Diversity of the Bambusicolous Fungus *Apiospora* in Korea: Discovery of New *Apiospora* Species

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**ABSTRACT**

Many *Apiospora* species have been isolated from bamboo plants – to date, 34 bambusicolous *Apiospora* species have been recorded. They are known as saprophytes, endophytes, and plant pathogens. In this study, 242 bambusicolous *Apiospora* were isolated from various bamboo materials (branches, culms, leaves, roots, and shoots) and examined using DNA sequence similarity based on the internal transcribed spacer, 28S large subunit ribosomal RNA gene, translation elongation factor 1-alpha, and beta-tubulin regions. Nine *Apiospora* species (*Ap. arundinis*, *Ap. camelliae-sinensis*, *Ap. hysterina*, *Ap. lageniformis* sp. nov., *Ap. paraphaeosperma*, *Ap. pseudophyphopodi* sp. nov., *Ap. raskravindrae*, *Ap. saccharicola*, and *Ap. sar-gassi*) were identified via molecular analysis. Moreover, the highest diversity of *Apiospora* was found in culms, and the most abundant species was *Ap. arundinis*. Among the nine *Apiospora* species, two (*Ap. hysterina* and *Ap. paraphaeosperma*) were unrecorded in Korea, and the other two species (*Ap. lageniformis* sp. nov. and *Ap. pseudophyphopodi* sp. nov.) were potentially novel species. Here, we describe the diversity of bambusicolous *Apiospora* species in bamboo organs, construct a multi-locus phylogenetic tree, and delineate morphological features of new bambusicolous *Apiospora* in Korea.

1. Introduction

*Apiospora* Sacc. (*Apiosporaceae, Sordariomycetes, Ascomycota*) was recognized and established with *Ap. montagnei* by Saccardo (1875), and 145 epithets of *Apiospora* have been listed in Index Fungorum (2022) [1,2]. *Apiospora* is a cosmopolitan fungus, reported from various sources such as plants, soil, air, and marine samples in tropical, subtropical, Mediterranean, temperate, and even cold regions [3]. Moreover, they have been characterized as endophytes, saprobes, and plant pathogens (especially in Poaceae) [4–7]. Morphologically, *Apiospora* is characterized by globose, subglobose to ellipsoid, oval, and obovoid conidia when observed in face view, lenticular in side view, and basauxic conidiogenous cells [3]. The genus *Apiospora* has been observed to have *Arthrinium*-like morphs in the asexual state and is thus synonymized under *Arthrinium* species [4,8,9]. However, differences in genetic, morphological, and ecological characteristics between the two genera were found by Pintos et al. [3]; 76 species of *Arthrinium* have been synonymized under *Apiospora*, and the two genera have been completely separated [3,6,10].

Bamboo plays a crucial role in global carbon cycling. It absorbs wastewater, and it is used in human economic activities, such as construction, furniture, food, and even medicine [11]. Bamboo is also known as a good host, and more than 1300 bamboo ascomycetes (more than 120 families and 400 genera) have been described or recorded [12]. Most bambusicolous fungi have been reported in bamboo organs, such as culms (665 species), leaves (216 species), sheaths (19 species), and branches (14 species), and the least number of fungi have been recorded in shoots, roots, and inflorescences [12,13]. According to previous research, the most commonly detected endophytic fungus in bamboo (*Yushania brevipaniculata*) is *Arthrinium* species (now including the genus *Apiospora*), comprising almost 50% of isolates, and it is also found in healthy bamboo leaves [14]. Kim et al. [15] isolated fungi (93

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**KEYWORDS** Bambusicolous *Apiospora*; diversity; multi-locus phylogeny; morphology; novel species

**ARTICLE HISTORY**  
Received 24 August 2022  
Revised 22 September 2022  
Accepted 5 October 2022
ascomycetes and 14 basidiomycetes) from bamboo chips with decayed parts and used them for the fungal decay test against bamboo [15]. In the study, Ap. arundinis (=Ar. arundinis) was isolated as the second dominant species comprising 19.7% of the ascomycetes, and it contributed to the highest rate of weight loss (17.9%) against giant bamboo (Phyllostachys bambusoides) [15]. However, a study of Apiospora diversity according to bamboo organs has not been conducted.

Approximately 70 bamboo species are distributed naturally or artificially in Korea, and the distribution area is estimated to occupy approximately 22,067 ha [16]. However, studies on the diversity of bambusicolous fungi (including the bambusicolous Apiospora) in Korea are lacking. Currently, 17 Apiospora species have been reported in Korea. Among these, 14 Apiospora species were collected from marine environments (Ap. agari, Ap. arctoscripi, Ap. arundinis, Ap. fermenti, Ap. koreana, Ap. marii, Ap. marina, Ap. piptatheri, Ap. pusillisperma, Ap. rasiakrivandrae, Ap. sacchari, Ap. saccharicola, Ap. sargassi, and Ap. taeanaensis). Three Apiospora species (Apiospora arundinis, Ap. camelliae-sinensis, and Ap. minutispora) have been collected from terrestrial environments, and only two Apiospora species have been reported in bamboo (Ap. arundinis and Ap. camelliae-sinensis) [5,6,15,17,18].

This study aimed to investigate the bambusicolous Apiospora diversity in Korea with bamboo organ specificity and to report new Apiospora species (with unrecorded Apiospora) in Korea. To accurately identify the Apiospora species, four DNA molecular datasets of the internal transcribed spacer (ITS), 28S large subunit ribosomal RNA gene (LSU), translation elongation factor 1-alpha (TEF), and beta-tubulin (TUB) were used for phylogenetic analysis. Furthermore, a detailed analysis of cultural and microscopic characteristics was conducted.

2. Material and methods

2.1. Sampling and isolation

Bamboo materials (branches, culms, leaves, roots, and shoots) were collected from various bamboo forests in Korea (Figure 1S). A small piece of bamboo material was placed on a 2% malt extract agar (MEA) medium containing 0.01% streptomycin. Apiospora-like hyphae and spores were isolated continuously until they were pure isolates. The pure strains were stocked in glycerol 10% stock and stored at −20°C in the Korea University Fungus Collection (KUC), Seoul, Korea. The strains examined in this study, including the type strains of novel Apiospora species candidates, were deposited at the National Institute of Biological Resources, Incheon, Korea (NIBR).

2.2. DNA extraction, polymerase chain reaction (PCR), and sequencing

Bambusicolous Apiospora strains were used for molecular identification. Genomic DNA was extracted from fungal mycelia using an AccuPrep Genomic DNA extraction kit (Bioneer, Daejeon, Korea) according to the manufacturer’s protocol. The AccuPower® PCR PreMix Kit (Bioneer) was used for PCR. PCR targeting ITS, LSU, TEF, and TUB regions. For the ITS region, ITS1F (or ITS5)/LR3 (or ITS4) primer sets were used [19,20]. For the LSU region, we used the LR0R/LR7 primer [21]. To amplify the TEF region, 728F (or 983F)/1567R primer sets were used [22,23]. For TUB region, Bt2a (or T1)/Bt2b (or T2) primer sets were used [24,25]. All PCR products were checked by electrophoresis on a 1% agarose gel and purified using the AccuPrep DNA Purification Kit (Bioneer). DNA sequencing was conducted by Cosmo Genetech (Seoul, Korea). All new sequences have been deposited in GenBank.

2.3. Phylogenetic analysis

All obtained sequences were assembled, proofread, and edited using Geneious Prime 2022.1.1 (Biomatter, Ltd., Auckland, New Zealand). The edited sequences were aligned with reference sequences of Apiospora, Arthrinium, and related genera downloaded from the GenBank database (https://www.ncbi.nlm.nih.gov/genbank/) using MAFFT 7.450 [26,27]. The ambiguous alignments were manually adjusted, and maximum likelihood (ML) analysis was performed using RAxML v. 8 with the GTR + G model with 1000 bootstrap replicates [28]. MrBayes (MB) analysis was carried out using MrBayes v. 3.2.6, with the best model selected for each ITS, LSU, TEF, and TUB dataset using jModeltest v. 2.1.10 [29,30]. To achieve stationary equilibrium, five million trees were generated, and the trees were sampled every 1000th generation. Posterior probabilities (PP) were calculated in the majority rule consensus tree after discarding the first 25% of the trees as burn-in. All analyses were performed using Geneious Prime software 2022.1.1 (https://www.geneious.com/prime/).

2.4. Morphological observation

The culture characteristics and growth rates of Apiospora were observed on the potato dextrose agar (PDA, Difco, Detroit, USA), MEA, and oatmeal
agar (OA, Difco) media at 15°C, 20°C, and 25°C in darkness for 2 weeks. The colony form, elevation, margin, presence of aerial mycelia, the color of mycelia and medium, and sporulation were recorded. Color-corresponding codes were determined according to the Munsell color chart (Munsell Color, 2009). Growth rates were measured every 24 h, and each measurement was performed in triplicates. Microscopic characteristics were observed on water agar medium (WA, Bacto agar (Difco) 15 g, distilled water 1000 mL) using an Olympus BX51 light microscope (Olympus, Tokyo, Japan) with a DP20 microscope camera (Olympus). The shape, size, and color of the conidiophores, conidia, and hyphae were observed and recorded. Ultra-high-resolution scanning electron microscopy (UHR SEM, Hitachi SU-70, Hitachi, Tokyo, Japan) was used to observe the detailed morphological characteristics.

3. Results

3.1. Diversity of bambusicolous Apiospora in Korea

A total of 108 bamboo samples were collected from 20 bamboo forests in Korea (Figure 1S). The collected bamboo materials were composed of 33 branches, 44 culms, 14 leaves, 13 roots, and four shoots, and were used as fungal isolation sources. As a result, 242 bambusicolous Apiospora strains were isolated and identified based on the DNA sequence similarity of ITS, LSU, TEF, and TUB regions against the NCBI database (http://www.ncbi.nlm.nih.gov/blast). Based on sequence similarity, the Apiospora strains were identified as nine Apiospora species (Ap. arundinis (181 strains), Ap. camelliae-sinensis (17 strains), Ap. hysterina (two strains), Ap. rasikravindrae (31 strains), Ap. saccharicola (two strains), Ap. sargassi (one strain), Ap. paraphaeosperma (two strains), Ap. lageniformis sp. nov. (four strains), and Ap. pseudohyphopodii sp. nov. (two strains)). Figure 2S shows that the diversity of Apiospora was the highest in the culm, followed by the branch, and the most abundant species was Ap. arundinis, which accounted for >74% of the total isolates, followed by Ap. rasikravindrae (13%) and Ap. camelliae-sinensis (7%), respectively. The portion of Ap. camelliae-sinensis and Ap. rasikravindrae was higher in the bamboo branch but lower in the culm (Figure 2S). A few Apiospora species have been isolated from leaves, roots, and shoots. Apiospora arundinis was isolated from the highest proportion of bamboo tissues. Apiospora sargassi has only been isolated from the shoot tissues.

Apiospora hysterina strains were isolated from bamboo branches and Ap. paraphaeosperma strains were isolated from culms. The strains of Ap. pseudohyphopodii sp. nov. was isolated from bamboo culms, and Ap. lageniformis sp. nov. was isolated from the branches and culms. According to the present study, two species (Ap. hysterina and Ap. paraphaeosperma) and two novel species (Ap. lageniformis sp. nov. and Ap. pseudohyphopodii sp. nov.) have been recognized as new candidate species in Korea. Thus, phylogenetic and morphological analyses were performed for accurate taxonomic evaluation.

3.2. Phylogenetic analysis

The multigene alignments (ITS, LSU, TEF, and TUB combined datasets) contained 151 reference strains, and 10 new isolated strains in this study with 3717 characters, including gaps, were analyzed using ML and MB methods. The multigene alignments (ITS, LSU, TEF, and TUB combined datasets) contained 151 reference strains, and 10 new isolated strains in this study with 3717 characters, including gaps, were analyzed using ML and MB methods (Table 1). In MB analysis, ITS and LSU sequence alignments were assigned as GTR +I+G to the best-fit model, and TEF and TUB were assigned as GTR +G and HKY +I+G, respectively. Both ML and MB trees showed similar tree topologies, and the ML tree is represented. Two new Apiospora species (Ap. lageniformis sp. nov. and Ap. pseudohyphopodii sp. nov.) were distinct from other Apiospora clades and were clustered as monophyletic groups, respectively with high support (1/100, PP/bootstrap value (BS)) (Figure 1). Although Ap. hysterina KUC21437 and KUC21438 formed a monophyletic group with Ap. hysterina ICPM 6889 and Ap. hysterina AP29717, they were not distinguished from Apiospora sasae CPC 38165 and Ap. yunnana MFLUCC 18-1102. Furthermore, Ap. paraphaeosperma KUC21488 and KUC21688 were grouped together with Ap. paraphaeosperma GUCC 10126 and MFLUCC 13-06044, but the resolution was low in the concatenated tree (Figure 1). A morphoanatomical analysis is needed to interpret the low resolution of the two unrecorded Apiospora species.

3.3. Taxonomy

Apiospora lageniformis S.L. Kwon & J.J. Kim, sp. nov. (Figure 2)

Mycobank: MB845439

Type: KOREA, Jeollabuk-do, Damyang-gun, 32°34’27.4”N, 124°52’17.8”E, isolated from the culm of Phyllostachys nigra var. henonis, Apr. 2021, S.L. Kwon (NIBRFGC000509393 = KUC21686).
| Species                  | Strain no. | Isolation source                     | Country     | ITS Accession no. | LSU Accession no. | TEF Accession no. | TUB Accession no. |
|-------------------------|------------|--------------------------------------|-------------|------------------|------------------|------------------|------------------|
| Apispora acutipica      | KUCC 20-0209 | Clump of Bambusa bambos | China       | MT94342          | MT94338          | MT947359         | MT947365         |
| Apispora acutipica      | KUCC 20-0210 | Clump of Bambusa bambos | China       | MT94343          | MT94339          | MT947360         | MT947366         |
| Apispora agari          | KUC21333    | Agarum criniforme                   | Korea       | MH948520         | MH948440         | MH544663         | MH948478         |
| Apispora agari          | KUC21361    | Agarum criniforme                   | Korea       | MH948519         | MH948449         | MH868914         | MH948477         |
| Apispora aquatica       | S-642       | Submerged wood                      | China       | MK028608         | MK035806         | –                | –                |
| Apispora arctoscopi     | KUC21333    | Egg masses of Arctosporus japonicus | Korea       | MH948529         | MH948449         | MH868918         | MH948487         |
| Apispora arundinis       | CBS 124788  | Lives of Fagus sylvatica            | Switzerland | KF144885         | KF144929         | KF145017         | KF144975         |
| Apispora aurea           | CBS 133509  | Sclerotium buried in sandy field    | USA         | KF144886         | KF144930         | KF145018         | KF144976         |
| Apispora aurae           | CBS 244.83  | –                                    | Air         | AB220251         | AB220435         | –                | –                |
| Apispora balearica       | AP24118     | Undetermined Poaceae                | Spain       | MK014869         | MK014836         | MK017975         | MK017946         |
| Apispora bambusicolor    | MFLUCC 20-0144 | Dead culms of bamboo | Thailand    | MW173030         | MW173087         | MW183262         | –                |
| Apispora biseriale       | CGMC3.20135 | Dead culms of bamboo                | China       | MW1841708        | MW1847885        | MWS22938         | MWS22955         |
| Apispora camelliae-sinensis | LCS5007c | Camellia sinensis                  | China       | KY494970         | KY494970         | KY705103         | KY705173         |
| Apispora camelliae-sinensis | LCS181c | Brassica rapa subsp. oleifera       | China       | KY494971         | KY494987         | KY705157         | KY705229         |
| Apispora chianghienesi   | MFLUCC 17-1505 | Dead culms of bamboo | Thailand    | MZ54250          | MZ54252          | –                | MZ546409         |
| Apispora chromolaena     | MFLUCC 17-1505 | Dead culms of Chromospora odorata | Thailand    | MT21434         | MT214436         | –                | –                |
| Apispora cordoyles       | GUCC 10026  | Cordyline fruticosa                 | China       | MT040105         | –                | MT040126         | MT040147         |
| Apispora cyclobalanopisi | CGMC3.20136 | Leaf of Cyclobalanopsis glauca (Thunb.) Oerst | China       | MW1841713        | MW1847892        | MWS22945         | MWS22962         |
| Apispora descalii         | AP31118c | –                                    | Spain       | MK014870         | MK014837         | MK017947         | MK017976         |
| Apispora dichotomanti    | LC4590c | Dichotomanthes tristisardica        | China       | KY494697         | KY494773         | KY705096         | KY705167         |
| Apispora espenfeldii     | AP16717c | Phyllostachys aurea                 | Spain       | MK014878         | MK014845         | MK017954         | MK017983         |
| Apispora euphorbiae      | IMI 285638b | Bambusa sp.                         | Bangladesh  | AB220241         | AB220345         | –                | AB220288         |
| Apispora fermenti        | KUC21288    | Seaweed                             | Korea       | MF615230         | MF615217         | MH544668         | MF615235         |
| Apispora gaoyouensis     | KUC21289    | Seaweed                             | Korea       | MF615226         | MF615213         | MH544667         | MF615231         |
| Apispora garethnense     | CFCC 52301  | Pherogetes aurantiacis              | China       | MH197124         | –                | MH236793         | MH236796         |
| Apispora gelatinosa      | JHB004c     | Bamboo                              | China       | KY356080         | KY356091         | –                | –                |
| Apispora gyangensis      | KUC14785c   | Dead branch of bamboo               | China       | MW1841706        | MW1847888        | MWS22941         | MWS22958         |
| Apispora guangensis      | HMAS 102403 | Dead culm of bamboo                 | China       | MW204667         | MW204577         | MW575935         | MW755604         |
| Apispora guangensis      | HMAS 102403 | Unidentified grass                   | China       | KY494708         | KY494784         | KY705107         | KY705177         |
| Apispora guangensis      | HMAS 102403 | –                                    | China       | KY494709         | KY494785         | KY705108         | KY705178         |
| Apispora guangensis      | HMAS 102403 | –                                    | Spain       | AB220242         | AB220336         | –                | AB220289         |
| Apispora hydei           | CBS 114990c | Culms of Bambusa tuludoides         | Hong Kong   | KF144880         | KF144936         | KF145024         | KF144982         |
| Apispora hyphopodi       | JHB003c     | Bamboo                              | China       | KY356088         | KY356093         | –                | –                |
| Apispora hystera         | MFLUCC 15-003 | Bamboo                              | Thailand    | KR069110         | –                | –                | –                |
| Apispora jiangdongensis  | AP29577     | Phyllostachys aurea                 | Spain       | MK014875         | MK014842         | MK017952         | MK017981         |
| Apispora kogelbergensis  | ICMP 6806c  | Bamboo                              | New Zealand | MK014874         | MK014841         | MK017951         | MK017980         |
| Apispora kogelbergensis  | KUC21437    | Branch of Phyllostachys bambusoides | Korea       | ON764018         | ON787757         | ON806622         | ON806632         |
| Apispora kogelbergensis  | KUC21437    | Branch of Phyllostachys bambusoides | Korea       | ON764019         | ON787758         | ON806623         | ON806633         |
| Apispora indica          | AP10118c | Arundinaria donax                   | Portugal     | MK014879         | MK014846         | MK017955         | MK017984         |
| Apispora koreana         | KUC21332c | Egg masses of Arctosporus japonicus | Korea       | MH948524         | MH948444         | MH544664         | MH948482         |
| Apispora koreana         | KUC21348    | Egg masses of Arctosporus japonicus | Korea       | MH948523         | MH948443         | MH868927         | MH948481         |

(continued)
| Species | Strain no. | Isolation source | Country | GenBank accession nos. |
|---------|-----------|------------------|---------|-----------------------|
| Ap. lageniformis sp. nov | KUC21685 | Branch of Phyllostachys pubescens | Korea | ON764020 ON787759 ON806624 ON806634 |
| Ap. lageniformis sp. nov | KUC21686 | Top of culm of | Korea | ON764021 ON787760 ON806625 ON806635 |
| Ap. lageniformis sp. nov | KUC21687 | Top of culm of Phyllostachys nigra var. henonis | Korea | ON764023 ON787762 ON806626 ON806636 |
| Ap. locuta-pollinisa | LC11683 | Bee bread | China | MF393959 – MF393961 MF393962 |
| Ap. longistroma | MFLUCC 11-0481 | Bamboo | Thailand | KU940141 KU863129 – – |
| Ap. malaysiana | CBS 251.29 | Culm base of Cinnamomum camphora | Malaysia | KF144897 KF144943 KF145031 KF144989 |
| Ap. marii | CBS 102053 | Macaranga hulittii | Malaysia | KF144896 KF144942 KF145030 KF144988 |
| Ap. mari | CBS 497.90 | Beach sand | Spain | AB202252 AB204497 KF145035 KF144993 |
| Ap. marina | CBS 114803 | Pseudeosa hindsii | Hong Kong | KF144899 KF144945 KF145033 KF144991 |
| Ap. marina | CUB 102052 | Seaweed | Korea | MH498537 MH498457 MH869293 MH498495 |
| Ap. mediterranea | IMI 326875 | Air | Spain | AB202243 AB202337 – AB202290 |
| Ap. minutispora | 1.70E-41 | Soil | Korea | LC17882 – LCI88883 LC518888 |
| Ap. myxillophora | DAOI 214595 | Andropogon sp. | India | KF144965 – – – |
| Ap. neobambusae | LC7106 | Leaf of bamboo | China | KY494818 KY494794 KY860204 KY705186 |
| Ap. neochinense | FCC 53036 | Fargesia qinlingensis | China | MK192921 – MK818545 MK818547 |
| Ap. neoregenetoides | HKAS 102408 | Bamboo | China | NR_171943 MK708989 – – |
| Ap. nesuglaboba | JHB007 | Bamboo | China | KY365095 KY365096 KY365097 KY365098 |
| Ap. obovata | LC4940 | Lithocarpus sp. | China | KY494696 KY494772 KY705059 KY705166 |
| Ap. ovata | CBS 115042 | Pseudeosa hindsii | Hong Kong | KF144903 KF144950 KF145037 KF144995 |
| Ap. paraphaeosperma | GUCC 10126 | Dead culms of bamboo | Thailand | KX822128 KX822124 – – |
| Ap. phragmites | MFLUCC 13-0644 | Culm of bamboo | Korea | ON764024 ON787763 ON806628 ON806638 |
| Ap. phyllostachydias | MFLUCC 18-1101 | Culms of Phyllostachys heteroclada | Italy | KF144909 KF144956 KF145043 KF145001 |
| Ap. piptatheri | AP4817A | Piptatheri milileum | Spain | MK014893 MK014860 MK017969 – |
| Ap. pterosperma | KUC2122 | Sargassum sp. | Korea | KT207736 KT207686 MF615223 KT207636 |
| Ap. pseudagazzinii | KUC2127 | Sargassum sp. | Korea | MF615229 MF615216 MF615221 MF615234 |
| Ap. pseudapetrenymphita | LC7234 | Leaf of bamboo | China | KY494743 KY494819 KY705139 KY705211 |
| Ap. pseudosasa | KUMCC 20-0208 | Sheath of Bambara dolicholacca | China | MT946343 – MT947361 MT947367 |
| Ap. pseudosinensis | CPC 18900 | Culms of Phragmites australis | China | MK351842 – MK340918 MK291949 |
| Ap. pseudosinensis | MFLUCC 18-1101 | Culms of Phyllostachys heteroclada | China | MK351842 – MK340918 MK291949 |
| Ap. pterosperma | CPC 20193 | Leaf of Lepidosperma gladiatum | Australia | KF144913 KF144960 KF145046 KF145004 |
| Ap. pulcherrimia | KUC2132 | Seaweed | Korea | MH498533 MH498453 MH869300 MH498491 |
| Ap. qinlingensis | FCC 52303 | Fargesia qinlingensis | China | MH197120 – MH236795 MH236791 |
| Ap. rafikvarum | FCC 52304 | Fargesia qinlingensis | China | MH197121 – MH236796 MH236792 |
| Ap. saracenica | LC5497 | Soil | China | KY494713 – KY705112 KY705182 |
| Ap. saracenica | LC7115 | Leaf of bamboo | China | KY494721 KY494797 KY705118 KY705189 |
| Ap. sacchari | CBS 301.41 | Bamboo | Indonesia | KF144917 – KF145048 KF145006 |
| Ap. sacchari | CBS 372.67 | Air | Korea | KF144918 KF144964 KF145049 KF145007 |
| Ap. saccharcola | CBS 191.73 | Air | Netherlands | KF144920 KF144966 KF145051 KF145009 |
| Ap. saccharcola | CBS 463.63 | Dead culms of Phragmites australis | Netherlands | KF144921 KF144968 KF145053 KF145011 |
| Ap. sargentii | KUC21226 | Sargassum sp. | Korea | KT207746 KT207696 MH544677 KT207644 |
| Ap. sae | KUC2123 | Seaweed | Korea | MH498532 MH498452 MH869310 MH498490 |
| Ap. septata | CPC 38165 | Dead culms of Sasa veitchii | Netherlands | MW883402 MW883797 MW890104 MW890120 |
| Ap. septrata | CGMCC 33134 | Dead branch of bamboo | China | MW481711 MW478890 MW522943 MW522960 |
| Ap. setosa | MG2220-0109 | Dead branch of bamboo | China | MW481712 MW478891 MW522944 MW522961 |
| Ap. setosa | IMI 326869 | Excipients, atmosphere and home dust | Spain | AB202205 AB202244 – AB202297 |
| Ap. setosa | MG2220-0109 | Dead branch of bamboo | China | MW481711 MW478891 MW522944 MW522961 |
| Ap. setosum | KUMCC 19-0217 | Dead branches of bamboo | China | MN528012 MN528011 MN527357 – |
| Ap. sibua | HKAS 107008 | Dead culm of Paeaceae | China | MW240648 MW240578 MW759536 MW775605 |
| Ap. stipa | CPC 38101 | Dead culm of Celtis gigantea | Spain | MW883403 MW883798 MW890105 MW890121 |
| Ap. subglobosa | MFLUCC 11-0397 | Bamboo | Thailand | KB069112 KB069113 – – |
| Ap. subhirsuta | LC7292 | Leaf of bamboo | China | KY494752 KY494606 KY705148 KY705220 |

(continued)
Table 1. Continued.

| Species | Strain no. | Isolation source | Country | ITS | LSU | TEF | TUB |
|---------|------------|------------------|---------|-----|-----|-----|-----|
| Ap. toeanensis | KUC21322 | Seaweed | Korea | MH498515 | MH498435 | MH544662 | MH498473 |
| Ap. thailandica | KUC21359 | Seaweed | Korea | MH498513 | MH498433 | MN869835 | MH498471 |
| Ar. sporophleum | MFLUCC 15-0202 | Dead culms of bamboo | Thailand | KUS10145 | KUB63133 | – | – |
| Ar. sphaerospermum | IMI 99670 | Citrus sinensis | Vietnam | KX986096 | KX986111 | KY019466 | – |
| Ar. sphaerospermum | CBS 478.86 | Soil from roadway | Zimbabwe | KF144925 | KF144970 | KF145055 | KF145013 |
| Ar. sorghi | CBS 595.66 | Soil | Austria | KF144926 | – | – | – |
| Ar. thailandica | MFLUCC 18-1102 | Dead or nearly dead culms of Phyllostachys heteroclada | China | MK351843 | KUB63135 | MK349019 | MK291950 |
| Ar. pseudophytopodi sp. nov | KUC21680 | Culm of Phyllostachys pubescens | Korea | ON764026 | ON777765 | ON806630 | ON806640 |
| Ar. austriacum | KUC21684 | Culm of Phyllostachys pubescens | Korea | ON764027 | ON777766 | ON806631 | ON806641 |
| Ar. japonicum | Sp. nov | – | Japan | AB220262 | AB220356 | – | AB220309 |
| Ar. luzulæ | AP7619-3 | Dead leaves of Luzula sylvatica | Spain | MW208937 | MW208863 | – | – |
| Ar. morthieri | GZU 345043 | Carex digitata | Austria | MW208938 | MW208864 | – | – |
| Ar. poaeospermum | CBS 114317 | Leaf of Hordeum vulgare | Iran | KF144906 | KF144953 | KF145040 | KF144998 |
| Ar. carinocola | AP23518 | Carex ericetorum | Germany | K014871 | K014838 | K017948 | K017977 |
| Ar. puccinioides | AG19066 | Pectobacteria | France | MW208931 | MW208861 | – | – |
| Ar. curvatum | AP25418 | Leaves of Carex sp. | Germany | K014872 | K014839 | K017947 | K017978 |
| Ar. japonicum | IFO 30500 | – | Japan | AB220262 | AB220356 | – | AB220309 |
| Ar. luzulæ | AP7619-3 | – | Spain | MW208937 | MW208863 | – | – |

Etymology: “lageniformis” refer to the lageniform shape of the conidiogenous cell.

Culture characteristics: PDA, colonies irregular form, flat, mycelium moderate, concentrically spreading, margin filiform; mycelia white; sporulation observed after 7 days at 15°C on hyphae; pigment not observed. MEA, colonies circular form, flat, mycelium low, concentrically spreading with sparse aerial mycelium, margin entire; mycelia hyaline to white colored; sporulation observed after 7 days at all temperatures on hyphae; pigment absent. OA, colonies circular form, mycelium abundant, fluffy, downy, crateriform, thick, concentrically spreading with abundant aerial mycelium, margin entire; mycelia white; sporulation not observed; pigment absent.

Colony diameters – 15°C PDA 6.4–7 cm/14 days, MEA 6.5–6.6 cm/14 days, OA 5.1–5.5 cm/14 days; 20°C PDA 7 cm/13 days, MEA 7 cm/12 days, OA 7 cm/13–14 days; 25°C PDA 7 cm/13 days, MEA 7 cm/9 days, OA 7 cm/12–13 days.

Asexual morphology: Conidiophores are reduced to conidiogenous cells. Conidiogenous cells aggregated in

*AG, Alain Gardiennet; AP, Ángel Pintos; CBS, Westerdijk Fungal Biodiversity Institute (WU), Utrecht, The Netherlands; CFC, China Forestry Culture Collection Center, Beijing, China; CGMCC, China General Microbiological Culture Collection Center, Beijing, China; CPC, Culture collection of Pedro Crous, housed at the Westerdijk Fungal Biodiversity Institute; DAOM, Canadian Collection of Fungal Cultures, Ottawa, Canada; GUCC, Guizhou culture collection, Guizhou, China; GZU, arl-Franzens-Universität Graz, Austria; HKAS, Herbarium of Cryptogams, Kunming Institute of Botany, Chinese Academy of Sciences, Yunnan, China; IFO, Institute for Fermentation in Osaka, Japan; IMI, CABI Bioscience, Eggham, UK; JHB, H.B. Jiang; KUC, the Korea University Fungus Collection, Seoul, Korea; KUMCC, Kunming Institute of Botany Culture Collection, Kunming, China; LC, Personal culture collection, Guizhou, China; MFLUCC, Mae Fah Luang University Culture Collection, Thailand; NFCCI, National Fungal Culture Collection of India; and URM, URMC culture collection in Brazil.

The sequences generated in this study are shown in bold.

Indicate the type materials.

GenBank accession no.:
a cluster on hyphae, basauxic, polyblastic, hyaline, lageniform, 8.0–10.5(–12) × 4.0–5.0 μm, apical neck 3.5–5.5 μm long, basal part 2.8–7.2 μm long. Conidia green to dark brown, surface smooth, globose to ellipsoid in surface view, (7.8–)8.1–9.0(–9.5) × (6.8–)7.5–8.5(–9.0) μm (X = 8.6 × 8.0 μm, n = 30); lenticular in side view, with equatorial slit, (7.0–)8.0–9.5(–9.5) × (5.3–)6.0–7.0(–7.5) μm (X = 8.6 × 6.4 μm, n = 30). Mycelium smooth, hyaline, branched, septate, 2.0–4.0 μm diam.

Additional materials examined: KOREA, Jeollabuk-do, Damyang-gun, 32°34'27.4"N, 124°52'17.8"E,
isolated from the culm of *Phyllostachys nigra* var. *henonis*, Apr. 2021, S.L. Kwon (NIBRFGC000509394 = KUC21687); KOREA, Jeollabuk-do, Gochang-gun, 35°25’50.9”N, 126°42’16.9”E, isolated from a branch of *Phyllostachys pubescens*, Mar. 2021, S.L. Kwon (NIBRFGC000509391 = KUC21681 and NIBRFGC000509392 = KUC21685).

**Remarks:** The *Ap. lageniformis* sp. nov. is characterized by a lageniform conidiogenous cell. This species is closely related to *Apispora jiangxiensis* LC4577 (M. Wang & L. Cai) Pintos & P. Alvarado (over 100% similarity in the ITS region, 100% in the LSU region, 99.77% in the TEF region, and 97.92% in the TUB region). However, they can be distinguished by phylogenetic analysis with high bootstrap values (1/100, PP/BS). In the original description, *Ap. jiangxiensis* LC4577 had luteous to sienna pigments on colonies and media [7]. However, no pigments were observed in the *Ap. lageniformis* sp. nov. Furthermore, the growth rate of *Ap. jiangxiensis* LC4577 (9 cm/10 days, at 25°C on PDA) was faster than *Ap. lageniformis* sp. nov. KUC21686 at 25°C on PDA (7 cm/13 days) [7].

*Apispora lageniformis* sp. nov. also is closely related to *Apispora obovata* (M. Wang & L. Cai) Pintos & P. Alvarado, and *Ap. arctoscopi* (S.L. Kwon, S. Jang & J.J. Kim) S.L. Kwon & J.J. Kim in concatenate phylogeny (Figure 1). However, *Ap. obovata* has obovoid, elongated to ellipsoidal conidia (size 16–31 × 9–16 µm), and *A. arctoscopi* has globose to elongated ellipsoid (in surface view, 9.5–13 × 7.5–12 µm) conidia (in lenticular side view, 5.5–7.5 µm) [5,7], which are different conidia characteristics of *Ap. lageniformis*. *Apispora arctoscopi* also has different conidiogenous cell shapes (cylindrical, sometimes ampulliform) [5].

*Apispora pseudohyphopodii* S.L. Kwon & J.J. Kim, sp. nov. (Figure 3)

**MycoBank:** MB845440

**Type:** KOREA, Jeollabuk-do, Gochang-gun, 35°25’50.9”N, 126°42’16.9”E, isolated from a branch of *Phyllostachys pubescens*, Mar. 2021, S.L. Kwon (NIBRFGC000509202 = KUC21680)

**Etymology:** Named after its morphological similarity to *Apispora hyphopodii*.

**Culture characteristics:** PDA, colonies circular form, flat, mycelium dense around the center and become sparse at the margin, concentrically
spreading with abundant aerial mycelium, margin filiform; mycelia white around the center, fading to hyaline at the margin; sporulation observed after 7 days at 15°C on hyphae; yellow (2.5Y, 7/8) pigment diffused after 5 days, and becoming converted to dark olive gray (5Y, 3/2) pigment from the center in reverse. MEA, colonies circular form, flat, mycelium low, concentrically spreading with sparse aerial mycelium, margin filiform; mycelia white colored; sporulation observed around plug after 7–8 days at 15°C; pigment absent. OA, colonies circular form, flat, mycelium abundant, dense, concentrically spreading with sparse aerial mycelium, margin entire; mycelia white; sporulation not observed; pigment absent.

Colony diameters – 15°C PDA 3.2–3.5 cm/14 days, MEA 1.9–2.2 cm/14 days, OA 7 cm/12–13 days; 20°C PDA 5.2–6.2 cm/14 days, MEA 4–4.3 cm/14 days, OA 7 cm/5–6 days; 25°C PDA 7 cm/9 days, MEA 7 cm/11–12 days, OA 7 cm/5 days.

Asexual morphology: Conidiophores are reduced to conidiogenous cells. Conidiogenous cells solitary on hyphae, hyaline, cylindrical, 9.5–13(–24) × 4.5–5.5 μm. Conidia were brown, smooth, globose to ellipsoid, sometimes polygonal or irregular, 20–25(–26) × 18–23 μm (x = 22.4 × 21.1 μm, n = 37). Elongated conidia brown, smooth, obovoid, clavate, (25–)27–40(–44) × 12–20(–22) μm in size. Hyphopodia blackish, lobed, irregular in shape, resembling coral and sea squirt, 20–35(–42) × 5–35 μm. Mycelium smooth, hyaline, branched, and septate.

Additional material examined: KOREA, Jeollabuk-do, Gochang-gun, 35°25′50.9″N, 126°42′16.9″E, isolated from a branch of Phyllostachys pubescens, Mar. 2021, S.L. Kwon (NIBRFGC000509389 = KUC21684).

Remarks: The Apiospora pseudohyphopodii sp. nov. is closely related to Apiospora pseudoparenchymatica LC7234 (over 96.2% similarity in the ITS region, 99.52% in the LSU region, 92.92% in the TEF region, and 93.62% in the TUB region) and Ap. hyphopodii MFLUCC 15-003 (over 98.68% similarity in the ITS region) in the phylogenetic analysis (Figure 1). This species is characterized by blackish-lobed hyphopodia and large and elongated conidia. Hyphopodia have also been observed in Ap. hyphopodii MFLU 15-0383 [31]. However, Ap. pseudohyphopodii sp. nov. KUC21680 has larger conidia (20–25(–26) × 18–22.5 μm (x = 22.5 × 21.2 μm, n = 37)) than Ap. hyphopodii MFLU 15-0383.
The conidia of *Ap. pseudoparenchymatica* are similar in size to those of *Ap. pseudohyphopodii* sp. nov. KUC21680. However, they were clearly distinguished based on their phylogenies. Also, the growth rate of *Ap. pseudohyphopodii* sp. nov. KUC21680 (7 cm/9 days at 25°C on PDA) is slower than *Ap. pseudoparenchymatica* (9 cm/8 days at 25°C on PDA) [7].

*Apiospora hysterina* (Sacc.) Pintos & P. Alvarado, Fungal Systematics and Evolution 7:206 (2021) [MB837743] (Figure 4).

**Culture characteristics:** PDA, colonies circular form, flat, mycelium moderate, concentrically spreading with abundant aerial mycelium, margin entire; mycelia white; sporulation observed after 7–10 days at 15°C and 20°C on hyphae; reddish yellow (5YR, 7/8) pigment partially observed after 11 days. MEA, colonies circular form, flat, mycelium low, concentrically spreading with aerial mycelium, margin entire; mycelia hyaline to white colored; sporulation observed after 7–10 days at all temperatures on hyphae; pigment absent. OA, colonies circular form, flat, mycelium concentrically spreading with abundant aerial mycelium, margin entire; mycelia white; sporulation observed after 7–10 days at 20–25°C on hyphae; pigment absent.

Colony diameters – 15°C PDA 5.4–5.8 cm/14 days, MEA 4.8–4.9 cm/14 days, OA 5.5–6.8 cm/14 days; 20°C PDA 7 cm/9–10 days, MEA 7 cm/11–12 days, OA 7 cm/9–10 days; 25°C PDA 7 cm/7 days, MEA 7 cm/8 days, OA 7 cm/7 days.

**Asexual morphology:** Conidiophores basauxic, polyblastic, hyaline to pale brown, septate or not, smooth or finely roughened with granular pigments, cylindrical, straight or flexuous, 10–25 × 2–3.5 μm, sometimes exceeding 98 μm long. Conidia brown to dark brown, surface smooth, finely roughened, globose to subglobose in surface view, 15.0–18.0 × (13.2–)14.0–16.5(–17.5) μm (x̄ = 16.3 × 15.7 μm, n = 30); obvoid with a horizontal scar at the edge in side view, 15.0–18.0 × (11.5–)13.0–16(–17.5) μm (x̄ = 16.7 × 14.9 μm, n = 50).

**Specimen examined:** KOREA, Chungcheongnam-do, Taean-gun, 36°29’51.0”N, 126°21’41.5”E, isolated from the branch of *Phyllostachys bambusoides*.

**Figure 4.** *Apiospora hysterina* (KUC21437). (A) PDA; (B) MEA; (C) OA; (D) conidia; (E, G) conidiogenous cell with conidia; (F, H, I) conidia under UHR-SEM.
Feb. 2020, S.L. Kwon (NIBRFGC000506558 = KUC21437 and NIBRFGC000509388 = KUC21438).

Remarks: The microscopic morphologies of Ap. hysterina KUC21437 and KUC21438 are well-matched with the original description. The former has longer conidiophores exceeding 98 μm and obovoid conidia with a horizontal scar resembling Ap. hysterina ICMP 6889 [32]. The diffused pigment of Ap. hysterina ICMP 6889 was observed on MEA [32]. However, the pigment of Ap. hysterina KUC21437 was not observed on the MEA medium but was observed on the PDA medium. The obovoid shape of conidia of Ap. hysterina are similar to those of Apiospora yunnana (D. Q. Dai & K.D. Hyde) Pintos & P. Alvarado, and Ap. sasae Crous & R.K. Schumach, and they are closely related in the concatenated phylogenetic tree (Figure 1). However, the long conidiophores and small conidia of Ap. hysterina KUC21437 differs from Ap. yunnana [33]. In the case of Apiospora sasae, it is morphologically similar to Ap. hysterina by producing subglobose, polygonal to urceolate (uniform) conidia ((16–17–18–20) × (15–)16–17–19 μm) [34]. However, this species can be distinguished by the septate and long conidiophores of Ap. hysterina KUC21437.

Apiospora paraphaeosperma (Senan. & K.D. Hyde) Pintos & P. Alvarado, Fungal Systematics and Evolution 7:206 (2021) [MB837705] (Figure 5)

Culture characteristics: PDA, colonies circular form, mycelium thick, fluffy, concentrically spreading, margin entire; mycelia white, partially yellow; sporulation not observed; pigment absent. MEA, colonies circular form, flat, mycelium low, margin entire; mycelia hyaline to white colored; sporulation observed after 8–10 days at 20–25 °C on hyphae; pigment absent. OA, colonies circular form, flat, mycelium thick, fluffy, concentrically spreading with abundant aerial mycelium, margin entire; mycelia white, partially yellow; sporulation not observed; Yellow (2.5Y, 8/8) pigment partially diffused in media.

Colony diameters – 15 °C PDA 5.2–5.3 cm/14 days, MEA 4.3–4.5 cm/14 days, OA 4.0–4.2 cm/14 days; 20 °C PDA 7.0 cm/13 days, MEA 5.3–5.8 cm/14 days, OA 5.5–6.0 cm/14 days; 25 °C PDA 7.0 cm/11–12 days, MEA 7.0 cm/12–13 days, OA 6.5–7.0 cm/14 days.

Asexual morphology: Conidiophores are reduced to conidiogenous cells. Conidiogenous cells aggregated in clusters on hyphae, basauxic, polyblastic, hyaline, cylindrical, and ampulliform, 3.0–5.1(–8.7) × 1.5–3.0 μm, elongated conidiogenous cells length

Figure 5. Apiospora paraphaeosperma (KUC21488). (A) PDA; (B) MEA; (C) OA; (D, E) conidiogenous cell with conidia; (F) conidia generated on WA medium under light microscope; (G–I) conidiogenous cell with conidia under UHR-SEM.
(11–)15–25(–34) μm. Conidia green to brown, surface smooth, globose to subglobose, 9.5–12.0 × 8.0–11.0 μm (x = 10.9 × 9.8 μm, n = 47) in surface view; lenticular in side view, with equatorial slit, 7.5–9.0 μm wide (x = 8.12 μm, n = 37) in side view, a slightly elongated cell was observed. Mycelium smooth, hyaline, branched, septate, 1.5–2.5 μm diam.

Specimen examined: KOREA, Jeju-do, Seogwipo-si, 33°15′26.4″N, 126°21′11.2″E, isolated from a culm of bamboo, 2018, J.J. Kim, (NIBRFGC00059203 = KUC21488 and NIBRFGC000509390 = KUC21688).

Remarks: In the original description, Ap. paraphaeosperma MFLUCC 13-0644 had a long conidiogenous cell (25–30 × 4–6 μm) [35]. Although the conidiogenous cells of Ap. paraphaeosperma KUC21488 usually were observed at an average of 3.0–5.1 (–8.7) μm long, sometimes the elongated conidiogenous cells are also observed ((11–)15–25(–34) μm long). This species is closely related to Apiospora rasikravindrae (Shiv M. Singh et al.) Pintos & P. Alvarado, and Apiospora marina (S.L. Kwon, S. Jang & J.J. Kim) S.L. Kwon & J.J. Kim in the concatenated phylogenetic analysis. However, they could be distinguished by the presence or absence of elongated conidiogenous cells in Ap. paraphaeosperma.

4. Discussion

In this study, 242 bambusicolous Apiospora strains were isolated from various bamboo organs and identified based on their DNA similarity against the NCBI database. As a result, in the bamboo organs, the highest Apiospora diversity was detected on the culms (seven species), followed by branches (six species), leaves (two species), shoots epidermis (two species), and roots (one species) (Figure 25). The finding that the most diverse Apiospora were found in bamboo culms is consistent with the previously reported result that most bambusicolous Apiospora species have been isolated from bamboo culms (23 species/34 species of total bambusicolous Apiospora) (Table 2) [4,10,31–33,35–45].

So far, only Ap. rasikravindrae species have been reported in bamboo shoots by Majeedano et al. [46]. In addition, no studies have reported on the isolation of Apiospora species from bamboo roots (Table 2). However, in this study, Ap. arundinis was isolated from all organs, including shoots and roots. In addition, this species had the highest abundance (74% of the total isolates) among the bambusicolous Apiospora species (Table 1S).

New records were identified based on morphological and phylogenetic analyses. The DNA barcode set (ITS, LSU, TEF, and TUB regions) was used in the phylogenetic analysis to distinguish them from cryptic species. In the case of Ap. pseudohyphopodii sp. nov., it is difficult to distinguish between them using only morphology. However, they were clearly distinguished in the phylogenetic analysis, with high bootstrap values (Figure 1). The Ap. pseudohyphopodii sp. nov. is morphologically noted to have hyphopodia and large conidia (Figure 3). Hyphopodia structures were also observed in the species Ap. hyphopodii within the genus Apiospora [31]. However, Ap. hyphopodii could be distinguished by having smaller conidia than Ap. pseudohyphopodii sp. nov. The conidia size of Ap. pseudohyphopodii sp. nov. (globose to ellipsoid, sometimes polygonal or irregular, 20–25(–26) × 18–22.5 μm (x = 22.5 × 21.2 μm, n = 37)) is similar to Ap. neogarethjonesii (globose to subglobose, 20–35 × 15–30 μm), Ap. pseudoparenchymatica (globose to subglobose, 13.5–27 × 12–23.5 μm), and Ap. yunnana (globose to obovoid, 17.5–26.5 × 15.5–25 μm) [7,33,42]. However, they could be distinguished by the shape of the conidia, the presence or absence of hyphopodia, and phylogeny. The Ap. lageniformis sp. nov. is closely related to Ap. jiangxiense (M. Wang & L. Cai) Pintos & P. Alvarado, Ap. ovbata (M. Wang & L. Cai) Pintos & P. Alvarado, and Ap. arctoscopi (S.L. Kwon, S. Jang & J.J. Kim) S.L. Kwon & J.J. Kim in concatenate phylogeny (Figure 1). However, they could be distinguished by culture characteristics, growth rates, conidia size, and conidiogenous cell shape. The Ap. lageniformis sp. nov. is characterized by basauxic, polyblastic, and lageniform conidiogenous cells. The other two unrecorded species, Ap. hysterina and Ap. paraphaeosperma, could also be distinguished from cryptic species and identified as a new record species in this study, but both morphological and phylogenetic analyses are needed.

To date, 34 Apiospora species have been reported in bamboo materials worldwide (Table 2). In contrast, only two bambusicolous Apiospora species have been reported in Korea (Ap. arundinis and Ap. camelliae-sinensis) [15,17]. In the present study, nine Apiospora species contained two unrecorded species (Ap. hysterina and Ap. paraphaeosperma), five recorded species (Ap. arundinis, Ap. camelliae-sinensis, Ap. rasikravindrae, Ap. sargassi, and Ap. saccharicola), and two novel species (Ap. pseudohyphopodii sp. nov. and Ap. lageniformis sp. nov.) were found in bamboo forests. Two previously unrecorded species have been reported from bamboo materials in New Zealand (Ap. hysterina), Spain (Ap. hysterina), and Thailand (Ap. paraphaeosperma) [32,35]. Moreover, one recorded species, Ap. rasikravindrae has been reported in bamboo in China [7]. However, the other two recorded species...
Table 2. List of bambusicolous *Apiospora* in worldwide.

| Species                  | Bamboo species | Organs         | Country                  | Reference                                      |
|--------------------------|----------------|----------------|--------------------------|-----------------------------------------------|
| *Ap. acutipica*          | *Ba. bambos*   | Clump, leaf    | China, Canada, China, Korea | Senanayake et al. [36]                        |
| *Ap. arundinis*          | *Sasa sp.*     | Culm, leaf     | China                    | Crous and Groenewald. [4], Wang et al. [7], Kim et al. [15] |
| *Ap. bambusicola*        | Unidentified   | Dead culm      | Thailand                 | Tang et al. [37]                              |
| *Ap. biseriale*          | *Ph. bambusoides* | Leaf      | Korea                    | Feng et al. [38]                              |
| *Ap. camelliae-sinensis* | Unidentified   | Dead culm      | Thailand                 | Tian et al. [10]                              |
| *Ap. chiangrains*        | *Ph. aurea*    | Dead culm      | Spain                     | Pintos et al. [32]                            |
| *Ap. euphorbiae*         | Unidentified   | Dead culm      | China                     | Jayasiri et al. [39]                          |
| *Ap. garetnjonesii*      | Unidentified   | Dead culm and branch | China                  | Dai et al. [40], Feng et al. [38]              |
| *Ap. gelatinosa*         | Unidentified   | Dead culm and branch | China                  | Senanayake et al. [36]                        |
| *Ap. guizhouensis*       | *Ba. multiplex* | Branch         | China                     | Crous and Groenewald. [4]                      |
| *Ap. hydei*              | *Ba. tuldoides*, unidentified | Culm, leaf | Hong Kong, China         | Senanayake et al. [31]                        |
| *Ap. hyphopodi*          | *Ba. tuldoides* | Culm          | Thailand                  | Senanayake et al. [31]                        |
| *Ap. hysterina*          | *Bambusa sp.*, *Ph. aurea* | Dead culm | New Zealand, Spain       | Pintos et al. [32]                            |
| *Ap. jiangxiensis*       | *Phyllostachys sp.*, unidentified | Leaf        | China                     | Wang et al. [7]                               |
| *Ap. longistroma*        | Unidentified   | Decaying culm  | Thailand                  | Dai et al. [33]                               |
| *Ap. neobambusae*        | Unidentified   | Leaf           | China                     | Wang et al. [7]                               |
| *Ap. neochinensis*       | *Fa. qinlingensis* | Culm        | China                     | Jang et al. [41]                              |
| *Ap. neogaretnjonesii*   | Unidentified   | Dead culm      | China                     | Hyde et al. [42]                              |
| *Ap. neoubiglobosa*      | Unidentified   | Dead culm      | China                     | Dai et al. [40]                               |
| *Ap. multiloculata*      | Unidentified   | Dead culm      | Thailand                  | Bhunjjan et al. [43]                          |
| *Ap. paraphaeosperma*    | *Bambusa sp.*  | Dead clumps    | Thailand                  | Hyde et al. [35]                              |
| *Ap. phyllostachydis*    | *Ph. heterocladia* | Dead culm  | China                     | Yang et al. [44]                              |
| *Ap. pseudoparenchymatica* | Unidentified   | Leaf           | China                     | Wang et al. [7]                               |
| *Ap. pseudosubglobosa*   | *Ba. dolichocladia* | Sheath   | China                     | Senanayake et al. [36]                        |
| *Ap. pseudosinensis*     | Unidentified   | Leaf           | Netherlands               | Crous and Groenewald. [4]                      |
| *Ap. qinlingensis*       | *Fa. qinlingensis* | Culm        | China                     | Jang et al. [45]                              |
| *Ap. rasikarvindraceae*  | Unidentified, *L. intermedia* | Dead culm, Leaf Shoot | China, Thailand           | Wang et al. [7], Tian et al. [10], Majeedano et al. [46] |
| *Ap. sacchari*           | Unidentified   | Dead culm      | Indonesia                 | Crous and Groenewald. [4]                      |
| *Ap. septata*            | Unidentified   | Dead culm      | China                     | Feng et al. [38]                              |
| *Ap. subglobosa*         | Unidentified   | Culm           | Thailand                  | Senanayake et al. [31]                        |
| *Ap. subrostrum*         | Unidentified   | Leaf           | China                     | Wang et al. [7]                               |
| *Ap. thailandica*        | Unidentified   | Culm           | Thailand                  | Dai et al. [33]                               |
| *Ap. yunnana*            | Unidentified   | Culm           | China                     | Dai et al. [33]                               |

*The genus names of bamboo were abbreviated as: *Ba., Bambusa; *Ph., Phyllostachys; *Fa., Fargesia; and *L., Lignania.*

(Ap. sargassi and Ap. saccharicola) have not been reported in bamboo until now; thus, this is the first report of these species isolated from bamboo materials.

Research on bambusicolous fungi may provide opportunities to control bamboo pathogens and promote bamboo cultivation [47]. However, the ecological roles of most of the *Apiospora* remain unknown. Therefore, *Apiospora* diversity and their ecological roles need to be explored further. This study will serve as a basis for the taxonomic study of *Apiospora* and is expected to be the groundwork for potentially determining the diversity of *Apiospora* in the bamboo forests of Korea.

**Acknowledgment**

The authors are grateful to Dr. Songjin Lee (Bamboo Resource Research Institute, Damyang-gun, Korea) for help in collecting and identifying the bamboo materials.

**Disclosure statement**

No potential conflict of interest was reported by the author(s).

**Funding**

This work was supported by National Research Foundation of Korea (NRF) grants funded by the Korean government (MSIT) [2021R1A2C1011894]; the National Institute of Biological Resources under the Ministry of Environment, Republic of Korea [NIBR202102107 and NIBR202203112].

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