# Stable isotopes, phylogenetics, and experimental data indicate a unique nutritional mode for *Rickenella fibula*, a bryophyte-associate in the Hymenochaetales

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Hailee Brynn Korotkin
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# ABSTRACT

Fungal-bryophyte interactions have been documented in all lineages of bryophytes, however, many of these relationships are poorly understood. The fungus *Rickenella fibula* is a known associate of various mosses, but results from previous studies have not yielded conclusive evidence of its relationship to mosses or its trophic mode. The *Rickenella* clade exhibits a wide variety of nutritional modes, including other bryophyte-associated fungi. Here, I combine a broad range of methods, using phylogenetics, stable isotope analyses, PCR assays, *in vitro* experiments, and genomics to determine the nutritional mode of *R. fibula*. First, phylogenetic analysis of a supermatrix of 28S rRNA, 18S rRNA, and *rpb2* gene regions affirms the evolutionarily derived position of the *Rickenella* clade in the Hymenochaetales, although support for this topology is weak. Ancestral state reconstruction analysis supports the hypothesis that ancestral Hymenochaetales were saprotrophic followed by two switches to bryophyte associations. A bryophyte association, however, is not evolutionarily stable as switches to an ectomycorrhizal state and reversals to a free-living state are observed. Stable isotope analysis of $\delta^{13}C$ [(delta^13)C] and $\delta^{15}N$ [(delta^15)N], indicates that *R. fibula* has a unique stable isotope signature suggesting a novel biotrophic mode. Assessment of the presence/absence of genes involved in degradation of lignin and cellulose suggests that *R. fibula* has largely retained these suites of genes involved in plant tissue degradation. However, unlike saprotrophic Hymenochaetales, the *R. fibula* genome indicates the presence of sucrolytic activity by invertase, consistent with a biotrophic or endophytic habit. PCR assays of the ITS region of *R. fibula* in moss host tissues support the presence of the fungus throughout the gametophyte tissues, including rhizoids and living and senescent portions of the moss. Lastly, in most cases, inoculation of moss gametophytes with *R. fibula* does not significantly impact productivity of the moss. Taken together, these results support a unique biotrophic mode in *R. fibula* with the fungus most likely maintaining a commensal endophytic relationship with its moss host.

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# SECTION 1: INTRODUCTION

Symbiotic relationships with fungi are key drivers of ecosystem form and function (Smith and Read, 2010). Fungi perform significant roles in nutrient cycling as root symbionts and primary decomposers. In addition, fungi have impacted the diversity of terrestrial plant life through the exchange of nutrients during mycorrhizal relationships, allowing vascular plants to grow larger, more robust, and expand into new territories (Sylvia, 2005). However, fungal-plant interactions are not limited to vascular plants. Indeed, some of the most ancient fungal-plant symbioses stem from fungal-bryophyte relationships (Pressel et al., 2010; Bidartondo et al., 2011; U'Ren et al., 2012; Field, Rimington, et al., 2015). Fungal symbioses have been documented in all lineages of bryophytes – mosses, liverworts, and hornworts (During and Van Tooren, 1990; Döbbeler, 1997; Davey and Currah, 2006; Pressel et al., 2010; Bidartondo et al., 2011; Field, Pressel, et al., 2015). Yet, despite decades of speculation about fungal-bryophyte interactions, many of these relationships are still poorly understood.

Studies of fungal-bryophyte symbioses have generally been restricted to few genera, mostly species of Ascomycota, with less of a focus on Basidiomycota (Kost, 1984, 1988; Duckett et al., 1991; Duckett and Ligrone, 1992; Dobbeler, 1997; Bresinsky and Schötz, 2006; Kauserud et al., 2008; Ptaszyńska et al., 2009; Davey, Heimdal, Ohlson, Kauserud, et al., 2013; Zhang et al., 2013; Yu et al., 2014; Wäli et al., 2014). Conclusions from these studies cover a broad range of interactions, but are generally inconclusive or incomplete. Hypothesized interactions include fungi acting as saprotrophs on senescing gametophyte tissue, biotrophs, mycorrhizal-like mutualists, commensalists, or a combination of these (Redhead, 1981; Kost, 1984; Bresinsky and Schötz, 2006; Davey, Heimdal, Ohlson and Kauserud, 2013; Grzesiak and Wolski, 2015). Very few studies have found evidence for pathogenicity. Most fungi do not kill their bryophyte partners, even if they may show signs of causing damage (Bresinsky and Schötz, 2006; Davey, Heimdal, Ohlson and Kauserud, 2013).

Most basidiomycete studies of fungal-bryophyte interactions stem from a few groups of Agaricomycetes, namely *Galerina*, *Mycena*, *Loreleia*, *Rickenella*, and Hygrophoraceae (Kost, 1984; Redhead et al., 2002; Bresinsky and Schötz, 2006; Seitzman et al., 2011; Davey, Heimdal, Ohlson and Kauserud, 2013; Latha et al., 2014; Grzesiak and Wolski, 2015). Davey et al. (2013) found that species of *Galerina* and *Mycena* (Agaricales) colonize both senescent and living gametophyte tissue of several moss species, with a higher abundance in senescent tissue, supporting the hypothesis that they are breaking down moribund gametophytes. However, they also note that parasitism cannot be ruled out due to the broad range of degradative enzymes produced that allow colonization of moss tissues.

Comparably, studies of *Rickenella* and *Loreleia* yield similar conclusions. Both genera were found to have high cellulase activity, which may function to help the fungus penetrate host cells (Bresinsky and Schötz, 2006). Furthermore, hyphae have been observed in rhizoids and thalli of bryophyte hosts, but do not appear to harm the host to the point of death (Redhead,

1981; Kost, 1984). However, species of *Loreleia* and *Rickenella* produce haustoria, an indication of parasitism (Redhead, 1981). Conclusions from these studies tend to lean towards endophytic saprotrophs or biotrophs, with the unestablished possibility that an endomycorrhizal-like mutualism is occurring (Kost, 1984; Bresinsky and Schötz, 2006), although parasitism has also been suggested (Redhead, 1981).

While the literature is generally dominated by biotrophic or saprotrophic interactions, many studies cannot rule out the existence of mycorrhizal-like symbioses between bryophytes and fungi (Carleton and Read, 1991; Duckett et al., 1991; Dobbeler, 1997; Kauserud et al., 2008; Day and Currah, 2011; Field, Rimington, et al., 2015). Pressel et al. (2010) point out that glomeromycete associations in liverworts have cellular interactions that resemble arbuscular mycorrhizas, and feather mosses have been found to be colonized by mycorrhizal fungi but may not be performing any mycorrhizal functions (Carleton and Read, 1991; Kauserud et al., 2008) Furthermore, some ascomycete fungi found in peat bog liverworts, though restricted to the rhizoids, are comparable to vascular plant mycorrhizas (Duckett et al., 1991). While these observations have been made, there has yet to be any evidence to support the mycorrhizal-like exchange of nutrients between the bryophyte and the associated fungi (Davey and Currah, 2006).

Another suggested relationship between fungi and bryophytes is commensalism. Several studies have suggested that commensal relationships between fungi and bryophytes may exist, but most speculations are based on observations that many bryophytes appear healthy even when colonized by various fungi (Jakucs et al., 2003; Bresinsky and Schötz, 2006; Davey and Currah, 2006). While it is possible that commensal relationships exist, a salubrious bryophyte does not necessarily mean nutrients are not siphoned by the inhabiting fungus and the relationship may still be biotrophic. However, very few fungal pathogens (disease causing parasites) have been reported in bryophytes, but those that have been are typically ascomycetes (Hassel and Kost, 1998). The lack of observed bryophyte pathogens may be due to endophytic commensal interactions that help fend off fungal invaders (During and Van Tooren, 1990; Kauserud et al., 2008) or due to use of a suite of peroxidases that deter the pathogens (Lehtonen et al., 2009).

An array of useful techniques are available to elucidate fungal-bryophyte symbioses, however, evidence is still lacking in many cases of specific fungal-bryophyte relationships and fungal trophic modes. To further trophic interaction investigations from both an ecological and evolutionary perspective, I focus on the fungal-bryophyte relationship between the fungus *Rickenella fibula* (Hymenochaetales) and the widespread acrocarpous moss *Dicranum scoparium* (Lang and Stech, 2014). *Rickenella fibula* is one of the few mushroom-forming fungi that produces agaricoid (pileus, stipe, and lamellae) fruitbodies that fruit on senescent portions of *D. scoparium*, in addition to other mosses. It is nested in the *Rickenella* clade with other bryophyte-associated fungi of Hymenochaetales, in addition to fungi associated with green algae and nematode predators (Redhead et al., 2002; Bresinsky and Schötz, 2006; Larsson et al., 2006). The *Rickenella* clade is part of the Hymenochaetales, an order characterized mostly by wood-decaying, white-rot saprotrophs with the ability to degrade lignin (Binder et al., 2005; Larsson et

al., 2006). However, species with brown-rot or ectomycorrhizal (ECM) capabilities have also been documented in the order (Binder et al., 2005; Larsson et al., 2006), including *Rickenella minuta*, which fruits on soil from ECM root tips of *Nothofagus* in southern South America (Tedersoo and Smith, 2013).

Different trophic modes commonly have predictable suites of enzymes, such as cellulose and lignin degradation enzymes. ECM fungi have been found to contain plant cell wall degradative enzymes such as cellobiohydralase, cellulase, chitinase, polygalacturonase, and xylanase, and lignin degradation enzymes such as laccase, manganese peroxidase, and peroxidase (Read et al., 2004; Talbot et al., 2008). Other types of biotrophic fungi, such as ericoid mycorrhizal fungi, often contain plant cell wall degradative enzymes such as arabinosidase, galactosidase, and mannosidase, in addition to the other plant cell wall degradative enzymes found in ECM fungi. They also have been found to contain lignin degradative enzymes such as laccase, ligninase, and peroxidase (Read et al., 2004; Talbot et al., 2008). However, all mycorrhizal fungi contain a much lower number of these enzymes compared to saprotrophic (SAP) fungi. SAP fungi have been found to contain all of the aforementioned enzymes in mycorrhizal species, but also to contain the plant cell wall degradative enzyme glucanase (Zhao et al., 2013; Kohler et al., 2015). Parasitic fungi vary in enzymes based on the type of parasite (i.e. facultative or obligate; plant or animal; Zhao et al., 2013). However, it can be noted that the enzyme invertase, an enzyme used to break down sucrose, is found in plant parasitic fungi, generally endophytes, but not in animal parasitic fungi. There is also evidence that it occurs in some, but not all mycorrhizal fungi (Parrent et al., 2009). There is limited work on enzymes found in commensalistic fungi, however, it may be expected that they exhibit a suite of enzymes similar to other biotrophic fungi (Parrent et al., 2009).

Previous studies have used stable isotope signatures of nitrogen ($\delta^{15}N$) and carbon ($\delta^{13}C$) to infer trophic mode of fungi, including SAP, ECM, and other biotrophic modes that do not fall under ECM (Hobbie et al., 2001; Trudell et al., 2004; Mayor et al., 2009; Seitzman et al., 2011; Tedersoo et al., 2012; Birkebak et al., 2013; Sánchez-García et al., 2014; Trappe et al., 2015). The general pattern observed for $\delta^{15}N$ is plants < saprotrophic fungi < mycorrhizal fungi < other biotrophic fungi and the pattern observed for $\delta^{13}C$ is plants < mycorrhizal fungi = other biotrophic fungi < litter decay fungi < wood decay fungi (Hobbie et al., 2001; Seitzman et al., 2011; Birkebak et al., 2013). However, at times an overlap of signatures between modes have been observed, making it necessary to employ several methods other than stable isotope analysis to parse out fungal trophic modes.

A multifaceted approach including phylogenetics, stable isotope data, PCR assays, *in vitro* experiments, and genomics has been implemented to determine 1) if the *Rickenella* clade is evolutionarily derived from white-rot saprotrophic ancestors in the Hymenochaetales, 2) if *R. fibula* has lost the ability to degrade organic material, including lignin, and 3) the trophic mode of *R. fibula* and other closely related bryophyte-associated Hymenochaetales. Prior work has suggested the *Rickenella* clade is monophyletic and that it is dominated by bryophyte-associated

species (Binder et al., 2005; Larsson et al., 2006). I predict that saprotrophy is the ancestral state of the Hymenochaetales, confirming the *Rickenella* clade and its unique trophic modes are evolutionarily derived. The genome of *R. fibula* may reveal a suite of genes capable of lignin-degradation and litter breakdown - indicators of decomposition. Although *R. fibula* may retain lignin degradation capabilities, bryophytes are only known to contain lignin-like polymers and not lignin itself (Ligrone et al., 2008) and for this reason, may not transcribe genes associated with lignin degradation if the bryophyte host is their only source of nutrition. Finally, *R. fibula* and other closely related bryophyte-associated Hymenochaetales have a biotrophic relationship with their bryophyte host, but may also be capable of decomposition. Table I summarizes predictions for all possible interactions.

**Table I. Summary of predictions for an ectomycorrhizal-like state (ECM-like); saprotrophic; not-ectomycorrhizal-not saprotrophic (NE-NS), which reflects selective biotrophic Clavariaceae data from Birkebak et al., (2013); commensalism; and parasitism.**

| | ECM-like | SAP | NE-NS | Commensalism | Parasitic |
|---|---|---|---|---|---|
| **Stable isotopes: $\delta^{15}N$** | Plants < Parasitism < Commensalism < SAP < ECM < NE-NS | | | | |
| **Stable isotopes: $\delta^{13}C$** | Plants < Parasitism < Commensalism < NE-NS = ECM < SAP | | | | |
| **Fungus presence (PCR assays)** | On rhizoids | Senescent gametophytes only | Non-restrictive, all tissues | Non-restrictive, all tissues | Non-restrictive, all tissues |
| ***In vitro* inoculations, impact on moss productivity** | Increase | Decrease | Increase | Unaffected | Decrease |
| **Plant cell wall degradative enzymes expected** | - | - | Arabinosidase | - | - |
| | Cellobiohydralase | Cellobiohydralase | Cellobiohydralase | Cellobiohydralase | Cellobiohydralase |
| | Cellulase | Cellulase | Cellulase | Cellulase | Cellulase |
| | Chitinase | - | Chitinase | Chitinase | Chitinase |
| | - | - | Galactosidase | - | - |
| | - | - | - | - | Invertase |
| | - | - | Mannosidase | - | - |
| | Polygalacturonase | - | Polygalacturonase | Polygalacturonase | Polygalacturonase |
| | Xylanase | - | Xylanase | Xylanase | Xylanase |
| **Lignin degradative enzymes expected** | Laccase | Laccase | Laccase | - | SAP: Laccase<br>Non-SAP: - |
| | - | Ligningase | - | - | SAP: Ligningase<br>Non-SAP: - |
| | Manganese peroxidase | Manganese peroxidase | Manganese peroxidase | - | SAP: Manganese peroxidase<br>Non-SAP: - |
| | Peroxidase | Peroxidase | Peroxidase | - | SAP: Peroxidase<br>Non-SAP: - |

## SECTION 2: MATERIALS AND METHODS

### *Collections and taxon sampling*

Fungal specimens from the genus *Rickenella* and moss specimens of *Dicranum scoparium* were collected from locations in Tennessee, North Carolina, and Washington state. All specimens were dried and deposited in the University of Tennessee Herbarium (TENN). Additional Hymenochaetales specimens were sampled from collections already stored at TENN; University of Helsinki (H); University of Turku (TUR); Universidad Nacional de Córdoba (CORD); and from other independent collectors. All available Hymenochaetales nuclear large subunit ribosomal RNA (nLSU), nuclear small subunit ribosomal RNA (nSSU), and second largest subunit of RNA polymerase II (*rpb2*) DNA sequences were downloaded from GenBank. All internal transcribed spacers (ITS) sequences of *Rickenella* species were downloaded from GenBank as well.

### *DNA extractions, PCR, and sequencing*

Genomic DNA from fungal specimens was extracted using 10–30 mg of dried tissue. Samples were ground with liquid nitrogen and a small amount of sterile sand using a mortar and pestle. Extractions were performed using an E.Z.N.A. HP Fungal DNA Kit (Omega Bio-Tek, Norcross, Georgia). Genomic DNA was subsequently diluted in a 1:10 sterile water solution. A mixture of sterile water, 5X buffer, dNTPs, and GoTaq was prepared for each sample of genomic DNA, diluted DNA, and controls. The following primer pairs were used for both PCR and sequencing: for ITS: ITS1F-ITS4 (Sappington and Taylor, 1990; Gardes et al., 1993); for nLSU: LR0R-LR7, if the region was not successfully amplified, then the shorter segment, LR0R-LR5 was amplified (Vilgalys and Hester, 1990); for nSSU: PNS1-NS41 (White et al., 1990; Hibbett, 1996); and for *rpb2*: b6f-b7.1R (Matheny, 2005). All new DNA sequences of specimens generated here have been deposited at GenBank (Appendix, Table VIII).

PCR conditions to amplify ITS, nLSU, and nSSU are outlined in White et al. (1990) and for *rpb2* in Matheny (2005). PCR products were viewed on 1.0% agarose gels prepared with SYBR Safe (Thermo Fisher Scientific, Rockwood, Tennessee) and a UV transilluminator. Amplified products were purified using spin columns from a QIAquick PCR purification kit (QIAGEN, Valencia, California) following the manufacturer's protocol. Sequence reactions were prepared with a BigDye Terminator 3.1-cycle sequencing kit (Applied Biosystems, Foster City, California) and subsequently purified using Sephadex G-50 columns (General Electric Healthcare, Piscataway, New Jersey), and sequenced on an ABI 3730 48-capillary electrophoresis analyzer at the Molecular Biology Resource Facility at the University of Tennessee. Raw sequences were visualized, edited, and assembled using Sequencher v.4.9 software (Gene Codes, Ann Arbor, Michigan).

### *Phylogenetic analyses*

Four nucleotide datasets were assembled and manually adjusted in AliView (Larsson, 2014) and concatenated in SeaView v.4.5.2 (Gouy et al., 2010). Gene regions absent for taxa were coded as missing data. Several studies have shown that the addition of taxa, despite missing data, can improve phylogenetic resolution (Wiens, 2006; Wiens & Morrill, 2011). The first dataset contains all Hymenochaetales with at least one locus (nLSU, nSSU, *rpb2*) present. This is called the "Hymenochaetales inclusive dataset" (HID) and includes 590 specimens. The second dataset contains all Hymenochaetales with two or more loci present, except all *Rickenella* clade sequences were included as long as at least the nLSU or nSSU locus was present. This is referred to as the "Hymenochaetales core dataset" (HCD) and includes 159 specimens. The third dataset contains nLSU, nSSU, and *rpb2* loci from members of the *Rickenella* clade only and is referred to as the "*Rickenella* clade dataset" (RCD) and includes 144 specimens. The fourth dataset contains ITS from the genus *Rickenella* and environmental sequences that are designated as *Rickenella*. This is referred to as the "*Rickenella* ITS dataset" (RID) and includes 51 specimens. A total of 91 nLSU, 54 nSSU, 32 *rpb2,* and 36 ITS are new sequences generated for these datasets. All datasets were analyzed with Maximum Likelihood (ML) in RAxML v.8.2.8 (Stamatakis, 2014), employing the GTR+GAMMA+I model, which was employed based on RAxML model selection and executing the initial1000 rapid ML bootstraps. Branches with high support (≥ 70) are labeled. All specimens in datasets can be found in Appendix, Table VIII. The four datasets and resulting phylogenetic trees have been submitted to TreeBase (Submission 21259).

### *Ancestral state reconstruction analysis*

ML ancestral state reconstruction (ASR) analysis was performed in Mesquite 2.75 (Maddison and Maddison, 2011) using a pruned one-species representative version of the HCD ML tree. The identification of species used for the pruned tree was based on branch length (a branch length of < 0.005 is considered the same species). Thus some taxa with the same name, but that differ > 0.005 genetically are both included in the pruned tree. One character with three states was estimated using maximum likelihood with the Mk1 model, they are: ECM (ectomycorrhizal - a biotrophic mutualism, associating with plant root tips), SAP (saprotrophic – decomposing dead or decaying organic material), and BRYO (fungal-bryophyte association, which could be a form of ECM, SAP, or another form of biotrophy) to determine the number of evolutionary transitions of nutritional mode and its ancestral state in the Hymenochaetales. Trophic mode was determined by current literature and author determined for those where a reference source could not be found. Appendix, Table VIII cites the literature used for determination.

### *Stable isotope analyses*

A total of 108 specimens, including 88 samples of Hymenochaetales, were analyzed at the University of New Hampshire Stable Isotope lab (www.isotope.unh.edu) on an Elementar

Americas Pyrocube (Elementar Americas Inc., Mt. Laurel, New Jersey) elemental analyzer combined with a GeoVision isotope ratio mass spectrometer (GeoVision Inc., Taiwan) for stable isotope signatures of carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) and elemental percent (%C, %N). The abundance values of $^{13}C$ were measured relative to the Vienna Pee Dee Belemnite and the $^{15}N$ abundance values relative to atmospheric nitrogen. Results were assessed in R statistical software (R Core Team, 2012). Results were compared with existing data from Mayor et al., (2009), Birkebak et al., (2013) and Sánchez-García et al., (2014) (Appendix, Table IX). Isotopic results were compared by a one-way, two-tailed ANOVA to determine differences across all trophic groups, unless the data was non-normal and then a Chi-square test was performed. For significant ANOVAs and Chi-squares, a Tukey-Kramer post-hoc test was implemented for a separation of means at the 0.05 level to determine if there are significant differences between individual trophic groups. Means are reported ± one standard error (SE). After stable isotope analysis, results were scored as either ECM, SAP, ECM-BRYO (a bryophyte-assocition that exhibits an ECM nutritional mode), SAP-BRYO (a bryophyte-assocition that exhibits an SAP nutritional mode), or BIO-BRYO (a non-ECM biotrophic bryophyte-associatition), or UN-BRYO (an unknown trophic mode, but a bryophyte-associate).

***Fungal DNA probes of moss tissues***

Wild collected specimens of *D. scoparium* were washed in double distilled sterile water for thirty seconds to remove any exterior debris. Two samples were taken from each specimen collection. The first sample was washed in a 10% sodium hypochlorite solution for thirty seconds (Vujičić et al., 2010), and the second sample was washed again in double distilled sterile water for thirty seconds. Samples were then partioned into living gametophyte tissue, senescent gametophyte tissue, sporophytes (if present), and rhizoids. DNA was extracted following the methods outlined above. PCR amplification of the fungal ITS region was performed to determine presence of *R. fibula* in each section of moss tissue. Resulting PCR products were purified and sequenced as described above and then the NCBI BLAST tool was used to determine species presence in the moss tissue. A 95% cut off was used to distinguish species presence.

***Moss in vitro cultivation***

Sporophyte capsules from wild collected *D. scoparium* specimens were washed in double distilled sterile water and then surface sterilized for 30 seconds in 10% sodium hypochlorite solution. Capsules were then crushed in double distilled sterile water to release spores. All spores were plated on sterile Murashige and Skoog media (Murashige and Skoog, 1962) until protonemata developed. Single protonema were then subcultured onto new Petri dishes filled with Murashige and Skoog media and grown until a thick protonemal mass formed. They were then subcultured into small jars and grown until mature leafy gametophytes formed. Cultures were kept at 18° C with 16 hours of low light (7-12 μmoles $m^{-2}s^{-1}$) and 8 hours of darkness for six months until inoculation with mycelium of *R. fibula*.

Fresh specimens of *R. fibula* were collected and basidiospore deposits gathered. Basidiospores were plated on malt dextrose agar (MEA). Moss gametophyte cultures were randomly assigned to one of four treatments: 1) inoculation with an MEA agar block of *R. fibula*, 2) inoculation in sterile water with *R. fibula*, 3) inoculation control of an MEA agar block without *R. fibula*, and 4) inoculation control of sterile water without *R. fibula*. Cultures were kept at the same temperature and light conditions as described above. After 8 months the moss gametophytes were weighed, and the lengths of the live (green) and senescent (brown) leafy gametophyte tissues were measured. These data were subject to statistical analysis using a two-sample t-test between each pair of treatments (MEA with and without *R. fibula* and sterile water with and without *R. fibula*), and a separation of means at a 0.05 significance level.

### *Presence/absence of genes involved in plant tissue degradation across Hymenochaetales genomes*

A full genome and transcriptome of *R. fibula* (JGI 333301 v1.0) was sequenced by the Joint Genome Institute (JGI) and is available via the JGI Genome Portal MycoCosm (http://jgi.doe.gov/fungi). Additional Hymenochaetales genomes at JGI, *Fomitiporia mediterranea* (JGI 56107 v1.0), *Onnia scaura* (JGI 245618 v1.0), *Porodaedalea niemelaei* (JGI 333975 v1.0), *Rickenella mellea* (JGI 334780 v1.0), *Schizopora paradoxa* (JGI 239088 v1.0), and *Trichaptum abietinum* (JGI 210203 v1.0) were analyzed for presence/absence using Interpro (EMBL-EBI, Cambridgeshire, UK) and Pfam (EMBL-EBI, Cambridgeshire, UK) for the following enzymes: arabinosidase, cellulase, cellobiohydrolase, chitinase, galactosidase, glucanase, invertase, laccase, ligninase, manganese peroxidase, mannosidase, peroxidase, polygalacturonase, and xylanase. Arabinosidase, cellulase, cellobiohydrolase, chitinase, galactosidase, glucanase, invertase, mannosidase, polygalacturonase, and xylanase are part of various glycoside hydrolase families, which are known to aid in plant cell wall degradation and are common in both parasitic and SAP fungi (Talbot et al., 2008; Zhao et al., 2013; Kohler et al., 2015). Laccase, ligninase, manganese peroxidase, and peroxidase are known to degrade lignin (Read et al., 2004; Talbot et al., 2008; Zhao et al., 2013; Kohler et al., 2015). Annotation updates to the genomes occur; the versions of the genomes above were last downloaded for analysis in this study on 20 June 2017.

# SECTION 3: RESULTS

### *Phylogenetic analyses of the Hymenochaetales and the Rickenella clade*

Four phylogenies have been produced based on the HID, HCD, RCD, and RID datasets. In the HID tree (Appendix, Figure IX), the genus *Rickenella* is monophyletic with weak bootstrap support (36%) and comprises two distinct clades, one composed of BRYO species, and the other of *Nothofagus*-associated ECM species. The *Rickenella* clade *sensu* Larsson et al. (2006) was not recovered, however, bootstrap support for the non-monophyly of the *Rickenella* clade in this analysis is low.

Phylogenetic analysis of the HCD (Figure I) does not recover the *Rickenella* clade *sensu* Larsson et al. (2006). The genus *Rickenella* is recovered as polyphyletic, as the BRYO *Rickenella,* which include *R. fibula, R. mellea, R setipes, R. swartzii,* and *R.* sp. and the South American ECM *Rickenella*, which include *R. minuta,* are not recovered as a single clade. However, its non-monophyly receives weak bootstrap support.

Phylogenetic analysis of the RCD demonstrates the genus *Rickenella* is polyphyletic, with BRYO species and ECM species clustering as separate groups (Figure II). The BRYO associated group is recovered as monophyletic with a bootstrap score of 64%. Two distinct clades of *Rickenella minuta* are recovered with high support for each (93% and 99%). BRYO or suspected BRYO species do not form a single clade and are polyphyletic. However, bootstrap support for again lacking.

Phylogenetic analysis of the RID recovers two separate groups of *Rickenella* species – BRYO species and ECM species, with possibly three species of *R. minuta* nested in the ECM clade (Figure III). Environmental samples of *Rickenella* from *Nothofagus* root tips and gametophyte tissues from two different species of bryophytes (*D. scoparium* and *Hypnum* sp.) cluster with the BRYO species (Figure III). An ITS dataset of all *Rickenella* clade members was compiled, however, the sequences were found to be highly divergent and could not be unambiguously aligned for analysis.

### *Ancestral state reconstruction analyses*

One of three trophic states was assigned to all species in the HCD tree: ECM, SAP, or BRYO. Trophic state was determined based on current literature and author determinined for those where a reference source could not be found (Appendix, Table VIII). The SAP state is resolved as the ancestral condition in the Hymenochaetales (Figure IV). The BRYO state is recovered as derived in the *Rickenella* clade (Figure IV and Figure V). Within the *Rickenella* clade, there are two transitions from a SAP state to a BRYO state and three reversals from the BRYO state back to SAP (Figure V). The *Rickenella minuta* group is the only recognized ECM lineage in the *Rickenella* clade and is derived from a common ancestor with the BRYO character state (Figure IV and Figure V). However, there is one other transition from SAP to ECM outside the *Rickenella* clade, but this is the only state transition outside the *Rickenella* clade (Figure IV).

**Figure I. HCD ML tree with ≥70 bootstrap values shown. ML relationships determined from at least two loci (nLSU, nSSU, *rpb2*) per sample, except for *Rickenella* clade species, which may be determined from only one locus. The *Rickenella* clade *sensu* Larsson et al., (2006) is highlighted in two groups. The weakly supported monophyletic group is highlighted in green with some additional species not included in Larsson et al., (2006). Species considered part of the *Rickenella* clade *sensu* Larsson et al., (2006) that did not resolve as monophyletic are highlighted in purple.**

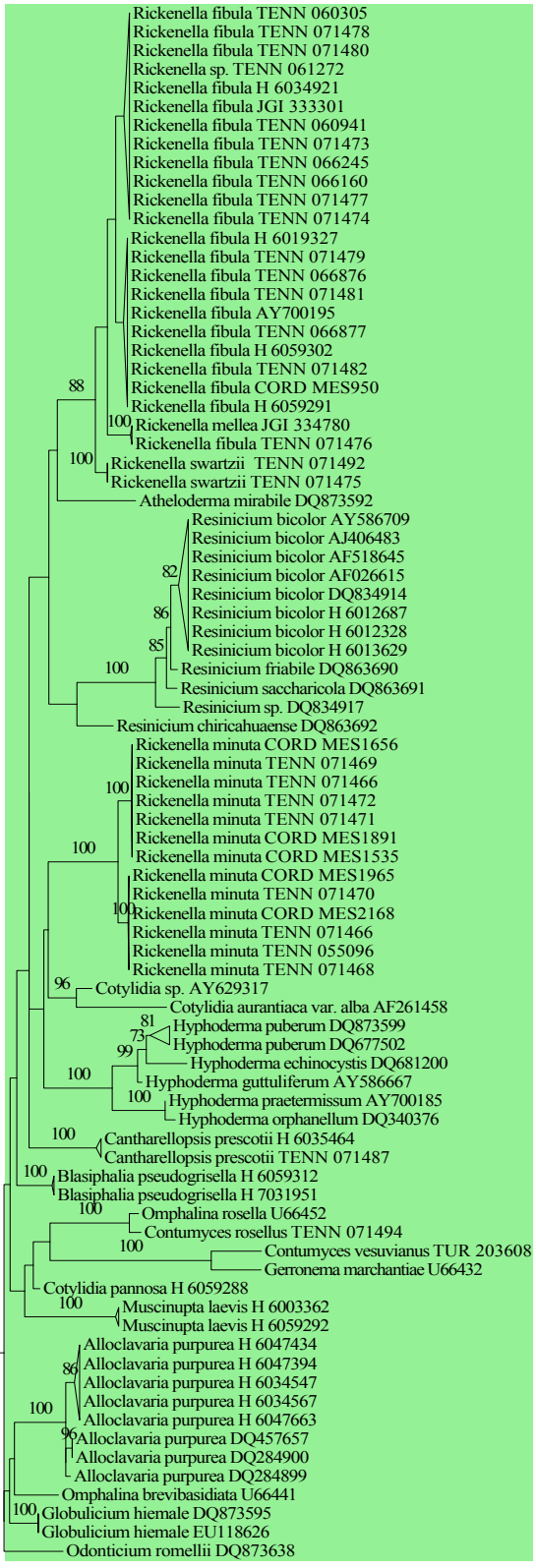



**Figure I. Continued.**

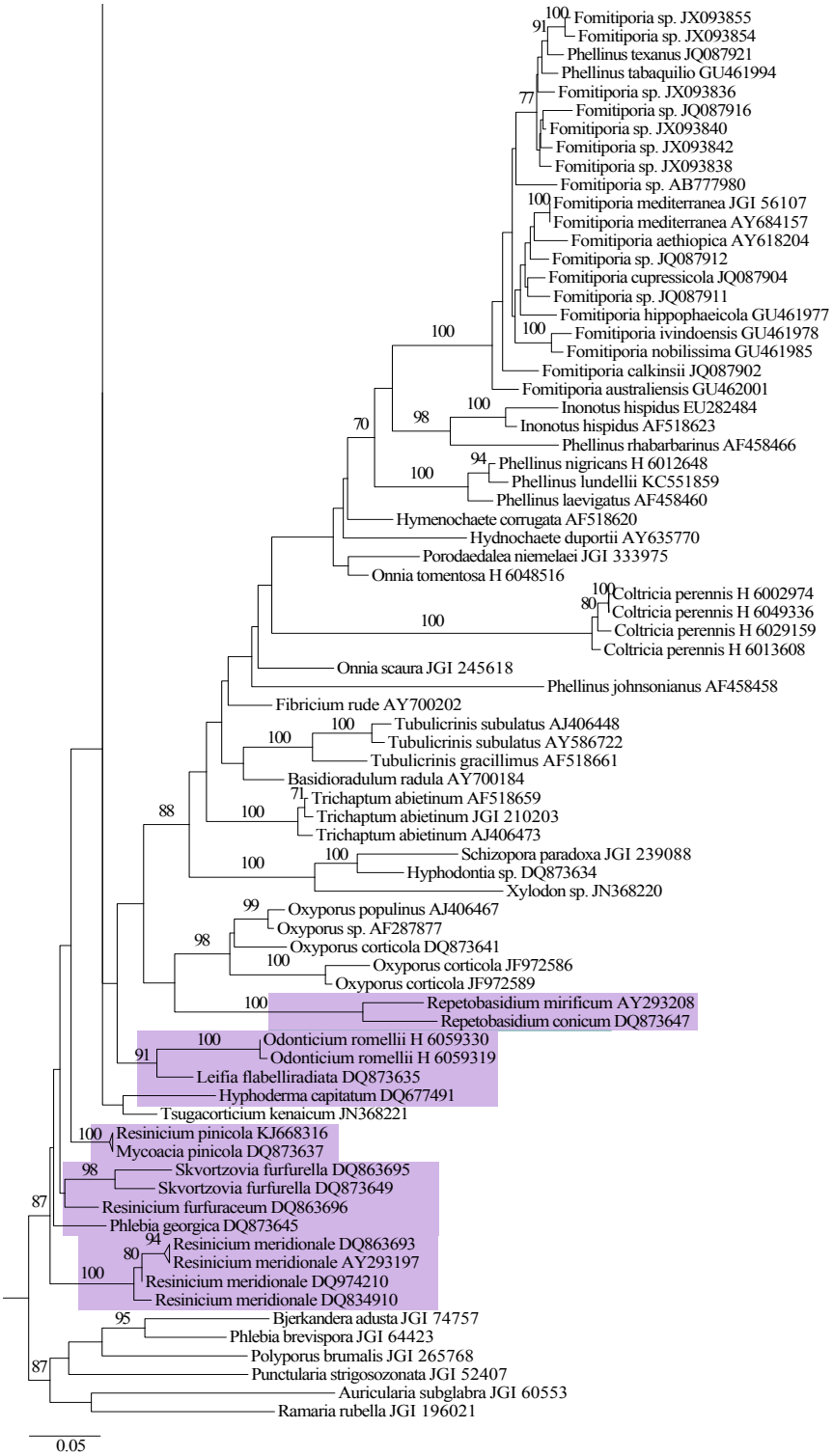



**Figure I. Continued.**

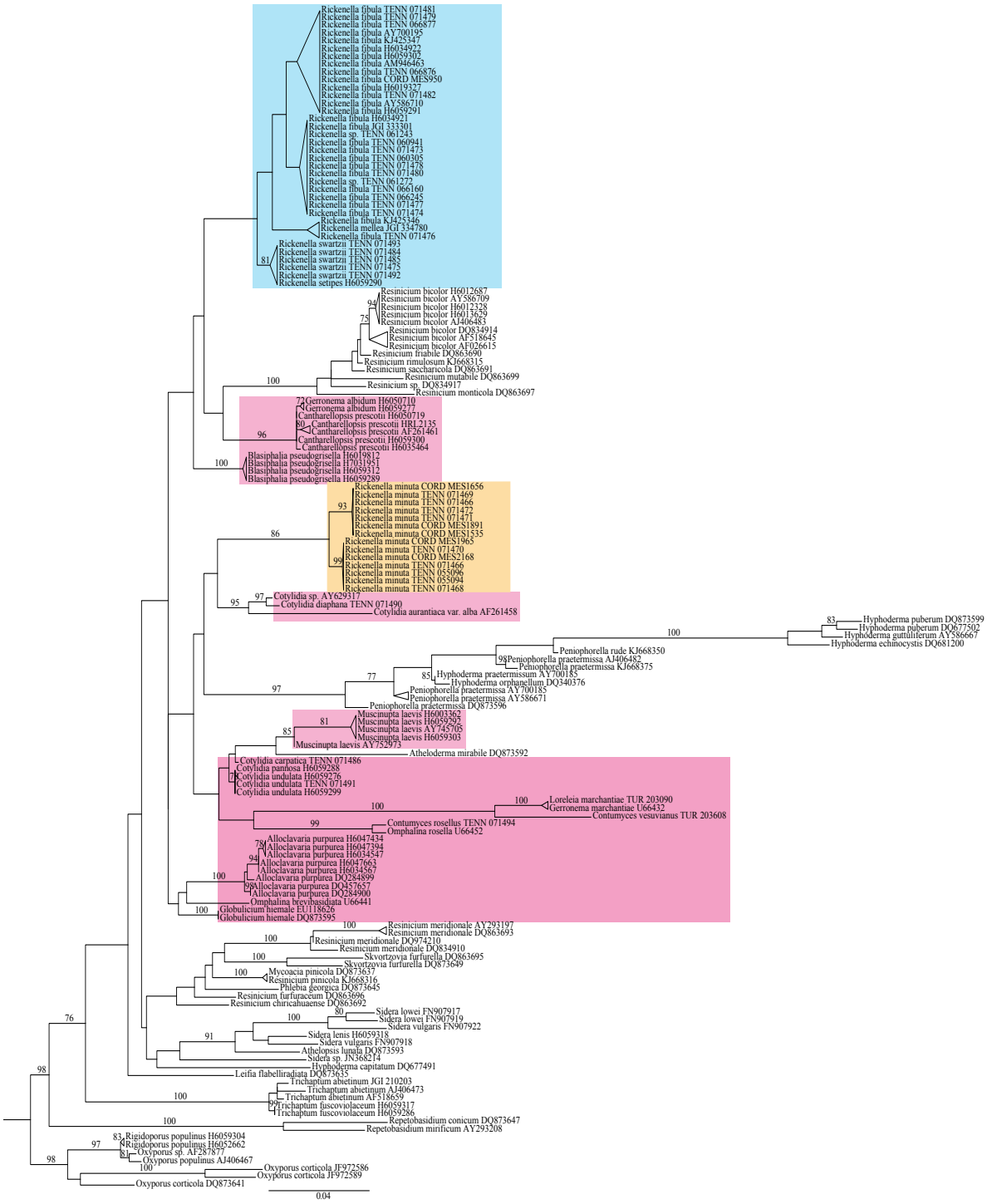



**Figure II. RCD ML tree with ≥70 bootstrap values shown. ML relationships determined by at least one locus per sample (nLSU, nSSU, *rpb2*). The tree includes environmental sequences of two bryophyte species (*Dicranum scoparium* and *Hypnum* sp.) and *Nothofagus* root tip samples. BRYO *Rickenella* species are highlighted in blue, South American ECM species are highlighted in orange, and other BRYO or suspected BRYO species are highlighted in pink.**

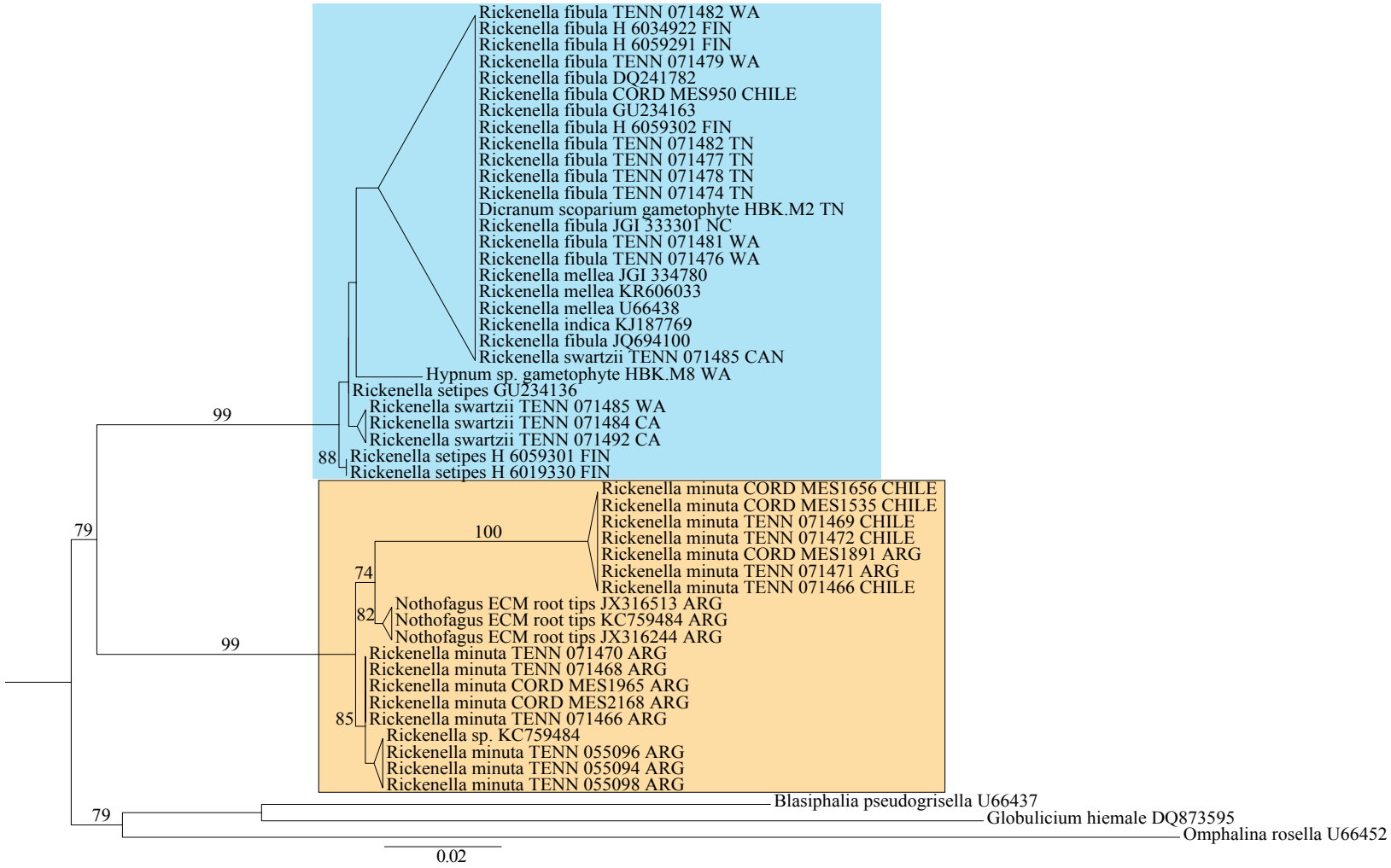



**Figure III. RID ML tree with ≥70 bootstrap values shown. ML relationships determined by the ITS locus. BRYO *Rickenella* species are highlighted in blue and South American ECM *Rickenella* that associate with *Nothofagus* are highlighted in orange.**

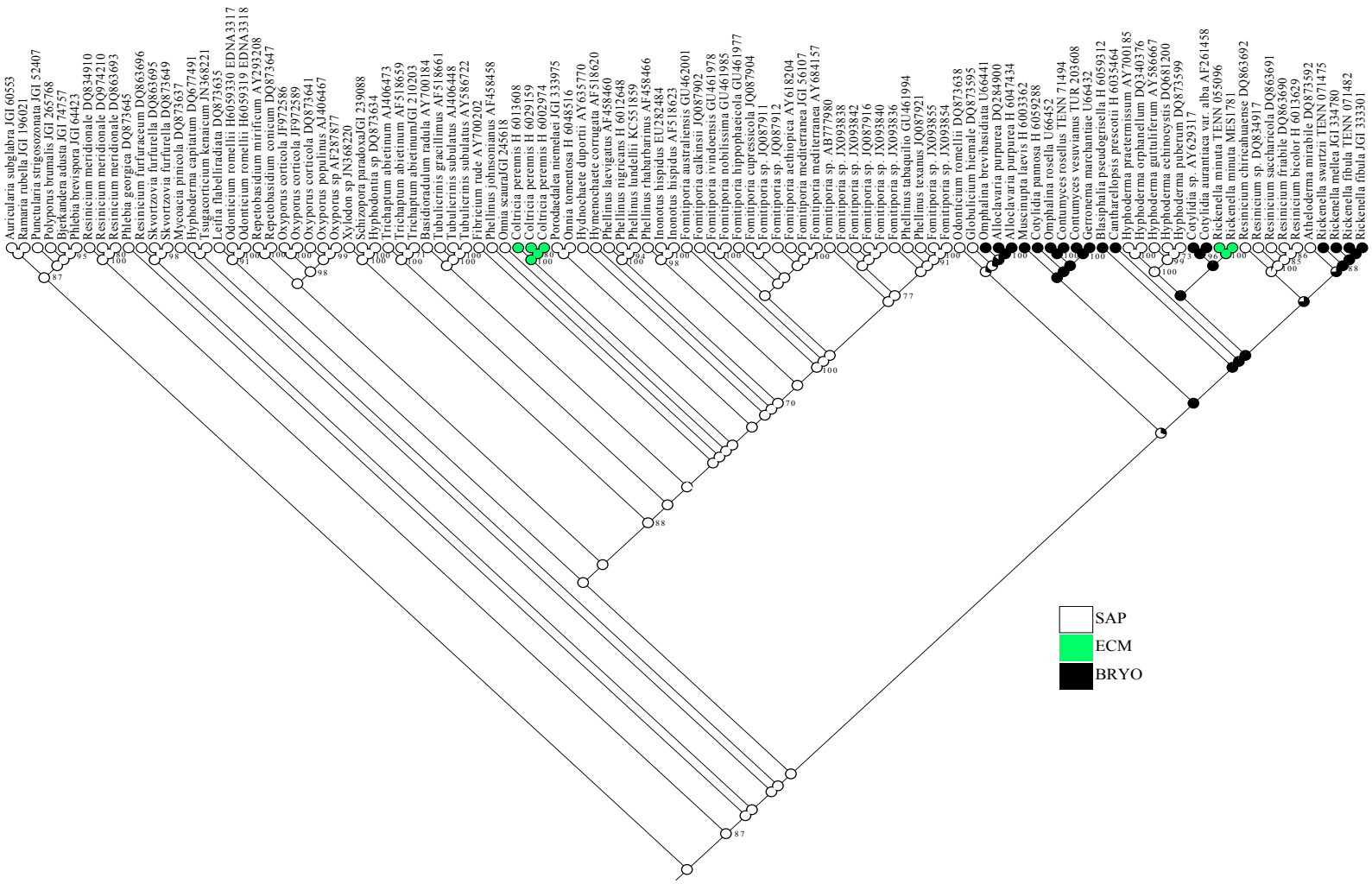



**Figure IV. ML ASR of the HID ML tree with designations saprotrophic (SAP), ectomycorrhizal (ECM), and bryophyte-associate (BRYO). A single representative was selected for each species based on the 0.05 branch length cutoff, thus two species with the same name may exist in the tree if their branch lengths were > 0.05.**

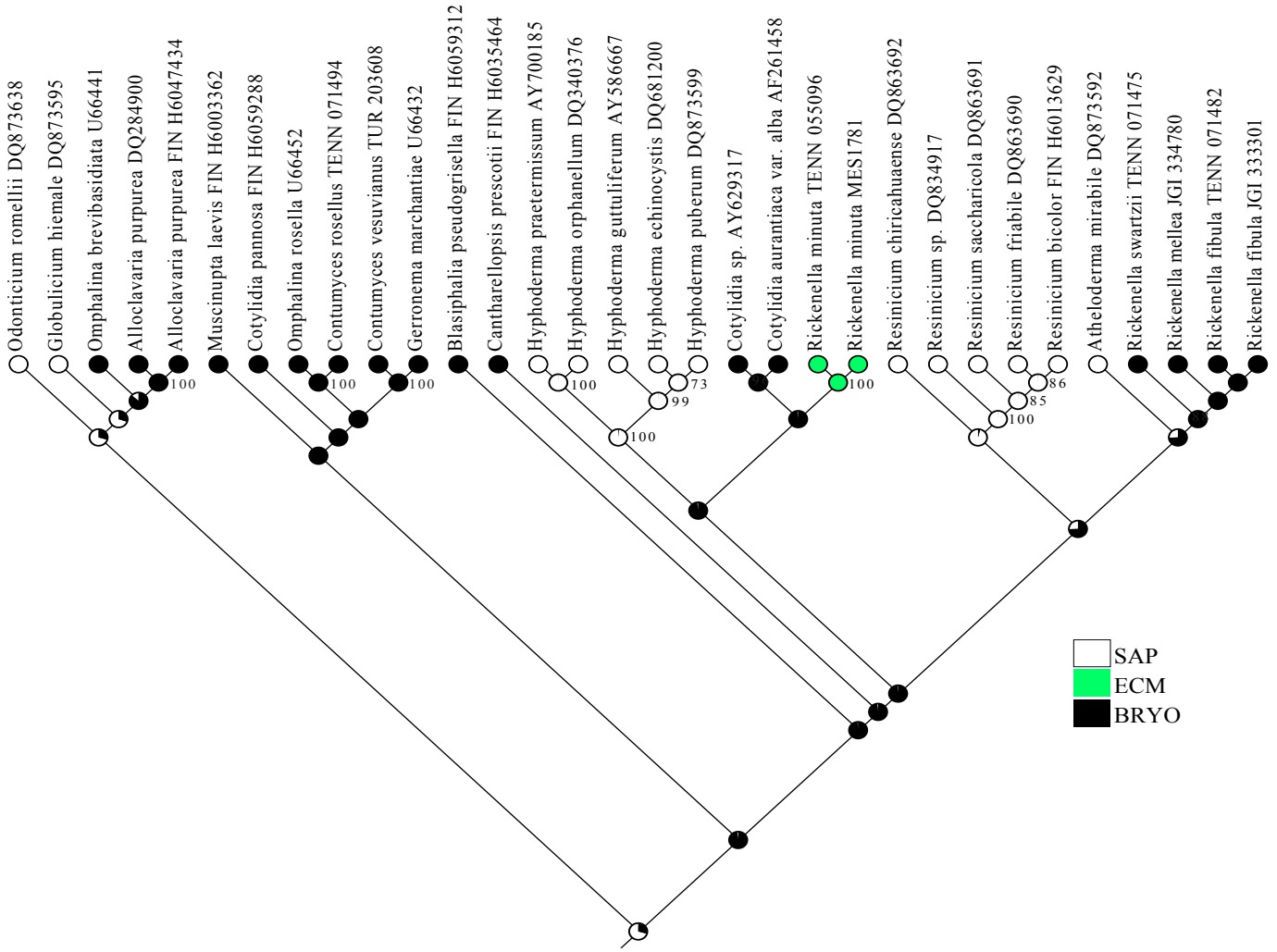



**Figure V. Pruned ML ASR of the *Rickenella* clade with designations saprotrophic (SAP), ectomycorrhizal (ECM), and bryophyte-associate (BRYO). A single representative was selected for each species.**

***Stable isotope results and inference of nutritional mode***

Of the 88 Hymenochaetales samples, 23 are inferred as ECM, 9 SAP, and 56 BRYO or putative BRYO with an inferred trophic mode of ECM-BRYO, SAP-BRYO, BIO-BRYO, or UN-BRYO determined post stable isotope analysis, as BRYO is not a trophic mode, but a fungal-host relationship. Of the 39 *Rickenella* samples, 24 are BRYO and 15 South American ECM samples. Species that had an ambiguous nutritional mode, but are suspected bryophyte-associates are considered BRYO. Trophic mode determination is based on the clustering of stable isotope samples (Figures VI, VII, VIII).

Figure VI shows four statistically distinct trophic groups: an ECM trophic group of species outside the genus *Rickenella* based on data generated from this study, Mayor et al., (2009), Birkebak et al., (2013), and Sánchez-García et al., (2014); an ECM trophic group based on *Rickenella minuta* species; a SAP trophic group based on data generated from this study and Mayor et al., (2009), Birkebak et al., (2013), Sánchez-García et al., (2014); and a BRYO trophic group based on species within the genus *Rickenella* from this study.

Figure VII shows all Hymenochaetales and *D. scoparium* stable isotope data generated in this study. The groups are shown as ECM species outside the *Rickenella* clade; SAP species outside the *Rickenella* clade; SAP species within the *Rickenella* clade; BRYO species within the *Rickenella* clade, but outside the genus *Rickenella*; ECM species within the *Rickenella* clade; BRYO species within the genus *Rickenella*; and *D. scoparium* samples.

Figure VIII shows data from all species within the *Rickenella* genus genereated in this study. With at least six species present: *R. fibula*, *R. setipes*, *R. swartzii*, two *R.* sp., and two different species of *R. minuta* based on clustering of species from RCD ML tree.

Table II summarizes the location information, herbarium information, stable isotope data, and trophic mode of species generated within this study.

Table III summarizes the means of carbon, nitrogen, and isotopic measurements of all Hymenchaetales specimens generated within this study. Means are separated into all Hymenochaetales ECM, all Hymenochaetales SAP, all BRYO Hymenochaetales, all BRYO within the genus *Rickenella*, and all ECM within the genus *Rickenella*.

Table IV is a summary of differences found between groups based on a one-way, two-tailed ANOVA or a Chi-square test for non-normal data, with a separation of means at the 0.05 significance level. Groups compared include: all data [including data generated from this study, Mayor et al., (2009); Birkebak et al., (2013); Sánchez-García et al., (2014)]; all Hymenochaetales groups; all BRYO Hymenochaetales; all *Rickenella* clade specimens; all specimens from the genus *Rickenella*; and BRYO within the genus *Rickenella* with it's host *D. scoparium*. All groups were found to be significantly different, except for BRYO within the genus *Rickenella* and *D. scoparium*.

Table V is Tukey-Kramer post-hoc tests to find significant differences between individual trophic groups, with a separation of means at the 0.05 significance level, in data

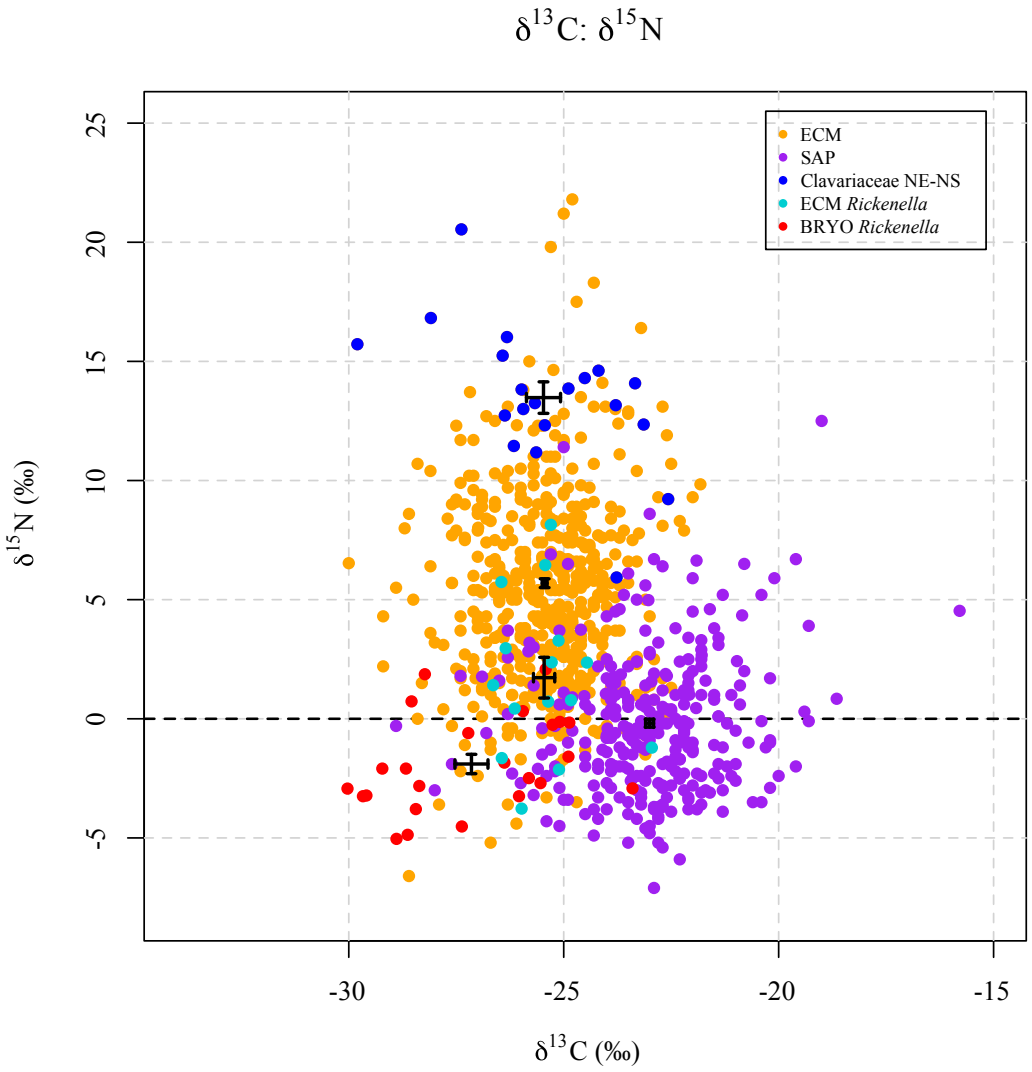



**Figure VI. Stable isotope signatures ($\delta^{13}C$ and $\delta^{15}N$) from global specimens of ECM, SAP, Clavariaceae NE-NS (Mayor et al., 2009; Birkebak et al., 2013; Sánchez-García et al., 2014), ECM *Rickenella* species, and BRYO *Rickenella* species. Cross hairs represent sample mean values ± SE.**

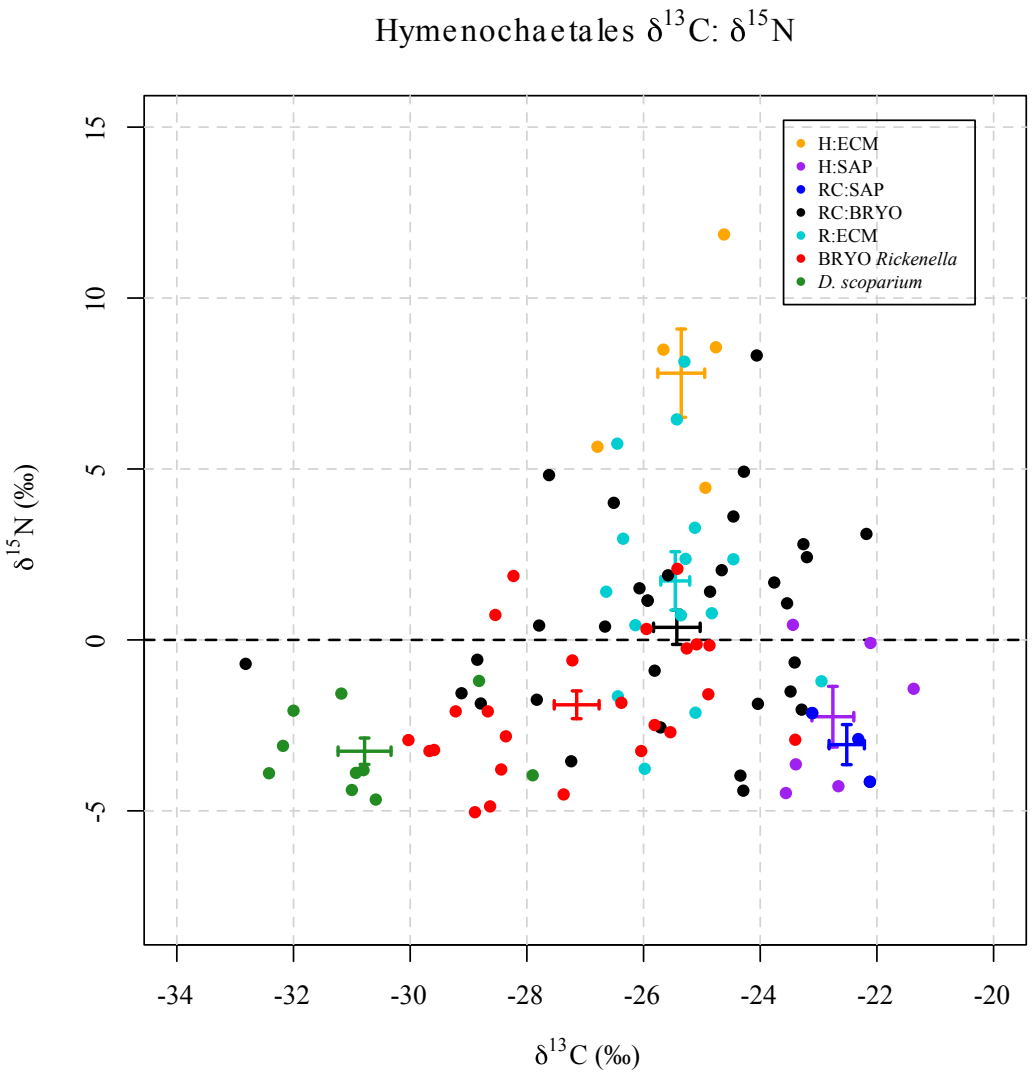



**Figure VII. Stable isotope signatures ($\delta^{13}C$ and $\delta^{15}N$) from Hymenochaetales ECM (H:ECM), Hymenochaetales SAP (H:SAP), *Rickenella* clade SAP (RC:SAP), *Rickenella* clade BRYO that are not in the genus *Rickenella* (RC:BRYO), BRYO in the genus *Rickenella*, and *Rickenella* species' bryophyte host *D. scoparium*. Cross hairs represent sample mean values ± SE.**

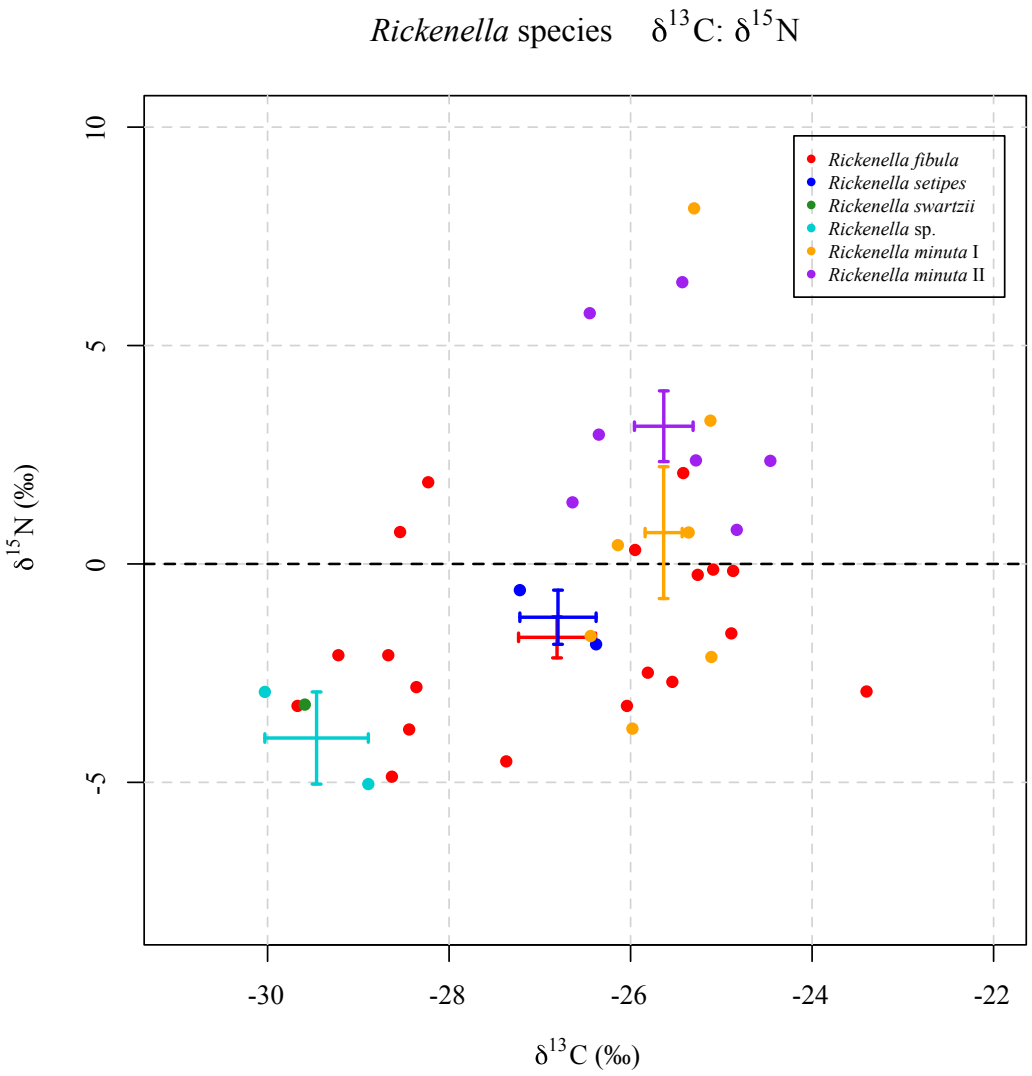



**Figure VIII. *Rickenella* species stable isotope comparison ($\delta^{13}C$ and $\delta^{15}N$) for at least six species (*R. fibula*, *R. setipes*, *R. swartzii*, two *R.* sp. and two different species of *R. minuta* based on RCD ML tree). Cross hairs represent sample mean values ± SE.**

**Table II. Collections analyzed by stable isotope mass spectrometry. Trophic modes for biotrophic taxa: ectomycorrhizal (ECM), saprotrophic (SAP), bryophyte-associates (BRYO), which have also been inferred as ECM, SAP, another form of biotrophy (BIO), or unknown (UN). If the taxon is part of the Hymenochaetales, but outside the *Rickenella* clade an H precedes the trophic designation. If part of the *Rickenella* clade an RC precedes the trophic designation. Trophic modes for host bryophytes are not scored and are given a dash (-).**

| Taxon | Herbarium | Location | $\delta^{15}N$ (‰) | $\delta^{13}C$ (‰) | %N | C/N | %C | Inferred trophic mode |
|---|---|---|---|---|---|---|---|---|
| *Alloclavaria purpurea* | TENN 071489 | Quebec | 4.92 | -24.28 | 5.79 | 7.14 | 41.35 | RC:BRYO - ECM |
| *Alloclavaria purpurea* | H 6047394 | Finland | 3.10 | -22.18 | 4.97 | 8.07 | 40.08 | RC:BRYO - ECM |
| *Alloclavaria purpurea* | H 6047434 | Finland | 1.41 | -24.86 | 4.15 | 10.11 | 41.93 | RC:BRYO - ECM |
| *Alloclavaria purpurea* | H 6034567 | Finland | 3.61 | -24.46 | 3.82 | 10.52 | 40.21 | RC:BRYO - ECM |
| *Alloclavaria purpurea* | H 6034547 | Finland | 4.01 | -26.51 | 3.93 | 10.38 | 40.81 | RC:BRYO - ECM |
| *Alloclavaria purpurea* | H 6047663 | Finland | 2.80 | -23.26 | 4.92 | 8.50 | 41.85 | RC:BRYO - ECM |
| *Amanita multisquamosa* | TENN 070497 | Tennessee | 4.11 | -27.04 | 4.45 | 10.45 | 46.54 | ECM |
| *Bjerkandera adusta* | TENN 059170 | Tennessee | 2.53 | -23.59 | 4.37 | 9.67 | 42.21 | SAP |
| *Blasiphalia pseudogrisella* | H 6059323 | Finland | 1.07 | -23.54 | 7.00 | 5.18 | 36.24 | RC:BRYO - SAP |
| *Blasiphalia pseudogrisella* | H 7031951 | Estonia | 3.41 | -26.18 | 7.27 | 4.27 | 31.09 | RC:BRYO - ECM |
| *Blasiphalia pseudogrisella* | H 6059312 | Finland | 1.68 | -23.76 | 4.86 | 5.24 | 25.49 | RC:BRYO - SAP |
| *Blasiphalia pseudogrisella* | H 6019812 | Finland | 2.04 | -24.66 | 8.51 | 4.36 | 37.16 | RC:BRYO - ECM |
| *Cantharellopsis prescotii* | TENN 71487 | Quebec | 0.42 | -27.79 | 6.49 | 6.74 | 43.77 | RC:BRYO - BIO |
| *Cantharellopsis prescotii* | H 6035464 | Finland | -0.70 | -32.82 | 4.06 | 10.31 | 41.81 | RC:BRYO - UN |
| *Cantharellopsis prescotii* | H 6050719 | Finland | 0.39 | -26.66 | 4.61 | 9.06 | 41.79 | RC:BRYO - BIO |
| *Cantharellopsis prescotii* | H 6059300 | Finland | -0.58 | -28.85 | 4.01 | 10.65 | 42.76 | RC:BRYO - BIO |
| *Coltricia cinnamomea* | H 6059308 | Finland | 6.64 | -26.91 | 4.88 | 9.32 | 45.47 | H:ECM |
| *Coltricia cinnamomea* | H 6059331 | Finland | 5.65 | -26.79 | 4.70 | 9.30 | 43.69 | H:ECM |
| *Coltricia montagnei* | TENN 066402 | Tennessee | 8.19 | -25.24 | 4.13 | 10.38 | 42.85 | H:ECM |
| *Coltricia montagnei* | TENN 065217 | North Carolina | 8.28 | -25.21 | 6.59 | 6.31 | 41.62 | H:ECM |
| *Coltricia perennis* | H 6029159 | Finland | 4.45 | -24.94 | 6.43 | 6.78 | 43.57 | H:ECM |
| *Coltricia perennis* | H 6002974 | Finland | 11.86 | -24.62 | 5.73 | 7.60 | 43.57 | H:ECM |

**Table II. Continued**

| Taxon | Herbarium | Location | $\delta^{15}N$ (‰) | $\delta^{13}C$ (‰) | %N | C/N | %C | Inferred trophic mode |
|---|---|---|---|---|---|---|---|---|
| *Coltricia perennis* | H 6013608 | Finland | 8.49 | -25.66 | 4.37 | 10.01 | 43.70 | H:ECM |
| *Coltricia perennis* | H 6059309 | Finland | 8.56 | -24.76 | 5.26 | 8.45 | 44.46 | H:ECM |
| *Contumyces rosellus* | TENN 071494 | California | 4.82 | -27.62 | 5.25 | 7.84 | 41.18 | RC:BRYO - ECM |
| *Contumyces vesuvianus* | TUR 203608 | Italy | -1.75 | -27.83 | 6.41 | 6.73 | 43.16 | RC:BRYO - BIO |
| *Cortinarius corrugatus* | TENN 070645 | Tennessee | 12.04 | -26.65 | 5.91 | 7.49 | 44.30 | ECM |
| *Cotylidia diaphana* | TENN 071490 | Quebec | 2.42 | -23.20 | 3.76 | 10.41 | 39.11 | RC:BRYO - UN |
| *Cotylidia pannosa* | TENN 071488 | Quebec | 8.32 | -24.06 | 3.72 | 11.01 | 41.01 | RC:BRYO - ECM |
| *Cotylidia pannosa* | H 6059288 | Finland | -1.87 | -24.04 | 3.79 | 10.43 | 39.55 | RC:BRYO - SAP |
| *Cotylidia undulata* | TENN 071491 | Quebec | -4.41 | -24.29 | 3.91 | 9.42 | 36.85 | RC:BRYO - SAP |
| *Cotylidia undulata* | H 6059276 | Finland | -3.97 | -24.34 | 3.98 | 10.08 | 40.16 | RC:BRYO - SAP |
| *Cotylidia undulata* | H 6059299 | Finland | -2.04 | -23.29 | 4.36 | 9.31 | 40.61 | RC:BRYO - SAP |
| *Dicranum scoparium* (living gametophyte) | TENN 071478 | Tennessee | -2.07 | -32.00 | 1.33 | 30.67 | 40.89 | - |
| *Dicranum scoparium* (senescent gametophyte) | TENN 071478 | Tennessee | -1.57 | -31.18 | 0.88 | 44.17 | 39.03 | - |
| *Dicranum scoparium* (living gametophyte) | DUKE bf20-3 | North Carolina | -4.67 | -30.59 | 0.76 | 58.94 | 45.08 | - |
| *Dicranum scoparium* (senescent gametophyte) | DUKE bf20-3 | North Carolina | -3.81 | -30.80 | 0.64 | 66.09 | 42.44 | - |
| *Dicranum scoparium* (living gametophyte) | TENN 071477 | Tennessee | -4.39 | -31.00 | 0.55 | 83.62 | 46.12 | - |
| *Dicranum scoparium* (senescent gametophyte) | TENN 071477 | Tennessee | -3.89 | -30.93 | 0.61 | 75.08 | 45.56 | - |
| *Dicranum scoparium* (living gametophyte) | TENN 071473 | Tennessee | -1.20 | -28.82 | 1.07 | 40.98 | 44.02 | - |

**Table II. Continued.**

| Taxon | Herbarium | Location | $\delta^{15}N$ (‰) | $\delta^{13}C$ (‰) | %N | C/N | %C | Inferred trophic mode |
|---|---|---|---|---|---|---|---|---|
| *Dicranum scoparium* (senescent gametophyte) | TENN 071473 | Tennessee | -3.96 | -27.90 | 0.63 | 69.09 | 43.83 | - |
| *Dicranum scoparium* (living gametophyte) | TENN 071474 | Tennessee | -3.90 | -32.42 | 0.91 | 46.62 | 42.49 | - |
| *Dicranum scoparium* (senescent gametophyte) | TENN 071474 | Tennessee | -3.10 | -32.18 | 0.77 | 51.88 | 40.10 | - |
| *Galerina marginata* | TENN 071079 | Tennessee | 0.42 | -23.33 | 3.13 | 13.19 | 41.26 | SAP |
| *Gerronema albidum* | H 6050710 | Finland | -1.86 | -28.79 | 4.17 | 10.13 | 42.22 | RC:BRYO – BIO |
| *Gerronema albidum* | H 6059277 | Finland | -1.56 | -29.12 | 4.16 | 9.97 | 41.45 | RC:BRYO – BIO |
| *Gerronema cinctum* | H 6059278 | Finland | -1.51 | -23.48 | 5.44 | 8.03 | 43.70 | RC:BRYO – SAP |
| *Inocybe subochracea* | TENN 062488 | Tennessee | -3.06 | -24.84 | 2.45 | 17.11 | 41.97 | ECM |
| *Loreleia marchantiae* | TUR 83652 | Finland | 1.51 | -26.07 | 4.99 | 6.95 | 34.66 | RC:BRYO – ECM |
| *Loreleia marchantiae* | TUR 203090 | Finland | 1.89 | -25.58 | 5.81 | 7.15 | 41.54 | RC:BRYO – ECM |
| *Loreleia postii* | H 6055478 | Finland | -0.66 | -23.41 | 6.07 | 6.38 | 38.77 | RC:BRYO – SAP |
| *Loreleia postii* | H 6059335 | Finland | -2.56 | -25.71 | 4.75 | 8.95 | 42.50 | RC:BRYO – UN |
| *Muscinupta laevis* | H 6059292 | Finland | -0.90 | -25.81 | 3.28 | 12.01 | 39.41 | RC:BRYO – UN |
| *Muscinupta laevis* | H 6059303 | Finland | -3.55 | -27.24 | 4.95 | 8.55 | 42.32 | RC:BRYO – BIO |
| *Muscinupta laevis* | H 6003362 | Finland | 1.15 | -25.93 | 3.86 | 11.04 | 42.58 | RC:BRYO – ECM |
| *Odonticium romellii* | H 6059330 | Finland | -2.90 | -22.32 | 1.51 | 27.30 | 41.15 | RC:SAP |
| *Onnia tomentosa* | H 6048516 | Finland | -1.43 | -21.37 | 2.59 | 15.93 | 41.29 | RC:SAP |
| *Onnia tomentosa* | H 6048491 | Finland | -4.28 | -22.66 | 2.08 | 19.93 | 41.46 | H:SAP |
| *Phellinus nigricans* | H 6012648 | Finland | 0.44 | -23.44 | 1.54 | 29.77 | 45.74 | H:SAP |
| *Phellinus nigricans* | H 6048524 | Finland | -4.48 | -23.56 | 1.60 | 27.07 | 43.32 | H:SAP |
| *Rickenella fibula* | TENN 066160 | Tennessee | -3.25 | -26.04 | 5.11 | 8.08 | 41.24 | RC:BRYO – BIO |
| *Rickenella fibula* | TENN 060941 | Tennessee | -3.79 | -28.44 | 4.60 | 7.99 | 36.72 | RC:BRYO – BIO |

**Table II. Continued.**

| Taxon | Herbarium | Location | $\delta^{15}N$ (‰) | $\delta^{13}C$ (‰) | %N | C/N | %C | Inferred trophic mode |
|---|---|---|---|---|---|---|---|---|
| *Rickenella fibula* | TENN 071479 | Washington | 1.87 | -28.23 | 8.90 | 4.22 | 37.53 | RC:BRYO – BIO |
| *Rickenella fibula* | TENN 071478 | Tennessee | 2.08 | -25.42 | 7.54 | 5.36 | 40.45 | RC:BRYO – BIO |
| *Rickenella fibula* | TENN 071480 | Tennessee | -4.96 | -28.71 | 5.07 | 7.90 | 40.01 | RC:BRYO - BIO |
| *Rickenella fibula* | TENN 071477 | Tennessee | -4.52 | -27.37 | 5.17 | 7.40 | 38.26 | RC:BRYO - BIO |
| *Rickenella fibula* | TENN 071476 | Washington | 0.73 | -28.54 | 6.17 | 6.62 | 40.84 | RC:BRYO - BIO |
| *Rickenella fibula* | TENN 071482 | Washington | -2.92 | -23.40 | 4.45 | 9.26 | 41.22 | RC:BRYO - BIO |
| *Rickenella fibula* | TENN 071474 | Tennessee | -3.25 | -29.67 | 3.85 | 9.90 | 38.09 | RC:BRYO - BIO |
| *Rickenella fibula* | TENN 071473 | Tennessee | -2.70 | -25.54 | 6.14 | 6.88 | 42.24 | RC:BRYO - BIO |
| *Rickenella fibula* | TENN 071479 | Washington | -2.09 | -29.22 | 4.23 | 9.02 | 38.16 | RC:BRYO - BIO |
| *Rickenella fibula* | TENN 060305 | Tennessee | -2.09 | -28.67 | 3.46 | 11.02 | 38.15 | RC:BRYO - BIO |
| *Rickenella fibula* | TENN 066877 | Massachusetts | -0.16 | -24.87 | 4.25 | 8.43 | 35.79 | RC:BRYO - BIO |
| *Rickenella fibula* | TENN 066876 | Massachusetts | 0.32 | -25.95 | 4.12 | 9.52 | 39.23 | RC:BRYO - BIO |
| *Rickenella fibula* | TENN 066245 | Tennessee | -4.87 | -28.63 | 5.26 | 7.85 | 41.32 | RC:BRYO - BIO |
| *Rickenella fibula* | H 6059291 | Finland | -2.49 | -25.81 | 4.04 | 10.00 | 40.39 | RC:BRYO - BIO |
| *Rickenella fibula* | H 6034921 | Finland | -2.82 | -28.36 | 5.95 | 7.01 | 41.67 | RC:BRYO - BIO |
| *Rickenella fibula* | H 6034922 | Finland | -0.25 | -25.26 | 5.23 | 7.89 | 41.23 | RC:BRYO - BIO |
| *Rickenella fibula* | H 6019327 | Finland | -1.59 | -24.89 | 5.44 | 6.96 | 37.85 | RC:BRYO - BIO |
| *Rickenella fibula* | H 6059302 | Finland | -0.13 | -25.09 | 6.66 | 6.38 | 42.48 | RC:BRYO - BIO |
| *Rickenella fibula* | CORD MES950 | Chile | -1.21 | -22.95 | 4.26 | 9.85 | 41.21 | RC:BRYO - BIO |
| *Rickenella minuta* | TENN 055098 | Argentina | 6.45 | -25.43 | 3.85 | 11.32 | 43.63 | RC:ECM |
| *Rickenella minuta* | TENN 055094 | Argentina | 2.37 | -25.28 | 4.38 | 9.08 | 39.79 | RC:ECM |
| *Rickenella minuta* | CORD MES1535 | Chile | -3.77 | -25.98 | 3.82 | 11.15 | 41.99 | RC:ECM |
| *Rickenella minuta* | TENN 071469 | Chile | 0.72 | -25.36 | 3.12 | 13.40 | 41.35 | RC:ECM |
| *Rickenella minuta* | TENN 071466 | Argentina | 0.78 | -24.83 | 4.83 | 8.81 | 41.88 | RC:ECM |
| *Rickenella minuta* | CORD MES2168 | Argentina | 2.36 | -24.46 | 4.75 | 8.53 | 39.90 | RC:ECM |

**Table II. Continued.**

| Taxon | Herbarium | Location | $\delta^{15}N$ (‰) | $\delta^{13}C$ (‰) | %N | C/N | %C | Inferred trophic mode |
|---|---|---|---|---|---|---|---|---|
| *Rickenella minuta* | TENN 071472 | Chile | -1.65 | -26.44 | 4.53 | 8.52 | 37.98 | RC:ECM |
| *Rickinella minuta* | TENN 071468 | Argentina | 5.74 | -26.45 | 5.01 | 8.38 | 41.36 | RC:ECM |
| *Rickinella minuta* | CORD MES1891 | Argentina | 8.14 | -25.30 | 3.70 | 11.14 | 40.79 | RC:ECM |
| *Rickinella minuta* | TENN 071471 | Argentina | 3.28 | -25.12 | 5.30 | 7.87 | 41.14 | RC:ECM |
| *Ricknella minuta* | CORD MES1965 | Argentina | 2.96 | -26.35 | 3.66 | 11.67 | 42.30 | RC:ECM |
| *Rickenella minuta* | CORD MES1656 | Chile | 0.43 | -26.14 | 2.80 | 12.76 | 35.74 | RC:ECM |
| *Rickenella minuta* | TENN 071466 | Chile | -2.13 | -25.11 | 3.01 | 11.50 | 34.17 | RC:ECM |
| *Rickenella minuta* | TENN 071470 | Argentina | 1.41 | -26.64 | 4.04 | 9.10 | 36.14 | RC:ECM |
| *Rickenella setipes* | H 6059279 | Finland | -0.60 | -27.22 | 4.74 | 7.44 | 35.24 | RC:BRYO - BIO |
| *Rickenella setipes* | H 6059290 | Finland | -1.84 | -26.38 | 5.43 | 7.31 | 39.70 | RC:BRYO - BIO |
| *Rickenella* sp. | TENN 061243 | North Carolina | -2.93 | -30.03 | 3.35 | 10.16 | 34.00 | RC:BRYO - BIO |
| *Rickenella* sp. | TENN 061272 | Quebec | -5.04 | -28.89 | 4.48 | 8.72 | 39.02 | RC:BRYO - BIO |
| *Rickenella swartzii* | TENN 071475 | Washington | -3.22 | -29.59 | 4.42 | 8.87 | 39.20 | RC:BRYO - BIO |
| *Rickenella swartzii* | TENN 071493 | California | 0.73 | -24.23 | 5.84 | 6.69 | 39.06 | RC:BRYO - BIO |
| *Rickenella swartzii* | TENN 071492 | California | -0.18 | -26.68 | 3.26 | 11.36 | 36.99 | RC:BRYO - BIO |
| *Rickenella swartzii* | TENN 071484 | California | 0.49 | -26.30 | 5.87 | 7.07 | 41.52 | RC:BRYO - BIO |
| *Rigidoporus populinus* | H 6059304 | Finland | -3.64 | -23.39 | 1.35 | 30.34 | 40.81 | H:SAP |
| *Rigidoporus populinus* | H 6052662 | Finland | -0.09 | -22.11 | 2.15 | 19.20 | 41.32 | H:SAP |
| *Trametes ochracea* | TENN 060148 | Russia | -3.50 | -22.42 | 3.15 | 13.02 | 41.06 | SAP |
| *Trichaptum fuscoviolaceum* | H 6059286 | Finland | -4.15 | -22.12 | 1.30 | 31.21 | 40.46 | SAP |
| *Trichaptum fuscoviolaceum* | H 6059317 | Finland | -2.14 | -23.11 | 1.36 | 29.86 | 40.64 | SAP |

**Table III. Summary of means carbon, nitrogen, and isotopic measurements with one standard error of all Hymenochaetales specimens sampled.**

| Hymenochaetales (n) | $\delta^{15}N$ (‰) | N% | $\delta^{13}C$ (‰) | C% | C/N |
|---|---|---|---|---|---|
| ECM (23) | 3.8 ± 0.86 | 4.5 ± 0.002 | -25.5 ± 0.9 | 41.2 ± 0.006 | 9.6 ± 0.38 |
| SAP (9) | -2.5 ± 0.61 | 1.8 ± 0.001 | -22.7 ± 0.25 | 41.9 ± 0.006 | 24.5 ± 1.9 |
| BRYO (56) | -0.5 ± 0.37 | 5.0 ± 0.002 | -26.3 ± 0.3 | 39.8 ± 0.004 | 8.4 ± 0.24 |
| BRYO *Rickenella* (24) | -1.9 ± 0.41 | 5.1 ± 0.003 | -27.1 ± 0.38 | 39.2 ± 0.005 | 8.0 ± 0.32 |
| ECM *Rickenella* (15) | 1.7 ± 0.85 | 4.1 ± 0.002 | -25.5 ± 0.25 | 40.0 ± 0.007 | 10.2 ± 0.45 |

**Table IV. Comparison of isotopic results based on one-way, two-tailed ANOVA or a Chi-square test for non-normal data for differences in multiple sample means. Separation of means at the 0.05 significance level. An asterisk (*) indicates a significant difference in means. Comparison data retrieved from Mayor et al., (2009); Birkebak et al., (2013); Sánchez-García et al., (2014).**

| Comparison (n) | $\delta^{15}N$ (‰) | $\delta^{13}C$ (‰) |
|---|---|---|
| All data (944) | $F(3,940) = 231.4$, $p < 0.001$* | $F(3,940) = 211.8$, $p < 0.001$* |
| Hymenochaetales (88) | $\chi^2$ (2) = 39.7, $p < 0.001$* | $F(2,85) = 14.4$, $p < 0.001$* |
| BRYO Hymenochaetales (58) | $F(1,56) = 10.9$, $p < 0.01$* | $F(1,56) = 8.9$, $p < 0.01$* |
| *Rickenella* clade (77) | $\chi^2(2) = 18.9$, $p < 0.001$* | $F(2,74) = 5.6$, $p < 0.01$* |
| All *Rickenella* spp. (39) | $F(1,37) = 18.4$, $p < 0.001$* | $F(1,37) = 10.3$, $p < 0.01$* |
| BRYO within genus *Rickenella* and *Dicranum scoparium* (34) | $F(1,32) = 4.0$, $p = 0.05$ | $F(1,32) = 29.8$, $p < 0.001$* |

**Table V. Tukey-Kramer post-hoc test for differences in means between trophic groups. Separation of means at the 0.05 significance level. An asterisk (*) indicates a significant difference in means. Comparison data retrieved from Mayor et al., (2009); Birkebak et al., (2013); Sánchez-García et al., (2014).**

| Group | Comparison | $\delta^{15}N$ (‰) | $\delta^{13}C$ (‰) |
|---|---|---|---|
| All data | BRYO vs. ECM | $p < 0.00001$* | $p < 0.001$* |
| | BRYO vs. NE-NS | $p < 0.00001$* | $p = 0.16$ |
| | BRYO vs. SAP | $p = 0.98$ | $p < 0.00001$* |
| | ECM vs. NE-NS | $p < 0.00001$* | $p = 1$ |
| | ECM vs. SAP | $p < 0.00001$* | $p < 0.00001$* |
| | NE-NS vs. SAP | $p < 0.00001$* | $p < 0.00001$* |
| Hymenochaetales | BRYO vs. ECM | $p < 0.00001$* | $p = 0.21$ |
| | BRYO vs. SAP | $p = 0.17$ | $p < 0.00001$* |
| | ECM vs. SAP | $p < 0.00001$* | $p < 0.001$* |
| | BRYO within genus *Rickenella* vs. BRYO outside the genus *Rickenella* | $p < 0.001$* | $p < 0.01$* |
| | BRYO within genus *Rickenella* vs. ECM within genus *Rickenella* | $p < 0.001$* | $p < 0.01$* |
| | BRYO within genus *Rickenella* vs. *Dicranum scoparium* | $p = 0.54$ | $p < 0.00001$* |

collected from this study and data from Mayor et al., (2009); Birkebak et al., (2013); Sánchez-García et al., (2014). Samples are separated into the following state groups to test for differences between the groups: EMC, SAP, NE-NS, and BRYO for all data comparisons. For comparisons within the Hymenochaetales only, groups are separated into ECM, SAP, BRYO, BRYO within the genus *Rickenella*, BRYO outside the genus *Rickenella*, ECM within the genus *Rickenella*, and the bryophyte host *D. scoparium.* All groups are found to be statistically significantly different, except for $\delta^{15}N$ for BRYO vs. SAP and for $\delta^{13}C$ for NE-NS vs. BRYO in all data and for $\delta^{15}N$ for BRYO vs. SAP and BYRO within the genus *Rickenella* vs. *D. scoparium* and for $\delta^{13}C$ for BRYO vs. ECM in Hymenochaetales comparisons.

***Rickenella fibula PRC assays in Dicranum scoparium***

The ITS region of *Rickenella fibula* is amplified/sequenced from all tissues of *D. scoparium*, including multiple samples of the living gametophyte, senescent gametophyte, and rhizoids in both sterilized and non-sterilized mosses, but ITS is amplified/sequenced in only one sterilized sporophyte. *Rickenella fibula* is most frequently found in living gametophyte tissue compared to other tissues (Table VI). There are no significant differences between treatments (sterile water and 10% sodium hypochlorite), thus frequency results are presented together. Other species outside the Hymenochaetales amplified/sequenced from the moss tissue include *Scytinopogon* sp., *Mycena clavicularis*, and *Trechisporales* sp., however, *R. fibula* and *R. mellea* are the most commonly found species.

***Dicranum scoparium productivity***

There are no statistically significant differences in mass and tissue length between living and senescent gametophyte regions of inoculated versus non-inoculated gametophytes ($p \geq 0.05$), except there is a significant difference in mass between the sterile water *R. fibula* inoculum versus sterile water only treatments [$t(17) = -2.5$, $p = 0.02$], where the gametophytes without *R. fibula* present had more mass than those with *R. fibula* present.

***Presence/absences analysis of decomposition genes***

Of the enzymes analyzed in the genome, *R. fibula* lacks manganese peroxidase. However, no Hymenochaetales analyzed possess manganese peroxidase (except *Fomitiporia mediterranea*, which had 2 out of 3 of the binding regions). *Rickenella fibula* and *R. mellea* possess invertase, an enzyme indicative of parasitism and endophytism, which the other sampled SAP species do not possess (Table VII). *Rickenella fibula* and *P. niemelaei* both possess xylanase, an enzyme used for plant cell wall degradation, which other Hymenochaetales do not. All Hymenochaetales genomes possess laccase, ligninase, and peroxidase, enzymes that are used for lignin degradation.

**Table VI. Detection of the ITS region *R. fibula* via PCR in sections of living gametophyte, senescent gametophyte, sporophyte, and rhizoid tissues of the moss *D. scoparium*.**

| Moss tissue | Frequency (n) |
|---|---|
| **Living gametophyte** | 41.2% (34) |
| **Senescent gametophyte** | 26.5% (34) |
| **Sporophyte** | 6.3% (16) |
| **Rhizoids** | 29.4% (34) |

**Table VII. Hymenochaetales presence/absence of genes typically found in wood- and litter-degrading species. Plus (+) and gray highlights indicate presence in genome. Asterisk indicates similarity, but only 2 out of 3 Mn-binding regions are conserved. Bryophyte associates are highlighted in green and saprotrophs are highlighted in blue. Enzymes indicative of plant cell wall degradation are highlighted in red and enzymes indicative of lignin degradation are highlighted in purple. All genomes analyzed are first versions.**

| | Enzyme | *Rickenella fibula* (333301) | *Rickenella mellea* (334780) | *Fomitiporia mediterranea* (56107) | *Onnia scaura* (245618) | *Porodaedalea niemelaei* (333975) | *Schizopora paradoxa* (239088) | *Trichaptum abietinum* (210203) |
|---|---|---|---|---|---|---|---|---|
| Plant Cell Wall Degradation | Arabinosidase | + | + | + | - | + | + | + |
| | Cellulase | + | + | + | + | + | + | + |
| | Cellobiohydrolase | + | + | + | - | - | + | + |
| | Chitinase | + | + | + | + | + | + | + |
| | Galactosidase | + | + | + | + | + | + | + |
| | Glucanase | + | + | + | + | + | + | + |
| | Invertase | + | + | - | - | - | - | - |
| | Mannosidase | + | + | + | + | + | + | + |
| | Polygalacturonase | + | + | + | + | + | + | + |
| | Xylanase | + | - | - | - | + | - | - |
| Lignin Degradation | Laccase | + | + | + | + | + | + | + |
| | Ligninase | + | + | + | + | + | + | + |
| | Manganese peroxidase | - | - | +* | - | - | - | - |
| | Peroxidase | + | + | + | + | + | + | + |

# SECTION 4: DISCUSSION

A handful of studies have attempted to elucidate the relationship of *R. fibula* with its bryophyte host and evidence has been suggested for a broad range of interactions, including parasitism, commensalism, and mutualism, but none have yielded any definitive conclusions (Redhead, 1981; Kost, 1984; Bresinsky and Schötz, 2006; Davey and Currah, 2006). Furthermore, no study has taken into account the *Rickenella* clade's ancestral history and the impact it may have on the group's nutritional mode. Using various analyses, I have been able to weaken several nutritional mode and fungal-host interaction hypotheses and provide supporting evidence for the ancestral nutritional mode of the *Rickenella* clade and the nutritional capabilities of *R. fibula*.

Stable isotope analyses reveal that BRYO *Rickenella* species have a unique $\delta^{13}C$: $\delta^{15}N$ signature that has not previously been observed in any fungal group, except for a single sample of a *Galerina* sp. that appears to have a similar signature and has been designated as biotrophic parasitism (Seitzman et al., 2011). The BRYO *Rickenella* signature is significantly lower in $\delta^{15}N$ and compared to the NE-NS, ECM, and SAP signatures and lower in $\delta^{13}C$ compared to ECM and SAP. Since the $\delta^{13}C$ signature is significantly different from ECM, and SAP signatures, this weakens the hypothesis for ECM-like and SAP modes. Furthermore, compared to the *D. scoparium* signature, BRYO *Rickenella* species are significantly higher in $\delta^{15}N$, but are not significantly different $\delta^{13}C$, suggesting that BRYO *Rickenella* species are gaining carbon from its host source, but not providing nitrogen in return, weakening the hypothesis for a mutualistic relationship, but providing supporting evidence for either a commensalistic or parasitic relationship.

Other experiments also support the stable isotope signature nutritional mode and fungal-bryophyte interaction findings. *Rickenella fibula* is found throughout all bryophyte tissue, including the living gametophyte, senescent gametophyte, rhizoids, and once in the sporophyte (out of 16 samples), thus weakening the hypotheses for an ECM-like and SAP relationship. If the relationship were ECM-like, it could be expected that fungal hyphae would only be found on the outside of the rhizoids and if SAP then likely only in the senescent tissue; again supporting the commensalistic or parasitic relationship.

*Rickenella* fibula, overall, does not reduce the productivity of *D. scoparium* in terms of mass and gametophyte growth, as demonstrated in the moss *in vitro* experiments. Although there is evidence of *R. fibula* hyphae penetrating bryophyte cells (Kost, 1984) and producing haustoria, generally an indication of parasitism (Redhead, 1981), this experiment demonstrates that it is not negatively impacting the moss, thus weakening the parasitic relationship hypothesis.

Examination of seven available Hymenochaetales genomes reveals that *R. fibula*, and closely related *R. mellea*, have the enzyme invertase, an enzyme used for sucrolytic activity and breaking down plant cell walls and is generally an indication of parasitism and endophytic behavior. *Rickenella fibula* also contains the enzyme xylanase, which is used for plant cell wall degradation and is not found in *R. mellea* or any of the SAP Hymenochaetales, except for

*Porodaedalea niemelaei*. Both *R. fibula* and *R. mellea* contain all other plant cell wall and lignin degradative enzymes, except for manganese peroxidase, however, none of the Hymenochaetales genomes contain manganese peroxidase, except for *Fomitiporia mediterranea*, which contains something similar. All nutritional modes could contain many of these enzymes, however, SAP fungi are likely to contain the most abundance of these enzymes compared to other modes. Since analysis is only based on presence/absence of the enzymes, enzyme quantification from living tissues would give further insight into the likelihood of each relationship.

However, since the phylogenetic analyses reveals that the *Rickenella* clade is phylogenetically derived compared to the rest of the Hymenochaetales and the ASR analysis reveals that the SAP state is resolved as ancestral for the Hymenochaetales, it is not surprising that *R. fibula* contains many genes necessary for a decomposition nutritional mode. Bryophytes do not contain lignin, but do contain lignin-like polymers (Ligrone et al., 2008), perhaps making it useful to have lignin degradative enzymes. It is also possible that while *R. fibula* contains the genes necessary to produce lignin degradation enzymes, the genes are no longer transcribed. Analysis of the transcriptome would yield further insight into enzymes involved in the bryophyte host relationship strategy.

The ASR analysis also reveals that the switch from SAP to BRYO occurred twice and there are two reversals from BRYO back to SAP. Additionally, there is also one switch from BRYO to ECM (*Rickenella minuta* groups). Trophic state switches indicate that the BRYO relationship may not be a stable mode in the Hymenochaetales. However, variation in stable isotope signatures within the BRYO species in the *Rickenella* clade suggest that not all BRYO species employ the same nutritional mode, with species reaching the ECM, SAP and BRYO *Rickenella* range. There is even some variation in the BRYO *Rickenella* species. This could be due to environmental variation or perhaps some BRYO *Rickenella* species are capable of employing a secondary nutritional ECM-like or SAP mode, making their signature closer to those respective ranges. As stated, BRYO *Rickenella* species have enzymes used in both ECM and SAP nutritional modes. However, despite variation in BRYO *Rickenella* signatures that may put them close to the ECM and SAP stable isotope ranges, there have yet to be any environmental sequences reported of BRYO *Rickenella* species. If living outside the bryophyte host was common, it may be expected that environmental sequences in bryophyte environments would occur occasionally through the use of universal fungal PCR primers.

Phylogenetic analyses reveal that the *Rickenella* clade is not monophyletic when comparing to the *Rickenella* clade *sensu* Larsson et al., (2006). The genus *Rickenella* is also not resolved as monophyletic in all analyses. However, bootstrap support was rather weak in all analyses. Rather than increasing taxon sampling of the Hymenochaetales, it may be more beneficial to increase the number of loci to improve phylogenetic resolution in the order. Despite poor bootstrap support, all analyses suggest that there are two distinct groups of *Rickenella* species – those that are BRYO and those that are ECM with *Nothofagus* in southern South America.

The possibility that *R. fibula* is an endophyte is supported both by the presence of the invertase enzyme and the presence of *R. fibula* in surface sterilized *D. scoparium* tissues. Previous research has also provided evidence of hyphae intracellulary in bryophytes (Redhead, 1981; Kost, 1984). Furthermore, while the hypothesis for ECM-like trophic mutualism is weakened by the analyses conducted, other mutualistic relationships have not been explored. Many endophytic fungi are useful as plant defenses, deterring herbivores or other parasitic and pathogenic fungi (Arnold et al., 2003; Jaber and Vidal, 2010; Romeralo et al., 2015). It is possible that *R. fibula* acts as a bryophyte defense, while gaining nutrients from the host in return.

Further exploration of *R. fibula*'s genome, transcriptome, and meta-transcriptome will yield a more complete understanding of trophic mode and fungal-host interactions by distinguishing between gene presence versus gene transcription. Quantitative PCR may also be a useful tool for determining the quantity of *R. fibula* found in distinctive bryophyte tissues, and where the fungus is concentrated within the host. Expanding studies to include other bryophyte hosts beyond *D. scoparium* will also help determine if *R. fibula* maintains a consistent relationship with all bryophyte hosts. Moreover, looking more in depth at other BRYO species within the *Rickenella* clade would help to determine the various trophic mode and fungal-bryophyte interactions occurring in the Hymenochaetales, as stable isotope results suggest that not all BRYO associated Hymenochaetales employ the same nutritional mode.

Other studies suggest that a normalization process on stable isotope data is sometimes necessary to correct for both temporal and location differences. Over time, carbon and nitrogen in the atmosphere can have an effect on the abundance of these elements found in samples. The Suess effect is meant to correct for these differences (Tans et al., 1979; McCarroll and Loader, 2004). However, it was found that while $\delta^{13}C$ values were significantly altered by employing the Suess effect, it did not alter the relative ordering of trophic mode groups in *Sedecula*, a genus of fungi (Trappe et al., 2015). The second correction concerns normalizing for differences in locations. While the correction process can increase accuracy of data values, it only slightly reduced commonality of ECM and SAP groups and was found to be of little statistical importance when distinguishing between trophic groups based on $\delta^{13}C$: $\delta^{15}N$ (Mayor et al., 2009). No corrections were made in this study's stable isotope data.

# SECTION 5: CONCLUSIONS

*Rickenella* is an evolutionarily derived group within the otherwise SAP dominated Hymenochaetales, which occupies new niches in association with bryophytes. Two distinct clades within the genus *Rickenella* have been recovered and can be differentiated based on nutritional mode. Analyses of phylogenies, stable isotopes, and lab experiments support a commensalistic relationship between the fungus *R. fibula* and the moss *D. scoparium*, or at most a weakly parasitic relationship. BRYO *Rickenella* species occupy a distinct stable isotope range that differs from ECM, SAP, and other BIO signatures and from other BRYO Hymenochaetales species, suggesting that BRYO *Rickenella* species have a unique nutritional mode.

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# APPENDIX

**Table VIII. Taxa included in each dataset and their corresponding GenBank or JGI numbers. Trophic mode is determined for specimens in the HCD tree in order to complete an ASR analysis. Some trophic modes were deteremined by the author if no other reference source could be found.**

| Dataset | Taxon | LSU | SSU | *rpb2* | ITS | Trophic Mode Reference |
|---|---|---|---|---|---|---|
| HID | *Alloclavaria purpurea* | DQ284899 | | | | |
| | *Alloclavaria purpurea* | DQ284900 | | | | |
| | *Alloclavaria purpurea* | DQ457657 | DQ437679 | | | |
| | *Alloclavaria purpurea* | MF318904 | MF318994 | | | |
| | *Alloclavaria purpurea* | MF318894 | MF318987 | | | |
| | *Alloclavaria purpurea* | MF318895 | MF318986 | | | |
| | *Alloclavaria purpurea* | MF318893 | MF318988 | | | |
| | *Alloclavaria purpurea* | MF318905 | MF318995 | | | |
| | *Alloclavaria purpurea* | MF318903 | | | | |
| | *Asterodon ferruginosus* | AY586631 | | | | |
| | *Asterodon ferruginosus* | HE650987 | | | | |
| | *Atheloderma mirabile* | DQ873592 | | | | |
| | *Athelopsis lunata* | DQ873593 | | | | |
| | *Auriciularia subglabra* | JGI 60553 | JGI 60553 | JGI 60553 | | |
| | *Aurificaria luteoumbrina* | AF450252 | | | | |
| | *Aurificaria luteoumbrina* | AY059033 | | | | |
| | *Basidioradulum radula* | | AF026611 | | | |
| | *Basidioradulum radula* | AJ406474 | | | | |
| | *Basidioradulum radula* | AY700184 | | | | |
| | *Basidioradulum radula* | KJ668426 | | | | |
| | *Bjerkandera adusta* | JGI 74757 | JGI 74757 | JGI 74757 | | |
| | *Blasiphalia pseudogrisella* | MF318896 | | | | |
| | *Blasiphalia pseudogrisella* | MF318897 | | | | |
| | *Blasiphalia pseudogrisella* | MF318899 | MF318990 | | | |
| | *Blasiphalia pseudogrisella* | MF318898 | MF318989 | | | |
| | *Cantharellopsis prescotii* | AF261461 | | | | |
| | *Cantharellopsis prescotii* | MF318901 | MF318992 | | | |
| | *Cantharellopsis prescotii* | MF318902 | | | | |
| | *Cantharellopsis prescotii* | MF318900 | MF318991 | | | |
| | *Coltricia cinnamomea* | AM412243 | | | | |
| | *Coltricia cinnamomea* | MF318906 | | | | |
| | *Coltricia cinnamomea* | KJ000217 | | | | |

**Table VIII. Continued.**

| Dataset | Taxon | LSU | SSU | *rpb2* | ITS | Trophic Mode Reference |
|---|---|---|---|---|---|---|
| HID | *Coltricia cinnamomea* | LC098757 | | | | |
| | *Coltricia crassa* | KJ000218 | | | | |
| | *Coltricia macropora* | KJ000220 | | | | |
| | *Coltricia minor* | KJ000222 | | | | |
| | *Coltricia montagnei* | AY039683 | | | | |
| | *Coltricia perennis* | | AF026583 | | | |
| | *Coltricia perennis* | AJ406472 | | | | |
| | *Coltricia perennis* | | | AY218526 | | |
| | *Coltricia perennis* | MF318907 | MF318996 | MF288856 | | |
| | *Coltricia perennis* | MF318908 | MF318997 | MF288857 | | |
| | *Coltricia perennis* | MF318909 | MF318998 | | | |
| | *Coltricia perennis* | MF318910 | MF318999 | MF288858 | | |
| | *Coltricia perennis* | MF318911 | | | | |
| | *Coltricia perennis* | HQ534102 | | | | |
| | *Coltricia perennis* | KJ000223 | | | | |
| | *Coltricia* sp. | JN168663 | | | | |
| | *Coltricia spina* | HQ328521 | | | | |
| | *Coltricia strigosipes* | KJ000225 | | | | |
| | *Coltricia stuckertiana* | HM635663 | | | | |
| | *Coltriciella dependens* | AM412248 | | | | |
| | *Coltriciella dependens* | AY059059 | | | | |
| | *Coltriciella navisporus* | AY059062 | | | | |
| | *Coltriciella oblectabilis* | AY059061 | | | | |
| | *Coltriciella pseudodependens* | KJ000227 | | | | |
| | *Coltriciella pusilla* | AY059060 | | | | |
| | *Coltriciella sonorensis* | HQ439179 | | | | |
| | *Coltriciella* sp. | AM412247 | | | | |
| | *Coltriciella* sp. | KC857267 | | | | |
| | *Coltriciella subglobosa* | KJ000230 | | | | |
| | *Contumyces rosellus* | MF318912 | MF319001 | MF288859 | | |
| | *Contumyces vesuvianus* | MF318913 | MF319002 | MF288860 | | |
| | *Cotylidia carpatica* | MF318914 | | | | |
| | *Cotylidia aurantiaca* | AF261458 | | | | |
| | *Cotylidia aurantiaca* var. *alba* | AF261458 | | | | |
| | *Cotylidia diaphana* | MF318915 | | | | |

**Table VIII. Continued.**

| Dataset | Taxon | LSU | SSU | *rpb2* | ITS | Trophic Mode Reference |
|---|---|---|---|---|---|---|
| | *Cotylidia pannosa* | MF318916 | | | | |
| | *Cotylidia* sp. | AY629317 | AY705958 | | | |
| | *Cotylidia undulata* | MF318918 | | | | |
| | *Cotylidia undulata* | MF318920 | | | | |
| | *Cotylidia undulata* | MF318917 | | | | |
| | *Cyclomyces lamellatus* | JQ279617 | | | | |
| | *Cyclomyces tabacinus* | AF385164 | | | | |
| | *Fibricium rude* | AY700202 | AY654888 | | | |
| | *Fibricium rude* | DQ679916 | | | | |
| | *Fomitiporella* sp. | DQ459301 | | | | |
| | *Fomitiporella* sp. | JQ910908 | | | | |
| | *Fomitiporia aethiopica* | AY618204 | | | | |
| | *Fomitiporia australiensis* | GU462001 | | | | |
| | *Fomitiporia calkinsii* | JQ087902 | | | | |
| | *Fomitiporia cupressicola* | JQ087904 | | | | |
| | *Fomitiporia hippophaeicola* | GU461977 | | | | |
| | *Fomitiporia ivindoensis* | GU461978 | | | | |
| **HID** | *Fomitiporia mediterranea* | AY684157 | AY662664 | | | |
| | *Fomitiporia mediterranea* | EF429232 | | | | |
| | *Fomitiporia mediterranea* | JGI 56107 | JGI 56107 | JGI 56107 | | |
| | *Fomitiporia nobilissima* | GU461985 | | | | |
| | *Fomitiporia pentaphylacis* | JQ003901 | | | | |
| | *Fomitiporia punctata* | | | AB778013 | | |
| | *Fomitiporia punctata* | | | AB778014 | | |
| | *Fomitiporia punctata* | | | AB778015 | | |
| | *Fomitiporia punctata* | | | AB778016 | | |
| | *Fomitiporia punctata* | | | JQ088000 | | |
| | *Fomitiporia punctata* | | | JQ088001 | | |
| | *Fomitiporia punctata* | JX093878 | | | | |
| | *Fomitiporia punctata* | | | | | |
| | *Fomitiporia* sp. | AB777980 | | | | |
| | *Fomitiporia* sp. | JQ087911 | | | | |
| | *Fomitiporia* sp. | JQ087912 | | | | |
| | *Fomitiporia* sp. | JQ087916 | | | | |
| | *Fomitiporia* sp. | JX093836 | | | | |

**Table VIII. Continued.**

| Dataset | Taxon | LSU | SSU | *rpb2* | ITS | Trophic Mode Reference |
|---|---|---|---|---|---|---|
| | *Fomitiporia* sp. | JX093838 | | | | |
| | *Fomitiporia* sp. | JX093840 | | | | |
| | *Fomitiporia* sp. | JX093842 | | | | |
| | *Fomitiporia* sp. | JX093854 | | | | |
| | *Fomitiporia* sp. | JX093855 | | | | |
| | *Fomitiporia* sp. | JX280907 | | | | |
| | *Fomitiporia tenuis* | GU461998 | | | | |
| | *Fomitiporia tenuitubus* | JQ003903 | | | | |
| | *Fomitiporia tsugina* | KC551836 | | | | |
| | *Fulvifomes chinensis* | KJ787807 | | | | |
| | *Fulvifomes fastuosus* | JX484000 | | | | |
| | *Fulvifomes fastuosus* | KR905666 | | | | |
| | *Fulvifomes imbricatus* | KR905670 | | | | |
| | *Fulvifomes indicus* | KC879259 | | | | |
| | *Fulvifomes inermis* | KJ787810 | | | | |
| | *Fulvifomes melleoporus* | JX484001 | | | | |
| | *Fulvifomes robiniae* | AF411825 | | | | |
| **HID** | *Fulvifomes* sp. | JX104712 | | | | |
| | *Fulvifomes* sp. | JX104713 | | | | |
| | *Fulvifomes* sp. | JX104718 | | | | |
| | *Fulvifomes* sp. | JX104721 | | | | |
| | *Fulvifomes* sp. | JX104723 | | | | |
| | *Fulvifomes* sp. | JX104726 | | | | |
| | *Fulvifomes* sp. | JX104729 | | | | |
| | *Fulvifomes* sp. | JX104731 | | | | |
| | *Fulvifomes* sp. | JX104753 | | | | |
| | *Fulvifomes* sp. | JX104754 | | | | |
| | *Fulvifomes* sp. | JX104758 | | | | |
| | *Fulvifomes* sp. | JX188001 | | | | |
| | *Fulvifomes* sp. | JX866777 | | | | |
| | *Fulvifomes* sp. | JX866778 | | | | |
| | *Fulvifomes* sp. | JX866779 | | | | |
| | *Fuscoporia atlantica* | KP058517 | | | | |
| | *Fuscoporia discipes* | HQ328524 | | | | |
| | *Fuscoporia ferrea* | DQ122398 | | | | |

**Table VIII. Continued.**

| Dataset | Taxon | LSU | SSU | *rpb2* | ITS | Trophic Mode Reference |
|---|---|---|---|---|---|---|
| HID | *Fuscoporia ferrea* | KJ668399 | | | | |
| | *Fuscoporia ferruginosa* | DQ122397 | | | | |
| | *Fuscoporia ferruginosa* | KJ668398 | | | | |
| | *Fuscoporia gilva* | AF518636 | | | | |
| | *Fuscoporia gilva* | AM269858 | | | | |
| | *Fuscoporia gilva* | | HM584805 | | | |
| | *Fuscoporia gilva* | KJ668397 | | | | |
| | *Fuscoporia montana* | AY059053 | | | | |
| | *Fuscoporia montana* | JX484007 | | | | |
| | *Fuscoporia palmicola* | AY618209 | | | | |
| | *Fuscoporia* sp. | AY618208 | | | | |
| | *Fuscoporia* sp. | KJ668396 | | | | |
| | *Fuscoporia torulosa* | AM269865 | | | | |
| | *Fuscoporia torulosa* | HM635681 | | | | |
| | *Fuscoporia torulosa* | JX484009 | | | | |
| | *Fuscoporia viticola* | AY885166 | | | | |
| | *Gerronema albidum* | MF318923 | | | | |
| | *Gerronema albidum* | MF318924 | | | | |
| | *Gerronema marchantiae* | U66432 | | | | |
| | *Globulicium hiemale* | DQ873595 | DQ873594 | | | |
| | *Globulicium hiemale* | EU118626 | EU118626 | | | |
| | *Hydnochaete asetosa* | JQ279642 | | | | |
| | *Hydnochaete duportii* | AY635770 | AY662669 | | | |
| | *Hydnochaete japonica* | AF385153 | | | | |
| | *Hydnochaete olivacea* | | AY293134 | | | |
| | *Hydnochaete olivacea* | AY293185 | | | | |
| | *Hydnochaete paucisetigera* | HQ328527 | | | | |
| | *Hymenochaete acanthophysata* | AF385144 | | | | |
| | *Hymenochaete acerosa* | JQ279657 | | | | |
| | *Hymenochaete adusta* | AF385161 | | | | |
| | *Hymenochaete australis* | HE650990 | | | | |
| | *Hymenochaete berteroi* | AF385160 | | | | |
| | *Hymenochaete bispora* | HE650992 | | | | |
| | *Hymenochaete boidinii* | AF385159 | | | | |

**Table VIII. Continued.**

| Dataset | Taxon | LSU | SSU | *rpb2* | ITS | Trophic Mode Reference |
|---|---|---|---|---|---|---|
| HID | *Hymenochaete carpatica* | AF385158 | | | | |
| | *Hymenochaete cervina* | HE650993 | | | | |
| | *Hymenochaete cervinoidea* | AF385157 | | | | |
| | *Hymenochaete cinnamomea* | AY586664 | | | | |
| | *Hymenochaete cinnamomea* | HE650994 | | | | |
| | *Hymenochaete corrugata* | AF518620 | AF518579 | | | |
| | *Hymenochaete cruenta* | AF385152 | | | | |
| | *Hymenochaete cruenta* | HE650995 | | | | |
| | *Hymenochaete cruenta* | JQ279681 | | | | |
| | *Hymenochaete curtisii* | HE650996 | | | | |
| | *Hymenochaete denticulata* | AF385155 | | | | |
| | *Hymenochaete denticulata* | KF438174 | | | | |
| | *Hymenochaete epichlora* | JQ279659 | | | | |
| | *Hymenochaete escobarii* | HE650999 | | | | |
| | *Hymenochaete floridea* | HE651000 | | | | |
| | *Hymenochaete floridea* | JQ279683 | | | | |
| | *Hymenochaete fuliginosa* | HE651001 | | | | |
| | *Hymenochaete fuliginosa* | HE651017 | | | | |
| | *Hymenochaete fulva* | JQ279648 | | | | |
| | *Hymenochaete huangshanensis* | JQ279669 | | | | |
| | *Hymenochaete innexa* | JQ279673 | | | | |
| | *Hymenochaete intricata* | HE651002 | | | | |
| | *Hymenochaete intricata* | KJ668379 | | | | |
| | *Hymenochaete koeljalgii* | HE651003 | | | | |
| | *Hymenochaete lenta* | JQ279628 | | | | |
| | *Hymenochaete luteobadia* | JQ279651 | | | | |
| | *Hymenochaete megaspora* | JQ279660 | | | | |
| | *Hymenochaete murina* | JQ716412 | | | | |
| | *Hymenochaete nanospora* | AF385151 | | | | |
| | *Hymenochaete nothofagicola* | HE651005 | | | | |
| | *Hymenochaete ochromarginata* | AF385150 | | | | |
| | *Hymenochaete peroxydata* | KF371647 | | | | |
| | *Hymenochaete pinnatifida* | AF385149 | | | | |
| | *Hymenochaete resupinata* | HE650988 | | | | |

**Table VIII. Continued.**

| Dataset | Taxon | LSU | SSU | *rpb2* | ITS | Trophic Mode Reference |
|---|---|---|---|---|---|---|
| HID | *Hymenochaete rhabarbarina* | AJ406468 | | | | |
| | *Hymenochaete rhabarbarina* | HE651007 | | | | |
| | *Hymenochaete rhabarbarina* | HE651018 | | | | |
| | *Hymenochaete rhabarbarina* | JQ279656 | | | | |
| | *Hymenochaete rheicolor* | HE651008 | | | | |
| | *Hymenochaete rhododendricola* | JQ279653 | | | | |
| | *Hymenochaete rubiginosa* | AF291339 | | | | |
| | *Hymenochaete rubiginosa* | AY586665 | | | | |
| | *Hymenochaete rubiginosa* | HE651009 | | | | |
| | *Hymenochaete rubiginosa* | JQ279667 | | | | |
| | *Hymenochaete sallei* | AF450258 | | | | |
| | *Hymenochaete semistupposa* | EU599573 | | | | |
| | *Hymenochaete senatoumbrina* | HE651010 | | | | |
| | *Hymenochaete separabilis* | AF385146 | | | | |
| | *Hymenochaete separabilis* | JQ279655 | | | | |
| | *Hymenochaete separata* | AF385147 | | | | |
| | *Hymenochaete* sp. | AY586666 | | | | |
| | *Hymenochaete* sp. | JQ279675 | | | | |
| | *Hymenochaete* sp. | KF438173 | | | | |
| | *Hymenochaete* sp. | KJ668378 | | | | |
| | *Hymenochaete sphaericola* | JQ279684 | | | | |
| | *Hymenochaete tasmanica* | HE651011 | | | | |
| | *Hymenochaete tasmanica* | JQ279664 | | | | |
| | *Hymenochaete tenuis* | JQ279641 | | | | |
| | *Hymenochaete ulmicola* | HE651012 | | | | |
| | *Hymenochaete yasudai* | KJ668377 | | | | |
| | *Hyphoderma capitatum* | DQ677491 | | | | |
| | *Hyphoderma echinocystis* | DQ681200 | | | | |
| | *Hyphoderma guttuliferum* | AY586667 | | | | |
| | *Hyphoderma orphanellum* | DQ340376 | | | | |
| | *Hyphoderma puberum* | DQ677502 | | | | |
| | *Hyphoderma puberum* | DQ873599 | DQ873598 | | | |
| | *Hyphoderma sibiricum* | DQ677503 | | | | |
| | *Hyphoderma sibiricum* | MF318925 | | | | |

**Table VIII. Continued.**

| Dataset | Taxon | LSU | SSU | *rpb2* | ITS | Trophic Mode Reference |
|---|---|---|---|---|---|---|
| | *Hyphodontia abieticola* | | DQ873600 | | | |
| | *Hyphodontia alutaria* | | DQ873602 | | | |
| | *Hyphodontia arguta* | | DQ873604 | | | |
| | *Hyphodontia barba-jovis* | | DQ873608 | | | |
| | *Hyphodontia breviseta* | | DQ873611 | | | |
| | *Hyphodontia crustosa* | | DQ873613 | | | |
| | *Hyphodontia floccosa* | | DQ873617 | | | |
| | *Hyphodontia nespori* | | DQ873621 | | | |
| | *Hyphodontia pruni* | | DQ873623 | | | |
| | *Hyphodontia rimosissima* | | DQ873626 | | | |
| | *Hyphodontia rimosissima* | | | LN714662 | | |
| | *Hyphodontia* sp. | DQ873634 | DQ873632 | | | |
| | *Hyphodontia subalutacea* | | DQ873629 | | | |
| | *Inocutus dryophilus* | AM269845 | | | | |
| | *Inonotus pegleri* | AY059049 | | | | |
| | *Inonotus andersonii* | AM269843 | | | | |
| | *Inonotus andersonii* | AY059041 | | | | |
| **HID** | *Inonotus baumii* | | AY839830 | | | |
| | *Inonotus baumii* | | GU903001 | | | |
| | *Inonotus baumii* | | GU903002 | | | |
| | *Inonotus baumii* | | HM584801 | | | |
| | *Inonotus baumii* | HQ328528 | | | | |
| | *Inonotus baumii* | | HQ593854 | | | |
| | *Inonotus baumii* | | HQ834534 | | | |
| | *Inonotus baumii* | KJ668363 | | | | |
| | *Inonotus chondromyelus* | AF311009 | | | | |
| | *Inonotus compositus* | KP030768 | | | | |
| | *Inonotus crocitinctus* | AY059043 | | | | |
| | *Inonotus cuticularis* | AF311010 | | | | |
| | *Inonotus dryadeus* | AM910615 | | | | |
| | *Inonotus dryophilus* | AF311012 | | | | |
| | *Inonotus formosanus* | AY059034 | | | | |
| | *Inonotus glomeratus* | AY059032 | | | | |
| | *Inonotus hispidus* | AF311014 | | | | |
| | *Inonotus hispidus* | AF518623 | | | | |

**Table VIII. Continued.**

| Dataset | Taxon | LSU | SSU | *rpb2* | ITS | Trophic Mode Reference |
|---|---|---|---|---|---|---|
| HID | *Inonotus hispidus* | AM269848 | | | | |
| | *Inonotus hispidus* | AM906066 | | | | |
| | *Inonotus hispidus* | EU282484 | EU282483 | | | |
| | *Inonotus jamaicensis* | AY059048 | | | | |
| | *Inonotus linteus* | | AB158296 | | | |
| | *Inonotus linteus* | | AY839828 | | | |
| | *Inonotus linteus* | | AY839829 | | | |
| | *Inonotus linteus* | AY839831 | | | | |
| | *Inonotus linteus* | GU462002 | | | | |
| | *Inonotus linteus* | | GU902998 | | | |
| | *Inonotus linteus* | | HM584799 | | | |
| | *Inonotus linteus* | | HM584800 | | | |
| | *Inonotus linteus* | | HQ593855 | | | |
| | *Inonotus linteus* | | JF972588 | | | |
| | *Inonotus linteus* | JX467701 | | | | |
| | *Inonotus ludo-vicianus* | AY059044 | | | | |
| | *Inonotus magnisetus* | HQ328530 | | | | |
| | *Inonotus marginatus* | EF429237 | | | | |
| | *Inonotus micantissimus* | HM635664 | | | | |
| | *Inonotus niduspici* | AF311015 | | | | |
| | *Inonotus nodulosus* | AF311016 | | | | |
| | *Inonotus nodulosus* | AJ406471 | | | | |
| | *Inonotus obliquus* | AF311017 | | | | |
| | *Inonotus obliquus* | AY279001 | | | | |
| | *Inonotus obliquus* | | GU903000 | | | |
| | *Inonotus plorans* | AY059046 | | | | |
| | *Inonotus porrectus* | AY059051 | | | | |
| | *Inonotus pruinosus* | AY059045 | | | | |
| | *Inonotus radiatus* | AF311018 | | | | |
| | *Inonotus rheades* | AF311019 | | | | |
| | *Inonotus rodwayi* | AY059047 | | | | |
| | *Inonotus* sp. | JQ910906 | | | | |
| | *Inonotus* sp. | KC589014 | | | | |
| | *Inonotus* sp. | KC999901 | | | | |
| | *Inonotus* sp. | KP059108 | | | | |

**Table VIII. Continued.**

| Dataset | Taxon | LSU | SSU | *rpb2* | ITS | Trophic Mode Reference |
|---|---|---|---|---|---|---|
| HID | *Inonotus subiculosus* | AF311020 | | | | |
| | *Inonotus tabacinus* | JQ279640 | | | | |
| | *Inonotus tamaricis* | AF311021 | | | | |
| | *Inonotus tenuicontextus* | JN169790 | | | | |
| | *Inonotus tropicalis* | AY598826 | | | | |
| | *Inonotus tropicalis* | KM350240 | | | | |
| | *Inonotus ulmicola* | AY059042 | | | | |
| | *Inonotus weirii* | AY059040 | | | | |
| | *Leifa flabelliradiata* | DQ873635 | | | | |
| | *Loreleia marchantiae* | MF318926 | | | | |
| | *Mensularia nodulosa* | AF291341 | | | | |
| | *Muscinupta laevis* | AY745705 | | | | |
| | *Muscinupta laevis* | | AY752973 | | | |
| | *Muscinupta laevis* | MF318928 | | MF288862 | | |
| | *Muscinupta laevis* | MF318922 | | | | |
| | *Muscinupta laevis* | MF318921 | MF319004 | MF288861 | | |
| | *Mycoacia pinicola* | DQ873637 | DQ873636 | | | |
| | *Odonticium romellii* | | DQ873638 | | | |
| | *Odonticium romellii* | MF318929 | | | | |
| | *Odonticium romellii* | MF318932 | | | | |
| | *Omphalina brevibasidiata* | U66441 | | | | |
| | *Omphalina rosella* | U66452 | | | | |
| | *Onnia scaura* | JGI 245618 | JGI 245618 | JGI 245618 | | |
| | *Onnia tomentosa* | H6048491 | | | | |
| | *Onnia tomentosa* | MF318931 | MF319006 | | | |
| | *Onnia tomentosa* | JX110116 | | | | |
| | *Onnia triquetra* | AF311024 | | | | |
| | *Oxyporus corticola* | | JF972589 | | | |
| | *Oxyporus corticola* | | JF972586 | | | |
| | *Oxyporus corticola* | DQ873641 | DQ873640 | | | |
| | *Oxyporus populinus* | AJ406467 | | | | |
| | *Oxyporus* sp. | AF287877 | AF026616 | | | |
| | *Palifer verecundus* | DQ873643 | | | | |
| | *Peniophorella praetermissa* | AJ406482 | | | | |
| | *Peniophorella praetermissa* | AY586671 | | | | |

**Table VIII. Continued.**

| Dataset | Taxon | LSU | SSU | *rpb2* | ITS | Trophic Mode Reference |
|---|---|---|---|---|---|---|
| HID | *Peniophorella praetermissa* | AY700185 | AY707094 | | | |
| | *Peniophorella praetermissa* | | DQ873596 | | | |
| | *Peniophorella praetermissa* | KJ668375 | | | | |
| | *Peniophorella rude* | KJ668350 | | | | |
| | *Phellinidium asiaticum* | KC859422 | | | | |
| | *Phellinidium sulphurascens* | AY829347 | | | | |
| | *Phellinidium weirii* | AY829345 | | | | |
| | *Phellinopsis asetosa* | KJ425523 | | | | |
| | *Phellinus andinopatagonicus* | KP347529 | | | | |
| | *Phellinus andinus* | KP347528 | | | | |
| | *Phellinus apiahynus* | AF450264 | | | | |
| | *Phellinus bicuspidatus* | AY059022 | | | | |
| | *Phellinus caribaeo* | DQ127279 | | | | |
| | *Phellinus caryophylli* | AY059021 | | | | |
| | *Phellinus castanopsidis* | JQ837957 | | | | |
| | *Phellinus chaquensis* | DQ122396 | | | | |
| | *Phellinus cinchonensis* | AY059024 | | | | |
| | *Phellinus cinereus* | AF311027 | | | | |
| | *Phellinus conchatus* | AF311028 | | | | |
| | *Phellinus contiguus* | AF311029 | | | | |
| | *Phellinus coronadensis* | JX110117 | | | | |
| | *Phellinus crustosus* | KP347526 | | | | |
| | *Phellinus ellipsoideus* | JQ837955 | | | | |
| | *Phellinus ellipsoideus* | JQ837962 | | | | |
| | *Phellinus extensus* | AF450257 | | | | |
| | *Phellinus extensus* | DQ349099 | | | | |
| | *Phellinus ferrugineofuscus* | AF311031 | | | | |
| | *Phellinus ferrugineovelutinus* | KC782529 | | | | |
| | *Phellinus fragrans* | AY059027 | | | | |
| | *Phellinus gabonensis* | HM635682 | | | | |
| | *Phellinus gilvus* | AF450255 | | | | |
| | *Phellinus gilvus* | AF458457 | | | | |
| | *Phellinus grenadensis* | AF450263 | | | | |
| | *Phellinus igniarius* | | AF026614 | | | |
| | *Phellinus igniarius* | | AY436631 | | | |

**Table VIII. Continued.**

| Dataset | Taxon | LSU | SSU | *rpb2* | ITS | Trophic Mode Reference |
|---|---|---|---|---|---|---|
| HID | *Phellinus igniarius* | AY839834 | | | | |
| | *Phellinus igniarius* | | GU903003 | | | |
| | *Phellinus igniarius* | | HM584803 | | | |
| | *Phellinus igniarius* | | | LN714693 | | |
| | *Phellinus igniarius* var. *cinereus* | AM269860 | | | | |
| | *Phellinus johnsonianus* | AF458458 | AY178015 | | | |
| | *Phellinus juniperinus* | | | KF444749 | | |
| | *Phellinus kawakamii* | AY059028 | | | | |
| | *Phellinus laevigatus* | AF311034 | | | | |
| | *Phellinus laevigatus* | AF458460 | AY178020 | | | |
| | *Phellinus laevigatus* | KJ668339 | | | | |
| | *Phellinus linteus* | AF458462 | | | | |
| | *Phellinus lundellii* | KC551859 | | | | |
| | *Phellinus mori* | HQ328535 | | | | |
| | *Phellinus nigricans* | MF318933 | MF319007 | | | |
| | *Phellinus nigricans* | MF318934 | | | | |
| | *Phellinus noxius* | HQ328532 | | | | |
| | *Phellinus noxius* | LC066618 | | | | |
| | *Phellinus occidentalis* | AY059019 | | | | |
| | *Phellinus pachyphloeus* | AY059020 | | | | |
| | *Phellinus palmicola* | AF450261 | | | | |
| | *Phellinus piptadeniae* | KP412272 | | | | |
| | *Phellinus punctatus* | AM906067 | | | | |
| | *Phellinus punctatus* | EF429225 | | | | |
| | *Phellinus rhabarbarinus* | AF458466 | AY178016 | | | |
| | *Phellinus rhabarbarinus* | JQ797671 | | | | |
| | *Phellinus ribis* | AF311040 | | | | |
| | *Phellinus rimosus* | AF450256 | | | | |
| | *Phellinus rimosus* | JX484003 | | | | |
| | *Phellinus robiniae* | AY059038 | | | | |
| | *Phellinus robustus* | AM269864 | | | | |
| | *Phellinus* sp. | DQ127283 | | | | |
| | *Phellinus* sp. | KC589015 | | | | |
| | *Phellinus* sp. | KF757337 | | | | |

**Table VIII. Continued.**

| Dataset | Taxon | LSU | SSU | *rpb2* | ITS | Trophic Mode Reference |
|---|---|---|---|---|---|---|
| | *Phellinus* sp. | KM523251 | | | | |
| | *Phellinus* sp. | KP027474 | | | | |
| | *Phellinus spiculosus* | AY059055 | | | | |
| | *Phellinus sulphurascens* | AY059016 | | | | |
| | *Phellinus tabaquilio* | GU461994 | | | | |
| | *Phellinus texanus* | JQ087921 | | | | |
| | *Phellinus tremulae* | AF311042 | | | | |
| | *Phellinus tremulae* | AM906069 | | | | |
| | *Phellinus tuberculosus* | AM906070 | | | | |
| | *Phellinus tuberculosus* | KJ668338 | | | | |
| | *Phellinus undulatus* | DQ131561 | | | | |
| | *Phellinus vaninii* | AY059056 | | | | |
| | *Phellinus wahlbergii* | AF311045 | | | | |
| | *Phellinus weirianus* | AY059035 | | | | |
| | *Phellinus xeranticus* | JQ279635 | | | | |
| | *Phlebia brevispora* | JGI 64423 | JGI 64423 | JGI 64423 | | |
| | *Phlebia georigica* | DQ873645 | DQ873644 | | | |
| **HID** | *Phylloporia bibulosa* | AF411824 | | | | |
| | *Phylloporia chrysita* | HM635665 | | | | |
| | *Phylloporia crataegi* | JF712922 | | | | |
| | *Phylloporia dependens* | KP698746 | | | | |
| | *Phylloporia ephedrae* | AF411826 | | | | |
| | *Phylloporia fontanesiae* | JF712924 | | | | |
| | *Phylloporia fulva* | KJ743247 | | | | |
| | *Phylloporia gutta* | JF712926 | | | | |
| | *Phylloporia hainaniana* | JF712928 | | | | |
| | *Phylloporia inonotoides* | KJ743250 | | | | |
| | *Phylloporia minutispora* | HM635671 | | | | |
| | *Phylloporia minutospora* | JF712929 | | | | |
| | *Phylloporia nandinae* | JF712930 | | | | |
| | *Phylloporia nouraguensis* | KC136222 | | | | |
| | *Phylloporia oreophila* | JF712933 | | | | |
| | *Phylloporia pectinata* | AF411823 | | | | |
| | *Phylloporia pectinata* | JX484012 | | | | |
| | *Phylloporia resupinata* | JF712935 | | | | |

**Table VIII. Continued.**

| Dataset | Taxon | LSU | SSU | *rpb2* | ITS | Trophic Mode Reference |
|---|---|---|---|---|---|---|
| HID | *Phylloporia ribis* | | AF334926 | | | |
| | *Phylloporia ribis* | AF518638 | | | | |
| | *Phylloporia rzedowskii* | HM635672 | | | | |
| | *Phylloporia* sp. | KC136225 | | | | |
| | *Phylloporia* sp. | KC136226 | | | | |
| | *Phylloporia* sp. | KC136228 | | | | |
| | *Phylloporia* sp. | KC136229 | | | | |
| | *Phylloporia* sp. | KC136231 | | | | |
| | *Phylloporia* sp. | KC778784 | | | | |
| | *Phylloporia* sp. | KJ743253 | | | | |
| | *Phylloporia* sp. | KJ743259 | | | | |
| | *Phylloporia* sp. | KJ743261 | | | | |
| | *Phylloporia* sp. | KJ743265 | | | | |
| | *Phylloporia* sp. | KJ743266 | | | | |
| | *Phylloporia* sp. | KJ743269 | | | | |
| | *Phylloporia* sp. | KJ743270 | | | | |
| | *Phylloporia* sp. | KJ743271 | | | | |
| | *Phylloporia* sp. | KJ743276 | | | | |
| | *Phylloporia* sp. | KJ743277 | | | | |
| | *Phylloporia* sp. | KJ743278 | | | | |
| | *Phylloporia* sp. | KJ743279 | | | | |
| | *Phylloporia* sp. | KJ743280 | | | | |
| | *Phylloporia* sp. | KJ743281 | | | | |
| | *Phylloporia* sp. | KJ743283 | | | | |
| | *Phylloporia* sp. | KJ743284 | | | | |
| | *Phylloporia spathulata* | AF411822 | | | | |
| | *Phylloporia ulloai* | HM635677 | | | | |
| | *Phylloporia weberiana* | JF712936 | | | | |
| | *Phylloporia yuchengii* | KM264324 | | | | |
| | *Polyporus brumalis* | JGI 265768 | JGI 265768 | JGI 265768 | | |
| | *Pordaedalea niemelaei* | JGI 333975 | JGI 333975 | JGI 333975 | | |
| | *Porodaedalea pini* | AF458459 | | | | |
| | *Porodaedalea pini* | | GU902999 | | | |
| | *Porodaedalea pini* | JX110079 | | | | |
| | *Pseudochaete* sp. | JQ716408 | | | | |

**Table VIII. Continued.**

| Dataset | Taxon | LSU | SSU | *rpb2* | ITS | Trophic Mode Reference |
|---|---|---|---|---|---|---|
| HID | *Pseudochaete* sp. | | | | | |
| | *Pseudoinonotus dryadeus* | AM269870 | | | | |
| | *Punctularia strigosozonata* | JGI 52407 | JGI 52407 | JGI 52407 | | |
| | *Pyrrhoderma adamanticum* | AY059031 | | | | |
| | *Pyrrhoderma scaurum* | AY059030 | | | | |
| | *Ramaria rubella* | JGI 196021 | JGI 196021 | JGI 196021 | | |
| | *Repetobasidium conicum* | DQ873647 | DQ873646 | | | |
| | *Repetobasidium mirificum* | AY293208 | AY293155.1 | | | |
| | *Resinicium bicolor* | AJ406483 | | | | |
| | *Resinicium bicolor* | AY586709 | | | | |
| | *Resinicium bicolor* | AF518645 | AF518588.1 | | | |
| | *Resinicium bicolor* | | AF026615 | | | |
| | *Resinicium bicolor* | | DQ834914 | | | |
| | *Resinicium bicolor* | MF318936 | MF319009 | | | |
| | *Resinicium bicolor* | MF318935 | | | | |
| | *Resinicium bicolor* | MF318937 | | | | |
| | *Resinicium chiricahuaense* | DQ863692 | DQ834912 | | | |
| | *Resinicium friabile* | DQ863690 | DQ834915 | | | |
| | *Resinicium furfuraceum* | DQ863696 | DQ834913 | | | |
| | *Resinicium meridionale* | AY293197 | AY293142 | | | |
| | *Resinicium meridionale* | DQ863693 | | | | |
| | *Resinicium meridionale* | | DQ834910 | | | |
| | *Resinicium meridionale* | | AY293142 | | | |
| | *Resinicium meridionale* | | DQ974210 | | | |
| | *Resinicium monticola* | DQ863697 | | | | |
| | *Resinicium mutabile* | DQ863699 | | | | |
| | *Resinicium pinicola* | KJ668316 | | | | |
| | *Resinicium saccharicola* | DQ863691 | DQ834916 | | | |
| | *Resinicium* sp. | | DQ834917 | | | |
| | *Rickenella fibula* | MF318973 | MF319026 | | | |
| | *Rickenella fibula* | MF318938 | MF319023 | MF288876 | | |
| | *Rickenella fibula* | AM946463 | | | | |
| | *Rickenella fibula* | AY700195 | AY771599 | DQ408115 | | |
| | *Rickenella fibula* | MF318939 | MF319010 | MF288863 | | |
| | *Rickenella fibula* | MF318949 | MF319027 | | | |

**Table VIII. Continued.**

| Dataset | Taxon | LSU | SSU | *rpb2* | ITS | Trophic Mode Reference |
|---|---|---|---|---|---|---|
| HID | *Rickenella fibula* | MF318945 | MF319028 | | | |
| | *Rickenella fibula* | H6034922 | | | | |
| | *Rickenella fibula* | MF318947 | MF319016 | MF288869 | | |
| | *Rickenella fibula* | MF318948 | MF319025 | | | |
| | *Rickenella fibula* | MF318940 | MF319011 | MF288864 | | |
| | *Rickenella fibula* | MF318941 | MF319012 | MF288865 | | |
| | *Rickenella fibula* | MF318942 | MF319013 | MF288866 | | |
| | *Rickenella fibula* | MF318943 | MF319014 | MF288867 | | |
| | *Rickenella fibula* | MF318944 | MF319015 | MF288868 | | |
| | *Rickenella fibula* | JGI 333301 | JGI 333301 | JGI 333301 | | |
| | *Rickenella fibula* | MF318950 | MF319017 | MF288871 | | |
| | *Rickenella fibula* | MF318951 | MF319018 | MF288872 | | |
| | *Rickenella fibula* | | KJ425346 | | | |
| | *Rickenella fibula* | | KJ425347 | | | |
| | *Rickenella fibula* | MF318957 | MF319024 | MF288877 | | |
| | *Rickenella fibula* | MF318952 | MF319020 | MF288873 | | |
| | *Rickenella fibula* | MF318953 | MF319021 | | | |
| | *Rickenella fibula* | MF318954 | MF319022 | MF288874 | | |
| | *Rickenella fibula* | MF318972 | MF319019 | MF288875 | | |
| | *Rickenella fibula* | MF318955 | MF319029 | MF288878 | | |
| | *Rickenella fibula* | AY586710 | | | | |
| | *Rickenella mellea* | JGI 334780 | JGI 334780 | JGI 334780 | | |
| | *Rickenella minuta* | MF318965 | | MF288879 | | |
| | *Rickenella minuta* | MF318967 | | MF288880 | | |
| | *Rickenella minuta* | MF318966 | MF319032 | MF288881 | | |
| | *Rickenella minuta* | MF318956 | MF319030 | | | |
| | *Rickenella minuta* | MF318958 | MF319034 | MF288883 | | |
| | *Rickenella minuta* | MF318959 | MF319031 | MF288882 | | |
| | *Rickenella minuta* | MF318971 | | | | |
| | *Rickenella minuta* | MF318962 | MF319036 | MF288884 | | |
| | *Rickenella minuta* | MF318961 | MF319037 | MF288887 | | |
| | *Rickenella minuta* | MF318964 | | MF288888 | | |
| | *Rickenella minuta* | MF318963 | MF319040 | MF288886 | | |
| | *Rickenella minuta* | MF318960 | MF319035 | | | |
| | *Rickenella minuta* | MF318970 | | MF288889 | | |

**Table VIII. Continued.**

| Dataset | Taxon | LSU | SSU | *rpb2* | ITS | Trophic Mode Reference |
|---|---|---|---|---|---|---|
| HID | *Rickenella minuta* | MF318969 | MF319038 | MF288885 | | |
| | *Rickenella setipes* | MF318968 | | | | |
| | *Rickenella* sp. | MF318974 | | | | |
| | *Rickenella* sp. | MF318975 | MF319041 | | | |
| | *Rickenella swartzii* | MF318976 | MF319042 | | | |
| | *Rickenella swartzii* | MF318977 | | | | |
| | *Rickenella swartzii* | MF318978 | | | | |
| | *Rickenella swartzii* | MF318979 | | | | |
| | *Rickenella swartzii* | MF318980 | MF319043 | | | |
| | *Rigidoporus populinus* | MF318981 | | | | |
| | *Rigidoporus populinus* | MF318982 | | | | |
| | *Rogersella griseliniae* | | DQ873650 | | | |
| | *Schizopora paradoxa* | | AF026612 | | | |
| | *Schizopora paradoxa* | JGI 239088 | JGI 239088 | JGI 239088 | | |
| | *Sidera lenis* | MF318983 | | | | |
| | *Sidera lowei* | FN907917 | | | | |
| | *Sidera lowei* | FN907919 | | | | |
| | *Sidera* sp. | JN368214 | | | | |
| | *Sidera vulgaris* | FN907918 | | | | |
| | *Sidera vulgaris* | FN907922 | | | | |
| | *Skvortzovia furfurella* | DQ873649 | | | | |
| | *Skvortzovia furfurella* | DQ863695 | DQ834911 | | | |
| | *Stipitochaete damicornis* | AF385162 | | | | |
| | *Trichaptum abietinum* | AF518659 | AF026585 | | | |
| | *Trichaptum abietinum* | AJ406473 | | | | |
| | *Trichaptum abietinum* | JGI 210203 | JGI 210203 | JGI 210203 | | |
| | *Trichaptum fuscoviolaceum* | MF318984 | | | | |
| | *Trichaptum fuscoviolaceum* | H6059317 | | | | |
| | *Tsugacorticium kenaicum* | JN368221 | JN368234 | | | |
| | *Tsugacorticium kenaicum* | JN368221 | JN368234 | | | |
| | *Tubulicrinis globisporus* | | DQ873654 | | | |
| | *Tubulicrinis gracillimus* | AF518661 | AF518592 | | | |
| | *Tubulicrinis hirtellus* | | DQ873656 | | | |
| | *Tubulicrinis inornatus* | | DQ873658 | | | |
| | *Tubulicrinis subulatus* | AJ406448 | | | | |

**Table VIII. Continued.**

| Dataset | Taxon | LSU | SSU | *rpb2* | ITS | Trophic Mode Reference |
|---|---|---|---|---|---|---|
| **HID** | *Tubulicrinis subulatus* | AY586722 | | | | |
| | *Xylodon* sp. | JN368220 | JN368233 | | | |
| **HCD** | *Alloclavaria purpurea* | | MF318895 | MF318986 | | Dentinger et al., (2015) |
| | *Alloclavaria purpurea* | | MF318893 | MF318988 | | |
| | *Alloclavaria purpurea* | | MF318904 | MF318994 | | |
| | *Alloclavaria purpurea* | | MF318894 | MF318987 | | |
| | *Alloclavaria purpurea* | | MF318905 | MF318995 | | |
| | *Alloclavaria purpurea* | | DQ284900 | | | |
| | *Alloclavaria purpurea* | | DQ457657 | DQ437679 | | |
| | *Alloclavaria purpurea* | | DQ284899 | | | |
| | *Atheloderma mirabile* | | DQ873592 | | | Author determined |
| | *Auricularia subglabra* | | JGI 60553 | JGI 60553 | JGI 60553 | Kim et al., (2016) |
| | *Basidioradulum radula* | | AY700184 | | | Nobles, (1967) |
| | *Bjerkandera adusta* | | JGI 74757 | JGI 74757 | JGI 74757 | Robledo et al., (2006) |
| | *Blasiphalia pseudogrisella* | | MF318899 | MF318990 | | Larsson et al., (2006) |
| | *Blasiphalia pseudogrisella* | | MF318898 | MF318989 | | |
| | *Cantharellopsis prescotii* | | MF318901 | MF318992 | | Larsson et al., (2006) |
| | *Cantharellopsis prescotii* | | MF318900 | MF318991 | | |
| | *Coltricia perennis* | | MF318907 | MF318996 | MF288856 | Larsson et al., (2006) |
| | *Coltricia perennis* | | MF318910 | MF318999 | MF288858 | |
| | *Coltricia perennis* | | MF318909 | MF318998 | | |
| | *Coltricia perennis* | | MF318908 | MF318997 | MF288857 | |
| | *Contumyces rosellus* | | MF318912 | MF319001 | MF288859 | Redhead et al., (2002) |
| | *Contumyces vesuvianus* | | MF318913 | MF319002 | MF288860 | Redhead et al., (2002) |
| | *Cotylidia aurantiaca* var. *alba* | | AF261458 | | | Redhead et al., (2002) |
| | *Cotylidia pannosa* | | MF318916 | MF319000 | | Larsson et al., (2006) |
| | *Cotylidia* sp. | | AY629317 | AY705958 | | Larsson et al., (2006) |
| | *Fibricium rude* | | AY700202 | AY654888 | | Binder et al., (2005) |
| | *Fomitiporia aethiopica* | | AY618204 | | | Larsson et al., (2006) |

**Table VIII. Continued.**

| Dataset | Taxon | LSU | SSU | *rpb2* | ITS | Trophic Mode Reference |
|---|---|---|---|---|---|---|
| HCD | *Fomitiporia australiensis* | | GU462001 | | | Larsson et al., (2006) |
| | *Fomitiporia calkinsii* | | JQ087902 | | | (Larsson et al., (2006) |
| | *Fomitiporia cupressicola* | | JQ087904 | | | Larsson et al., (2006) |
| | *Fomitiporia hippophaeicola* | | GU461977 | | | Larsson et al., (2006) |
| | *Fomitiporia ivindoensis* | | GU461978 | | | Larsson et al., (2006) |
| | *Fomitiporia mediterranea* | | AY684157 | AY662664 | | Larsson et al., (2006) |
| | *Fomitiporia mediterranea* | | JGI 56107 | JGI 56107 | JGI 56107 | |
| | *Fomitiporia nobilissima* | | GU461985 | | | Larsson et al., (2006) |
| | *Fomitiporia* sp. | | JX093854 | | | Larsson et al., (2006) |
| | *Fomitiporia* sp. | | JX093855 | | | Larsson et al., (2006) |
| | *Fomitiporia* sp. | | JX093836 | | | Larsson et al., (2006) |
| | *Fomitiporia* sp. | | JQ087916 | | | Larsson et al., (2006) |
| | *Fomitiporia* sp. | | JX093840 | | | Larsson et al., (2006) |
| | *Fomitiporia* sp. | | JX093842 | | | Larsson et al., (2006) |
| | *Fomitiporia* sp. | | JX093838 | | | Larsson et al., (2006) |
| | *Fomitiporia* sp. | | AB777980 | | | Larsson et al., (2006) |
| | *Fomitiporia* sp. | | JQ087912 | | | Larsson et al., (2006) |
| | *Fomitiporia* sp. | | JQ087911 | | | Larsson et al., (2006) |
| | *Gerronema marchantiae* | | U66432 | | | Redhead et al., (2002) |
| | *Globulicium hiemale* | | DQ873595 | DQ873594 | | Olsson and Jonsson, (2010) |
| | *Globulicium hiemale* | | EU118626 | EU118626 | | |
| | *Hydnochaete duportii* | | AY635770 | AY662669 | | Larsson et al., (2006) |
| | *Hymenochaete corrugata* | | AF518620 | AF518579 | | Larsson et al., (2006) |
| | *Hyphoderma capitatum* | | DQ677491 | | | Larsson et al., (2006) |

**Table VIII. Continued.**

| Dataset | Taxon | LSU | SSU | *rpb2* | ITS | Trophic Mode Reference |
|---|---|---|---|---|---|---|
| HCD | *Hyphoderma echinocystis* | | DQ681200 | | | Larsson et al., (2006) |
| | *Hyphoderma guttuliferum* | | AY586667 | | | Larsson et al., (2006) |
| | *Hyphoderma orphanellum* | | DQ340376 | | | Larsson et al., (2006) |
| | *Hyphoderma praetermissum* | | AY700185 | AY707094 | AY787221 | Larsson et al., (2006) |
| | *Hyphoderma puberum* | | DQ677502 | | | Larsson et al., (2006) |
| | *Hyphoderma puberum* | | DQ873599 | DQ873598 | | |
| | *Hyphodontia* sp. | | DQ873634 | DQ873632 | | Larsson et al., (2006) |
| | *Inonotus hispidus* | | AF518623 | | | Larsson et al., (2006) |
| | *Inonotus hispidus* | | EU282484 | EU282483 | | |
| | *Leifia flabelliradiata* | | DQ873635 | | | Larsson et al., (2006) |
| | *Muscinupta laevis* | | MF318928 | | MF288862 | Larsson et al., (2006) |
| | *Muscinupta laevis* | | MF318921 | MF319004 | MF288861 | |
| | *Mycoacia pinicola* | | DQ873637 | DQ873636 | | Larsson et al., (2006) |
| | *Odonticium romellii* | | | DQ873638 | | Larsson et al., (2006) |
| | *Odonticium romellii* | | MF318929 | | | |
| | *Odonticium romellii* | | MF318932 | | | |
| | *Omphalina brevibasidiata* | | U66441 | | | Larsson et al., (2006) |
| | *Omphalina rosella* | | U66452 | | | Larsson et al., (2006) |
| | *Onnia scaura* | | JGI 245618 | JGI 245618 | JGI 245618 | Larsson et al., (2006) |
| | *Onnia tomentosa* | | MF318931 | MF319006 | | Larsson et al., (2006) |
| | *Oxyporus corticola* | | | JF972589 | | Larsson et al., (2006) |
| | *Oxyporus corticola* | | | JF972586 | | |
| | *Oxyporus corticola* | | DQ873641 | DQ873640 | | |
| | *Oxyporus populinus* | | AJ406467 | | | Larsson et al., (2006) |
| | *Oxyporus* sp. | | AF287877 | AF026616 | | Larsson et al., (2006) |
| | *Phellinus johnsonianus* | | AF458458 | AY178015 | | Larsson et al., (2006) |
| | *Phellinus laevigatus* | | AF458460 | AY178020 | | Larsson et al., (2006) |

**Table VIII. Continued.**

| Dataset | Taxon | LSU | SSU | *rpb2* | ITS | Trophic Mode Reference |
|---|---|---|---|---|---|---|
| HCD | *Phellinus lundellii* | | KC551859 | | | Larsson et al., (2006) |
| | *Phellinus nigricans* | | MF318933 | MF319007 | | Larsson et al., (2006) |
| | *Phellinus rhabarbarinus* | | AF458466 | AY178016 | | Larsson et al., (2006) |
| | *Phellinus tabaquilio* | | GU461994 | | | Larsson et al., (2006) |
| | *Phellinus texanus* | | JQ087921 | | | Larsson et al., (2006) |
| | *Phlebia brevispora* | | JGI 64423 | JGI 64423 | JGI 64423 | Kuuskeri et al., (2015) |
| | *Phlebia georigica* | | DQ873645 | DQ873644 | | Kuuskeri et al., (2015) |
| | *Polyporus brumalis* | | JGI 265768 | JGI 265768 | JGI 265768 | Parrent et al., (2009) |
| | *Pordaedalea niemelaei* | | JGI 333975 | JGI 333975 | JGI 333975 | Larsson et al., (2006) |
| | *Punctularia strigosozonata* | | JGI 52407 | JGI 52407 | JGI 52407 | Sjokvist et al., (2012) |
| | *Ramaria rubella* | | JGI 196021 | JGI 196021 | JGI 196021 | Hobbie et al., (2001) |
| | *Repetobasidium conicum* | | DQ873647 | DQ873646 | | Larsson et al., (2006) |
| | *Repetobasidium mirificum* | | AY293208 | AY293155.1 | | Larsson et al., (2006) |
| | *Resinicium bicolor* | | AJ406483 | | | Larsson et al., (2006) |
| | *Resinicium bicolor* | | AY586709 | | | |
| | *Resinicium bicolor* | | AF518645 | AF518588.1 | | |
| | *Resinicium bicolor* | | | AF026615 | | |
| | *Resinicium bicolor* | | | DQ834914 | | |
| | *Resinicium bicolor* | | MF318936 | MF319009 | | |
| | *Resinicium bicolor* | | MF318935 | | | |
| | *Resinicium bicolor* | | MF318937 | | | |
| | *Resinicium chiricahuaense* | | DQ863692 | DQ834912 | | Larsson et al., (2006) |
| | *Resinicium friabile* | | DQ863690 | DQ834915 | | Larsson et al., (2006) |
| | *Resinicium furfuraceum* | | DQ863696 | DQ834913 | | Larsson et al., (2006) |
| | *Resinicium meridionale* | | AY293197 | AY293142 | | Larsson et al., (2006) |
| | *Resinicium meridionale* | | DQ863693 | | | |

**Table VIII. Continued.**

| Dataset | Taxon | LSU | SSU | *rpb2* | ITS | Trophic Mode Reference |
|---|---|---|---|---|---|---|
| HCD | *Resinicium meridionale* | | | DQ834910 | | Larsson et al., (2006) |
| | *Resinicium pinicola* | | KJ668316 | | | Larsson et al., (2006) |
| | *Resinicium saccharicola* | | DQ863691 | DQ834916 | | Larsson et al., (2006) |
| | *Resinicium* sp. | | | DQ834917 | | Larsson et al., (2006) |
| | *Rickenella fibula* | | MF318973 | MF319026 | | Larsson et al., (2006) |
| | *Rickenella fibula* | | MF318941 | MF319012 | MF288865 | |
| | *Rickenella fibula* | | MF318939 | MF319010 | MF288863 | |
| | *Rickenella fibula* | | MF318945 | MF319028 | | |
| | *Rickenella fibula* | | JGI 333301 | JGI 333301 | JGI 333301 | |
| | *Rickenella fibula* | | MF318938 | MF319023 | MF288876 | |
| | *Rickenella fibula* | | MF318944 | MF319015 | MF288868 | |
| | *Rickenella fibula* | | MF318955 | MF319029 | MF288878 | |
| | *Rickenella fibula* | | MF318952 | MF319020 | MF288873 | |
| | *Rickenella fibula* | | MF318972 | MF319019 | MF288875 | |
| | *Rickenella fibula* | | MF318942 | MF319013 | MF288866 | |
| | *Rickenella fibula* | | MF318951 | MF319018 | MF288872 | |
| | *Rickenella fibula* | | MF318950 | MF319017 | MF288871 | |
| | *Rickenella fibula* | | MF318948 | MF319025 | | |
| | *Rickenella fibula* | | MF318954 | MF319022 | MF288874 | |
| | *Rickenella fibula* | | MF318949 | MF319027 | | |
| | *Rickenella fibula* | | MF318953 | MF319021 | | |
| | *Rickenella fibula* | | AY700195 | AY771599 | DQ408115 | |
| | *Rickenella fibula* | | MF318943 | MF319014 | MF288867 | |
| | *Rickenella fibula* | | MF318957 | MF319024 | MF288877 | |
| | *Rickenella fibula* | | MF318947 | MF319016 | MF288869 | |
| | *Rickenella fibula* | | MF318940 | MF319011 | MF288864 | |
| | *Rickenella mellea* | | JGI 334780 | JGI 334780 | JGI 334780 | Tedersoo and Smith, (2013) |
| | *Rickenella minuta* | | MF318965 | | MF288879 | |
| | *Rickenella minuta* | | MF318967 | | MF288880 | |
| | *Rickenella minuta* | | MF318966 | MF319032 | MF288881 | |
| | *Rickenella minuta* | | MF318959 | MF319031 | MF288882 | |
| | *Rickenella minuta* | | MF318958 | MF319034 | MF288883 | |
| | *Rickenella minuta* | | MF318956 | MF319030 | | |

**Table VIII. Continued.**

| Dataset | Taxon | LSU | SSU | *rpb2* | ITS | Trophic Mode Reference |
|---|---|---|---|---|---|---|
| HCD | *Rickenella minuta* | | MF318962 | MF319036 | MF288884 | Tedersoo and Smith, (2013) |
| | *Rickenella minuta* | | MF318969 | MF319038 | MF288885 | |
| | *Rickenella minuta* | | MF318960 | MF319035 | | |
| | *Rickenella minuta* | | MF318961 | MF319037 | MF288887 | |
| | *Rickenella minuta* | | MF318963 | MF319040 | MF288886 | |
| | *Rickenella minuta* | | MF318970 | | MF288889 | |
| | *Rickenella minuta* | | MF318964 | | MF288888 | |
| | *Rickenella* sp. | | MF318975 | MF319041 | | Larsson et al., (2006) |
| | *Rickenella swartzii* | | MF318976 | MF319042 | | Larsson et al., (2006) |
| | *Rickenella swartzii* | | MF318980 | MF319043 | | |
| | *Schizopora paradoxa* | | JGI 239088 | JGI 239088 | JGI 239088 | Larsson et al., (2006) |
| | *Skvortzovia furfurella* | | DQ873649 | | | Larsson et al., (2006) |
| | *Skvortzovia furfurella* | | DQ863695 | DQ834911 | | |
| | *Trichaptum abietinum* | | AF518659 | AF026585 | | Larsson et al., (2006) |
| | *Trichaptum abietinum* | | JGI 210203 | JGI 210203 | JGI 210203 | |
| | *Trichaptum abietinum* | | AJ406473 | | | |
| | *Tsugacorticium kenaicum* | | JN368221 | JN368234 | | Nakasone and Jr, (2012) |
| | *Tubulicrinis gracillimus* | | AF518661 | AF518592 | | Larsson et al., (2006) |
| | *Tubulicrinis subulatus* | | AJ406448 | | | Larsson et al., (2006) |
| | *Tubulicrinis subulatus* | | AY586722 | | | |
| | *Xylodon* sp. | | JN368220 | JN368233 | | Author determined |
| RCD | *Alloclavaria purpurea* | MF318895 | MF318986 | | | |
| | *Alloclavaria purpurea* | MF318893 | MF318988 | | | |
| | *Alloclavaria purpurea* | MF318904 | MF318994 | | | |
| | *Alloclavaria purpurea* | MF318905 | MF318995 | | | |
| | *Alloclavaria purpurea* | MF318894 | MF318987 | | | |
| | *Alloclavaria purpurea* | DQ457657 | DQ437679 | | | |
| | *Alloclavaria purpurea* | DQ284900 | | | | |
| | *Alloclavaria purpurea* | DQ284899 | | | | |
| | *Alloclavaria purpurea* | MF318903 | | | | |
| | *Atheloderma mirabile* | DQ873592 | | | | |

**Table VIII. Continued.**

| Dataset | Taxon | LSU | SSU | *rpb2* | ITS | Trophic Mode Reference |
|---|---|---|---|---|---|---|
| RCD | *Athelopsis lunata* | DQ873593 | | | | |
| | *Blasiphalia pseudogrisella* | MF318896 | | | | |
| | *Blasiphalia pseudogrisella* | MF318899 | MF318990 | | | |
| | *Blasiphalia pseudogrisella* | MF318898 | MF318989 | | | |
| | *Blasiphalia pseudogrisella* | MF318897 | | | | |
| | *Cantharellopsis prescotii* | MF318900 | MF318991 | | | |
| | *Cantharellopsis prescotii* | MF318902 | | | | |
| | *Cantharellopsis prescotii* | MF318901 | MF318992 | | | |
| | *Cantherellopsis prescotii* | AF261461 | | | | |
| | *Contumyces rosellus* | MF318912 | MF319001 | MF288859 | | |
| | *Contumyces vesuvianus* | MF318913 | MF319002 | MF288860 | | |
| | *Cotylidia carpatica* | MF318914 | | | | |
| | *Cotylidia aurantiaca* var. *alba* | AF261458 | | | | |
| | *Cotylidia diaphana* | MF318915 | | | | |
| | *Cotylidia pannosa* | MF318916 | MF319000 | | | |
| | *Cotylidia* sp. | AY629317 | AY705958 | | | |
| | *Cotylidia undulata* | MF318918 | | | | |
| | *Cotylidia undulata* | MF318917 | | | | |
| | *Cotylidia undulata* | MF318920 | | | | |
| | *Gerronema albidum* | MF318923 | | | | |
| | *Gerronema albidum* | MF318924 | | | | |
| | *Gerronema marchantiae* | U66432 | | | | |
| | *Globulicium hiemale* | DQ873595 | DQ873594 | | | |
| | *Globulicium hiemale* | EU118626 | EU118626 | | | |
| | *Leifa flabelliradiata* | DQ873635 | | | | |
| | *Loreleia marchantiae* | MF318926 | | | | |
| | *Muscinupta laevis* | MF318928 | | MF288862 | | |
| | *Muscinupta laevis* | MF318921 | MF319004 | MF288861 | | |
| | *Muscinupta laevis* | AY745705 | | | | |
| | *Muscinupta laevis* | MF318922 | | | | |
| | *Muscinupta laevis* | | AY752973 | | | |
| | *Mycoacia pinicola* | DQ873637 | DQ873636 | | | |
| | *Omphalina brevibasidiata* | U66441 | | | | |
| | *Omphalina rosella* | U66452 | | | | |
| | *Oxyporus corticola* | | JF972589 | | | |

**Table VIII. Continued.**

| Dataset | Taxon | LSU | SSU | *rpb2* | ITS | Trophic Mode Reference |
|---|---|---|---|---|---|---|
| RCD | *Oxyporus corticola* | | JF972586 | | | |
| | *Oxyporus corticola* | DQ873641 | DQ873640 | | | |
| | *Oxyporus populinus* | AJ406467 | | | | |
| | *Oxyporus* sp. | AF287877 | AF026616 | | | |
| | *Peniophorella praetermissa* | AJ406482 | | | | |
| | *Peniophorella praetermissa* | KJ668375 | | | | |
| | *Peniophorella praetermissa* | AY700185 | AY707094 | AY787221 | | |
| | *Peniophorella praetermissa* | AY586671 | | | | |
| | *Peniophorella praetermissa* | | DQ873596 | | | |
| | *Peniophorella rude* | KJ668350 | | | | |
| | *Phlebia georigica* | DQ873645 | DQ873644 | | | |
| | *Repetobasidium conicum* | DQ873647 | DQ873646 | | | |
| | *Repetobasidium mirificum* | AY293208 | AY293155.1 | | | |
| | *Resinicium bicolor* | AY586709 | | | | |
| | *Resinicium bicolor* | MF318936 | MF319009 | | | |
| | *Resinicium bicolor* | MF318935 | | | | |
| | *Resinicium bicolor* | MF318937 | | | | |
| | *Resinicium bicolor* | AJ406483 | | | | |
| | *Resinicium bicolor* | | DQ834914 | | | |
| | *Resinicium bicolor* | AF518645 | AF518588.1 | | | |
| | *Resinicium bicolor* | | AF026615 | | | |
| | *Resinicium chiricahuaense* | DQ863692 | DQ834912 | | | |
| | *Resinicium friabile* | DQ863690 | DQ834915 | | | |
| | *Resinicium furfuraceum* | DQ863696 | DQ834913 | | | |
| | *Resinicium meridionale* | AY293197 | AY293142 | | | |
| | *Resinicium meridionale* | DQ863693 | | | | |
| | *Resinicium meridionale* | | DQ974210 | | | |
| | *Resinicium meridionale* | | DQ834910 | | | |
| | *Resinicium monticola* | DQ863697 | | | | |
| | *Resinicium mutabile* | DQ863699 | | | | |
| | *Resinicium pinicola* | KJ668316 | | | | |
| | *Resinicium rimulosum* | KJ668315 | | | | |
| | *Resinicium saccharicola* | DQ863691 | DQ834916 | | | |
| | *Resinicium* sp. | | DQ834917 | | | |
| | *Rickenella fibula* | AY700195 | AY771599 | DQ408115 | | |

**Table VIII. Continued.**

| Dataset | Taxon | LSU | SSU | *rpb2* | ITS | Trophic Mode Reference |
|---|---|---|---|---|---|---|
| RCD | *Rickenella fibula* | | KJ425347 | | | |
| | *Rickenella fibula* | MF318948 | MF319025 | | | |
| | *Rickenella fibula* | MF318953 | MF319021 | | | |
| | *Rickenella fibula* | MF318946 | | | | |
| | *Rickenella fibula* | MF318954 | MF319022 | MF288874 | | |
| | *Rickenella fibula* | MF318951 | MF319018 | MF288872 | | |
| | *Rickenella fibula* | MF318950 | MF319017 | MF288871 | | |
| | *Rickenella fibula* | AM946463 | | | | |
| | *Rickenella fibula* | MF318949 | MF319027 | | | |
| | *Rickenella fibula* | MF318957 | | MF288877 | | |
| | *Rickenella fibula* | MF318943 | MF319014 | MF288867 | | |
| | *Rickenella fibula* | AY586710 | | | | |
| | *Rickenella fibula* | MF318947 | MF319016 | MF288869 | | |
| | *Rickenella fibula* | MF318945 | MF319028 | | | |
| | *Rickenella fibula* | JGI 333301 | JGI 333301 | JGI 333301 | | |
| | *Rickenella fibula* | MF318974 | | | | |
| | *Rickenella fibula* | MF318938 | MF319023 | MF288876 | | |
| | *Rickenella fibula* | MF318944 | MF319015 | MF288868 | | |
| | *Rickenella fibula* | MF318941 | MF319012 | MF288865 | | |
| | *Rickenella fibula* | MF318955 | MF319029 | MF288878 | | |
| | *Rickenella fibula* | MF318952 | MF319020 | MF288873 | | |
| | *Rickenella fibula* | MF318972 | MF319019 | MF288875 | | |
| | *Rickenella fibula* | MF318942 | MF319013 | MF288866 | | |
| | *Rickenella fibula* | MF318939 | MF319010 | MF288863 | | |
| | *Rickenella fibula* | MF318973 | MF319026 | | | |
| | *Rickenella fibula* | | KJ425346 | | | |
| | *Rickenella fibula* | MF318940 | MF319011 | MF288864 | | |
| | *Rickenella mellea* | JGI 334780 | JGI 334780 | JGI 334780 | | |
| | *Rickenella minuta* | MF318965 | | MF288879 | | |
| | *Rickenella minuta* | MF318967 | | MF288880 | | |
| | *Rickenella minuta* | MF318966 | MF319032 | MF288881 | | |
| | *Rickenella minuta* | MF318959 | MF319031 | MF288882 | | |
| | *Rickenella minuta* | MF318958 | MF319034 | MF288883 | | |
| | *Rickenella minuta* | MF318956 | MF319030 | | | |
| | *Rickenella minuta* | MF318971 | | | | |

**Table VIII. Continued.**

| Dataset | Taxon | LSU | SSU | *rpb2* | ITS | Trophic Mode Reference |
|---|---|---|---|---|---|---|
| RCD | *Rickenella minuta* | MF318962 | MF319036 | MF288884 | | |
| | *Rickenella minuta* | MF318969 | MF319038 | MF288885 | | |
| | *Rickenella minuta* | MF318960 | MF319035 | | | |
| | *Rickenella minuta* | MF318961 | MF319037 | MF288887 | | |
| | *Rickenella minuta* | MF318963 | MF319040 | MF288886 | | |
| | *Rickenella minuta* | MF318970 | | MF288889 | | |
| | *Rickenella minuta* | MF318964 | | MF288888 | | |
| | *Rickenella setipes* | MF318968 | | | | |
| | *Rickenella* sp. | MF318975 | MF319041 | | | |
| | *Rickenella swartzii* | MF318976 | MF319042 | | | |
| | *Rickenella swartzii* | MF318980 | MF319043 | | | |
| | *Rickenella swartzii* | MF318979 | | | | |
| | *Rickenella swartzii* | MF318978 | | | | |
| | *Rickenella swartzii* | MF318977 | | | | |
| | *Rigidoporus populinus* | MF318981 | | | | |
| | *Rigidoporus populinus* | MF318982 | | | | |
| | *Sidera lenis* | MF318983 | | | | |
| | *Sidera lowei* | FN907919 | | | | |
| | *Sidera lowei* | FN907917 | | | | |
| | *Sidera* sp. | JN368214 | | | | |
| | *Sidera vulgaris* | FN907922 | | | | |
| | *Sidera vulgaris* | FN907918 | | | | |
| | *Skvortzovia furfurella* | DQ863695 | DQ834911 | | | |
| | *Skvortzovia furfurella* | DQ873649 | | | | |
| | *Trichaptum abietinum* | JGI 210203 | JGI 210203 | JGI 210203 | | |
| | *Trichaptum abietinum* | AF518659 | AF026585 | | | |
| | *Trichaptum abietinum* | AJ406473 | | | | |
| | *Trichaptum fuscoviolaceum* | MF318985 | | | | |
| | *Trichaptum fuscoviolaceum* | MF318984 | | | | |
| RID | *Blasiphalia pseudogrisella* | | | | U66437 | |
| | *Contumyces rosella* | | | | U66452 | |
| | *Dicranum scoparium* gametophyte | | | | - | |
| | *Globulicium hiemale* | | | | DQ873595 | |
| | *Hypnum* sp. gametophyte | | | | - | |

**Table VIII. Continued.**

| Dataset | Taxon | LSU | SSU | *rpb2* | ITS | Trophic Mode Reference |
|---|---|---|---|---|---|---|
| RID | *Nothofagus* ECM root tips | | | | JX316244 | |
| | *Nothofagus* ECM root tips | | | | KC759484 | |
| | *Nothofagus* ECM root tips | | | | JX316513 | |
| | *Rickenella fibula* | | | | MF319083 | |
| | *Rickenella fibula* | | | | MF319090 | |
| | *Rickenella fibula* | | | | MF319091 | |
| | *Rickenella fibula* | | | | MF319087 | |
| | *Rickenella fibula* | | | | DQ241782 | |
| | *Rickenella fibula* | | | | MF319096 | |
| | *Rickenella fibula* | | | | GU234163 | |
| | *Rickenella fibula* | | | | MF319092 | |
| | *Rickenella fibula* | | | | MF319084 | |
| | *Rickenella fibula* | | | | MF319081 | |
| | *Rickenella fibula* | | | | MF319094 | |
| | *Rickenella fibula* | | | | MF319082 | |
| | *Rickenella fibula* | | | | JGI 333301 | |
| | *Rickenella fibula* | | | | MF319086 | |
| | *Rickenella fibula* | | | | MF319080 | |
| | *Rickenella fibula* | | | | JQ694100 | |
| | *Rickenella indica* | | | | KJ187769 | |
| | *Rickenella mellea* | | | | JGI 334780 | |
| | *Rickenella mellea* | | | | U66438 | |
| | *Rickenella mellea* | | | | KR606033 | |
| | *Rickenella minuta* | | | | MF319107 | |
| | *Rickenella minuta* | | | | MF319099 | |
| | *Rickenella minuta* | | | | MF319104 | |
| | *Rickenella minuta* | | | | MF319098 | |
| | *Rickenella minuta* | | | | MF319101 | |
| | *Rickenella minuta* | | | | MF319102 | |
| | *Rickenella minuta* | | | | MF319103 | |
| | *Rickenella minuta* | | | | MF319105 | |
| | *Rickenella minuta* | | | | MF319100 | |
| | *Rickenella minuta* | | | | MF319106 | |
| | *Rickenella minuta* | | | | MF319108 | |
| | *Rickenella minuta* | | | | MF319097 | |

**Table VIII. Continued.**

| Dataset | Taxon | LSU | SSU | *rpb2* | ITS | Trophic Mode Reference |
|---|---|---|---|---|---|---|
| RID | *Rickenella minuta* | | | | KY352655 | |
| | *Rickenella minuta* | | | | KY352654 | |
| | *Rickenella minuta* | | | | KY559327 | |
| | *Rickenella setipes* | | | | GU234136 | |
| | *Rickenella setipes* | | | | MF319111 | |
| | *Rickenella setipes* | | | | MF319109 | |
| | *Rickenella* sp. | | | | KC759484 | |
| | *Rickenella swartzii* | | | | MF319113 | |
| | *Rickenella swartzii* | | | | MF319112 | |
| | *Rickenella swartzii* | | | | MF319085 | |
| | *Rickenella swartzii* | | | | MF319114 | |

**Table IX. Comparison stable isotope data from other sources.**

| Taxa | $\delta^{15}N$ (‰) | $\delta^{13}C$ (‰) | Trophic Mode | Reference |
|---|---|---|---|---|
| *Camarophyllopsis atropuncta* | -25.64 | 11.18 | NE-NS | Birkebak et al., (2013) |
| *Camarophyllopsis foetens* | -23.77 | 5.93 | NE-NS | |
| *Clavaria acuta* | -22.57 | 9.22 | NE-NS | |
| *Clavaria* aff. *argillacea* | -23.14 | 12.35 | NE-NS | |
| *Clavaria fragilis* | -23.79 | 13.16 | NE-NS | |
| *Clavaria fragilis* | -26.42 | 15.24 | NE-NS | |
| *Clavaria fragilis* | -23.34 | 14.08 | NE-NS | |
| *Clavaria zollinger* | -26.37 | 12.73 | NE-NS | |
| *Clavaria zollinger* | -25.44 | 12.32 | NE-NS | |
| *Clavaria zollinger* | -25.67 | 13.25 | NE-NS | |
| *Clavulinopsis sulcata* | -29.80 | 15.72 | NE-NS | |
| *Clavuniopsis aurantiocinnabarina* | -28.09 | 16.82 | NE-NS | |
| *Ramariopsis corniculata* | -25.98 | 13.82 | NE-NS | |
| *Ramariopsis fusiformis* | -26.32 | 16.02 | NE-NS | |
| *Ramariopsis fusiformis* | -27.38 | 20.54 | NE-NS | |
| *Ramariopsis fusiformis* | -24.51 | 14.30 | NE-NS | |
| *Ramariopsis kunzei* | -24.89 | 13.86 | NE-NS | |
| *Ramariopsis kunzei* | -24.19 | 14.61 | NE-NS | |
| *Ramariopsis kunzei* | -25.94 | 13.00 | NE-NS | |
| *Ramariopsis laeticolor* | -26.16 | 11.45 | NE-NS | |
| *Agaricales* sp. | -2.4 | -20 | SAP | Mayor et al., (2009) |
| *Agaricus praeclaresquamosus* | -0.1 | -23.2 | SAP | |
| *Agaricus praeclaresquamous* | 6.7 | -19.6 | SAP | |
| *Agaricus silvaticus* | 5.9 | -22 | SAP | |
| *Agaricus silvicola* | 1.1 | -23.6 | SAP | |
| *Agaricus silvicola* | 5.2 | -20.4 | SAP | |
| *Agaricus* sp. | 3.2 | -22.8 | SAP | |
| *Agaricus* sp. | 3.1 | -21.4 | SAP | |
| *Agaricus subrutilescens* | 11.4 | -25 | SAP | |
| *Agaricus subrutilescens* | -0.4 | -23.5 | SAP | |
| *Albatrellus avellaneus* | 4.3 | -25.1 | ECM | |
| *Albatrellus ovinus* | 6.1 | -25.9 | ECM | |
| *Amanita abrupta* | -1.7 | -25 | ECM | |
| *Amanita* aff. *ovalispora* | 1.5 | -28.3 | ECM | |
| *Amanita angustilamellata* | 3.2 | -26.8 | ECM | |

**Table IX. Continued.**

| Taxa | $\delta^{15}N$ (‰) | $\delta^{13}C$ (‰) | Trophic Mode | Reference |
|---|---|---|---|---|
| *Amanita angustilamellata* | 6.6 | -24.8 | ECM | Mayor et al., (2009) |
| *Amanita citrina* | 1.7 | -26.7 | ECM | |
| *Amanita citrina* | 1.3 | -23.1 | ECM | |
| *Amanita constricta* | 1.8 | -25.5 | ECM | |
| *Amanita esculenta* | 2.4 | -23.4 | ECM | |
| *Amanita franchetii* | 1.1 | -25.4 | ECM | |
| *Amanita fulva* | 2.1 | -26.3 | ECM | |
| *Amanita fulva* | 1.5 | -25.6 | ECM | |
| *Amanita longistriata* | 6.3 | -25 | ECM | |
| *Amanita muscaria* | 5.5 | -26.6 | ECM | |
| *Amanita muscaria* | 7.9 | -26.3 | ECM | |
| *Amanita muscaria* | 1.2 | -25.5 | ECM | |
| *Amanita muscaria* | 3.5 | -24.6 | ECM | |
| *Amanita neo-ovoidea* | 5.2 | -24 | ECM | |
| *Amanita pachycolea* | 1.5 | -25.8 | ECM | |
| *Amanita pantherina* | 5.6 | -23.7 | ECM | |
| *Amanita pantherina* | -1.3 | -24.5 | ECM | |
| *Amanita pantherina* | 7.3 | -24.4 | ECM | |
| *Amanita porphyria* | 2.1 | -24.8 | ECM | |
| *Amanita porphyria* | 2.3 | -23.3 | ECM | |
| *Amanita rubescens* | 4.3 | -25.3 | ECM | |
| *Amanita rubescens* | 1 | -26.2 | ECM | |
| *Amanita rubescens* | 2.5 | -22.9 | ECM | |
| *Amanita rubrovolvata* | 3.6 | -24.3 | ECM | |
| *Amanita* sp. | 1.7 | -24.4 | ECM | |
| *Amanita* sp. | 1.7 | -25.4 | ECM | |
| *Amanita* sp. | 6.8 | -25.4 | ECM | |
| *Amanita* sp. | 10.2 | -27.2 | ECM | |
| *Amanita vaginata* | -2.4 | -27 | ECM | |
| *Amanita vaginata* | 0.4 | -27.8 | ECM | |
| *Amanita virosa* | 4.1 | -25.1 | ECM | |
| *Amauroderma gusmanianum* | 0.6 | -24.5 | SAP | |
| *Amauroderma gusmanianum* | 0.4 | -24.4 | SAP | |
| *Amauroderma gusmanianum* | 1 | -23.9 | SAP | |
| *Aphyllophorales* sp. | 6.5 | -20.8 | SAP | |
| *Aphyllophorales* sp. | -2.6 | -21 | SAP | |

**Table IX. Continued.**

| Taxa | $\delta^{15}N$ (‰) | $\delta^{13}C$ (‰) | Trophic Mode | Reference |
|---|---|---|---|---|
| *Armillaria albolanaripes* | 1 | -21.5 | SAP | Mayor et al., (2009) |
| *Armillaria borealis* | -2 | -23.8 | SAP | |
| *Armillaria gallica* | -0.9 | -20.2 | SAP | |
| *Armillaria gallica* | 0.6 | -20.9 | SAP | |
| *Armillaria nabsnona* | 0.6 | -23.2 | SAP | |
| *Armillaria ostoyae* | -0.6 | -22.2 | SAP | |
| *Armillaria straminea* var. *americana* | 3.4 | -22.1 | SAP | |
| *Armillariella mellea* | -0.1 | -22.2 | SAP | |
| *Ascocoryne sarcoides* | -5.2 | -22.8 | SAP | |
| *Aureoboletus subvirens* | 5.4 | -25.6 | ECM | |
| *Aureoboletus thibetanus* | 2.1 | -27.5 | ECM | |
| *Auriscalpium vulgare* | -3 | -22.2 | SAP | |
| *Baeospora myosura* | -1.9 | -21 | SAP | |
| *Boletaceae* sp. | 4.3 | -25.3 | ECM | |
| *Boletaceae* sp. | 0 | -24.5 | ECM | |
| *Boletaceae* sp. | 5.7 | -25.8 | ECM | |
| *Boletellus 76xiguous Henkel & Fulgenzi* | 4.3 | -25.3 | ECM | |
| *Boletellus russellii* | 2.7 | -25.2 | ECM | |
| *Boletopsis leucomelaena* | 12.3 | -25.5 | ECM | |
| *Boletus aestivalis* | 5.7 | -23.9 | ECM | |
| *Boletus chrysenteron* | 4.9 | -25.6 | ECM | |
| *Boletus coniferarum* | 11 | -25.3 | ECM | |
| *Boletus edulis* | 8.5 | -24.6 | ECM | |
| *Boletus edulis* | 3.8 | -25.9 | ECM | |
| *Boletus edulis* | 3.8 | -27 | ECM | |
| *Boletus edulis* | 3.7 | -23.8 | ECM | |
| *Boletus mirabilis* | 3.7 | -26.4 | ECM | |
| *Boletus pinophilus* | 17.5 | -24.7 | ECM | |
| *Boletus pseudocalopus* | -0.3 | -24 | ECM | |
| *Boletus pseudocalopus* | 1.5 | -23.7 | ECM | |
| *Boletus subvelutipes* | 4.7 | -24 | ECM | |
| *Boletus truncatus* | 9.4 | -25 | ECM | |
| *Boletus zelleri* | 5.9 | -26.8 | ECM | |
| *Boletus zelleri Murrill* | 4.9 | -24.6 | ECM | |
| *Boletus zoelleri* | 2.6 | -25 | ECM | |
| *Bondarzewia montana* | 1.8 | -22.1 | SAP | |

**Table IX. Continued.**

| Taxa | $\delta^{15}N$ (‰) | $\delta^{13}C$ (‰) | Trophic Mode | Reference |
|---|---|---|---|---|
| *Calocera viscosa* | -2.3 | -21.5 | SAP | Mayor et al., (2009) |
| *Calvatia craniiformis* | 2.4 | -23.3 | SAP | |
| *Calvatia craniiformis* | -1.5 | -23.4 | SAP | |
| *Camarophyllopsis atropuncta* | 11.18 | -25.64 | ECM | |
| *Camarophyllopsis foetens* | 5.93 | -23.77 | ECM | |
| *Camarophyllopsis foetens* | 6.14 | -25.59 | ECM | |
| *Cantharellus atratus Corner* | 5.7 | -26.3 | ECM | |
| *Cantharellus cibarius* | 4 | -25.5 | ECM | |
| *Cantharellus cibarius* | 5.3 | -26.4 | ECM | |
| *Cantharellus cibarius* | 5.3 | -26.3 | ECM | |
| *Cantharellus cibarius* | 0.7 | -26.6 | ECM | |
| *Cantharellus cibarius1* | 7.7 | -25.2 | ECM | |
| *Cantharellus formosus* | 5 | -26.5 | ECM | |
| *Cantharellus formosus* | 3.2 | -25.8 | ECM | |
| *Cantharellus lutescens* | 2.6 | -25 | ECM | |
| *Cantharellus tubaeformis* | 1.5 | -25.2 | ECM | |
| *Cantharellus tubiformis* | 0.9 | -25.9 | ECM | |
| *Cantherellus guianensis* | 6.7 | -26 | ECM | |
| *Cantherellus pleurotoides* | 2.8 | -25.24 | ECM | |
| *Cantherellus pleurotoides* | 0.48 | -25.919 | ECM | |
| *Cantherellus pleurotoides* | 1 | -25 | ECM | |
| *Catathelasma ventricosum* | 12.9 | -23.5 | ECM | |
| *Chalciporus piperatus* | 8.3 | -22.3 | ECM | |
| *Chalciporus piperatus* | 9.3 | -22 | ECM | |
| *Chalciporus piperatus* | 7.9 | -22.2 | ECM | |
| *Chroogomphus rutilus* | 3.8 | -26 | ECM | |
| *Chroogomphus rutilus* | 4.2 | -25.3 | ECM | |
| *Chroogomphus tomentosus* | 4.1 | -24.8 | ECM | |
| *Chroogomphus tomentosus* | 4.6 | -25.4 | ECM | |
| *Chroogomphus tomentosus* | -3.5 | -24.7 | ECM | |
| *Chroogomphus tomentosus* | -4.4 | -26.1 | ECM | |
| *Chroogomphus tomentosus* | -0.7 | -26 | ECM | |
| *Chrysomphalina aurantiaca* | -1.2 | -23.7 | SAP | |
| *Clavaria acuta* | 9.22 | -22.57 | ECM | |
| *Clavaria* aff. *Argillacea* | 12.35 | -23.14 | ECM | |
| *Clavaria fragilis* | 13.16 | -23.79 | ECM | |

**Table IX. Continued.**

| Taxa | $\delta^{15}N$ (‰) | $\delta^{13}C$ (‰) | Trophic Mode | Reference |
|---|---|---|---|---|
| *Clavaria fragilis* | 15.24 | -26.42 | ECM | Mayor et al., (2009) |
| *Clavaria fragilis* | 14.08 | -23.34 | ECM | |
| *Clavaria zollinger* | 12.73 | -26.37 | ECM | |
| *Clavaria zollinger* | 12.32 | -25.44 | ECM | |
| *Clavaria zollinger* | 12.32 | -26.09 | ECM | |
| *Clavaria zollinger* | 12.39 | -23.73 | ECM | |
| *Clavaria zollinger* | 13.25 | -25.67 | ECM | |
| *Clavicorona pyxidata* | 0 | -22.4 | SAP | |
| *Clavicorona pyxidata* | 5.2 | -21.3 | SAP | |
| *Claviocorona pyxidata* | 2 | -22 | SAP | |
| *Clavulina* "coral tiny wood" | 3 | -24.7 | ECM | |
| *Clavulina* "kunmudlutse grey" | 9.7 | -24.9 | ECM | |
| *Clavulina caespitosa* | 5.8 | -26.2 | ECM | |
| *Clavulina caespitosa* | 7.4 | -24.8 | ECM | |
| *Clavulina caespitosa* | 3.3 | -25.9 | ECM | |
| *Clavulina cristata* | 1.6 | -25.5 | ECM | |
| *Clavulina cristata* | 2 | -24.3 | ECM | |
| *Clavulina cristata* | 3.5 | -26.4 | ECM | |
| *Clavulina humicola* | 4.8 | -25.1 | ECM | |
| *Clavulina rugosa* | 3.4 | -26.4 | ECM | |
| *Clavulinopsis sulcata* | 15.72 | -29.8 | ECM | |
| *Clavuniopsis aurantiocinnabarina* | 16.82 | -28.09 | ECM | |
| *Clitocybe clavipes* | -2 | -23.6 | SAP | |
| *Clitocybe clavipes* | -2.1 | -25.6 | SAP | |
| *Clitocybe dealbata* | 1.2 | -22.2 | SAP | |
| *Clitocybe gibba* | -0.6 | -23.8 | SAP | |
| *Clitocybe subconnexa* | 1 | -21.8 | SAP | |
| *Clitocybe subditopoda* | 0.5 | -23.5 | SAP | |
| *Clitopilus prunulus* | 6.7 | -22.9 | SAP | |
| *Clitopilus prunulus* | 3.8 | -22.4 | SAP | |
| *Clytocibe clavipes* | 0.3 | -23 | SAP | |
| *Clytocibe vibecina* | 0.8 | -23.1 | SAP | |
| *Coliatia* sp. | -1.4 | -24 | SAP | |
| *Collybia butyracea* | -0.5 | -22.9 | SAP | |
| *Collybia dryophila* | -2.2 | -23.9 | SAP | |
| *Collybia dryophila* | -0.2 | -22.3 | SAP | |

**Table IX. Continued.**

| Taxa | $\delta^{15}N$ (‰) | $\delta^{13}C$ (‰) | Trophic Mode | Reference |
|---|---|---|---|---|
| *Collybia laccata* | 1.77 | -26.9 | SAP | Mayor et al., (2009) |
| *Collybia* sp. | 1 | -22.4 | SAP | |
| *Collybia* sp. | -3.3 | -24.2 | SAP | |
| *Cookiena* "on-wood" | 0.6 | -24.9 | SAP | |
| *Coprinus atramentarius* | 0.4 | -22.6 | SAP | |
| *Coprinus comatus* | -0.3 | -23.6 | SAP | |
| *Coprinus disseminatus* | 0.8 | -23.5 | SAP | |
| *Coprinus radians* | 4.5 | -22 | SAP | |
| *Coprinus* sp. | 0.6 | -23.1 | SAP | |
| *Coprinus* sp. | 4.5 | -23.8 | SAP | |
| *Cortinariaceae* sp. | 8.9 | -24.8 | ECM | |
| *Cortinariaceae* sp. | 6.8 | -27 | ECM | |
| *Cortinarius acutus* | 4 | -25.5 | ECM | |
| *Cortinarius* aff. *Violaceous* | 7.9 | -27 | ECM | |
| *Cortinarius albo-violaceus* | 10.7 | -28.4 | ECM | |
| *Cortinarius alboviolaceus* | 10.4 | -28.1 | ECM | |
| *Cortinarius anomalus* | 7.4 | -26.8 | ECM | |
| *Cortinarius armeniacus* | 7.2 | -24.5 | ECM | |
| *Cortinarius armeniacus* | 5.4 | -25.1 | ECM | |
| *Cortinarius armillatus* | 9.2 | -26.9 | ECM | |
| *Cortinarius armillatus* | 9.1 | -27.5 | ECM | |
| *Cortinarius bataillei* | 3.1 | -25.3 | ECM | |
| *Cortinarius biformis* | 8.3 | -25.2 | ECM | |
| *Cortinarius bolaris* | 8.8 | -27 | ECM | |
| *Cortinarius bolaris* | 6.3 | -25.9 | ECM | |
| *Cortinarius brunneus* | 5.8 | -26.1 | ECM | |
| *Cortinarius brunneus* | 5.6 | -25.3 | ECM | |
| *Cortinarius cacao-color* | 5.9 | -25 | ECM | |
| *Cortinarius cacao-color* | 6.7 | -25 | ECM | |
| *Cortinarius calochrous* | 5.3 | -24.8 | ECM | |
| *Cortinarius calopus* | 5.8 | -25 | ECM | |
| *Cortinarius camphoratus* | 12.3 | -25.6 | ECM | |
| *Cortinarius camphoratus* | 7.6 | -23.7 | ECM | |
| *Cortinarius cinnamomeoluteus* | 5.3 | -26.9 | ECM | |
| *Cortinarius clandestinus* | 8.1 | -24.6 | ECM | |
| *Cortinarius crocea* | 4.3 | -29.2 | ECM | |

**Table IX. Continued.**

| Taxa | $\delta^{15}N$ (‰) | $\delta^{13}C$ (‰) | Trophic Mode | Reference |
|---|---|---|---|---|
| *Cortinarius delibutus* | 7.5 | -26.2 | ECM | Mayor et al., (2009) |
| *Cortinarius evernuis* | 7.7 | -24.8 | ECM | |
| *Cortinarius fennoscandicus* | -0.3 | -27.6 | ECM | |
| *Cortinarius gentilis* | 5.3 | -25.6 | ECM | |
| *Cortinarius gentilis* | 5.3 | -26.6 | ECM | |
| *Cortinarius gentilis* | 4.4 | -25.1 | ECM | |
| *Cortinarius hemitrichus* | 3.1 | -27.8 | ECM | |
| *Cortinarius laniger* | 10.1 | -26.4 | ECM | |
| *Cortinarius laniger* | 8.3 | -25.9 | ECM | |
| *Cortinarius laniger* | 8.2 | -25.4 | ECM | |
| *Cortinarius limonius* | 6.6 | -25.9 | ECM | |
| *Cortinarius malachius* | 10.5 | -24.8 | ECM | |
| *Cortinarius malachius* | 6.3 | -25.5 | ECM | |
| *Cortinarius malachius* | 4.9 | -25.5 | ECM | |
| *Cortinarius malicorius* | 9.4 | -26 | ECM | |
| *Cortinarius montanus* | 6.3 | -26.5 | ECM | |
| *Cortinarius montanus* | 5 | -26.2 | ECM | |
| *Cortinarius muscigenus* | 5 | -26.1 | ECM | |
| *Cortinarius muscigenus* | 6.7 | -26.6 | ECM | |
| *Cortinarius obtusus* | 4.9 | -26.5 | ECM | |
| *Cortinarius obtusus* | 6.9 | -25.9 | ECM | |
| *Cortinarius olympianus* | 6 | -24.7 | ECM | |
| *Cortinarius paleaceus* | 3.5 | -25.7 | ECM | |
| *Cortinarius paleaceus* | 2.6 | -25 | ECM | |
| *Cortinarius paragaudis* ssp. *paragaudis* | 15 | -25.8 | ECM | |
| *Cortinarius pholideus* | 5.7 | -27.6 | ECM | |
| *Cortinarius pholideus* | 5.4 | -26.3 | ECM | |
| *Cortinarius sanguineus* | 5.8 | -26.3 | ECM | |
| *Cortinarius saturninus* | 4.1 | -25.4 | ECM | |
| *Cortinarius scaurus* | 5.4 | -25.2 | ECM | |
| *Cortinarius semisanguineus* | 7.4 | -24.9 | ECM | |
| *Cortinarius semisanguineus* | 6.4 | -25.2 | ECM | |
| *Cortinarius semisanguineus* | 10.4 | -26.3 | ECM | |
| *Cortinarius septentrionalis* | 2.7 | -27.3 | ECM | |
| *Cortinarius* sp. | 5.1 | -23.8 | ECM | |
| *Cortinarius* sp. | 4.3 | -25.6 | ECM | |

**Table IX. Continued.**

| Taxa | $\delta^{15}N$ (‰) | $\delta^{13}C$ (‰) | Trophic Mode | Reference |
|---|---|---|---|---|
| *Cortinarius* sp. | 0.1 | -26.9 | ECM | Mayor et al., (2009) |
| *Cortinarius* sp. | 0 | -28.4 | ECM | |
| *Cortinarius* sp. | 12.7 | -26.8 | ECM | |
| *Cortinarius* sp. | 3.4 | -26.6 | ECM | |
| *Cortinarius spadiceus* | 5.7 | -24.5 | ECM | |
| *Cortinarius speciosissimus* | 6 | -25.8 | ECM | |
| *Cortinarius stillatitius* | 6.4 | -24.2 | ECM | |
| *Cortinarius strobilaceus* | 8.6 | -27 | ECM | |
| *Cortinarius strobilaceus* | 4.2 | -25.5 | ECM | |
| *Cortinarius subtortus* | 10.6 | -25.7 | ECM | |
| *Cortinarius talus* | 7 | -25.9 | ECM | |
| *Cortinarius torvus* | 5.8 | -24.3 | ECM | |
| *Cortinarius traganus* | 11.9 | -25.2 | ECM | |
| *Cortinarius traganus* | 9 | -25.6 | ECM | |
| *Cortinarius uliginosus* | 3.2 | -28 | ECM | |
| *Cortinarius vanduzerensis* | 8.9 | -24.7 | ECM | |
| *Cortinarius variosimilis* | -1.5 | -23.1 | ECM | |
| *Cortinarius vibratilis* | 6.2 | -25.1 | ECM | |
| *Cortinarius vibratilis* | 6.1 | -26.1 | ECM | |
| *Cortinarius.* Sp. | 0.2 | -22.6 | ECM | |
| *Cortinarius.* Sp. | 7.5 | -23.4 | ECM | |
| *Cortinarius.* Sp. | 9.7 | -24.4 | ECM | |
| *Craterellus* sp. | 6.3 | -25.6 | ECM | |
| *Craterellus tubaeformis* | 5 | -25.7 | ECM | |
| *Crepidotus cesatii* var. *cesatii* | -5.4 | -22.7 | SAP | |
| *Crepidotus* sp. | 1.5 | -22.1 | SAP | |
| *Crucibulum leave* | -3 | -21.3 | SAP | |
| *Cyptotrama chrysopeplum* | 0.5 | -23.1 | SAP | |
| *Cyptotrma chrysopeplum* | -0.1 | -19.3 | SAP | |
| *Cystoderma amianthinum* | -2.3 | -26.2 | SAP | |
| *Cystoderma amianthinum* | -2.8 | -24.3 | SAP | |
| *Cystoderma amiantinum* | 0.6 | -22.2 | SAP | |
| *Cystoderma caracharias* | 1 | -23.8 | SAP | |
| *Cystoderma granulosum* | -0.3 | -25.2 | SAP | |
| *Cystoderma granulosum* | -2.1 | -24.2 | SAP | |
| *Daedalea dickinsii* | 1.7 | -20.2 | SAP | |

**Table IX. Continued.**

| Taxa | $\delta^{15}N$ (‰) | $\delta^{13}C$ (‰) | Trophic Mode | Reference |
|---|---|---|---|---|
| *Dermocybe cinnamomea* | -5.2 | -26.7 | ECM | Mayor et al., (2009) |
| *Dermocybe* sp. | -0.7 | -23.1 | ECM | |
| *Earliella scabrosa* | -0.5 | -23.5 | SAP | |
| *Entoloma clypeatus* | -0.6 | -23.4 | ECM | |
| *Entoloma nitidum* | 2.2 | -23.5 | SAP | |
| *Entoloma* sp. | 9.3 | -22.8 | ECM | |
| *Entoloma* sp. | 11.1 | -23.7 | ECM | |
| *Favolaschia* sp. "bubble-wrap" | -0.8 | -23.9 | SAP | |
| *Flammulina velutipes* | -0.8 | -24 | SAP | |
| *Fomitopis canjanderi* | -2.5 | -23.4 | SAP | |
| *Fomitopsis feei* | -0.4 | -25.5 | SAP | |
| *Fomitopsis pinicola* | -1 | -20.7 | SAP | |
| *Fomitopsis pinicola* | -2.5 | -22.3 | SAP | |
| *Fomitopsis pinicola* | -3.6 | -21.8 | SAP | |
| *Fomitopsis pinicola* | -3.9 | -22.5 | SAP | |
| *Fomes fomentarius* | -0.2 | -22.7 | SAP | |
| *Fomes fomentarius* | -3.7 | -22.9 | SAP | |
| *Fomitopsis pinicola* | -4.1 | -22.8 | SAP | |
| *Fomitopsis pinicola* | -3.1 | -21.6 | SAP | |
| *Fomitopsis* sp. | -5.2 | -23.5 | SAP | |
| *Galerina heterocystis* | -1.9 | -27.6 | SAP | |
| *Ganoderma applanatum* | 3.3 | -21.8 | SAP | |
| *Ganoderma applanatum* | -4.2 | -22.8 | SAP | |
| *Ganoderma australe* | 1.8 | -27.4 | SAP | |
| *Ganoderma oregonense* | -2 | -21.2 | SAP | |
| *Ganoderma stipitatum* | 3.74 | -24.6 | SAP | |
| *Gomphidius glutinosus* | 6 | -26.4 | ECM | |
| *Gomphidius oregonensis* | 6.1 | -26.6 | ECM | |
| *Gomphidius roseus* | 6.7 | -24.9 | ECM | |
| *Gomphidius smithii* | 7.9 | -23.6 | ECM | |
| *Gomphidius subroseus* | 1.6 | -26.7 | ECM | |
| *Gomphidus glutinosus* | 5.5 | -24.6 | ECM | |
| *Gomphus clavatus* | 7.6 | -24.1 | ECM | |
| *Gomphus fujisanensis* | 9.8 | -24.6 | ECM | |
| *Grifola frondosa* | 2.5 | -21.8 | SAP | |
| *Gymnopilus bellulus* | 5 | -23.3 | SAP | |

**Table IX. Continued.**

| Taxa | $\delta^{15}N$ (‰) | $\delta^{13}C$ (‰) | Trophic Mode | Reference |
|---|---|---|---|---|
| *Gymnopilus junonius* | 4.3 | -24 | SAP | Mayor et al., (2009) |
| *Gymnopilus penetrans* | -1.7 | -22.4 | SAP | |
| *Gymnopilus penetrans* | -1.5 | -23.6 | SAP | |
| *Gymnopus acervatus* | 0.1 | -22.8 | SAP | |
| *Gymnopus acervatus* | 1 | -22.2 | SAP | |
| *Hebeloma crustuliniforme* | 2.1 | -27.1 | ECM | |
| *Hebeloma incarnatulum* | 1.8 | -24.6 | ECM | |
| *Hebeloma mesophaeum* | 8.4 | -26.8 | ECM | |
| *Hebeloma mesophaeum* | 4.6 | -24.6 | ECM | |
| *Hebeloma radicosoides* | 21.2 | -25 | ECM | |
| *Hebeloma velutipes* | 1.9 | -26.6 | ECM | |
| *Hebeloma vinosophyllum* | 21.8 | -24.8 | ECM | |
| *Heimiella* sp. | 7.4 | -25.6 | ECM | |
| *Heterobasidion annosum* | -1.6 | -24.5 | SAP | |
| *Heterobasidion annosum* | -4.5 | -25.1 | SAP | |
| *Hexagonia tennis* | -2.7 | -26 | SAP | |
| *Hirschioparus* | -3.8 | -22.1 | SAP | |
| *Hydnellum aurantiacum* | 7.6 | -25.1 | ECM | |
| *Hydnellum caeruleum* | 13.1 | -22.7 | ECM | |
| *Hydnellum caeruleum* | 8.4 | -25.3 | ECM | |
| *Hydnellum ferrugineum* | 10.7 | -22.5 | ECM | |
| *Hydnellum peckii* | 10.4 | -23.3 | ECM | |
| *Hydnellum peckii* | 6.3 | -25.5 | ECM | |
| *Hydnum repandum* | 9.2 | -26 | ECM | |
| *Hydnum repandum* | 8.6 | -28.6 | ECM | |
| *Hydnum repandum* | 8.6 | -25.4 | ECM | |
| *Hydnum rufescens* | 8.9 | -25.4 | ECM | |
| *Hydnum rufescens* | 7 | -26 | ECM | |
| *Hydnum umbilicatum* | 6.3 | -25 | ECM | |
| *Hygrocybe* “toe-head” | 7.994 | -28.7 | ECM | |
| *Hygrophoropsis aurantiaca* | -0.1 | -20.4 | SAP | |
| *Hygrophoropsis aurantiaca* | 0.3 | -19.4 | SAP | |
| *Hygrophoropsis aurantiaca* | -1 | -20.2 | SAP | |
| *Hygrophoropsis aurantiaca* | 4.6 | -21.6 | SAP | |
| *Hygrophoropsis aurantiaca* | -2.8 | -22 | SAP | |
| *Hygrophoropsis aurantiaca* | -1.2 | -20.3 | SAP | |

**Table IX. Continued.**

| Taxa | $\delta^{15}N$ (‰) | $\delta^{13}C$ (‰) | Trophic Mode | Reference |
|---|---|---|---|---|
| *Hygrophoropsis auriantiaceae* | -2 | -19.6 | SAP | Mayor et al., (2009) |
| *Hygrophorus agathosmus* | 6.4 | -28.1 | ECM | |
| *Hygrophorus bakerensis* | 3.5 | -25.5 | ECM | |
| *Hygrophorus camarophyllus* | 3.1 | -24.6 | ECM | |
| *Hygrophorus camarophyllus* | 4.1 | -25.5 | ECM | |
| *Hygrophorus camarophyllus* | -0.4 | -23.6 | ECM | |
| *Hygrophorus chrysodon* | 1.1 | -25.7 | ECM | |
| *Hygrophorus eburneus* | 3.1 | -25.7 | ECM | |
| *Hygrophorus lindtneri* | -6.6 | -28.6 | ECM | |
| *Hygrophorus olivaceoalbus* | -1.7 | -26 | ECM | |
| *Hygrophorus olivaceoalbus* | 2.7 | -24.9 | ECM | |
| *Hygrophorus purpurascens* | 7.6 | -24.9 | ECM | |
| *Hygrophorus* sp. | 3 | -25.3 | ECM | |
| *Hymenogasterales* sp. | 13.1 | -26.3 | ECM | |
| *Hypholoma capnoides* | -1.3 | -24.1 | SAP | |
| *Hypholoma capnoides* | -3.8 | -21.9 | SAP | |
| *Hypholoma fasciculare* | -3.8 | -24.3 | SAP | |
| *Hypholoma fasciculare* | 0.1 | -21.4 | SAP | |
| *Hypholoma fasciculare* | -0.5 | -22.2 | SAP | |
| *Hypholoma fasciculare* | -0.9 | -23.4 | SAP | |
| *Hypholoma fasciculare* | 0.4 | -23.8 | SAP | |
| *Hypholoma fasiculare* | -0.6 | -22.8 | SAP | |
| *Hypholoma marginatum* | -2.8 | -22.5 | SAP | |
| *Hypholoma udum* | 6.9 | -25.3 | SAP | |
| *Inocbe friesii* | 4.1 | -27 | ECM | |
| *Inocybe acuta* | 2.9 | -26.2 | ECM | |
| *Inocybe assimilata* | 2.8 | -24.7 | ECM | |
| *Inocybe ayangannae* | 7.4 | -25.5 | ECM | |
| *Inocybe cincinnata* | 3.5 | -26.5 | ECM | |
| *Inocybe fastigiata* | 0.5 | -25 | ECM | |
| *Inocybe fastigiata* | 3.6 | -25 | ECM | |
| *Inocybe geophylla* | 1.2 | -26.9 | ECM | |
| *Inocybe geophylla* | 4.2 | -25 | ECM | |
| *Inocybe geophylla* | 1.5 | -24.5 | ECM | |
| *Inocybe geophylla* | 1.7 | -22.7 | ECM | |
| *Inocybe geophylla* | 1.6 | -24.6 | ECM | |

**Table IX. Continued.**

| Taxa | $\delta^{15}N$ (‰) | $\delta^{13}C$ (‰) | Trophic Mode | Reference |
|---|---|---|---|---|
| *Inocybe hirsuta* var. *maxima* | 3.3 | -24.6 | ECM | Mayor et al., (2009) |
| *Inocybe lacera* | 1.3 | -22.5 | ECM | |
| *Inocybe leiocephala* | 3.8 | -25.9 | ECM | |
| *Inocybe olympiana* | 0.5 | -24.9 | ECM | |
| *Inocybe pseudodestricta* | 1.5 | -26.5 | ECM | |
| *Inocybe rimosa* | 1.4 | -24.7 | ECM | |
| *Inocybe* sp. | 5 | -23.1 | ECM | |
| *Inocybe* sp. | 3.7 | -24 | ECM | |
| *Inocybe* sp. | -0.7 | -26.3 | ECM | |
| *Inocybe tigrina* | 1.3 | -26.9 | ECM | |
| *Inocybe vaccina* | 1.2 | -24.6 | ECM | |
| *Inocybe xanthomelas* | 1 | -26.2 | ECM | |
| *Inonotus tomentosus* | -2.1 | -23.5 | SAP | |
| *Inonotus tomentosus* | -3.9 | -21.3 | SAP | |
| *Ischnoderma resinosum* | -2.4 | -21.1 | SAP | |
| *Kobayasia nipponica* | -3.6 | -23.2 | SAP | |
| *Laccaria amethstina* | -3.6 | -26.3 | ECM | |
| *Laccaria amethystea* | -3.6 | -27.9 | ECM | |
| *Laccaria amethystina* | 1.7 | -27.4 | ECM | |
| *Laccaria amethystina* | -0.5 | -24.1 | ECM | |
| *Laccaria bicolor* | 1.3 | -25.3 | ECM | |
| *Laccaria bicolor* | 0.2 | -25.1 | ECM | |
| *Laccaria bicolor* | -0.5 | -25.3 | ECM | |
| *Laccaria bicolor* | 2.4 | -24 | ECM | |
| *Laccaria laccata* | 1.6 | -25.3 | ECM | |
| *Laccaria laccata* | -3.3 | -25.4 | ECM | |
| *Laccaria.* Sp. | 1.4 | -23 | ECM | |
| *Lactarius badiosanguinea* | 8.5 | -26.2 | ECM | |
| *Lactarius camphoratus* | 3.8 | -26.8 | ECM | |
| *Lactarius chrysorrheus* | 1.3 | -23.9 | ECM | |
| *Lactarius chrysorrheus* | 2.6 | -23.3 | ECM | |
| *Lactarius chrysorrheus* | -0.5 | -24.3 | ECM | |
| *Lactarius deliciosus* | 6.5 | -24.9 | ECM | |
| *Lactarius deterrimus* | 7.5 | -26.6 | ECM | |
| *Lactarius fallax* var. *concolor* | 1.1 | -24.4 | ECM | |
| *Lactarius fuliginosus* | 6.4 | -24.9 | ECM | |

**Table IX. Continued.**

| Taxa | $\delta^{15}N$ (‰) | $\delta^{13}C$ (‰) | Trophic Mode | Reference |
|---|---|---|---|---|
| *Lactarius glyciosmus* | 4.3 | -27 | ECM | Mayor et al., (2009) |
| *Lactarius hatsudake* | 2.5 | -24.8 | ECM | |
| *Lactarius helvus* | 6.9 | -23.8 | ECM | |
| *Lactarius kauffmanii* var. *kauffmanii* | 5.3 | -25.6 | ECM | |
| *Lactarius mitissimus* | 5.4 | -25.1 | ECM | |
| *Lactarius musteus* | 1.6 | -24.9 | ECM | |
| *Lactarius necator* | 2.5 | -26 | ECM | |
| *Lactarius obscuratus* | 6 | -27.1 | ECM | |
| *Lactarius olivaceo-umbrinus* | 1.8 | -25.1 | ECM | |
| *Lactarius olympianus* | 5.3 | -24.8 | ECM | |
| *Lactarius olympianus* | 5.4 | -24.9 | ECM | |
| *Lactarius pallescens* var. *pallescens* | 3.3 | -25.1 | ECM | |
| *Lactarius pseudomucidus* | 2.9 | -25.5 | ECM | |
| *Lactarius pseudomucidus* | 1.5 | -25.1 | ECM | |
| *Lactarius quietus* | 3.4 | -24.3 | ECM | |
| *Lactarius repraesentaneus* | 6.4 | -26.5 | ECM | |
| *Lactarius rubrilacteus* | 4.7 | -24.3 | ECM | |
| *Lactarius rufus* | 4 | -24.9 | ECM | |
| *Lactarius rufus* | 2 | -25.3 | ECM | |
| *Lactarius scrobiculatus* | 7.6 | -27.3 | ECM | |
| *Lactarius* sp. | 3.7 | -25.9 | ECM | |
| *Lactarius* sp. | 6.7 | -25.5 | ECM | |
| *Lactarius* sp. | 8.7 | -23.7 | ECM | |
| *Lactarius* sp. | 10.3 | -26.6 | ECM | |
| *Lactarius subcircellatus* | 2.6 | -26.7 | ECM | |
| *Lactarius subdulcis* | -1 | -26.7 | ECM | |
| *Lactarius subflammeus* | 5.2 | -25.8 | ECM | |
| *Lactarius theiogalus* | 2.5 | -27.1 | ECM | |
| *Lactarius theiogalus* | -0.6 | -25 | ECM | |
| *Lactarius theiogalus* | 2.6 | -24.6 | ECM | |
| *Lactarius torminosus* | 5.5 | -25.8 | ECM | |
| *Lactarius trivialis* | 6.6 | -23.5 | ECM | |
| *Lactarius uvidus* | 3.4 | -26 | ECM | |
| *Lactarius uvidus* | 3.5 | -26 | ECM | |
| *Lactarius vietus* | 1.7 | -26.2 | ECM | |
| *Laetiporus conifericola* | -2.4 | -21.8 | SAP | |

**Table IX. Continued.**

| Taxa | $\delta^{15}N$ (‰) | $\delta^{13}C$ (‰) | Trophic Mode | Reference |
|---|---|---|---|---|
| *Laetiporus* sp. | 0.4 | -22.5 | SAP | Mayor et al., (2009) |
| *Laetiporus sulphureus* | -0.2 | -22.6 | SAP | |
| *Laetiporus sulphureus* | 1 | -21.1 | SAP | |
| *Leccinum aurantiacum* | 9 | -27.3 | ECM | |
| *Leccinum holopus* | 2.2 | -29.2 | ECM | |
| *Leccinum molle* | 9 | -27.6 | ECM | |
| *Leccinum rotundifoliae* | 8.3 | -26.7 | ECM | |
| *Leccinum scabrum* | 4.5 | -24.6 | ECM | |
| *Leccinum scabrum* | 9.2 | -27.5 | ECM | |
| *Leccinum scabrum* | 7.3 | -26.4 | ECM | |
| *Leccinum scabrum* | 4.3 | -27.4 | ECM | |
| *Leccinum variicolor* | 7.7 | -27.6 | ECM | |
| *Leccinum variicolor* | 5.3 | -26.1 | ECM | |
| *Leccinum versipelle* | 12.3 | -27.5 | ECM | |
| *Leccinum versipelle* | 11.7 | -27.1 | ECM | |
| *Leccinum vulpinum* | 12.8 | -25 | ECM | |
| *Lentinula edodes* | 0.9 | -24.8 | SAP | |
| *Lentinus* sp. | -1.9 | -24.2 | SAP | |
| *Leotia lubrica* | 3 | -25.7 | SAP | |
| *Lepiota acutesquamosa* | 0.5 | -22.7 | SAP | |
| *Lepiota clypeolaria* | 3.8 | -21.5 | SAP | |
| *Lepiota cristata* | 1.8 | -22.6 | SAP | |
| *Lepiota cristata* | 1.6 | -21.7 | SAP | |
| *Lepiota magnispora* | -0.8 | -23.4 | SAP | |
| *Lepiota* sp. | -0.7 | -23.1 | SAP | |
| *Leucopaxillis amarus* | 5.9 | -20.1 | SAP | |
| *Leucopaxillus amarus* | 3.9 | -19.3 | SAP | |
| *Leucopaxillus giganteus* | -2.2 | -23 | SAP | |
| *Lycoperdon foetidum* | -2 | -24.5 | SAP | |
| *Lycoperdon perlatum* | 2.4 | -23.3 | SAP | |
| *Lycoperdon perlatum* | 1.9 | -22.9 | SAP | |
| *Lycoperdon* sp. | -4.9 | -24.3 | SAP | |
| *Lycoperdon* sp. | -1 | -24.9 | SAP | |
| *Lyophyllum connatum* | 1.4 | -20.9 | SAP | |
| *Lyophyllum fumosum* | 16.4 | -23.2 | ECM | |
| *Lyophyllum semitale* | 11.7 | -25 | ECM | |

**Table IX. Continued.**

| Taxa | $\delta^{15}N$ (‰) | $\delta^{13}C$ (‰) | Trophic Mode | Reference |
|---|---|---|---|---|
| *Macrolepiota* sp. | 0.8 | -23.5 | SAP | Mayor et al., (2009) |
| *Marasmius androsaceus* | -3.2 | -25.7 | SAP | |
| *Marasmius maximus* | 8.6 | -23 | SAP | |
| *Marasmius* sp. | 2.9 | -21.8 | SAP | |
| *Marasmius* sp. | -0.9 | -22.4 | SAP | |
| *Marasmius* sp. | -2.2 | -25.2 | SAP | |
| *Megacollybia platyphylla* | -0.9 | -23 | SAP | |
| *Micromphale perforans* | -3.4 | -25 | SAP | |
| *Microporus vernicipes* | -0.3 | -28.9 | SAP | |
| *Microporus vernicipes* | 2.5 | -24 | SAP | |
| *Mycena amicta* | -2.7 | -22.8 | SAP | |
| *Mycena aurantiidisca* | -4.3 | -25.4 | SAP | |
| *Mycena aurantiidisca* | -3.4 | -24.9 | SAP | |
| *Mycena clavicularis* | -4 | -24.5 | SAP | |
| *Mycena clavicularis* | -2 | -25.2 | SAP | |
| *Mycena epipterygia* | -3.7 | -22.8 | SAP | |
| *Mycena galericulata* | -3.3 | -22.1 | SAP | |
| *Mycena galopus* | -3.6 | -22.7 | SAP | |
| *Mycena gr. murina* | -3.8 | -24 | SAP | |
| *Mycena haematopoda* | -2.2 | -22.4 | SAP | |
| *Mycena haematopoda* | -2.9 | -20.2 | SAP | |
| *Mycena haematopus* | -2.9 | -22.7 | SAP | |
| *Mycena inclinata* | -1.7 | -22.3 | SAP | |
| *Mycena leptophylla* | -0.4 | -23.3 | SAP | |
| *Mycena maculata* | -1 | -22.1 | SAP | |
| *Mycena pura* | 6.4 | -22.7 | SAP | |
| *Mycena pura* | 0.8 | -22.9 | SAP | |
| *Mycena pura* | 0.4 | -23.9 | SAP | |
| *Mycena rosella* | -3 | -23.3 | SAP | |
| *Mycena rosella* | -2.9 | -23.9 | SAP | |
| *Mycena simia* | 4.6 | -23.7 | SAP | |
| *Mycena* sp. | -1 | -22.3 | SAP | |
| *Mycena* sp. | -0.2 | -21.2 | SAP | |
| *Mycena sp.* | 0.8 | -21.5 | SAP | |
| Mycena sp. | -3 | -28 | SAP | |
| *Mycena* sp. | 6.1 | -23.5 | SAP | |

**Table IX. Continued**

| Taxa | $\delta^{15}N$ (‰) | $\delta^{13}C$ (‰) | Trophic Mode | Reference |
|---|---|---|---|---|
| *Mycena* sp. | 0.6 | -25.1 | SAP | Mayor et al., (2009) |
| *Mycena strobilinoides* | -3.3 | -23.2 | SAP | |
| *Mycoleptodonoides aitchisonii* | -0.2 | -22.1 | SAP | |
| *Naematoloma fasciculare* | -0.8 | -24 | SAP | |
| *Naucoria escharoides* | 4.3 | -25.7 | ECM | |
| *Oligoporus perdelicatus* | -3.5 | -20.4 | SAP | |
| *Omphalotus olearis* | -0.4 | -22.9 | SAP | |
| *Onnia vallata* | -4.2 | -24.2 | SAP | |
| *Oudemansiella mucida* | -7.1 | -22.9 | SAP | |
| *Oudemansiella mucida* | -3.4 | -22.1 | SAP | |
| *Oudemansiella radicata* | -0.6 | -23.2 | SAP | |
| *Oudemansiella venusolamellata* | 0.7 | -23.5 | SAP | |
| *Oxyporus cuneatus* | -0.7 | -23.5 | SAP | |
| *Paxillus atromentarius* | 2.8 | -23 | SAP | |
| *Paxillus atrotomentosus* | -1.3 | -22.4 | SAP | |
| *Paxillus involutus* | 9.1 | -26.6 | ECM | |
| *Paxillus involutus* | 6.6 | -24.6 | ECM | |
| *Perenniporia* sp. | -1 | -24.5 | SAP | |
| *Perriniporia inflexibilis* | 2.57 | -26.3 | SAP | |
| *Perriniporia inflexibilis* | 2.8286 | -25.823 | SAP | |
| *Perriniporia inflexibilis* | 3.1919 | -25.7969 | SAP | |
| *Peziza badoconfusa* | 2.5 | -22.1 | SAP | |
| *Phaeocollybia attenuata* | 9.1 | -24.3 | ECM | |
| *Phaeocollybia benzokauffmanii* | 12.8 | -23.5 | ECM | |
| *Phaeocollybia fallax* | 6.9 | -24.3 | ECM | |
| *Phaeocollybia gregaria* | 13 | -23.8 | ECM | |
| *Phaeocollybia kauffmanii* | 11 | -25.4 | ECM | |
| *Phaeocollybia lilacifolia* | 10.5 | -26 | ECM | |
| *Phaeocollybia piceae* | 7 | -25.3 | ECM | |
| *Phaeolepiota aurea* | 3.4 | -21.4 | SAP | |
| *Phaeolus schweinitzii* | -0.2 | -23 | SAP | |
| *Phaeolus schweinitzii* | 0 | -22.9 | SAP | |
| *Phallus impudicus* | -4.5 | -23 | SAP | |
| *Phallus impudicus* | -2.8 | -22.7 | SAP | |
| *Phellinus pini* | -3.1 | -21.8 | SAP | |
| *Phellinus robustus* | -0.7 | -24 | SAP | |

**Table IX. Continued.**

| Taxa | $\delta^{15}N$ (‰) | $\delta^{13}C$ (‰) | Trophic Mode | Reference |
|---|---|---|---|---|
| *Phellinus xeranticus* | -0.9 | -23.4 | SAP | Mayor et al., (2009) |
| *Phellodon niger* | 13.5 | -24.6 | ECM | |
| *Phellodon niger* | 8.1 | -22.7 | ECM | |
| *Phellodon tomentosa* | 14.1 | -24.1 | ECM | |
| *Pholiota astragalina* | -1.2 | -22.1 | SAP | |
| *Pholiota astragalina* | -3.3 | -22.6 | SAP | |
| *Pholiota decorata* | -2 | -23.7 | SAP | |
| *Pholiota decorata* | -2.6 | -23.1 | SAP | |
| *Pholiota flammans* | -2.4 | -23.2 | SAP | |
| *Pholiota flammans* | -3.7 | -22.7 | SAP | |
| *Pholiota flavida* | -1 | -22 | SAP | |
| *Pholiota lenta* | -1.5 | -25.5 | SAP | |
| *Pholiota lenta* | -4 | -23.5 | SAP | |
| *Pholiota lubrica* | -1.7 | -22.3 | SAP | |
| *Pholiota spumosa* | -1.9 | -21.4 | SAP | |
| *Pholiota squarrosa* | 5.2 | -23.6 | SAP | |
| *Pholiota squarrosa* | 5.6 | -23.1 | SAP | |
| *Piptoporus betulinus* | -4.6 | -23.1 | SAP | |
| *Pisolithus tinctorius* | 8.8 | -24.7 | ECM | |
| *Pleurocybe porrigens* | -1.2 | -21.3 | SAP | |
| *Pleurocybella porrigens* | -1.1 | -21.5 | SAP | |
| *Pleurotus ostreatus* | 1.4 | -25.7 | SAP | |
| *Pleurotus* sp. | -2.3 | -22.2 | SAP | |
| *Pluteus cervinus* | -1.8 | -22.6 | SAP | |
| *Pluteus cervinus* | -2 | -23.8 | SAP | |
| *Pluteus lutescens* | 1.7 | -24 | SAP | |
| *Podocypha nitidula* | 0.8 | -23.9 | SAP | |
| *Polyporaceae* sp. | -3.5 | -20.6 | SAP | |
| *Polyporus alveolarius* | -2.4 | -23.3 | SAP | |
| *Polyporus arcularius* | -1.6 | -22.4 | SAP | |
| *Polyporus badius* | -5.9 | -22.3 | SAP | |
| *Polyporus melanopus* | 0.1 | -23.8 | SAP | |
| *Polyporus melanopus* | -2.9 | -25.1 | SAP | |
| *Polyporus* sp. | -2 | -22.5 | SAP | |
| *Polyporus tenuiculus* | -1.9 | -23.9 | SAP | |
| *Psathyrella* gr. *Tephrophylla* | 2.4 | -22.3 | SAP | |

**Table IX. Continued.**

| Taxa | $\delta^{15}N$ (‰) | $\delta^{13}C$ (‰) | Trophic Mode | Reference |
|---|---|---|---|---|
| *Psathyrella piluliformis* | -3.3 | -23.7 | SAP | Mayor et al., (2009) |
| *Psathyrella* sp. | 0.3 | -22.5 | SAP | |
| *Psathyrella* sp. | -0.5 | -24.8 | SAP | |
| *Psathyrella* sp. | 1.1 | -25 | SAP | |
| *Psathyrella* sp. | 2.2 | -23.9 | SAP | |
| *Pseudocolus schellenbergiae* | 1.5 | -23.9 | SAP | |
| *Pseudohydnum gelatinosum* | -2.7 | -24 | SAP | |
| *Pseudoplectania melaena* | 0.8 | -24.9 | SAP | |
| *Pseudoplectania melaena* | -2.4 | -25.4 | SAP | |
| *Pseudotulostoma volvata* | 3.7 | -27.4 | ECM | |
| *Pseudotulostoma volvata* | 8.9 | -26.6 | ECM | |
| *Pseudotulostoma volvata* | 5.721 | -26.42 | ECM | |
| *Psilocybe* sp. | 12.5 | -19 | SAP | |
| *Ramaria abietina* | -0.5 | -23 | SAP | |
| *Ramaria* sp. | 11.7 | -27.4 | ECM | |
| *Ramaria testaceoflava* | 6 | -25.4 | ECM | |
| *Ramariaceae* sp. | -1.3 | -25.3 | SAP | |
| *Ramariopsis corniculata* | 13.82 | -25.98 | ECM | |
| *Ramariopsis fusiformis* | 16.02 | -26.32 | ECM | |
| *Ramariopsis fusiformis* | 20.54 | -27.38 | ECM | |
| *Ramariopsis fusiformis* | 14.3 | -24.51 | ECM | |
| *Ramariopsis kunzei* | 13 | -25.94 | ECM | |
| *Ramariopsis kunzei* | 13.86 | -24.89 | ECM | |
| *Ramariopsis kunzei* | 13.8 | -25.94 | ECM | |
| *Ramariopsis kunzei* | 13.71 | -27.18 | ECM | |
| *Ramariopsis kunzei* | 14.61 | -24.19 | ECM | |
| *Ramariopsis laeticolor* | 11.45 | -26.16 | ECM | |
| *Rhizopogon obtextus* | 9.5 | -25 | ECM | |
| *Rhizopogon* sp. | 9.3 | -25.4 | ECM | |
| *Rhodocollybia extuberans* | 2.2 | -21.8 | SAP | |
| *Rhodocollybia extuberans* | -1.4 | -23.6 | SAP | |
| *Rhodocollybia maculata* | -0.5 | -21 | SAP | |
| *Rhodocybe nitellina* | 2 | -20.8 | SAP | |
| *Roseoformes subflexibilis* | -2.5 | -22.3 | SAP | |
| *Rozites caperata* | 4 | -25.3 | ECM | |
| *Rozites caperata* | 8.1 | -25.8 | ECM | |

**Table IX. Continued.**

| Taxa | $\delta^{15}N$ (‰) | $\delta^{13}C$ (‰) | Trophic Mode | Reference |
|---|---|---|---|---|
| *Rozites caperata* | 6.6 | -24.7 | ECM | Mayor et al., (2009) |
| *Rozites caperatus* | 3.4 | -26.6 | ECM | |
| *Russula adusta* | 4.3 | -26.8 | ECM | |
| *Russula aeruginea* | 2.2 | -26 | ECM | |
| *Russula* aff. *Mariae* | 6.2 | -24.6 | ECM | |
| *Russula alboareolata* | 2 | -25.3 | ECM | |
| *Russula albonigra* | 5.4 | -27 | ECM | |
| *Russula atrorubens* | 1.4 | -25.5 | ECM | |
| *Russula betularum* | -0.7 | -25.1 | ECM | |
| *Russula betularum* | 0.6 | -25.5 | ECM | |
| *Russula bicolor* | -1.3 | -26.7 | ECM | |
| *Russula brevipes* | 3.5 | -24.8 | ECM | |
| *Russula brevipes* | 6 | -24.4 | ECM | |
| *Russula claroflava* | 2.6 | -24.1 | ECM | |
| *Russula coerulea* | 5.1 | -24.1 | ECM | |
| *Russula crassotunicata* | 0.4 | -26.4 | ECM | |
| *Russula cremericolor* | 1.2 | -27.3 | ECM | |
| *Russula decolorans* | 0.8 | -25.4 | ECM | |
| *Russula decolorans* | 1 | -23.3 | ECM | |
| *Russula delica* | 7.9 | -24.5 | ECM | |
| *Russula emetica* | 3.4 | -24.9 | ECM | |
| *Russula emetica* | 1.9 | -24.9 | ECM | |
| *Russula fellea* | -0.4 | -26.2 | ECM | |
| *Russula fellea* | 2.4 | -24.6 | ECM | |
| *Russula foetens* | 8.4 | -24.8 | ECM | |
| *Russula fragilis* | 1.6 | -26 | ECM | |
| *Russula fragilis* | -0.6 | -25.5 | ECM | |
| *Russula fragilis* | 0.9 | -25.7 | ECM | |
| *Russula gr. Fragilis* | 0.5 | -27.1 | ECM | |
| *Russula gracillima* | 8.4 | -27.7 | ECM | |
| *Russula griseascens* | 2.6 | -26.4 | ECM | |
| *Russula integra* | 4.4 | -25.4 | ECM | |
| *Russula integra* | 1.4 | -24.9 | ECM | |
| *Russula integra* | 3.8 | -24.9 | ECM | |
| *Russula krombholzii* | 3.6 | -28.1 | ECM | |
| *Russula laurocerasi* | 4.7 | -24.9 | ECM | |

**Table IX. Continued.**

| Taxa | $\delta^{15}N$ (‰) | $\delta^{13}C$ (‰) | Trophic Mode | Reference |
|---|---|---|---|---|
| *Russula mairei* | -2.2 | -27.4 | ECM | Mayor et al., (2009) |
| *Russula nigricans* | 4.6 | -25.2 | ECM | |
| *Russula occidentalis* | 0.5 | -25.3 | ECM | |
| *Russula ochroleuca* | 2.4 | -26.7 | ECM | |
| *Russula ochroleuca* | 5.2 | -24.2 | ECM | |
| *Russula paludosa* | 6.3 | -25 | ECM | |
| *Russula paludosa* | 3.8 | -25.2 | ECM | |
| *Russula puellaris* | 1.8 | -25.5 | ECM | |
| *Russula puellaris* | 1 | -26.7 | ECM | |
| *Russula puellaris* | 3.1 | -24.1 | ECM | |
| *Russula queletii* | 7.9 | -27.5 | ECM | |
| *Russula queletii* | 1 | -24.8 | ECM | |
| *Russula raoultii* | -1.1 | -27.3 | ECM | |
| *Russula rhodopoda* | 0.5 | -26 | ECM | |
| *Russula rosacea* | 1.3 | -23.7 | ECM | |
| *Russula sanguinea* | 9 | -24.5 | ECM | |
| *Russula sardonia* | 4.4 | -26.3 | ECM | |
| *Russula sororia* | 4.3 | -23 | ECM | |
| *Russula sororia* | 4.4 | -25.2 | ECM | |
| *Russula* sp. | 2.6 | -25.8 | ECM | |
| *Russula* sp. | 6.3 | -24.3 | ECM | |
| *Russula* sp. | 4.9 | -24.3 | ECM | |
| *Russula vinosa* | 0 | -25.3 | ECM | |
| *Russula* sp. | 6.8 | -25.1 | ECM | |
| *Russula* sp. | 7.2 | -24.4 | ECM | |
| *Russula* sp. | -0.6 | -24.2 | ECM | |
| *Russula* sp. | 8.4 | -25 | ECM | |
| *Russula* sp. | -1.9 | -25.1 | ECM | |
| *Russula* sp. | 0.8 | -24 | ECM | |
| *Russula* sp. | 0.8 | -22.9 | ECM | |
| *Russula* sp. | 4.4 | -24.5 | ECM | |
| *Russula xerampelina* | -0.4 | -26.3 | ECM | |
| *Russula xerampelina* | 4 | -24.8 | ECM | |
| *Sarcodon fuscoindicum* | 9.1 | -25.3 | ECM | |
| *Sarcodon scabrosum* | 7.6 | -24.9 | ECM | |
| *Scleroderma citrinum* | 2.6 | -25.4 | ECM | |

**Table IX. Continued.**

| Taxa | $\delta^{15}N$ (‰) | $\delta^{13}C$ (‰) | Trophic Mode | Reference |
|---|---|---|---|---|
| *Scleroderma citrinum* | 5.7 | -24.7 | ECM | Mayor et al., (2009) |
| *Scleroderma verrucosum* | 2 | -27.4 | ECM | |
| *Scleroderma* sp. | 5.5 | -28.9 | ECM | |
| *Stereum red-sta avg* | -2.5 | -21.4 | SAP | |
| *Stereum-o hym* | -1.2 | -23.2 | SAP | |
| *Stipitochaete damaechornis* | -0.6 | -26.8 | SAP | |
| *Stipitochaete damaechornis* | 6.5 | -24.9 | SAP | |
| *Stipitochaete damaechornis* | 2.7 | -23 | SAP | |
| *Strobilomyces polypyramis* | 4.5 | -27.1 | ECM | |
| *Strobilomyces* sp. | 8.6 | -25.7 | ECM | |
| *Strobilurus esculentus* | -2.3 | -21.9 | SAP | |
| *Stropharia ambigua* | -4.2 | -23.3 | SAP | |
| *Stropharia hornemanii* | 1.4 | -23.1 | SAP | |
| *Suillus bovinus* | 10.1 | -25.2 | ECM | |
| *Suillus bovinus* | 12.5 | -25.2 | ECM | |
| *Suillus granulatus* | 5.6 | -24.1 | ECM | |
| *Suillus lakei* | 5.8 | -24.5 | ECM | |
| *Suillus lakei* | 8.9 | -23.9 | ECM | |
| *Suillus lakei* | 11.9 | -22.6 | ECM | |
| *Suillus luteus* | 11.8 | -24.6 | ECM | |
| *Suillus pseudobrevipes* | 6.7 | -24.3 | ECM | |
| *Suillus punctatipes* | 11.6 | -25 | ECM | |
| *Suillus sibiricus* | 6 | -24.1 | ECM | |
| *Suillus variegatus* | 6 | -25 | ECM | |
| *Suillus variegatus* | 4.8 | -24.3 | ECM | |
| *Thelephora* sp. | 9.9 | -27.4 | ECM | |
| *Thelephoraceae* sp. | 5.8 | -24.3 | ECM | |
| *Thelephoraceae* sp. | 5.7 | -27.6 | ECM | |
| *Tomentella* sp. | 5 | -28.5 | ECM | |
| *Trametes* aff. *Brevis* | 1.5 | -23.8 | SAP | |
| *Trametes hirsuta* | 0.2 | -24 | SAP | |
| *Trametes scopulosa* | 1.6 | -26.5 | SAP | |
| *Trametes versicolor* | 2.2 | -24.2 | SAP | |
| *Trametes versicolor* | -3.1 | -23.2 | SAP | |
| *Trametes versicolor* | -1.3 | -23.1 | SAP | |
| *Trichaptum biforme* | -2.5 | -22.3 | SAP | |

**Table IX. Continued.**

| Taxa | $\delta^{15}N$ (‰) | $\delta^{13}C$ (‰) | Trophic Mode | Reference |
|---|---|---|---|---|
| *Trichholomopsis platyphylla* | 1.2 | -22.1 | SAP | Mayor et al., (2009) |
| *Tricholoma* "hygrophorous lg. orange" | 5.35 | -26.6 | ECM | |
| *Tricholoma atroviolaceum* | 7.5 | -27.3 | ECM | |
| *Tricholoma atroviolaceum* | 11 | -25.7 | ECM | |
| *Tricholoma columbetta* | 10.2 | -27.1 | ECM | |
| *Tricholoma flavovirens* | 10 | -25.4 | ECM | |
| *Tricholoma flavovirens* | 2.7 | -26.1 | ECM | |
| *Tricholoma flavovirens* | 7.7 | -25.3 | ECM | |
| *Tricholoma focale* | 9.7 | -26 | ECM | |
| *Tricholoma fracticum* | 13.1 | -24.3 | ECM | |
| *Tricholoma fucatum* | 8.2 | -25.8 | ECM | |
| *Tricholoma fulvum* | 12.5 | -26.6 | ECM | |
| *Tricholoma imbricatum* | 6.6 | -26.7 | ECM | |
| *Tricholoma inamoenum* | 5.4 | -25.3 | ECM | |
| *Tricholoma magnivelare* | 12.1 | -25.7 | ECM | |
| *Tricholoma myomyces* | 6.4 | -25.5 | ECM | |
| *Tricholoma nigrum* | 9.7 | -26.3 | ECM | |
| *Tricholoma pardinum* | 7.6 | -24.9 | ECM | |
| *Tricholoma saponaceum* | 6.5 | -24 | ECM | |
| *Tricholoma saponaceum* | 7.7 | -24.2 | ECM | |
| *Tricholoma saponaceum* | 10.3 | -25.3 | ECM | |
| *Tricholoma sciodes* | 8.9 | -26.9 | ECM | |
| *Tricholoma sejunctum* | 6.8 | -25.5 | ECM | |
| *Tricholoma ustale* | 9.6 | -27.1 | ECM | |
| *Tricholoma vaccinum* | 9.4 | -26.9 | ECM | |
| *Tricholoma vaccinum* | 6.8 | -25.3 | ECM | |
| *Tricholoma virgatum* | 11 | -25.2 | ECM | |
| *Tricholoma virgatum* | 10.7 | -24.3 | ECM | |
| *Tricholoma virgatum* | 9.8 | -25.7 | ECM | |
| *Tricholoma virgatum* | 8.4 | -23.9 | ECM | |
| *Tricholoma* sp. | 8 | -24.8 | ECM | |
| *Tricholoma* sp. | 18.3 | -24.3 | ECM | |
| *Tricholoma* sp. | 19.8 | -25.3 | ECM | |
| *Tricholomataceae sp.* | 3.7 | -23.1 | SAP | |
| *Tricholomopsis decora* | -1.9 | -22.7 | SAP | |
| *Tricholomopsis decora* | -3.8 | -22.9 | SAP | |

**Table IX. Continued.**

| Taxa | $\delta^{15}N$ (‰) | $\delta^{13}C$ (‰) | Trophic Mode | Reference |
|---|---|---|---|---|
| *Tricholomopsis sulfureoides* | -1.3 | -22 | SAP | Mayor et al., (2009) |
| *Tylopilus castaneiceps* | 7.4 | -24.6 | ECM | |
| *Tylopilus exiguus* | 5.4 | -27.1 | ECM | |
| *Tylopilus exiguus* | 4.1 | -25.6 | ECM | |
| *Tylopilus exiguus* | 5.659 | -25.3 | ECM | |
| *Tylopilus felleus* | 3 | -25 | ECM | |
| *Tylopilus porphyrosporus* | 3.9 | -24.4 | ECM | |
| *Tylopilus potamogeton* var. *irengensis* | 4.3 | -24.8 | ECM | |
| *Tylopilus* sp. | 6.6 | -23.3 | ECM | |
| *Tylopilus* sp. | 5.7 | -23.5 | ECM | |
| *Tylopilus* sp. | 7.7 | -23.9 | ECM | |
| *Tylopilus* sp. | 8.4 | -24.7 | ECM | |
| *Xanthoconium affine* | 5.4 | -24.1 | ECM | |
| *Xerocomus badius* | 5.6 | -25.3 | ECM | |
| *Xerocomus badius* | 2.1 | -25.8 | ECM | |
| *Xerocomus badius* | 3.7 | -23.7 | ECM | |
| *Xerocomus chrysenteron* | 4.2 | -26.4 | ECM | |
| *Xerocomus subtomentosus* | 6.7 | -25.9 | ECM | |
| *Xerocomus subtomentosus* | 3.4 | -24.1 | ECM | |
| *Xeromphalina campanella* | -3 | -21.7 | SAP | |
| *Xeromphalina campanella* | -1.4 | -22 | SAP | |
| *Xeromphalina cornui* | -3.5 | -23.5 | SAP | |
| *Xeromphalina cornui* | -4.8 | -23 | SAP | |
| *Xylaria* sp. | 0.2 | -26.3 | SAP | |
| *Xylaria* sp. "on D. cor. Pod" | 3.7 | -26.3 | SAP | |
| *Xylaria* sp. "on D. cor. Pod" | 3.7 | -25.1 | SAP | |
| *Aspropxillus septentriahs* | 4.34 | -20.85 | SAP | Sánchez-García et al., (2014) |
| *Albomagister* sp. | 1.7 | -27.05 | ECM | |
| *Albomagister subaustralis* | 9.08 | -25.86 | ECM | |
| *Albomagister subaustralis* | 7.33 | -24.53 | ECM | |
| *Albomagister subaustralis* | 10.28 | -25.7 | ECM | |
| *Callistosporium luteo-olivaceum* | 0.45 | -21.92 | SAP | |
| *Calocybe naucoria* | -2.6 | -23.44 | SAP | |
| *Cleistocybe vernalis* | 0.84 | -18.65 | SAP | |
| *Clitocybe candicans* | 1.01 | -22.08 | SAP | |
| *Clitocybe dealbata* | 2.67 | -21.79 | SAP | |

**Table IX. Continued.**

| Taxa | $\delta^{15}N$ (‰) | $\delta^{13}C$ (‰) | Trophic Mode | Reference |
|---|---|---|---|---|
| *Clitocybe nebularis* | 1.56 | -22.96 | SAP | Sánchez-García et al., (2014) |
| *Clitocybe* sp. | -1.08 | -23.31 | SAP | |
| *Clitopilus prunulus* | 2.42 | -20.97 | SAP | |
| *Clitopilus scyphoides* | 1.05 | -24.02 | SAP | |
| *Dennisiomyces* sp. | 0.95 | -24.52 | SAP | |
| *Infundibulicybe gibba* | 0.1 | -21.4 | SAP | |
| *Lepista irina* | 4.98 | -23.03 | SAP | |
| *Lepista personata* | 6.64 | -21.91 | SAP | |
| *Lepista sordida* | 4.53 | -15.79 | SAP | |
| *Leucopaxillae gracillimus* | 13.1 | -24.03 | ECM | |
| *Lyophyllum aff decastes* | 14.64 | -25.24 | ECM | |
| *Notholepista subzonalis* | -0.41 | -23.98 | SAP | |
| *Porpoloma portentosum* | 8.02 | -26.99 | ECM | |
| *Porpoloma sejunctum* | 9.84 | -21.82 | ECM | |
| *Porpoloma* sp. | 6.53 | -30 | ECM | |
| *Porpoloma* sp. | 7.78 | -23.25 | ECM | |
| *Porpoloma terreum* | 6.69 | -24.35 | ECM | |
| *Pseudoclitocybe* sp. | 1.76 | -23.84 | SAP | |
| *Pseudoomphalina kalchbrenneri* | -0.94 | -22.24 | SAP | |
| *Pseudoomphalina pachyphylla* | -0.41 | -23.06 | SAP | |
| *Rhodocybe mundula* | 1.88 | -22.63 | SAP | |
| *Singerocybe adirondackensis* | 1.19 | -22.7 | SAP | |
| *Termitomyces microcarpus* | 1.86 | -23.67 | SAP | |

**Figure IX. HID ML tree with ≥70 bootstrap values shown. ML relationships determined from at least one locus (nLSU, nSSU, *rpb2*) per sample. The *Rickenella* clade *sensu* Larsson et al., (2006) is highlighted in two groups. The weakly supported monophyletic group is highlighted in green, with some additional species not included in Larsson et al., (2006). Species considered part of the *Rickenella* clade *sensu* Larsson et al., (2006) that did not resolve as monophyletic are highlighted in purple.**

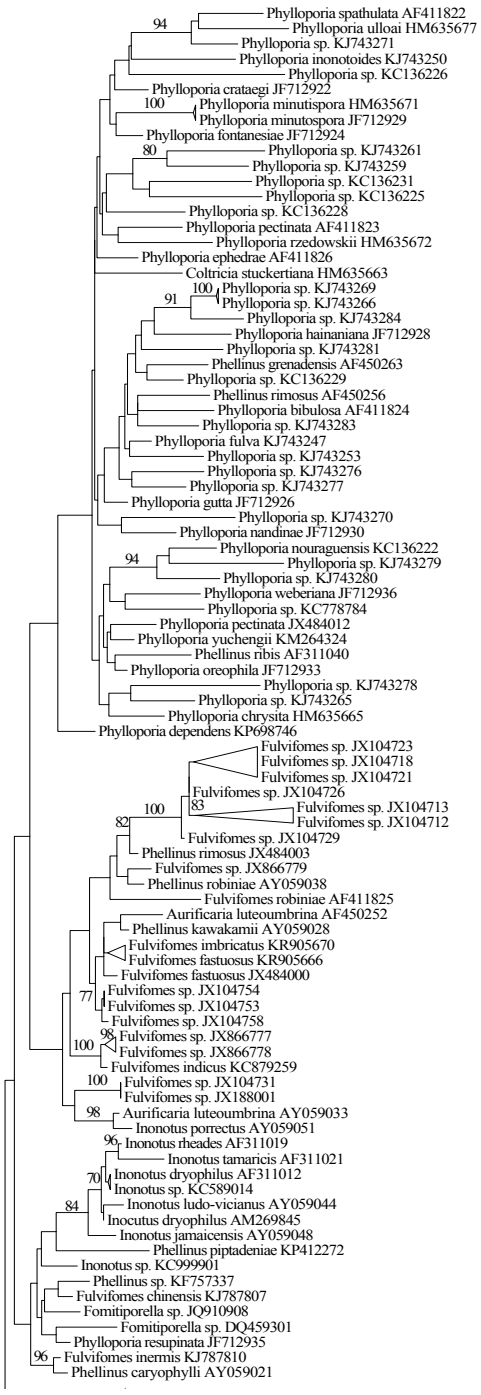



**Figure IX. Continued.**

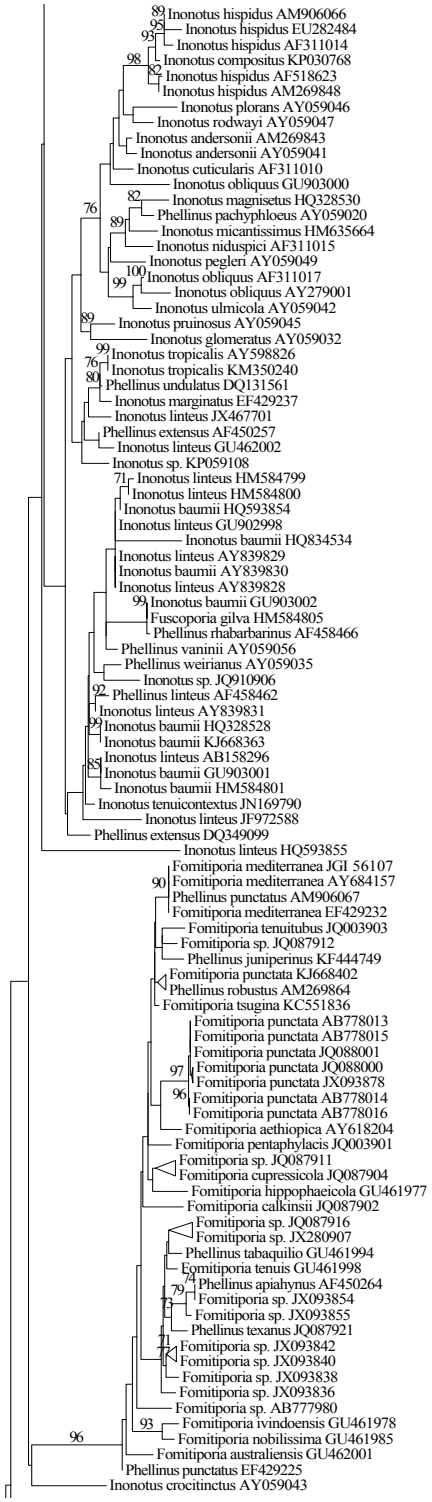



**Figure IX. Continued.**

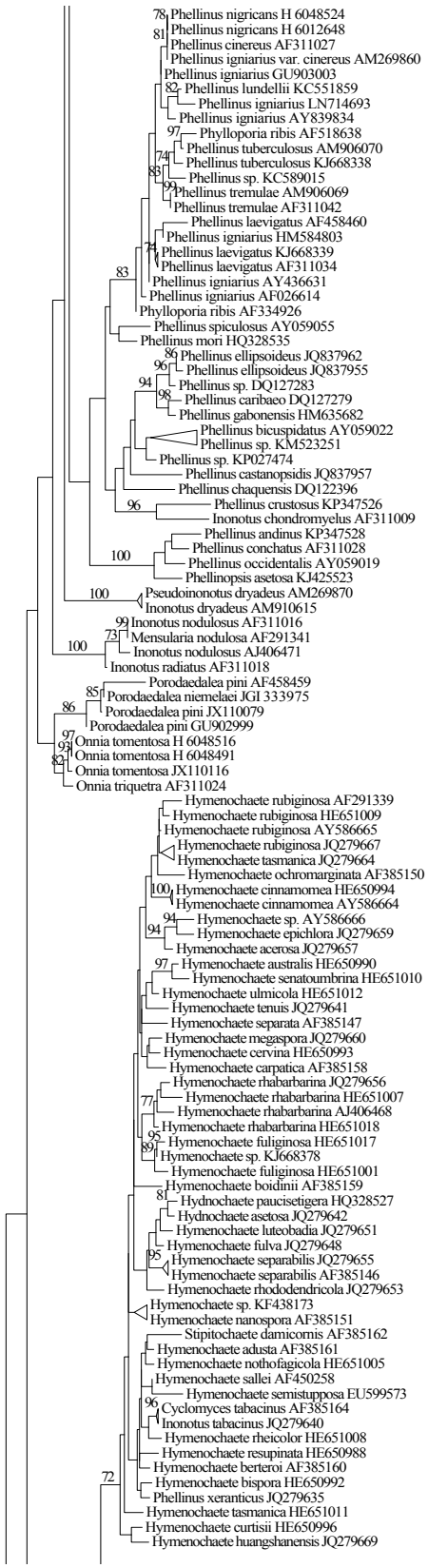



**Figure IX. Continued.**

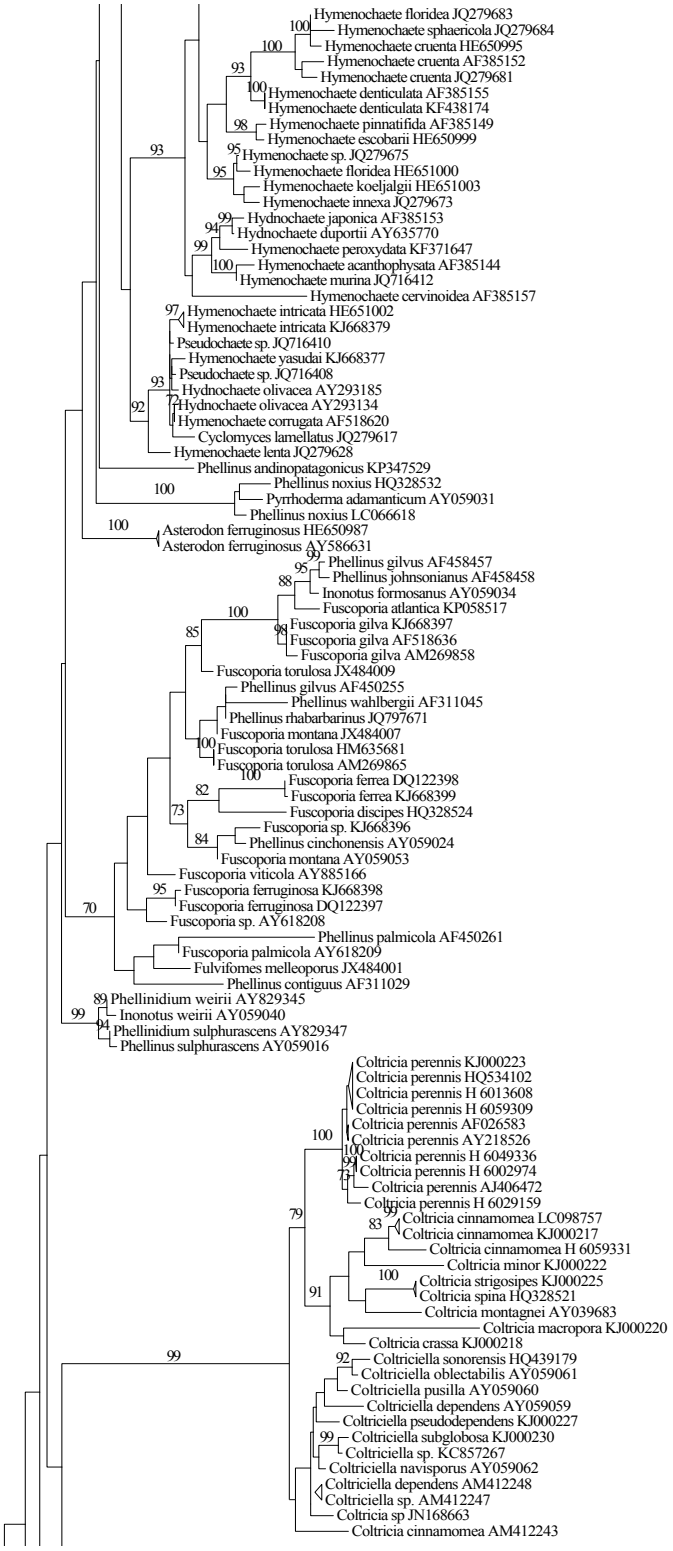



**Figure IX. Continued.**

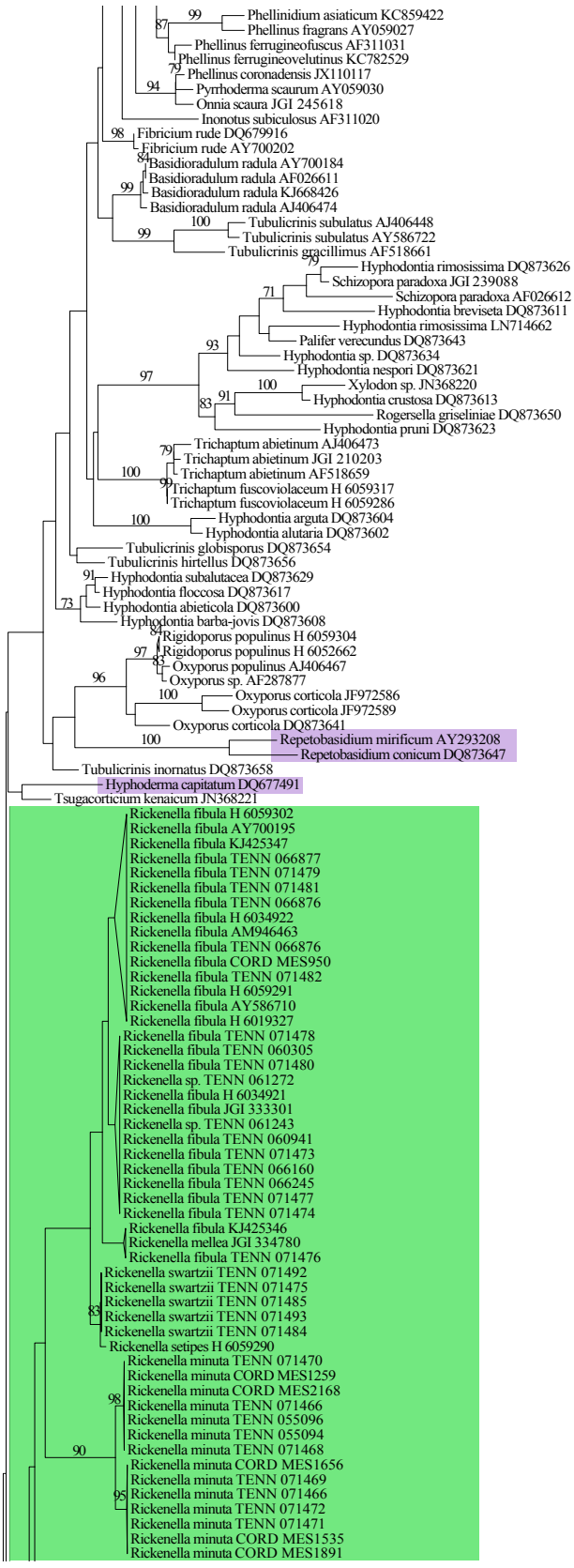



**Figure IX. Continued.**

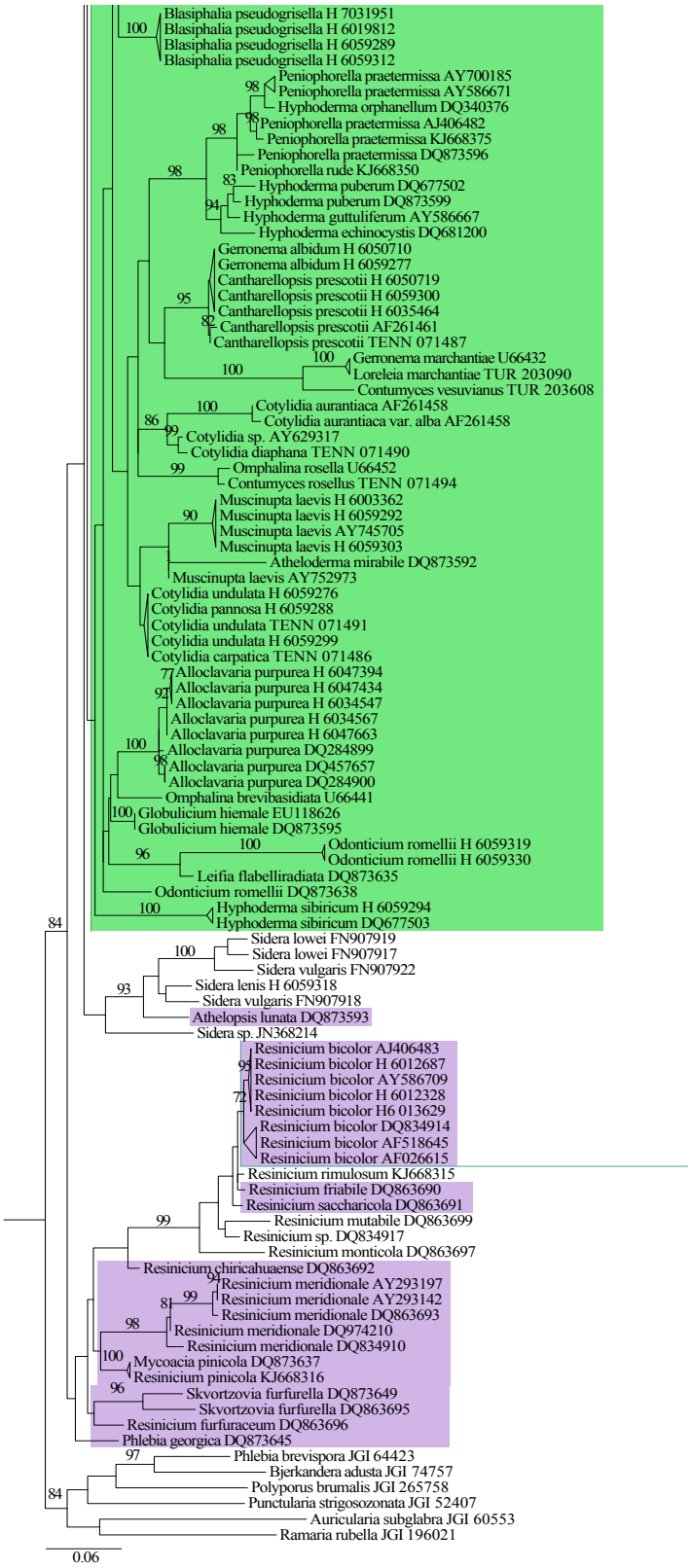



**Figure IX. Continued.**

# VITA

Hailee Brynn Korotkin was born and raised in Birmingham, Michigan by her parents Steven and Laura with her three siblings, Aiden, Rachel, and Ari. She graduated with a Bachelor of Science in Business Administration from the University of Tennessee in 2012. However, at the end of her undergraduate career, she became fascinated with fungi and their inherent differences from plants. In 2013, she began working for Dr. Brandon Matheny in his fungal systematics lab at the University of Tennessee, where she became interested in organismal symbioses with fungi. In 2015, she started her pursuit of a Masters of Science in Ecology and Evolutionary Biology under the guidance of Dr. Matheny.