 taxa and 3386 characters, of which 28 % were missing and gap characters. The alignment had 82 % representation for SSU, 100 % for LSU and 60 % for *tef1*. BP support of each familial clade in the LSU tree was generally improved by adding the SSU and *tef1* dataset with missing data, e.g., from 82 % to 100 % in the *Massarinaceae*, and from 90 % to 100 % in the *Trematosphaeriaceae*.

The ML tree of *Massarinaceae* based on the SSU and LSU nrDNA and *tef1* regions with the highest log likelihood (−36965.05250) is shown in Fig. 1. A total of 237 taxa of the *Massarinaceae* formed a clade (with 98 % BP support) and were scattered in 12 familial clades and five unknown clades. Seven families previously recognised, namely the *Dictyosporiaceae* (nom. prov., 100 % BP), *Didymosphaeriaceae* (99 % BP), *Latoruaceae* (99 % BP), *Macrodiplodiopsidaceae* (96 % BP), *Massarinaceae* (100 % BP), *Morosphaeriaceae* (98 % BP), and *Trematosphaeriaceae* (100 % BP) were highly supported as independent monophyletic groups. The *Bambusicolaceae* and *Lentitheciaceae* received moderate BP support, 87 % and 71 %, respectively. We erected two new families, the *Parabambusicolaceae* (81 % BP) and *Sulcatifloraceae* (97 % BP), to accommodate several genera, which cannot be placed in any of the existing families in the *Massarinaceae*. Although species in the genus *Periconia* have been treated as members of the *Massarinaceae* (Zhang et al. 2012, Hyde et al. 2013), we have placed them in a distinct family, the *Periconiaceae* (100 % BP), which was established by Nannizzi (1934).

### Taxonomy

As a result of morphological comparisons and phylogenetic analyses of 106 strains, along with sequences from 131 taxa obtained from GenBank, at least 12 families including two new families (the *Parabambusicolaceae* and *Sulcatifloraceae*) are recognised. Ten new genera, 22 new species, and seven new combinations are proposed. Taxa are arranged in alphabetical

**Table 2.** Cultures and GenBank accession numbers of *Massarineae* used for phylogenetic analysis.

Taxon	Family <sup>1</sup>	Culture no. <sup>2</sup>	GenBank accession no. <sup>3</sup>		
			SSU	LSU	<i>tef1</i>
<i>Alloconiothyrium aptrootii</i>	Did	CBS 980.95 <sup>HT</sup>	NS	JX496234	NS
<i>Aquaticheirosora lignicola</i>	Dic	RK-2006a <sup>HT</sup>	AY736377	AY736378	NS
<i>Aquilomyces patris</i>	Mor	CBS 135661 <sup>HT</sup>	KP184077	KP184041	NS
<i>Asteromassaria pulchra</i>	IS	CBS 124082	GU296137	GU301800	GU349066
<i>Bambusicola bambusae</i>	Bam	MFLUCC 11-0614 <sup>HT</sup>	JX442039	JX442035	NS
<i>B. irregulispora</i>	Bam	MFLUCC 11-0437 <sup>HT</sup>	JX442040	JX442036	NS
<i>B. loculata</i>	Bam	MFLUCC 13-0856 <sup>HT</sup>	KP761735	KP761729	KP761724
<i>B. massarina</i>	Bam	MFLUCC 11-0389 <sup>HT</sup>	JX442041	JX442037	NS
<i>B. splendida</i>	Bam	MFLUCC 11-0439 <sup>HT</sup>	JX442042	JX442038	NS
<i>Bambusistroma didymosporum</i>	Per	MFLUCC 13-0862 <sup>HT</sup>	NS	KP761730	KP761727
<i>Bimuria novae-zelandiae</i>	Did	CBS 107.79 <sup>HT</sup>	AY016338	AY016356	DQ471087
<i>Byssothecium circinans</i>	Mas	CBS 675.92	GU205235	AY016357	GU349061
<i>Camarographium koreanum</i>	Mac	CBS 117159 <sup>HT</sup>	NS	JQ044451	NS
" <i>Corynespora</i> " <i>leucadendri</i>	Mas	CBS 135133 <sup>HT</sup>	NS	KF251654	NS
" <i>C.</i> " <i>olivacea</i>	Mas	CBS 114450	NS	GU301809	GU349014
<i>Cucurbitodthis pityophila</i>	Did	CBS 149.32	U42480	DQ384102	NS
<i>Darksidea alpha</i>	Len	CBS 135650 <sup>HT</sup>	KP184049	KP184019	KP184166
<i>D. beta</i>	Len	CBS 135637 <sup>HT</sup>	KP184074	KP184023	KP184189
<i>D. gamma</i>	Len	CBS 135634 <sup>HT</sup>	KP184073	KP184028	KP184188
<i>D. delta</i>	Len	CBS 135638 <sup>HT</sup>	KP184069	KP184024	KP184184
<i>D. epsilon</i>	Len	CBS 135658 <sup>HT</sup>	KP184070	KP184029	KP184186
<i>D. zeta</i>	Len	CBS 135640 <sup>HT</sup>	KP184071	KP184013	KP184191
<i>Dendryphiella vinosa</i>	Dic	–	EU848589	EU848590	NS
<i>Deniquelata barringtoniae</i>	Did	MFLUCC 110422 <sup>HT</sup>	JX254656	JX254655	NS
<i>Dictyosporium alatum</i>	Dic	ATCC 34953 <sup>HT</sup>	DQ018080	DQ018101	NS
<i>D. elegans</i>	Dic	NBRC 32502	DQ018079	DQ018100	NS
<i>D. inflatum</i>	Dic	NTOU 3855	JQ267361	JQ267363	NS
<i>D. meiosporum</i>	Dic	MFLUCC 10-0131 <sup>HT</sup>	KP710946	KP710945	NS
<i>D. stellatum</i>	Dic	CCFC 241241 <sup>HT</sup>	NS	JF951177	NS
<i>D. strelitziae</i>	Dic	CBS 123359 <sup>HT</sup>	NS	FJ839653	NS
<i>D. thailandicum</i>	Dic	MFLUCC 13-0773 <sup>HT</sup>	NS	KP716707	NS
<i>D. toruloides</i>	Dic	CBS 209.65	DQ018081	DQ018104	NS
<i>Didymocrea sadasivanii</i>	Did	CBS 438.65 <sup>IT</sup>	DQ384066	DQ384103	NS
<i>Didymosphaeria rubi-ulmifolii</i>	Did	MFLUCC 14-0023 <sup>HT</sup>	KJ436588	KJ436586	NS
" <i>D.</i> " <i>spartii</i>	Mas	CBS 183.58	GU205250	GU205225	NS
<i>Digitodesmium bambusicola</i>	Dic	CBS 110279 <sup>HT</sup>	NS	DQ018103	NS
" <i>Diplococcium</i> " <i>asperum</i>	Dic	CBS 139.95	EF204511	EF204493	NS
<i>Falciformispora lignatilis</i>	Tre	BCC 21117	GU371834	GU371826	GU371819
<i>F. senegalensis</i>	Tre	CBS 196.79 <sup>HT</sup>	KF015636	KF015631	KF015687
<i>F. tompkinsii</i>	Tre	CBS 200.79 <sup>HT</sup>	KF015639	KF015625	KF015685
<i>Flavomyces fulophazii</i>	Per	CBS 135761 <sup>HT</sup>	KP184082	KP184040	NS
<i>Halomassarina thalassiae</i>	Tre	BCC 17054	GQ925842	GQ925849	NS
<i>H. thalassiae</i>	Tre	JK 5262D	NS	GU301816	GU349011
<i>Helicascus aegyptiacus</i>	Mor	FWCC 99 <sup>HT</sup>	KC894852	KC894853	NS
<i>H. aquaticus</i>	Mor	MFLUCC 10-0918 <sup>HT</sup>	KC886638	KC886640	NS
<i>H. elaterascus</i>	Mor	A22-5A = HKUCC 7769	AF053727	AY787934	NS
<i>H. nypae</i>	Mor	BCC 36751	GU479754	GU479788	GU479854
<i>H. nypae</i>	Mor	BCC 36752	GU479755	GU479789	GU479855
<i>H. thalassioideus</i>	Mor	MFLUCC10-0911	KC886637	KC886636	NS

(continued on next page)

Table 2. (Continued).

Taxon	Family <sup>1</sup>	Culture no. <sup>2</sup>	GenBank accession no. <sup>3</sup>		
			SSU	LSU	<i>tef1</i>
<i>H. unilocularis</i>	Mor	MJF14020 <sup>HT</sup>	NS	KP637166	NS
<i>Hysterium pulicare</i>	OG	CBS 12337	FJ161161	FJ161201	FJ161109
<i>Hysterobrevium mori</i>	OG	CBS 12356	FJ161155	FJ161196	FJ161104
<i>Inflatipora pseudostromatica</i>	IS	CBS 123110 <sup>HT</sup>	JN231132	JN231131	NS
" <i>Kalmusia (Montagnula)</i> " <i>anthostomoides</i>	Did	CBS 615.86	GU205246	GU205223	NS
<i>K. ebuli</i>	Did	CBS 123120 <sup>NT</sup>	JN851818	JN644073	NS
<i>K. italica</i>	Did	MFLUCC 13–0066 <sup>HT</sup>	KP325442	KP325441	NS
<i>K. spartii</i>	Did	MFLUCC 14–0560 <sup>HT</sup>	KP753953	KP744487	NS
<i>K. variispora</i>	Did	CBS 121517 <sup>HT</sup>	NS	JX496143	NS
<i>Karstenula rhodostoma</i>	Did	CBS 690.94	GU296154	GU301821	GU349067
<i>Keissleriella cladophila</i>	Len	CBS 104.55	GU296155	GU301822	GU349043
<i>K. genistae</i>	Len	CBS 113798	GU205242	GU205222	NS
<i>K. linearis</i>	Len	IFRD 2008	FJ795478	FJ795435	NS
<i>K. poagena</i>	Len	CBS 136767 <sup>HT</sup>	NS	KJ869170	NS
<i>K. sparticola</i>	Len	MFLUCC 14–0196 <sup>HT</sup>	NS	KP639571	NS
<i>K. trichophoricola</i>	Len	CBS 136770 <sup>HT</sup>	NS	KJ869171	NS
<i>Latorua caligans</i>	Lat	CBS 576.65 <sup>HT</sup>	NS	KR873266	NS
<i>L. grootfonteinensis</i>	Lat	CBS 369.72 <sup>HT</sup>	NS	KR873267	NS
<i>Lentithecium aquaticum</i>	Len	CBS 123099 <sup>HT</sup>	GU296156	GU301823	GU349068
<i>L. fluviatile</i>	Len	CBS 122367	GU296158	GU301825	GU349074
<i>Leptosphaeria doliolum</i>	Lep	CBS 505.75	GU296159	GU301827	GU349069
<i>Letendraea eurotioides</i>	Did	CBS 212.31	NS	AY787935	NS
<i>L. helminthicola</i>	Did	CBS 884.85	AY016345	AY016362	NS
<i>L. padouk</i>	Did	CBS 485.70	GU296162	AY849951	NS
<i>Lophiostoma arundinis</i>	Lop	JCM 13550	AB618679	AB618998	LC001737
<i>L. macrostomum</i>	Lop	JCM 13544	AB618691	AB619010	LC001751
<i>Macrodiplodiopsis desmazieri</i>	Mac	CBS 140062 <sup>ET</sup>	NS	KR873272	NS
<i>M. desmazieri</i>	Mac	CBS 221.37	DQ678013	DQ678065	DQ677908
<i>Massarina eburnea</i>	Mas	CBS 473.64	GU296170	GU301840	GU349040
<i>Montagnula aloes</i>	Did	CBS 132531 <sup>HT</sup>	NS	JX069847	NS
<i>M. graminicola</i>	Did	MFLUCC 13–0352 <sup>HT</sup>	KM658316	KM658315	NS
<i>M. opulenta</i>	Did	CBS 168.34	AF164370	DQ678086	NS
<i>Morosphaeria ramunculicola</i>	Mor	BCC 18404	GQ925838	GQ925853	NS
<i>M. velatispora</i>	Mor	BCC 17059	GQ925841	GQ925852	NS
<i>Multiseptospora thailandica</i>	Par	MFLUCC 11–0183 <sup>HT</sup>	KP753955	KP744490	NS
<i>Munkovalsaria appendiculata</i>	Did	CBS 109027 <sup>HT</sup>	NS	AY772016	NS
<i>Murilentithecium clematidis</i>	Len	MFLUCC 14–0561 <sup>HT</sup>	KM408761	KM408759	KM454445
<i>Neobambusicola strelitziae</i>	Sul	CBS 138869 <sup>HT</sup>	NS	KP004495	NS
<i>Noosia banksiae</i>	Per	CBS 129526 <sup>HT</sup>	NS	JF951167	NS
<i>Palmiascoma gregariascomum</i>	Bam	MFLUCC 11–0175 <sup>HT</sup>	KP753958	KP744495	NS
<i>Paracamarosporium leucandendri</i>	Did	CBS 123027 <sup>HT</sup>	NS	EU552106	NS
<i>P. psoraleae</i>	Did	CBS 136628 <sup>HT</sup>	NS	KF777199	NS
<i>Paraconiothyrium estuarinum</i>	Did	CBS 109850 <sup>HT</sup>	NS	JX496129	NS
" <i>P.</i> " <i>flavescens</i>	Dic	CBS 178.93	GU238216	GU238075	NS
" <i>P.</i> " <i>fuckelii</i>	Did	CBS 797.95	GU238204	GU237960	NS
<i>P. maculicutis</i>	Did	CBS 101461 <sup>HT</sup>	EU754101	EU754200	NS
<i>P. thysanolaenae</i>	Did	MFLUCC 10–0550 <sup>HT</sup>	KP753959	KP744496	NS
" <i>P.</i> " <i>tiliae</i>	Did	CBS 265.94 <sup>LT</sup>	EU754040	EU754139	NS
<i>Paraphaeosphaeria michotii</i>	Did	CBS 652.86	GQ387520	GQ387581	GU456266



**Table 2.** (Continued).

Taxon	Family <sup>1</sup>	Culture no. <sup>2</sup>	GenBank accession no. <sup>3</sup>		
			SSU	LSU	<i>tef1</i>
" <i>P.</i> " <i>spartii</i>	Did	MFLUCC 13-0398 <sup>HT</sup>	KP711367	KP711362	NS
<i>Periconia macrospinoso</i>	Per	CBS 135663	KP184080	KP184038	NS
<i>Phaeodothis winteri</i>	Did	CBS 182.58	GU296183	GU301857	DQ677917
<i>Phragmocamarosporium hederarum</i>	Len	MFLUCC 13-0552 <sup>HT</sup>	KP842918	KP842915	NS
<i>P. platani</i>	Len	MFLUCC 14-1191 <sup>HT</sup>	KP842919	KP842916	NS
" <i>Pithomyces</i> " <i>valparadisiacus</i>	Mor	CBS 113339	NS	EU552152	NS
<i>Pleospora herbarum</i>	Ple	CBS 191.86	DQ247812	DQ247804	DQ471090
<i>Pleurophoma pleurospora</i>	Len	CBS 130329 <sup>LT</sup>	NS	JF740327	NS
<i>Poaceascoma helicoides</i>	Len	MFLUCC 11-0136 <sup>HT</sup>	KP998463	KP998462	KP998461
<i>Polyschema congolensis</i>	Lat	CBS 542.73 <sup>HT</sup>	NS	EF204502	NS
<i>P. larviformis</i>	Lat	CBS 463.88	NS	EF204503	NS
<i>P. terricola</i>	Lat	CBS 301.65 <sup>HT</sup>	EF204519	EF204504	NS
<i>Pseudocamarosporium brabeji</i>	Did	CBS 119219 <sup>HT</sup>	NS	EU552104	NS
<i>P. cotinae</i>	Did	MFLUCC 14-0624 <sup>HT</sup>	KP753964	KP744505	NS
<i>P. propinquum</i>	Did	MFLUCC 13-0544 <sup>ET</sup>	KJ819949	KJ813280	NS
<i>P. tilicola</i>	Did	MFLUCC 13-0550 <sup>HT</sup>	KJ819950	KJ813281	NS
<i>Pseudochaetosphaerium larense</i>	Mac	CBS 640.73 <sup>HT</sup>	KF015652	KF015611	KF015684
<i>Pseudodictyosporium elegans</i>	Dic	CBS 688.93 <sup>HT</sup>	DQ018084	DQ018106	NS
<i>P. wauense</i>	Dic	NBRC 30078	DQ018083	DQ018105	NS
<i>Setoseptoria arundinacea</i>	Len	CBS 619.86	GU296157	GU301824	NS
<i>S. arundinacea</i>	Len	CBS 123131	GU456298	GU456320	GU456281
<i>S. phragmitis</i>	Len	CBS 114802 <sup>HT</sup>	NS	KF251752	NS
<i>S. phragmitis</i>	Len	CBS 114966 <sup>PT</sup>	NS	KF251753	NS
<i>Sporidesmiella fusiformis</i>	Did	HKUCC 10831	NS	DQ408577	NS
" <i>Sporidesmium</i> " <i>tengii</i>	Per	HKUCC 10837	NS	DQ408559	NS
<i>Stagonospora duoseptata</i>	Mas	CBS 135093 <sup>HT</sup>	NS	KF251758	NS
" <i>S.</i> " <i>macropycnidia</i>	Len	CBS 114202	GU296198	GU301873	GU349026
<i>S. paludosa</i>	Mas	CBS 135088 <sup>NT</sup>	NS	KF251760	NS
<i>S. (Neottiosporina) paspali</i>	Mas	CBS 331.37	EU754073	EU754172	GU349079
<i>S. perfecta</i>	Mas	CBS 135099 <sup>HT</sup>	NS	KF251761	NS
<i>S. pseudocaricis</i>	Mas	CBS 135132 <sup>HT</sup>	NS	KF251763	NS
<i>S. pseudopaludosa</i>	Mas	CBS 136424 <sup>HT</sup>	NS	KF777239	NS
<i>S. pseudovitensis</i>	Mas	S602 <sup>PT</sup>	NS	KF251765	NS
<i>S. trichophoricola</i>	Mas	CBS 136764 <sup>HT</sup>	NS	KJ869168	NS
<i>S. uniseptata</i>	Mas	CBS 135090 <sup>HT</sup>	NS	KF251767	NS
<i>Suttonomyces clematidis</i>	Mas	MFLUCC 14-0240 <sup>HT</sup>	KP842920	KP842917	NS
<i>Trematosphaeria grisea</i>	Tre	CBS 332.50 <sup>HT</sup>	KF015641	KF015614	KF015698
<i>T. grisea</i>	Tre	CBS 135984	KF015632	KF015618	KF015694
<i>T. pertusa</i>	Tre	CBS 122368 <sup>ET</sup>	FJ201991	FJ201990	KF015701

<sup>1</sup> Abbreviation of family names: Acr (*Acrocalymmataceae*), Bam (*Bambusicolaceae*), Dic (*Dictyosporaceae*), Did (*Didymosphaeriaceae*), IS (*insertae sedis*), Lat (*Latoruaceae*), Len (*Lentitheciaceae*), Lep (*Leptosphaeriaceae*), Lop (*Lophiostomataceae*), Mac (*Macrodiplodiopsidaceae*), Mas (*Massarinaceae*), Mor (*Morosphaeriaceae*), OG (outgroup), Par (*Parabambusicolaceae*), Per (*Periconiaceae*), Ple (*Pleosporaceae*), Sul (*Sulcatisporaceae*), and Tre (*Trematosphaeriaceae*).

<sup>2</sup> Isolate ex ET (epitype), HT (holotype), IT (isotype), LT (lectotype), NT (neotype), and PT (paratype).

<sup>3</sup> NS: No sequence available in GenBank.

order by family, genus, and species. For the known species a brief description and/or taxonomic notes are provided.

**Dictyosporiaceae** nom. prov. (see Liu *et al.* 2015)

Type genus: *Dictyosporium* Corda.

*Dictyosporium* Corda, Weitenweber's Beitr. Nat.: 87. 1836.

Type species: *Dictyosporium elegans* Corda.

Notes: *Dictyosporium* species have been reported worldwide from dead wood and decaying leaves in terrestrial and

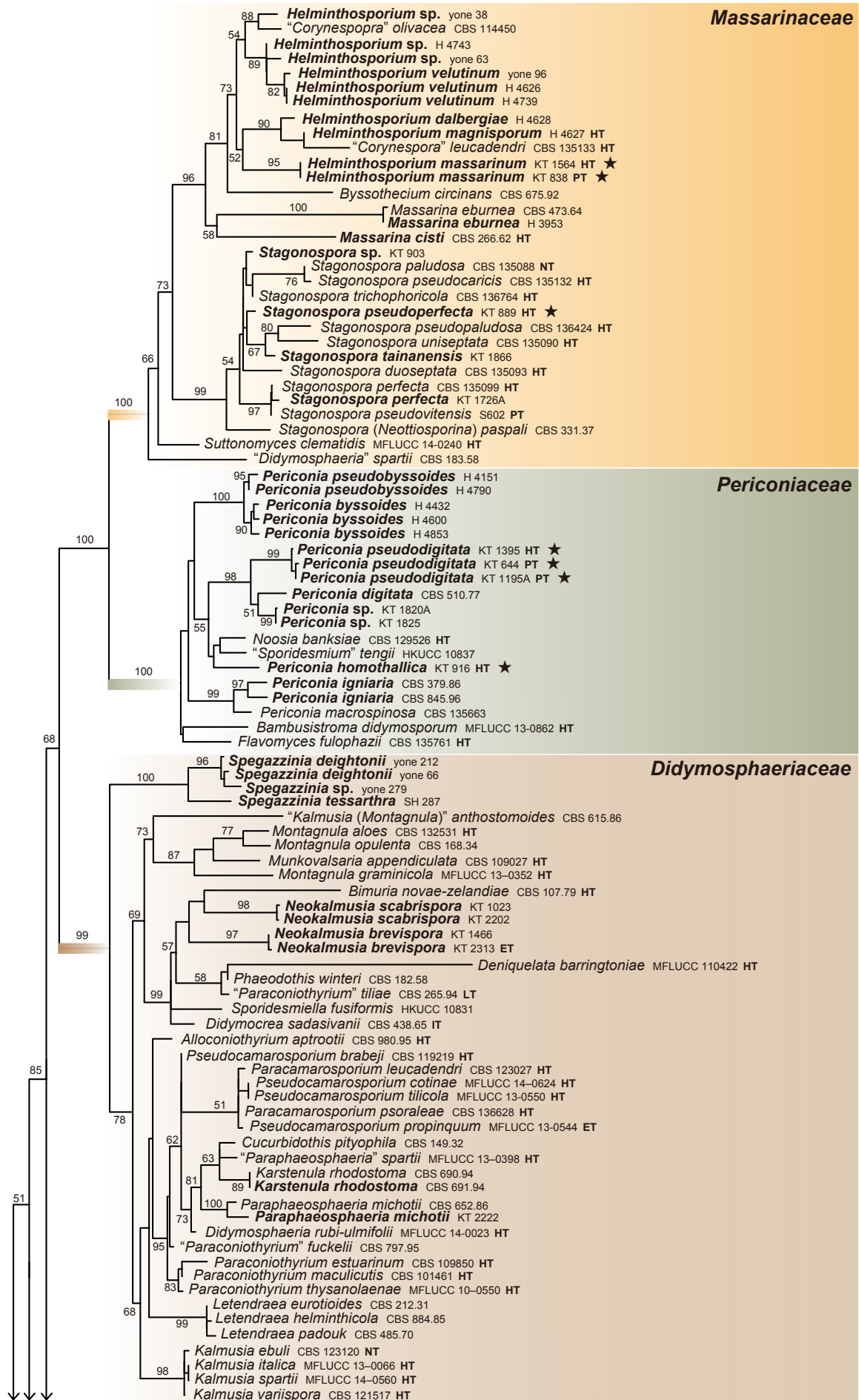


Fig. 1. Maximum-likelihood tree of Massarinaceae based on the SSU and LSU nrDNA and *tef1* regions. ML bootstrap proportion (BP) greater than 50 % is presented at the nodes. An original isolate designation (or culture collection number) is noted after the species name. Sequences derived from holotype, isotype, neotype, paratype and epitype

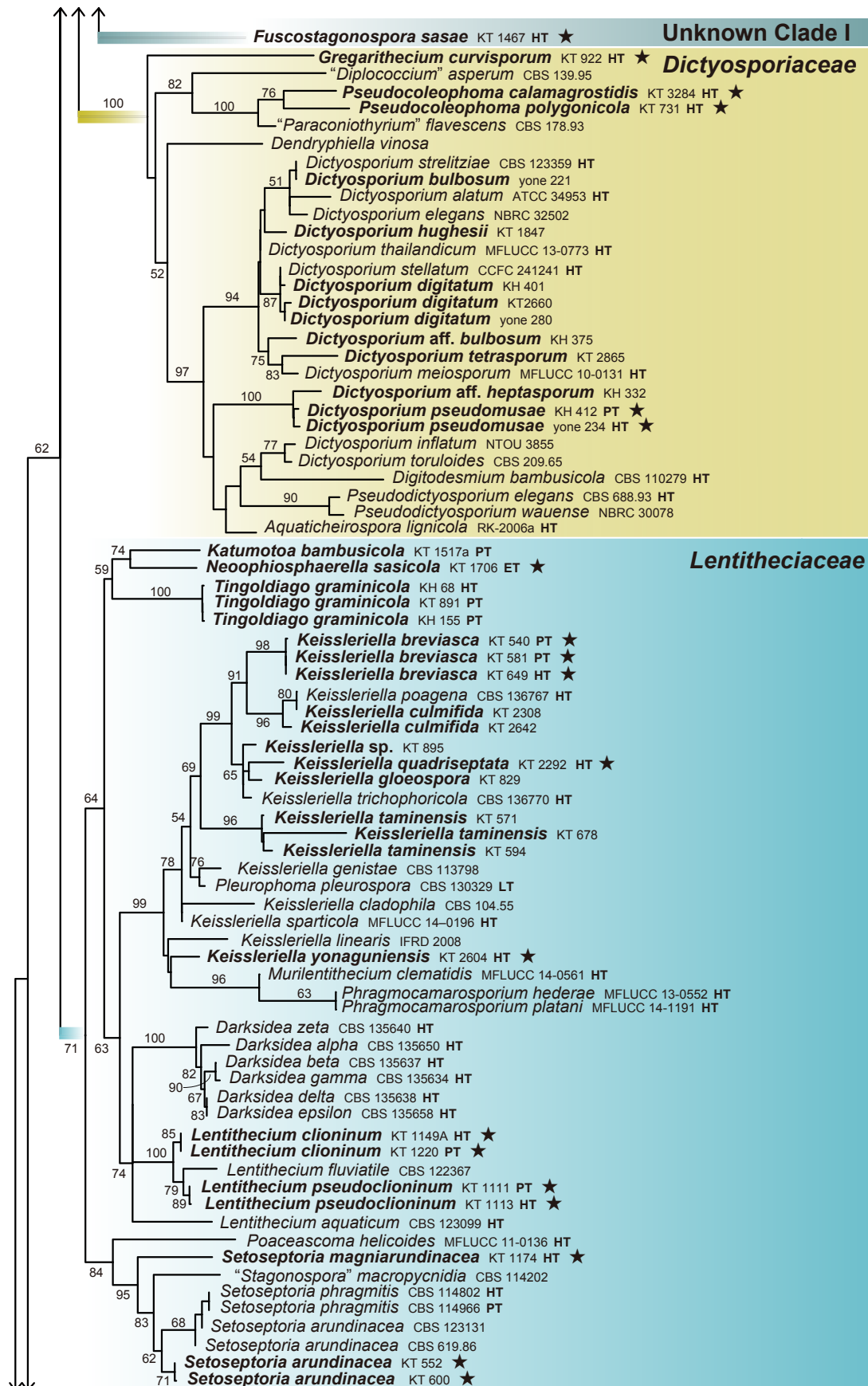


Fig. 1. (Continued).

materials are indicated as HT, IT, NT, PT and ET, respectively. Species used for morphological observation in this study are formatted in bold. New names are marked by five-pointed stars. Families, where known, are indicated with coloured blocks. The tree was rooted to *Hysterobrevium mori* and *Hysterium pulicare* in the *Hysteriales*. The scale bar represents the number of nucleotide substitutions per site.



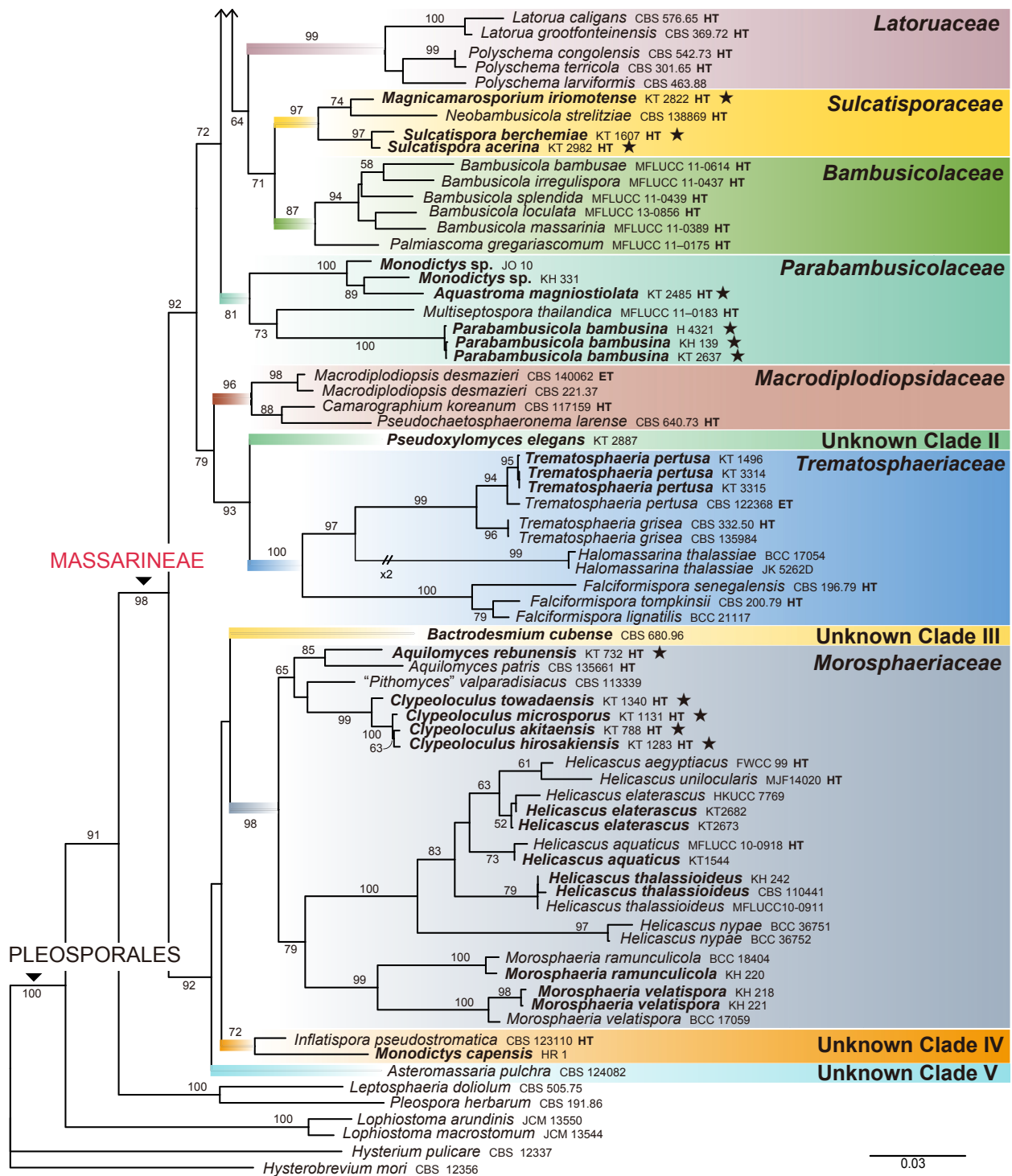


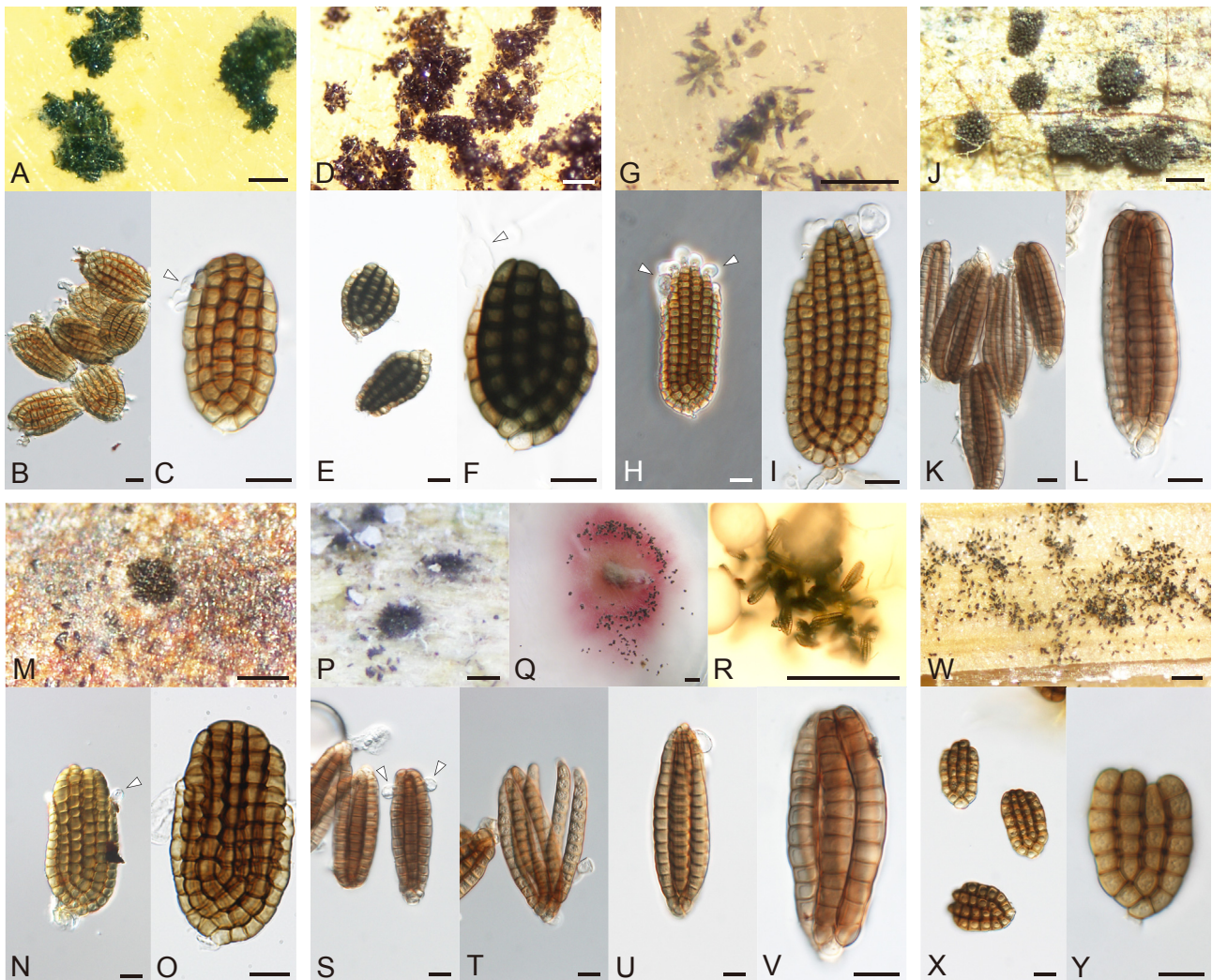
Fig. 1. (Continued).

freshwater environments. The genus is characterised by pigmented, cheiroid conidia formed on sporodochial colonies. It has been considered that the genus is closely related to the *Massariniaceae* in the *Pleosporales* based on phylogenetic analysis using SSU and LSU nrDNA sequences (Tsui *et al.* 2006). After taxonomic revision of the genus (Goh *et al.* 1999, Cai *et al.* 2003), 33 species were accepted as *Dictyosporium* (Crous *et al.* 2009a). In addition, 16 species have been further recorded in this genus (Manoharachary *et al.* 2007, Zhang *et al.*

2009a, Wongsawas *et al.* 2009, Hu *et al.* 2010, McKenzie 2010, Crous *et al.* 2011a, Whitton *et al.* 2012, Kirschner *et al.* 2013, Liu *et al.* 2015, Prasher & Verma 2015).

*Dictyosporium bulbosum* Tzean & J.L. Chen, Mycol. Res. 92: 500. 1989. Fig. 2A–C.

*Specimen examined:* Japan, Okinawa, Isl. Iriomote, near Maryudu-falls, on dead twigs of woody plant, 27 Sep. 2007, H. Yonezawa & K. Tanaka, yone 221 = HHUF 29990, culture MAFF 243835.



**Fig. 2.** *Dictyosporium* spp. A–C. *D. bulbosum* (A from culture yone 221; B, C from yone 221); D–F. *D. aff. bulbosum* (culture KH 375); G–I. *D. digitatum* (G from culture KT 2660; H from culture yone 280; I from culture KH 401); J–L. *D. aff. heptasporum* (KH 332); M–O. *D. hughesii* (M, O from KT 1847; N from culture KT 1847); P–V. *D. pseudomusae* (P from yone 234; Q, T from culture yone 234; R, U from culture KH 412; S, V from KH 412); W–Y. *D. tetrasporum* (culture KT 2865). A, D, G, J, M, P–R, W. Conidial masses on culture media or natural substrates (A, D, G, Q, R, W from culture; J, M, P from nature); B, C, E, F, H, I, K, L, N, O, S–V, X, Y. Conidia (arrowheads indicate conidial appendages). Scale bars: A, D, G, J, M, P–R, W = 200  $\mu$ m; B, C, E, F, H, I, K, L, N, O, S–V, X, Y = 10  $\mu$ m.

**Note:** This specimen was identified as *D. bulbosum* and morphological features were described and illustrated by Hirayama *et al.* (2012).

***Dictyosporium* aff. *bulbosum*** Fig. 2D–F.

**Specimen examined:** Japan, Okinawa, Isl. Iriomote, Uehara, near Tropical Biosphere Research Center (Ryukyu Univ.), small stream, on submerged twigs of woody plant, 13 Jul. 2011, K. Hirayama & K. Tanaka, KH 375 = HHUF 30127, culture JCM 19403 = MAFF 243829.

**Notes:** The above isolate produced an asexual morph in culture, which is similar to that on the natural specimen. Conidia in culture were 36–50  $\times$  26–33  $\mu$ m (av. 45.7  $\times$  29.1  $\mu$ m,  $n$  = 33), l/w 1.3–1.8 (av. 1.6,  $n$  = 33), consisting of 29–47 cells arranged in 5–6 rows, with apical appendages. These features almost agree with the description in the protologue of *D. bulbosum* (Tzean & Chen 1989), but the ITS sequences of our material (KH 375; GenBank LC014542) differed from those of *D. bulbosum* (GenBank LC014544 and DQ018086) in ca. 8 % (40/515) positions.

***Dictyosporium digitatum*** J.L. Chen *et al.*, Mycol. Res. 95: 1145. 1991. Fig. 2G–I.

**Specimens examined:** Japan, Okinawa, Isl. Ishigaki, trail of Mt. Omoto, on dead stems of herbaceous plant, 16 Jul. 2011, K. Hirayama & K. Tanaka, KH 401 = HHUF 30128, culture JCM 19404 = MAFF 243830; Okinawa, Isl. Iriomote, Komi, on dead wood of *Castanopsis sieboldii*, 15 Sep. 2009, Y. Kurihara, KT 2660 = HHUF 30131, culture JCM 19405 = MAFF 243833; Okinawa, Isl. Iriomote, Kanpire-falls, on dead twigs of woody plant, 21 Nov. 2008, K. Tanaka & K. Hirayama, yone 280 = HHUF 30093, culture MAFF 243837.

**Notes:** The morphological characters of our specimens are consistent with those of *D. digitatum* (Chen *et al.* 1991), as reported by Hirayama *et al.* (2012). The ITS sequences of this species from our three isolates were highly similar (99.1–99.8 %) but their similarities with a deposited sequence of *D. digitatum* in GenBank (GenBank DQ018089) were rather low (90.1–90.4 %).

***Dictyosporium* aff. *heptasporum*** Fig. 2J–L.

**Specimen examined:** Japan, Okinawa, Isl. Ishigaki, Mt. Banna, near small stream, on dead twigs of woody plant, 14 Jul. 2011, K. Hirayama & K. Tanaka, KH 332 = HHUF 30126, culture JCM 19406 = MAFF 243828.

**Notes:** The morphological features of the above specimen were as follows; conidia 70–90  $\times$  21–31  $\mu$ m (av. 79.7  $\times$  23.3  $\mu$ m,



$n = 43$ ), cylindrical, l/w 3.1–3.9 (av. 3.4,  $n = 43$ ), with (5–)7 rows, 16–18-septate, without appendages. This agrees with the details in the description of *D. heptasporum* (Goh *et al.* 1999), but the conidia in our material are somewhat larger (vs. 50–80 × 20–30 µm; Goh *et al.* 1999). A BLAST search using ITS sequences from our culture showed *D. heptasporum* (GenBank DQ018090) as the closest species, but the similarity was relatively low (493/518 = 95.2 %).

***Dictyosporium hughesii*** McKenzie, Mycotaxon 111: 156. 2010. Fig. 2M–O.

*Specimen examined:* Japan, Kagoshima, Isl. Yakushima, Shirataniansuikyo, on dead twigs of *Stewartia monadelphica*, 18 Oct. 2005, K. Tanaka & T. Hosoya, KT 1847 = HHUF 30130 = TNS-F-12407, culture JCM 19407 = MAFF 243832.

*Note:* This collection was identified as *D. hughesii* (McKenzie 2010) based on the conidial morphology; conidia 43–51 × 18–28 µm (av. 46.8 × 24.8 µm,  $n = 30$ ), l/w 1.6–2.3(–2.6) (av. 1.9,  $n = 30$ ), consisting of 50–71 cells arranged in 6–7 rows, with or without apical appendages.

***Dictyosporium pseudomusae*** Kaz. Tanaka, G. Sato & K. Hiray., **sp. nov.** MycoBank MB811297. Fig. 2P–V.

*Etymology:* After its morphological similarity to *Dictyosporium musae*.

*Sporodochia* on natural substrate scattered, punctiform, dark brown to black. *Mycelium* immersed, 170–490 µm diam. *Conidiophores* micronematous, not differentiated from vegetative hyphae. *Conidiogenous cells* holoblastic, cylindrical, 5.5–8 µm wide. *Conidia* solitary, brown, ellipsoid to cylindrical, cheiroid, not complanate, (58–)61–78(–81) × 19–29(–33) µm (av. 69.9 × 22.9 µm,  $n = 60$ ), l/w (2.2–)2.5–3.8(–4.0) (av. 3.1,  $n = 60$ ), consisting of 78–100 cells arranged in (6–)7 rows and basal connecting cell (6–8 × 5.5–8 µm); each row cylindrical, with 13–15 cells. *Appendages* globose to subglobose, hyaline, 6–11.5 µm diam, bearing from apical cells or side of outer rows. Sexual morph unknown.

Colonies on PDA (after 4 wk) attaining a diam of 3.9–4.4 cm, white to rosy buff; reverse buff to cinnamon; rosy vinaceous pigment produced. In culture asexual morph formed.

*Specimens examined:* Japan, Okinawa, Isl. Ishigaki, Mt. Banna, near small stream, on dead twigs of Bamboo, 14 Jul. 2011, K. Hirayama & K. Tanaka, KH 412 = HHUF 30129, culture JCM 19408 = MAFF 243831; Okinawa, Isl. Iriomote, Inamori-path, on dead twigs of woody plant, 25 Sep. 2007, H. Yonezawa & K. Tanaka (**holotype** yone 234 = HHUF 30133, culture **ex-type** CBS 139686 = JCM 19409 = MAFF 243836).

*Notes:* Among the described species, *D. pseudomusae* is most similar to *D. musae* (Photita *et al.* 2002) in having large-sized conidia comprised of seven cell rows and with appendages arising from side cells of the outer rows. Conidia of the latter species, however, are smaller (45–65 × 20–27 µm, av. 55.9 × 23.5 µm) and comprised of fewer cells (49–77 cells; Photita *et al.* 2002). The closest species to *D. pseudomusae* appear to be *D. digitatum* [GenBank DQ018089; identities = 504/516 (97.7 %), gaps = 2/516] and *D. giganticum* [GenBank DQ018095; identities = 497/516 (96.3 %), gaps = 2/516] from a BLAST search using ITS sequences.

***Dictyosporium tetrasporum*** L. Cai & K.D. Hyde, Mycoscience 48: 290. 2007. Fig. 2W–Y.

*Specimen examined:* Japan, Okinawa, Isl. Ishigaki, Mt. Banna, near small stream, on dead twigs of woody plant, 16 Jul. 2011, K. Tanaka & K. Hirayama, KT 2865 = HHUF 30132, culture JCM 19410 = MAFF 243834.

*Notes:* The collection matches the original description of *D. tetrasporum* (Cai & Hyde 2007a). The characters of our specimen are as follows; conidia 22–37 × 15–21 µm (av. 27.5 × 17.5 µm,  $n = 30$ ), l/w 1.2–2.2 (av. 1.6,  $n = 30$ ), consisting of 11–28 cells arranged in (3–)4 rows, without apical appendages. In culture, conidia were produced that were identical to those on the natural specimen (24–38 × 16–24 µm; av. 30.3 × 20.1 µm,  $n = 32$ ).

***Gregarithhecium*** Kaz. Tanaka & K. Hiray., **gen. nov.** MycoBank MB811298.

*Etymology:* Referring to the gregarious ascomata.

*Ascomata* grouped, immersed to erumpent, depressed globose to hemispherical with flattened base in section. *Ostiolar neck* short terete, central, with periphyses, covered by black clypeus. *Ascomatal wall* composed of thin-walled cells, surrounded by vertically-orientated stromatic tissue. *Pseudoparaphyses* septate, branched and anastomosed. *Asci* fissitunicate, cylindrical, short-stalked, with 8 biseriate ascospores. *Ascospores* broadly fusiform, with a median septum, hyaline, smooth, surrounded by an entire sheath. Asexual morph unknown.

*Type species:* *Gregarithhecium curvisporum* Kaz. Tanaka & K. Hiray.

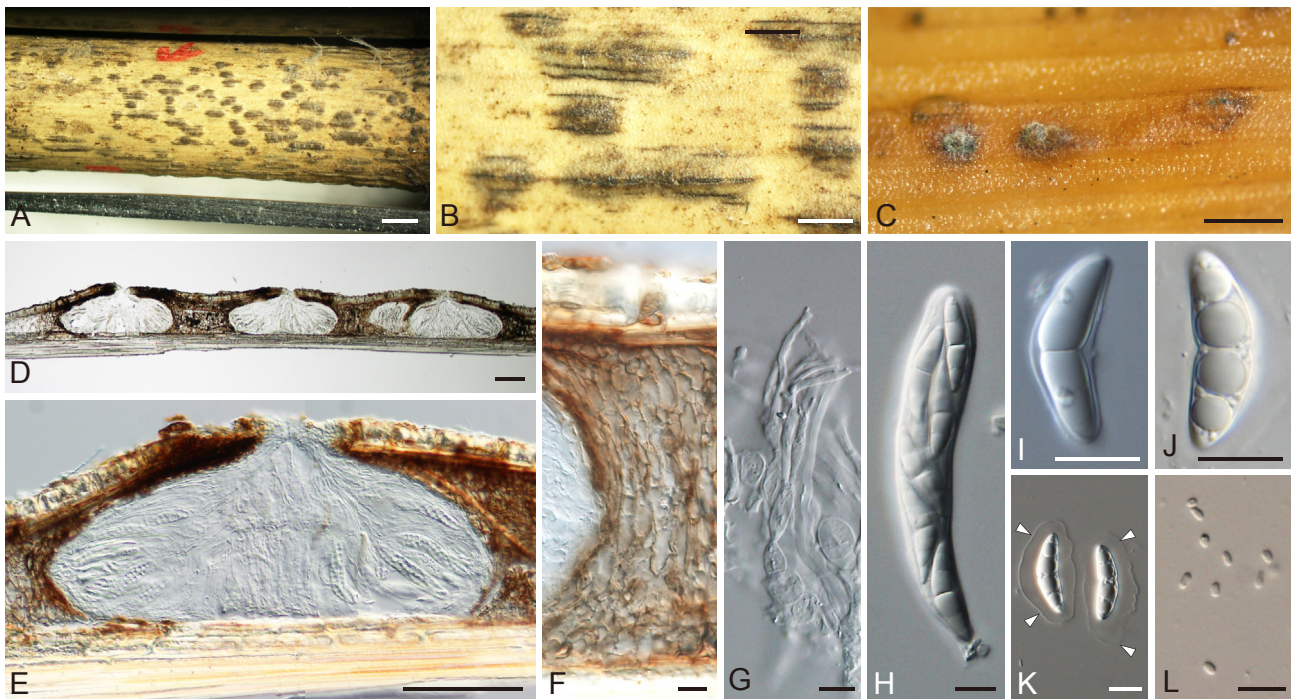
*Notes:* In its depressed globose ascomata with clypeate ostiole, *Gregarithhecium* is reminiscent of species in *Massarina* s. lat. (Aptroot 1998, Tanaka & Harada 2003b), but *Gregarithhecium* can be separated from the latter by the presence of stromatic tissue surrounding the ascomata. *Massarina* s. lat. is regarded as being polyphyletic and thus has recently been segregated into several new genera. These are scattered in the *Lentitheciaceae* (*Tingoldiogo*; Hirayama *et al.* 2010), *Morosphaeriaceae* (*Morosphaeria*; Suetrong *et al.* 2009), *Trematosphaeriaceae* (*Halomassarina*; Suetrong *et al.* 2009), *Tetraplosphaeriaceae* (*Triplosphaeria*; Tanaka *et al.* 2009), and *Lindgomycetaceae* (*Lindgomycetes*; Hirayama *et al.* 2010), but are not so far reported in the *Dictyosporiaceae*.

***Gregarithhecium curvisporum*** Kaz. Tanaka & K. Hiray., **sp. nov.** MycoBank MB811299. Fig. 3.

*Etymology:* From the Latin *curvi-*, in reference to the curved ascospores.

*Ascomata* grouped in numbers of 3–6, immersed to erumpent, depressed globose to hemispherical with flattened base in section, 140–180 µm high, 290–430 µm diam. *Ostiolar neck* short terete, central, with an ostiole (25–50 µm diam) and short periphyses, covered by a black clypeus composed of small cells (2.5–7.5 × 1–3 µm). *Ascomatal wall* in longitudinal section 8–12 µm thick at the sides, composed of thin-walled, flattened, pale brown cells, surrounded by vertically-oriented stromatic





**Fig. 3.** *Gregarithecium curvisporum*. A, B. Ascomata on the natural host surface; C. Ascomata in culture (on rice straw); D, E. Ascomata in longitudinal section; F. Ascomatal wall; G. Pseudoparaphyses; H. Ascus; I–K. Ascospores (arrowheads indicate mucilaginous sheath); L. Spermatia. A, B, D–I from KT 922; C, J–L from culture KT 922. Scale bars: A = 2 mm; B, C = 500  $\mu$ m; D, E = 100  $\mu$ m; F–L = 10  $\mu$ m.

tissue composed of rectangular to polygonal cells (5–25  $\times$  5–16  $\mu$ m) or by compact brown hyphae. *Pseudoparaphyses* septate, branched and anastomosed, 2–3.5(–5)  $\mu$ m wide. *Asci* fissitunicate, cylindrical, 73.5–102  $\times$  11–15.5  $\mu$ m (av. 87.4  $\times$  13.6  $\mu$ m, n = 50), rounded at the apex, with a shallow ocular chamber (0.5–1  $\mu$ m high), short-stalked (5–15  $\mu$ m long; av. 9.6  $\mu$ m, n = 32), with 8 biseriate ascospores. *Ascospores* broadly fusiform, mostly curved, 19–31  $\times$  4.5–6.5  $\mu$ m (av. 24.2  $\times$  5.8  $\mu$ m, n = 50), l/w (3.3–)3.6–4.9(–5.2) (av. 4.2, n = 50), with a median (0.50) septum and constricted, hyaline, smooth, with an entire sheath; sheath sharply delimited and 1–2  $\mu$ m wide at first, diffuse and 4–8  $\mu$ m wide at a later. Senescent ascospores 3-septate, thick-walled, dark brown.

Colonies on PDA (after 4 wk) attaining a diam of 6.2–6.8 cm, buff to smoke grey; reverse pale luteous to sienna; no pigment produced. In culture ascomatal and spermatial morphs observed. *Asci* 82.5–101.5  $\times$  14.5–17.5  $\mu$ m. *Ascospores* 21–31  $\times$  6–8  $\mu$ m (av. 24.5  $\times$  7.0  $\mu$ m, n = 31), l/w 3.1–4.2 (av. 3.5, n = 31). *Spermatia* 2.2–3.5  $\times$  1.4–2.1  $\mu$ m (av. 3.0  $\times$  1.8  $\mu$ m, n = 20), subglobose, hyaline.

*Specimen examined:* Japan, Aomori, Hirosaki, Kozawa, on dead culms of *Sasa* sp., 25 Oct. 2002, T. Handa (**holotype** KT 922 = HHUF 30134, culture **ex-type** CBS 139688 = JCM 19411 = MAFF 243838).

***Pseudocoleophoma*** Kaz. Tanaka & K. Hiray., **gen. nov.** MycoBank MB811300.

*Etymology:* Referring to the similarity of the asexual morph with that of *Coleophoma*.

*Ascomata* scattered to grouped, immersed to erumpent, globose to subglobose in section. *Ostiole* central, composed of subglobose dark brown cells. *Ascomatal wall*

composed of polygonal to rectangular cells. *Pseudoparaphyses* numerous. *Asci* fissitunicate, cylindrical to clavate, short-stalked, with 8 ascospores. *Ascospores* fusiform, 1-septate, smooth, with a conspicuous sheath. *Conidiomata* coleophoma-like, pycnidial, subglobose. *Conidiophores* absent. *Conidiogenous cells* phialidic, doliform to lageniform. *Conidia* cylindrical, hyaline, smooth.

*Type species:* *Pseudocoleophoma calamagrostidis* Kaz. Tanaka & K. Hiray.

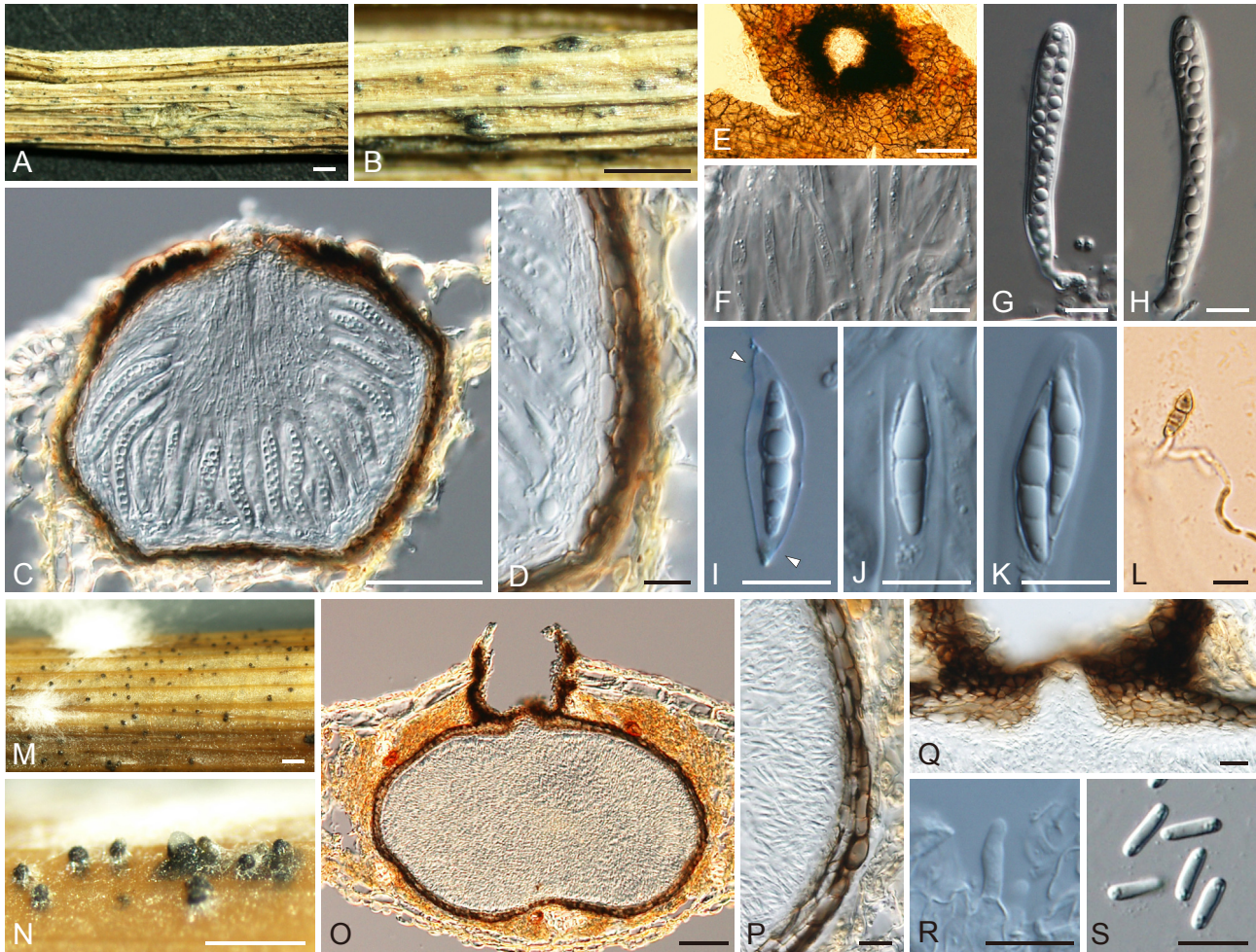
*Notes:* The pycnidial asexual morph of *Pseudocoleophoma* bears a slight resemblance to that of *Coleophoma*. The type species of *Coleophoma* (*C. crateriformis*), however, has pycnidia possessing paraphyses that are not found in *Pseudocoleophoma*, and is a member of the *Dothideales*, rather than the *Pleosporales* (De Gruyter et al. 2009).

***Pseudocoleophoma calamagrostidis*** Kaz. Tanaka & K. Hiray., **sp. nov.** MB811301. Fig. 4.

*Etymology:* Referring to the host plant.

*Ascomata* scattered, immersed, erumpent at the top, globose to depressed globose, 140–200  $\mu$ m high, 160–220  $\mu$ m diam, ostiolate. *Ostiole* central. *Ascomatal wall* in longitudinal section 5–10  $\mu$ m thick at sides, composed of 2–3 layers of thin-walled, polygonal, flattened, 5–12  $\times$  2–5  $\mu$ m, brown cells; of polygonal to subglobose, 2–5  $\times$  1.5–2.5  $\mu$ m cells around ostiole. *Pseudoparaphyses* septate, branched and anastomosed, 2.5–5  $\mu$ m wide. *Asci* fissitunicate, cylindrical, 62.5–80  $\times$  7.5–10  $\mu$ m (av. 69.0  $\times$  8.4  $\mu$ m, n = 50), rounded at the apex, with a shallow ocular chamber, short-stalked (5–12  $\mu$ m long), with 8 biseriate ascospores. *Ascospores* narrowly fusiform,





**Fig. 4.** *Pseudocoleophoma calamagrostidis*. A, B. Ascomata on the natural host surface; C. Ascoma in longitudinal section; D. Ascomatal wall at side; E. Ascomatal wall surface around ostiole; F. Pseudoparaphyses; G, H. Asci; I–K. Ascospores (arrowheads indicate gelatinous sheath; I. in Black-Blue ink); L. Germinating ascospore; M, N. Conidiomata in culture (on rice straw); O. Conidioma in longitudinal section; P. Conidiomatal wall at side; Q. Conidiomatal wall around ostiole; R. Conidiogenous cell; S. Conidia. A–L from KT 3284; M–S from culture KT 3284. Scale bars: A, B, M, N = 500  $\mu$ m; C, E, O = 50  $\mu$ m; D, F–L, P–S = 10  $\mu$ m.

(14.5–)16–19(–21)  $\times$  3–4.5  $\mu$ m (av. 17.4  $\times$  3.8  $\mu$ m, n = 30), l/w 4.0–5.3 (av. 4.5, n = 30), with a nearly median (0.43–0.54, av. 0.50, n = 26) septum, constricted at the septum, hyaline, smooth, with an entire sheath; sheath sharply delimited, 1–2  $\mu$ m wide at sides, 4–6  $\mu$ m long at both ends, staining with Black-Blue ink when in fresh condition.

Colonies on PDA (after 4 wk) attaining a diam of 2.3–3.2 cm, buff to honey; reverse similar; no pigment produced. In culture coelomycetous asexual morph formed. *Conidiomata* pycnidial, 220–300  $\mu$ m high, (150–)250–500  $\mu$ m diam, immersed to erumpent, depressed globose. *Ostiolar neck* well-developed, 75–100  $\mu$ m long, 85–100  $\mu$ m wide, cylindrical, central. *Conidiomatal wall* in longitudinal section uniformly 7.5–15  $\mu$ m thick, composed of 3–4 layers of slightly thick-walled, polygonal to subglobose, 6–15  $\times$  2–6.5  $\mu$ m, pale brown cells; of polygonal to rectangular, 2–6  $\times$  1.5–2.5  $\mu$ m cells around ostiole. *Conidiophores* absent. *Conidiogenous cells* phialidic, 5–9  $\times$  2–4  $\mu$ m, doliform to subglobose. *Conidia* cylindrical, aseptate, hyaline, smooth, 6–10  $\times$  2–2.5  $\mu$ m (av. 8.6  $\times$  2.2  $\mu$ m, n = 50), l/w 2.9–4.7 (av. 3.9, n = 50).

*Specimen examined*: Japan, Aomori, Hirosaki, Mt Iwaki, on dead leaves of *Calamagrostis matsumurae*, 27 Jul. 2013, K. Tanaka (holotype KT 3284 = HHUF 30450, culture ex-type CBS 139700).

*Note*: This species is phylogenetically close to *P. polygonicola*, but the ITS sequence similarity between these two species is relatively low (490/521 = 94.0 %).

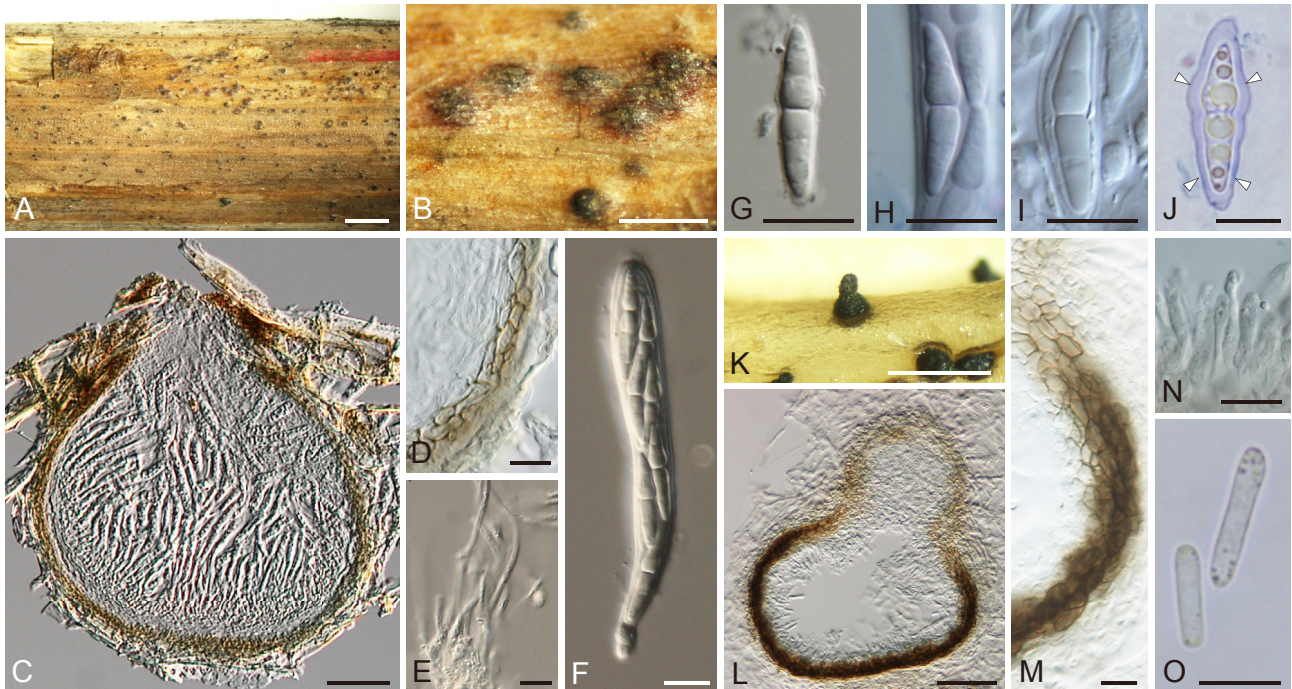
***Pseudocoleophoma polygonicola*** Kaz. Tanaka & K. Hiray., sp. nov. MycoBank MB811302. Fig. 5.

*Etymology*: Referring to the host plant.

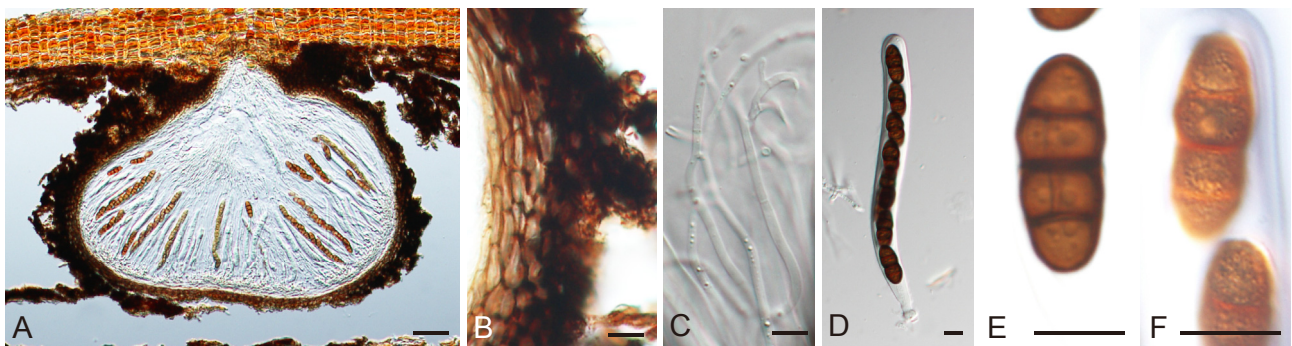
*Ascomata* scattered to 2–4 grouped, immersed to erumpent, 230–310  $\mu$ m high, 280–350  $\mu$ m diam. *Ostiolar neck* central, 50–75  $\mu$ m long, 70–100  $\mu$ m wide. *Ascromatal wall* in longitudinal section 7–13  $\mu$ m thick at sides. *Pseudoparaphyses* 2–2.5  $\mu$ m wide. *Asci* cylindrical to clavate, (67–)74–90(–100)  $\times$  9–12.5  $\mu$ m (av. 81.3  $\times$  10.7  $\mu$ m, n = 48). *Ascospores* fusiform, (17.5–)19–23(–25)  $\times$  4–6  $\mu$ m (av. 20.6  $\times$  4.8  $\mu$ m, n = 50), l/w 3.6–4.8 (av. 4.2, n = 45), with a septum suprmedian (0.46–0.50; av. 0.48, n = 40), surrounded by a sheath; sheath 1–2  $\mu$ m wide at sides, 2–5  $\mu$ m long at both ends, staining with Black-Blue ink when in fresh condition.

Colonies on PDA (after 4 wk) attaining a diam of 3.4–4.8 cm, white; reverse white to straw; no pigment produced. In culture coelomycetous asexual morph formed. *Conidiomata* pycnidial,





**Fig. 5.** *Pseudocoleophoma polygonicola*. A, B. Ascomata on the natural host surface; C. Ascoma in longitudinal section; D. Ascomatal wall; E. Pseudoparaphyses; F. Ascus; G–J. Ascospores (arrowheads indicate gelatinous sheath; J. in Black-Blue ink); K. Conidiomata in culture; L. Conidioma in longitudinal section; M. Conidiomatal wall; N. Conidiogenous cells; O. Conidia. A–J from KT 731; K–O from culture KT 731. Scale bars: A = 2 mm; B, K = 500 µm; C, L = 50 µm; D–J, M–O = 10 µm.



**Fig. 6.** *Karstenula rhodostoma*. A. Ascoma in longitudinal section; B. Ascomatal wall; C. Pseudoparaphyses; D. Ascus; E, F. Ascospores. All from UPS (F-141152) 425947. Scale bars: A = 50 µm; B–F = 10 µm.

170–250 µm diam. *Conidiomatal wall* in longitudinal section 12–15 µm wide at sides. *Conidiophores* absent. *Conidiogenous cells* phialidic, 7–17 × 3.5–5 µm, doliiform to lageniform, formed all around the locular cavity. *Conidia* cylindrical, aseptate, hyaline, smooth, (9–)11.5–18(–21.5) × 3–4.5 µm (av. 14.4 × 3.4 µm, n = 31).

*Specimen examined:* Japan, Hokkaido, Isl. Rebun, Kafuka, Nairo-river, on dead stems of polygonaceous plant, 30 Aug. 2001, K. Tanaka (**holotype** KT 731 = HHUF 27558, culture **ex-type** CBS 139701 = JCM 19412 = MAFF 239468).

*Notes:* Additional details of this species were reported by Tanaka & Harada (2003b), who misidentified this fungus as *Massarina rubi* based mostly on the morphology of the sexual morph. However, *Pseudocoleophoma* is phylogenetically different from *M. rubi*, which belongs to the *Lophiotremataceae* (Zhang *et al.* 2009b, Hirayama & Tanaka 2011b). This species resembles *P. calamagrostidis* but has larger ascospores (20.6 × 4.8 µm vs. 17.4 × 3.8 µm) and conidia (14.4 × 3.4 µm vs. 8.6 × 2.2 µm).

*Didymosphaeriaceae* Munk, Dansk Bot. Ark. 15 (2): 128. 1953.  
= *Montagnulaceae* M.E. Barr, Mycotaxon 77: 194. 2001.

*Type genus:* *Didymosphaeria* Fuckel.

*Karstenula* Speg., Decades Mycologicae Italicae 7–12: no. 94. 1879.

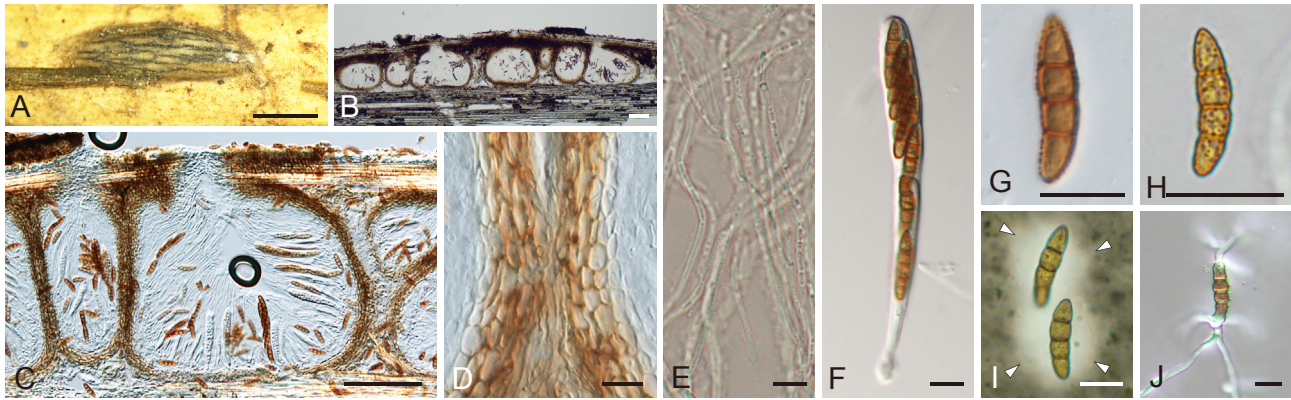
*Type species:* *Karstenula rhodostoma* (Alb. & Schwein.) Speg.

*Notes:* This genus is phylogenetically close to *Paraphaeosphaeria*, but can be distinguished from the latter by the ascomata surrounded by well-developed subiculum and cylindrical asci with uniseriate ascospores.

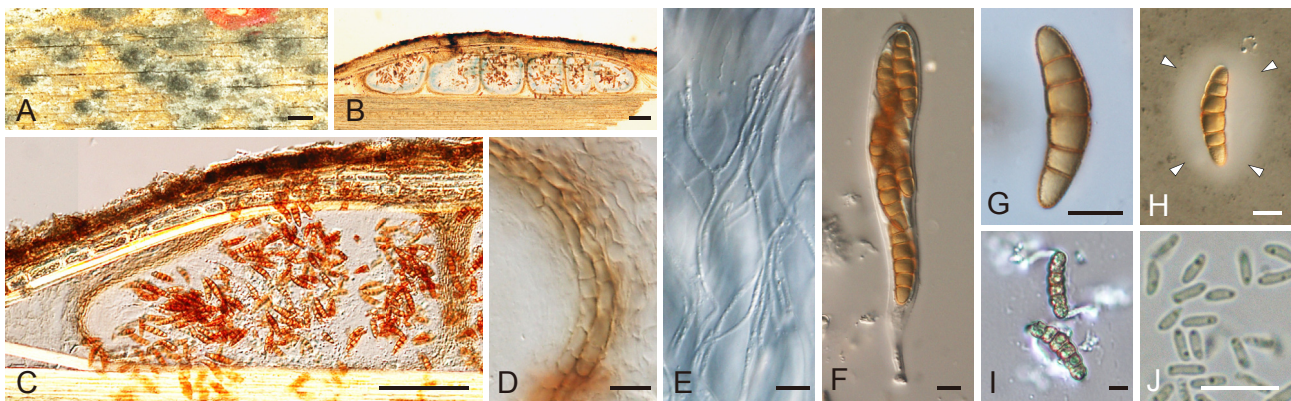
*Karstenula rhodostoma* (Alb. & Schwein.) Speg., Decades Mycologicae Italicae 7–12: no. 94. 1879. Fig. 6.

*Basionym:* *Sphaeria rhodostoma* Alb. & Schwein., Consp. Fung. (Leipzig): 43. 1805.





**Fig. 7.** *Neokalmusia brevispora*. A. Ascomata on the natural host surface; B, C. Ascomata in longitudinal section; D. Ascomatal wall; E. Pseudoparaphyses; F. Ascus; G–I. Ascospores (arrowheads indicate gelatinous sheath; I. in India ink); J. Germinating ascospore. A, F, G, J from KT 2313; B–D, I from KT 1466; E, H from culture KT 1466. Scale bars: A = 1 mm; B, C = 100  $\mu$ m; D–J = 10  $\mu$ m.



**Fig. 8.** *Neokalmusia scabrispora*. A. Ascomata on the natural host surface; B, C. Ascomata in longitudinal section (B. in lactophenol cotton blue); D. Ascomatal wall; E. Pseudoparaphyses; F. Ascus; G, H. Ascospores (arrowheads indicate gelatinous sheath; H. in India ink); I. Germinating ascospores; J. Spermata. A–D from KT 1023; E–I from KT 2202; J from culture KT 1023. Scale bars: A = 1 mm; B, C = 100  $\mu$ m; D–J = 10  $\mu$ m.

Asci cylindrical, 145–175  $\times$  12.5–14.5  $\mu$ m (av. 162.2  $\times$  13.4  $\mu$ m, n = 20), with a short stipe (14–23  $\mu$ m long). Ascospores cylindrical to ellipsoid, 22–26  $\times$  8–10  $\mu$ m (av. 23.7  $\times$  9.1  $\mu$ m, n = 20), l/w 2.3–2.9 (av. 2.6, n = 20), with a submedian primary septum (0.50–0.54; av. 0.52, n = 20), with 3 transverse septa (1+1+1), with or without 1 longitudinal septum.

*Specimen examined:* Sweden, “Odlingen” field, ca. 250 m S of Jerusalem, on twigs of *Frangula alnus*, Jan. 1995, K. Holm & L. Holm, UPS (F-141152) 425947, culture CBS 691.94.

*Notes:* For further description of this species including its asexual morph (*Microdiplodia frangulae*), see Constantinescu (1993) and Zhang et al. (2012). More than 360 species are recorded as *Microdiplodia* (Mycobank, <http://www.mycobank.org>), but the validity of this genus is unknown due to lack of phylogenetic information regarding the lectotype species, *M. conigena* (Clements & Shear 1931).

***Neokalmusia*** Kaz. Tanaka et al., Fungal Divers. 68: 92. 2014.

*Type species:* *Neokalmusia brevispora* (Nagas. & Y. Otani) Kaz. Tanaka et al.

*Notes:* *Neokalmusia* is characterised by subglobose to oblong ascomata including several pseudothecia in a row and verrucose ascospores (Ariyawansa et al. 2014). Two bambusicolous

species, *N. brevispora* on *Sasa* and *N. scabrispora* on *Phyllostachys* are known in this genus. Although they share many morphological features, monophyly of *Neokalmusia* was not supported in this study (Fig. 1). Additional taxa and sequence data of this genus are needed to evaluate validity of *Neokalmusia*.

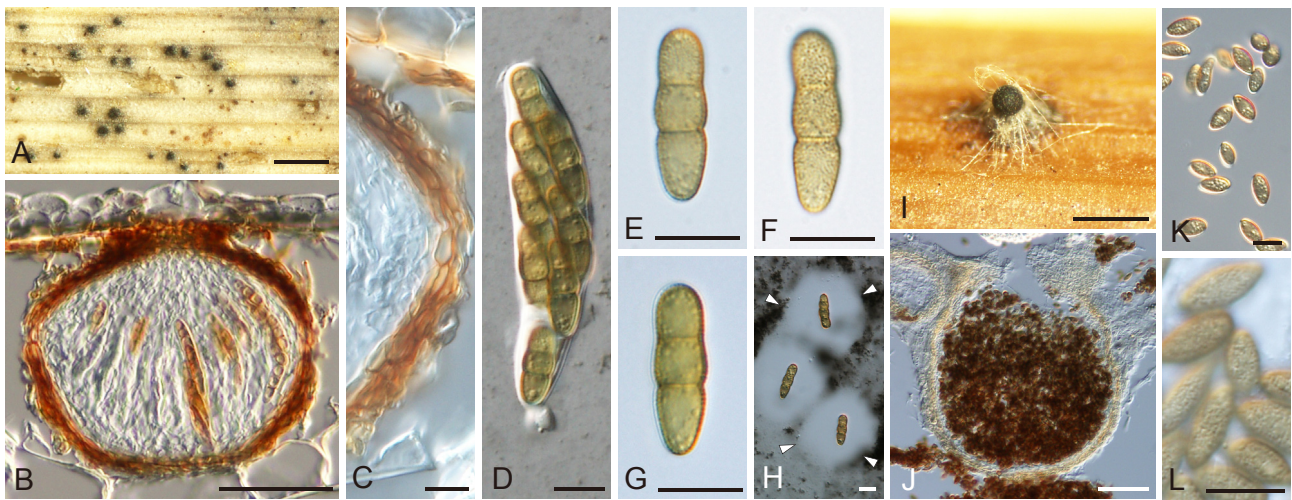
***Neokalmusia brevispora*** (Nagas. & Y. Otani) Kaz. Tanaka et al., Fungal Divers. 68: 92. 2014. Fig. 7.

*Basionym:* *Phaeosphaeria arundinacea* var. *brevispora* Nagas. & Y. Otani, Rep. Tottori Mycol. Inst. 15: 38. 1977.

*Specimens examined:* Japan, Hokkaido, Sapporo, Moiva-yama, on culms of *Sasa* sp., 13 Jun. 1972, E. Nagasawa (holotype of *Phaeosphaeria arundinacea* var. *brevispora* TMI 3175); Fukushima, Minamiaizu, Ose pond, on dead twigs of *Sasa* sp., 30 Aug. 2003, N. Asama, KT 1466 = HHUF 28229, culture CBS 120248 = JCM 13543 = MAFF 239276; Hokkaido, Isl. Rishiri, Afutoromanai-river, on dead twigs of *Sasa kurilensis*, 29 Jul. 2007, K. Tanaka & G. Sato (epitype designated here KT 2313 = HHUF 30016, MBT202863, culture ex-epitype NBRC 106240).

*Notes:* For other descriptions of this species, see Nagasawa & Otani (1977), Shoemaker & Babcock (1989), Tanaka & Harada (2004), and Ariyawansa et al. (2014). Although this species was transferred to *Kalmusia* (Zhang et al. 2009b), subsequent molecular studies (Hyde et al. 2013, Zhang et al. 2014a) did not support this placement, and thus *Neokalmusia* was established to accommodate *N. brevispora* as the type species of this genus (Ariyawansa et al. 2014). We here designate an epitype specimen for this species.





**Fig. 9.** *Paraphaeosphaeria michotii*. A. Ascomata on the natural host surface; B. Ascoma in longitudinal section; C. Ascomatal wall; D. Ascus; E–H. Ascospores (arrowheads indicate gelatinous sheath; H. in India ink); I. Conidioma in culture (on rice straw); J. Conidioma in longitudinal section; K, L. Conidia. A–C from KT 2222; D–L from culture KT 2222. Scale bars: A, I = 500 µm; B, J = 50 µm; C–H, K, L = 10 µm.

***Neokalmusia scabrispora*** (Teng) Kaz. Tanaka *et al.*, Fungal Divers. 68: 92. 2014. [Fig. 8](#).

**Basionym:** *Leptosphaeria scabrispora* Teng, Sinensia, Shanghai 4: 378. 1934.

**Specimens examined:** **Japan**, Tochigi, Kanuma, near Ooashi-river, on dead twigs of *Phyllostachys bambusoides*, 6 Mar. 2003, N. Asama, KT 1023 = HHUF 28608, culture CBS 120246 = JCM 12851 = MAFF 239517; Kagoshima, Kumagegun, Isl. Yakushima, Miyanouura-river, riverbank, on dead twigs of *Phyllostachys bambusoides*, 17 Mar. 2007, K. Tanaka & H. Yonezawa, KT 2202 = HHUF 30013, culture NBRC 106237.

**Notes:** For a description of this species, see [Tanaka \*et al.\* \(2005a\)](#). This fungus was originally described as a *Lepptosphaeria* ([Teng 1934](#)), and later transferred to *Massariosphaeria* ([Shoemaker & Babcock 1989](#)) or *Kalmusia* ([Tanaka \*et al.\* 2005a](#)). Molecular studies, however, did not support these placements ([Tanaka \*et al.\* 2009](#), [Zhang \*et al.\* 2014a](#)). This species is currently treated as *Neokalmusia* ([Ariyawansa \*et al.\* 2014](#)), but we were not able to confirm the congenericity of *N. scabrispora* with *N. brevispora* (type species of *Neokalmusia*) ([Fig. 1](#)).

***Paraphaeosphaeria*** O.E. Erikss., Ark. Bot. 6: 405. 1967.

**Type species:** *Paraphaeosphaeria michotii* (Westend.) O.E. Erikss.

**Notes:** The genus *Paraphaeosphaeria* was established by [Eriksson \(1967\)](#) as a generic segregate from *Leptosphaeria*. To date, about 35 taxa have been described as species within *Paraphaeosphaeria* (<http://www.indexfungorum.org>, Aug. 2015), of which nine species have been transferred to *Neophaeosphaeria* (*Coniothyriaceae* or *Leptosphaeriaceae*) or *Phaeosphaeriopsis* (*Phaeosphaeriaceae*) based on ascospore and conidial morphology, as well as sequence data from SSU and ITS nrDNA ([Cámara \*et al.\* 2001, 2003](#)), and 10 asexual species with coniothyrium-like morphology have been added to this genus based on molecular evidence ([Trakunyingcharoen \*et al.\* 2014](#), [Verkley \*et al.\* 2014](#), [Liu \*et al.\* 2015](#)).

***Paraphaeosphaeria michotii*** (Westend.) O.E. Erikss., Arkiv Bot. 6: 405. 1967. [Fig. 9](#).

**Basionym:** *Sphaeria michotii* Westend., Bull. Acad. R. Sci. Belg., Cl. Sci., sér. 2, 7: 87. 1859.

In culture, both sexual and asexual morphs were observed. *Asci* 77–90 × 13–14.5 µm. *Ascospores* ellipsoid, 18–24 × 5–7 µm (av. 21.3 × 6.2 µm, n = 30), l/w 2.8–3.8 (av. 3.5, n = 30), with a submedian primary septum (0.56–0.67; av. 0.61, n = 30), 2-septate (1+1+0). *Conidia* broadly fusiform to ellipsoid, 8–14.5 × 4–7 µm (av. 10.8 × 5.3 µm, n = 50), l/w 1.6–2.9 (av. 2.0, n = 50), echinulate.

**Specimen examined:** **Japan**, Tochigi, Utsunomiya, Ootani-kannon, on dead leaves of *Typha latifolia*, 29 Mar. 2007, K. Tanaka & Y. Harada, KT 2222 = HHUF 30142, culture MAFF 243861.

**Notes:** Morphological features of the sexual morph in our material agree well with the description of *P. michotii* reported by several authors ([Eriksson 1967](#), [Shoemaker & Eriksson 1967](#), [Shoemaker & Babcock 1985](#), [Ariyawansa \*et al.\* 2014](#)). The conidia we observed are somewhat larger than those reported by [Webster \(1955; 6–10 × 3–5 µm\)](#) and [Cámara \*et al.\* \(2001; 4–8 × 2.4–4.4 µm\)](#), but match those reported by [Sivanesan \(1984; 5–13.5 × 3–5 µm\)](#). A BLAST search using ITS sequences showed 99.8 % similarity to sequences from the ex-epitype of *P. michotii* (GenBank KJ939279; 519/520) deposited in GenBank by [Ariyawansa \*et al.\* \(2014\)](#).

***Spegazzinia*** Sacc., Michelia 2 (6): 37. 1880.

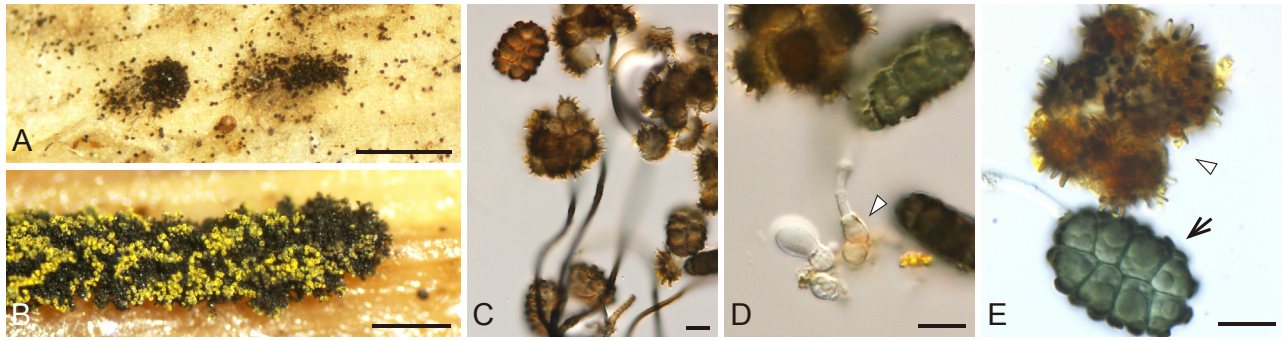
**Type species:** *Spegazzinia ornata* Sacc.

**Notes:** Based on the morphological features of basauxic conidiogenesis, [Hyde \*et al.\* \(1998\)](#) considered *Spegazzinia* to be a possible member of the *Apiosporaceae* (*Sordariomycetes*), although this was not fully resolved by molecular evidence ([Hyde \*et al.\* 2011](#), [Crous & Groenewald 2013](#)). We have assigned this genus to the *Didymosphaeriaceae* ([Fig. 1](#)).

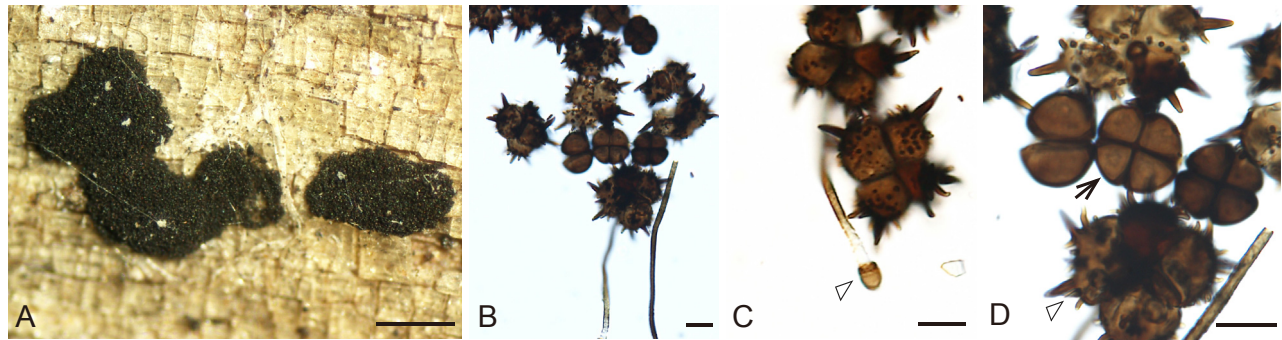
***Spegazzinia deightonii*** (S. Hughes) Subram., J. Indian Bot. Soc. 35: 78. 1956. [Fig. 10](#).

**Basionym:** *Spegazzinia tessartha* var. *deightonii* S. Hughes, Mycol. Pap. 50: 65. 1953.

**Specimens examined:** **Japan**, Kagoshima, Isl. Yakushima, Kurio, on dead leaves of *Arundo donax*, 14 Mar. 2007, K. Tanaka & H. Yonezawa, yone 66 = HHUF



**Fig. 10.** *Spegazzinia deightonii*. A, B. Sporodochia on the natural host surface; C, D. Conidiophores and conidiogenous cells (arrowheads indicate basauxic conidiogenesis); E. Conidia (arrowheads indicate a type conidia, arrows indicate b type conidia). A from yone 66; B–E from culture yone 66. Scale bars: A, B = 500  $\mu$ m; C–E = 10  $\mu$ m.



**Fig. 11.** *Spegazzinia tessartha*. A. Sporodochia on the natural host surface; B, C. Conidiophores and conidiogenous cells (arrowheads indicate basauxic conidiogenesis); D. Conidia (arrowheads indicate a type conidia, arrows indicate b type conidia). All from SH 287. Scale bars: A = 500  $\mu$ m; B–D = 10  $\mu$ m.

30150, culture MAFF 243876; Okinawa, Isl. Iriomote, Inamori path, on dead stems of herbaceous plant, 25 Sep. 2007, H. Yonezawa & K. Tanaka, yone 212 = HHUF 30151, culture MAFF 243877.

**Note:** The above collections match the original description and illustration of *S. tessartha* var. *deightonii* provided by Hughes (1953b).

***Spegazzinia tessartha*** (Berk. & M.A. Curtis) Sacc., Syll. Fung. 4: 758. 1886. Fig. 11.

**Basionym:** *Sporidesmium tessarthurum* Berk. & M.A. Curtis, J. Linn. Soc., Bot. 10: 355. 1868 (1869).

**Specimen examined:** Japan, Aomori, Towada, Sanbongi, Yagami, on balsawood, 9 Nov. 2002, S. Hatakeyama, SH 287 = HHUF 27691, culture MAFF 243875.

**Notes:** The features of the collection match the description of *S. tessartha* (Ellis 1971). The ITS sequences from the above isolate were identical to those of *S. tessartha* in GenBank (GenBank JQ673429).

**Lentitheciaceae** Y. Zhang *et al.*, Stud. Mycol. 64: 93. 2009.

**Type genus:** *Lentithecium* K.D. Hyde *et al.*

***Katumotoa*** Kaz. Tanaka & Y. Harada, Mycoscience 46: 313. 2005.

**Type species:** *Katumotoa bambusicola* Kaz. Tanaka & Y. Harada.

**Notes:** Two bambusicolous genera, *Katumotoa* (Tanaka & Harada 2005) and *Neophiosphaerella*, formed a clade as reported in previous molecular studies (Schoch *et al.* 2009, Tanaka

*et al.* 2009, Zhang *et al.* 2012), but these have ascospores with distinct features, i.e., apiosporous in *Katumotoa* and multi-septate scolecosporous in *Neophiosphaerella*. Furthermore, sequence similarity between the type species of both genera was 82.7% (417/504) in their ITS regions, suggesting that they are not congeneric. Although a correlation between phylogenetic relationships and host preferences has been noted in these bambusicolous fungi (Zhang *et al.* 2012), discovery of additional species in both monotypic genera will be needed to confirm this.

***Katumotoa bambusicola*** Kaz. Tanaka & Y. Harada, Mycoscience 46: 313. 2005. Fig. 12.

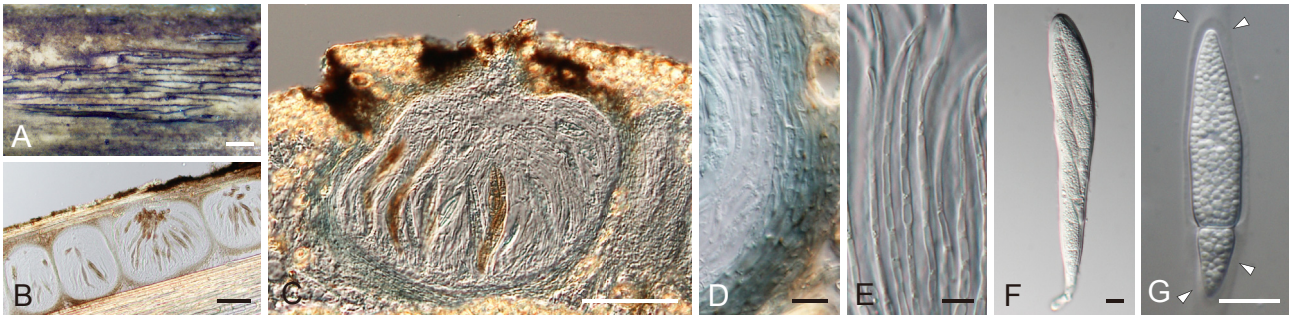
**Specimen examined:** Japan, Iwate, Nishine, Hirakasa, near Yakebashiri, Mt. Iwate, on *Sasa kurilensis*, 19 Oct. 2003, K. Tanaka (paratype KT 1517a = HHUF 28661, culture ex-paratype JCM 13131 = MAFF 239641).

***Keissleriella*** Höhn., Sber. Akad. Wiss. Wien, Math.-naturw. Kl., Abt. 1 128: 582. 1919.

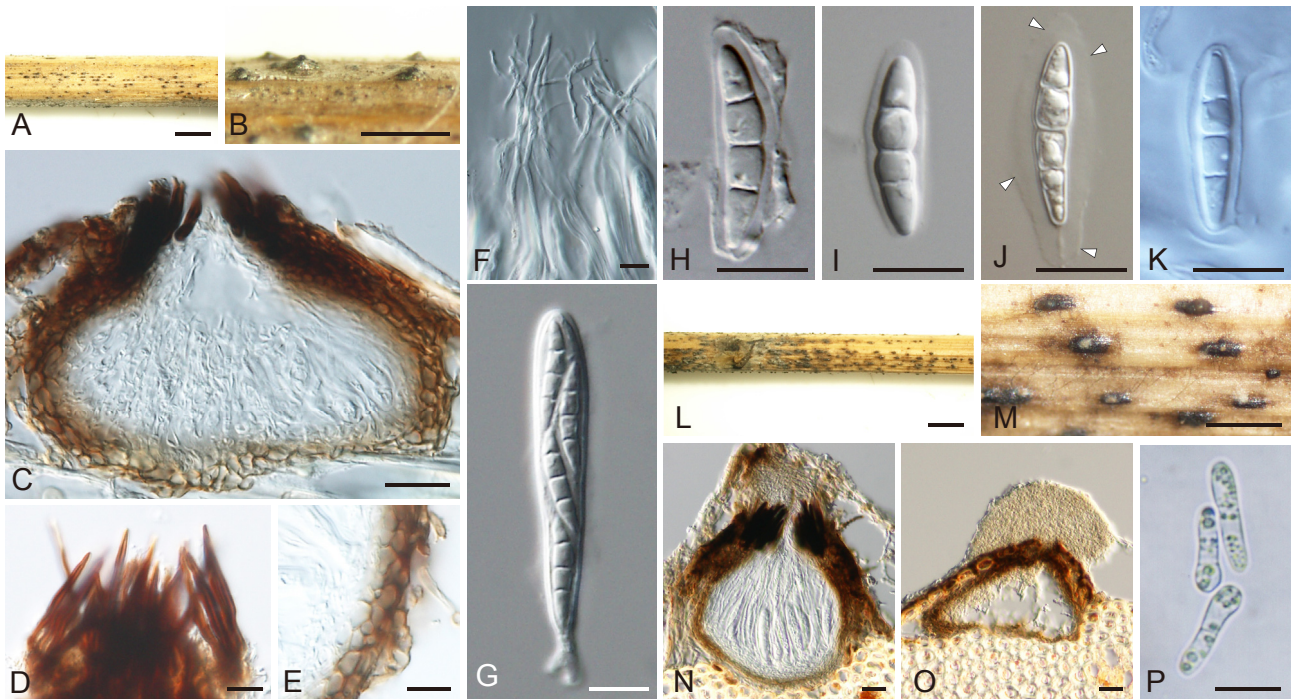
**Type species:** *Keissleriella aesculi* (Höhn.) Höhn.

**Notes:** *Keissleriella* is characterised by an ostiolar neck covered by short dark setae. Munk (1953) introduced *Trichometasphaeria*, which can be separated from *Keissleriella* by their host preferences and the morphological features of hamathecium and ascospores. *Trichometasphaeria* occurs on herbaceous plants and has cellular pseudoparaphyses and septate ascospores, while *Keissleriella* occurs on woody plants and has trabecular pseudoparaphyses and 1-septate ascospores (Munk 1957, Barr 1990a, 1992). However, Bose (1961) treated *Trichometasphaeria* as a synonym of *Keissleriella*, and this opinion was accepted by several authors (e.g., Eriksson 1967, Dennis 1978, Sivanesan 1984). We also regard these two genera as





**Fig. 12.** *Katumotoa bambusicola*. A. Ascomata on the natural host surface; B, C. Ascomata in longitudinal section; D. Ascomatal wall (in lactophenol cotton blue); E. Pseudoparaphyses; F. Ascus; G. Ascospore (arrowheads indicate gelatinous sheath). A–D from KT 1517; E–G from culture KT 1517. Scale bars: A = 1 mm; B, C = 100  $\mu$ m; D–G = 10  $\mu$ m.



**Fig. 13.** *Keissleriella breviasca*. A, B. Ascomata on the natural host surface; C. Ascoma in longitudinal section; D. Apical setae of ascoma; E. Ascomatal wall; F. Pseudoparaphyses; G. Ascus; H–K. Ascospores (arrowheads indicate gelatinous sheath); L, M. Ascomata and conidiomata in culture (on rice straw); N. Ascoma produced in culture; O. Conidioma produced in culture; P. Conidia. A–C, E, I from KT 649; D, G, H from KT 540; F, J from KT 581; K from culture KT 581; L–O from culture KT 649; P from culture KT 540. Scale bars: A, L = 2 mm; B, M = 500  $\mu$ m; C, N, O = 20  $\mu$ m; D–K, P = 10  $\mu$ m.

congeneric as species with the features of *Trichometasphaeria* (e.g., *K. gloeospora*, the type species of *Trichometasphaeria*) and *Keissleriella* (e.g., *K. cladophila*; Corbaz 1956, Bose 1961) form a clade (Fig. 1), although the type of the latter genus (*K. sambucina*) is not included in our analysis.

***Keissleriella breviasca*** Kaz. Tanaka & K. Hiray., sp. nov. MycoBank MB811304. Fig. 13.

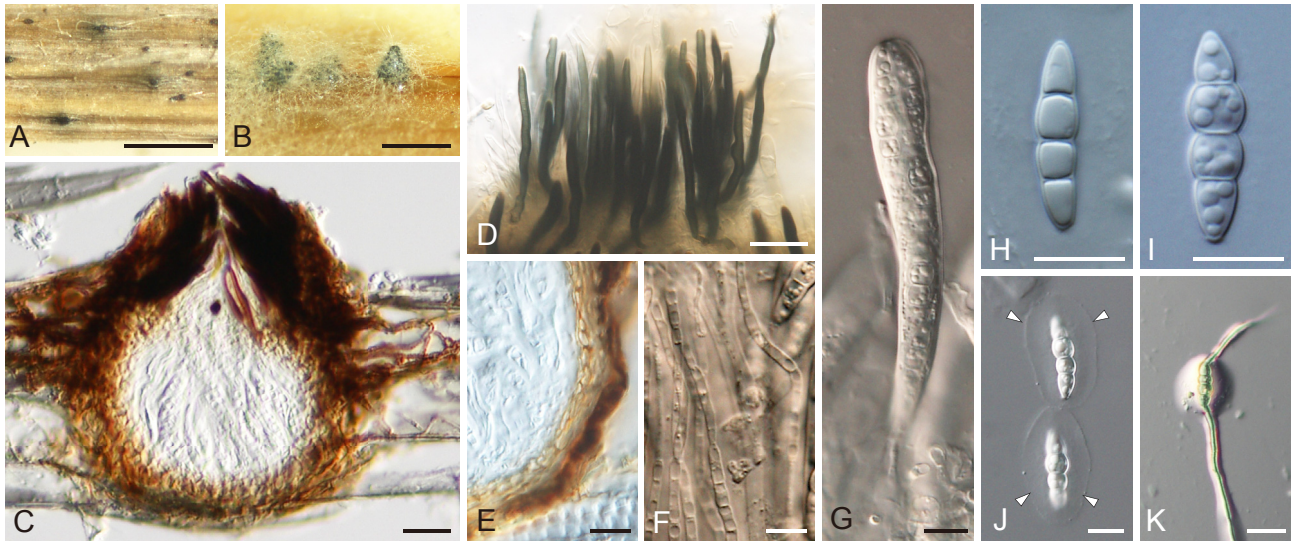
**Etymology:** From the Latin *brevi-* meaning short, in reference to the ascus length.

**Ascomata** scattered, erumpent, 95–115  $\mu$ m high, 130–165  $\mu$ m diam. **Ostiolar neck** papillate, 18–23(–50)  $\mu$ m long, covered with 1-celled, thick-walled, dark brown to almost black setae. **Ascomatal wall** 7.5–11.5  $\mu$ m thick at sides, composed of 3–4 layers of polygonal to subglobose cells of 2.5–10  $\times$  2.5–5  $\mu$ m. **Pseudoparaphyses** cellular, septate, branched and anastomosed, 2–3.5  $\mu$ m wide. **Asci** fissitunicate, clavate to cylindrical, 51–66  $\times$  7–11  $\mu$ m (av. 59.0  $\times$  8.7  $\mu$ m, n = 39), rounded at the

apex and with a shallow ocular chamber, short-stalked (5–12  $\mu$ m long), with 4 biseriolate ascospores. **Ascospores** narrowly fusiform, 17.5–24.5  $\times$  3.5–5  $\mu$ m (av. 21.1  $\times$  4.3  $\mu$ m, n = 64), l/w (3.7–) 4.0–5.7(–6.3) (av. 4.9, n = 64), with a nearly median primary septum (0.44–0.53; av. 0.49, n = 48), 3-septate (1+1+1), slightly constricted at the septa, hyaline, smooth, with an entire sheath; sheath gelatinous and 8–11  $\mu$ m wide when fresh, delimited and 1–2  $\mu$ m wide when dry.

Colonies on PDA (after 4 wk) attaining a diam of 1.0–1.3 cm, coral with white margin; reverse red to flesh; sienna pigment produced. In culture coelomycetous asexual morph formed. **Conidiomata** pycnidial, 70–90  $\mu$ m high, 120–200  $\mu$ m diam, subglobose to hemispherical in section. **Conidiomatal wall** 7–15  $\mu$ m thick at sides, composed of thin-walled, flattened cells. **Conidiogenous cells** cylindrical to doliiform, 8–13  $\times$  2.5–3.5  $\mu$ m, holoblastic. **Conidia** cylindrical to bone-shaped, 0–3-septate, hyaline, smooth, 11–20  $\times$  3–4  $\mu$ m (av. 15.2  $\times$  3.7  $\mu$ m, n = 20), l/w 3.7–5.0 (av. 4.1, n = 20), without sheath. Sometimes, sexual morph formed. **Ascospores** 19–23  $\times$  3.5–4.5  $\mu$ m.





**Fig. 14.** *Keissleriella culmifida*. A. Ascomata on the natural host surface; B. Ascomata in culture (on rice straw); C. Ascoma in longitudinal section; D. Apical setae of ascoma; E. Ascomatal wall; F. Pseudoparaphyses; G. Ascus; H–J. Ascospores (arrowheads indicate gelatinous sheath); K. Germinating ascospore. A, C, E, K from KT 2642; B, D, F, G, I, J from culture KT 2308; H from KT 2308. Scale bars: A, B = 500  $\mu$ m; C, D, K = 20  $\mu$ m; E–J = 10  $\mu$ m.

**Specimens examined:** Japan, Aomori, Hirosaki, Campus of Hirosaki Univ., on dead culms of *Dactylis glomerata*, 13 Jun. 2001, K. Tanaka, KT 540 = HHUF 27715, culture JCM 19413 = MAFF 239476; *ibid.*, 20 Jul. 2001, KT 581 = HHUF 27717, culture JCM 19414 = MAFF 243843; Aomori, Hirakawa, Hirakawa-river, riverbank, on dead culms of *Dactylis glomerata*, 5 Aug. 2001, K. Tanaka (**holotype** KT 649 = HHUF 27718, culture **ex-type** CBS 139691 = JCM 19415 = MAFF 243844).

**Notes:** To date, 50 species have been described as *Keissleriella* (or *Trichometasphaeria*; MycoBank, <http://www.mycobank.org>, April 2015), but *K. breviasca* can be distinguished from all known species by its short asci with consistently four ascospores (Fig. 13G). The asexual morph of *K. breviasca* is similar to that of *K. gallica* reported as “*Ascochyta* sp.” (Sivanesan 1984), but the conidia of *K. breviasca* have 0–3 septa (vs. 0–1 septa in *K. gallica*). A collection of *K. culmifida* with 4-spored asci has sometimes been reported (Dennis 1978, Ridley 1988), which is most probably conspecific with *K. breviasca*.

***Keissleriella culmifida*** (P. Karst.) S.K. Bose, *Phytopath. Z.* 41: 188. 1961. Fig. 14.

**Basionym:** *Leptosphaeria culmifida* P. Karst., *Bidr. Känn. Finl. Nat. Folk* 23: 103. 1873.

**Ascomata** 120–145  $\mu$ m high, 120–150  $\mu$ m diam, with dark brown setae of 30–58  $\times$  3–5  $\mu$ m around the ostiole. **Asci** 8-spored, 70.5–84  $\times$  10.5–13  $\mu$ m. **Ascospores** fusiform, 17.5–22  $\times$  4–5.5  $\mu$ m (av. 19.4  $\times$  4.9  $\mu$ m,  $n = 36$ ), l/w 3.5–5.0 (av. 3.9,  $n = 36$ ), with nearly median primary septum (0.47–0.53; av. 0.51,  $n = 35$ ), 3-septate (1+1+1), surrounded by an entire gelatinous sheath, 3–9  $\mu$ m wide.

In culture sexual morph formed. **Asci** 90–127.5  $\times$  10.5–15  $\mu$ m (av. 102.9  $\times$  13.0  $\mu$ m,  $n = 40$ ). **Ascospores** fusiform, 19–26  $\times$  5–7  $\mu$ m (av. 22.5  $\times$  5.9  $\mu$ m,  $n = 60$ ), l/w 3.3–4.5 (av. 3.8,  $n = 60$ ), with a nearly median primary septum (0.46–0.55; av. 0.50,  $n = 60$ ). Asexual morph not observed.

**Specimens examined:** Japan, Hokkaido, Isl. Rishiri, Forest park, on dead stems of *Agrostis flaccida*, 29 Jul. 2007, K. Tanaka & G. Sato, KT 2308 = HHUF 30135, culture JCM 19416 = MAFF 243848; Iwate, Hachimantai, Top of Aspite line, on

dead leaves of *Festuca* sp. 25 Jul. 2009, K. Tanaka & Y. Harada, KT 2642 = HHUF 30136, culture JCM 19417 = MAFF 243849.

**Notes:** We identified these specimens as *K. culmifida*, based on the description (Karsten 1873, Holm 1957, Bose 1961) and illustration (Berlese 1894, Eriksson 1967) of this species. However, ITS sequences from the above materials completely matched with those from the ex-type of *K. poagena* (GenBank KJ869112), a species recently published by Crous *et al.* (2014a). *Keissleriella poagena* is morphologically close to *K. culmifida*, and thus taxonomic reassessment of these two species will be needed.

***Keissleriella gloeospora*** (Berk. & Curr.) S.K. Bose, *Phytopath. Z.* 41: 190. 1961. Fig. 15.

**Basionym:** *Sphaeria gloeospora* Berk. & Curr., *Ann. Mag. Nat. Hist.*, Ser. 3 7: 454. 1861.

**Ascomata** 130–230  $\mu$ m high, 350–480  $\mu$ m diam, with dark brown setae (up to 60  $\mu$ m long) around the ostiole. **Asci** clavate, 80–118  $\times$  14–19  $\mu$ m (av. 97.2  $\times$  16.8  $\mu$ m,  $n = 20$ ), short-stalked (10–25  $\mu$ m long). **Ascospores** fusiform to clavate, 21.5–33  $\times$  6–9  $\mu$ m (av. 28.0  $\times$  7.3  $\mu$ m,  $n = 50$ ), l/w 3.3–4.9 (av. 3.8,  $n = 50$ ), with a suprmedian primary septum (0.39–0.48; av. 0.43,  $n = 50$ ), 4–6-septate (1+1+2, 1+1+3, 2+1+2, 2+1+3), sometimes with a vertical septum in central cells, surrounded by an entire sheath (6–10  $\mu$ m wide when fresh, 2–3  $\mu$ m wide when dry).

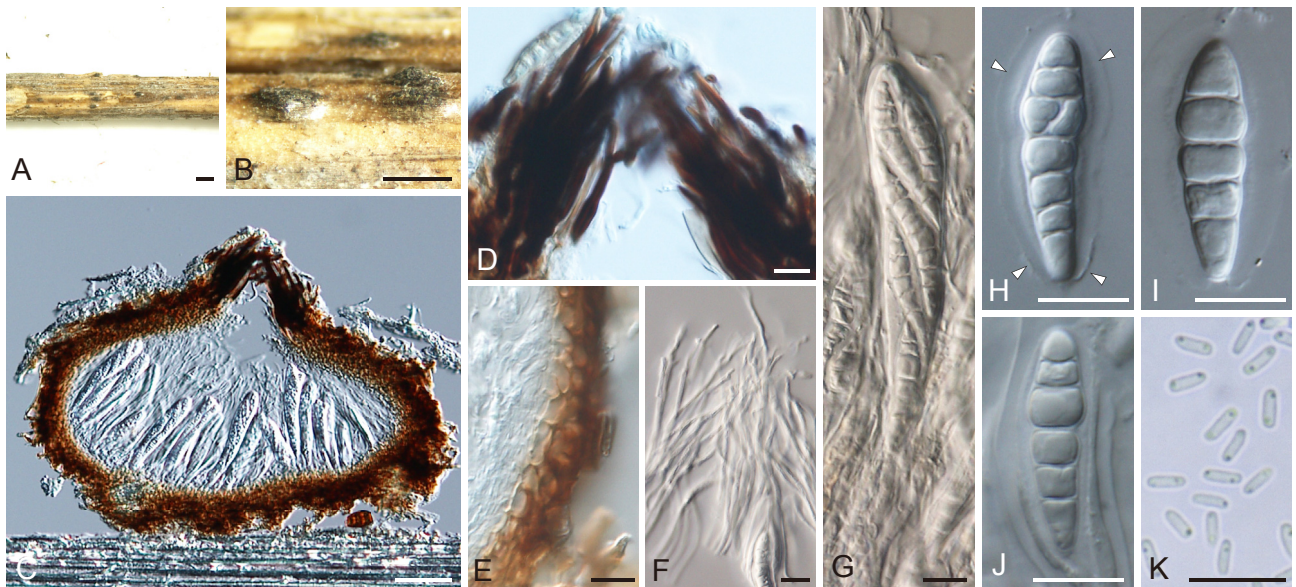
In culture spermatial morph formed. **Spermatia** 3.3–4.9  $\times$  1.2–1.8  $\mu$ m (av. 4.1  $\times$  1.5  $\mu$ m,  $n = 20$ ), hyaline, cylindrical.

**Specimen examined:** Japan, Aomori, Hirosaki, Campus of Hirosaki Univ., on dead culms of *Setaria faberii*, 4 Nov. 2001, K. Tanaka, KT 829 = HHUF 27704, culture MAFF 239474.

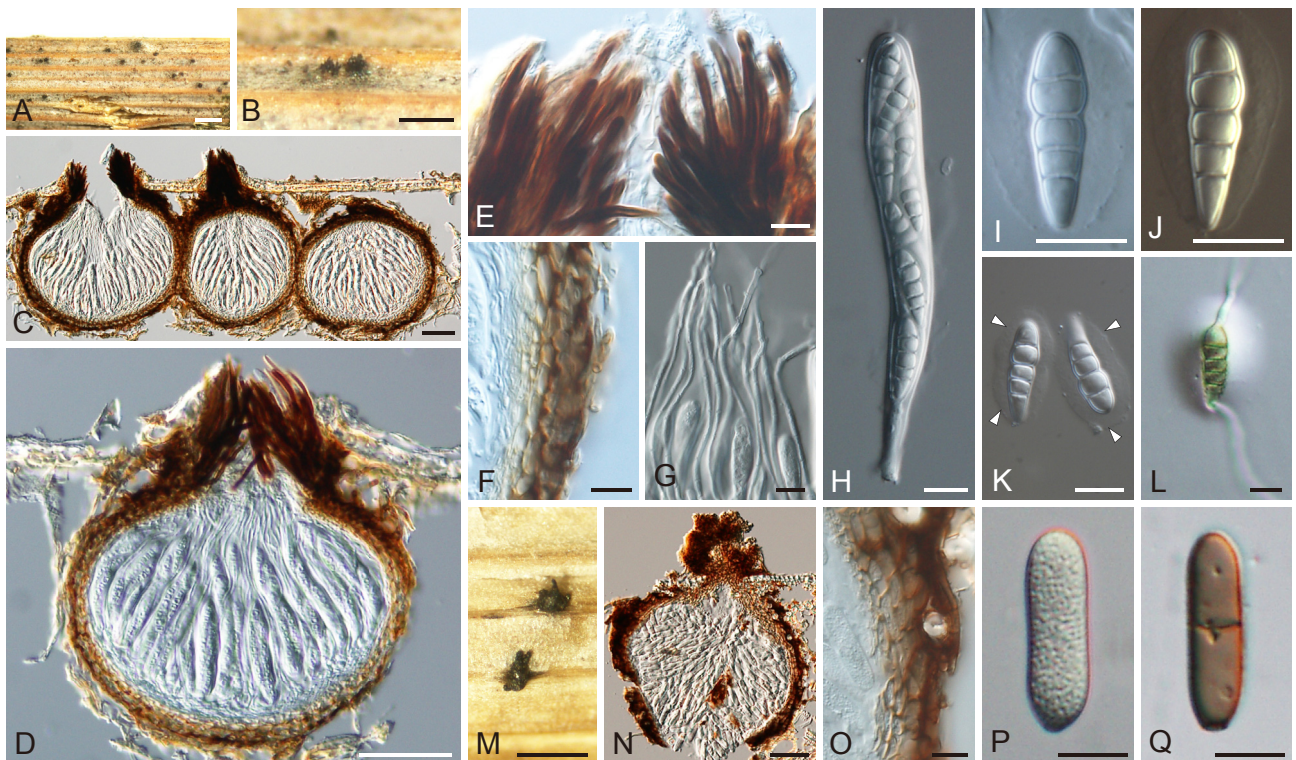
**Note:** The above material matches well the descriptions of *K. gloeospora* provided by Bose (1961) and Shearer *et al.* (1993).

***Keissleriella quadriseptata*** Kaz. Tanaka & K. Hiray., **sp. nov.** MycoBank MB811305. Fig. 16.





**Fig. 15.** *Keissleriella gloeospora*. A, B. Ascomata on the natural host surface; C. Ascma in longitudinal section; D. Apical setae of ascma; E. Ascomatal wall; F. Pseudoparaphyses; G. Ascus; H–J. Ascospores (arrowheads indicate gelatinous sheath); K. Spermatia. A–J from KT 829; K from culture KT 829. Scale bars: A = 1 mm; B = 500  $\mu$ m; C = 50  $\mu$ m; D–K = 10  $\mu$ m.



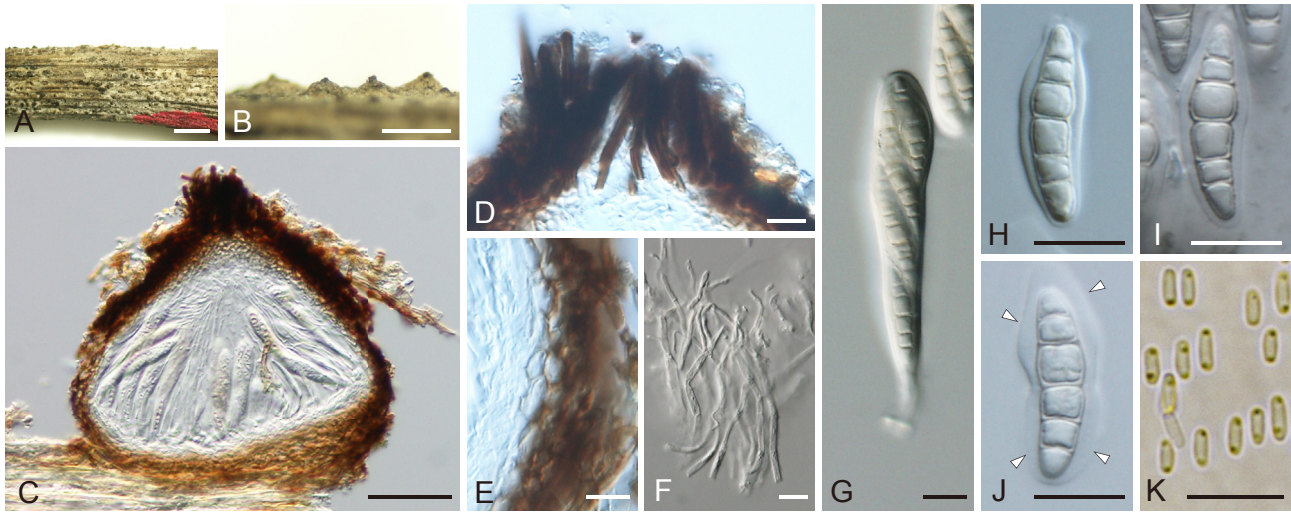
**Fig. 16.** *Keissleriella quadrisepitata*. A, B. Ascomata on the natural host surface; C, D. Ascomata in longitudinal section; E. Apical setae of ascma; F. Ascomatal wall; G. Pseudoparaphyses; H. Ascus; I–K. Ascospores (arrowheads indicate gelatinous sheath); L. Germinating ascospore; M. Conidiomata in culture (on rice straw); N. Conidioma in longitudinal section; O. Conidiomatal wall; P. Conidium; Q. Senescent conidium. A–L from KT 2292; M–Q from culture KT 2292. Scale bars: A, M = 500  $\mu$ m; B = 200  $\mu$ m; C, D, N = 50  $\mu$ m; E–L, O–Q = 10  $\mu$ m.

**Etymology:** Referring to the 4-septate ascospores.

*Ascomata* scattered to 2–4 grouped, immersed to erumpent, globose in section, 210–320  $\mu$ m high, 170–310  $\mu$ m diam. *Ostiolar neck* central, papillate, 35–50  $\mu$ m long, 55–62  $\mu$ m diam, with setae; setae bluntly pointed, aseptate, slightly waved, dark brown to black, 37–93  $\mu$ m long, 2.5–4  $\mu$ m wide at the base. *Ascomatal wall* in longitudinal section uniformly 15–20  $\mu$ m thick, composed of 5–6 layers of polygonal, slightly thick-walled,

4.5–16.5  $\times$  3–7.5  $\mu$ m, brown cells. *Pseudoparaphyses* cellular, septate, branched and anastomosed, 2–2.5  $\mu$ m wide. *Asci* fissitunicate, clavate, 78.5–107.5  $\times$  12–14.5  $\mu$ m (av. 92.8  $\times$  13.1  $\mu$ m, n = 30), rounded at the apex and with a shallow ocular chamber, short-stalked (5–24  $\mu$ m long; av. 13.1  $\mu$ m, n = 26), with 8 biseriolate ascospores. *Ascospores* clavate, 19–24.5  $\times$  5–7  $\mu$ m (av. 21.5  $\times$  5.8  $\mu$ m, n = 50), l/w 3.3–4.4 (av. 3.7, n = 50), with a supramedian primary septum (0.38–0.45; av. 0.42, n = 50), 4-septate (1+1+2), slightly constricted at the





**Fig. 17.** *Keissleriella taminensis*. A, B. Ascomata on the natural host surface; C. Ascoma in longitudinal section; D. Apical setae of ascoma; E. Ascromatal wall; F. Pseudoparaphyses; G. Ascus; H–J. Ascospores (arrowheads indicate gelatinous sheath); K. Spermata. A–E, G, I from KT 594; F, H from KT 571; J from KT 678; K from culture KT 594. Scale bars: A = 2 mm; B = 500  $\mu$ m; C = 50  $\mu$ m; D–K = 10  $\mu$ m.

primary septum, hyaline, smooth, with an entire gelatinous sheath of 4–6  $\mu$ m wide.

Colonies on PDA (after 2 wk) attaining a diam of 1.7–2.2 cm, pale luteous; reverse rust; no pigment produced. In culture asexual morph formed. *Conidiomata* pycnidial, 200–380  $\mu$ m high, 160–310  $\mu$ m diam, globose in section. *Ostiolar neck* papillate, 60–90  $\mu$ m long, 50–75  $\mu$ m wide. *Conidiomatal wall* 13–25  $\mu$ m thick, composed of 4–6 layers of polygonal cells (5–17  $\times$  2.5–6.5  $\mu$ m). *Conidiophores* absent. *Conidiogenous cells* lageniform, holoblastic. *Conidia* cylindrical, rounded at the apex, slightly truncate at the base, straight, aseptate, hyaline, smooth, 25–32  $\times$  6–8.5  $\mu$ m (av. 28.4  $\times$  7.2  $\mu$ m, n = 30), l/w 3.3–4.8 (av. 3.9, n = 30), without sheath; senescent spores brown, 0–1-septate.

*Specimen examined:* Japan, Hokkaido, Isl. Rishiri, Beach near Ryuzinnoiva, on dead culms of *Dactylis glomerata*, 28 Jul. 2007, K. Tanaka & G. Sato (**holotype** KT 2292 = HHUF 30137, culture **ex-type** CBS 139692 = JCM 19418 = MAFF 243850).

*Notes:* This species is characterised by its consistently 4-septate ascospores (1+1+2). Phylogenetically, it is closest to *K. gloeospora* (97.8%; 904/924 in *tef1*), but the latter has larger ascospores (21.5–33  $\times$  6–9  $\mu$ m) with 4–6 septa (1+1+2, 1+1+3, 2+1+2, 2+1+3). In culture, *K. quadriseptata* produced an asexual morph with cylindrical, aseptate, hyaline conidia, but only a spermatial morph was found in *K. gloeospora*.

***Keissleriella taminensis*** (H. Wegelin) S.K. Bose, *Phytopath.* Z. 41: 190. 1961. Fig. 17.

*Basionym:* *Leptosphaeria taminensis* H. Wegelin, *Mitt. Thürgau. Naturf. Ges.* 12: 173. 1896.

*Ascomata* 190–280  $\mu$ m high, 180–300  $\mu$ m diam. *Asci* clavate, 70–106  $\times$  11.5–16  $\mu$ m (av. 84.3  $\times$  13.3  $\mu$ m, n = 53), short-stalked (8–25  $\mu$ m long; av. 15.5  $\mu$ m, n = 27). *Ascospores* fusiform, 19–25  $\times$  4–7  $\mu$ m (av. 21.9  $\times$  5.9  $\mu$ m, n = 103), l/w 3.0–4.5(–5.0) (av. 3.7, n = 103), with a supramedian primary septum (0.43–0.51; av. 0.47, n = 100), 4–5-septate (1+1+2, 2+1+2), surrounded by an entire sheath (3–10  $\mu$ m wide when fresh, 1–2  $\mu$ m wide when dry).

In culture spermatial morph formed. *Spermata* cylindrical, hyaline, 3.5–8.8  $\times$  1.3–2.3  $\mu$ m (av. 5.5  $\times$  1.8  $\mu$ m, n = 60). Sometimes sexual morph observed.

*Specimens examined:* Japan, Aomori, Hirosaki, Sanpinai, on dead stems of herbaceous plant, 17 Jul. 2001, K. Tanaka, KT 571 = HHUF 27707, culture MAFF 243846; Aomori, Hirosaki, Kadoke, Oowasawa-river, riverbank, on dead stems of herbaceous plant, 29 Jul. 2001, K. Tanaka, KT 594 = HHUF 27709, culture MAFF 243847; *ibid.*, 14 Aug. 2001, K. Tanaka, KT 678 = HHUF 27711, culture MAFF 239475.

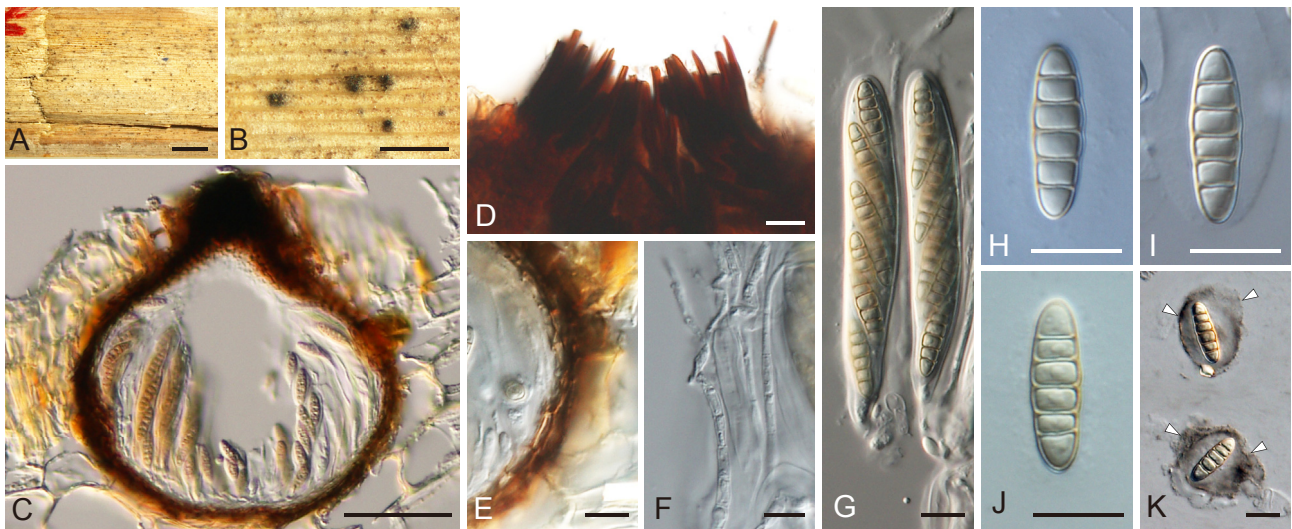
*Note:* These materials agree well with the description of *K. taminensis* except for the slightly wider ascospores in our collections (4–7  $\mu$ m vs. 4.5–5  $\mu$ m; Bose 1961).

***Keissleriella yonaguniensis*** Kaz. Tanaka & K. Hiray., **sp. nov.** MycoBank MB811307. Fig. 18.

*Etymology:* Referring to the collection site.

*Ascomata* scattered, immersed to erumpent, globose in section, 100–170  $\mu$ m high, 100–180  $\mu$ m diam. *Ostiolar neck* central, papillate to terete, 37–45  $\mu$ m long, 32–35  $\mu$ m diam, with setae; setae bluntly pointed, aseptate, straight, dark brown to black, 20–30  $\mu$ m long, 3–4.5  $\mu$ m wide at the base. *Ascromatal wall* in longitudinal section uniformly 7.5–10  $\mu$ m thick, composed of 3–5 layers of polygonal, thin-walled, flattened, 3.5–7.5  $\times$  1.5–2.5  $\mu$ m, brown cells. *Pseudoparaphyses* cellular, septate, branched and anastomosed, 1.5–2.5  $\mu$ m wide (3–4.5  $\mu$ m wide at below). *Asci* fissitunicate, cylindrical, 65–99.5(–112.5)  $\times$  10.5–14.5  $\mu$ m (av. 80.1  $\times$  12.1  $\mu$ m, n = 35), rounded at apex and with a shallow ocular chamber, with a short stipe of 5–13  $\mu$ m long, 8-spored. *Ascospores* cylindrical with rounded ends, 15–20  $\times$  4.5–6.5  $\mu$ m (av. 18.1  $\times$  5.3  $\mu$ m, n = 50), l/w 3.0–3.9 (av. 3.5, n = 50), with a nearly median primary septum (0.47–0.53; av. 0.50, n = 50), 5-septate (2+1+2), yellow, smooth, with an entire gelatinous sheath of 3–5  $\mu$ m wide (later diffuse up to 10  $\mu$ m wide).

Colonies on PDA (after 4 wk) attaining a diam of 5.2–5.7 cm, white to pale luteous; reverse similar; no pigment produced. In culture sexual morph identical to that formed on the natural host produced.



**Fig. 18.** *Keissleriella yonaguniensis*. A, B. Ascomata on the natural host surface; C. Ascoma in longitudinal section; D. Apical setae of ascoma; E. Ascomatal wall; F. Pseudoparaphyses; G. Asci; H–K. Ascospores (arrowheads indicate gelatinous sheath; K. in India ink). All from KT 2604. Scale bars: A = 2 mm; B = 500  $\mu$ m; C = 50  $\mu$ m; D–K = 10  $\mu$ m.

*Specimen examined:* **Japan**, Okinawa, Isl. Yonaguni, Kubura pond, on dead leaves of *Typha latifolia*, 23 Nov. 2008, K. Tanaka & K. Hirayama (**holotype** KT 2604 = HHUF 30138, culture **ex-type** CBS 139693 = JCM 19419 = MAFF 243851).

*Notes:* Among the 50 described species in *Keissleriella* (or *Trichometasphaeria*), six are known to have 5-septate ascospores like *K. yonaguniensis*. These are *K. abruptipapilla*, *K. gloeospora*, *T. papillisetosa*, *K. pindaundeensis*, *T. populi* and *K. taminensis*. Among these, *K. gloeospora*, *T. populi* and *K. taminensis* differ from *K. yonaguniensis* in having asymmetrically-septate ascospores (Bose 1961, Barr 1992). *Keissleriella pindaundeensis* (Kobayasi 1971) and *T. papillisetosa* (Yuan & Barr 1994) are distinguished from *K. yonaguniensis* by larger ascospores that are more than 20  $\mu$ m long. *Keissleriella abruptipapilla* (Barr 1990a) is similar but its ascospores are verruculose. In our phylogenetic tree (Fig. 1), *K. yonaguniensis* grouped with *K. linearis* (= *Lentithecium lineare*; Zhang et al. 2009c), *Murilentithecium* with muriform ascospores and conidia (Wanasinghe et al. 2014), and *Phragmocamarosporium* spp. with phragmosporous conidia (Wijayawardene et al. 2015), although this clade received no support. We include this species as *Keissleriella* based on the morphology of its sexual morph pending further studies of related taxa.

***Lentithecium*** K.D. Hyde et al., Fungal Divers. 38: 234. 2009.

*Type species:* *Lentithecium fluviatile* (Aptroot & Van Ryck.) K.D. Hyde et al.

*Notes:* *Lentithecium* was established by Zhang et al. (2009c) using *L. fluviatile* as the type species. This genus was characterised by the lenticular ascomata, but reexamination based on the holotype of *L. fluviatile* revealed that the species has globose ascomata (Hyde et al. 2013).

***Lentithecium clioninum*** (Kaz. Tanaka et al.) Kaz. Tanaka & K. Hiray., **comb. nov.** MycoBank MB811308. Fig. 19.

*Basionym:* *Massarina clionina* Kaz. Tanaka et al., Mycoscience 46: 288. 2005.

*Ascomata* 210–280  $\mu$ m high, 330–430  $\mu$ m diam. *Ostiolar neck* 50–75  $\mu$ m long, 75–125  $\mu$ m wide. *Ascromatal wall* 15–23  $\mu$ m

thick at sides. *Pseudoparaphyses* 2  $\mu$ m wide. *Asci* clavate, (81.5–)86–118(–128)  $\times$  15–19(–21)  $\mu$ m (av. 100.1  $\times$  17.2  $\mu$ m, n = 70), short-stalked (5–23  $\mu$ m long). *Ascospores* fusiform, (26–)27.5–34.5(–37)  $\times$  7–10(–11)  $\mu$ m (av. 31.0  $\times$  8.7  $\mu$ m, n = 70), l/w 3.2–4.1 (av. 3.6, n = 70), with a septum mostly median (0.48–0.52; av. 0.50, n = 64), with a wing-like sheath staining with Black-Blue ink when fresh.

In culture ascromatal morph formed. *Ascospores* 27–35  $\times$  8–11  $\mu$ m (av. 31.0  $\times$  9.3  $\mu$ m, n = 50). No asexual morph observed.

*Specimens examined:* **Japan**, Hokkaido, Akkeshi, Bekanbeushi-river (near Bekanbeushi bridge), on submerged twigs of woody plant, 2 Jun. 2003, K. Tanaka & S. Hatakeyama (**holotype** KT 1149A = HHUF 28199, culture **ex-type** CBS 139694 = JCM 12703 = MAFF 239293); Hokkaido, Akkeshi, Toraihetsu-river, on submerged twigs of woody plant, 3 Jun. 2003, K. Tanaka & S. Hatakeyama (**paratype** KT 1220 = HHUF 28213, culture **ex-paratype** MAFF 243839).

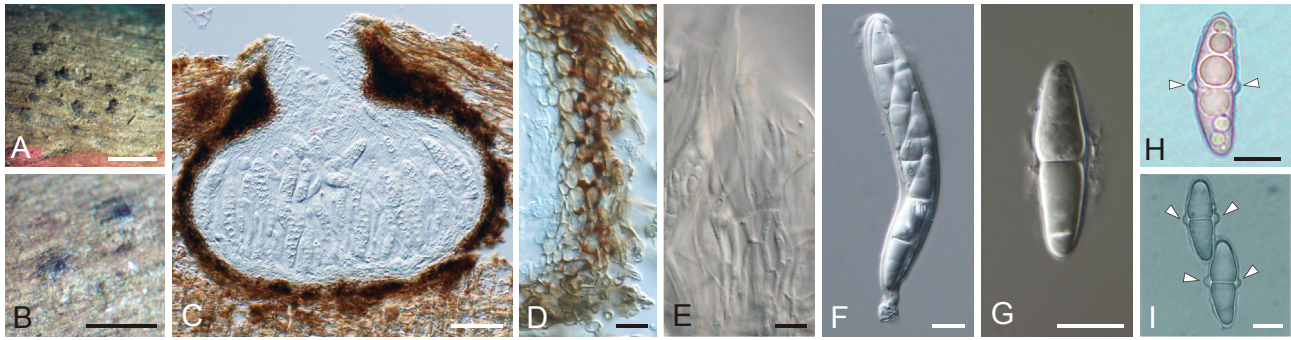
*Notes:* This species was previously described as *Massarina* (Tanaka et al. 2005b), but we here transfer it to *Lentithecium*, because it has morphological similarities with *L. fluviatile*, the type species of the genus (see Fig. 43 in Zhang et al. 2012). Both have globose ascomata composed of small polygonal peridial cells, short pedicellate asci, and fusiform ascospores with obtuse ends. In our phylogenetic tree (Fig. 1), this species and *L. pseudoclioninum* nested on a well-supported branch (100 %) with *L. fluviatile*.

***Lentithecium pseudoclioninum*** Kaz. Tanaka & K. Hiray., **sp. nov.** MycoBank MB811309. Fig. 20.

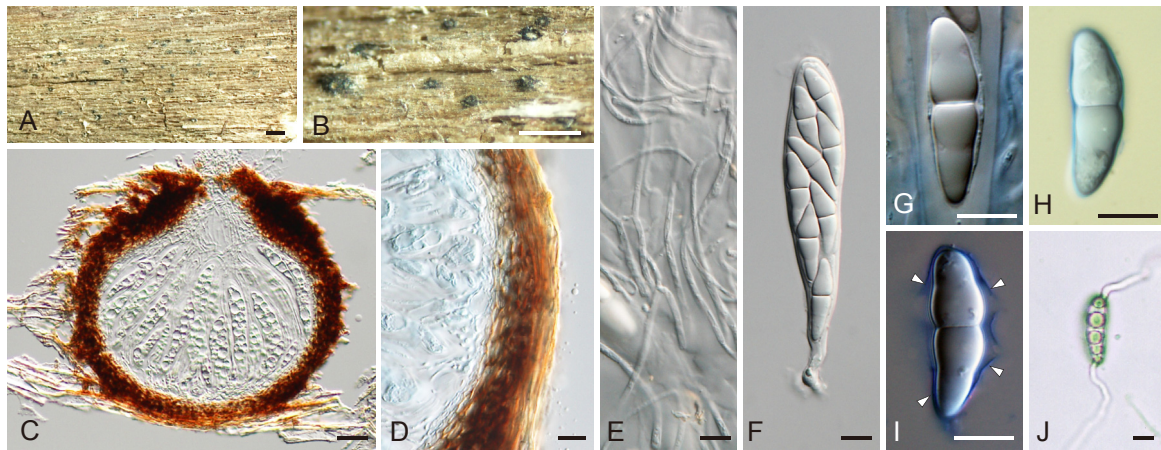
*Etymology:* Referring to its resemblance to *Lentithecium clioninum*.

*Ascomata* scattered to 2–3 grouped, immersed to erumpent, globose in section, 200–220  $\mu$ m diam, with sparse brown hyphae around ascomata. *Ostiolar neck* central, papillate, 40–50  $\mu$ m long, 30  $\mu$ m diam, with periphyses. *Ascromatal wall* in longitudinal section uniformly 17.5–20  $\mu$ m thick, composed of 5–6 layers of polygonal to subglobose, 5–12.5  $\times$  2  $\mu$ m, brown cells. *Pseudoparaphyses* septate, branched and anastomosed,





**Fig. 19.** *Lentithecium clioninum*. A, B. Ascomata on the natural host surface; C. Ascoma in longitudinal section; D. Ascomatal wall; E. Pseudoparaphyses; F. Ascus; G–I. Ascospores (arrowheads indicate gelatinous sheath; H, I. in Black-Blue ink). A–D from KT 1149A; E–G from KT 1220; H, I from culture KT 1149A. Scale bars: A = 1 mm; B = 500  $\mu$ m; C = 50  $\mu$ m; D–I = 10  $\mu$ m.



**Fig. 20.** *Lentithecium pseudoclioninum*. A, B. Ascomata on the natural host surface; C. Ascoma in longitudinal section; D. Ascomatal wall; E. Pseudoparaphyses; F. Ascus; G–I. Ascospores (arrowheads indicate gelatinous sheath; all in Black-Blue ink); J. Germinating ascospore. All from KT 1113. Scale bars: A = 1 mm; B = 500  $\mu$ m; C = 50  $\mu$ m; D–J = 10  $\mu$ m.

2–3  $\mu$ m wide. Asci fissitunicate, clavate, 62.5–116  $\times$  14–25  $\mu$ m (av. 92.0  $\times$  18.4  $\mu$ m, n = 95), rounded at the apex and with a shallow ocular chamber, short-stalked (5–17.5  $\mu$ m long; av. 9.9  $\mu$ m, n = 67), with 8 biseriate ascospores. Ascospores clavate to broadly fusiform, slightly curved, 22–39  $\times$  6.5–11.5  $\mu$ m (av. 29.2  $\times$  8.5  $\mu$ m, n = 77), l/w (2.4–)2.8–4.1(–4.6) (av. 3.5, n = 77), with a supramedian septum (0.43–0.50; av. 0.48, n = 73), constricted at the septum, hyaline, smooth, with an amorphous gelatinous sheath (1–4  $\mu$ m wide) staining with Black-Blue ink when in fresh condition.

Colonies on PDA (after 4 wk) attaining a diam of 2.7–3.0 cm, smoke grey; reverse vinaceous buff to citrine; no pigment produced. In culture sexual morph identical to that formed on the natural host produced.

**Specimens examined:** Japan, Aomori, Hirosaki, Aoki, Mohei pond, on submerged twigs of woody plant, 3 May 2003, K. Tanaka & N. Asama, KT 1111 = HHUF 29053, culture JCM 19421 = MAFF 243840; *ibid.* (**holotype** KT 1113 = HHUF 29055, culture **ex-type** CBS 139695 = JCM 19422 = MAFF 243841).

**Notes:** Morphologically, this species is close to *L. clioninum*, but is clearly separated from it on the basis of its smaller ascospores with a supramedian septum. The wing-like sheath of ascospores found in *L. clioninum* was not observed in *L. pseudoclioninum*.

***Neophiosphaerella*** Kaz. Tanaka & K. Hiray., **gen. nov.** MycoBank MB811310.

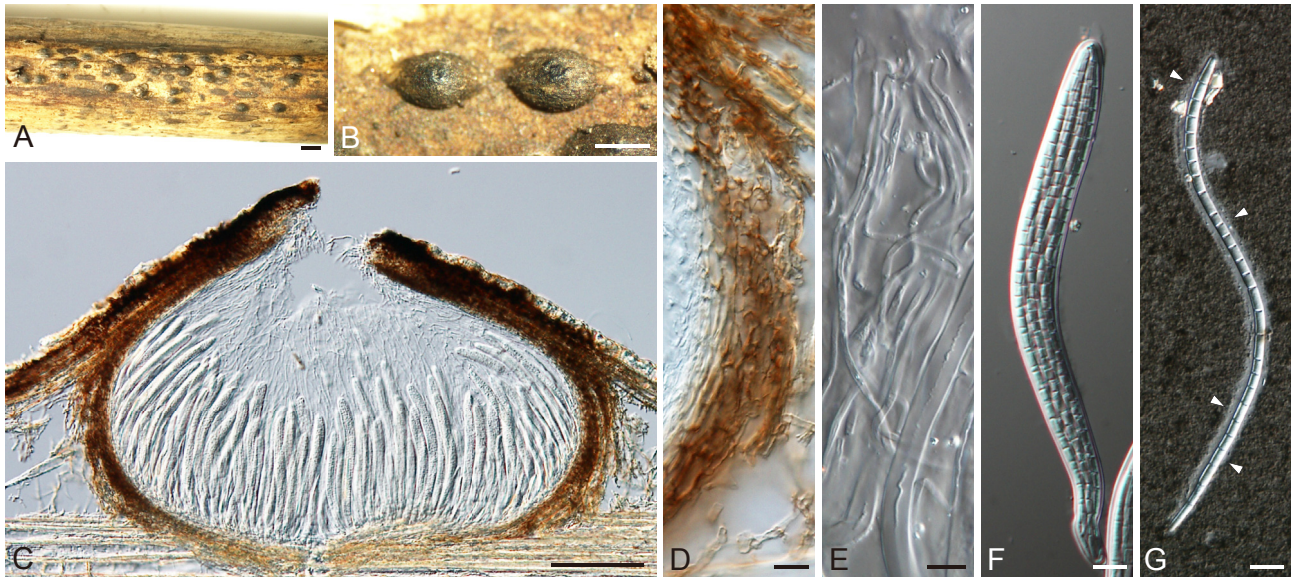
**Etymology:** After its morphological similarity to *Ophiosphaerella*.

Ascomata scattered to grouped, erumpent, subglobose to hemispherical with flattened base. *Ostiolar neck* central, terete, flush, covered by black clypeus. *Ascomatal wall* at sides composed of several layers of thin-walled brown cells. *Pseudoparaphyses* numerous, cellular, branched. *Asci* fissitunicate, cylindrical, short-stalked, with 8 parallel or twisted ascospores. *Ascospores* filiform, multiseptate, hyaline to pale yellowish brown, smooth, surrounded by a sheath. Asexual morph unknown.

**Type species:** *Neophiosphaerella sasicola* (Nagas. & Y. Otani) Kaz. Tanaka & K. Hiray.

**Notes:** *Neophiosphaerella sasicola*, the type species of this genus, was originally described as a species of *Phaeosphaeria* (Nagasawa & Otani 1977) and later transferred to *Ophiosphaerella* (Shoemaker & Babcock 1989). These two genera, however, belong to the *Phaeosphaeriaceae* in the *Pleosporineae* (Cámara *et al.* 2000, Schoch *et al.* 2009, Phookamsak *et al.* 2014), a family distantly related to the *Lentitheciaceae*. We therefore propose a new genus, *Neophiosphaerella*, to accommodate this species. *Ophiosphaerella* has globose to subglobose ascomata with a papillate ostiolar neck (Phookamsak *et al.* 2014), while *Neophiosphaerella* is characterised by hemispherical ascomata without papilla but being covered by clypei.





**Fig. 21.** *Neophiosphaerella sasicola*. A, B. Ascomata on the natural host surface; C. Ascoma in longitudinal section; D. Ascomatal wall; E. Pseudoparaphyses; F. Ascus; G. Ascospore (arrowheads indicate gelatinous sheath; in India ink). All from KT 1706. Scale bars: A = 1 mm; B = 500  $\mu$ m; C = 100  $\mu$ m; D–G = 10  $\mu$ m.

***Neophiosphaerella sasicola*** (Nagas. & Y. Otani) Kaz. Tanaka & K. Hiray., **comb. nov.** MycoBank MB811312. Fig. 21.

**Basionym:** *Phaeosphaeria sasicola* Nagas. & Y. Otani, Rep. Tottori Mycol. Inst. 15: 39. 1977.

**Specimens examined:** Japan, Hokkaido, Ebetsu, Nopporo, on *Sasa senanensis*, 15 May 1972, E. Nagasawa (holotype of *Phaeosphaeria sasicola* TMI 3176); Hokkaido, Isl. Rebun, Funadomari, Akaiwa, on dead culms of *Sasa kurilensis*, 5 Jun. 2004, K. Tanaka (epitype designated here KT 1706 = HHUF 29443, MBT202864, culture ex-epitype CBS 120247 = JCM 13134 = MAFF 239644).

**Note:** The collection HHUF 29443 is designated as epitype for *N. sasicola*, the type species of *Neophiosphaerella*.

***Setoseptoria*** Quaedvl. *et al.*, Stud. Mycol. 75: 382, 2013.

**Type species:** *Setoseptoria phragmitis* Quaedvl. *et al.*

**Notes:** Quaedvlieg *et al.* (2013) established the genus *Setoseptoria* typified by *S. phragmitis* on *Phragmites*. The sexual morph of this coelomycetous genus is presently unknown.

***Setoseptoria arundinacea*** (Sowerby) Kaz. Tanaka & K. Hiray., **comb. nov.** MycoBank MB811313. Fig. 22.

**Basionym:** *Sphaeria arundinacea* Sowerby, Col. Fig. Engl. Fung. 3: 139, t. 336. 1803.

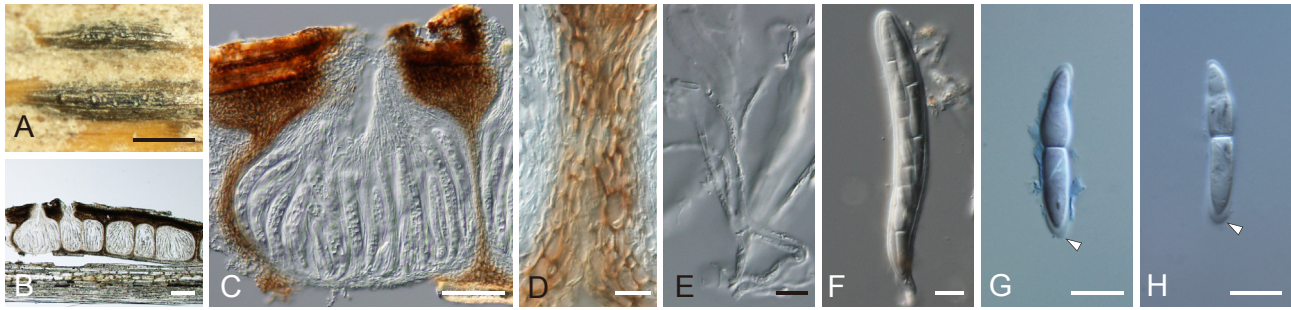
**Specimens examined:** Japan, Aomori, Hirosaki, Sanpinai, on dead culms of *Phragmites australis*, 1 Jul. 2001, K. Tanaka, KT 552 = HHUF 27543, culture MAFF 239460; Aomori, Hirosaki, Kadoke, Oowasawa-river, on dead culms of *Phragmites australis*, 29 Jul. 2001, K. Tanaka, KT 600 = HHUF 27544, culture MAFF 243842.

**Notes:** This species has been placed in various pleosporalean genera, such as *Leptosphaeria* (see Crane & Shearer 1991), *Lophiostoma* (Hyde *et al.* 2002), *Massarina* (Leuchtman 1984), *Metasphaeria* (Vasilyeva 1998), and *Phaeosphaeria* (Hedjaroude 1968). Most recently, it has been transferred to *Lentithecium* based on the results of phylogenetic analyses using SSU + LSU nrDNA and *rpb2* (Zhang *et al.* 2009c).

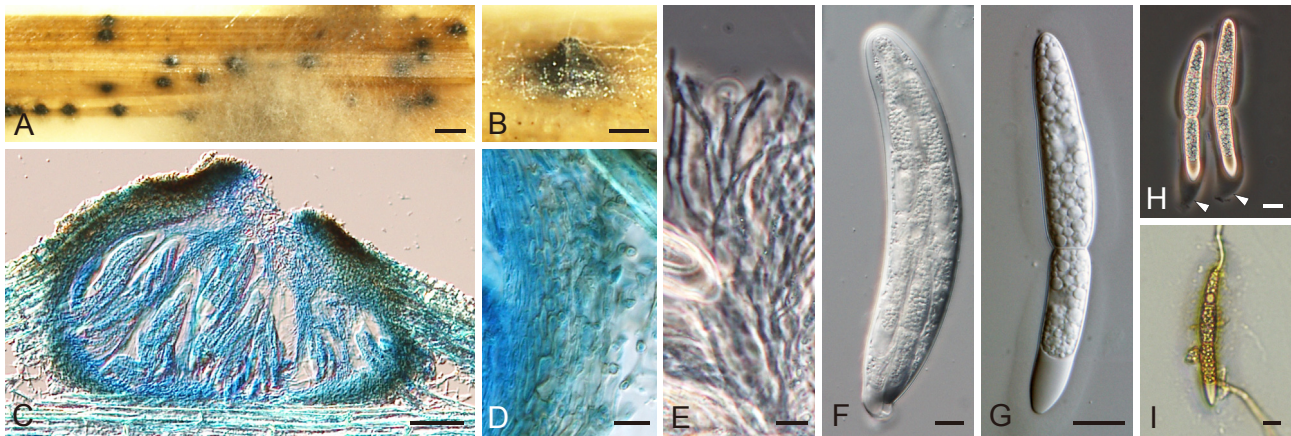
However, later molecular studies (Schoch *et al.* 2009, Shearer *et al.* 2009, Zhang *et al.* 2009b, 2012, Liu *et al.* 2011), as well as our own work (Fig. 1), do not support this placement. This species and its phenotypically and phylogenetically close relative *Massarina magniarundinacea* (Tanaka *et al.* 2004) do not belong to any genera previously suggested. They should, therefore, be transferred to another genus. One candidate genus to accommodate these species would be *Setoseptoria*. The monotypic genus *Setoseptoria* typified by *S. phragmitis* was introduced for a stagonospora-like pycnidial coelomycete with (1–)3-septate, subcylindrical, hyaline conidia (Quaedvlieg *et al.* 2013). The sexual morph of *Setoseptoria* is unknown. In contrast, two massarina-like species, *M. arundinacea* and *M. magniarundinacea*, have been reported to produce only sexual morphs in culture (Lucas 1968, Leuchtman 1984, Tanaka & Harada 2003b, Tanaka *et al.* 2004). Although there is no example of production of stagonospora-like asexual morphs from the massarina-like sexual morphs in culture, congeneric relationships have been suggested several times between *Stagonospora elegans* (Aptroot 1998, Eriksson & Hawksworth 2003) or *S. vexata* (Grove 1935) and *M. arundinacea*, based on their close association on the same host tissue. Furthermore, two stagonospora-like species (*Setoseptoria phragmitis* and “*Stagonospora*” *macropycnidia*) and two massarina-like species (*M. arundinacea* and *M. magniarundinacea*) form a strongly supported clade (Fig. 1) and sequence similarities between these species in the LSU region are considerably higher (826/834 = 99.0 %). We therefore tentatively assign the two massarina-like species to the genus *Setosphaeria*, although asexual morphs of these species are presently unknown. A species with both sexual and asexual morphs will be required to confirm the validity of our generic treatment.

The two isolates of *S. arundinacea* that we examined did not form a clade with *S. arundinacea* from GenBank (Fig. 1). This species has been reported many times as a common species on *Phragmites* culms (Aptroot 1998, Tanaka & Harada 2003b), but *S. arundinacea* may consist of several cryptic species with close morphological resemblance.





**Fig. 22.** *Setoseptoria arundinacea*. A. Surface view of ascomata; B, C. Ascomata in longitudinal section; D. Ascomatal wall; E. Pseudoparaphyses; F. Ascus; G, H. Ascospores (arrowheads indicate gelatinous sheath). All from KT 600. Scale bars: A = 500  $\mu$ m; B = 100  $\mu$ m; C = 50  $\mu$ m; D–H = 10  $\mu$ m.



**Fig. 23.** *Setoseptoria magniarundinacea*. A, B. Surface view of ascomata; C. Ascoma in longitudinal section (in lactophenol cotton blue); D. Ascomatal wall (in lactophenol cotton blue); E. Pseudoparaphyses; F. Ascus; G, H. Ascospores (arrowheads indicate gelatinous sheath); I. Germinating ascospore. A, B, E–H from culture KT 1174; C, D, I from KT 1174. Scale bars: A = 1 mm; B = 500  $\mu$ m; C = 50  $\mu$ m; D–I = 10  $\mu$ m.

***Setoseptoria magniarundinacea*** (Kaz. Tanaka & Y. Harada) Kaz. Tanaka & K. Hiray., **comb. nov.** MycoBank MB811314. Fig. 23.

**Basionym:** *Massarina magniarundinacea* Kaz. Tanaka & Y. Harada, Mycotaxon 90: 349. 2004.

*Ascomata* subglobose to hemispherical with flattened base, 150–280  $\mu$ m high, 310–410  $\mu$ m diam. *Ostiolar neck* central, short papillate. *Ascomatal wall* 12.5–20  $\mu$ m thick at sides. *Pseudoparaphyses* cellular, 1.5–3.5  $\mu$ m wide. *Asci* (119–) 125–182.5(–200)  $\times$  25–35(–47.5)  $\mu$ m (av. 151.5  $\times$  30.2  $\mu$ m,  $n = 37$ ). *Ascospores* 67–82  $\times$  6.5–9  $\mu$ m (av. 74.0  $\times$  7.7,  $n = 50$ ),  $l/w$  8.4–11.0 (av. 9.6,  $n = 50$ ), with a submedian primary septum (0.52–0.57; av. 0.54,  $n = 50$ ).

In culture the ascomatal morph is similar to that observed on the natural host.

**Specimen examined:** Japan, Hokkaido, Akkeshi, Ariake, small stream, on submerged stems of herbaceous plant, 3 Jun. 2003, K. Tanaka & S. Hatakeyama (**holotype** KT 1174 = HHUF 28293, culture **ex-type** CBS 139702 = MAFF 239294).

**Note:** The ascospores of *S. magniarundinacea* are most similar in shape and colour to those of *S. arundinacea*, but are considerably larger (67–82  $\times$  6.5–9  $\mu$ m vs. 23–40  $\times$  3.5–6  $\mu$ m, Tanaka et al. 2004).

***Tingoldiagio*** K. Hiray. & Kaz. Tanaka, Mycologia 102: 740. 2010.

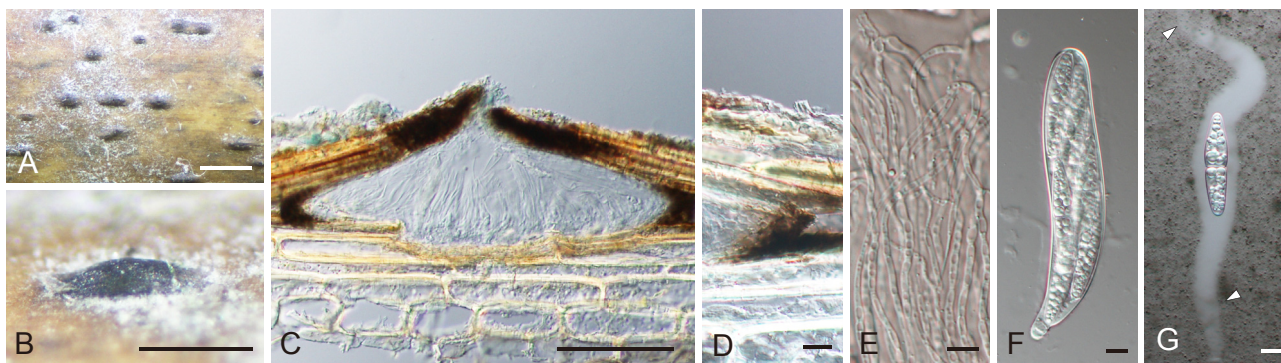
**Type species:** *Tingoldiagio graminicola* K. Hiray. & Kaz. Tanaka.

**Notes:** *Tingoldiagio*, found in freshwater environments, is characterised by lens-shaped ascomata and narrowly fusiform ascospores, each of which has an elongated sheath (Hirayama et al. 2010; Fig. 27). This genus, however, was regarded as a synonym of *Lentithecium*, despite the fact that the *Lentithecium* clade that included *Tingoldiagio* was not well-supported (21%; Zhang et al. 2012). When *Lentithecium* was established, the lenticular ascomata with simple peridial structure and hyaline 1-septate ascospores were emphasised as important characters to define the genus (Zhang et al. 2009c), but this generic circumscription is incorrect (see Notes in *Lentithecium*).

***Tingoldiagio graminicola*** K. Hiray. & Kaz. Tanaka, Mycologia 102: 740. 2010. Fig. 24.

**Specimens examined:** Japan, Hokkaido, Isl. Rishiri, Himenuma (pond), on submerged culms of *Phragmites australis*, 27 Jul. 2007, K. Hirayama & K. Tanaka (**holotype** KH 68 = HHUF 30009, culture **ex-type** JCM 16485 = NBRC 106131); *ibid.*, 25 Jul. 2008, K. Hirayama & K. Tanaka (**paratype** KH 155 = HHUF 30010, culture **ex-paratype** JCM 16486 = NBRC 106132); Aomori, Hirosaki, Kadoke, Oowasawa-river, on submerged culms of *Phragmites japonica*, 28 Sep. 2002, K. Tanaka (**paratype** KT 891 = HHUF 27882, culture **ex-paratype** MAFF 239472).

**Notes:** The morphological features of this species have been described by Hirayama et al. (2010). *Tingoldiagio graminicola* and *Setoseptoria arundinacea*, formerly treated as *Lentithecium* by Zhang et al. (2009c, 2012), have lens-shaped ascomata, but are not in the clade of *Lentithecium* s. str. (Fig. 1). Instead, *Lentithecium* is restricted to species with globose ascomata (Figs 19C, 20C).



**Fig. 24.** *Tingoldiagio graminicola*. A, B. Ascomata on the natural host surface; C. Ascoma in longitudinal section; D. Ascomatal wall; E. Pseudoparaphyses; F. Ascus; G. Ascospore (arrowheads indicate gelatinous sheath; in India ink). A–D, F, G from KH 68; E from culture KT 891. Scale bars: A = 1 mm; B = 500  $\mu$ m; C = 100  $\mu$ m; D–G = 10  $\mu$ m.

**Massarinaceae** Munk, Friesia 5: 305. 1956.

Type genus: *Massarina* Sacc.

**Helminthosporium** Link, Mag. Gesell. naturf. Freunde, Berlin 3(1–2): 10. 1809.

Type species: *Helminthosporium velutinum* Link.

**Notes:** Although more than 700 taxa have been described as species within *Helminthosporium* (<http://www.indexfungorum.org>, Aug. 2015), the genus has been quite heterogeneous. Several unrelated pathogens of the *Poaceae* were segregated from *Helminthosporium* to other genera, i.e., *Bipolaris* (= *Cochliobolus*), *Curvularia* (= *Pseudocochliobolus*), *Exserohilum* (= *Setosphaeria*), and *Pyrenophora* (= *Drechslera*), all of which belong to the *Pleosporaceae* (Sivanesan 1987, Hyde *et al.* 2013). Further distantly related species (e.g., *H. asterinum*) in the *Leotiomyces* were excluded from *Helminthosporium*, and this genus was restricted to species having phylogenetic affinity with the *Massarinaceae* (Olivier *et al.* 2000, Kodsueb *et al.* 2007, Hyde *et al.* 2013).

Little is known about the sexual morphs of *Helminthosporium* s. str. Hughes (1953a) reported that an ascospore isolate of a *Massaria* species found on *Quercus* produced a *Helminthosporium* asexual morph. Subramanian & Sekar (1987) described *Splanchnonema kalakadense* as the sexual morph of *H. velutinum* based on cultural study. However, the validity of the generic classification based on the sexual morphs of these two examples remains unknown. The sexual morph of *H. massarinum* differs from those of *Massaria* (*Massariaceae*; Voglmayr & Jaklitsch 2011) and *Splanchnonema* (*Pleomassariaceae*; Hyde *et al.* 2013) in its ellipsoidal hyaline ascospores, and is rather similar to that of *Massarina*, although *M. eburnea* (the type species of *Massarina*) does not have a hyphomycetous asexual morph like that of *Helminthosporium*.

***Helminthosporium massarinum*** Kaz. Tanaka, K. Hiray. & Shirouzu, **sp. nov.** MycoBank MB811315. Fig. 25.

**Etymology:** Referring to the similarity of the sexual morph with that of the genus *Massarina*.

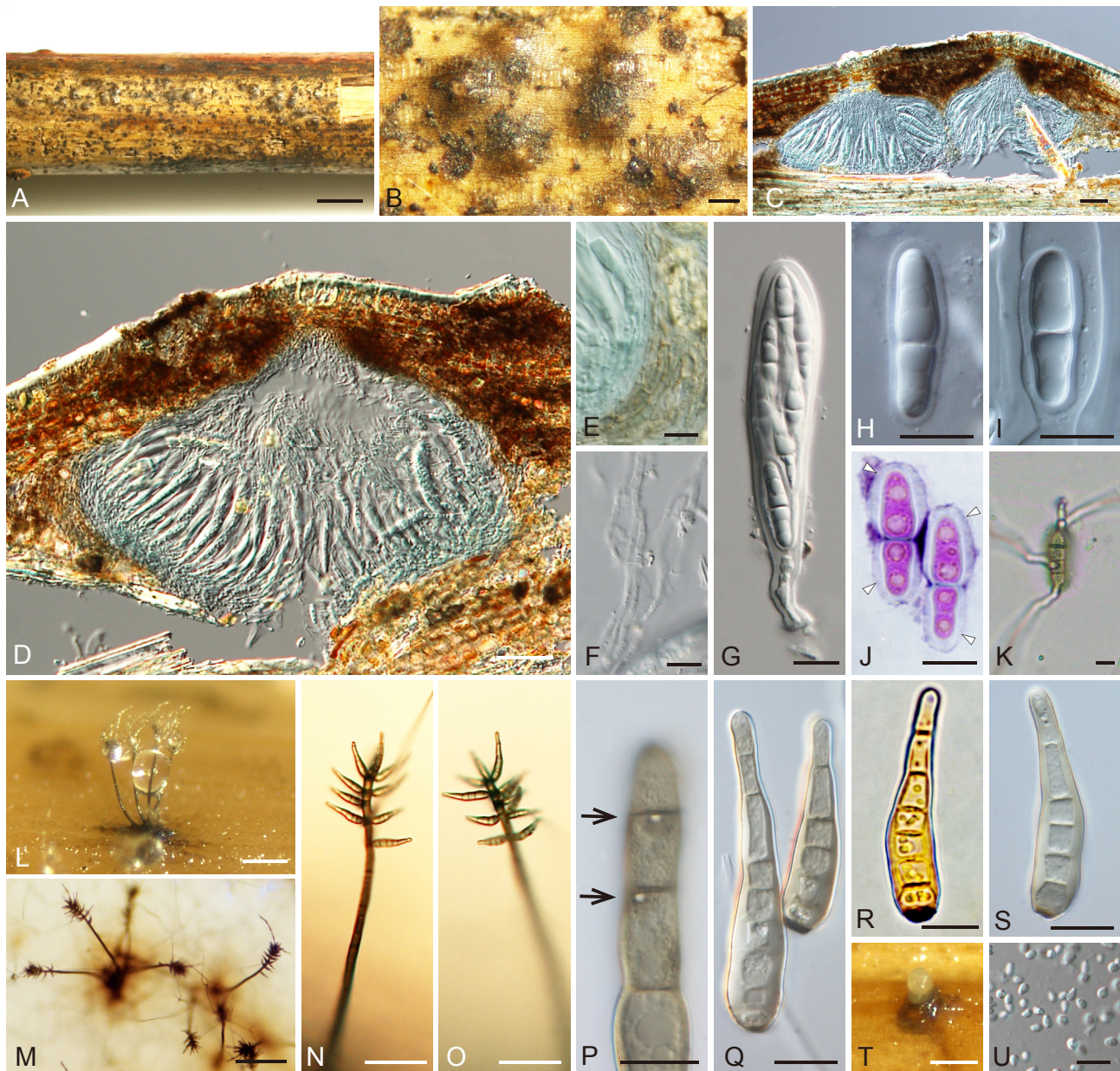
**Ascomata** numerous, scattered to 2–4 grouped, immersed below the host epidermis, hemispherical to subglobose with

somewhat flattened base, 315–390  $\mu$ m high, 300–430  $\mu$ m diam. **Ostiolar neck** central, cylindrical to papillate, 125–165  $\mu$ m long, 75–125  $\mu$ m wide, composed of subglobose, 3–5  $\mu$ m diam, brown cells, surrounded by dark brown clypeus-like structure, without periphyses. **Ascomatal wall** surface of *textura prismatica*, in a longitudinal section 12–18  $\mu$ m wide at sides and base, composed of 5–7 layers of polygonal to rectangular, 5–15  $\times$  2.5–6.5  $\mu$ m, brown cells. **Pseudoparaphyses** cellular, 1.5–3  $\mu$ m wide, septate at 7–16  $\mu$ m long intervals, branched, anastomosed. **Asci** fissitunicate, clavate, 82–135  $\times$  13–16  $\mu$ m (av. 111.0  $\times$  14.8  $\mu$ m, n = 90), rounded at the apex, with a narrow apical chamber and faint ring, short-stalked (7–24  $\mu$ m long; av. 16.7  $\mu$ m, n = 35), with 8 ascospores biseriate above and uniseriate below. **Ascospores** ellipsoidal with rounded ends, mostly straight, 20–25(–27)  $\times$  5–8  $\mu$ m (av. 22.6  $\times$  7.0  $\mu$ m, n = 100), l/w 2.7–3.9 (av. 3.2, n = 100), with a submedian septum (0.50–0.58; av. 0.54, n = 100), constricted at the septum, asymmetric, with wider upper cell, hyaline, guttulate, smooth, with a conspicuous gelatinous sheath of 2–3  $\mu$ m wide in fresh condition (with a delimited firm sheath of 1  $\mu$ m wide in dry condition).

Colonies on PDA (after 4 wk) attaining a diam of 5.5–7.1 cm, white to olivaceous grey; reverse smoke grey to buff; no pigment produced. In culture hyphomycetous asexual morph and spermatial morph formed. **Conidiophores** macronematous, mononematous, 380–810  $\mu$ m long (av. 587  $\mu$ m, n = 20), 7–9  $\mu$ m wide at the apex, 13.5–21  $\mu$ m wide at the base, arising singly or in groups of 4–5 from the stromata, straight or slightly curved, dark brown, guttulate, 15–25-septate at 8–45  $\mu$ m long intervals, with small (ca. 1–2  $\mu$ m diam) pores at the apex and beneath of septa, with thick wall of 1–4  $\mu$ m wide. **Conidia** tretric, solitary or in short chains (5–6), 1–8-septate, 17–56.5  $\times$  5–9  $\mu$ m (av. 37.9  $\times$  7.4  $\mu$ m, n = 95), l/w 2.9–7.5 (av. 5.1, n = 95) [but mostly 4–6-septate, 27–53  $\times$  6–9  $\mu$ m (av. 38.7  $\times$  7.4  $\mu$ m, n = 64), l/w 4.1–6.8 (av. 5.3, n = 64)], obclavate, rostrate, pale brown, smooth, with or without guttules. **Conidia** germinating from both end cells. **Spermogonia** pycnidial, produced under the conidiophores, solitary or gregarious, 100–150(–300)  $\mu$ m diam, subglobose, uniloculate to multiloculate. **Spermatogenous cells** cylindrical, up to 5  $\mu$ m long, appearing phialidic. **Spermatia** 3–4(–5)  $\times$  2–2.5  $\mu$ m (av. 3.5  $\times$  2.2  $\mu$ m, n = 26), globose to subglobose, hyaline, smooth.

**Specimens examined:** Japan, Aomori, Towada, Sanbongi, Yagami, on vines of *Berchemia racemosa*, 15 Dec. 2001, S. Hatakeyama, KT 838 = HHUF 27573, culture JCM 13094 = MAFF 239604; *ibid.*, 23 Nov. 2003, S. Hatakeyama





**Fig. 25.** *Helminthosporium massarinum*. A, B. Ascomata on the natural host surface; C, D. Ascomata in longitudinal section (in lactophenol cotton blue); E. Ascomatal wall (in lactophenol cotton blue); F. Pseudoparaphyses; G. Ascus; H–J. Ascospores (arrowheads indicate gelatinous sheath; J. in Black-Blue ink); K. Germinating ascospore; L–O. Conidiophores; P. Conidiogenous cells (arrows indicate tretic pores); Q–S. Conidia; T. Spermogonium; U. Spermata. A–I, K from KT 1564; J from KT 838; L–U from culture KT 838. Scale bars: A = 2 mm; B, L, M, T = 200 µm; C, D, N, O = 50 µm; E–K, P–S, U = 10 µm.

(holotype KT 1564 = HHUF 29089, culture **ex-type** CBS 139690 = JCM 13095 = MAFF 239605); *ibid.*, KT 1565 = HHUF 29090; *ibid.*, KT 1566 = HHUF 29091; *ibid.*, 2 Dec. 2003, K. Tanaka, S. Hatakeyama & N. Nakagawara, KT 1613–1615 = HHUF 29092–29094.

**Note:** This species is somewhat similar to *H. hypselodelphys* in having solitary or catenate conidia but the latter has smaller conidia ( $15\text{--}28 \times 6.5\text{--}8 \mu\text{m}$ , av.  $25 \times 7.1 \mu\text{m}$ ) (Ellis 1961).

**Massarina** Sacc., Syll. Fung. 2: 153. 1883.

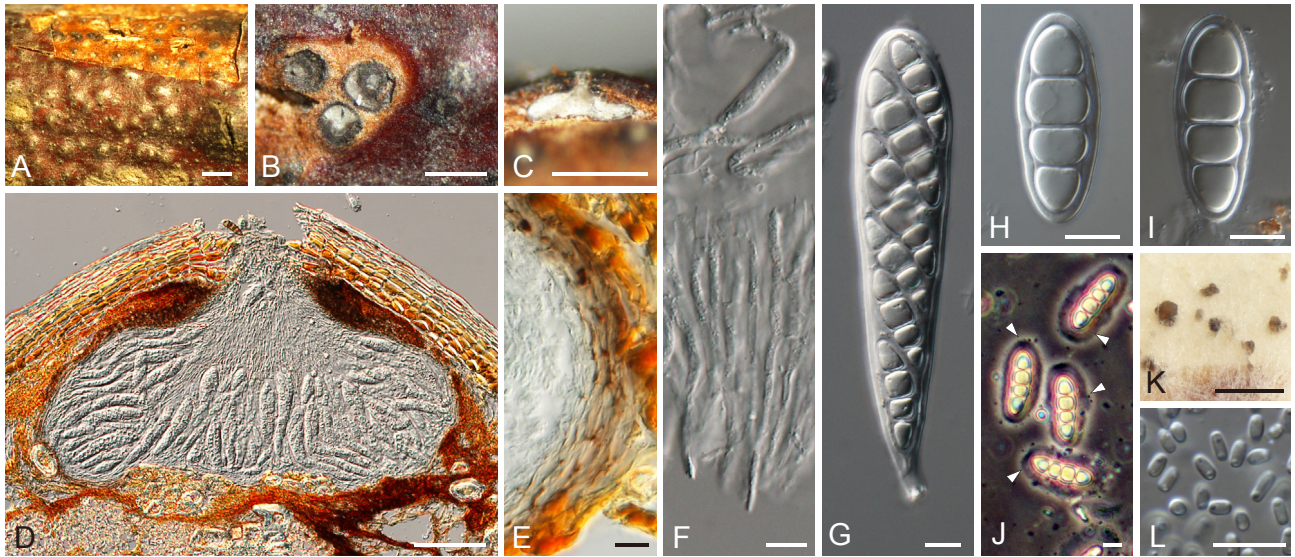
**Type species:** *Massarina eburnea* (Tul. & C. Tul.) Sacc.

**Notes:** Since establishment of the genus (Saccardo 1883), more than 176 taxa have been described within *Massarina* (Index Fungorum; <http://www.indexfungorum.org>, Aug. 2015), but the heterogeneity of the genus has been continuously suggested. Several taxonomic reassessments of many species within

*Massarina* have been attempted based on morphology (Bose 1961, Barr 1992, Hyde 1995, Aptroot 1998, Hyde *et al.* 2002, Tanaka & Harada 2003b). It has more recently been revealed that the genus is highly polyphyletic based on molecular data (Liew *et al.* 2002), and most species in *Massarina* except for the type (*M. eburnea*) have been excluded from the genus. The genera segregated from *Massarina s. lat.* are phylogenetically diverse groups in the *Pleosporales*; *Halomassarina* (*Trematosphaeriaceae*; Suetrong *et al.* 2009), *Lentithecium* and *Tingoldiagio* (*Lentitheciaceae*; Zhang *et al.* 2009c, Hirayama *et al.* 2010), *Lindgomyces* (*Lindgomycetaceae*; Hirayama *et al.* 2010), *Morosphaeria* (*Morosphaeriaceae*; Suetrong *et al.* 2009), and *Triplosphaeria* (*Tetraplosphaeriaceae*; Tanaka *et al.* 2009).

**Massarina eburnea** (Tul. & C. Tul.) Sacc., Syll. Fung. 2: 153. 1883. Fig. 26.





**Fig. 26.** *Massarina eburnea*. A, B. Ascomata on the natural host surface; C. Side view of ascoma; D. Ascoma in longitudinal section; E. Ascomatal wall; F. Pseudoparaphyses; G. Ascus; H–J. Ascospores (arrowheads indicate gelatinous sheath); K. Spermogonia in culture; L. Spermatia. A–J from H 3953; K, L from culture H 3953. Scale bars: A = 1 mm; B, C, K = 500  $\mu$ m; D = 100  $\mu$ m; E–J, L = 10  $\mu$ m.

**Basionym:** *Massaria eburnea* Tul. & C. Tul., *Select. Fung. Carpol.* 2: 239. 1863.

**Ascomata** scattered to 2–4 grouped, immersed, hemispherical with flattened base or depressed globose, 300–420  $\mu$ m high, 570–680  $\mu$ m diam. **Ostiole** neck short papillate, 60–90  $\mu$ m long, central, with black clypeus (250–400  $\mu$ m wide). **Ascomatal wall** 12–18  $\mu$ m thick at sides, composed of 3–5 layers of thin-walled prismatic cells (5–12.5  $\times$  2–4  $\mu$ m). **Pseudoparaphyses** numerous, cellular, 2–3(–4.5)  $\mu$ m wide. **Asci** fissitunicate, clavate, (110–)120–180  $\times$  21.5–30  $\mu$ m (av. 141.6  $\times$  25.6  $\mu$ m,  $n = 50$ ), with a stipe of 12.5–25  $\mu$ m long (av. 18.6  $\mu$ m,  $n = 38$ ). **Ascospores** broadly fusiform with rounded ends, 34–40  $\times$  12–15(–16)  $\mu$ m (av. 37.2  $\times$  13.9  $\mu$ m,  $n = 50$ ); including firm sheath of 1–2  $\mu$ m thick, l/w 2.5–2.9 (av. 2.7,  $n = 50$ ), 3-septate (primary septum submedian: 0.51–0.55, av. 0.53,  $n = 50$ ), hyaline, smooth, with a sharply delimited firm sheath of 1–2  $\mu$ m thick (but up to 6  $\mu$ m thick when fresh).

**Specimen examined:** UK, Wales, Swansea, dead twigs of *Fagus sylvatica*, Apr. 2001, H 3953 = HHUF 26621, culture CBS 139697 = JCM 14422.

**Notes:** The morphological characteristics of the above specimen fit well with those in the description of *M. eburnea* (Hyde 1995). A pycnidial morph of *M. eburnea* reported as *Ceratophoma* sp. (Bose 1961, Sivanesan 1984) was observed in our isolate, but the “conidia” did not germinate on several agar media (e.g., water agar, PDA, CMA, and MEA) over 7 d. The *Ceratophoma* morph is therefore considered to be spermatial in function.

***Stagonospora*** (Sacc.) Sacc., *Syll. Fung.* 3: 445. 1884.

**Type species:** *Stagonospora paludosa* (Sacc. & Speg.) Sacc.

**Notes:** *Stagonospora* has been defined morphologically based on a broad generic concept (Sutton 1980) and has been believed to have phylogenetic affinities with the *Phaeosphaeriaceae* (Zhang *et al.* 2012). However, in a comprehensive phylogenetic study on *Stagonospora* and morphologically similar genera,

Quaedvlieg *et al.* (2013) revealed that *Stagonospora* is polyphyletic and *Stagonospora s. str.* (based on *S. paludosa*) belongs to the *Massarinaceae*. Several new genera, such as *Neostagonospora* and *Parastagonospora*, have been established to accommodate unrelated stagonospora-like species in the *Phaeosphaeriaceae* (Quaedvlieg *et al.* 2013).

*Neottiosporina*, typified by *N. apoda* (Subramanian 1961) may have phylogenetic relationships with *Stagonospora*, although phylogenetic placement of the type species has not been clarified. At least *N. paspali*, transferred from *Stagonospora* to *Neottiosporina* (Sutton & Alcorn 1974), should be regarded within *Stagonospora*, because this taxon has close morphological and phylogenetic affinity to *Stagonospora* species (Fig. 1).

***Stagonospora bicolor*** (D. Hawksw. *et al.*) Kaz. Tanaka & K. Hiray., **comb. nov.** MycoBank MB811316.

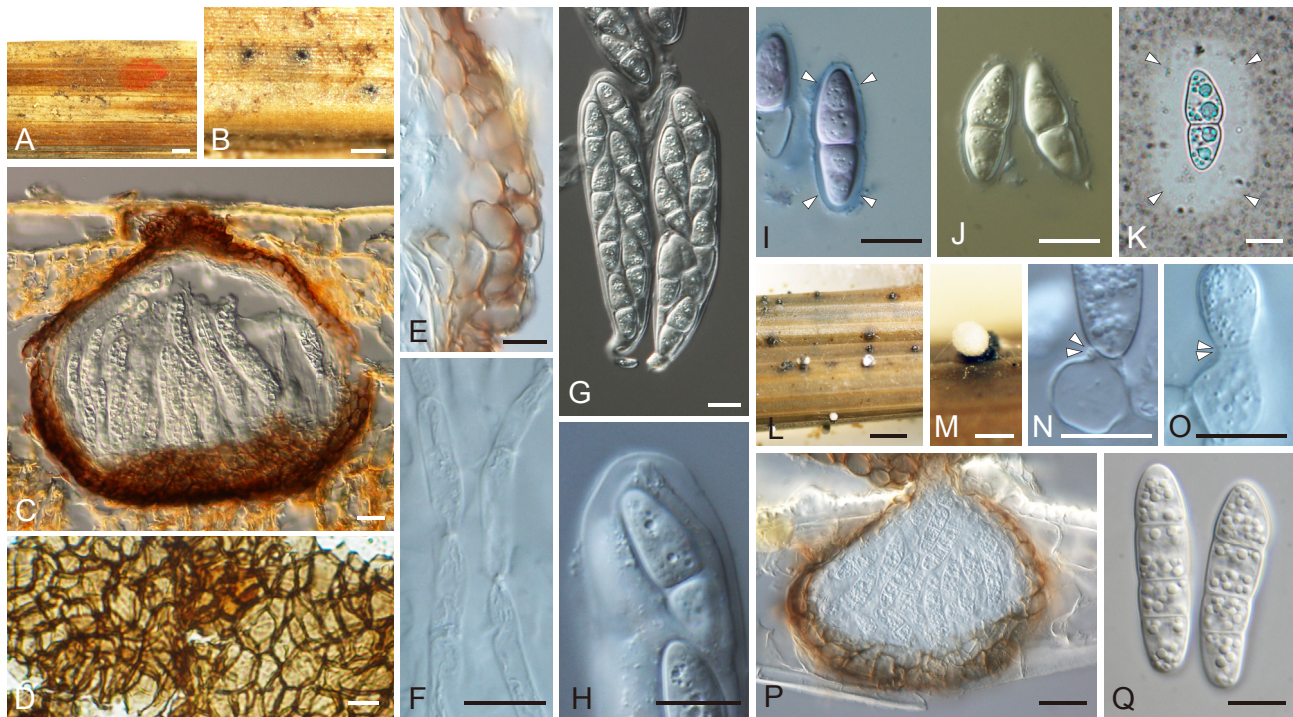
**Basionym:** *Leptosphaeria bicolor* D. Hawksw. *et al.*, *Mycologia* 71: 483. 1979.

$\equiv$  *Saccharicola bicolor* (D. Hawksw. *et al.*) D. Hawksw. & O.E. Erikss., *Mycologia* 95: 431. 2003.

**Notes:** Although we did not observe any material of this species, the illustration in the original description of *Leptosphaeria bicolor* (Kaiser *et al.* 1979), as well as SSU (GenBank U04202) and ITS (GenBank U04203) sequences derived from the type culture (ATCC 42652) of this species clearly indicates that it is a member of *Stagonospora*, as recently circumscribed by Quaedvlieg *et al.* (2013). Based on *L. bicolor*, Eriksson & Hawksworth (2003) erected *Saccharicola* for leptosphaeria-like species on sugarcane, but *Saccharicola* should be regarded as a synonym of *Stagonospora*. The sexual morph of *Stagonospora s. str.* has been referred to as didymella-like (Quaedvlieg *et al.* 2013), and some species of *Didymella* with a stagonospora-like asexual morph (e.g., *D. proximella* on *Carex*; Corlett & Smith 1978) may have phylogenetic affinity with *Stagonospora s. str.* based on their morphologies.

***Stagonospora perfecta*** Quaedvlieg *et al.*, *Stud. Mycol.* 75: 378. 2013. Fig. 27.





**Fig. 27.** *Stagonospora perfecta*. A, B. Ascomata on the natural host surface; C. Ascoma in longitudinal section; D. Ascomatal wall in surface view; E. Ascomatal wall at side; F. Pseudoparaphyses; G. Asci; H. Apex of ascus; I–K. Ascospores (arrowheads indicate gelatinous sheath; I. in Black-Blue ink; K. in India ink); L, M. Conidiomata in culture (on rice straw); N, O. Conidiogenous cells (arrowheads indicate annellations); P. Conidioma in longitudinal section; Q. Conidia. A–K from KT 1726; L–Q from culture KT 1726. Scale bars: A, L = 1 mm; B, M = 200  $\mu$ m; C, P = 20  $\mu$ m; D–K, N, O, Q = 10  $\mu$ m.

*Ascomata* scattered, immersed, globose to subglobose in section, 160–220  $\mu$ m high, 140–250  $\mu$ m diam. *Ostiolar neck* central, papillate to short cylindrical, 37–50  $\mu$ m long, 52–75(–100)  $\mu$ m wide. *Ascromatal wall* in longitudinal section uniformly 12–20  $\mu$ m thick, composed of 4–6 layers of polygonal to subglobose, brown cells of 5–20  $\times$  3.5–10  $\mu$ m. *Pseudoparaphyses* cellular, septate, branched and anastomosed, 2.5–4  $\mu$ m wide. *Asci* fissitunicate, cylindrical, 75–115  $\times$  15–20.5  $\mu$ m (av. 89.8  $\times$  17.5  $\mu$ m, n = 30), rounded at the apex and with a shallow ocular chamber, short-stalked (7–14.5  $\mu$ m long), with 8 biseriolate ascospores. *Ascospores* broadly fusiform, 20–28  $\times$  6.5–11  $\mu$ m (av. 23.4  $\times$  8.3  $\mu$ m, n = 50), l/w 2.3–3.3 (av. 2.8, n = 50), with a submedian septum (0.54–0.59; av. 0.56, n = 50), constricted at the septum, hyaline, smooth, with an entire sheath; sheath gelatinous, 2–7  $\mu$ m, staining with Black-Blue ink when in fresh condition, delimited and 1–3  $\mu$ m wide when in dry condition.

In culture both sexual and asexual morphs formed. *Conidiomata* pycnidial, 80–100  $\mu$ m high, 100–120  $\mu$ m diam, scattered, globose in section. *Conidiomatal wall* in longitudinal section uniformly 6–13  $\mu$ m wide, composed of 3–4 layers of polygonal, thin-walled, 7–17  $\times$  2.5–6  $\mu$ m, pale brown cells. *Conidiophores* absent. *Conidiogenous cells* annellidic, cylindrical to subglobose, 8–17  $\times$  5–9  $\mu$ m. *Conidia* cylindrical, 3(–5)-septate, hyaline, smooth, (25–)27–37(–48)  $\times$  8–11  $\mu$ m (av. 32.9  $\times$  9.5  $\mu$ m, n = 60), l/w 2.7–4.1(–5.1) (av. 3.5, n = 60), without sheath. Ascospores in culture slightly larger than those on the natural host, 27–33  $\times$  10–12  $\mu$ m.

*Specimen examined:* Japan, Hokkaido, Isl. Rebun, Funadomari, Kusyuko (pond), on dead leaves of *Carex* sp., 3 Jun. 2004, K. Tanaka, KT 1726A = HHUF 29095, culture JCM 13099 = MAFF 239609.

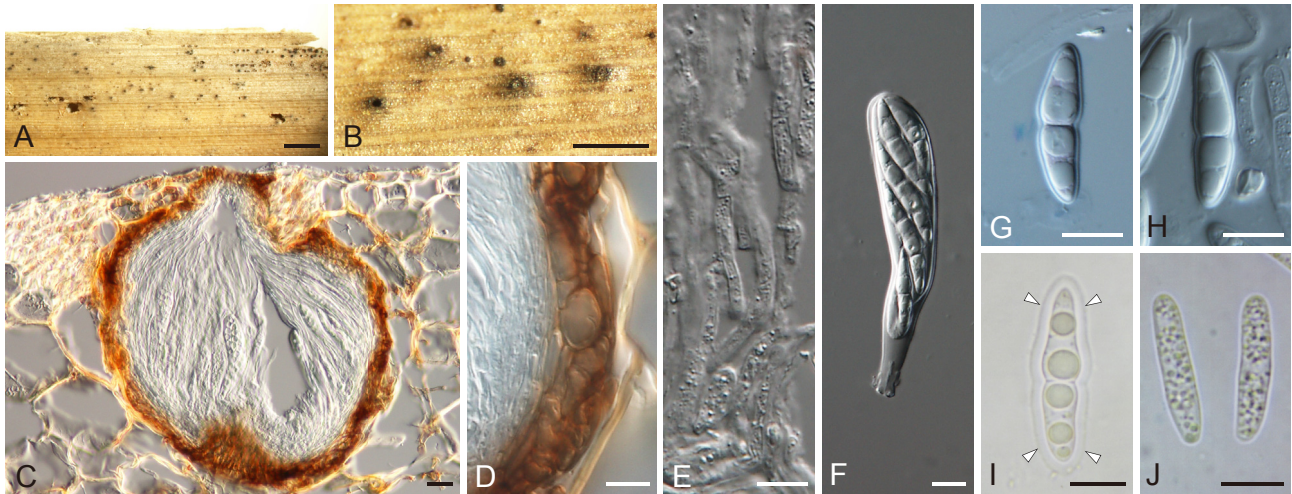
*Notes:* The characteristics of the above material match those in the original description of *S. perfecta* described from *Carex acutiformis* in the Netherlands (Quaedvlieg et al. 2013), except that the conidia in our material were wider (8–11  $\mu$ m vs. 6–8  $\mu$ m). LSU and ITS sequences obtained from our material and those from the ex-type of *S. perfecta* (GenBank LSU: KF251761, ITS: KF251258) were identical. The sexual morph of this species has been referred to as didymella-like (Quaedvlieg et al. 2013), and fits well with the generic concept of *Saccharicola* (Eriksson & Hawksworth 2003), but this genus should be synonymised under the older genus *Stagonospora* (Saccardo 1884).

***Stagonospora pseudoperfecta*** Kaz. Tanaka & K. Hiray., *sp. nov.* MycoBank MB811317. Fig. 28.

*Etymology:* After its morphological similarity to *Stagonospora perfecta*.

*Ascomata* scattered, immersed, globose in section, 200–250  $\mu$ m high, 210–260  $\mu$ m diam. *Ostiolar neck* central, papillate, 35–63  $\mu$ m long, 63  $\mu$ m wide. *Ascromatal wall* in longitudinal section uniformly 10–15  $\mu$ m thick, composed of 3–5 layers of polygonal to subglobose, brown cells of 6–16.5  $\times$  3.5–11.5  $\mu$ m. *Pseudoparaphyses* cellular, numerous, 3–6  $\mu$ m wide, septate, branched, anastomosed. *Asci* fissitunicate, clavate, 66–100  $\times$  13.5–17.5  $\mu$ m (av. 86.3  $\times$  15.4  $\mu$ m, n = 20), rounded at apex and with a shallow apical chamber, short-stalked (7–17.5  $\mu$ m long), with 8 irregularly biseriolate to triseriate ascospores. *Ascospores* narrowly fusiform, straight or slightly curved, 21–30.5  $\times$  5–7  $\mu$ m (av. 26.0  $\times$  5.7  $\mu$ m, n = 40), l/w 3.3–5.9 (av. 4.6, n = 40), with submedian septum (0.50–0.57, av. 0.54, n = 40), slightly constricted at the septum, hyaline, with or without guttules, smooth, with an entire sheath; sheath gelatinous, 0.5–2  $\mu$ m wide at side.





**Fig. 28.** *Stagonospora pseudoperfecta*. A, B. Ascomata on the natural host surface; C. Ascoma in longitudinal section; D. Ascomatal wall; E. Pseudoparaphyses; F. Ascus; G–I. Ascospores (arrowheads indicate gelatinous sheath); J. Conidia. A–I from KT 889; J from culture KT 889. Scale bars: A = 2 mm; B = 500  $\mu$ m; C = 20  $\mu$ m; D–J = 10  $\mu$ m.

Colonies on PDA (after 2 wk) attaining a diam of 4.9–5.5 cm, white; reverse sepia to fuscous black; no pigment produced. In culture asexual morph formed. *Conidiomata* pycnidial. *Conidia* cylindrical, aseptate, hyaline, 21.5–26  $\times$  4–5.5  $\mu$ m (av. 24.1  $\times$  4.9  $\mu$ m, n = 10), l/w 4.6–5.8 (av. 5.0, n = 10).

*Specimens examined:* **Japan**, Aomori, Hirosaki, Kadoke, Oowasawa-river, riverbank (Horikoshi-bridge), on dead leaves of *Typha latifolia*, 8 Sep. 2002, K. Tanaka (**holotype** KT 889 = HHUF 29087, culture **ex-type** CBS 120236 = JCM 13097 = MAFF 239607); *ibid.*, KT 888 = HHUF 29086.

*Notes:* Eight species are currently accepted in *Stagonospora* s. str. based on molecular evidence (Crous *et al.* 2013b, 2014b, Quaedvlieg *et al.* 2013). *Stagonospora pseudoperfecta* is similar to *S. perfecta*, but has slightly longer and more slender ascospores (l/w 4.6 vs. 2.8). In terms of overall morphology and host preference, *S. pseudoperfecta* superficially resembles “*Massarina lacustris sensu Leuchtman (1984)* (non *Wettsteinina lacustris sensu Shoemaker & Babcock 1989*, or *Khashnobish & Shearer 1993*) reported from *Typha* and *Schoenoplectus*. However, molecular data (SSU, *rpb2*, *tef1*) obtained from a strain studied by Leuchtman (CBS 618.86) suggests that the latter fungus is a member of the *Lentitheciaceae* (Schoch *et al.* 2009). In ITS analysis with other *Stagonospora* species (data not shown), *S. pseudoperfecta* positioned as a sister taxon to *S. duoseptata*, but similarity between the two taxa in this region was 95.2 % (452/475) with 1.3 % (6/475) gaps.

In culture, pycnidial conidiomata with cylindrical hyaline conidia were observed only once, but this may have been an immature condition because the conidia were aseptate and smaller (Fig. 28J). Unfortunately, the asexual morph in culture failed to be observed again, despite several attempts.

***Stagonospora tainanensis*** W.H. Hsieh, *Mycologia* 71: 893. 1979. Fig. 29.

*Asci* ovoid to cylindrical, 102–122.5  $\times$  26.5–32.5  $\mu$ m, 8-spored. *Ascospores* fusiform, 36–44  $\times$  8.5–12  $\mu$ m, l/w 3.6–4.7, with a submedian septum (0.53–0.56), hyaline, smooth, with an entire sheath (2–5  $\mu$ m wide when fresh, 1–2  $\mu$ m wide when dry).

In culture, both sexual and asexual morphs formed. *Ascospores* 32–40  $\times$  10.5–13  $\mu$ m, l/w 2.8–3.2, with a submedian septum (0.54–0.56). *Conidia* ellipsoid, 37–48(–55)  $\times$  12–13(–15)  $\mu$ m, l/w 3.0–3.8, 3-septate, hyaline.

*Specimen examined:* **Japan**, Kagoshima, Isl. Yakushima, Nunobikinotaki park, on dead leaves of herbaceous plant, 19 Oct. 2005, K. Tanaka & T. Hosoya, KT 1866 = HHUF 30141, culture MAFF 243860.

*Notes:* The ITS sequence from this material is identical with the sequence (GenBank AF439464) of *Stagonospora taiwanensis* obtained from the ex-type culture (ATCC 38204; Hsieh 1979), and two ITS sequences (GenBank AF439462, AF439463) of *Saccharicola taiwanensis* on *Saccharum*. An unnamed “*Saccharicola*” on *Miscanthus* (O’Neill & Farr 1996), a grass genus related to *Saccharum*, is also considered to be conspecific, because these have identical ITS sequences (GenBank AF439467; Câmara *et al.* 2002) and morphological similarities (O’Neill & Farr 1996). Morphologically, our specimen agrees with the previous description of this species (as *Leptosphaeria taiwanensis*; Hsieh 1979, Sivanesan 1984, Sivanesan & Waller 1986), but the large ascospores reported by Shoemaker & Babcock (1989) were not observed.

**Morosphaeriaceae** Suetrong *et al.*, *Stud. Mycol.* 64: 161. 2009.

*Type genus:* *Morosphaeria* Suetrong *et al.*

***Aquilomyces*** D.G. Knapp *et al.*, *Persoonia* 35: 93. 2015.

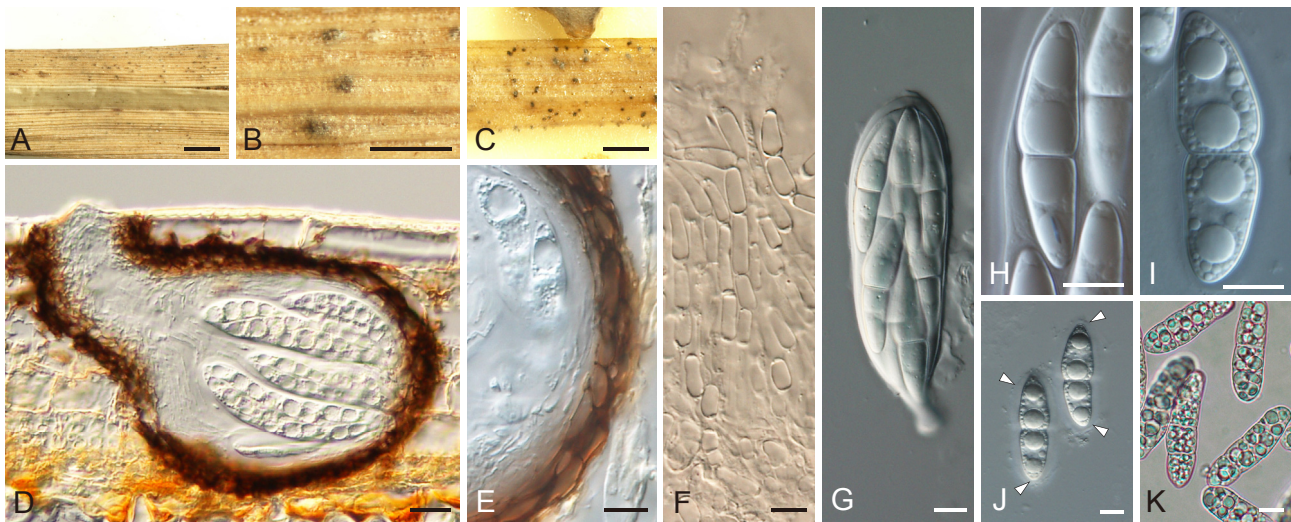
*Type species:* *Aquilomyces patris* D.G. Knapp *et al.*

*Notes:* *Aquilomyces* was erected by Knapp *et al.* (2015) to accommodate *A. patris*, a root endophyte of white poplar. There was no morphological information of this genus, because no fructifications were observed for *A. patris*.

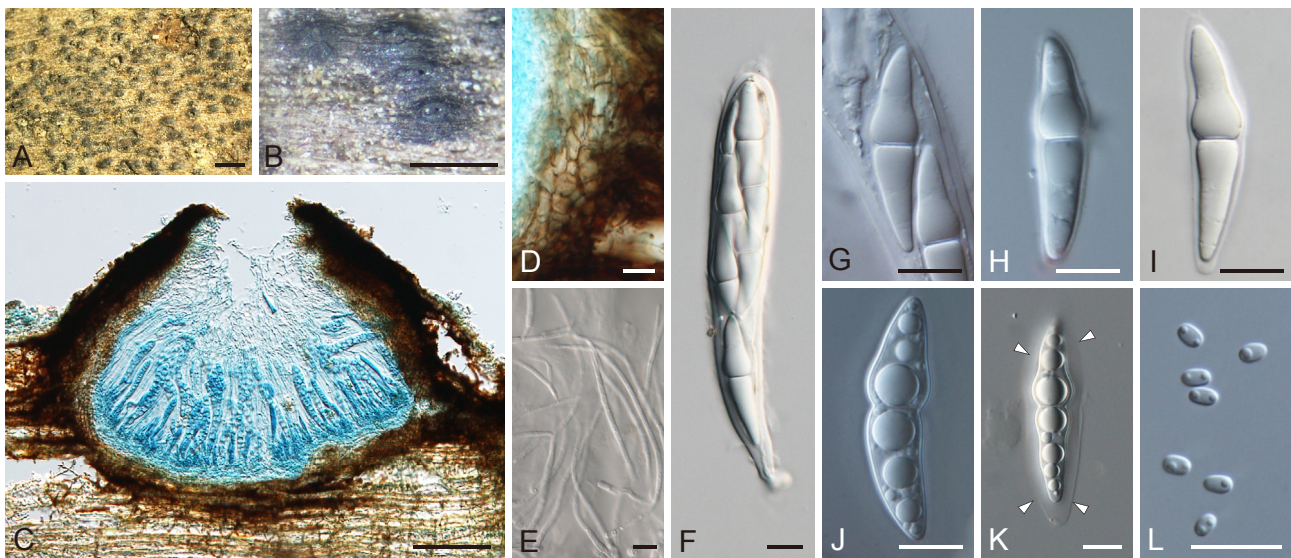
***Aquilomyces rebunensis*** Kaz. Tanaka & K. Hiray., **sp. nov.** MycoBank MB811322. Fig. 30.

*Etymology:* After the locality where this fungus was collected.





**Fig. 29.** *Stagonospora tainanensis*. A, B. Ascomata on the natural host surface; C. Ascomata and conidiomata in culture (on rice straw); D. Ascma in longitudinal section; E. Ascumatal wall; F. Pseudoparaphyses; G. Ascus; H–J. Ascospores (arrowheads indicate gelatinous sheath); K. Conidia. A, B, D, E, G, H from KT 1866; C, F, I–K from culture KT 1866. Scale bars: A, C = 2 mm; B = 500  $\mu$ m; D = 20  $\mu$ m; E–K = 10  $\mu$ m.



**Fig. 30.** *Aquilomyces rebunensis*. A, B. Ascomata on the natural host surface; C. Ascma in longitudinal section (in lactophenol cotton blue); D. Ascumatal wall; E. Pseudoparaphyses; F. Ascus; G–K. Ascospores (arrowheads indicate gelatinous sheath); L. Spermatia. A–D, F–I from KT 732; E, J–L from culture KT 732. Scale bars: A = 1 mm; B = 500  $\mu$ m; C = 100  $\mu$ m; D–L = 10  $\mu$ m.

*Ascomata* subglobose, 350–550  $\mu$ m high, (430–)600–700  $\mu$ m diam, covered with numerous brown hyphae of 2–3  $\mu$ m thick. *Ostiole* neck terete, central, 85–130  $\mu$ m long, 75–130  $\mu$ m wide, clypeate, with periphyses, composed of carbonaceous polygonal cells of 5–10  $\times$  3–5  $\mu$ m. *Ascumatal wall* at side wedge-shaped, up to 125  $\mu$ m thick, composed of vertically orientated angular brown cells (5–8  $\times$  2–5  $\mu$ m); wall at the base 25–50  $\mu$ m thick, composed of 3–8  $\mu$ m diam, subglobose, brown cells. *Pseudoparaphyses* branched and anastomosed, septate, 1.5–2  $\mu$ m wide. *Asci* fissitunicate, cylindrical to clavate, 97.5–147.5  $\times$  15–21  $\mu$ m (av. 121.3  $\times$  18.3  $\mu$ m, n = 45), with a short stipe of 7.5–25(–37.5)  $\mu$ m (av. 18.0  $\mu$ m, n = 34). *Ascospores* fusiform, slightly curved, 30–38.5  $\times$  6.5–11.5  $\mu$ m (av. 35.1  $\times$  8.6  $\mu$ m, n = 50), l/w 3.3–5.0(–5.6) (av. 4.2, n = 50), with a suprmedian septum (0.44–0.50; av. 0.47, n = 57), hyaline, smooth, with a sheath of 1–2  $\mu$ m wide.

Colonies on PDA (after 4 wk) attaining a diam of 4.3–4.6 cm, pale olivaceous grey with white margin; reverse black to

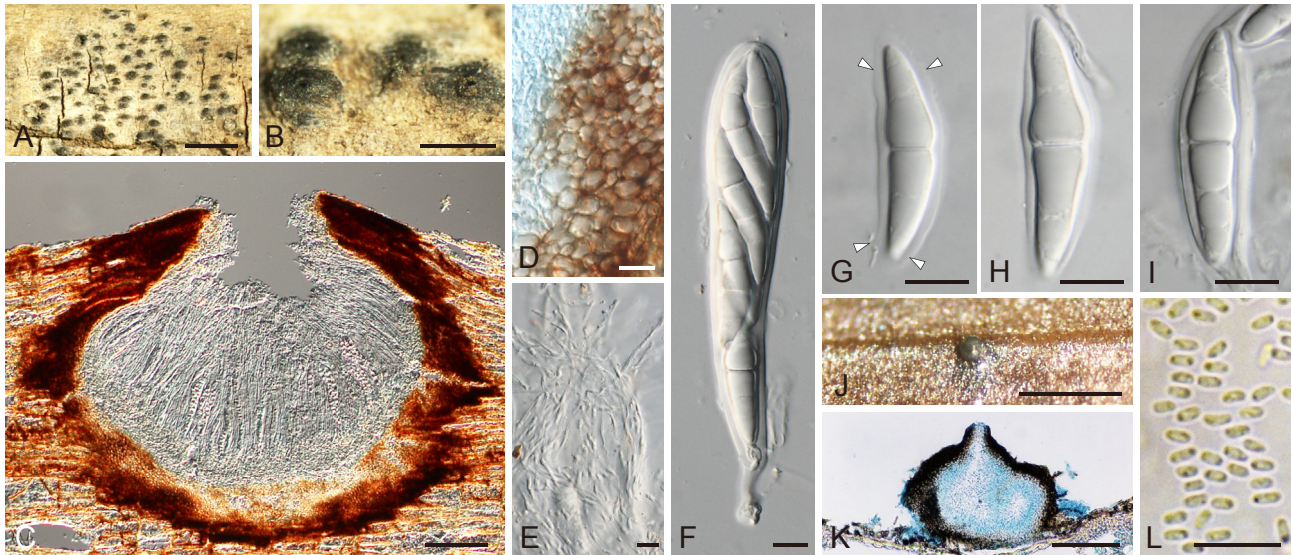
olivaceous grey; no pigment produced. In culture spermatial and ascumatal morphs formed. *Spermatia* 2–3  $\times$  1.5–1.8  $\mu$ m, subglobose to oblong. *Ascospores* slightly larger than those found on nature, 35–48  $\times$  8–11  $\mu$ m (av. 39.7  $\times$  9.3  $\mu$ m, n = 25).

*Specimen examined:* Japan, Hokkaido, Isl. Rebun, Kafuka, Nairo-river, on submerged twigs of woody plant, 30 Aug. 2001, K. Tanaka (**holotype** KT 732-2 = HHUF 27556, culture **ex-type** CBS 139684 = JCM 19427 = MAFF 243862).

*Notes:* We tentatively describe this aquatic fungus as *Aquilomyces* based on our molecular results. Phylogenetic analysis showed that *A. patris*, the type species of *Aquilomyces*, and *A. rebunensis* clustered into a distinct and moderately-supported clade (85 %, Fig. 1). Sequence similarities between these two taxa were 97.7 % (858/878) with 2.3 % gaps (20/878) in LSU and 95.4 % (576/604) with 0.7 % gaps (4/604) in ITS, suggesting that they are congeneric.

***Clypeolocolus*** Kaz. Tanaka & K. Hiray., **gen. nov.** MycoBank MB811318.





**Fig. 31.** *Clypeoloculus akitaensis*. A, B. Ascomata on the natural host surface; C. Ascus in longitudinal section; D. Ascomatal wall; E. Pseudoparaphyses; F. Ascus; G–I. Ascospores (arrowheads indicate gelatinous sheath); J. Spermatium in culture (on rice straw); K. Spermatium in longitudinal section (in lactophenol cotton blue); L. Spermatia. A–I from KT 788; J–L from culture KT 788. Scale bars: A = 2  $\mu\text{m}$ ; B, J = 500  $\mu\text{m}$ ; C, K = 100  $\mu\text{m}$ ; D–I, L = 10  $\mu\text{m}$ .

**Etymology:** Referring to the morphology of the ascomata covered by clypeus.

**Ascomata** scattered to 2–3 grouped, immersed to erumpent, subglobose or hemispherical with flattened base in section, covered with numerous brown hyphae around ascomata. **Ostiolar neck** terete to papillate, central, clypeate, composed of carbonaceous cells. **Ascomatal wall** wedge-shaped or “rim-like” at sides. **Pseudoparaphyses** septate, branched and anastomosed. **Asci** fissitunicate, clavate, with a short stipe, 8-spored. **Ascospores** narrowly fusiform, slightly curved, with a primary septum median to suprmedian, constricted at the septum, hyaline, smooth, surrounded by an entire gelatinous sheath. Asexual morph unknown.

**Type species:** *Clypeoloculus akitaensis* Kaz. Tanaka & K. Hiray.

**Notes:** A new genus, *Clypeoloculus*, is proposed here for freshwater species having globose to subglobose ascomata with prominent clypeus, clavate asci, and 1-septate, hyaline ascospores with an entire sheath. These morphological characters fit with the broad generic concept of *Massarina* (Aptroot 1998, Tanaka & Harada 2003b), but *Clypeoloculus* can be distinguished from *Massarina* s. str. by the ascomata with wedge-shaped or “rim-like” ascomatal wall and narrowly fusiform ascospores. Furthermore, species in *Clypeoloculus* are located in the *Morosphaeriaceae* clade and are distantly related to *M. eburnea*, the type species of *Massarina* (*Massarinaceae*; Fig. 1).

***Clypeoloculus akitaensis*** Kaz. Tanaka & K. Hiray., sp. nov. MycoBank MB811319. Fig. 31.

**Etymology:** Referring to the location where the specimen was collected.

**Ascomata** scattered to 2–3 grouped, immersed to erumpent, globose to subglobose in section, 400–550  $\mu\text{m}$  high, 580–720  $\mu\text{m}$  diam, covered with numerous brown hyphae around ascomata. **Ostiolar neck** terete, central, clypeate,

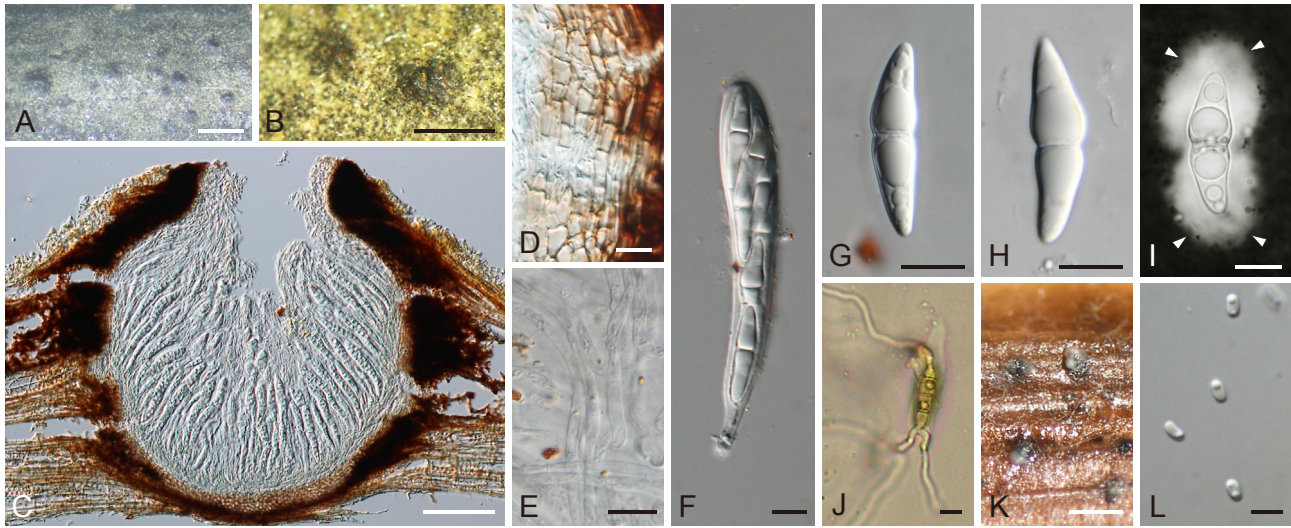
composed of carbonaceous cells. **Ascomatal wall** in longitudinal section 37–100  $\mu\text{m}$  wide at sides and base, composed of subglobose to globose, thick-walled, 2.5–10  $\mu\text{m}$  diam, brown cells. **Pseudoparaphyses** septate, branched and anastomosed, 2–2.5  $\mu\text{m}$  wide. **Asci** fissitunicate, clavate, (95–) 110–155  $\times$  17.5–27.5  $\mu\text{m}$  (av. 125.1  $\times$  20.9  $\mu\text{m}$ ,  $n = 30$ ), with a short stipe of (7.5–)12–27.5(–30)  $\mu\text{m}$  (av. 19.4  $\mu\text{m}$ ,  $n = 26$ ) long, with 8 biseriolate ascospores. **Ascospores** narrowly fusiform, slightly curved, 33.5–43  $\times$  7–10  $\mu\text{m}$  (av. 38.7  $\times$  8.6  $\mu\text{m}$ ,  $n = 50$ ),  $l/w$  3.8–5.2 (av. 4.5,  $n = 50$ ), with a primary septum suprmedian (0.44–0.50; av. 0.48,  $n = 47$ ), constricted at the septum, hyaline, smooth, surrounded by an entire gelatinous sheath, 1.5–3  $\mu\text{m}$  wide.

Colonies on PDA (after 4 wk) attaining a diam of 2.0–2.2 cm, greenish grey; reverse black to smoke grey; no pigment produced. Spermatial morph observed in culture. **Spermatia** oblong, hyaline, 2.8–4  $\times$  1.3–1.9  $\mu\text{m}$  (av. 3.3  $\times$  1.7  $\mu\text{m}$ ,  $n = 30$ ).

**Specimen examined:** Japan, Akita, Kisakata, Akagawa-river, riverbank, on submerged twigs of woody plant, 23 Sep. 2001, K. Tanaka (holotype KT 788 = HHUF 27557, culture ex-type CBS 139681 = JCM 19424 = MAFF 239467).

**Notes:** In ascospore dimensions, *C. akitaensis* (av. 38.7  $\times$  8.6  $\mu\text{m}$ ) is most similar to *C. towadaensis* (av. 38.7  $\times$  8.7  $\mu\text{m}$ ), but the latter species has hemispherical ascomata with flattened bases and longer asci [(112–)120–170  $\mu\text{m}$  long]. In the ITS sequences of these two species, there were differences at 29 positions.

Tanaka & Harada (2003b) reported this fungus as *Massarina peerallyi* (Hyde & Aptroot 1998). However, our re-examination of *M. peerallyi* based on its holotype [HKU (M) 2409] revealed that they are distinct species, because *M. peerallyi* has broader asci (80–127.5  $\times$  25–35  $\mu\text{m}$ ) and larger ascospores (37–45  $\times$  9–12  $\mu\text{m}$ ) with a suprmedian septum (0.43–0.50 av. 0.48,  $n = 32$ ). The morphological features of *M. peerallyi* are generally in accordance with the generic concept of *Clypeoloculus*, but phylogenetic reassessment using molecular sequences will be necessary before a new combination is proposed for this species.



**Fig. 32.** *Clypeoloculus hirosakiensis*. A, B. Ascomata on the natural host surface; C. Ascoma in longitudinal section; D. Ascomatal wall; E. Pseudoparaphyses; F. Ascus; G–I. Ascospores (arrowheads indicate gelatinous sheath; I. in India ink); J. Germinating ascospore; K. Spermogonia in culture (on rice straw); L. Spermatia. A–J from KT 1283; K, L from culture KT 1283. Scale bars: A = 1 mm; B, K = 500  $\mu$ m; C = 100  $\mu$ m; D–J, L = 10  $\mu$ m.

***Clypeoloculus hirosakiensis*** Kaz. Tanaka & K. Hiray., **sp. nov.**  
Mycobank MB811320. [Fig. 32.](#)

**Etymology:** Referring to the collection site.

*Ascomata* scattered, immersed to erumpent, globose to subglobose in section, 350–520  $\mu$ m high, 340–550  $\mu$ m diam, covered with numerous brown hyphae around ascomata. *Ostiolar neck* terete, central, 75–100  $\mu$ m long, 40–170  $\mu$ m wide, clypeate, composed of carbonaceous cells. *Ascomatal wall* in longitudinal section at sides, 50–60  $\mu$ m wide, composed of parallel rows of rectangular to polygonal, brown to dark brown cells of 7.5–12.5  $\times$  3.5–9.5  $\mu$ m; wall at the base 17–25  $\mu$ m wide, composed of subglobose to polygonal, slightly thick-walled, 3–10  $\times$  3.5–6.5  $\mu$ m, brown cells. *Pseudoparaphyses* septate, branched and anastomosed, 1.5–3  $\mu$ m wide. *Asci* fissitunicate, clavate, 100–147.5  $\times$  (13.5–)15–20  $\mu$ m (av. 118.6  $\times$  16.5  $\mu$ m,  $n = 50$ ), with a short stipe of (7.5–)10–25(–30)  $\mu$ m (av. 16.5  $\mu$ m,  $n = 50$ ) long, with 8 biseriate ascospores. *Ascospores* narrowly fusiform, slightly curved, (24–)29–36  $\times$  7–9.5  $\mu$ m (av. 33.0  $\times$  8.0  $\mu$ m,  $n = 50$ ), l/w 3.7–4.7 (av. 4.1,  $n = 50$ ), with a primary septum nearly median (0.47–0.52; av. 0.50,  $n = 50$ ), constricted at the septum, hyaline, smooth, surrounded by an entire gelatinous sheath, 3–7  $\mu$ m wide.

Colonies on PDA (after 4 wk) attaining a diam of 2.7–3.0 cm, greenish grey to lavender grey; reverse chestnut; ochreous pigment produced. In culture spermatial morph formed. *Spermatia* oblong, hyaline, 2.6–3.5  $\times$  1.2–1.5.

**Specimen examined:** Japan, Aomori, Hirosaki, Zatoishi (river), on submerged twigs of woody plant, 19 Jul. 2003, K. Tanaka & N. Asama (**holotype** KT 1283 = HHUF 30144, culture **ex-type** CBS 139682 = JCM 19425 = MAFF 243864).

**Note:** The ascospores of *C. hirosakiensis* (av. 33.0  $\times$  8.0  $\mu$ m) are larger than those of *C. microsporus* (av. 29.9  $\times$  7.0  $\mu$ m) but smaller than those of *C. akitaensis* (av. 38.7  $\times$  8.6  $\mu$ m) and *C. towadaensis* (av. 38.7  $\times$  8.7  $\mu$ m).

***Clypeoloculus microsporus*** Kaz. Tanaka & K. Hiray., **sp. nov.**  
Mycobank MB811321. [Fig. 33.](#)

**Etymology:** Referring to the small ascospores.

*Ascomata* scattered to 2–3 grouped, immersed to erumpent, globose to subglobose in section, 290–310  $\mu$ m high, 280–350  $\mu$ m diam, covered with sparse brown hyphae around ascomata. *Ostiolar neck* central, papillate, 70–90  $\mu$ m long, 100–120  $\mu$ m wide, clypeate, composed of carbonaceous cells. *Ascomatal wall* in longitudinal section 25–38  $\mu$ m wide at sides and 25–30  $\mu$ m wide at the base, composed of subglobose brown cells (2.5–10  $\mu$ m diam). *Pseudoparaphyses* branched and anastomosed, septate, 2–3  $\mu$ m wide. *Asci* fissitunicate, cylindrical to clavate, 80–145  $\times$  13.5–22.5  $\mu$ m (av. 115.5  $\times$  17.5  $\mu$ m,  $n = 33$ ), with a short stipe of (5–)7.5–15(–29.5)  $\mu$ m (av. 13.9  $\mu$ m,  $n = 30$ ) long, with 8 biseriate to triseriate ascospores. *Ascospores* narrowly fusiform, slightly curved, 25.5–34.5  $\times$  6–8(–9)  $\mu$ m (av. 29.9  $\times$  7.0  $\mu$ m,  $n = 56$ ), l/w 3.4–5.2(–5.5) (av. 4.3,  $n = 56$ ), with a primary septum nearly median (0.47–0.52; av. 0.50,  $n = 56$ ), constricted at the septum, hyaline, smooth, surrounded by an entire gelatinous sheath of 2–4  $\mu$ m wide.

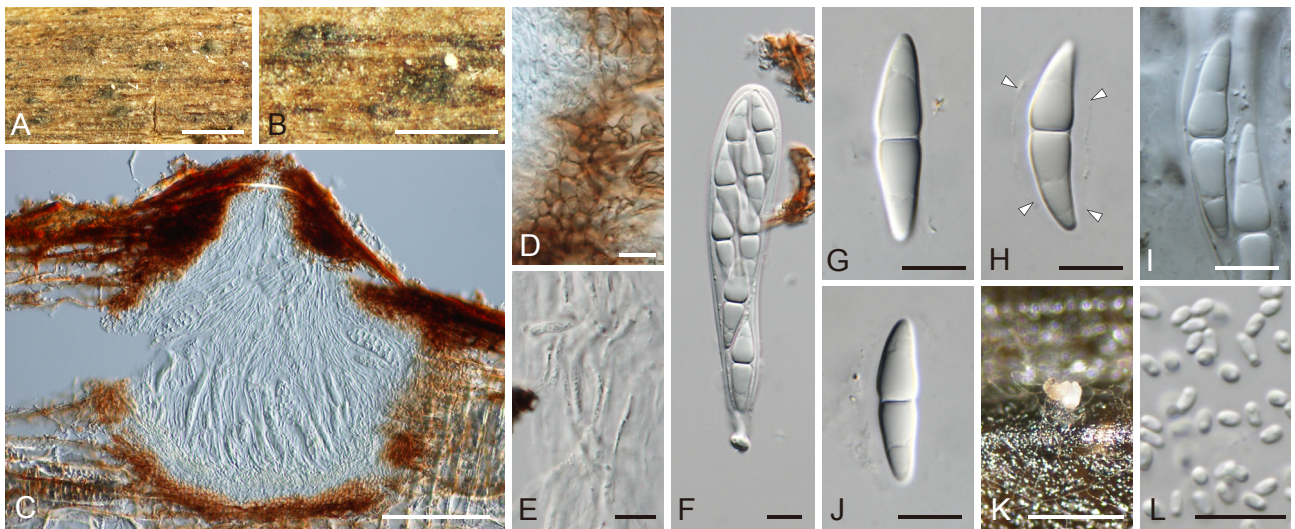
Colonies on PDA (after 4 wk) attaining a diam of 3.1–3.3 cm, olivaceous grey; reverse umber to chestnut; amber pigment produced. In culture spermatial morph formed. *Spermatia* oblong, hyaline, 2.5–3.2  $\times$  1.2–1.6  $\mu$ m.

**Specimen examined:** Japan, Aomori, Kuroishi, Lake Nizinoko, on submerged twigs of woody plant, 3 May 2003, K. Tanaka & N. Asama (**holotype** KT 1131 = HHUF 30143, culture **ex-type** CBS 139683 = JCM 19426 = MAFF 243863).

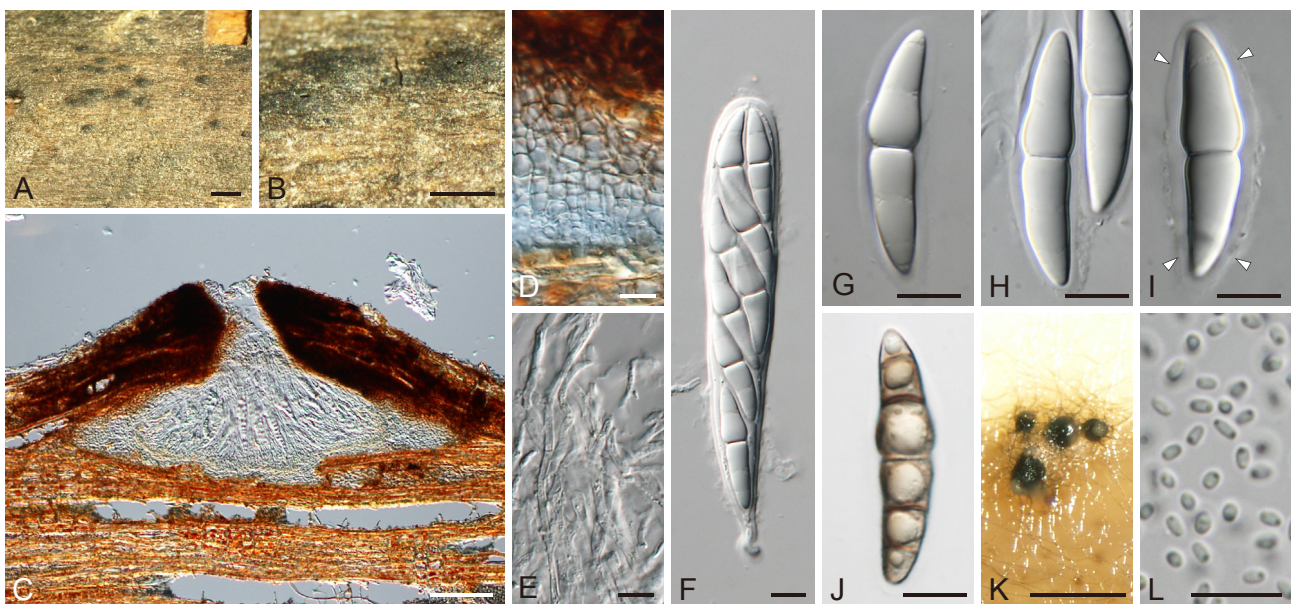
**Note:** This species is distinguished from other species of *Clypeoloculus* by having the smallest ascospores known in the genus.

***Clypeoloculus towadaensis*** Kaz. Tanaka & K. Hiray., **sp. nov.**  
Mycobank MB811323. [Fig. 34.](#)





**Fig. 33.** *Clypeoloculus microsporius*. A, B. Ascomata on the natural host surface; C. Ascma in longitudinal section; D. Ascomatal wall; E. Pseudoparaphyses; F. Ascus; G–J. Ascospores (arrowheads indicate gelatinous sheath); K. Spermogonium in culture (on rice straw); L. Spermatia. A–J from KT 1131; K, L from culture KT 1131. Scale bars: A = 1 mm; B, K = 500  $\mu$ m; C = 100  $\mu$ m; D–J, L = 10  $\mu$ m.



**Fig. 34.** *Clypeoloculus towadaensis*. A, B. Ascomata on the natural host surface; C. Ascma in longitudinal section; D. Ascomatal wall; E. Pseudoparaphyses; F. Ascus; G–J. Ascospores (arrowheads indicate gelatinous sheath; J. senescent ascospore); K. Spermogonia in culture; L. Spermatia. A–J from KT 1340; K, L from culture KT 1340. Scale bars: A = 1 mm; B, K = 500  $\mu$ m; C = 100  $\mu$ m; D–J, L = 10  $\mu$ m.

**Etymology:** Referring to the collection site.

**Ascomata** scattered to 2–3 grouped, immersed to erumpent, hemispherical with flattened base in section, 260–360  $\mu$ m high, 550–700  $\mu$ m diam. **Ostiolar neck** central, terete, 65–135  $\mu$ m long, 75–88  $\mu$ m wide, clypeate, composed of carbonaceous cells. **Ascomatal wall** at sides 95–150  $\mu$ m wide and “rim-like”, composed of vertically orientated, rectangular to subglobose, hyaline to pale brown cells of 6–10  $\times$  3–6  $\mu$ m; at the base 15–25  $\mu$ m wide or poorly developed. **Pseudoparaphyses** septate, branched and anastomosed, 1–2  $\mu$ m wide. **Asci** fissitunicate, cylindrical, (112–)120–170  $\times$  17.5–25  $\mu$ m (av. 136.7  $\times$  21.3  $\mu$ m, n = 35), with a short stipe of (7.5–)12.5–25  $\mu$ m (av. 17.2  $\mu$ m, n = 35) long, with 8 biseriate ascospores. **Ascospores** narrowly fusiform, slightly curved, 34–43  $\times$  7–10  $\mu$ m (av. 38.7  $\times$  8.7  $\mu$ m, n = 50), l/w 3.9–5.3 (av. 4.5, n = 50), with a

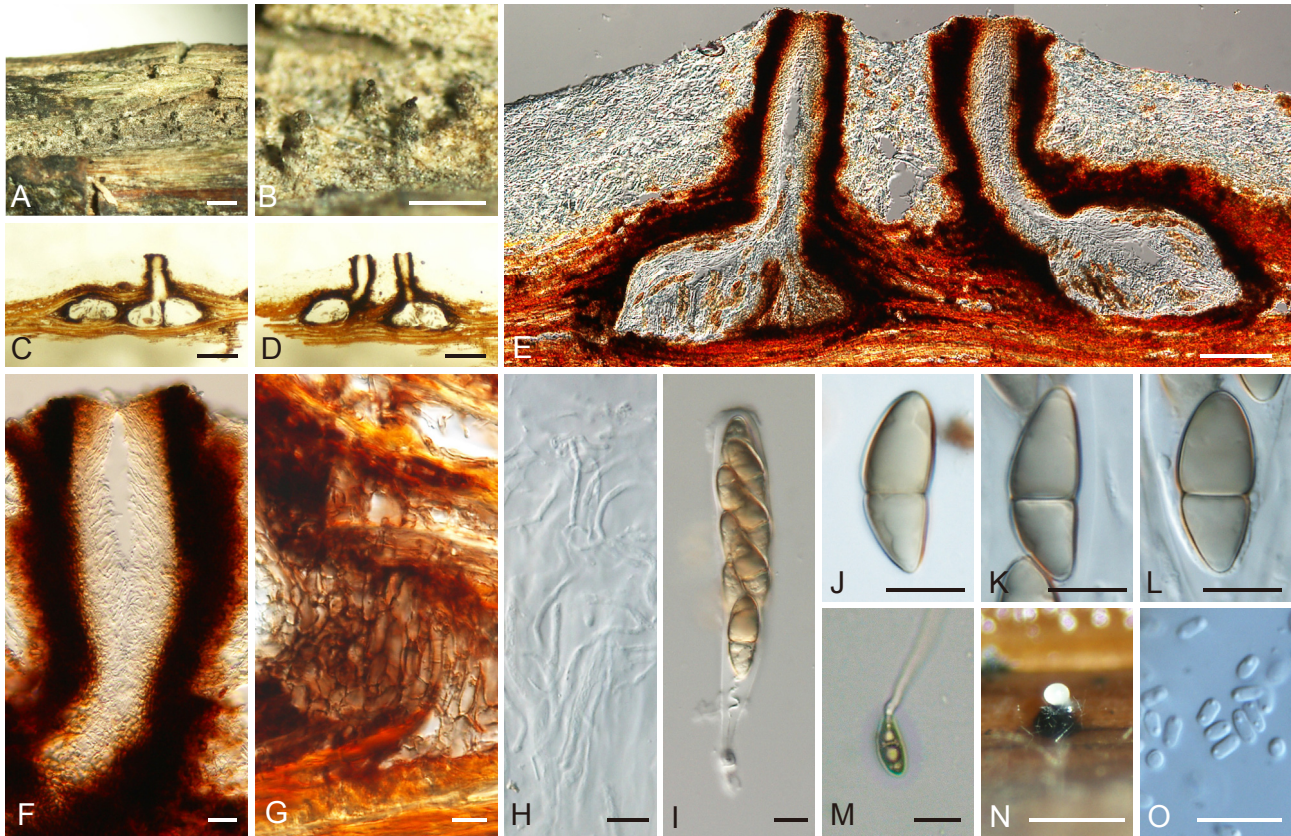
primary septum nearly median (0.47–0.53; av. 0.50, n = 50), constricted at the septum, hyaline, smooth, surrounded by an entire gelatinous sheath of 1–5  $\mu$ m wide. Senescent ascospores becoming brown, 1–3(–5)-septate.

Colonies on PDA (after 4 wk) attaining a diam of 1.9–2.2 cm, greenish grey; reverse buff to sepia; ochreous pigment produced. In culture spermatial morph formed. **Spermatia** oblong to subglobose, hyaline, 3–4  $\times$  1.4–1.8  $\mu$ m.

**Specimen examined:** Japan, Akita, Kazuno, Kosaka, Lake Towada, on submerged twigs of woody plant, 26 Jul. 2003, K. Tanaka & N. Asama (holotype KT 1340 = HHUF 30145, culture ex-type CBS 139685 = JCM 19428 = MAFF 243865).

**Notes:** The most distinctive feature of *C. towadaensis* is its hemispherical ascomata with “rim-like” ascomatal walls. The asci





**Fig. 35.** *Helicascus aquaticus*. A, B. Ascomata on the natural host surface; C–E. Ascomata in longitudinal section; F. Ostiolar neck of ascoma; G. Ascomatal wall; H. Pseudoparaphyses; I. Ascus; J–L. Ascospores; M. Germinating ascospore; N. Spermatogonium in culture (on rice straw); O. Spermata. A–M from KT 1544; N, O from culture KT 1544. Scale bars: A = 1 mm; B, N = 500 µm; C–E = 100 µm; F, M = 20 µm; G–L, O = 10 µm.

of this species are longer than those of other species in *Clypeoloculus*.

***Helicascus*** Kohlm., *Canad. J. Bot.* 47: 1471. 1969.

*Type species: Helicascus kanaloanus* Kohlm.

**Notes:** *Helicascus* was revised by Zhang *et al.* (2013) who accepted six species: two marine (*H. kanaloanus* and *H. nypae*) and four freshwater species (*H. aegyptiacus*, *H. aquaticus*, *H. elaterascus* and *H. thalassioideus*). Recently, two additional species in freshwater habitat (*H. gallicus* and *H. unilocularis*) were described in the genus (Zhang *et al.* 2014b, 2015).

***Helicascus aquaticus*** H. Zhang & K.D. Hyde, *Sydowia* 65: 155. 2013. Fig. 35.

*Ascomata* scattered to 2–3 grouped, immersed, hemispherical in section, 170–300 µm high (excluding the long ostiolar neck), 230–530 µm diam. *Ostiolar neck* cylindrical, oblique to central, 230–340 µm long, 110–160 µm wide, composed of polygonal to subglobose, thick-walled, 2.5–7.5 × 2–4 µm, brown to dark brown cells, with dense periphyses. *Ascomatal wall* in longitudinal section, 40–110 µm thick at sides, “rim-like”, composed of parallel rows of rectangular to polygonal, brown cells of 3.5–20 × 2.5–10 µm; at base poorly developed, 7–15 µm thick, composed of thin-walled flattened cells. *Pseudoparaphyses* septate, branched and anastomosed, 1.5–2(–3.5) µm wide, associated with gelatinous material. *Asci* fissitunicate, cylindrical to clavate, 80–122.5 × 15–19.5 µm (av. 102.8 × 17.5 µm, n = 20), with a stipe of

17.5–32.5 µm long (av. 24.7 µm long, n = 20), 8-spored. *Ascospores* broadly fusiform, slightly curved, 21.5–29 × 8–10.5 µm (av. 24.4 × 9.1 µm, n = 50), l/w 2.2–3.3 (av. 2.7, n = 50), with a submedian septum (0.51–0.60; av. 0.57, n = 50), constricted at the septum, pale greenish brown to brown, smooth, without sheath.

In culture spermatial morph formed. *Spermata* oblong, hyaline, 2.4–4 × 1.5–2 µm.

**Specimen examined:** Japan, Aomori, Hirosaki, Aoki, Mohei-pond, on submerged twigs of woody plant, 25 Oct. 2003, K. Tanaka & N. Asama, KT 1544 = HHUF 30146, culture JCM 19423 = MAFF 243866.

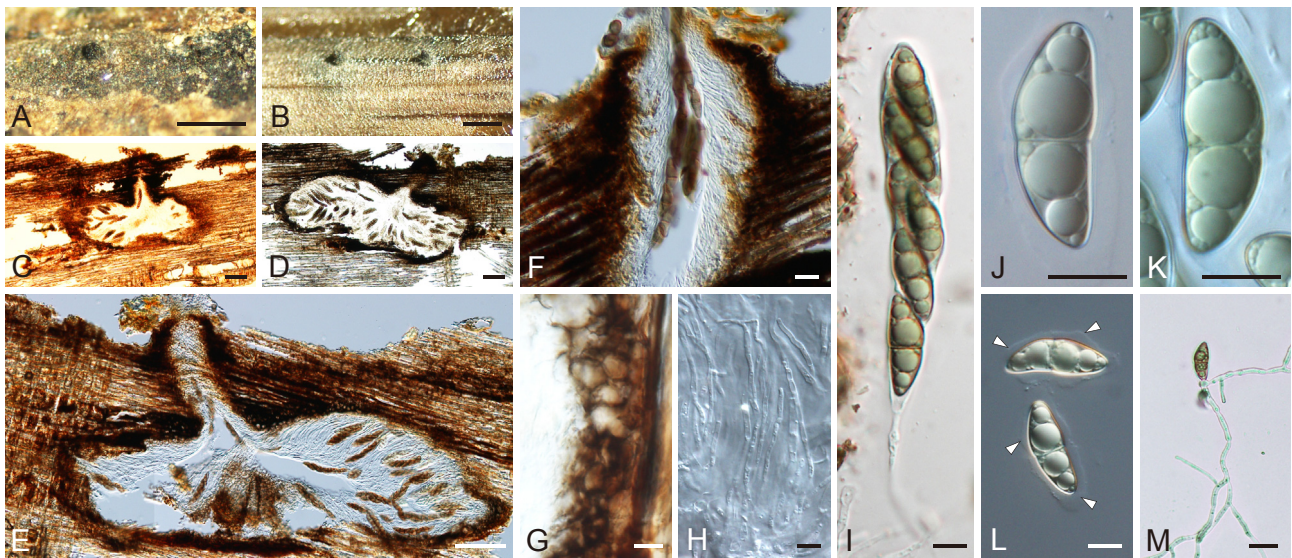
**Notes:** The ITS sequence from the above isolate showed 100 % identity with that from the ex-type of *H. aquaticus* (GenBank KC886639), an aquatic species formerly known only from the type specimen collected on submerged wood in Thailand (Zhang *et al.* 2013). Our collection has a longer ascomatal neck (vs. 130–200 µm) and shorter asci [vs. 90–140(–185) µm] than described in the original publication. The ascospores possessing three septa were noted as the most distinctive feature of *H. aquaticus* (Zhang *et al.* 2013), but these were consistently 1-septate in our material.

***Helicascus elaterascus*** (Shearer) H. Zhang & K.D. Hyde, *Sydowia* 65: 158. 2013. Fig. 36.

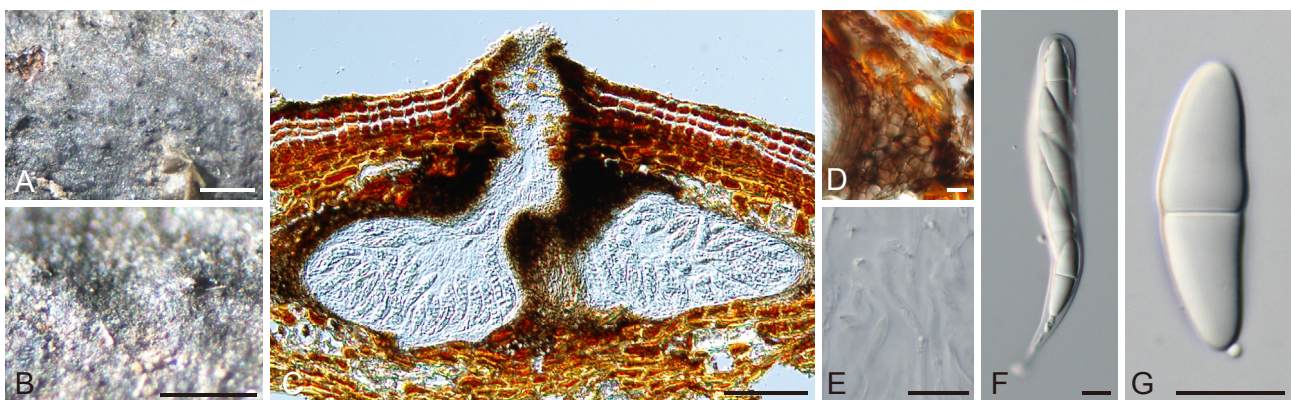
**Basionym:** *Kirschsteiniothelia elaterascus* Shearer, *Mycologia* 85: 963. 1994 (1993).

*Ascomata* scattered, immersed, depressed globose in section, 250–300 µm high (excluding the long ostiolar neck),





**Fig. 36.** *Helicascus elaterascus*. A. Ascomata on the natural host surface; B. Ascomata in culture (on rice straw); C–E. Ascomata in longitudinal section; F. Ostiolar neck of ascoma; G. Ascomatal wall; H. Pseudoparaphyses; I. Ascus; J–L. Ascospores (arrowheads indicate gelatinous sheath); M. Germinating ascospore. A, C–E, I, M from KT 2673; B, H, J–L from culture KT 2673. Scale bars: A, B = 500 µm; C–E = 100 µm; F, M = 20 µm; G–L = 10 µm.



**Fig. 37.** *Helicascus thalassioideus*. A, B. Ascomata on the natural host surface; C. Ascomata in longitudinal section; D. Ascomatal wall; E. Pseudoparaphyses; F. Ascus; G. Ascospore. All from KH 242. Scale bars: A = 1 mm; B = 500 µm; C = 100 µm; D–G = 10 µm.

600–910 µm diam. *Ostiolar neck* 200–230 µm long, 110–160 µm wide, with dense periphyses. *Pseudoparaphyses* branched and anastomosed, septate, associated with gelatinous material. *Asci* fissitunicate, clavate, ca. 140 × 19 µm, with a long stipe, 8-spored. *Ascospores* broadly fusiform, slightly curved, 26.5–31.5 × 9–12.5 µm (av. 29.0 × 10.6 µm, n = 30), l/w 2.4–3.1 (av. 2.8, n = 30), with a submedian septum (0.50–0.58; av. 0.54, n = 30), slightly constricted at the septum, pale greenish brown to brown, with an entire sheath slightly enlarged below. In culture only sexual morph observed.

*Specimens examined:* **Japan**, Okinawa, Isl. Ishigaki, Mt. Omoto (river), on submerged twigs of woody plant, 2 Dec. 2009, Y. Kurihara, KT 2673 = HHUF 30147, culture MAFF 243867; Okinawa, Isl. Iriomote, Aira-river, on submerged twigs of woody plant, 8, Dec. 2009, Y. Kurihara & A. Ooba, KT 2682 = HHUF 30451, culture CBS 139689.

*Notes:* The morphological features of the examined material matched well with those in the original description of this species (Shearer 1993, as *Kirschsteiniothelia elaterascus*) and the LSU sequences were identical with that of the species deposited in GenBank (GenBank AY787934; Kodsueb *et al.* 2006). This species has been reported frequently from submerged wood in

temperate and tropical freshwater habitats (Shearer & Raja 2010, Raja *et al.* 2011) including Japan (Tsui *et al.* 2003).

*Helicascus thalassioideus* (K.D. Hyde & Aptroot) H. Zhang & K.D. Hyde, Sydowia 65: 159. 2013. Fig. 37.

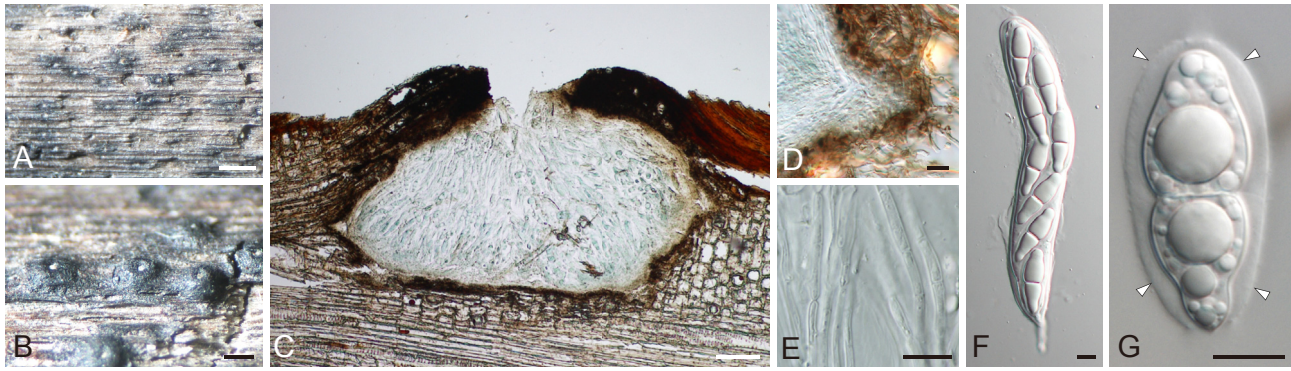
*Basionym:* *Massarina thalassioidea* K.D. Hyde & Aptroot, Nova Hedwigia: 498. 1998.

*Asci* clavate, 80–120 × 15–17.5 µm (av. 100.2 × 16.7 µm, n = 30), with a stipe of 15–32.5 µm long (av. 23.0 µm, n = 30). *Ascospores* 25–31 × 8–10 µm (av. 27.5 × 8.6 µm, n = 30), l/w 2.8–3.5 (av. 3.2, n = 30), with a median septum. Asexual morph unknown.

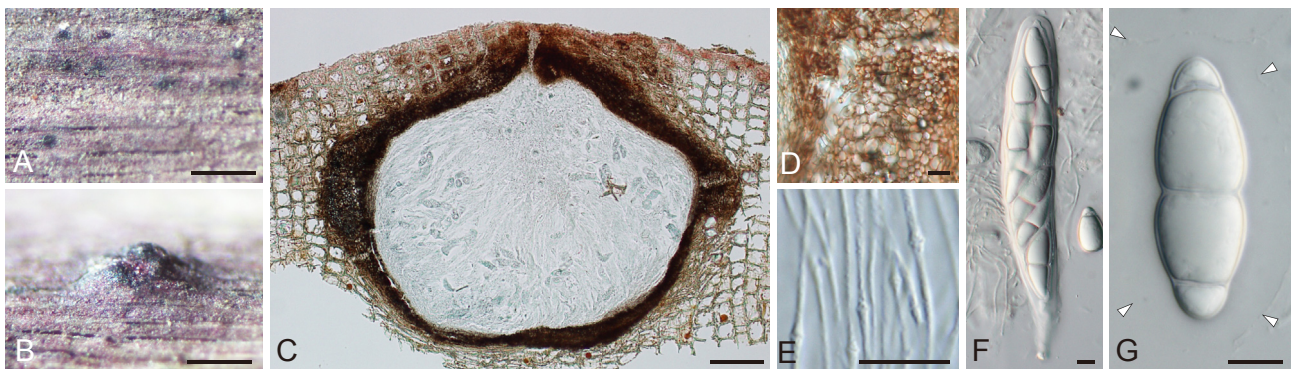
*Specimens examined:* **Japan**, Okinawa, Isl. Iriomote, Geta-river, on submerged twigs of woody plant, 22 Nov. 2008, K. Hirayama & K. Tanaka, KH 242 = HHUF 30069, culture JCM 17526 = NBRC 107811. **China**, Hong Kong, Lam Tsuen river, N.T. on submerged wood, culture CBS 110441 = JCM 14147.

*Notes:* A more detailed description of this species was provided by Hirayama & Tanaka (2011a). This species was originally described as *Massarina* (Hyde & Aptroot 1998) and has commonly been reported from submerged wood in freshwater habitats throughout the world including Australia, Brunei, China





**Fig. 38.** *Morosphaeria ramunculicola*. A, B. Ascomata on the natural host surface; C. Ascoma in longitudinal section; D. Ascomatal wall; E. Pseudoparaphyses; F. Ascus; G. Ascospore (arrowheads indicate gelatinous sheath). All from KH 220. Scale bars: A = 1 mm; B = 500  $\mu$ m; C = 100  $\mu$ m; D–G = 10  $\mu$ m.



**Fig. 39.** *Morosphaeria velatispora*. A, B. Ascomata on the natural host surface; C. Ascoma in longitudinal section; D. Ascomatal wall; E. Pseudoparaphyses; F. Ascus; G. Ascospore (arrowheads indicate gelatinous sheath). A, D from KH 218; B, C, E–G from KH 221. Scale bars: A = 1 mm; B = 500  $\mu$ m; C = 100  $\mu$ m; D–G = 10  $\mu$ m.

(Yunnan), French West Indies, Hong Kong, the Philippines, and Thailand (Zhang *et al.* 2013, 2015). Zhang *et al.* (2014b) suspected that helicascus-like taxa with a worldwide distribution might be a species-complex. However, ITS sequences obtained from the above two isolates were identical and differed by only one position (517/518) from that of *H. thalassioideus* collected in French West Indies (GenBank KP637162, Zhang *et al.* 2015).

***Morosphaeria*** Suetrong *et al.*, Stud. Mycol. 64: 161. 2009.

*Type species: Morosphaeria velatispora* (K.D. Hyde & Borse) Suetrong *et al.*

*Notes:* The genus *Morosphaeria* currently comprises two marine species, *M. ramunculicola* and *M. velatispora* (Suetrong *et al.* 2009). A freshwater fungus, *Kirschsteiniothelia elaterascus*, was transferred to *Morosphaeria* (Boonmee *et al.* 2012), but it is presently placed in *Helicascus* (Zhang *et al.* 2013).

***Morosphaeria ramunculicola*** (K.D. Hyde) Suetrong *et al.*, Stud. Mycol. 64: 162. 2009. Fig. 38.

*Basionym: Massarina ramunculicola* K.D. Hyde, Mycologia 83: 839. 1992 (1991).

*Asci* cylindrical to clavate, 121–187.5  $\times$  22–32.5  $\mu$ m, stalked (20–42.5  $\mu$ m long). *Ascospores* 33–41  $\times$  11–15  $\mu$ m (av. 36.5  $\times$  12.6  $\mu$ m,  $n = 30$ ), l/w 2.4–3.4 (av. 2.9,  $n = 30$ ), with a submedian primary septum (0.50–0.56; av. 0.52,  $n = 30$ ). Asexual morph unknown.

*Specimen examined: Japan*, Okinawa, Isl. Iriomote, Oomijya-river, on twigs of *Rhizophora mucronata*, 22 Nov. 2008, K. Hirayama & K. Tanaka, KH 220 = HHUF 30070, culture NBRC 107813.

*Notes:* The morphological features of the specimen cited here were identical to those of *M. ramunculicola* (Hyde 1991). There were only 1–2 bp differences between the LSU sequences (ca. 1280 bp) of our material and those of *M. ramunculicola* deposited in GenBank (GenBank GQ925853, GQ925854).

***Morosphaeria velatispora*** (K.D. Hyde & Borse) Suetrong *et al.*, Stud. Mycol. 64: 161. 2009. Fig. 39.

*Basionym: Massarina velatispora* K.D. Hyde & Borse, Mycotaxon 27: 161. 1986.

*Asci* clavate, (135–)165–245(–280)  $\times$  25–38  $\mu$ m (av. 212.2  $\times$  32.8  $\mu$ m,  $n = 30$ ), with a stipe of 25–55  $\mu$ m long (av. 37.0  $\mu$ m,  $n = 26$ ). *Ascospores* 42–52  $\times$  14–18  $\mu$ m (av. 47.1  $\times$  16.1  $\mu$ m,  $n = 40$ ), l/w 2.6–3.4 (av. 2.9,  $n = 40$ ), 1–3-septate, with a median primary septum (0.49–0.53; av. 0.50,  $n = 40$ ). Asexual morph unknown.

*Specimens examined: Japan*, Okinawa, Isl. Iriomote, Oomijya-river, on twigs of *Rhizophora mucronata*, 22 Nov. 2008, K. Hirayama & K. Tanaka, KH 218 = HHUF 30072, culture JCM 17529 = NBRC 107814; Okinawa, Isl. Iriomote, Geda river, on twigs of *Rhizophora mucronata*, 20 Nov. 2008, K. Hirayama & K. Tanaka, KH 221 = HHUF 30073, culture JCM 17530 = NBRC 107812.

*Note:* Hirayama & Tanaka (2011a) provided a more precise description based on the above specimens.



**Parabambusicolaceae** Kaz. Tanaka & K. Hiray., **fam. nov.** MycoBank MB811324.

*Etymology*: Referring to the name of the type genus.

*Ascomata* scattered to grouped, immersed to erumpent, globose to subglobose in surface view, depressed globose to hemispherical in section. *Ostiolar neck* or short papillate, central, sometimes compressed, composed of heavily melanised cells. *Ascomatal wall* composed of pale brown cells, with or without "rim-like" stromatic region. *Pseudoparaphyses* septate, branched and anastomosed. *Asci* fissitunicate, clavate to broadly cylindrical, stipitate, with 8 ascospores. *Ascospores* clavate to fusiform, with a supramedian primary septum, multiseptate, slightly constricted at septa, hyaline, smooth, with an entire sheath. Asexual morph where known sporodochial, monodictys-like hyphomycetes.

*Type genus*: *Parabambusicola* Kaz. Tanaka & K. Hiray.

*Notes*: This family superficially resembles *Bambusicola*, but can be distinguished from the latter by the ascomata surrounded by stromatic tissue (*Parabambusicola*) or compressed necks with wide ostioles (*Aquastroma*), and the multiseptate, clavate to fusiform, hyaline ascospores.

***Aquastroma*** Kaz. Tanaka & K. Hiray., **gen. nov.** MycoBank MB811325.

*Etymology*: From the Latin *aqua* meaning water and *stroma*.

*Ascomata* scattered to grouped, immersed to erumpent, globose in surface view, depressed globose in section. *Ostiolar neck* central, compressed, composed of thick-walled, heavily melanised, subglobose cells, with a wide ostiole. *Ascomatal wall* composed of pale brown, thin-walled cells. *Pseudoparaphyses* septate, branched and anastomosed. *Asci* fissitunicate, clavate, stipitate, with 8 ascospores. *Ascospores* clavate to fusiform, slightly curved, with a supramedian primary septum, multiseptate, slightly constricted at septa, hyaline, smooth, with an entire sheath. Asexual morph unknown.

*Type species*: *Aquastroma magniostiolata* Kaz. Tanaka & K. Hiray.

*Notes*: *Aquastroma* is superficially similar to *Quintaria* in having multiseptate ascospores and aquatic habitat. However, the type species of *Quintaria*, *Q. lignatilis* known from marine habitats, has long-necked ascomata with black incrustations surrounding the sides of the ostiolar canal (Zhang *et al.* 2012), and is phylogenetically close to members of the family *Amniculicolaceae* (Shearer *et al.* 2009) or the *Testudinaceae/Platystomaceae* (Suetrong *et al.* 2009, Zhang *et al.* 2012). *Quintaria* is regarded as a polyphyletic genus, because *Q. submersa* known from freshwater habitats does not cluster with *Q. lignatilis* and forms a sister clade to the *Lindgomycetaceae* (Zhang *et al.* 2012). An asexual morph was not observed for *Aquastroma* in culture, but this genus forms a clade with two hyphomycetes, *Monodictys* species, and their relationship is highly supported (100 %; Fig. 1). *Monodictys*, however, is not monophyletic and species in this genus are phylogenetically distributed in three ascomycete classes, *Dothideomycetes*, *Leotiomyces*, and *Sordariomyces*

(see Notes in *Monodictys*). *Aquastroma* should be retained as a distinct genus, until sequence data of the type species of *Monodictys* (*M. putredinis*) become available to clarify the phylogenetic placement of *Monodictys* s. str.

***Aquastroma magniostiolata*** Kaz. Tanaka & K. Hiray., **sp. nov.** MycoBank MB811326. Fig. 40.

*Etymology*: From the Latin *mangi-*, meaning large, and *ostiolata*, meaning ostiolate.

*Ascomata* scattered to 3–4 grouped, immersed to erumpent, globose in surface view, depressed globose in section, 180–250 µm high, 260–340 µm diam. *Ostiolar neck* central, compressed, 60–750 µm long, 75–130 µm wide, composed of thick-walled, heavily melanised, subglobose cells (2–3 µm diam), with a wide ostiole. *Ascomatal wall* in longitudinal section 25–30 µm thick at sides, composed of 5–7 layers of polygonal, thin-walled, 6–17 × 2.5–7.5 µm, pale brown cells; wall at the base 10–18 µm thick or poorly developed, composed of thin-walled flattened cells. *Pseudoparaphyses* septate, branched and anastomosed, 2–3 µm wide. *Asci* fissitunicate, clavate, 112.5–137.5 × 25–29.5 µm, with a stipe of 22–28 µm long, with 8 biseriate to triseriate ascospores. *Ascospores* clavate to fusiform, slightly curved, 30–44 × 9–13.5 µm (av. 36.5 × 10.3 µm, n = 39), l/w 2.8–4.5 (av. 3.6, n = 39), with a supramedian primary septum (0.40–0.47; av. 0.43, n = 39), 6–8-septate (2+1+3, 2+1+4, 3+1+3, 3+1+4), slightly constricted at septa, hyaline, smooth, with an entire sheath; sheath delimited and 2–3 µm wide at first, diffuse and up to 10 µm wide at a later.

Colonies on PDA (after 4 wk) attaining a diam of 3.2–3.4 cm, greenish grey; reverse almost black; no pigment produced. In culture sexual morph formed. *Asci* and ascospores larger than those on the natural host. *Asci* 130–170 × 22.5–37.5 µm (av. 148.9 × 29.9 µm, n = 30). *Ascospores* 39–47.5 × 11–16 µm (av. 43.5 × 13.5 µm, n = 50), l/w 2.8–3.8 (av. 3.2, n = 50).

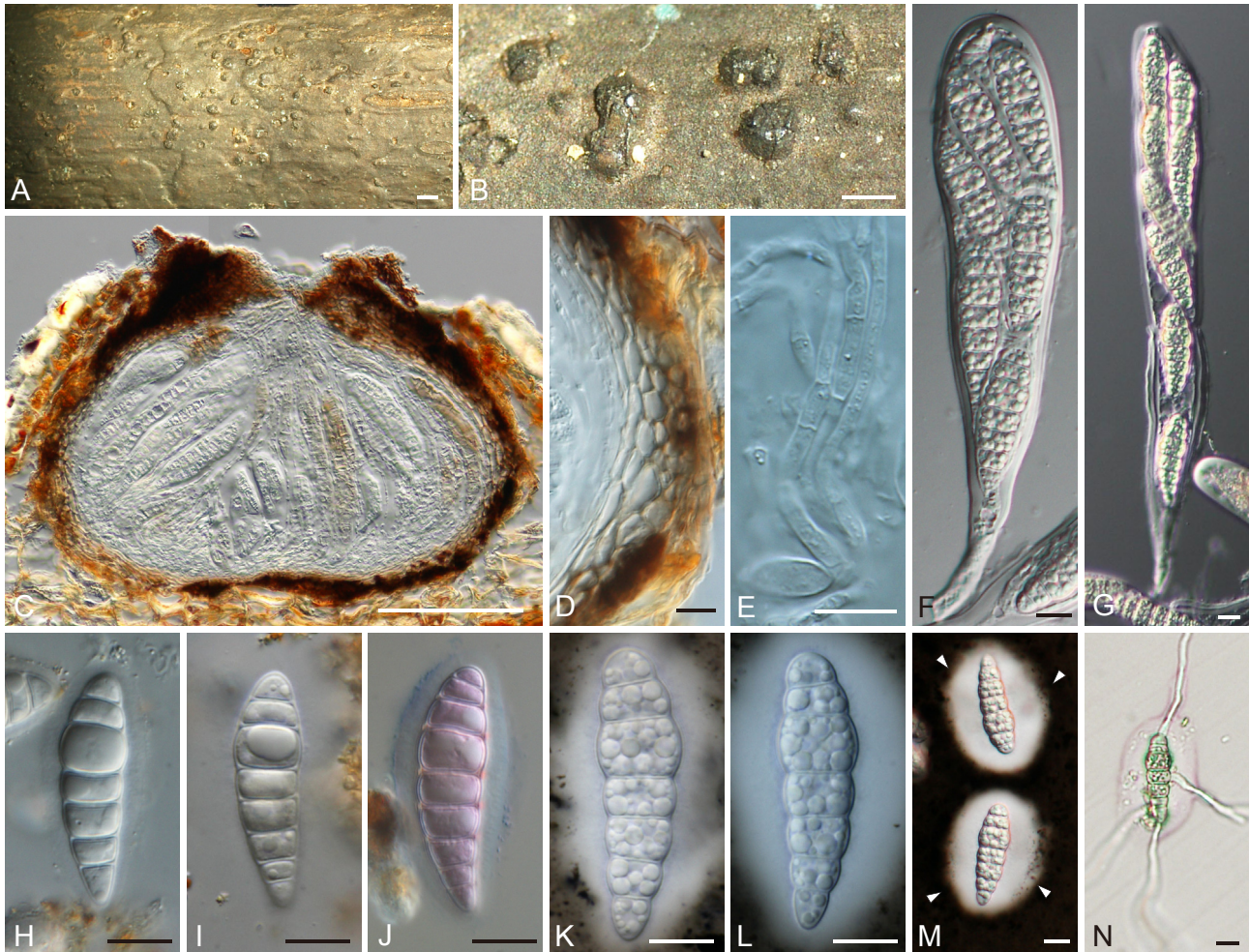
*Specimen examined*: Japan, Mie, Tsu, Kamihama, Hyourtan pond, on submerged twigs of woody plant, 1 Jun. 2008, K. Tanaka & H. Yonezawa (**holotype** KT 2485 = HHUF 30122, culture **ex-type** CBS 139680 = JCM 19429 = MAFF 243824).

*Notes*: *Aquastroma magniostiolata* is shown to be morphologically distinct from *Quintaria aquatica* by its ascospores with 6–8 septa [vs. (10–)11–13(–14) septa in *Q. aquatica*; Hyde & Goh 1999]. It is also different from *Q. microspora* in its larger ascospores (vs. 26–31 × 5–5.5 µm in *Q. microspora*; Zhang *et al.* 2008a).

***Parabambusicola*** Kaz. Tanaka & K. Hiray., **gen. nov.** MycoBank MB811327.

*Etymology*: After its phylogenetic similarity to *Bambusicola*.

*Ascomata* mostly grouped, immersed to erumpent, subglobose in surface view, hemispherical with flattened base in section. *Ostiolar neck* short papillate, central. *Ascomatal wall* at the sides composed of pale brown, flattened cells; at the rim, composed of parallel rows of rectangular to polygonal cells. *Pseudoparaphyses* numerous. *Asci* broadly cylindrical to clavate, short-stalked, 8-spored. *Ascospores* fusiform, multiseptate, primary



**Fig. 40.** *Aquastroma magniostiolata*. A, B. Ascomata on the natural host surface; C. Ascoma in longitudinal section; D. Ascomatal wall; E. Pseudoparaphyses; F, G. Asci; H–M. Ascospores (arrowheads indicate gelatinous sheath; J. in Black-Blue ink; K–M. in India ink); N. Germinating ascospore. A–E, G–J, N from KT 2485; F, K–M from culture KT 2485. Scale bars: A = 1 mm; B = 500  $\mu$ m; C = 100  $\mu$ m; D–N = 10  $\mu$ m.

septum mostly supramedian, hyaline, smooth, with an entire sheath. Asexual morph unknown.

*Type species: Parabambusicola bambusina* (Teng) Kaz. Tanaka & K. Hiray.

*Notes:* A new genus *Parabambusicola* is established to accommodate *P. bambusina* formerly classified in *Massarina* (Teng 1936, Aptroot 1998, Tanaka & Harada 2003b). *Parabambusicola* differs from *Massarina* in its hemispherical to depressed globose ascomata surrounded by stromatic tissue and without prominent clypeus, broadly cylindrical asci, and fusiform ascospores with several septa. It is distantly related to *Massarina* (Fig. 1).

***Parabambusicola bambusina*** (Teng) Kaz. Tanaka & K. Hiray., **comb. nov.** MycoBank MB811392. Fig. 41.

*Basionym:* *Massarina bambusina* Teng, *Sinensia* 7: 512. 1936.

*Specimens examined:* **Japan**, Hokkaido, Chitose, Shikotsuko, on dead twigs of *Sasa kurilensis*, 5 Sep. 2001, Y. Harada, H 4321 = HHUF 26590, culture MAFF 239462; Iwate, Hachimantai, Aspitate line, on dead twigs of *Sasa kurilensis*, 25 Jul. 2009, K. Tanaka & Y. Harada, KT 2637 = HHUF 30120, culture MAFF 243822; Aomori, Hirosaki, Tokiwano, Kuromori, Top of Mt. Iwaki, on dead twigs of *Sasa* sp., 21 Jun. 2008, K. Hirayama & K. Tanaka, KH 139 = HHUF 30121, culture MAFF 243823.

*Note:* For further information on this species, see Teng (1936) and Tanaka & Harada (2003b).

***Periconiaceae*** (Sacc.) Nann., *Repert. mic. uomo* 4: 482. 1934. **emend.**

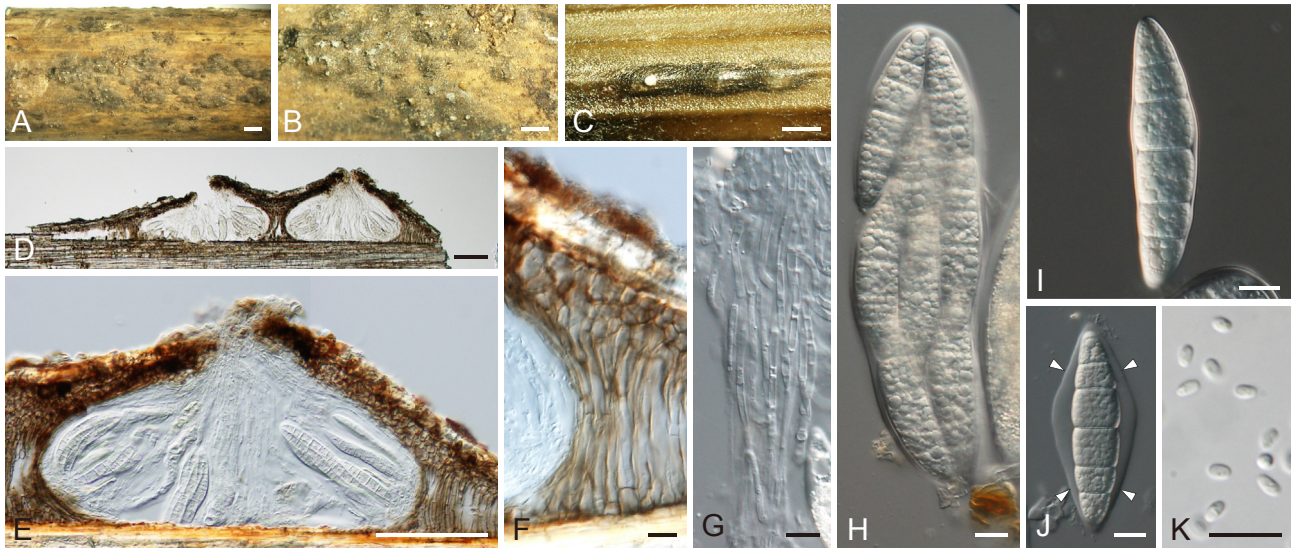
= *Periconieae* Sacc., *Syll. Fung.* 4: 235. 1886.

*Ascomata* scattered to grouped, immersed to erumpent, globose. *Ostiole* central, papillate, with hyaline periphyses. *Ascomatal wall* in longitudinal section composed of several layers of thin-walled, pale brown to brown cells. *Pseudoparaphyses* cellular, branched, anastomosed. *Asci* fissitunicate, oblong to cylindrical, 8-spored. *Ascospores* broadly fusiform, 1-septate, hyaline, smooth, with an entire sheath. *Conidiomata* periconia- or noosia-like. *Conidiophores* macronematous, mononematous, sometimes lacking. *Branches* pale brown to brown, smooth to slightly echinulate. *Conidial heads* spherical. *Conidiogenous cells* monoblastic to polyblastic, discrete on stipe and branches. *Conidia* globose to ellipsoidal, aseptate, catenate, brown, verruculose to echinulate.

*Type genus: Periconia* Tode.

*Note:* Although *Periconiaceae* (Nannizzi 1934) has long been ignored in modern fungal systematics, it should be regarded as a natural taxon in the suborder *Massarineae*.





**Fig. 41.** *Parabambusicola bambusina*. A, B. Ascomata on the natural host surface; C. Ascomata in culture (on rice straw); D, E. Ascomata in longitudinal section; F. Ascumatal wall; G. Pseudoparaphyses; H. Ascus; I, J. Ascospores (arrowheads indicate gelatinous sheath); K. Spermatia. A, B from KH 139; C, G–J from culture KH 139; D–F from KT 2637; K from culture KT 2637. Scale bars: A = 1 mm; B, C = 500  $\mu$ m; D, E = 100  $\mu$ m; F–K = 10  $\mu$ m.

***Periconia*** Tode, Fung. mecklenb. sel. (Lüneburg) 2: 2. 1791.

*Type species: Periconia lichenoides* Tode.

**Notes:** Among more than 185 taxa described as *Periconia* (<http://www.indexfungorum.org>, Aug. 2015), only two species have been reported to have sexual morphs. They are *P. igniaria* (the sexual morph was referred to as *Didymosphaeria* or *Massarina* in the *Dothideomycetes*; Booth 1968, Aptroot 1998) and *P. prolifica* (*Remispora* or *Okeanomyces* in the *Sordariomycetes*; Kohlmeyer 1969, Pang et al. 2004), and therefore it is obvious that the genus *Periconia* is not monophyletic. DNA sequence data of the type species of this genus, *P. lichenoides*, are currently unavailable, but we judged that the lineage of *Periconia* in the *Dothideomycetes*, including typical members of *Periconia*, such as *P. byssoides*, *P. cookei*, *P. igniaria*, and *P. digitata*, corresponds to *Periconia* s. str., based on their morphological similarities with *P. lichenoides* (Mason & Ellis 1953). In contrast, *P. prolifica*, a marine fungus in the *Sordariomycetes*, does not have macronematous conidiophores (Anastasiou 1963, Kohlmeyer 1969), and is not regarded as *Periconia* s. str.

***Periconia homothallica*** Kaz. Tanaka & K. Hiray., sp. nov. MycoBank MB811328. Fig. 42.

**Etymology:** Referring to its homothallism.

**Ascomata** scattered, immersed to erumpent, globose, 140–190  $\mu$ m high, 160–180  $\mu$ m diam, with an ostiole. **Ostiolar neck** central, papillate, 24–40  $\mu$ m long, 37–62  $\mu$ m wide, with hyaline periphyses. **Ascumatal wall** in longitudinal section uniformly 11–15  $\mu$ m thick, composed of 4–6 layers of polygonal, thin-walled, 3–15  $\times$  2–5  $\mu$ m, pale brown cells. **Pseudoparaphyses** cellular, 2–2.5  $\mu$ m wide at the apex, up to 5  $\mu$ m wide at the base, branched, anastomosed. **Asci** fissitunicate, cylindrical to lageniform, 85–119.5  $\times$  13–17.5  $\mu$ m (av. 96.5  $\times$  15.3  $\mu$ m, n = 20), with a shallow ocular chamber, short-stalked (3.5–6  $\mu$ m long), with 8 biseriate ascospores. **Ascospores** broadly fusiform, 22–31  $\times$  7–10  $\mu$ m (av. 26.3  $\times$  8.7  $\mu$ m,

n = 60), l/w 2.6–3.7 (av. 3.0, n = 60), with a nearly median septum (0.48–0.53; av. 0.51, n = 38), hyaline, smooth, with an entire sheath; sheath gelatinous, up to 10  $\mu$ m wide when fresh, later 1–2  $\mu$ m wide.

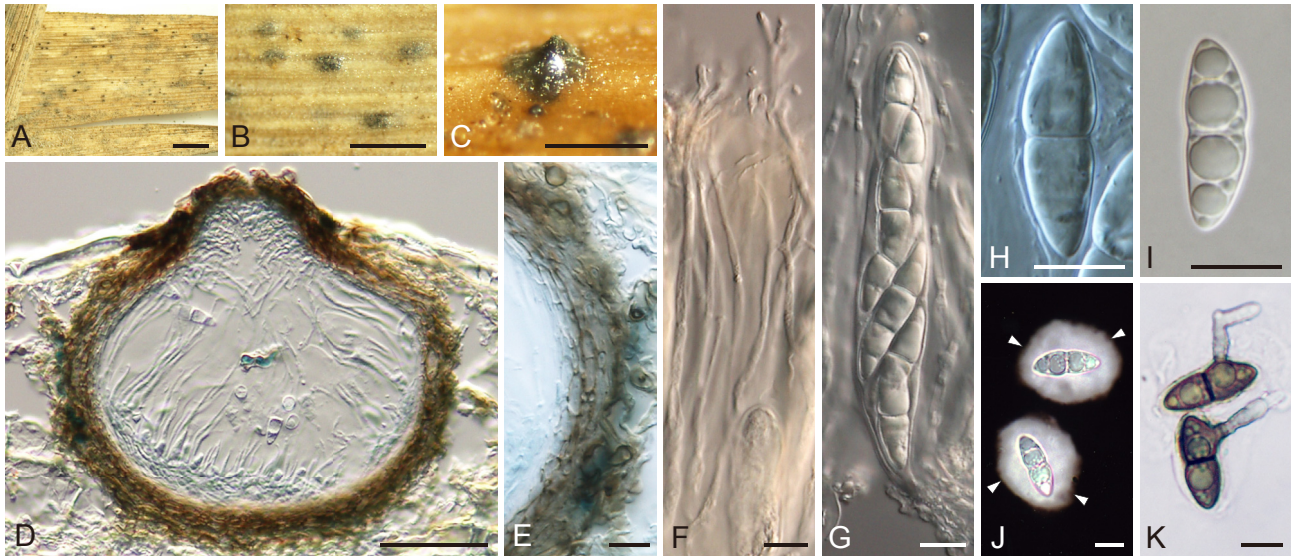
Colonies on PDA (after 2 wk) attaining a diam of 4.3–5.6 cm, straw; reverse similar; no pigment produced. In culture sexual morph formed. **Ascospores** slightly smaller than those on the natural host, 20–28  $\times$  6–9  $\mu$ m (av. 24.0  $\times$  7.8  $\mu$ m, n = 45), l/w 2.7–3.5 (av. 3.1, n = 45).

**Specimen examined:** Japan, Yamagata, Mogamigun, Sakekawa, Magarikawariver, riverbank, on dead leaves of *Phragmites japonica*, 13 Oct. 2002, Y. Ooki & Y. Harada (**holotype** KT 916 = HHUF 29105, culture **ex-type** CBS 139698 = JCM 13100 = MAFF 239610).

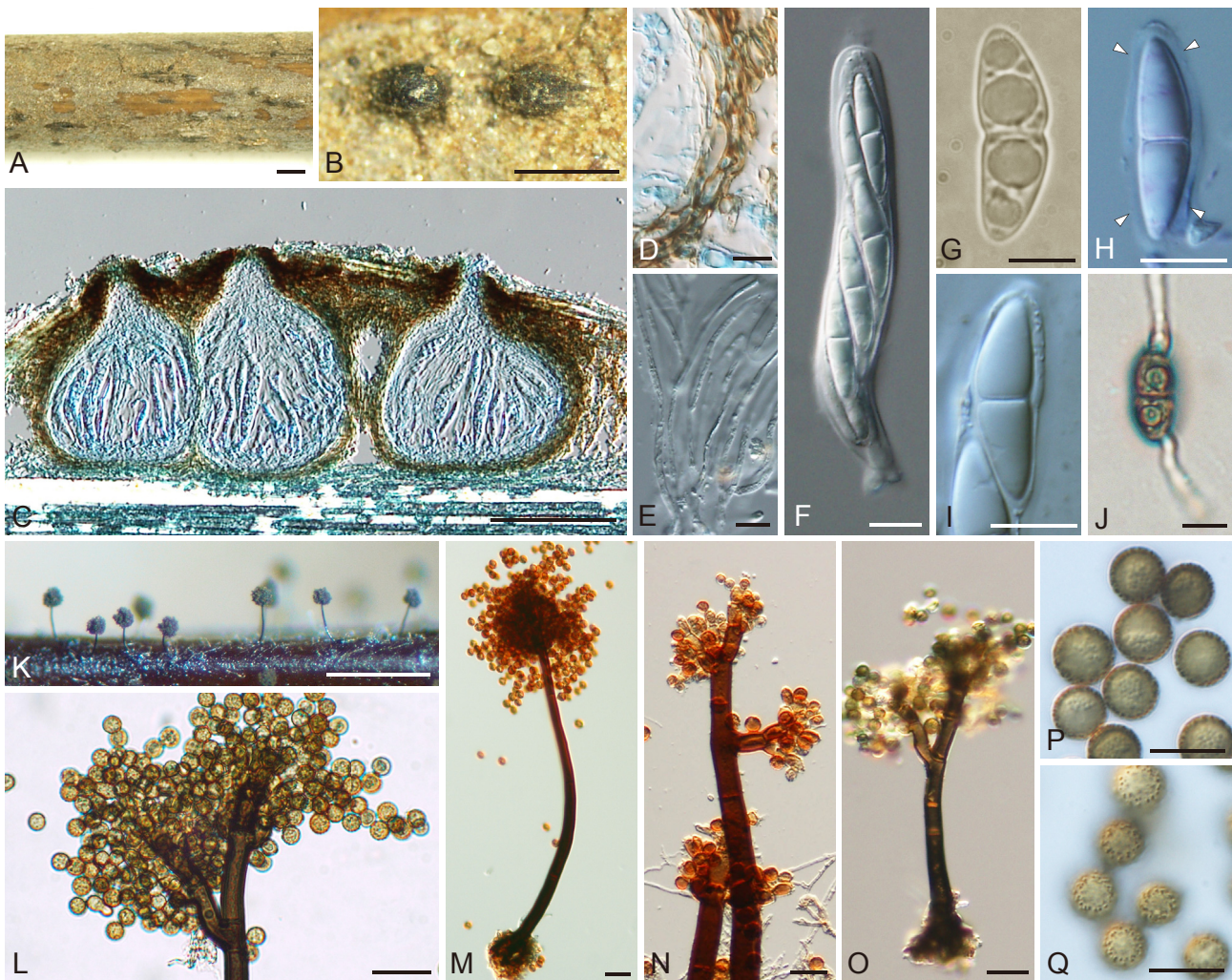
**Notes:** Although we were not able to observe a typical periconia-like asexual morph from our specimen and isolate, we introduce this as a new species of *Periconia* based on the morphology of the sexual morph. The above material shares many characteristics with sexual species in *Periconia* s. str. (i.e., *P. igniaria* and *P. pseudodigitata*), such as those with immersed globose ascomata with papillate necks, a peridium composed of thin-walled polygonal cells, cylindrical asci, and broadly fusiform hyaline ascospores with nearly median septum. *Periconia homothallica*, however, has shorter but wider asci than those of *P. igniaria* (85–119.5  $\times$  13–17.5  $\mu$ m vs. 150–165  $\times$  8–12  $\mu$ m, Booth 1968) and has wider ascospores than those of *P. pseudodigitata* [22–31  $\times$  7–10  $\mu$ m vs. 19.5–27(–32)  $\times$  5–7  $\mu$ m].

In our phylogenetic tree (Fig. 1), *P. homothallica* formed an unsupported clade with *P. igniaria*, as well as species in other hyphomycetous genera, such as “*Sporidesmium*” *tengii* that have macronematous conidiophores and multiseptate conidia (Wu & Zhuang 2005), and *Noosia banksiae*, a species that lacks conspicuous conidiophores (Crous et al. 2011a). The presence of these genera in this lineage may indicate that *Periconia* should be subdivided into several morphologically similar genera or that the taxonomic status of these *Noosia*/*Sporidesmium* isolates should be re-evaluated.





**Fig. 42.** *Periconia homothallica*. A, B. Ascomata on the natural host surface; C. Ascoma in culture (on rice straw); D. Ascoma in longitudinal section (in lactophenol cotton blue); E. Ascomatal wall; F. Pseudoparaphyses; G. Ascus; H–J. Ascospores (arrowheads indicate gelatinous sheath; J. in India ink); K. Germinating ascospores. A, B, D–H, K from KT 916; C, I, J from culture KT 916. Scale bars: A = 2 mm; B, C = 500  $\mu$ m; D = 50  $\mu$ m; E–K = 10  $\mu$ m.



**Fig. 43.** *Periconia pseudodigitata*. A, B. Ascomata on the natural host surface; C. Ascomata in longitudinal section (in lactophenol cotton blue); D. Ascomatal wall; E. Pseudoparaphyses; F. Ascus; G–I. Ascospores (arrowheads indicate gelatinous sheath; H. in Black-Blue ink); J. Germinating ascospore; K. Conidiomata in culture (on rice straw); L–O. Conidial heads and conidiophores; P, Q. Conidia. A, B, E, G–J from KT 1395; C, D, F from KT 644; K–M from culture KT 1195; N from culture KT 644; O–Q from culture KT 1395. Scale bars: A = 1 mm; B, K = 500  $\mu$ m; C = 100  $\mu$ m; D–J, P, Q = 10  $\mu$ m; L–O = 20  $\mu$ m.



***Periconia pseudodigitata*** Kaz. Tanaka & K. Hiray., **sp. nov.** MycoBank MB811329. Fig. 43.

**Etymology:** After its morphological and phylogenetic similarity to *Periconia digitata*.

**Ascomata** numerous, scattered or 2–3 grouped, immersed to erumpent, globose, 160–200 µm high, 130–250 µm diam. **Ostiolar neck** central, papillate, 45–55 µm long, 45–65 µm wide, with hyaline periphyses, surrounded by clypeus-like structure composed of subglobose to polygonal, slightly thickened, 5–7 × 3–4 µm, dark brown cells. **Ascomatal wall** in longitudinal section 8–13 µm thick at side, 5–8 µm thick at the base, composed of 3–5 layers of thin-walled, 6–13 × 2–5 µm, brown cells. **Pseudoparaphyses** cellular, numerous, 2–2.5 µm wide at the apex, 4–6 µm wide at the base, septate, branched, anastomosed, guttulate, associated with gelatinous material. **Asci** fissitunicate, cylindrical, 70–110 × 10.5–15.5 µm (av. 88.4 × 12.2 µm, n = 33), rounded at the apex and with an apical chamber, short-stalked (5–15 µm long), with 8 irregularly biseriate ascospores. **Ascospores** broadly fusiform with rounded ends, straight or slightly curved, 19.5–27(–32) × 5–7 µm (av. 22.5 × 6.1 µm, n = 134), l/w 2.9–4.5 (av. 3.7, n = 134), with almost median septum (0.48–0.55, av. 5.1, n = 36), slightly constricted at the septum, hyaline, with or without guttules, smooth, with an entire sheath; sheath gelatinous, 1–2 µm wide at side and 2–4 µm wide at both ends in fresh, becoming delimited sheath in dry condition. Senescent spores brown, echinulate, 1-septate. Ascospores germinating from one or both ends.

Colonies on PDA (after 4 wk) attaining a diam of 3.2–4.6 cm, straw to amber with white margin; reverse pale luteous; no pigment produced. In culture conidial and spermatial morphs formed. **Conidiophores** macronematous, mononematous, single or rarely 2–3 together on stromata, 250–450 µm long, mostly 8.5–15 µm wide (16–24 µm wide at basal stromatic portion), 4–7-septate at 35–90 µm long intervals, with several branches. **Branches** 10–50 µm long, septate, pale brown to brown, slightly echinulate. **Conidial heads** spherical, ca. 60–120(–150) µm diam. **Conidiogenous cells** monoblastic, discrete on stipe and branches. **Conidia** catenate, globose, brown, verruculose to shortly echinulate, 7–9.5 µm (av. 8.3 µm, n = 90). **Spermogonia** globose to subglobose, single to gregarious, uniloculate to multiloculate, 140–340 µm diam. **Spermatia** subglobose, hyaline, smooth, 3–5 × 1.5–2 µm (av. 3.7 × 1.7 µm, n = 30).

**Specimens examined:** Japan, Aomori, Hirakawa, Hirakawa-river, riverbank, on dead culms of *Phragmites australis*, 5 Aug. 2001, K. Tanaka, KT 644 = HHUF 27569, culture JCM 13164 = MAFF 239674; Aomori, Hirosaki, Kawai, Hirakawa-river, riverbank, 18 Aug. 2001, K. Tanaka, KT 680 = HHUF 27570; Aomori, Hirosaki, Shimizumori, Oowasawa-river, riverbank, 14 Aug 2001, K. Tanaka, KT 673 = HHUF 27571; Hokkaido, Akkeshi, Toraihetsu-river, on submerged stems of herbaceous plant, 3 Jun. 2003, K. Tanaka & S. Hatakeyama, KT 1195A = HHUF 29368, culture JCM 13165 = MAFF 239675; *ibid.*, on dead culms of *Phragmites australis*, 7 Sep. 2003, K. Tanaka & S. Hatakeyama (**holotype** KT 1395 = HHUF 29370, culture **ex-type** CBS 139699 = JCM 13166 = MAFF 239676); *ibid.*, KT 1396–1398 = HHUF 29371–29373.

**Notes:** *Periconia pseudodigitata* is phylogenetically and morphologically closest to *P. digitata*, but the conidial dimensions of *P. pseudodigitata* (7–9.5 µm) are slightly smaller than those

reported for *P. digitata* by Ellis (1971; 7–11 µm). Sequence similarity between these two taxa in the ITS region was 95.8 % (503/525) with 0.8 % (4/525) gaps. *Periconia pseudodigitata* superficially resembles *P. igniaria* (= *Massarina igniaria*), which also has an ascomatal morph. The sexual morph of *P. pseudodigitata*, however, differs from that of *P. igniaria* (Booth 1968) by its narrower ascospores (5–7 µm vs. 8–9 µm) surrounded by a mucilaginous sheath, and shorter but wider asci (70–110 × 10.5–15.5 µm vs. 150–165 × 8–12 µm) with biseriate ascospores. The asexual morph of *P. pseudodigitata* has verruculose to shortly echinulate conidia, while that of *P. igniaria* has conidia with conspicuous spines about 1 µm long (Mason & Ellis 1953, Ellis 1971, Matsushima 1971, Bunning & Griffiths 1984).

***Sulcatisporaceae*** Kaz. Tanaka & K. Hiray., **fam. nov.** MycoBank MB814431.

**Etymology:** Referring to the name of the type genus.

**Ascomata** scattered to grouped, immersed to erumpent, globose in surface view, subglobose to hemispherical in section. **Ostiolar neck** short papillate, central, with periphyses. **Ascomatal wall** composed of several layers of compressed cells, poorly developed at the base. **Pseudoparaphyses** trabeculate, branched and anastomosed. **Asci** clavate, short-stalked, 8-spored. **Ascospores** broadly fusiform, 1-septate, hyaline, with an entire sheath. **Conidiomata** pycnidial, globose. **Conidiogenous cells** cylindrical to doliiform, annellidic or phialidic. **Conidia** ellipsoid to subglobose, hyaline to dark brown, 1- to multi-septate (occasionally muriform), with or without striate ornamentation.

**Type genus:** *Sulcatispora* Kaz. Tanaka & K. Hiray.

**Note:** A new family, *Sulcatisporaceae* is established here for *Magnicamarosporium* and *Sulcatispora* genera nova and *Neobambusicola* (Crous *et al.* 2014b).

***Magnicamarosporium*** Kaz. Tanaka & K. Hiray., **gen. nov.** MycoBank MB811292.

**Etymology:** After its morphological similarity to *Camarosporium* and its large-sized conidiomata.

**Conidiomata** pycnidial, scattered, immersed, depressed globose in section. **Ostiolar neck** central, papillate to short cylindrical. **Paraphyses** filamentous, sometimes branched, associated with gelatinous material. **Conidiophores** absent. **Conidiogenous cells** holoblastic, cylindrical to doliiform. **Conidia** subglobose to obovoid, sometimes obpyriform, muriform, dark brown. Sexual morph unknown.

**Type species:** *Magnicamarosporium iriomotense* Kaz. Tanaka & K. Hiray.

**Notes:** Several coelomycetous genera are known to have dictyosporous pigmented conidia and their taxonomic revision has been reported (e.g., Van Warmelo & Sutton 1981, Nag Raj 1989, Verkley *et al.* 2005, Crous *et al.* 2015b). *Amarenographium* is characterised by longer and branched conidiophores and conidia with cap-like gelatinous appendages (Eriksson 1982). Species in this genus are reported from marine environments (Kohlmeyer &

Volkman-Kohlmeyer 1991) or palms (Taylor & Hyde 2003), and may be genetically close to the *Trematosphaeriaceae* (Hodhod et al. 2012). *Camarosporellum* and *Camarographium* have distoseptate conidia (Sutton 1980, Verkley et al. 2005) rather than euseptate conidia like *Magnicamarosporium*. *Camarographium* is heterogenous, and *C. koreanum* belongs to Unknown Clade III of the *Massarineae* (Fig. 1), while *C. carpini* may have affinity with the *Sporormiaceae* based on a BLAST search using LSU and ITS nrDNA sequences (Crous et al. 2011b). *Camarosporium*, to some degree resembles our new genus, but *Magnicamarosporium* has larger conidiomata with a conspicuous projecting ostiole composed of thick-walled cells, long paraphyses with a gelatinous coating, and larger dark brown conidia than *Camarosporium*. In addition, *Camarosporium* does not have phylogenetic affinity with *Magnicamarosporium*, because the type species of *Camarosporium* (*C. quaternatum*) is a member of the *Pleosporineae*, based on molecular data (Crous et al. 2006, Wijayawardene et al. 2014a, b, d, Crous et al. 2015b).

The phylogenetic tree generated in this study indicated that *Magnicamarosporium* and *Neobambusicola* cluster together with 74 % BP (Fig. 1). However, the conidial morphology of *Neobambusicola* (fusoid-ellipsoid and 1-septate; Crous et al. 2014b) is quite distinct from that of *Magnicamarosporium*.

***Magnicamarosporium iriomotense*** Kaz. Tanaka & K. Hiray., **sp. nov.** MycoBank MB811293. Fig. 44.

*Etymology*: Referring to the location where the specimen was collected.

*Conidiomata* pycnidial, scattered, deeply immersed, depressed globose in section, 330–440 µm high, 700–760 µm diam. *Ostiolar neck* central, papillate to short cylindrical, 120–150 µm long, 80–100 µm wide, composed of polygonal to rectangular, thick-walled, dark brown cells of 2–5 µm diam. *Conidiomatal wall* in longitudinal section uniformly 10–20 µm thick, composed of 3–6 layers of polygonal to subglobose, thin-walled, pale brown cells of 2–7.5 × 2–5 µm. *Paraphyses* sometimes branched, 20–50(–80) µm long, 1.5–2.5 µm wide, associated with gelatinous material. *Conidiophores* absent. *Conidiogenous cells* holoblastic, 7–11 × 4.5–6 µm, cylindrical to doliiform. *Conidia* subglobose to obovoid, sometimes obpyriform, 29–40.5(–42.5) × 19.5–25(–27) µm (av. 34.7 × 22.2 µm, n = 100), l/w 1.2–2.0 (av. 1.6, n = 100), with 4–6 trans- and 1–2 vertical-septa, frequently with oblique septa, dark brown, smooth, without sheath.

Colonies on PDA (after 4 wk) attaining a diam of 1.1–1.5 cm, olivaceous black with buff margin; reverse buff to honey; no pigment produced. In culture asexual morph formed. *Conidiomata* pycnidial, 130–170 µm diam, scattered to 2–3 grouped, globose to subglobose. *Conidia* 29.5–43 × 18–23 µm (av. 35.3 × 20.3 µm, n = 31), l/w 1.5–2.1 (av. 1.7, n = 31). Sexual morph unknown.

*Specimen examined*: Japan, Okinawa, Isl. Iriomote, Tropical botanic garden, on dead twigs of *Diplospora dubia*, 13 Jul. 2011, K. Tanaka & K. Hirayama (**holotype** KT 2822 = HHUF 30125, culture **ex-type** CBS 139696 = JCM 19402 = MAFF 243827).

*Notes*: There are more than 500 names in *Camarosporium* (<http://www.indexfungorum.org>, Aug. 2015). Many of these taxa have been described on the basis of their host associations (Sutton 1980, Marincowitz et al. 2008), but there is no record of

*Camarosporium* from host plants within the *Rubiales*, which includes *Diplospora dubia*, the host of *M. iriomotense*.

***Sulcatispora*** Kaz. Tanaka & K. Hiray., **gen. nov.** MycoBank MB811294.

*Etymology*: From the Latin *sulcatus* meaning “furrowed” and *spora* meaning “spore”, referring to the striate ornamentation of the conidia.

*Ascomata* scattered to grouped, immersed to erumpent, globose in surface view, subglobose to hemispherical in section. *Ostiolar neck* short papillate, central, with paraphyses. *Ascomatal wall* composed of several layers of compressed cells, poorly developed at the base. *Pseudoparaphyses* trabeculate, branched and anastomosed. *Asci* fissitunicate, clavate, short-stalked. *Ascospores* broadly fusiform, 1-septate, hyaline, with an entire sheath. *Conidiomata* pycnidial, globose. *Conidiogenous cells* cylindrical, annellidic. *Conidia* ellipsoid, yellowish brown, multi-septate, with striate ornamentation.

*Type species*: *Sulcatispora acerina* Kaz. Tanaka & K. Hiray.

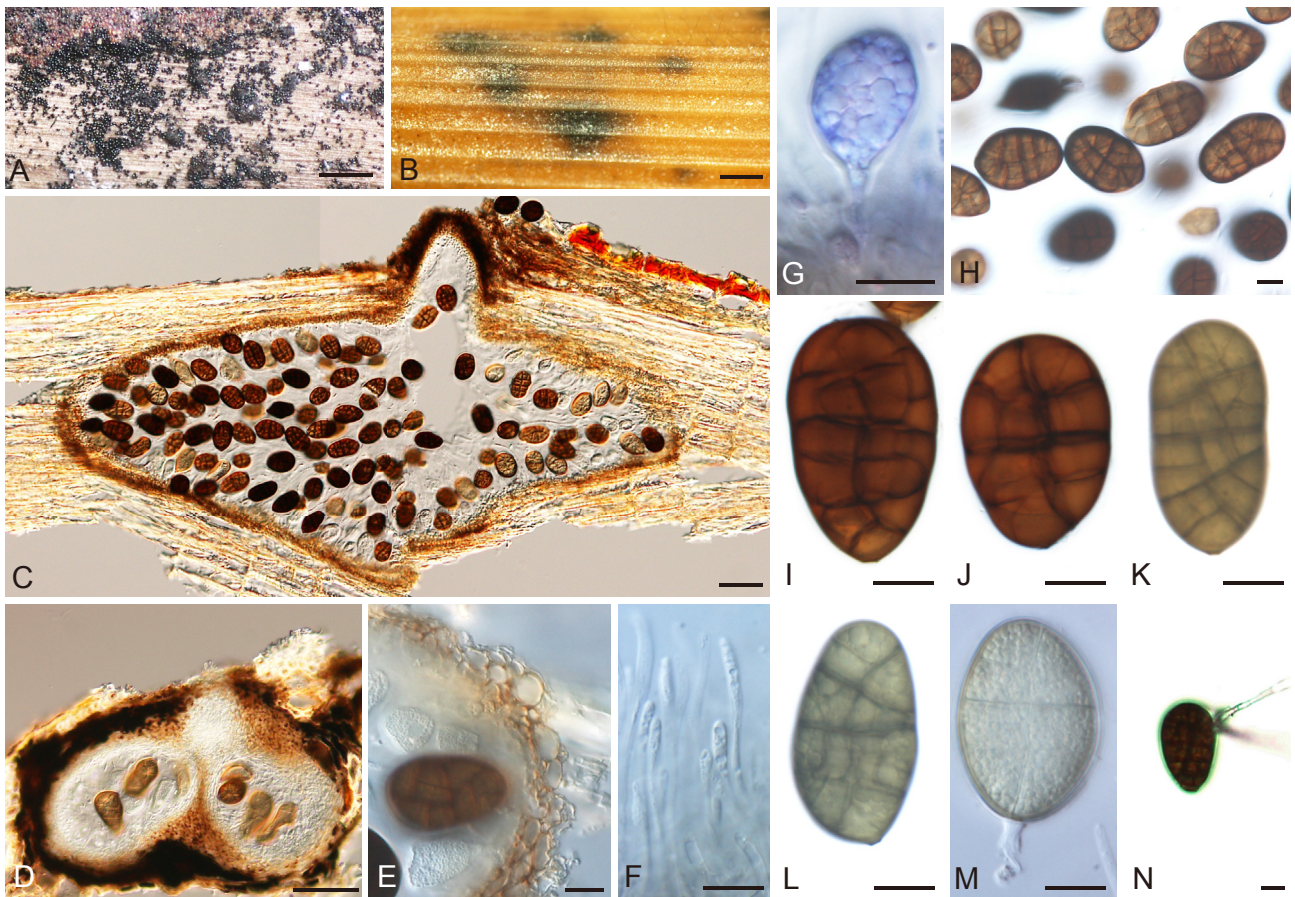
*Notes*: Ascomatal features of *Sulcatispora* are most similar to those of *Massarina s. str.* (*Massarinaceae*) but the ascomata lack a prominent clypeus, in contrast to species within *Massarina s. str.* The most distinctive feature of *Sulcatispora* is the striated conidia. Some species in *Phaeophleospora* (e.g., *P. striae*; Taylor & Hyde 2003) are known to have such conidia, but *Phaeophleospora* (type species: *P. eugeniae*) is phylogenetically placed in the *Mycosphaerellaceae* of the *Capnodiales* (Crous et al. 2007, 2009b). *Sclerostagonospora* also has species with conidia with striate ornamentation (e.g., *S. opuntiae*; Huhndorf 1992), but species of *Sclerostagonospora* have phylogenetic affinities with members of the *Phaeosphaeriaceae*, such as “*Phoma*” *caloplacae* and “*Phoma*” *foliaceiphila* (Crous et al. 2011a, Lawrey et al. 2012), and may have phaeosphaeria-like sexual morphs (Quaedvlieg et al. 2013). *Sulcatispora* is phylogenetically related to *Bambusicola*, which also has a similar asexual morph. *Bambusicola*, however, has conical ascomata with flattened bases, narrower asci (up to 14 µm wide), and narrowly fusiform ascospores (Dai et al. 2012).

***Sulcatispora acerina*** Kaz. Tanaka & K. Hiray., **sp. nov.** MycoBank MB811295. Fig. 45.

*Etymology*: Referring to the generic name of the host.

*Ascomata* scattered, immersed to erumpent, globose in surface view, depressed globose to hemispherical in section, 200–250 µm high, 260–450 µm diam. *Ostiolar neck* inconspicuous short papillate, 60–85 µm diam, central, with paraphyses. *Ascomatal wall* in longitudinal section 12–25 µm thick at sides, composed of polygonal, 5–8 × 2–3 µm, compressed cells, surrounded by short, brown hyphae (2.5–3.5 µm thick), poorly developed at the base. *Pseudoparaphyses* trabeculate, 1.5–2 µm wide, branched and anastomosed, associated with gelatinous material. *Asci* fissitunicate, clavate, 87–113 × 15–20 µm (av. 98.4 × 17.1 µm, n = 17), rounded at the apex, with an apical chamber and faint ring, short-stalked (15–22 µm long). *Ascospores* broadly fusiform, slightly acute at the apex, (23–)26–32 × 7–9 µm (av. 28.5 × 7.7 µm, n = 50), l/





**Fig. 44.** *Magnicamarosporium iriomotense*. A. Immersed conidiomata and discharged conidia lying on the natural host surface; B. Conidiomata produced in culture (on rice straw); C, D. Conidiomata in longitudinal section (C. on nature; D. in culture); E. Conidiomatal wall; F. Paraphyses; G. Conidiogenous cell (in trypan blue); H–L. Conidia; M. Immature conidium; N. Germinating conidium. A, C, E, H–J, N from KT 2822; B, D, F, G, K–M from culture KT 2822. Scale bars: A, B = 500  $\mu$ m; C, D = 50  $\mu$ m; E–N = 10  $\mu$ m.

w 3.2–4.2 (av. 3.7, n = 50), with a submedian primary septum (0.50–0.57; av. 0.53, n = 50), hyaline, surrounded by an entire sheath; sheath 2–3  $\mu$ m wide at first, later diffuse, 4–5  $\mu$ m wide.

Colonies on PDA (after 4 wk) attaining a diam of 2.1–2.4 cm, grey olivaceous to honey; reverse olivaceous to black; no pigment produced. In culture asexual morph formed. *Conidiomata* pycnidial, 180–270  $\mu$ m high, 160–240  $\mu$ m diam, immersed, scattered, globose, ostiolate. *Ostiolar neck* short papillate, 25–45  $\mu$ m long, 35–45  $\mu$ m diam. *Conidiomatal wall* uniformly 10–20  $\mu$ m thick, composed of 4–7 layers of polygonal, 6–10  $\times$  2–3  $\mu$ m, dark brown cells. *Conidiophores* absent. *Conidiogenous cells* cylindrical to lageniform, 10–20  $\mu$ m long, 2  $\mu$ m wide at the apex, 3.5–5.5  $\mu$ m wide at the base, annellidic. *Conidia* ellipsoid, rounded at the apex, truncate at the base, yellowish brown, 20–28(–30)  $\times$  6.5–8  $\mu$ m (av. 25.9  $\times$  7.2  $\mu$ m, n = 50), l/w 3.1–4.2 (av. 3.6, n = 50), 3(–5)-septate (1+1+1, rarely 2+1+2), with striate ornamentation.

*Specimen examined:* Japan, Fukuoka, Kasuya, Hisayama, Yamada, Mt. Tachibanayama, on dead twigs of *Acer palmatum*, 31 Mar. 2012, K. Tanaka (**holotype** KT 2982 = HHUF 30449, culture **ex-type** CBS 139703).

*Note:* The conidia of *S. acerina* are very similar to those of *S. berchemiae*, but *S. acerina* can be distinguished from the latter by its larger ascospores [(23–)26–32  $\times$  7–9  $\mu$ m vs. 22–29  $\times$  5.5–7  $\mu$ m].

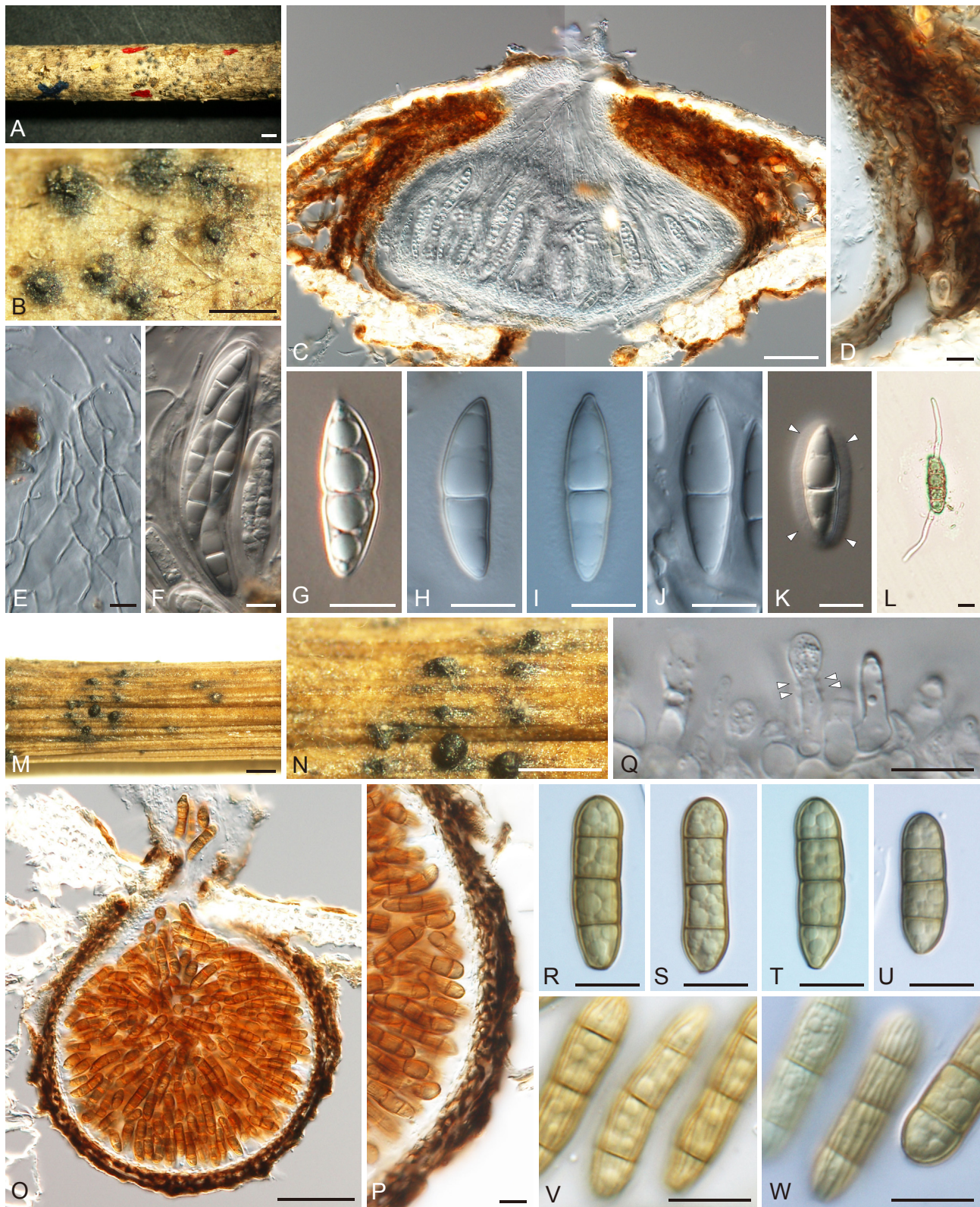
***Sulcatispora berchemiae*** Kaz. Tanaka & K. Hiray., **sp. nov.** MycoBank MB811296. Fig. 46.

*Etymology:* Referring to the generic name of the host.

*Ascomata* scattered to 2–4 grouped, immersed to erumpent, globose in surface view, subglobose to hemispherical in section, 150–280  $\mu$ m high, 350–530  $\mu$ m diam. *Ostiolar neck* short papillate, ca. 60  $\mu$ m diam, central, with periphyses. *Ascomatal wall* in longitudinal section 10–18  $\mu$ m thick at sides, composed of 3–6 layers of 7–18  $\times$  2  $\mu$ m compressed cells, poorly developed at the base. *Pseudoparaphyses* trabeculate, 1.5–2.5  $\mu$ m wide, branched and anastomosed, associated with gelatinous material. *Asci* fissitunicate, clavate, 77.5–100  $\times$  13.5–18  $\mu$ m (av. 90.1  $\times$  15.2  $\mu$ m, n = 20), rounded at the apex, with an apical chamber and faint ring, short-stalked (13–15  $\mu$ m long). *Ascospores* broadly fusiform, 22–29  $\times$  5.5–7  $\mu$ m (av. 26.0  $\times$  6.4  $\mu$ m, n = 50), l/w 3.5–4.4(–4.7) (av. 4.1, n = 50), with a submedian primary septum (0.50–0.57; av. 0.53, n = 49), hyaline, surrounded by an entire sheath; sheath delimited, 2  $\mu$ m wide at first, later diffuse, up to 6  $\mu$ m wide.

Colonies on PDA (after 4 wk) attaining a diam of 2.7–2.8 cm, white to buff; reverse buff to greyish sepia; no pigment produced. In culture asexual morph formed. *Conidiomata* pycnidial, 90–130  $\mu$ m high, 90–150  $\mu$ m diam, immersed, scattered, globose to subglobose, ostiolate. *Ostiolar neck* short papillate. *Conidiomatal wall* uniformly 12–17.5  $\mu$ m thick, composed of flattened, thin-walled, polygonal cells (3.5–6  $\times$  1.5–2.5  $\mu$ m). *Conidiophores* absent. *Conidiogenous cells* cylindrical, 12–15  $\mu$ m long, 2  $\mu$ m wide at the apex, 4–8  $\mu$ m wide at the base, annellidic. *Conidia* ellipsoid, 20–30  $\times$  6.5–8  $\mu$ m (av. 24.8  $\times$  7.1  $\mu$ m, n = 50), l/w 2.9–4.2 (av. 3.5, n = 50), rounded at





**Fig. 45.** *Sulcatispora acerina*. A, B. Ascomata on the natural host surface; C. Ascma in longitudinal section; D. Ascomatal wall; E. Pseudoparaphyses; F. Ascus; G–K. Ascospores (arrowheads indicate mucilaginous sheath); L. Germinating ascospore; M, N. Conidiomata in culture (on rice straw); O. Conidioma in longitudinal section; P. Conidiomatal wall; Q. Conidiogenous cells (arrowheads indicate annellations); R–W. Conidia. A–L from KT 2982; M–W from culture KT 2982. Scale bars: A = 1 mm; B, M, N = 500  $\mu$ m; C, O = 50  $\mu$ m; D–L, P–W = 10  $\mu$ m.

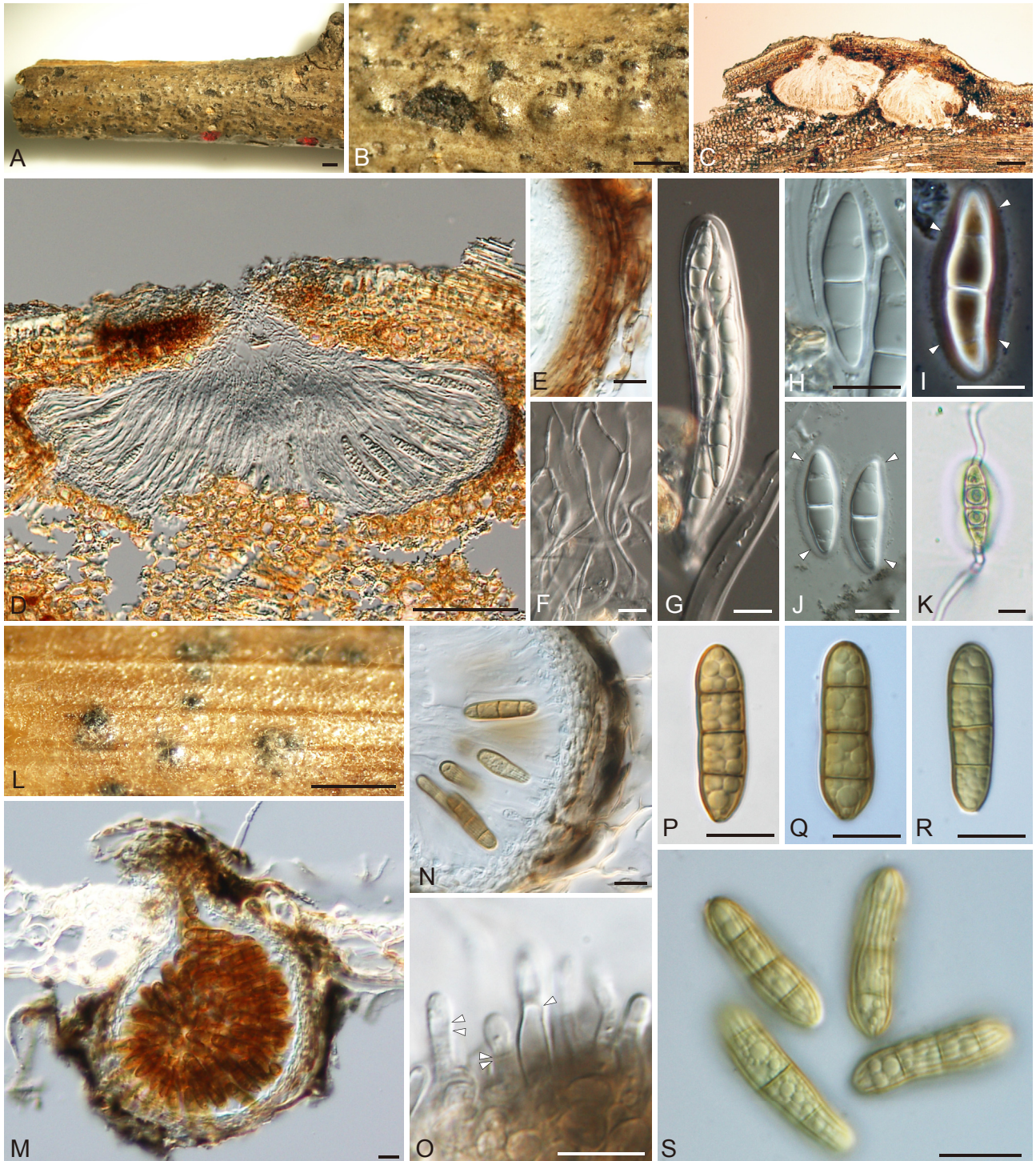
the apex, truncate at the base, yellowish brown, 3(–5)-septate (1+1+1, rarely 2+1+2), with striate ornamentation.

*Specimens examined:* **Japan**, Aomori, Towada, Sanbongi, Yagami, on vines of *Berchemia racemosa*, 2 Dec. 2003, K. Tanaka, S. Hatakeyama & N. Nakagawara (**holotype** KT 1607 = HHUF 29097, culture **ex-type** CBS 139704 = JCM 13101 = MAFF 239611); *ibid.*, KT 1608 = HHUF 29098.

*Note:* This species is closely related to *S. acerina* with regard to its LSU sequences (similarity 1295/1302 = 99.5 %), but the ITS sequence shows a great deal of variation compared to the ITS of *S. acerina* (similarity 770/850 = 90.6 %, with gaps 29/850 = 3.4 %).

**Trematosphaeriaceae** K.D. Hyde *et al.*, *Cryptog. Mycol.* 32: 347. 2011.





**Fig. 46.** *Sulcatispora berchemiae*. A, B. Ascomata on the natural host surface; C, D. Ascomata in longitudinal section; E. Ascomatal wall; F. Pseudoparaphyses; G. Ascus; H–J. Ascospores (arrowheads indicate mucilaginous sheath); K. Germinating ascospore; L. Conidiomata in culture (on rice straw); M. Conidioma in longitudinal section; N. Conidiomatal wall; O. Conidiogenous cells (arrowheads indicate annellations); P–S. Conidia. A–K from KT 1607; L–S from culture KT 1607. Scale bars: A = 1 mm; B, L = 500  $\mu$ m; C, D = 100  $\mu$ m; E–K, M–S = 10  $\mu$ m.

*Type genus:* *Trematosphaeria* Fuckel.

***Trematosphaeria*** Fuckel, Jb. nassau. Ver. Naturk. 23–24: 161. 1870.

*Type species:* *Trematosphaeria pertusa* Fuckel.

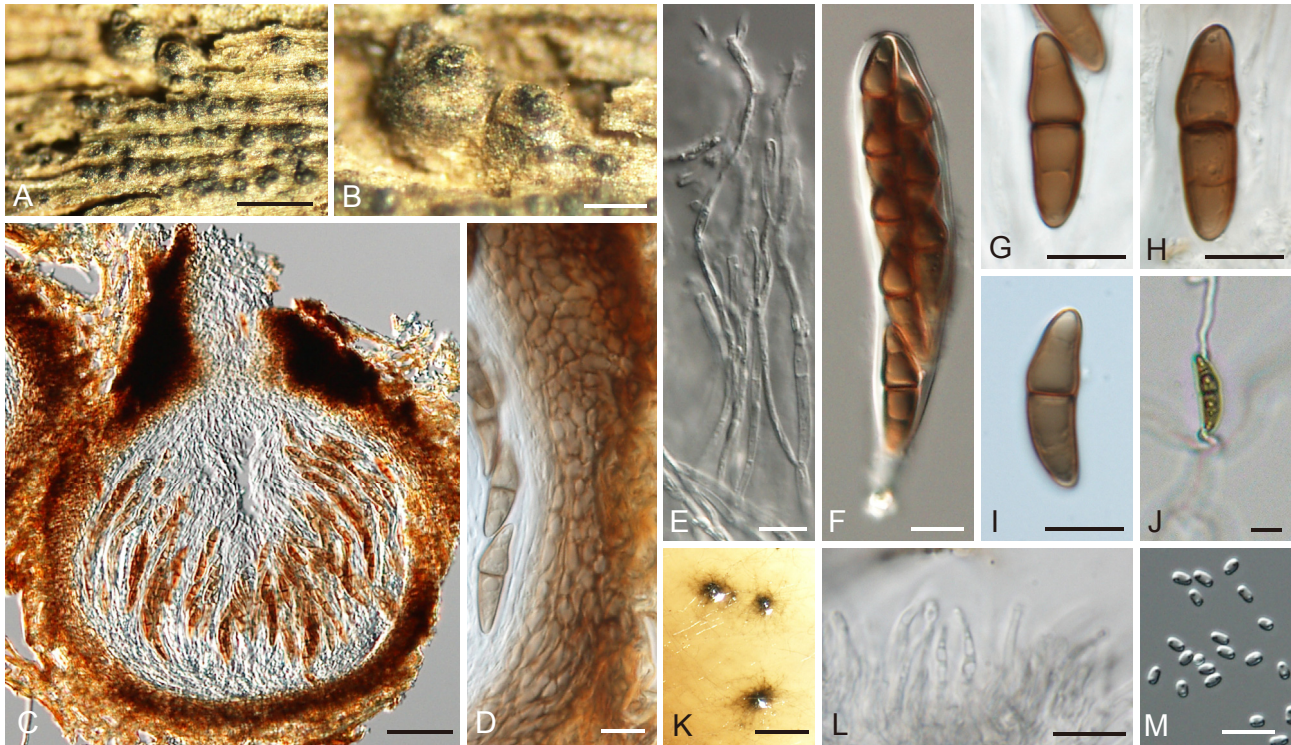
*Notes:* Although more than 200 species have been assigned to *Trematosphaeria* (<http://www.indexfungorum.org>, Aug. 2015), most of these species have not had their generic placements verified by molecular evidence. The type species of this genus,

*T. pertusa*, usually grows on terrestrial wood, but also can survive within freshwater (Suetrong *et al.* 2011b). Recently, *Madurella grisea*, originating from a human infection, water and pastry gel, was added to *Trematosphaeria* based on a multi-gene phylogeny (Ahmed *et al.* 2014).

***Trematosphaeria pertusa*** Fuckel, Jb. Nassau. Ver. Naturk. 23–24: 161. 1870. Fig. 47.

*Ascomata* gregarious, immersed or becoming superficial by weathering of host tissue, globose to pyriform in section,





**Fig. 47.** *Trematosphaeria pertusa*. A, B. Ascomata on the natural host surface; C. Ascoma in longitudinal section; D. Ascomatal wall; E. Pseudoparaphyses; F. Ascus; G–I. Ascospores; J. Germinating ascospore; K. Spermogonia in culture; L. Spermatiphores; M. Spermatia. A–J from KT 1496; K–M from culture KT 1496. Scale bars: A, K = 500 µm; B = 200 µm; C = 50 µm; D–J, L, M = 10 µm.

270–380 µm high, 190–350 µm diam. *Ostiolar neck* central, papillate to cylindrical, 70–140 µm long, 90–130 µm wide, composed of thick-walled, heavily melanised cells (2–4 µm diam), with periphyses. *Ascomatal wall* in longitudinal section uniformly 17–25 µm thick, composed of 6–9 layers of polygonal to rectangular, thin-walled, brown cells (2–15 × 2–5 µm). *Pseudoparaphyses* branched and anastomosed, 1.5–2.5 µm wide. *Asci* fissitunicate, clavate to cylindrical, 73.5–102.5 × 12.5–17 µm (av. 89.8 × 14.6 µm, n = 20), with a stipe of 8.5–22 µm long, with 8 biserial ascospores. *Ascospores* fusiform, slightly curved, 20–27.5 × 6–8 µm (av. 23.9 × 7.1 µm, n = 50), l/w 2.8–4.0 (av. 3.4, n = 50), with a nearly median or somewhat suprmedian primary septum (0.43–0.53; av. 0.48, n = 50), rarely 3-septate, slightly constricted at the septum, reddish brown, smooth, without sheath.

In culture spermatial morph formed. *Spermatia* subglobose, hyaline, 2.8–3.9 × 1.9–2.3 µm (av. 3.4 × 2.1 µm, n = 20), l/w 1.4–1.9 (av. 1.6, n = 20).

**Specimens examined:** **Japan**, Aomori, Hirosaki, Aoki, Mohei-pond, on submerged twigs of woody plant, 27 Sep. 2003, K. Tanaka & N. Asama, KT 1496 = HHUF 30153, culture JCM 19430 = MAFF 243879; Hokkaido, Isl. Rebun, Nairo, Nairo-river, on submerged twigs of woody plant, 16 Aug. 2013, K. Tanaka, KT 3314 = HHUF 30452, culture CBS 139705; *ibid.*, KT 3315 = HHUF 30453, culture CBS 139706.

**Notes:** We identified our specimens/isolates as *T. pertusa*, the type species of *Trematosphaeria*, based on close similarities between sequences obtained from the above isolates and an ex-epitype strain of the species (CBS 122368; Ahmed *et al.* 2014), i.e., 484/485 (99.8 %) in ITS (GenBank KF015668) and 900/907 (99.2 %) in *tef1* (GenBank KF015701) regions. In comparison with the

description of *T. pertusa* based on the neotype (Zhang *et al.* 2008b), our specimens have shorter asci (73.5–102.5 µm vs. 100–145 µm) and ascospores (av. 20–27.5 µm vs. 27.5–32.5 µm). Further collections of this species are needed to clarify the taxonomic significance of the intraspecific morphological variation.

## Unknown Clade I

***Fuscostagonospora*** Kaz. Tanaka & K. Hiray., **gen. nov.**  
Mycobank MB811330.

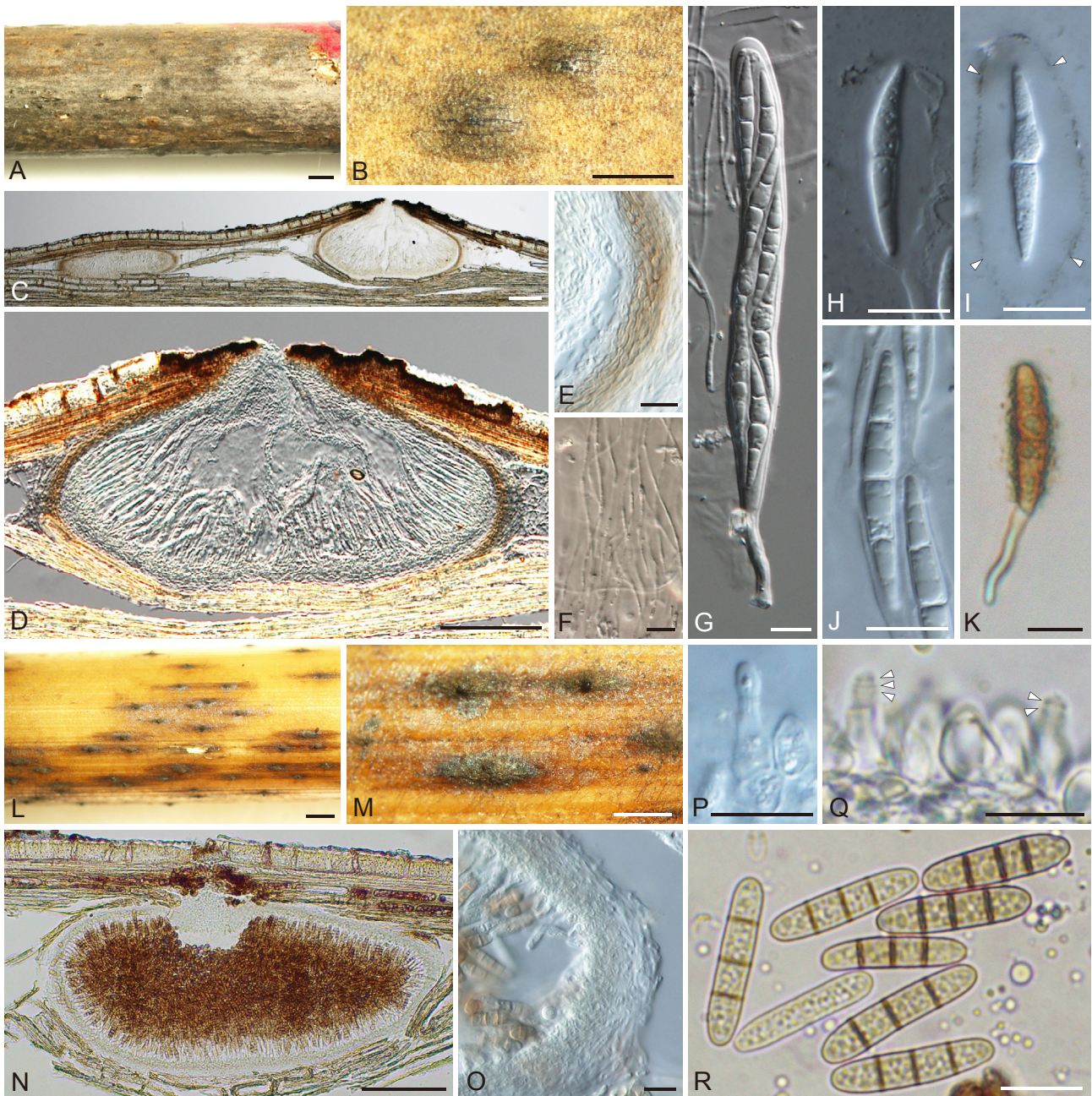
**Etymology:** From the Latin *fusco-*, meaning dark brown and the generic name, *Stagonospora*.

*Ascomata* scattered, immersed, globose to subglobose. *Ostiolar neck* clypeate, central, short papillate, with periphyses. *Ascomatal wall* composed of pale brown, compressed cells. *Pseudoparaphyses* appearing trabecular, branched and anastomosed, associated with gelatinous material. *Asci* fissitunicate, cylindrical, with a long stipe. *Ascospores* narrowly fusiform, 1(–3)-septate, hyaline, with an entire sheath. *Conidiomata* pycnidial, scattered, immersed, depressed globose, ostiolate. *Conidiomatal wall* composed of thin-walled cells. *Conidiophores* absent. *Conidiogenous cells* doliiform, annellidic. *Conidia* yellow to pale brown and 3-septate.

**Type species:** *Fuscostagonospora sasae* Kaz. Tanaka & K. Hiray.

**Notes:** The new genus, *Fuscostagonospora*, is introduced to accommodate the bambusicolous fungus, *F. sasae*. This genus is reminiscent of *Stilbospora* in having pigmented phragmosporous conidia, but the latter genus has acervular conidiomata filled with paraphyses and phylogenetically groups within the





**Fig. 48.** *Fuscostagonospora sasae*. A, B. Ascomata on the natural host surface; C, D. Ascomata in longitudinal section; E. Ascomatal wall; F. Pseudoparaphyses; G. Ascus; H–J. Ascospores (arrowheads indicate gelatinous sheath; H, I. in India ink); K. Germinating ascospore; L, M. Conidiomata in culture (on rice straw); N. Conidioma in longitudinal section; O. Conidiomatal wall; P, Q. Conidiogenous cells (arrowheads indicate annellations); R. Conidia. A–K, N, O from KT 1467; L, M, P–R from culture KT 1467. Scale bars: A, L = 1 mm; B, M = 500  $\mu$ m; C, D, N = 100  $\mu$ m; E–K, O–R = 10  $\mu$ m.

*Diaporthales* in the *Sordariomycetes* (Crous *et al.* 2012, Voglmayr & Jaklitsch 2014). The conidial morphology of *Fuscostagonospora* is also similar to that of *Sclerostagonospora*, but the latter genus has phylogenetic affinity with species in the *Phaeosphaeriaceae* (*Pleosporales*) and may have a phaeosphaeria-like sexual morph (Quaedvlieg *et al.* 2013). In overall morphology, such as the narrowly fusiform ascospores and pigmented septate conidia, as well as in host preferences, *Fuscostagonospora* is most similar to *Bambusicola* (*Bambusicolaceae*; Dai *et al.* 2012). *Fuscostagonospora*, however, has ascomata with a prominent clypeus and phylogenetically deviates from the *Bambusicolaceae*, forming an Unknown Clade I (Fig. 1).

***Fuscostagonospora sasae*** Kaz. Tanaka & K. Hiray., *sp. nov.*  
Mycobank MB811331. Fig. 48.

*Etymology*: Referring to the host genus.

*Ascomata* scattered, immersed, globose to subglobose, 220–250  $\mu$ m high, 400–450  $\mu$ m diam. *Ostiolar neck* clypeate, central, short papillate, 50–65  $\mu$ m long, 75–90  $\mu$ m wide, with periphyses. *Ascomatal wall* in longitudinal section 10–15  $\mu$ m thick at sides, composed of 3–4 layers of compressed, 5–10  $\times$  2–3  $\mu$ m, pale brown cells. *Pseudoparaphyses* appearing trabecular, 1–1.5  $\mu$ m wide, branched and anastomosed, associated with gelatinous material. *Asci* fissitunicate, cylindrical, 90–140  $\times$  8.5–14.5  $\mu$ m (av. 107.6  $\times$  9.8  $\mu$ m,  $n = 30$ ), with an apical chamber, with a relatively long stipe (20–32.5  $\mu$ m long). *Ascospores* narrowly fusiform, 1(–3)-septate, 22–31.5(–36)  $\times$  3–5.5  $\mu$ m (av. 27.5  $\times$  4.1  $\mu$ m,  $n = 25$ ), l/w 5.6–8.3 (av. 6.8,  $n = 25$ ), with a nearly median septum (0.48–0.57; av. 0.52,  $n = 20$ ), hyaline, surrounded by an entire gelatinous sheath up to 7  $\mu$ m wide.



*Conidiomata* on the natural host pycnidial, scattered, immersed, depressed globose in section, 250 µm high, 500 µm diam, ostiolate. *Conidiomatal wall* in longitudinal section 12–20 µm thick, composed of thin-walled, hyaline to pale brown cells. In culture same coelomycetous asexual morph formed. *Conidiophores* absent. *Conidiogenous* cells doliiform, annellidic, 5–12 × 3–7 µm (av. 9.7 × 5.3 µm, n = 20). *Conidia* hyaline and aseptate at first, later yellow to pale brown and 3-septate, 17–22.5 × 4–5 µm (av. 19.8 × 4.4 µm, n = 50), l/w (3.4–)3.7–5.5 (av. 4.5, n = 50).

Colonies on PDA (after 4 wk) attaining a diam of 3.7–4.7 cm, iron grey; reverse similar; no pigment produced. In culture asexual morph formed.

*Specimen examined*: Japan, Fukushima. Minamiaizu, Ose pond, on dead twigs of *Sasa* sp., 30 Aug. 2003, N. Asama (holotype KT 1467 = HHUF 29106, culture ex-type CBS 139687 = JCM 13104 = MAFF 239614).

## Unknown Clade IV

*Pseudoxylomyces* Kaz. Tanaka & K. Hiray., **gen. nov.** MycoBank MB811332.

*Etymology*: After its morphological similarity to *Xylomyces*.

*Colonies* on natural substratum scattered, dark brown, glistening. *Mycelium* immersed in agar medium, pale brown to reddish brown. *Stromata* lacking. *Conidiophores* branched, septate, brown. *Conidiogenesis* holoblastic. *Conidia* broadly fusiform, with several trans-septa of thick-walled, yellowish brown to dark brown with paler end cells. *Chlamydospores* absent. Sexual morph unknown.

*Type species*: *Pseudoxylomyces elegans* (Goh *et al.*) Kaz. Tanaka & K. Hiray.

*Notes*: A new genus *Pseudoxylomyces* is proposed to accommodate *Xylomyces elegans*. The type species of *Xylomyces* (*X. chlamydosporus*) is known to have phylogenetic affinities with the freshwater genus, *Jahnula* in the *Jahnulales* (Campbell *et al.* 2007, Sivichai *et al.* 2011). Therefore, *Xylomyces* is now regarded as a synonym of *Jahnula* (Hyde *et al.* 2013). *Xylomyces elegans* was excluded from the genus (Suetrong *et al.* 2011a), because it did not cluster with the type species of *Xylomyces* in phylogenetic analyses using ITS (Prihatini *et al.* 2008) and SSU sequences (Shearer *et al.* 2009). However, no taxonomic decision has been made for *X. elegans*.

*Xylomyces* is characterised by its lack of conidiophores and conidiogenous cells but it produces large, dark, thick-walled, multiseptate, intercalary, narrowly fusiform chlamydospores (Goos *et al.* 1977, Goh *et al.* 1997). In contrast, *Pseudoxylomyces* typified by *P. elegans* is quite distinctive in producing broadly fusiform conidia holoblastically at the tip of the conidiophores (Fig. 49A, B).

*Pseudoxylomyces elegans* (Goh *et al.*) Kaz. Tanaka & K. Hiray., **comb. nov.** MycoBank MB811333. Fig. 49.

*Basionym*: *Xylomyces elegans* Goh *et al.*, Mycol. Res. 101: 1324. 1997.

*Mycelium* immersed in agar, pale brown to reddish brown. *Conidiophores* up to 40 µm long. *Conidiogenesis* holoblastic. *Conidia* broadly fusiform, 4–7-septate, 72.5–98 × 35–41 µm, l/w 2.0–2.8, brown, with paler end cells. Sexual morph unknown.



Fig. 49. *Pseudoxylomyces elegans*. A, B. Conidiophores and conidia; C–E. Conidia (E, bleached conidium); F. Germinating conidium. A, B, D, E from culture KT 2887; C, F from KT 2887. Scale bars: A = 200 µm; B–F = 20 µm.

*Specimen examined*: Japan, Okinawa, Isl. Iriomote, Oomijya-river, on submerged twigs of woody plant, 12 Jul. 2011, K. Tanaka & K. Hirayama, KT 2887 = HHUF 30139, culture MAFF 243852.

*Notes*: This species appears to be widely distributed and has been reported from Australia, Seychelles (Goh *et al.* 1997), Thailand (Sivichai *et al.* 2000), Hong Kong (Tsui & Hyde 2004), USA (Raja *et al.* 2007), Brazil (Barbosa & Gusmão 2011), and India (Patil & Borse 2015). A BLAST search using ITS sequences from our culture showed 98.7 % (464/470) similarity to sequences of *X. elegans* (GenBank FJ887920) collected from Thailand (Prihatini *et al.* 2008).

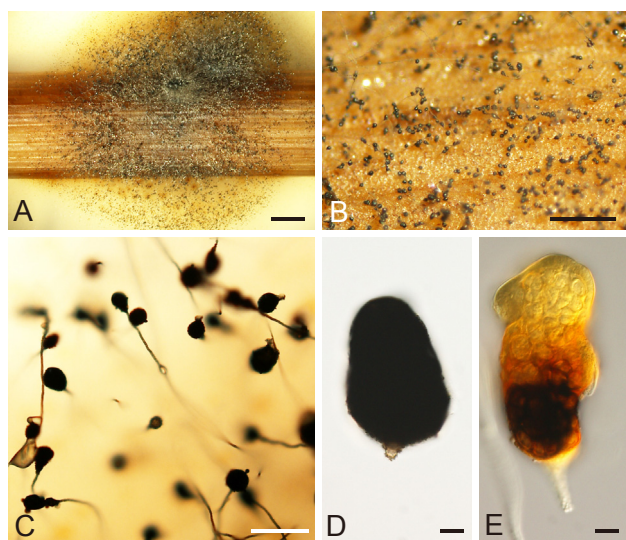
## Unknown Clade VI

*Monodictys* S. Hughes, Canad. J. Bot. 36: 785. 1958.

*Type species*: *Monodictys putredinis* (Wallr.) S. Hughes, Canad. J. Bot. 36: 785. 1958.

*Notes*: More than 60 species have been described in *Monodictys* (<http://www.indexfungorum.org>, Aug. 2015), but their phylogenetic placements are mostly unknown. Apparently, *Monodictys* is a heterogeneous group of hyphomycetes. Several species within this genus such as *M. arctica* (Leptosphaeriaceae; Day *et al.* 2006), *M. cf. putredinis* (Melanommataceae; Samuels 1980), *Monodictys* spp. (Parabambusicolaceae; Fig. 1), and *M. capensis* (Unknown Clade IV; Fig. 1) are scattered within the *Dothideomycetes*. *Monodictys pelagica* is known to have phylogenetic relationships with the *Sordariomycetes* (Mouzouras & Jones 1985, Campbell *et al.* 2002), and *Monodictys* sp. is reported as an asexual morph of *Hyaloscypha albohyalina* var. *monodictys* (Hosoya & Huhtinen





**Fig. 50.** *Monodictys capensis*. A, B. Colonies on rice straw in culture; C. Conidiophores and conidia; D, E. Conidia (E. bleached conidium). All from culture HR 1. Scale bars: A = 2 mm; B = 500  $\mu$ m; C = 100  $\mu$ m; D, E = 10  $\mu$ m.

2002; currently *Hyaloscypha monodictys*, Han *et al.* 2014) in the *Leotiomyces*. Phylogenetic reassessment of many species of *Monodictys* including the type species of this genus (*M. putredinis*) is needed for taxonomic revision of this genus.

***Monodictys capensis*** R.C. Sinclair *et al.*, Mycotaxon 59: 359. 1996. Fig. 50.

*Specimen examined:* Russia, St. Petersburg, Botanical garden of the Komarov Botanical Institute of the Russian Academy of Sciences, on dead wood of *Padus avium*, 19 Oct. 2005, V. Mel'nik, HR 1 = HHUF 29712 = LE 226298, culture CBS 134928 = VKM F-4506.

*Notes:* This material has been reported as *M. capensis* by Mel'nik & Shabunin (2010). In culture, abundant conidia similar to those on the natural host were produced on rice straw agar (RSA).

## DISCUSSION

### New familial lineages

The *Parabambusicolaceae* is erected here to accommodate *Aquastroma* (Fig. 40) and *Parabambusicola* (Fig. 41), as well as two unnamed "*Monodictys*" species. This family is superficially similar to the *Bambusicolaceae* in having depressed globose to hemispherical ascomata. In particular, *Parabambusicola*, the type genus of the *Parabambusicolaceae*, has a bambusicolous habitat like that of *Bambusicola* (Dai *et al.* 2012). However, members of the *Parabambusicolaceae* have ascomata surrounded by stromatic tissue (*Parabambusicola*) or compressed necks with wide ostioles (*Aquastroma*), and also multiseptate, clavate to fusiform, hyaline ascospores, unlike those of the *Bambusicolaceae*. Asexual morphs possessing sporodochial conidiomata and muriform conidia like those of *Monodictys* are not found in the *Bambusicolaceae*.

A new family *Sulcatisporaceae* is introduced to encompass *Magnicamarosporium* and *Sulcatispora* genera nova, as well as *Neobambusicola* (Crous *et al.* 2014b). These three genera form a strongly supported clade (97 %), which is a sister of the *Bambusicolaceae*. The sexual morphs of species in the

*Sulcatisporaceae* are superficially similar to those of *Bambusicolaceae*, but subglobose to obovoid conidia with muriform septation (*Magnicamarosporium*) or 1 to several septate conidia with or without striate ornamentation (*Neobambusicola*, *Sulcatispora*) are not found in species of the *Bambusicolaceae*.

We resurrect the *Periconiaceae* as a sister taxon of the *Massarinaceae* (Fig. 1). The name of "*Periconiaceae*" was originally used for dematiaceous hyphomycetes that have macronematous conidiophores and 1-celled, pigmented conidia forming conidial heads (Saccardo 1886). Later, the group was raised to familial rank, and *Periconia* and *Stachybotrys* were assigned to the *Periconiaceae* (Nannizzi 1934), the latter genus now being placed in its own family, *Stachybotryaceae* (Crous *et al.* 2014a). The *Periconiaceae* has long been ignored in modern fungal systematics, but it should be regarded as a natural taxon in the suborder *Massarineae*. The main genus *Periconia* has been treated as a member of the *Massarinaceae* based on a topology of genealogical trees (Kodsueb *et al.* 2007, Schoch *et al.* 2009, Zhang *et al.* 2009b, c, 2012, Hyde *et al.* 2013). Species of *Periconia*, however, are separated from the *Massarinaceae* and form a strongly supported clade of the *Periconiaceae* (100 %; Fig. 1). Sexual morphs within the *Periconiaceae* (Figs 42, 43) differ from those of *Helminthosporium* (Fig. 25) and *Massarina* (Fig. 26) in the *Massarinaceae*. Members in the latter family possess medium to large subglobose ascomata, which are covered by a clypeus, and have clavate asci. The small ascomata of *Periconia* superficially resemble those of *Stagonospora* (= *Saccharicola*, *Massarinaceae*; Figs 27–29) but differ in having a peridium composed of small-sized compressed cells. The most diagnostic features of the *Periconiaceae* are the asexual morphs of *Periconia*; these have macronematous, mononematous conidiophores with globose to cylindrical, blastic conidia (Mason & Ellis 1953, Ellis 1971).

*Dictyosporium* and phenotypically similar genera, such as *Aquatichiospora* and *Pseudodictyosporium*, have been considered to belong in the *Massarinaceae* (Wijayawardene *et al.* 2012). However, the group including dictyosporium-like fungi forms a distinct lineage (as *Dictyosporiaceae* nom. prov.; see Liu *et al.* 2015), independent from the *Massarinaceae* (Fig. 1). One of the diagnostic features of the *Dictyosporiaceae* is their multicellular cheiroid conidia (Fig. 2), and these morphological features separate it from other families in the *Massarineae*. Sexual morphs observed in the *Dictyosporiaceae* (*Gregarithecium* and *Pseudocoleophoma*; Figs 3–5) are somewhat similar to those of the *Massarinaceae* (e.g., *Stagonospora*; Figs 27–29) or the *Periconiaceae* (e.g., *Periconia*; Figs 42, 43), but can be differentiated by their subglobose to hemispherical ascomata with or without surrounding stromatic tissue, short ascomatal necks without clypeus, cylindrical asci with a short stipes, and narrowly fusiform, 1-septate, hyaline ascospores.

### Summary of accepted families and genera *incertae sedis* of the *Massarineae*

Based on our phylogenetic analyses and morphological evaluation of fungi in the *Massarineae*, we recognise the following 12 families, as well as "*Massarineae, incertae sedis*".

***Bambusicolaceae*.** This family was established by Hyde *et al.* (2013) to accommodate *Bambusicola* species on bamboo (Dai *et al.* 2012). *Palmiascoma* on dead fronds of palms

in Thailand was also reported as a member of *Bambusicolaceae* (Liu *et al.* 2015).

**Dictyosporiaceae (Figs 2–5).** *Dictyosporiaceae* (nom. prov., see Liu *et al.* 2015) includes the four asexual genera *Aquaticheirospora* (Kodsueb *et al.* 2007), *Dendryphiella* (Jones *et al.* 2008), *Dictyosporium* (Fig. 2) and *Pseudodictyosporium* (Kirschner *et al.* 2013), and two new genera with sexual morphs, *Gregarithecium* (Fig. 3) and *Pseudocoleophoma* (Figs 4, 5). The two asexual monotypic genera *Cheirosporium* (Cai *et al.* 2008) and *Kamatia* (Kirschner *et al.* 2013) also belong in the *Dictyosporiaceae*. “*Diplococcium*” *asperum* (Pirozynski 1972, Goh & Hyde 1998) is located in the *Dictyosporiaceae* (Fig. 1), but the type species of *Diplococcium* (*D. spicatum*) has phylogenetic affinity with the *Helotiales* (Shenoy *et al.* 2010). This species as well as *Diplococcium pulneyense*, the asexual morph of *Otthia pulneyensis* (Subramanian & Sekar 1987), are both related to the *Dothideomycetes*, and should be excluded from *Diplococcium* s. str. Likewise, “*Paraconiothyrium*” *flavescens* in the *Dictyosporiaceae* clade should be renamed, because the type lineage of the genus, represented by *P. estuarinum*, groups with the *Didymosphaeriaceae* (= *Montagnulaceae*) (Verkley *et al.* 2014). The *Dictyosporiaceae* clade includes *Digitodesmium bambusicola* (Cai *et al.* 2002), but the phylogenetic placement of the generic type *D. elegans* is unknown at present.

**Didymosphaeriaceae (Figs 6–11).** Ariyawansa *et al.* (2014) accepted 16 genera including *Karstenula* (Fig. 6), *Neokalmusia* (Figs 7, 8), and *Paraphaeosphaeria* (Fig. 9) as members of the *Didymosphaeriaceae*, and subsequently three genera, *Paracamarosporium*, *Pseudocamarosporium*, and *Pseudotrachia* were also added to this family (Thambugala *et al.* 2014, Wijayawardene *et al.* 2014d). We assigned the hyphomycetous genus *Spegazzinia* (Figs 10, 11) with basauxic conidiogenesis and pigmented conidia with spine-like appendages, to the *Didymosphaeriaceae*, although it has long been treated as “*Ascomycota, genera incertae sedis*” (Wijayawardene *et al.* 2012). However, taxonomic reassessment will be required for several genera, such as *Neokalmusia*, *Paraconiothyrium*, *Paraphaeosphaeria* and *Pseudocamarosporium*, because their monophyletic status was not supported in this study. In addition to these genera, the type species of *Cucurbitodithis* (*C. pityophila*) resides in the *Didymosphaeriaceae* (Fig. 1). *Phaeodothis winteri* with a didymosphaeria-like sexual morph (Aptroot 1995), and *Sporidesmiella fusiformis* with macronematous conidiophores and obclavate, multi-distoseptate, pigmented conidia (Wu & Zhuang 2005) are placed in the *Didymosphaeriaceae*, but sequences of the type species of these genera are presently unknown. Two species of “*Camarosporium*” with muriform conidia, *C. brabeji* and *C. leucadendri* (Marincowitz *et al.* 2008), are positioned in the *Didymosphaeriaceae*, and have subsequently been allocated to *Pseudocamarosporium* and *Paracamarosporium*, respectively (Crous *et al.* 2015b). In contrast, the type species of *Camarosporium* (*C. quaternatum*) is known to cluster within the *Pleosporineae* (Crous *et al.* 2006, Wijayawardene *et al.* 2014b). *Munkovalsaria appendiculata* (Aptroot 2004) groups with *Montagnula* species (*M. aloes*, *M. opulenta* and *M. graminicola*). However, *Munkovalsaria* is apparently polyphyletic, because *M. rubra* is found outside the *Pleosporales* (Voglmayr & Jaklitsch 2011, Hernández-Restrepo *et al.* 2014). Although *Munkovalsaria* is regarded as a member of the *Dacampiaceae* (Hyde *et al.* 2013), molecular data from the generic type (*M. donacina*) are needed to clarify its phylogenetic position.

**Latoruaceae.** This family was established by Crous *et al.* (2015a) to accommodate two hyphomycetous genera, *Latorua* and *Polyschema*, both mostly known from soil (Ellis 1976, Shenoy *et al.* 2010, Crous *et al.* 2015a). More recently, a new genus *Matsushimamyces* from soil has been added to this family (Sharma *et al.* 2015).

**Lentitheciaceae (Figs 12–24).** *Darksidea* (Knapp *et al.* 2015), *Katumotoa* (Fig. 12), *Keissleriella* (Figs 13–18), *Lentithecium* (Figs 19, 20), *Murilentithecium* (Wanasinghe *et al.* 2014), *Phragmocamarosporium* (Wijayawardene *et al.* 2015), *Poaceascoma* (Phookamsak *et al.* 2015) and *Tingoldiogo* (Fig. 24) have been assigned in the *Lentitheciaceae*, and we add another two genera, i.e., *Neoophiosphaerella* (Fig. 21) and *Setoseptoria* (Figs 22, 23). The clade comprising species of these six genera received moderate BP support (71 %; Fig. 1). “*Wettsteinina*” *lacustris* is also a member of this clade (Schoch *et al.* 2009). In our preliminary analysis using SSU and LSU sequences, *Ascorhombispora aquatica* (Cai & Hyde 2007b) resided in the *Lentitheciaceae* (data not shown), but the phylogenetic affinity of this species with members in the *Dictyosporiaceae* (Cai & Hyde 2007b) or *Didymosphaeriaceae* (Shearer *et al.* 2009) has also been suggested. Further investigation using additional sequence data is needed to confirm familial placement of this genus.

**Macrodiplodiopsidaceae.** Three species with coelomycetous asexual morphs, i.e., *Camarographium koreanum* (on *Cornus*, Verkley *et al.* 2005), *Macrodiplodopsis desmazieri* (on *Platanus*, Barr 1982), and *Pseudochaetosphaeronema larense* (a human pathogen, Ahmed *et al.* 2014) comprise the *Macrodiplodiopsidaceae*, which was recently established by Crous *et al.* (2015a).

**Massarinaceae (Figs 25–29).** *Byssothecium* (Boise 1983), *Helminthosporium* (Fig. 25), *Massarina* (Fig. 26), *Stagonospora* (Figs 27–29) and *Suttonomyces* (Wijayawardene *et al.* 2015) are accepted in the *Massarinaceae* (Fig. 1). *Neottiosporina paspali* (Sutton & Alcorn 1974) should be treated as *Stagonospora paspali* (Atkinson 1897) based on the phylogenetic topology (Fig. 1) as well as the morphological resemblance with *S. paludosa*, the type species of *Stagonospora* (Quaedvlieg *et al.* 2013). The two *Corynespora* species *C. leucadendri* (Quaedvlieg *et al.* 2013) and *C. olivacea* (Ellis 1960) clustered in this family but are not congeneric. The type species of *Corynespora* (*C. mazei* = *C. cassicola*, Wei 1950) is sister of the clade of the *Pleosporineae* + *Massarineae* (Hyde *et al.* 2013), hence the *Corynespora* species in the *Massarinaceae* should be renamed. “*Didymosphaeria*” *spartii* has been previously transferred to *Montagnula* (Aptroot 1995) and also to *Didymosphaerella* (Chlebicki 2009), but these generic placements are inappropriate (Fig. 1). A cultural study of *D. spartii* (Scheinflug 1958, using CBS 183.58) indicated that it has a dendrophoma-like asexual morph with conidia 4–7 × 1–2 µm in size.

**Morosphaeriaceae (Figs 30–39).** In addition to *Aquilomyces* (Fig. 30), *Helicascus* (Figs 35–37) and *Morosphaeria* (Figs 38, 39), which were previously recognised as members of the *Morosphaeriaceae* (Suetrong *et al.* 2009, Hyde *et al.* 2013, Knapp *et al.* 2015), we add the new genus *Clypeolocus* (Figs 31–34) to this family. Species in these four genera are only known to have sexual morphs. A pleurophomopsis-like conidial state has been reported for *H. aquaticus* (Zhang *et al.* 2013) as its asexual morph, and we also observed this for *H. aquaticus*, as well as for four species in *Clypeolocus*, but these should be regarded as spermatial morphs. “*Pithomyces*” *valparadisiacus*



(Kirk 1983, Marincowitz *et al.* 2008) is basal to *Clypeolocus* species, and is found to be a rare case in which a species known only from an asexual form belongs to the *Morosphaeriaceae* (Fig. 1). A hyphomycetous genus *Pithomyces* is regarded as a heterogenous group comprising more than three lineages (Phookamsak *et al.* 2013), and the generic type (*P. flavus*) has phylogenetic affinity with *Astrosphaeriella* basal to family *Aigiaceae* (Pratibha & Prabhugaonkar 2015).

**Parabambusicolaceae** (Figs 40, 41). This new family includes two new sexual genera, *Aquastroma* (Fig. 40) and *Parabambusicola* (Fig. 41). *Multiseptospora* formerly classified in *Pleosporales*, genera *incertae sedis* (Liu *et al.* 2015) is also accepted as a member of the *Parabambusicolaceae*. Two unnamed *Monodictys* species with muriform conidia are also located in this clade, but this genus is obviously heterogenous (see Notes in *Monodictys capensis*).

**Periconiaceae** (Figs 42, 43). *Bambusistroma* (Adamčik *et al.* 2015), *Flavomyces* (Knapp *et al.* 2015), *Periconia* (Figs 42, 43) and *Noosia* (Crous *et al.* 2011a) are accepted in this family. “*Sporidesmium*” *tengii* is also placed in the *Periconiaceae*, but the phylogenetic position of the type species of *Sporidesmium* (*S. atrum*) is currently unknown. According to Shenoy *et al.* (2006), this genus is not monophyletic and species in *Sporidesmium* are phylogenetically distributed in seven lineages between two major ascomycete classes, *Dothideomycetes* and *Sordariomycetes*. *Periconia* species used in this study did not form a single clade. Therefore, a taxonomic revision of *Periconia* species along with *Noosia* and “*Sporidesmium*” *tengii* should be conducted in future.

**Sulcatisoraceae** (Figs 44–46). *Magnicamarosporium* (Fig. 44) on *Diplospora* (*Rubiaceae*) and two species of *Sulcatispora*, *S. acerina* (Fig. 45) on *Acer* (*Aceraceae*) and *S. berchemiae* (Fig. 46) on *Berchemia* (*Rhamnaceae*), are assigned to the *Sulcatisoraceae*. *Neobambusicola* (on *Grewia* sp.; *Malvaceae*) previously placed in the *Bambusicolaceae* (Crous *et al.* 2014b) is accepted here as a member of the *Sulcatisoraceae*.

**Trematosphaeriaceae** (Fig. 47). This family was established by Suetrong *et al.* (2011b) to accommodate the three genera, *Falciformispora*, *Halomassarina*, and *Trematosphaeria* (Fig. 47) (Hyde *et al.* 2013). Later, *Bryosphaeria*, *Hadrospora*, and *Medicopsis* were listed as additional members of the *Trematosphaeriaceae* (Wijayawardene *et al.* 2014c). However, the placement of *Bryosphaeria* has not been verified by molecular data. *Hadrospora* may have affinity with the *Lindgomycetaceae* (Tanaka, unpublished data), and *Medicopsis* belongs to the *Pleosporineae*, rather than the *Massarineae* (Ahmed *et al.* 2014). A coelomycetous species, *Amarenographium solium* with pigmented muriform conidia (Hodhod *et al.* 2012), has been reported to have phylogenetic affinity to the *Trematosphaeriaceae*/*Didymosphaeriaceae*, but molecular data from the generic type (*A. metableticum*, Eriksson 1982) are currently unavailable.

**Massarineae incertae sedis (Unknown Clades I–V; Figs 48–50)**. *Fuscostagonospora* (Fig. 48) on bamboo is located in the Unknown Clade I and its familial placement remains unresolved. *Pseudoxylomyces* (Fig. 49), from freshwater environments, occupies a basal position in the *Trematosphaeriaceae* (Unknown Clade II, Fig. 1). *Bactrodesmium cubense* (Unknown Clade III), a sporodochial fungus with pigmented phragmoconidia (Zucconi & Lughini 1997), is a sister taxon of the *Morosphaeriaceae* (Fig. 1). *Monodictys capensis* (Fig. 50), without a known sexual morph (Mel'nik & Shabunin 2010), and *Inflatipora*

*pseudostromatica*, without a known asexual morph (Zhang *et al.* 2011), groups in Unknown Clade IV.

## Morphological characteristics of sexual morphs

The *Massarineae* clade is supported by high BP support (100 %, Fig. 1), but it is somewhat difficult to circumscribe based on their sexual morphs. The *Massarineae* mainly contains two types of sexual morphs; massarina-like and stagonospora-like. The sexual morph observed in *Helminthosporium* (Fig. 25) and *Massarina* (Fig. 26) have immersed, hemispherical, medium to large (ca. 400–700 µm diam) ascomata with short papillate necks covered by a clypeus, clavate asci, and broadly fusiform to ellipsoidal, 1- to 3-septate, hyaline ascospores surrounded by a thick conspicuous sheath. Those of *Stagonospora* (Figs 27–29) are characterised by globose, small (ca. 200–300 µm diam) ascomata lacking a clypeus, cylindrical to clavate asci, and fusiform, 1-septate, hyaline ascospores with a thin sheath. This family, however, includes further sexual species, such as “*Didymosphaerella* (or *Montagnula*)” *spartii* with globose ascomata and thick-walled, 1-septate, pigmented ascospores (Aptroot 1995, Chlebicki 2009), and *Byssothecium circinans* with subglobose ascomata with broadly papillate necks and versicoloured ascospores (Boise 1983). Further molecular investigation using additional taxa close to *Massarina* and *Stagonospora* may provide sufficient data to subdivide this family.

*Bambusicolaceae*, *Macrodiplodiopsidaceae*, *Parabambusicolaceae* and *Sulcatisoraceae* presently include only a few species. One to two genera with sexual morphs are recognised in each family: *Bambusicola* (Dai *et al.* 2012) and *Palmascoma* (Liu *et al.* 2015) in the *Bambusicolaceae*, *Macrodiplodiopsis* (Crous *et al.* 2015a) in the *Macrodiplodiopsidaceae*, *Aquastroma* (Fig. 40) and *Parabambusicola* (Fig. 41) in the *Parabambusicolaceae*, and *Sulcatispora* (Figs 45, 46) in the *Sulcatisoraceae*. The sexual morphs in the *Bambusicolaceae*, *Parabambusicolaceae* and *Sulcatisoraceae* are similar to those of *Massarina* s. lat. (Aptroot 1998, Tanaka & Harada 2003b) in having immersed to erumpent, hemispherical to depressed globose ascomata. Species in the *Bambusicolaceae* have conical ascomata with short ostiolar necks, narrow pseudoparaphyses, cylindrical asci, and narrowly fusiform, 1-septate ascospores, whereas those in the *Parabambusicolaceae* lack a prominent neck, and have relatively wide pseudoparaphyses, clavate to broadly cylindrical asci, and clavate to fusiform ascospores with multiple transverse septa. Species in the *Sulcatisoraceae* have subglobose ascomata, trabeculate pseudoparaphyses, clavate asci, and broadly fusiform ascospores, and occur on woody host plant rather than herbaceous host. On the other hand, the sexual morphs in the *Macrodiplodiopsidaceae* are similar to those of *Pleomassarriaceae* s. lat. (Barr 1982). *Macrodiplodiopsis desmazieri* (= *Splanchnonema platani*) in this family is characterised by large-sized ascomata (500–900 µm diam) with thick ascomatal wall, clavate asci, and dark brown ascospores with 3–5(–6) eudistosepta (Barr 1982, Crous *et al.* 2015a).

*Morosphaeriaceae* (Figs 30–39) and *Trematosphaeriaceae* (Fig. 47), mostly found from aquatic environments, are characterised by immersed to erumpent, medium to large, black, carbonaceous ascomata with or without papillate necks, but necks are prominent and/or surrounded by a clypeus in members of the *Morosphaeriaceae*. Asexual morphs are relatively

rare in these families with few exceptions, i.e., *Pithomyces valparadiacus* (*Morosphaeriaceae*, Kirk 1983), and *Trematosphaeria grisea* (*Trematosphaeriaceae*, Ahmed et al. 2014). This tendency has been observed in the *Aliquandostipitaceae* (*Jahnulales*), which also occurs in aquatic habitats, and a few asexual species in the genera *Brachiosphaera*, *Speiropsis*, and *Xylomyces* (Suetrong et al. 2011a).

We tentatively accept the *Lentitheciaceae* as a diverse assemblage. Four groups seem to be recognised based on morphological variations in the sexual morphs: *Lentithecium* with immersed, globose ascomata without clypeus, and broadly fusiform, 1-septate, hyaline ascospores (Figs 19, 20), *Keissleriella* with small, globose to subglobose ascomata with setose necks and several septate ascospores (Figs 13–18), *Setoseptoria* (Figs 22, 23) and *Tingoldiagio* (Fig. 24) with single to grouped, hemispherical ascomata and cylindrical to fusiform ascospores, *Katumotoa* (Fig. 12) and *Neoophiosphaerella* (Fig. 21) with subglobose ascomata without prominent necks and fusiform or filiform ascospores. The morphological diversity of the family, as well as relatively low phylogenetic support of the clade (71 %, Fig. 1), strongly suggests polyphyly of the *Lentitheciaceae* s. lat. used in this study.

Similarly, various sexual morphs are observed in the *Didymosphaeriaceae* (Figs 6–9). Most of the species in this family have previously been placed in several genera of the *Pleosporineae*, which include *Didymosphaeria* (*Montagnula opulenta*, *Phaeodothis winteri*), *Leptosphaeria* (*Paraconiothyrium fuckelii*, *Neokalmusia scabrispora*), and *Phaeosphaeria* (*Neokalmusia brevispora*). The type species of *Montagnula* (*M. infernalis*; Berlese 1896) has been treated as *Leptosphaeria* or *Pleospora* (Wehmeyer 1961). Species having muriform ascospores similar to *Pleospora* are known in *Deniquelata* (Ariyawansa et al. 2013) and *Tremateia* (Kohlmeyer et al. 1995). Sexual morphs in the *Didymosphaeriaceae* have small to medium, globose to subglobose ascomata with papillate necks and melanised, didymo/phragmo/dictyo-ascospores resembling those of the *Pleosporineae*, but the ascomata are surrounded by abundant hyphae that form an apical clypeus at times, as was defined by Barr (2001). In addition, *Bimuria* (Hawksworth et al. 1979), a soil-borne ascomycete, with unique morphological characters such as ascomata composed of very thin peridium, 2-spored asci, and muriform, dark brown, verrucose ascospores, also belongs in the *Didymosphaeriaceae*. The family includes a wide variety of sexual morphs with dark coloured ascospores, as well as coniothyrium-like or *Spegazzinia* asexual morphs, and the clade receives 99 % BP support (Fig. 1).

In contrast, the *Dictyosporiaceae* and *Periconiaceae* mostly comprise asexual species. The few known sexual morphs in these families are characterised by single to grouped, globose to hemispherical ascomata with or without surrounding stromatic tissue, cylindrical asci with short stipes, and fusiform to broadly fusiform, 1-septate, hyaline ascospores. Examples are *Dictyosporium* (e.g., *D. meiosporum*; Liu et al. 2015), *Gregarithhecium* (Fig. 3) and *Pseudocoleophoma* (Figs 4, 5) in the *Dictyosporiaceae* and *Bambusistroma* (Adamčík et al. 2015) and *Periconia* (Figs 42, 43) in the *Periconiaceae*. These morphological features agree in most respects with those of *Massarina* s. lat. (Aptroot 1998, Tanaka & Harada 2003b) and are similar to those of species in the *Massarinaceae* (e.g., *Stagonospora*). In the *Latoruaceae*, no sexual morphs are known at present (Crous et al. 2015a).

## Morphological characteristics of asexual morphs

Although various asexual genera are found in the *Massarinaceae*, hyphomycetous species with macronematous, mononematous conidiophores are restricted to the *Massarinaceae* [*Helminthosporium* (Fig. 25) and *Corynespora*], *Periconiaceae* [*Periconia* (Fig. 43) and *Sporidesmium*], *Dictyosporiaceae* (*Diplococcium* and *Dendryphiella*), and *Didymosphaeriaceae* (*Sporidesmiella*). Similarly, synnematos hyphomycetes are extremely rare in this suborder and have only been observed in one instance, in *Aquaticheirosora* (Kodsueb et al. 2007) in the *Dictyosporiaceae*. Hyphomycetous asexual morphs without prominent conidiophores are found in the *Periconiaceae* (*Noosia*), *Latoruaceae* (*Latorua* and *Polyschema*), and the *Morosphaeriaceae* (*Pithomyces*). Sporodochial hyphomycetes are scattered through the *Dictyosporiaceae* [*Dictyosporium* (Fig. 2) and its morphologically similar genera], *Didymosphaeriaceae* (*Spegazzinia*, Figs 10, 11), *Parabambusicolaceae* (*Monodictys*), and Unknown Clades III (*Bactrodesmium*) and IV (*Monodictys*, Fig. 50). In contrast, coelomycetous genera seem to be more common than hyphomycetous asexual morphs and are present throughout this suborder, i.e., in the *Bambusicolaceae* (*Bambusicola*), *Dictyosporiaceae* (*Pseudocoleophoma*, Figs 4, 5), *Didymosphaeriaceae* [*Paracamarosporium*, *Paraconiothyrium*, *Pseudocamarosporium*, *Karstenula*, *Paraphaeosphaeria* (Fig. 9)], *Lentitheciaceae* [*Keissleriella* (Figs 13, 16), *Setoseptoria*], *Macrodiplodiopsidaceae* (*Camarographium*, *Macrodiplodiopsis*, *Pseudochaetosphaeronema*), *Massarinaceae* (*Stagonospora*, Figs 27–29), *Sulcatisporaceae* [*Magnicamarosporium* (Fig. 44), *Sulcatispora* (Figs 45, 46)] and Unknown Clades I (*Fuscostagonospora*, Fig. 48).

In general, *Dictyosporiaceae* is characterised by hyphomycetous asexual morphs with pigmented cheiroconidia. These usually have sporodochial (e.g., *Dictyosporium*, *Digitodesmium*, and *Pseudodictyosporium*) or synnematos conidiomata (e.g., *Aquaticheirosora*). *Dendryphiella* and *Diplococcium* have macronematous, mononematous conidiophores with pigmented, multi-celled, tetric conidia. The coelomycetous morphs known in this family are "*Paraconiothyrium*" *flavescens* and *Pseudocoleophoma* species, with phialidic, 1-celled conidia. In contrast, most asexual species in the *Periconiaceae* have mononematous, macronematous conidiophores and produce conidia in chains (e.g., *Periconia*), but some deviating species, such as "*Sporidesmium*" *tengii* have monoblastic, obpyriform, multi-septate, pigmented conidia (Wu & Zhuang 2005), and *Noosia* which lacks a prominent conidiophore (Crous et al. 2011a), are also known in the family. Further phylogenetic investigations of asexual genera exhibiting morphological resemblance to these two groups but without molecular information, such as dictyosporium-like (e.g., *Cheiromyella*, *Digitomyces*, *Paratetraploa*; Seifert et al. 2011) and periconia-like genera (e.g., *Lacellinopsis*, *Sadasivania*, *Trichobotrys*; Seifert et al. 2011), should be conducted to evaluate the phylogenetic significance of these phenotypic characters at familial level, and/or to clarify taxonomic understanding of the *Dictyosporiaceae* and *Periconiaceae*. Although in some families (e.g., the *Didymosphaeriaceae* and *Massarinaceae*), asexual morphs are extremely diverse and thus asexual characters alone appear insufficient for familial circumscriptions, there are many recent examples of families that are well defined by asexual



morphological characters along with their phylogenetic information. These include the *Coniothyriaceae* (De Gruyter *et al.* 2013), *Cladosporiaceae* (Bensch *et al.* 2012), *Kirschsteinioteliaceae* (Boonmee *et al.* 2012), *Planistromellaceae* (Minnis *et al.* 2012), and *Tetraplospiraaceae* (Tanaka *et al.* 2009).

## Habitat

In contrast to the *Pleosporineae* which comprises numerous plant pathogens (Zhang *et al.* 2009b), such as necrotrophs (e.g., *Alternaria*, *Bipolaris*) and hemibiotrophs (e.g., *Leptosphaeria*, *Setosphaeria*) on economically important crops (Ohm *et al.* 2012), the *Massarineae*, a sister lineage of the *Pleosporineae*, mostly includes saprobes on various plant substrates.

Species in the *Morosphaeriaceae* and *Trematosphaeriaceae* have been reported mostly as saprobes on decomposed woody substrates submerged in freshwater or marine habitats. Recently, several human pathogenic species have been reported in genera in the *Trematosphaeriaceae*, and an association of the virulence factors with oligotrophism or halotolerance has been suggested (Ahmed *et al.* 2014). This may further indicate the presence of undescribed lineages of mycetoma agents in the *Morosphaeriaceae*.

Most other families in the *Massarineae* do not seem to have specific habitat preferences in each family. Species in the *Dictyosporiaceae*, for example, are reported from ecologically diverse environments, i.e., terrestrial monocots and dicots (e.g., *Dictyosporium strelitziae* and *Diplococcium asperum*; Pirozynski 1972, Crous *et al.* 2009a), submerged wood in freshwater (e.g., *Aquaticheirospora lignicola*; Kodsueb *et al.* 2007), mangroves or drift wood in marine ecosystems (*Dictyosporium inflatum*; Kirschner *et al.* 2013), and rhizosphere soil (*Pseudodictyosporium elegans*; De Gruyter *et al.* 2013). In the *Didymosphaeriaceae*, many coelomycetous species similar to *Phoma s. lat.* are generally soil-borne fungi (Verkley *et al.* 2014), but species with other ecological features, e.g., endophytes (*Dendrothyrium*; Verkley *et al.* 2014), mycoparasites (*Paraphaeosphaeria minitans*; Campbell 1947), symbionts with scale insects (*Cucurbitodithis pityophila*; Casagrande 1969, Barr 1990b), and marine saprobes (*Tremateia halophila*; Kohlmeyer *et al.* 1995) are also known. *Paraconiothyrium fuckelii* in the *Didymosphaeriaceae* is known as an agent of mycetoma and a serious plant pathogen of the *Rosaceae* (Verkley *et al.* 2014).

In the suborder *Massarineae*, relatively few species are known as plant pathogens. They are restricted to the *Didymosphaeriaceae* (*Paraconiothyrium tiliae*, *Deniquelata barringtoniae*; Butin & Kehr 1995, Ariyawansa *et al.* 2013), *Massarineae* (*Byssothecium circinans*, *Stagonospora* spp., *Helminthosporium solani*; Kaiser *et al.* 1979, Semeniuk 1983, Errampalli *et al.* 2001) and *Periconiaceae* (*Periconia igniaria*; Kolomiets *et al.* 2008); lineages rich in asexual species. Coprophilous species such as those in the *Sporormiaceae* (Kruys & Wedin 2009) and lichenicolous species such as *Arthopyrenia salicis* (Nelsen *et al.* 2009) are not known from the *Massarineae*.

## Future studies

We examined the morphology of 106 taxa belonging to the *Massarineae* and analysed their phylogenetic relationships based on sequences from SSU rDNA, LSU rDNA and *tef1*, along

with sequences of 131 taxa previously assigned to the *Massarineae*. Our results delineated 10 new genera and 29 new species/new combinations in more than 12 families and five unknown lineages (Fig. 1). Our study has contributed to the understanding of species diversity within the *Massarineae*, and improves the classification of these species, but several taxonomic issues remain unclear. The *Lentitheciaceae s. lat.* used here, for example, is probably polyphyletic based on the ecological and morphological divergence of these species, as well as based on our phylogenetic analysis, although we have tentatively accepted the family at this point. Furthermore, the presence of several lineages (Unknown Clades I to V), which we were unable to assign to any existing families, makes it certain that there are many undiscovered taxa, which should form a new family in the suborder.

Several comprehensive works have been published recently that have shown interest in the phylogeny of the *Dothideomycetes*. Schoch *et al.* (2006) provided a fundamental overview of the class, and its composition of two subclasses, the *Pleosporomycetidae* (pseudoparaphyses present) and the *Dothideomycetidae* (pseudoparaphyses absent), based on phylogenetic analyses of four loci (nucSSU, nucLSU rDNA, *tef1*, *rpb2*) from 96 taxa. Schoch *et al.* (2009) reconstructed the dothideomycete phylogeny based on five genes (nucSSU, nucLSU rDNA, *tef1*, *rpb1*, *rpb2*) from 356 isolates, and discussed the evolutionary transitions of ecological characteristics. Following these publications, the understanding of the natural relationships among dothideomycetous taxa and their taxonomic revision have tremendously progressed, and the number of accepted families in this class has been increased from 41 (Schoch *et al.* 2009) to 105 (Hyde *et al.* 2013) with or without molecular evidence. Monographic revision based on the type specimens along with phylogenetic analyses have been published by Zhang *et al.* (2012) who concentrated on reassessment of genera in the *Pleosporales*, and by Hyde *et al.* (2013) who circumscribed each family in the *Dothideomycetes*. The phylogenies of plant pathogenic taxa in this class, such as *Alternaria* (Woudenberg *et al.* 2013), *Cercospora* (Groenewald *et al.* 2013), *Cladosporium* (Bensch *et al.* 2012), *Phoma* (De Gruyter *et al.* 2013), *Pseudocercospora* (Crous *et al.* 2013a), *Septoria* (Quaedvlieg *et al.* 2013, Verkley *et al.* 2013) and several genera in the *Botryosphaeriales* (Phillips *et al.* 2013, Slippers *et al.* 2013, Wikke *et al.* 2013), have been intensively studied. More recently, a special issue of *Phytotaxa* has been published, comprising 26 articles focused on the taxonomy and phylogeny of the *Dothideomycetes* (Mckenzie *et al.* 2014).

However, these works on *Dothideomycetes* include relatively few species belonging to the *Massarineae*. The number of *Massarineae* taxa used in phylogenetic analyses of the *Dothideomycetes* was only six (among 96 taxa; Schoch *et al.* 2006), and 35 (among 356 taxa; Schoch *et al.* 2009). In the revision of the *Pleosporales* by Zhang *et al.* (2012) who recognised the validity of *Massarineae*, only 46 taxa of the suborder were phylogenetically analysed. Furthermore, most families in this suborder including the *Bambusicolaceae* (Hyde *et al.* 2013), *Lentitheciaceae* (Zhang *et al.* 2009b), *Morosphaeriaceae* (Suetrong *et al.* 2009), and *Trematosphaeriaceae* (Suetrong *et al.* 2011b), have been lineages recently recognised based on molecular data, and are currently characterised morphologically by only a few genera. To provide more precise circumscription of these families, as well as of the unnamed lineages we

have found (Clades I to V, Fig. 1), further phylogenetic analyses using a greater number of taxa should be conducted with priority. These should include a fundamental taxonomic approach to species discovery along with sequence verification, such as the work undertaken by Fungal Planet (Crous *et al.* 2015c), Fungal Diversity Notes (Liu *et al.* 2015) and Fungal Systematics and Evolution (FUSE) (Crous *et al.* 2015b).

In due course further phylogenetic study is also necessary of the more than 1 500 asexual genera treated as “*Ascomycota, genera incertae sedis*” (Wijayawardene *et al.* 2012); those without sexual links or molecular phylogenetic information. However, asexual characters alone may not provide good resolution for familial circumscription for some aquatic lineages, such as *Morosphaeriaceae* and *Trematosphaeriaceae*, in which predominantly sexual species are known. In contrast, species in the *Dictyosporiaceae* and *Periconiaceae* comprise a high proportion of asexual taxa. These have previously been treated as *Massarinaceae* (Hyde *et al.* 2013), but we have further characterised these as independent families based on their sexual morphs, in addition to their distinct asexual morphologies. Recognition of the *Dictyosporiaceae* and *Periconiaceae* partially indicates the phylogenetic significance of asexual taxa, but further comprehensive taxonomic work based on the holomorph and not weighted towards a particular fungal morph (e.g., Crous *et al.* 2009b, Tanaka *et al.* 2009, 2010, Voglmayr & Jaklitsch 2011, Dai *et al.* 2012, Phillips *et al.* 2013, Boonmee *et al.* 2014) should be conducted to revise sexual morph-based fungal systematics.

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