2013

A Phylogenetic Analysis of Species Diversity, Specificity, and Distribution of Mycodiplosis on Rust Fungi

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A PHYLOGENETIC ANALYSIS OF SPECIES DIVERSITY, SPECIFICITY, AND DISTRIBUTION OF MYCODIPLOSIS ON RUST FUNGI

A Thesis

Submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of
Master of Science

in

The Department of Plant Pathology and Crop Physiology

by
Donald J. Nelsen
B.S., Minnesota State University, Mankato, 2010
May 2013

Acknowledgments

Many people gave of their time and energy to ensure that this project was completed. First, I would like to thank my major professor, Dr. M. Catherine Aime, for allowing me to pursue this research, for providing an example of scientific excellence, and for her comprehensive expertise in mycology and phylogenetics. Her professionalism and ability to discern the important questions continues to inspire me toward a deeper understanding of what it means to do exceptional scientific research.

I would also like to thank my committee members for unfailing support and advice: Dr. Meredith Blackwell for her inspirational mycological expertise and suggestions which made this project a success, Dr. Christopher Clark for his broader understanding of the context of this research, and Dr. Marc Cohn for his technical advice and interest in my professional success.

While working on this project I also was privileged to collaborate with two scientists in Japan. Dr. Tsuyoshi Hosoya at the National Museum of Nature and Science in Tsukuba, Japan provided lab space and equipment, collecting opportunities, and assisted in the identification of rust fungi that I collected while visiting his institution. Dr. Yuichi Yamaoka at the University of Tsukuba in Tsukuba, Japan gave his time to take me collecting for several days and also provided his expertise with the identification of rust fungi occurring in Japan. I am grateful to the Louisiana Board of Regents for providing funding in support of this effort.

In the course of pursuing this project I have had the pleasure of discussing various aspects of the work with many faculty and fellow graduate students. I would like to extend my gratitude to Dr. Eric Achberger for his advice on PCR protocol development. I would also like to thank Drs. James Geaghan and Bin Li for their advice on appropriate statistical methods. A special thanks to Dr. Hector Urbina for advice on using MEGA and RAxML software as well as listening to my ideas regarding interpretation of the data. I am thankful for the advice and guidance in molecular techniques provided by the post doctoral researchers Alistair McTaggart, Merje Toome, and Gregory Heller. I’ve also had the pleasure to work alongside some wonderful graduate students without whom this work would not have been possible; to Sebastian Albu, Andrew Rodriguez, Tomas Rush, Rachel Koch, Youwen Gong, and Jorge Diaz I extend my heartfelt appreciation for their support and friendship. I would also like to thank Paige Muse and Catherine Perino for keeping the lab running so I could complete this work.

I must also mention that I am so very grateful to my friends and family for their unfailing support and encouragement. I thank Britta Simonson for inspiring me to pursue my dream. I thank Chad Borgheiink for his lifelong friendship and interest in my research. To my sisters, Teri and Jodi, I extend special thanks for their willingness to listen and help me find my way back to the goal of this research. I would like to thank my mother and her husband, Dee and Dean Hoeft, for always listening and providing practical advice that has always kept me grounded. I also thank my father, Donald James Nelsen, for his kindness, patience and perspective.

Table of Contents

Abstract

There are more than 7800 species of Pucciniales (rust fungi) described. Aeciospores and urediniospores of rust fungi are a food source for the larval stage of members of the fly genus *Mycodiplosis*, hence these could be of interest as potential biological control agents. Currently, *Mycodiplosis* contains 49 described species based on adult male morphology. A survey of 1,350 rust-infected plants from 44 countries was recently conducted to assess the occurrence of *Mycodiplosis* fly larvae across a broad spectrum of Pucciniales. Larvae were found on 261 collections from 25 countries. Statistical analyses explored the distribution of larvae in relation to host species. Five of 127 rust species in the survey data were identified as infested at a greater frequency than expected using binomial probability analysis of presence/absence. DNA was extracted from individual larvae and 28S nuclear ribosomal RNA and mitochondrial cytochrome c oxidase subunit 1 (COI) genes were amplified and sequences were concatenated for maximum likelihood analyses. Test analyses were done using identical sequence regions of 28S and COI from *Bradysia* species and *Asteromyia* species respectively, to verify the ability of individual loci to resolve species. The 206 larval specimens analyzed were resolved into approximately 33 clades, 17 of which received significant support. One clade has a global distribution in the survey. Twelve clades occurred in the United States. There are currently seven species described from the United States, the finding of 12 clades in this study represents potential additional species in the *Mycodiplosis*. The distribution of larvae within clades could be explained partially by geographic origin but not by rust host at any taxonomic level; thus even though there is evidence for preferential feeding by larvae on some rust species, there is no evidence of host-specificity between clades of larvae and their hosts.

Chapter 1. Introduction and Literature Review

1.1 Pucciniales

The Pucciniales (rust fungi) are an order of phytopathogenic Basidiomycota. These fungi are diverse and host-specific, with over 7800 described species from 133 genera in 13 families (Aime 2006; Cummins and Hiratsuka 2003). Recent phylogenetic analyses have begun to resolve evolutionary relationships within rust fungi (Aime 2006; van der Merwe, et al. 2007; van der Merwe, et al. 2008). The rust fungi are characterized by up to five spore-producing life stages occurring on one (autoecious) or two (heteroecious) plant hosts (Cummins and Hiratsuka 2003). These spore states reflect anamorphic and teleomorphic reproductive strategies and are numbered 0-IV (Cummins and Hiratsuka 2003; Hiratsuka 1973). The aecial (I) and uredinial (II) stages of the rust fungal life cycle are dikaryotic asexual spore states that constitute a major food source for the larval stage of the fly genus *Mycodiplosis* (Gagné 2004; Henk, et al. 2011; Kaushal, et al. 2001; Powell 1971).

1.2 Mycodiplosis

Mycodiplosis is a poorly studied genus of flies in the family Cecidomyiidae. Members of this genus are described using morphology of adult males to distinguish species. There are 49 accepted species, with five species deposited in the entomological collections of the National Museum of Natural History from Jamaica and the United States, and four additional described species from the Neotropical region (Gagné 1994; Gagné 2004). In Gagné's 2010 revision of his 2004 catalog of Cecidomyiidae (Gagné 2004), he lists all 49 species and their synonyms. The earliest records of *Mycodiplosis* are two species collected in Germany and identified in 1853 by Johann Winnertz, *M. ceomatis* and *M. coniophaga*. The latter species was described again in 1901 under the name *M. reaumuri* by Jean-Jaques Kieffer in France, and five more times under five different names between 1901 and 1911 by then New York State Entomologist Ephriam P. Felt. Between 1853 and 1969, 32 species of *Mycodiplosis* were described. Since 1970, only 17 new species have been published. Interest in this genus appears to be increasing however, as Russian entomologist Z.A. Fedotova has described eight *Mycodiplosis* species since 1985, with five between 2002 and 2004 from a single study site in Russia differentiated based on adult male reproductive morphology (Fedotova 2002; Fedotova and Sidorenko 2003, 2004). Additional entomological interest could result in discovery of more species previously undescribed.

The possibility of hidden biodiversity and many more undescribed species in the genus was recently raised (Henk, et al. 2011). Herbarium collections of rust-infected plant material have been found to contain *Mycodiplosis* larvae (Henk, et al. 2011). The life cycle stages of a representative species of *Mycodiplosis* from India have been described, and the possible use of the insect as a biological control agent of rust fungi suggested (Kaushal, et al. 2001). The larvae of *Mycodiplosis* species are often obligate feeders on urediniospores and aeciospores of Pucciniales while some species share the galling habit common to other genera within Cecidomyiidae. Twenty one of the 49 described species were found on rust-infected plant material (Gagné 2004). In one study examining *Mycodiplosis* feeding on rust in India, the *Mycodiplosis* life cycle coincides with the secondary infection cycle of its rust food source, lasting approximately 15 days (Kaushal, et al. 2001). The fly larvae of this *Mycodiplosis* species fed on spores and reduced the quantity of secondary inoculum that would otherwise produce additional disease cycles (Kaushal, et al. 2001). The possibility of *Mycodiplosis* species larvae being used as a biological control agent for phytopathogenic Pucciniales is a practical consideration for exploring the diversity of these organisms and their ecological relationship with the rust fungi. Little else is known about the relationship between these fly larvae and their fungal food source. By examining the evolutionary history of this ecologically intimate relationship, it is possible to understand more about both Pucciniales and *Mycodiplosis.*

Many insects and mammals feed on fungal fruiting bodies and reproductive propagules (Pirozynski and Hawksworth 1988; Wheeler and Blackwell 1984; Wilding, et al. 1989). The larvae of *Mycodiplosis* flies are thought to feed extensively on the spores of rust fungi and powdery mildew, while adults have been found feeding in nectaries of cacao flowers and on the termite prey of spiders (Gagné 1994; Kaushal, et al. 2001; Powell 1971). Among the described species of *Mycodiplosis* are larval stages that were discovered feeding upon Erysiphales (powdery mildews, five spp. of *Mycodiplosis*), Peronosporales (downy mildews, *M. inimica*), and even a saprotrophic Russulales, *Peniophora cinerea* (*M. gloeopeniophorae*). Of the 49 described species, 27 are known to be mycophagous in the larval stage, with 21 occurring on rust. Several other species were described from adults reared in a laboratory from larvae found in plant galls (Fedotova 2002; Fedotova and Sidorenko 2003, 2004; Gagné 2004). These plant-galling species of *Mycodiplosis* represent a shared ecological specialization with other genera of the Cecidomyiidae family, otherwise known as the gall midges. Thus, the placement of *Mycodiplosis* in Cecidomyiidae is supported by morphology (Gagné 1994) and galling strategies.

Rust-feeding species in this fly genus are thought to be limited in range and dispersal, commonly colonizing rust infected plants within a small geographic range (Kaushal, et al. 2001; Powell 1971). The somewhat selective mycophagous habit of *Mycodiplosis* larvae is an ecological specialization that has had little exploration to determine its evolutionary significance with regard to either flies or fungi. To date, a single pilot study has been published presenting the possibility of feeding specificity and coevolution in this intimate ecological relationship (Henk, et al. 2011). In the pilot study by Henk, et al. (2011) they examined forensic larval specimens from herbarium collections of rust-infected plant material. The presence of *Mycodiplosis* larvae in herbarium rust collections provides an opportunity to examine their level of feeding specialization and the number of these fly species feeding on rust fungi.

1.3 Host specialization and coevolution

The feeding niche of an organism can be that of a generalist, which exploits all locally available food sources that are physiologically compatible, or a specialist, exploiting food sources more narrowly defined by species, genus, or family groupings (Fox and Morrow 1981). Specialization is described in terms of behavior, physiology, and genetics (Jaenike 1990). There is a possibility of a range of specialization within *Mycodiplosis*, Henk, et al. (2011) found molecular evidence for possible feeding specialization among several potential species. Although *M. coniophaga*, *M. melampsorae* and *M. pucciniae* have been found on many rust species, and *M. rubida* was described twice by E. P. Felt, once on *Uromyces pisi* and once on a *Puccinia* sp., there are still 16 described *Mycodiplosis* species that have only been associated with a single rust species (Gagné 2004). The degree of specialization in *Mycodiplosis* species larval feeding remains undetermined.

Host specialization may provide evidence of coevolutionary relationships between two groups of organisms (Jermy 1984). Coevolution describes reciprocal changes in species that share a close ecological relationship. Jermy (1984) discusses the impact of host-specialized herbivorous insects influencing selection for herbivory-resistant offspring, and the subsequent evolution of the herbivorous insect to overcome this resistance. Coevolution of species that are ecologically intimate can lead to increases in allopatric speciation and biodiversity assuming populations remain locally distinct. Molecular phylogenetic evidence and ecological niche specializations in a recent study of the diversification of the Cecidomyiid genus *Asteromyia* on their host plants suggests that coevolution of species within the Cecidomyiidae is occurring (Stireman, et al. 2010). Coevolution of mycophagous insect species and their fungal food sources is a topic of scientific interest as a potential driver of speciation, and hence biodiversity, and as a possible source of organisms potentially useful as biological control agents for phytopathogenic fungi (Henk, et al. 2011; Kaushal, et al. 2001). Determining the number of *Mycodiplosis* species occurring on rust-infected plant material provides an opportunity to examine the extent of specialization and potential coevolution. Distinguishing separate species in *Mycodiplosis* from larval specimens presents a challenge.

1.4 Species concepts

There are many species concepts, and the argument over which is the most acceptable for delimiting species is ongoing. In the case of Dipterans, the morphological species concept has been used to describe species based on the reproductive morphology of adult males (Gullan and Cranston 2010). This method is not suited to species determination in the larval stage of the fly life cycle as many species can appear similar at this stage (Gullan and Cranston 2010). *Mycodiplosis* species are associated with rust in the larval stage, so species determination using morphology in the case of this genus requires rearing the insect if it is collected with rust-ifected plant material. This is not possible when examining forensic specimens that may be archived with rust in herbarium collections of infected plant material.

The biological species concept describes species based on reproductive isolation (Mayr 1996). This concept presents species as discrete units separated by the capacity to produce fertile offspring. Insect species are often separated by incompatible sexual organs constituting a morphological mechanism of reproductive isolation (Gullan and Cranston 2010). Thus, applying the morphological species concept to the determination of insect species based on reproductive morphology is consistent with the biological concept of species. The problem of species recognition using forensic larval specimens remains.

The genealogical species concept focuses on the evolutionary history of populations on the basis of DNA evidence, among other potentially useful characters such as morphology and ecological niche (Baum and Donoghue 1995; McKitrick and Zink 1988). In the case of DNA evidence, this concept is based on genetic divergence. A single DNA locus measure of phylogenetic history often does not represent the true extent of species or the true relationship among a set of samples, but by building phylogenies based on concatenation of multiple loci the gene phylogeny may more closely resemble the true species tree (Hudson and Coyne 2002; McKitrick and Zink 1988; Rokas, et al. ; Taylor, et al. 2000). Genetic divergence can be used to identify known species (Hebert, et al. 2003), infer the presence of species yet to be described (Frezal and Leblois 2008), and allow the examination of species-level clades in phylogenetic analysis (McKitrick and Zink 1988; Taylor, et al. 2000). The use of a genealogical species concept based on phylogenetic analysis of DNA evidence is suited to examination of species diversity and association of *Mycodiplosis* larva from archived collections of rust-infected plant material available in herbaria.

1.5 DNA based species identification

Advances in the field of phylogenetics allow for the identification of species based on DNA sequence information. One way to accomplish sequence-based identification of species and determination of undescribed species has been the development of a universal “barcode.” The barcode is a conserved gene in a larger taxon with variation in nucleotide sequences. Initially, it was hoped that there would be a single barcode region applicable across all kingdoms (Hebert, et al. 2003). This does not appear to be the case, but there are genes which have barcoding utility within kingdoms (Frézal and Leblois 2008; Hebert, et al. 2003; Schoch, et al. 2012). The cytochrome c oxidase I (COI) gene of mitochondrial DNA (mtDNA) is the currently favored region for barcoding of animals (Jinbo, et al. 2011). The gene is retained within the kingdom. COI is also variable in nucleotide sequence, allowing discrimination on multiple taxon levels (Hebert, et al. 2003). Species identification using sequence divergence of COI has been achieved with 100% success in known Lepidopterans (Hebert, et al. 2003).

Another way to accomplish species recognition with DNA sequence is through the application of the phylogenetic species concept to assign species-level clades in a phylogenetic tree. COI has been used in phylogenetic efforts to infer the evolutionary history of previously described species within the Diptera, as well as to infer the existence of species not yet taxonomically described. Sequence information from COI (Tokuda, et al. 2008), supplemented by sequence data from other loci (COII and Leucine tRNA (Stireman, et al. 2010); and nuclear 28S rRNA (Dorchin, et al. 2004; Friedrich and Tautz 1997; Paterson, et al. 2000)), can be used to generate individual phylogenetic trees and concatenated phylogenetic trees with species-level resolution describing the evolutionary history of clades within Diptera.

Phylogenetic analysis of rDNA sequences can be applied to increase the resolution of inferred species relationships. Within the rust fungi, family-level evolutionary history has been an area of active research and recent work using both 18S and 28S regions of rDNA (Aime 2006) has resolved some Pucciniales taxa. Understanding the relationships of fungi in this order could be useful for determining how rust-feeding *Mycodiplosis* species may be tied to their host.

The distribution of larvae on rust-infected plant material may be useful to infer if there may be some specificity in the relationship between insect and fungus. Statistical analyses of the occurrence of *Mycodiplosis* on rust may help to determine if there is a significant association at species, genus, or family level of the rust host. Larval species that are significantly associated with certain rust taxa may have co-evolved with their food source. Statistical analysis of the presence or absence of larvae on rust fungi can show the specificity of such an association. Larval clades from phylogenetic analysis can then be used in a co-phylogenetic assessment of coevolution if there is significant association. A co-phylogeny, or a comparison between two phylogenetic trees, can result in topologies that may mirror each other if species that share a symbiotic association are coevolving over time (Roy 2001; van der Merwe, et al. 2008). Conversely, if the comparison of phylogenies has limited or no congruence, it is possible that either host jumping occurred or the feeding behavior is that of a generalist (Roy 2001). *Mycodiplosis* species could take advantage of available diverse nutrient sources within their geographic range, suggesting a more generalist approach to feeding behavior (although not ruling out specificity to the genus or family level). Alternatively, incongruence can be caused by intrahost speciation events where *Mycodiplosis* speciates on the same host; these two new species may then cospeciate with the rust and lead to duplicate lineages (Paterson, et al. 2000). If there is no significance in the distribution of *Mycodiplosis* species on rust, then co-phylogenetic analysis would be unnecessary.

A recent phylogenetic analysis of *Mycodiplosis* using nuclear 28S rDNA shows variation in that locus between sampled larvae from different collections of rust-infected plant material (Henk, et al. 2011). This raises the possibility of biodiversity within *Mycodiplosis* occurring on rust, host-specificity in the feeding of these fly species, and potential co-evolution occurring between *Mycodiplosis* species and rust species on their plant hosts. The pilot study of *Mycodiplosis* by Henk et al. provides a starting point to examine the potential diversity and level of association with rust fungi in this fly genus using DNA evidence as a basis to infer species.

Mycodiplosis larvae have been found on herbarium collections of rust fungi from most regions of the world (Henk, et al. 2011). Henk's pilot study examined 543 rust collections from nine countries. His study generated four *Mycodiplosis* 28S sequences that were deposited in GenBank (Henk, et al. 2011). The available sequence data for *Mycodiplosis* are limited to those four, and the current study represents an attempt to further explore diversity of *Mycodiplosis* species and their rust fungal association using 28S and COI sequences. The purpose of the present study is to use phylogenetic analyses of DNA sequence data obtained from surveying a large dataset of rust-infected plant material in both herbarium and fresh collections for *Mycodiplosis* larvae to examine the number of potential fly species, their potential host-specificity on rust, and to better understand the host and geographical distribution of *Mycodiplosis* larvae.

1.6 Objectives

1) Determine the number of potential *Mycodiplosis* species present in herbarium holdings and fresh collections of rust-infected plants using DNA sequence information and a phylogenetic concept of species.

2) Examine the distribution of larvae geographically and by host, and determine the level of specificity in the relationship between clades of *Mycodiplosis* larvae and rust fungi. If there are significant factors in the distribution and specificity of larvae from rust-infected plant material, then statistical analyses will identify these factors. If *Mycodiplosis* species are specific to rust on some taxonomic level, then statistical analysis will identify the significance of the relationship between fly and rust.

Chapter 2. Materials and Methods

2.1 Collecting larvae for analysis

Herbarium holdings and fresh collections of rust infected plants were surveyed for *Mycodiplosis* larvae. All fresh collections and all available collection material from herbarium holdings of Dr. M. C. Aime were surveyed, for a total of 1350 examined collections (Appendix A, Table A-1 page 57). Leaves and stems of each collection were scanned with a Nikon SMZ-U stereo microscope (Nikon Corporation, Melville, NY) set at 1.1X magnification for either two minutes, or if material was limited, until all material in the collection was examined. Larvae detected on rust-infected plant material were removed individually with a fine horse hair brush, and the brush was cleaned with 70% ethanol between collections. Larvae collected from each herbarium specimen were placed in sterile microfuge tubes and labeled with a unique identifier. If more than one larva was present on a collection of rust-infected plant material, up to 30 were isolated for replicate analyses. A single larva was separated from each larval collection and placed in a 0.2ml microfuge tube for subsequent DNA extraction. Single-larva isolates were labeled with a unique identifier. A total of 187 larval collections from examined herbarium materials were isolated for sequencing and phylogenetic analysis.

A total of 124 rust-infected plant collections were made in Japan during July and August 2012. Plants from these collections were identified by morphology when possible, and rust fungi were identified by macro and micro-morphological characteristics as well as host association using The Rust Flora of Japan (Hiratsuka 1992). Collections were surveyed prior to pressing and drying of plant material, and larval specimens isolated as described above. Of these, 74 larval collections were isolated for phylogenetic analysis from the Japanese collections of infected plant material. From herbarium and Japanese collections surveyed, 261 total collections contained larvae.

2.2 DNA extraction, amplification, and sequencing

2.2.1 DNA extractions

Three extraction methods were tested for their capacity to obtain DNA from larvae. An initial extraction attempt from five samples, consisting of 1-5 larvae per tube respectively, was made using the available Promega Wizard Genomic DNA Purification Kit (Promega Corporation, Madison, WI) following manufacturer's protocol (Appendix C, page 151) with the following changes: 600µl nuclei lysis solution, incubation at 65°C for 15 minutes, 200µl protein precipitation solution, suspended DNA in 30µl of 1X TE buffer. No DNA bands were visible in 1% agarose gel electrophoresis (90V, 45min) of 2µl extracted DNA mixed with 1µl dye solution (1:100 gel red to xylene cyanol). Due to apparent low concentration of extracted DNA, PCR reactions were done to establish the presence of DNA in solution. Gel electrophoresis (as previously described) of PCR product from these extractions showed very weak product in the single larva tube, so two additional extraction methods were tested.

The Bio-Rad InstaGene Matrix (Bio-Rad Laboratories, Hercules, CA) was tested on three single-larva samples at 50, 100, and 200µl of matrix used respectively. Manufacturer's protocol for DNA preparation from whole blood was followed (Appendix C, page 151) with these modifications: skipped steps 1-4 as they were not applicable to tissue extraction, volume of matrix used varied as previously stated, 10µl of supernatant were used for each PCR reaction. Agarose gel electrophoresis was done as described above, and each extraction provided strong PCR product.

In the third method, DNA extractions from two single larva samples were carried out using *prep*GEM Insect extraction kit (ZyGem Corporation Ltd, Hamilton, New Zealand). The manufacturer's protocol (Appendix C, page 151) was modified as follows: 17.5µl of PCR-grade water, 2µl of 10X buffer BLACK, and 1µl of *prep*GEM extraction enzyme solution per reaction. Five volumes of extracted DNA, in 1µl increments from 1-5µl, were then tested in PCR reactions. Agarose gel electrophoresis of PCR products was done as previously described and all exhibited strong PCR product bands. The *prep*GEM Insect extraction kit provided the strongest PCR product band using the least amount of suspended DNA in the extraction solution, so this method was used for all subsequent DNA extractions from single larval samples.

The protocol for DNA extraction of single *Mycodiplosis* larval samples using *prep*GEM Insect was as follows: each larva was placed in a 0.2ml microfuge tube, reagents were added to the tubes using the volumes described above, the mix was incubated in a thermal cycler (Tetrad, Bio-Rad Laboratories, Hercules, CA) at 75°C for 15min followed by 5min at 95°C, supernatant was pipetted to new labeled 0.2ml microfuge tubes, 2µl of 10X TE buffer pH 7.5 was added, and the extract was stored at 4°C for short term or -20°C for long term viability of suspended DNA.

DNA extractions were made from 333 individual larval samples from 261 collections of rust-infected plants (Appendix A, Table A-1 page 57).

2.2.2 PCR amplification and sequencing

Two nuclear loci were chosen initially for amplification and analysis. The 28S ribosomal RNA gene was chosen based on preliminary evidence of genetic diversity in *Mycodiplosis* (Henk, et al. 2011), and on the ability of this locus to resolve generic level relationships (Martinsson, et al. 2011). The internal transcribed spacer 2 (ITS2) region of nuclear DNA was also amplified and examined based on apparent genetic distance between species within a genus

(Marinho, et al. 2011), as well as the ability of this locus to resolve relationships between species of *Asphondylia*, a relative of *Mycodiplosis* within the Cecidomyiidae (Joy and Crespi 2007). ITS2 was not used in the phylogenetic analysis of *Mycodiplosis* samples due to no variation in sequence among 8 tested samples. In addition the nuclear DNA locus, two mitochondrial loci were chosen for amplification and analysis. The choice of cytochrome c oxidase subunit 1 (COI) was based on resolution of species within genera of the fly families Mycetophilidae (Martinsson, et al. 2011), and Cecidomyiidae (Stireman, et al. 2010; Tokuda, et al. 2005; Tokuda, et al. 2008). The small subunit 12S region was also selected based on the potential to resolve higher level phylogenetic relationships in combination with other data (Carapelli, et al. 2000) and to see if there was also potential for species level resolution in *Mycodiplosis*, but 12S was not used in phylogenetic analyses due to nonspecific amplification that resulted in multiple PCR products.

Each locus required the use of internal primers for nested PCR reactions (Table 1). The 28S primers developed by Henk et al (2011) did not consistently amplify template from single larva DNA extractions. In order to provide consistent amplification of target sequence additional primers were developed (Table 1). Successful initial amplifications were sequenced and these sequences were aligned with the four previously published 797bp amplicons from the pilot study of *Mycodiplosis* (Henk, et al. 2011) using MEGA 5.0 alignment software (Tamura, et al. 2011). A primer pair internal to the available GenBank sequences and successful initial amplifications was selected by identification of conserved areas among all sequences. This potential 28S primer pair was then analyzed using the National Center for Biotechnology Information (NCBI) Primer-BLAST (basic local alignment search tool) gateway (Ye, et al. 2012) to verify limited self and pair complementarity, identify melting temperature, and verify lack of hairpin formation. This primer was then tested, and temperature protocols optimized, in nested PCR reactions on a gradient thermal cycler and the amplified product was visualized on 1% agarose gel via electrophoresis (120V, 50min). The primer pair was used in subsequent PCR reactions to amplify 28S from *Mycodiplosis* samples. Nested PCR reactions were conducted using product directly from initial reactions, as well as 5µl of initial product cleaned using exonuclease I and shrimp alkaline phosphatase (ExoSAP). ExoSAP reaction volumes and protocol were as follows: 0.11µl each of Exo and SAP, and 1.98µl molecular grade water were added to each 5µl PCR product, reactions were carried out in a thermal cycler at 37°C for 15 minutes, 85°C for 15 minutes, and then stored at 4°C. Analysis of nested PCR efficacy was done using 1% agarose gel electrophoresis (120V, 50min). No visible difference was detected between PCR using direct addition of product template versus ExoSAP cleaned template. Sequencing results for both direct and cleaned nested PCR products produced sequence of similar quality. Subsequent nested PCR was conducted using direct addition of PCR product from first round amplifications as template.

Internal primers for COI were developed from successful amplifications of extracted DNA using fly-specific COI primers (Table 1). No COI sequence for *Mycodiplosis* had been previously archived in GenBank, so sequences were identified as likely *Mycodiplosis* based on 90% or greater similarity to closely related genera within Cecidomyiidae as determined by NCBI BLAST search. Sequence alignment and internal primer development for COI then commenced as described above.

Nested amplification of 12S was accomplished using previously published primers (Table 1). Amplification of 12S resulted in nonspecific priming after nested gradient PCR. This locus was discarded for phylogenetic analysis based on the difficulty of obtaining initial product for sequence validation, as well as limited available information regarding its utility for phylogenetic analyses to the species level.

Nested amplification of ITS2 was accomplished using previously published primers (Table 1). Amplification of ITS2 was successful, but the locus was discarded as it exhibited no variation between sample sequences. Amplification details of PCR reactions and cycling conditions follows.

All PCR amplification reactions conducted in this project consisted of 12.5µl of 2X PCR master mix (Promega Corporation, Madison, WI, and Genesee Scientific, San Diego, CA), 1.25µl of each 10µM primer, 9 µl PCR-grade water, and 1µl of DNA template. Each PCR run contained a negative control substituting 1µl of PCR-grade water for DNA template. All PCR reactions were carried out in a Tetrad thermal cycler (Bio-Rad Corporation, Hercules, CA). The basic amplification protocol for 25µl PCR was as follows: initial denaturation at 94°C for 7min followed by 35 cycles of 94°C for 45sec, primer annealing at 52°C for 90sec, elongation at 72°C for 90sec, with a terminal elongation step of 72°C for 7min (Henk, et al. 2011). All PCR products and negative controls were visualized using 1% agarose gel electrophoresis run at 120V for 50min to 60min. In each lane of the agarose gel was loaded with 2µl of reaction product mixed with1µl of 1:100 Gel Red:xylene cyanol loading dye solution. When negative controls contained a visible product band the PCR reactions were discarded and retried. Products from successful PCR amplifications were then sent for sequencing to Beckman Coulter Genomics in Danvers, Massachusetts.

Initial 28S amplification was conducted as described above, using Fly28f and Fly28r primers developed by Henk, et al. (2011) (Table 1). Nested amplification of 28S also was conducted as described above with the following modifications: primers Fly28-IF-5 and Fly28-IR-5 (Table 1), 1µl of initial 28S PCR product as template, initial denaturation decreased to 2 minutes, 94°C for 30sec, annealing temperature decreased to 50°C for 40sec, and elongation time decreased to 30sec.

Initial ITS2 amplification was conducted using ITS5 and LR22 primers (Table 1) with the following modifications to the basic protocol: 94°C for 30sec, annealing temperature decreased to 50°C for 45sec, and elongation time decreased to 45sec. Nested amplification of ITS2 was conducted using ITS2A and ITS2B primers (Table 1) with the following modifications to the basic protocol: Initial denaturation time decreased to 2min, annealing temperature decreased to 51°C for 45sec, and elongation time decreased to 45sec.

Initial COI amplification was conducted using C1-J-2161 and C1-N-2678 primers from Simon et al. (1994) (Table 1) with the following modifications to the basic protocol: Initial denaturation time decreased to 3min, 94°C for 45sec, annealing time decreased to 45sec, and elongation time decreased to 45sec. Nested amplification of COI was conducted using MC1-J1 and MC1-N1 primers (Table 1) with the following modifications to the basic protocol: Initial denaturation time decreased to 3min, 94°C for 45sec, annealing temperature decreased to 42°C for 45sec, and elongation time decreased to 45sec.

Initial 12S amplification was conducted using SR-J-14199 and SR-N-14939 primers (Table 1) with the following gradient thermal cycler protocol: initial denaturation at 95°C for 5min, followed by 37 cycles of 95°C for 45sec, primer annealing gradient from 37°C to 45°C for 60sec, elongation at 72°C for 60sec, with a terminal elongation step of 72°C for 10min. Nested amplification of 12S was conducted using SR-J-14214 and SR-N-14776 primers (Table 1) using the above protocol with a primer annealing gradient from 55°C to 65°C.

Table 1. Primers used in PCR reactions to amplify selected loci of *Mycodiplosis* larval DNA extractions.

Primer Name	Primer Sequence (5'--3')	Locus	Amplicon (bp)	Reference
Fly28F (forward)	AGAGTCGNGTTGCTTGANAGTGC	28S (initial)	1756	Henk et al 2011
Fly28R (reverse)	AGACCNGCTGCGGATATNGGTA			
Fly28-IF-5 (forward)	TGAGTGTAATAAGACCCACTTTTAG	28S (nested)	489	Herein
Fly28-IR-5 (reverse)	CGGTGGACATGGAAGTCGTA			
ITS5 (forward)	GGAAGTAAAAGTCGTAACAAGG	ITS2 (initial)	1500 (approx.)	White et al 1990
LR22 (reverse)	CCTCACGGTACTTGTTCGCT			Vilgalys lab, Duke University
ITS2A (forward)	TGTGAACTGCAGGACACAT	ITS2 (nested)	480	Beebe & Saul 1995
ITS2B (reverse)	TATGCTTAAATTCAGGGGGT			
C1-J-2161 (forward)	CAACATTTATTTTGATTTTTTGG	COI (initial)	517	Simon et al 1994
C1-N-2678 (reverse)	GTCAATCCAGTAAATAATGG			
MC1-J1 (forward)	GTTTTAGGAATAATTTATGC	COI (nested)	326	Herein
MC1-N1 (reverse)	TGAAAATGAGCTACTACATA			
SR-J-14199 (forward)	TACTATGTTACGACTTAT	12S (initial)	740	Dorchin et al 2004
SR-N-14939 (reverse)	AAGTTTTATTTTGGCTTA			Simon et al 1994
SR-J-14214 (forward)	AAGAGCGACGGGCGATGTGT	12S (nested)	562	Simon et al 1994
SR-N-14776 (reverse)	GACCAAATTGGTGCCAGCAGT			

2.3 Phylogenetic analyses

2.3.1 Sequence assembly, alignment, outgroup selection, and phylogenetic analysis

Sequencing of PCR product was done using both forward and reverse primers at Beckman Coulter Genomics in Danvers, Massachusetts. Forward and reverse sequence reads were received in chromatogram file format (.ab1) from Beckman Coulter Genomics for 277 28S amplicons and 305 COI amplicons. Sequence files were edited manually by visual inspection of chromatogram data. Contiguous sequences were assembled using Sequencher 5.0 (Gene Codes

Corporation, Ann Arbor, MI). Some sequences were discarded during assembly due to poor quality of sequence reads. The remaining sequences were then verified by using NCBI BLAST nucleotide search engine to align individual sequences with those archived in GenBank. Aligned sample sequences sharing the greatest percentage of coverage and identical nucleotides with archived sequences are given a "maximum identity" score in the form of a percentage by the BLAST engine. 28S sequences with the greatest maximum identity to *Mycodiplosis* or Cecidomyiidae sequences in GenBank were then kept for analysis (95% or more, with no greater similarity to any other organisms). The 28S amplicon for ML 65 was identified as *Mayetiola destructor* (Appendix A, Table A-1 page 57) with 99% maximum identity. No *Mycodiplosis* sequence data were available for COI. Sequences of COI from samples were kept if maximum identity results were of a closely related genus, *Asteromyia* (80% or more, with no greater similarity to any other organisms). Nine COI amplicons were identified as other than *Mycodiplosis* by maximum identity (Appendix A, Table A-1 page 57). A total of 206 *Mycodiplosis* samples had valid contiguous sequences for 28S and COI using these maximum identity criteria. Sequences for each locus were combined in FASTA files and aligned in MEGA 5.0 (Tamura, et al. 2011) using a MUSCLE algorithm (Edgar 2004). Alignments were refined by eye in MEGA 5.0. Aligned contiguous sequences for 28S and COI measured 407bp and 300bp respectively. Sequences were analyzed in MEGA 5.0 for nucleotide content, percent distance, and parsimony informative sites.

Homologous 28S and COI sequences for *Mayetiola destructor* were obtained from GenBank and used as outgroup sequences for phylogenetic analysis. Outgroup selection was determined based on both the use of *Mayetiola destructor* sequence as outgroup in the preliminary study (Henk, et al. 2011), and the lack of available sequence data for identical regions of both loci from any other closely related taxa. Outgroup sequences were then aligned and phylogenetic analyses performed.

Maximum likelihood (ML) analyses of sequence alignments were conducted using RAxML 7.3.2 (Stamatakis 2006) on XSEDE via the CIPRES Science Gateway at http://www.phylo.org/index.php/portal (Miller, et al. 2010). Each locus was analyzed separately, using 1000 bootstrap iterations and a general time reversible (GTR) model of evolution to assess the resolving strength of sequences in the reported consensus trees. Branch support values greater than 50 were considered significant.

2.3.2 Test analyses using comparable data sets

Mycodiplosis larvae in this analysis were morphologically similar. Fly species are traditionally identified based on adult morphology, making species identification difficult from desiccated herbarium larval specimens. In addition, DNA sequence information from species in this genus is limited to four 28S sequences archived on GenBank (Henk, et al. 2011). This limited frame of reference to analyze sequence diversity in the *Mycodiplosis* was addressed by using sequence data from previously published research on identified fly species to determine where to interpret the formation of species-level clades. Examining tree topologies generated using identical sequence regions of species in genera related to *Mycodiplosis* provided a means to interpret species-level clades in the phylogeny of *Mycodiplosis* samples.

A test was run to determine appropriate assignment of species-level clades in the *Mycodiplosis* phylogenies using identical regions of 28S and COI sequences from close relatives of *Mycodiplosis*. Identical regions of sequence for both loci were obtained from recently published studies using 28S from *Bradysia* species within family Sciaridae, and COI from *Asteromyia* species (Bertone, et al. 2008; Shin, et al. 2013; Stireman, et al. 2010).

Mycodiplosis 28S and COI sequences were used in a BLAST nucleotide search of GenBank sequence archives and identical sequence regions were downloaded from NCBI. Recent submission of 28S sequences from *Bradysia* species allowed phylogenetic analysis of known species using identical sequence regions (Bertone, et al. 2008; Shin, et al. 2013). Nineteen *Bradysia* sequences were downloaded and aligned with three *Mycodiplosis* sequences using MUSCLE algorithm in MEGA 5.0. The aligned sequences were then edited by eye and used in ML phylogenetic analysis as previously described. The resulting phylogeny was then examined to identify the formation of supported species-level clades using *Bradysia* 28S data.

Identical regions of COI from species of *Asteromyia*, a genus of gall midges in the Cecidomyiidae, were found in the manner outlined above (Stireman, et al. 2010). A set of 66 sequences from the 2010 study were aligned with two *Mycodiplosis* sequences and edited by eye as before. Maximum likelihood phylogenetic analysis was conducted. Theresulting phylogeny was examined to identify the formation of supported species-level clades using these test data.

2.3.3 Phylogenetic analyses of 28S and COI sequences of *Mycodiplosis*

Sequences of 28S and COI from 206 collected *Mycodiplosis* samples were used in phylogenetic analyses of genetic diversity. Four available *Mycodiplosis* 28S sequences from GenBank were added to the 206 sequences generated from extracted samples in this project. Maximum likelihood analysis of 28S sequences was done with homologous sequence of *Mayetiola destructor* as outgroup, using a GTR model of evolution and 1000 bootstrap iterations. Clades in phylogenetic tree topology were considered significant if bootstrap support was 50 or greater. Phylogenetic analysis of the 206 COI sequences was done in the same manner.

2.3.4 Phylogenetic analysis of concatenated sequences of *Mycodiplosis*

Matching 407bp 28S and 300bp COI sequences for 206 larvae were concatenated for phylogenetic analysis using both loci. A partition file was created to denote the two separate segments for analysis. A partitioned ML analysis with 1000 bootstrap iterations was run as described above, with the addition of the partition file. The phylogeny was examined for clades with bootstrap support values of 50 or greater. The resultant supported clades were interpreted based on the test analyses to represent potential species that were then used in statistical analysis of the distribution and specificity of *Mycodiplosis* on rust fungi. The unsupported clades were not analysed for distribution as they could represent unresolved multi-species clades.

2.4 Geographical and host-specificity of *Mycodiplosis* larvae

2.4.1 Collection of data

Collection information was recorded to examine the specificity and distribution of *Mycodiplosis* larvae, and well supported clades of *Mycodiplosis* determined by phylogenetic analysis. The categories of data recorded included: date, location, fungal identification, plant host identification, amount of material in collection, and stage of rust. A subset of total collections was used in statistical analyses of occurrence due to missing information for some collections. Of 1350 collections, 224 had data for each category to use in principal component analysis (PCA) of larval occurrence.

2.4.2 PCA analysis of larval occurrence

Principal component analysis (PCA) can be used to identify factors in a multivariate matrix that may be predictive of the value of a chosen variable (Jolliffe 2005), the presence or absence of larvae in this case. The distribution of larvae on collections was assessed initially using PCA for a subset of 224 collections that had information for twelve factors potentially predictive of the presence or absence of larvae (Appendix B, Table B-1 page 113). The twelve factors were used in analysis for their potential to predict larval outcome: month, year, season, amount of material in collection, rust species, rust family, plant host species, plant host family, country, continent, Northern or Southern hemisphere, and Eastern or Western hemisphere. Data for factors of collections were transformed to numerical values and used for PCA analysis in R statistical software (Appendix B, Table B-2 page 124). Principal components responsible for variation in the dataset were generated and the factors responsible for the variation in collection data were identified and plotted to examine correlation.

Fisher's exact test can be used to identify dependence or independence between categories of data (Dr. Bin Li, pers. comm.). The presence or absence of larvae was examined using Fisher's exact test in R to determine if there was significant association with identified factors. Subsequent identification of specific predictive factors in the presence or absence of larvae was done in R using a binomial probability test (Dr. Li, Bin, pers. comm.).

2.4.3 Clade level analysis of larval occurrence

Fisher's exact test was also used to assess the dependence of phylogenetically supported larval clades on species, generic, and familial taxonomic levels of rust fungi, as well as location of collections. Matrix data were assembled by examination of the well supported clades numbered in the phylogenetic tree derived from concatenated sequences of *Mycodiplosis* samples. Rust taxon and location data were recorded in matrices for each larval sample in each supported clade. The resulting matrices for phylogenetic clades by rust species, genus, family, and collection location were then used to conduct Fisher's exact tests using R.

Chapter 3. Results

3.1 DNA extraction, amplification, and sequencing

DNA was extracted from 333 larval samples isolated from 261 collections of infected plant material (Appendix A, Table A-1 page 57). PCR amplification and sequencing of extracted DNA provided 305 COI sequences and 277 28S sequences from larval samples. Sequence data for both loci were generated for 252 larvae. Of these sequences, 46 were discarded based on ambiguous sequence reads obtained from sequencing efforts or by identification as DNA of other species during BLAST search verification of sequence (Appendix A, Table A-1 page 57). The remaining 206 samples with sequence for both loci were then used in phylogenetic analysis.

3.2 Phylogenetic analyses

3.2.1 Test analyses using comparable data sets

Test analyses using identical portions of 28S and COI sequences from *Bradysia* species and *Asteromyia* species respectively provided an assessment of the potential species level clades in *Mycodiplosis* analyses. Maximum likelihood analysis of 28S sequence from *Bradysia* species showed limited species resolution (Figure 1). This suggests a potential to underestimate species in the analysis of *Mycodiplosis* 28S sequences.

Phylogenetic analysis of COI sequences in *Asteromyia* showed an overestimation of species clades (Figure 2). Three species in the analysis (*A. modesta, A. laeviana,* and *A. chrysothamni*) were paraphyletic in the analysis. This suggests the possibility for *Mycodiplosis* phylogenetic analysis using this locus to be an overestimation of species. The combination of 28S and COI sequences for *Mycodiplosis* samples may provide a more reasonable estimation of species clades based on these test analyses.

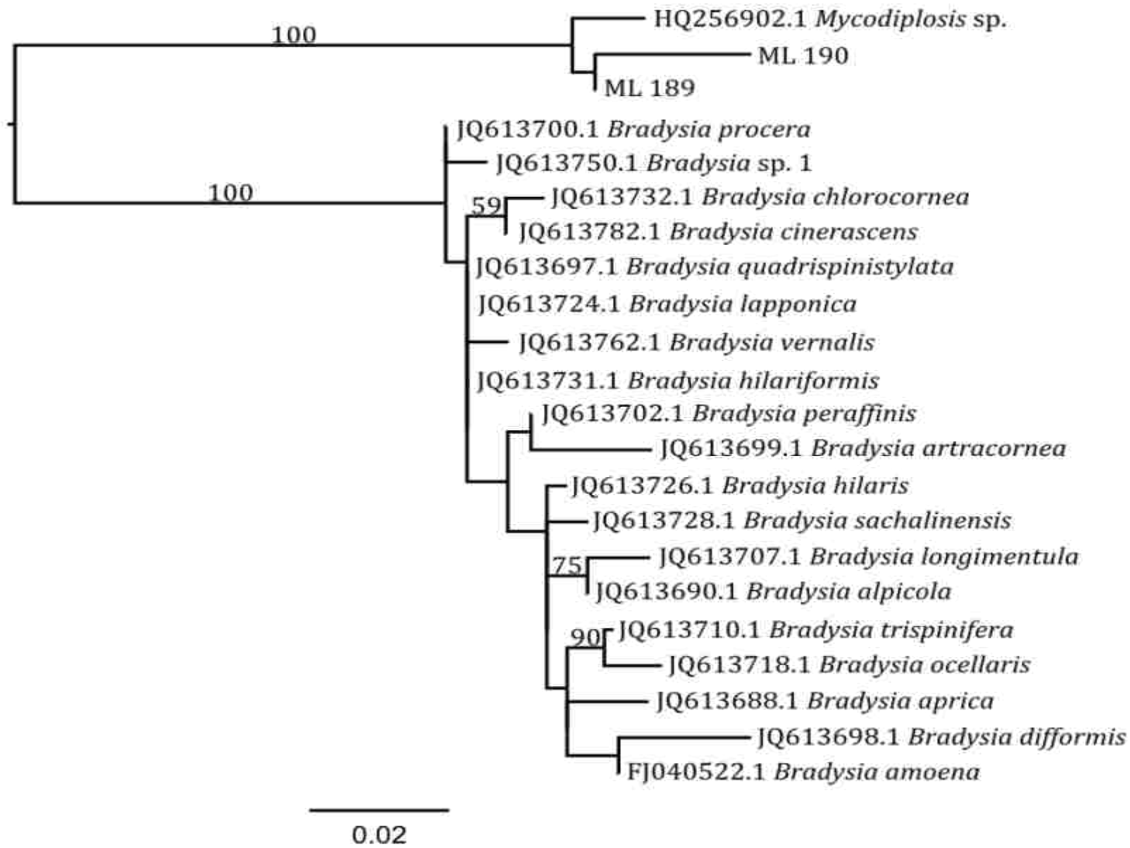


Figure 1. Maximum likelihood phylogeny of *Bradysia* 28S sequences (Bertone, et al. 2008; Shin, et al. 2013). Species clades are underestimated with 407bp regions of 28S sequence identical to that used in analysis of diversity in *Mycodiplosis.* The tree is rooted to midpoint with bootstrap support values greater than 50 shown.

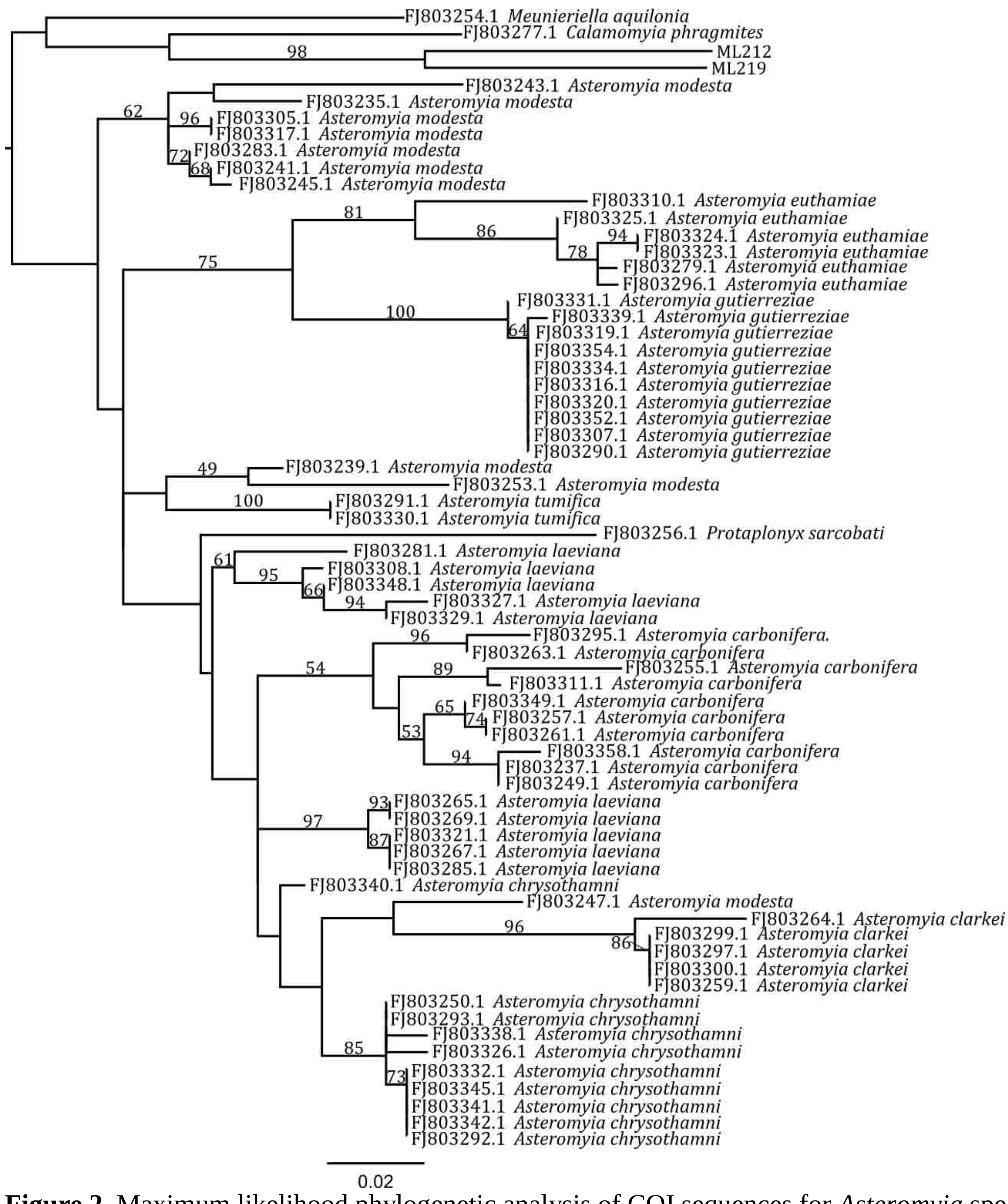


Figure 2. Maximum likelihood phylogenetic analysis of COI sequences for *Asteromyia* species (Stireman, et al. 2010). Species clades are overestimated in this test analysis with 300bp regions of COI sequence data identical to that used in analysis of diversity in *Mycodiplosis*. *A. modesta*, *A. laeviana*, and *A. chrysothamni* appear paraphyletic in this analysis. The tree is rooted with *Mycodiplosis* taxa as outgroup. Bootstrap support values greater than 50% are shown, an exception is inclusion of branch support for *A. modesta* isolates that illustrates only moderate support for the placement of this unresolved species using COI data.

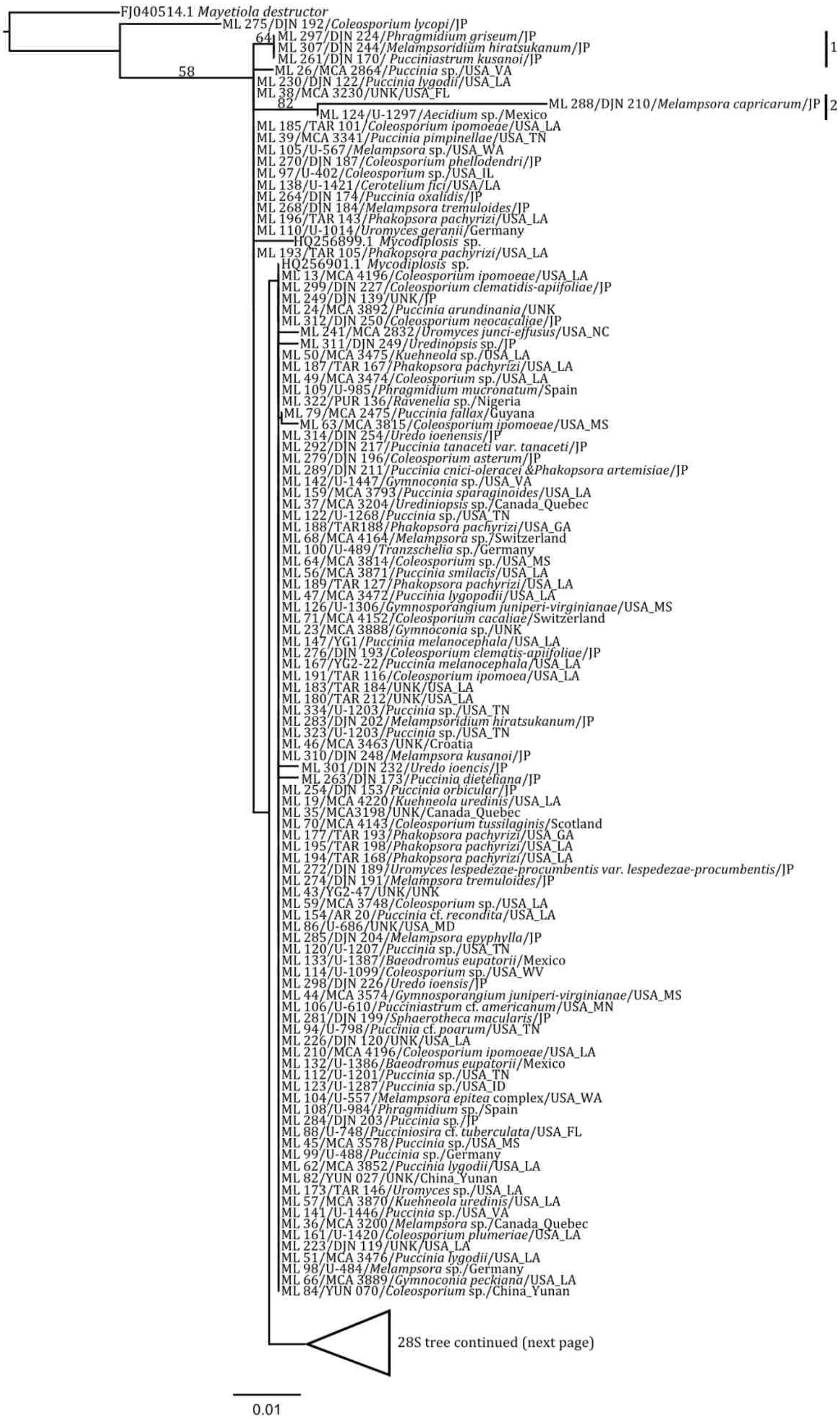
3.2.2 Phylogenetic analyses of 28S and COI sequence diversity in *Mycodiplosis*

Maximum likelihood phylogenetic analyses of 28S and COI sequence fragments from individual *Mycodiplosis* larvae resolved samples into 7 and 17 supported clades respectively (Figures 3 & 4). The phylogeny of *Mycodiplosis* 28S sequences contains a total of 10 clades including the unsupported topology, with two of the supported clades derived from larger unsupported groupings.

3.2.3 Concatenated phylogenetic analysis of sequence diversity in *Mycodiplosis*

Concatenated ML analysis of 28S and COI sequence resolved samples into 17 supported clades of approximately 33 (Figure 5). Potential species clades of *Mycodiplosis* were assigned based on species resolution in test analyses, branch lengths, geographic information, and 50% or greater bootstrap support values. Clades with branch support values less than 50% were not used in distributional analyses. The supported clades determined in the concatenated 28S and COI tree were examined for host specificity on rust fungi and larval distribution.

Figure 3. Maximum likelihood phylogenetic analysis of 28S sequence data from 207 *Mycodiplosis* larvae samples. Analysis suggests 7 clades with bootstrap support values greater than 50. Taxa labels contain larval sample number/rust collection number/location information respectively.



FJ040514.1 Mayetiola destructor
ML 275/DJN 192/Coleosporium lycopi/JP
64
ML 297/DJN 224/Phragmidium griseum/JP
ML 307/DJN 244/Melampsoridium hiratsukanum/JP
ML 261/DJN 170/ Pucciniastrum kusanoi/JP
1
58
ML 26/MCA 2864/Puccinia sp./USA_VA
ML 230/DJN 122/Puccinia lygodii/USA_LA
ML 38/MCA 3230/UNK/USA_FL
82
ML 288/DJN 210/Melampsora capricarum/JP
2
ML 124/U-1297/Aecidium sp./Mexico
ML 185/TAR 101/Coleosporium ipomoeae/USA_LA
ML 39/MCA 3341/Puccinia pimpinellae/USA_TN
ML 105/U-567/Melampsora sp./USA_WA
ML 270/DJN 187/Coleosporium phellodendri/JP
ML 97/U-402/Coleosporium sp./USA_IL
ML 138/U-1421/Cerotelium fici/USA/LA
ML 264/DJN 174/Puccinia oxalidis/JP
ML 268/DJN 184/Melampsora tremuloides/JP
ML 196/TAR 143/Phakopsora pachyrizi/USA_LA
ML 110/U-1014/Uromyces geranii/Germany
HQ256899.1 Mycodiplosis sp.
ML 193/TAR 105/Phakopsora pachyrizi/USA_LA
HQ256901.1 Mycodiplosis sp.
ML 13/MCA 4196/Coleosporium ipomoeae/USA_LA
ML 299/DJN 227/Coleosporium clematidis-apiifoliae/JP
ML 249/DJN 139/UNK/JP
ML 24/MCA 3892/Puccinia arundinania/UNK
ML 312/DJN 250/Coleosporium neocacaliae/JP
ML 241/MCA 2832/Uromyces junci-effusus/USA_NC
ML 311/DJN 249/Uredinopsis sp./JP
ML 50/MCA 3475/Kuehneola sp./USA_LA
ML 187/TAR 167/Phakopsora pachyrizi/USA_LA
ML 49/MCA 3474/Coleosporium sp./USA_LA
ML 109/U-985/Phragmidium mucronatum/Spain
ML 322/PUR 136/Ravenelia sp./Nigeria
ML 79/MCA 2475/Puccinia fallax/Guyana
ML 63/MCA 3815/Coleosporium ipomoeae/USA_MS
ML 314/DJN 254/Uredo ioenensis/JP
ML 292/DJN 217/Puccinia tanaceti var. tanaceti/JP
ML 279/DJN 196/Coleosporium asterum/JP
ML 289/DJN 211/Puccinia cnici-oleracei &Phakopsora artemisiae/JP
ML 142/U-1447/Gymnoconia sp./USA_VA
ML 159/MCA 3793/Puccinia sparaginoides/USA_LA
ML 37/MCA 3204/Urediniopsis sp./Canada_Quebec
ML 122/U-1268/Puccinia sp./USA_TN
ML 188/TAR188/Phakopsora pachyrizi/USA_GA
ML 68/MCA 4164/Melampsora sp./Switzerland
ML 100/U-489/Tranzschelia sp./Germany
ML 64/MCA 3814/Coleosporium sp./USA_MS
ML 56/MCA 3871/Puccinia smilacis/USA_LA
ML 189/TAR 127/Phakopsora pachyrizi/USA_LA
ML 47/MCA 3472/Puccinia lygopodii/USA_LA
ML 126/U-1306/Gymnosporangium juniperi-virginianae/USA_MS
ML 71/MCA 4152/Coleosporium cacaliae/Switzerland
ML 23/MCA 3888/Gymnoconia sp./UNK
ML 147/YG1/Puccinia melanocephala/USA_LA
ML 276/DJN 193/Coleosporium clematis-apiifoliae/JP
ML 167/YG2-22/Puccinia melanocephala/USA_LA
ML 191/TAR 116/Coleosporium ipomoea/USA_LA
ML 183/TAR 184/UNK/USA_LA
ML 180/TAR 212/UNK/USA_LA
ML 334/U-1203/Puccinia sp./USA_TN
ML 283/DJN 202/Melampsoridium hiratsukanum/JP
ML 323/U-1203/Puccinia sp./USA_TN
ML 46/MCA 3463/UNK/Croatia
ML 310/DJN 248/Melampsora kusanoi/JP
ML 301/DJN 232/Uredo ioencis/JP
ML 263/DJN 173/Puccinia dieteliana/JP
ML 254/DJN 153/Puccinia orbicular/JP
ML 19/MCA 4220/Kuehneola uredinis/USA_LA
ML 35/MCA3198/UNK/Canada_Quebec
ML 70/MCA 4143/Coleosporium tussilaginis/Scotland
ML 177/TAR 193/Phakopsora pachyrizi/USA_GA
ML 195/TAR 198/Phakopsora pachyrizi/USA_LA
ML 194/TAR 168/Phakopsora pachyrizi/USA_LA
ML 272/DJN 189/Uromyces lespedezae-procumbentis var. lespedezae-procumbentis/JP
ML 274/DJN 191/Melampsora tremuloides/JP
ML 43/YG2-47/UNK/UNK
ML 59/MCA 3748/Coleosporium sp./USA_LA
ML 154/AR 20/Puccinia cf. recondita/USA_LA
ML 86/U-686/UNK/USA_MD
ML 285/DJN 204/Melampsora epyphylla/JP
ML 120/U-1207/Puccinia sp./USA_TN
ML 133/U-1387/Baeodromus eupatorii/Mexico
ML 114/U-1099/Coleosporium sp./USA_WV
ML 298/DJN 226/Uredo ioensis/JP
ML 44/MCA 3574/Gymnosporangium juniperi-virginianae/USA_MS
ML 106/U-610/Pucciniastrum cf. americanum/USA_MN
ML 281/DJN 199/Sphaerotheca macularis/JP
ML 94/U-798/Puccinia cf. poarum/USA_TN
ML 226/DJN 120/UNK/USA_LA
ML 210/MCA 4196/Coleosporium ipomoeae/USA_LA
ML 132/U-1386/Baeodromus eupatorii/Mexico
ML 112/U-1201/Puccinia sp./USA_TN
ML 123/U-1287/Puccinia sp./USA_ID
ML 104/U-557/Melampsora epitea complex/USA_WA
ML 108/U-984/Phragmidium sp./Spain
ML 284/DJN 203/Puccinia sp./JP
ML 88/U-748/Pucciniosira cf. tuberculata/USA_FL
ML 45/MCA 3578/Puccinia sp./USA_MS
ML 99/U-488/Puccinia sp./Germany
ML 62/MCA 3852/Puccinia lygodii/USA_LA
ML 82/YUN 027/UNK/China_Yunan
ML 173/TAR 146/Uromyces sp./USA_LA
ML 57/MCA 3870/Kuehneola uredinis/USA_LA
ML 141/U-1446/Puccinia sp./USA_VA
ML 36/MCA 3200/Melampsora sp./Canada_Quebec
ML 161/U-1420/Coleosporium plumeriae/USA_LA
ML 223/DJN 119/UNK/USA_LA
ML 51/MCA 3476/Puccinia lygodii/USA_LA
ML 98/U-484/Melampsora sp./Germany
ML 66/MCA 3889/Gymnoconia peckiana/USA_LA
ML 84/YUN 070/Coleosporium sp./China_Yunan
28S tree continued (next page)
0.01


28S tree continued (previous page)
90
ML 252/DJN 150/Coleosporium sp./JP
ML 280/DJN 197/Puccinia nanbuana/JP
ML 306/DJN 242/Uromyces veratri/JP
ML 267/DJN 183/Puccinia lantanae/JP
ML 257/DJN 156/Puccinia nipponica/JP
3
ML 303/DJN 234/Sphaerotheca macularis/JP
ML 269/DJN 185/Powdery mildew/JP
ML 305/DJN 236/Coleosporium asterum/JP
ML 253/DJN 151/Coleosporium sp./JP
ML 251/DJN 149/Coleosporium asterum/JP
ML 256/DJN 155/Pucciniastrum bohemeriae/JP
ML 287/DJN 209/Puccinia sp./JP
ML 258/DJN 158/Ochropsora kraunhiae/JP
ML 290/DJN 215/Puccinia tokyensis/JP
ML 250/DJN 149/Coleosporium asterum/JP
ML 260/DJN 162/Puccinia nanbuana/JP
ML 286/DJN 206/Melampsora larisi-populina/JP
ML 273/DJN 190/Coleosporium phellodendri/JP
ML 300/DJN 228/Puccinia argentata/JP
ML 278/DJN 195/Puccinia brachypodii/JP
ML 304/DJN 235/Puccinia violae/JP
ML 244/DJN 132/Puccinia oxalidis/JP
ML 313/DJN 251/Puccinia or Uredo sp./JP
85 HQ256902.1 Mycodiplosis sp.
HQ256900.1 Mycodiplosis sp.
4
ML 58/MCA 3768/Phragmidium sp./USA_AK
ML 157/AR 18/Gymnoconia nitens/USA_LA
ML 131/U-1381/Puccinia sp.?/USA_ID
ML 119/U-1206/Puccinia violae/USA_TN
ML 266/DJN 182/Puccinia coronata var. coronate/JP
50
ML 176/TAR 112/UNK/USA_LA
ML 225/DJN 119/UNK/USA_LA
ML 111/U-1063/Coleosporium sp./USA_MD
ML 42/MCA 3343/Puccinia melanocephala/USA_LA
ML 54/MCA 3620/Coleosporium sp./USA_LA
ML 150/YG2-7/Puccinia melanocephala/USA_LA
5
91
ML 277/DJN 194/Puccinia miscanthi/JP
ML 184/TAR 166/UNK/USA_LA
ML 236/DJN 123/Cerotelium fici/USA_LA
ML 61/MCA 3756/Puccinia sp./USA_LA
ML 18/MCA 4207/Puccinia hemerocalliidis/USA_LA
ML 52/MCA 3478/Puccinia sp./USA_LA
ML 237/DJN 123/Cerotelium fici/USA_LA
ML 93/U-421/Uredo sp.?/Guam
53
ML 78/MCA 2453/Coleosporium vernoniae/Guyana
ML 190/TAR 115/UNK/USA_LA
ML 174/TAR 141/Puccinia similuncis/USA_LA
ML 55/MCA 3634/Cerotelium fici/USA_LA
ML 69/MCA 4228/Puccinia cf. malvacearum/USA_LA
6
ML 222/DJN 118/UNK/USA_LA
ML 238/DJN 123/Cerotelium fici/USA_LA
ML 160/AR/Cerotelium fici/UNK (USA_LA)
ML 31/MCA 2888/Phakopsora meibomiae/Costa Rica
ML 17/MT 8/Puccinia sp./USA_LA
ML 235/DJN 123/Cerotelium fici/USA_LA
ML 87/U-688/Prospodium sp.?/Guam
ML 175/TAR 144/Tranzshelia arthuri?/USA_LA
ML 140/U-1460/Puccinia psidii/Puerto Rico
ML 179/TAR 148/Puccinia poaceae/USA_LA
ML 60/MCA 3749/Gymnosporangium sp./USA_LA
ML 197/TAR 105/Phakopsora pachyrizi/USA_LA
ML 282/DJN 201/Melampsora tremuloides/JP
84
ML 29/MCA 2554/Puccinia sp./Equador
ML 28/MCA 2551/UNK/Equador
7
ML 317/DJN 260/Cerotelium fici/USA_LA
ML 239/U-1451/Coleosporium ipomoeae/UNK
ML 168/YG2-26/Puccinia melanocephala/USA_LA
ML 318/DJN 260/Cerotelium fici/USA_LA
ML 320/JRH2003-113/Cerotelium sabiceae/Guyana
ML 308/DJN 245/Pucciniastrum hydrangese-petiolaris/JP
ML 5/MCA 4196/Coleosporium ipomoeae/USA_LA
ML 162/YG2-43/Puccinia melanocephala/USA_LA
ML 148/YG2-33/Puccinia melanocephala/USA_LA
ML 271/DJN 188/Coleosporium sp./JP
ML 205/MCA 4196/Coleosporium ipomoeae/USA_LA
ML 12/MCA 4196/Coleosporium ipomoeae/USA_LA
ML 211/MCA 4196/Coleosporium ipomoeae/USA_LA
ML 149/YG2-6/Puccinia melanocephala/USA_LA
ML 169/YG2-36/Puccinia melanocephala/USA_LA
ML 202/MCA 4196/Coleosporium ipomoeae/USA_LA
ML 182/TAR 189/Phakopsora pachyrizi/USA_GA
ML 172/TAR 140/ Uromyces sp./USA_LA
ML 166/YG2-13/Puccinia melanocephala/USA_LA
ML 209/MCA 4196/Coleosporium ipomoeae/USA_LA
ML 232/DJN 122/Puccinia lygodii/USA_LA
ML 233/DJN 123/Cerotelium fici/USA_LA
ML 152/YG2-42/Puccinia melanocephala/USA_LA
ML 9/MCA 4196/Coleosporium ipomoeae/USA_LA
ML 332/PUR 136/Ravenelia sp./Nigeria
ML 165/YG2-34/Puccinia melanocephala/USA_LA
ML 220/DJN 118/UNK/USA_LA
ML 315/DJN 260/Cerotelium fici/USA_LA
ML 204/MCA 4196/Coleosporium ipomoeae/USA_LA
ML 186/TAR 118/Uromyces sp. /USA_LA
ML 200/MCA 4196/Coleosporium ipomoeae/USA_LA
ML 199/MCA 4196/Coleosporium ipomoeae/USA_LA
ML 27/MCA 2531/Coleosporium sp./Equador
ML 208/MCA 4196/Coleosporium ipomoeae/USA_LA
0.01

Figure 4. Maximum likelihood phylogenetic analysis of COI sequence data from 207 *Mycodiplosis* larvae samples. Analysis suggests 17 clades with bootstrap support values greater than 50. Taxa labels contain larval sample number/rust collection number/location information respectively.


GQ387648.1 Mayetiola destructor
ML 300/DJN 228/Puccinia argentata/JP
ML 260/DJN 162/Puccinia nanbuana/JP
ML 256/DJN 155/Pucciniastrum bohemeriae/JP
ML 225/DJN 119/UNK/USA_LA
ML 42/MCA 3343/Puccinia melanocephala/USA_LA
ML 54/MCA 3620/Coleosporium sp./USA_LA
ML 176/TAR 112/UNK/USA_LA
ML 150/YG2-7/Puccinia melanocephala/USA_LA
ML 111/U-1063/Coleosporium sp./USA_MD
ML 168/YG2-26/Puccinia melanocephala/USA_LA
ML 301/DJN 232/Uredo ioencis/JP
ML 152/YG2-42/Puccinia melanocephala/USA_LA
ML 166/YG2-13/Puccinia melanocephala/USA_LA
ML 172/TAR 140/ Uromyces sp./USA_LA
ML 148/YG2-33/Puccinia melanocephala/USA_LA
ML 162/YG2-43/Puccinia melanocephala/USA_LA
ML 169/YG2-36/Puccinia melanocephala/USA_LA
ML 182/TAR 189/Phakopsora pachyrizi/USA_GA
ML 303/DJN 234/Sphaerotheca macularis/JP
ML 191/TAR 116/Coleosporium ipomoea/USA_LA
ML 287/DJN 209/Puccinia sp./JP
ML 31/MCA 2888/Phakopsora meibomiae/Costa Rica
ML 87/U-688/Prospodium sp.?/Guam
ML 93/U-421/Uredo sp.?/Guam
ML 306/DJN 242/Uromyces veratri/JP
ML 197/TAR 105/Phakopsora pachyrizi/USA_LA
ML 282/DJN 201/Melampsora tremuloides/JP
ML 190/TAR 115/UNK/USA_LA
ML 61/MCA 3756/Puccinia sp./USA_LA
ML 222/DJN 118/UNK/USA_LA
ML 179/TAR 148/Puccinia poaceae/USA_LA
ML 238/DJN 123/Cerotelium fici/USA_LA
ML 175/TAR 144/Tranzshelia arthuri?/USA_LA
ML 52/MCA 3478/Puccinia sp./USA_LA
ML 184/TAR 166/UNK/USA_LA
ML 18/MCA 4207/Puccinia hemerocalliidis/USA_LA
ML 174/TAR 141/Puccinia similuncis/USA_LA
ML 55/MCA 3634/Cerotelium fici/USA_LA
ML 17/MT 8/Puccinia sp./USA_LA
ML 235/DJN 123/Cerotelium fici/USA_LA
ML 160/AR/Cerotelium fici/UNK (USA_LA)
ML 69/MCA 4228/Puccinia cf. malvacearum/USA_LA
ML 236/DJN 123/Cerotelium fici/USA_LA
ML 237/DJN 123/Cerotelium fici/USA_LA
ML 233/DJN 123/Cerotelium fici/USA_LA
ML 140/U-1460/Puccinia psidii/Puerto Rico
ML 78/MCA 2453/Coleosporium vernoniae/Guyana
ML 28/MCA 2551/UNK/Equador
ML 29/MCA 2554/Puccinia sp./Equador
ML 196/TAR 143/Phakopsora pachyrizi/USA_LA
ML 27/MCA 2531/Coleosporium sp./Equador
ML 253/DJN 151/Coleosporium sp./JP
ML 277/DJN 194/Puccinia miscanthi/JP
ML 289/DJN 211/Puccinia cnici-oleracei &Phakopsora artemisiae/JP
ML 261/DJN 170/ Pucciniastrum kusanoi/JP
ML 297/DJN 224/Phragmidium griseum/JP
ML 199/MCA 4196/Coleosporium ipomoeae/USA_LA
ML 165/YG2-34/Puccinia melanocephala/USA_LA
ML 208/MCA 4196/Coleosporium ipomoeae/USA_LA
ML 232/DJN 122/Puccinia lygodii/USA_LA
ML 220/DJN 118/UNK/USA_LA
ML 149/YG2-6/Puccinia melanocephala/USA_LA
ML 60/MCA 3749/Gymnosporangium sp./USA_LA
ML 26/MCA 2864/Puccinia sp./USA_VA
ML 202/MCA 4196/Coleosporium ipomoeae/USA_LA
ML 200/MCA 4196/Coleosporium ipomoeae/USA_LA
ML 204/MCA 4196/Coleosporium ipomoeae/USA_LA
ML 332/PUR 136/Ravenelia sp./Nigeria
ML 239/U-1451/Coleosporium ipomoeae/UNK
ML 317/DJN 260/Cerotelium fici/USA_LA
ML 320/JRH2003-113/Cerotelium sabiceae/Guyana
ML 205/MCA 4196/Coleosporium ipomoeae/USA_LA
ML 12/MCA 4196/Coleosporium ipomoeae/USA_LA
ML 209/MCA 4196/Coleosporium ipomoeae/USA_LA
ML 5/MCA 4196/Coleosporium ipomoeae/USA_LA
ML 318/DJN 260/Cerotelium fici/USA_LA
ML 315/DJN 260/Cerotelium fici/USA_LA
ML 9/MCA 4196/Coleosporium ipomoeae/USA_LA
ML 186/TAR 118/Uromyces sp. /USA_LA
ML 211/MCA 4196/Coleosporium ipomoeae/USA_LA
ML 39/MCA 3341/Puccinia pimpinellae/USA_TN
ML 110/U-1014/Uromyces geranii/Germany
ML 251/DJN 149/Coleosporium asterum/JP
ML 138/U-1421/Cerotelium fici/USA/LA
ML 185/TAR 101/Coleosporium ipomoeae/USA_LA
ML 38/MCA 3230/UNK/USA_FL
ML 193/TAR 105/Phakopsora pachyrizi/USA_LA
ML 308/DJN 245/Pucciniastrum hydrangese-petiolaris/JP
ML 267/DJN 183/Puccinia lantanae/JP
ML 252/DJN 150/Coleosporium sp./JP
ML 272/DJN 189/Uromyces lespedezae-procumbentis var. lespedezae-procumbentis/JP
ML 119/U-1206/Puccinia violae/USA_TN
ML 157/AR 18/Gymnoconia nitens/USA_LA
ML 58/MCA 3768/Phragmidium sp./USA_AK
ML 131/U-1381/Puccinia sp.?/USA_ID
ML 279/DJN 196/Coleosporium asterum/JP
ML 290/DJN 215/Puccinia tokyensis/JP
ML 266/DJN 182/Puccinia coronata var. coronate/JP
COI tree continued(next page)
0.04
94
95
51
98
49
67
97
50
85
68
81
95
92
89
89
100
58
92
59
97
87
99
93
51
1
2
3
4
5
6
7
8
9
10
11

COI tree continued (previous page)
ML 120/U-1207/Puccinia sp./USA_TN
ML 112/U-1201/Puccinia sp./USA_TN
ML 70/MCA 4143/Coleosporium tussilaginis/Scotland
ML 71/MCA 4152/Coleosporium cacaliae/Switzerland
ML 254/DJN 153/Puccinia orbicular/JP
ML 278/DJN 195/Puccinia brachypodii/JP
ML 122/U-1268/Puccinia sp./USA_TN
ML 250/DJN 149/Coleosporium asterum/JP
ML 304/DJN 235/Puccinia violae/JP
ML 273/DJN 190/Coleosporium phellodendri/JP
ML 281/DJN 199/Sphaerotheca macularis/JP
ML 108/U-984/Phragmidium sp./Spain
ML 241/MCA 2832/Uromyces junci-effusus/USA_NC
ML 268/DJN 184/Melampsora tremuloides/JP
ML 322/PUR 136/Ravenelia sp./Nigeria
ML 283/DJN 202/Melampsoridium hiratsukanum/JP
ML 323/U-1203/Puccinia sp./USA_TN
ML 68/MCA 4164/Melampsora sp./Switzerland
ML 264/DJN 174/Puccinia oxalidis/JP
ML 99/U-488/Puccinia sp./Germany
ML 124/U-1297/Aecidium sp./Mexico
ML 79/MCA 2475/Puccinia fallax/Guyana
ML 263/DJN 173/Puccinia dieteliana/JP
ML 311/DJN 249/Uredinopsis sp./JP
ML 258/DJN 158/Ochropsora kraunhiae/JP
ML 275/DJN 192/Coleosporium lycopi/JP
ML 310/DJN 248/Melampsora kusanoi/JP
ML 132/U-1386/Baeodromus eupatorii/Mexico
ML 299/DJN 227/Coleosporium clematidis-apiifoliae/JP
ML 109/U-985/Phragmidium mucronatum/Spain
ML 46/MCA 3463/UNK/Croatia
ML 284/DJN 203/Puccinia sp./JP
100
ML 154/AR 20/Puccinia cf. recondita/USA_LA
ML 19/MCA 4220/Kuehneola uredinis/USA_LA
12
ML 285/DJN 204/Melampsora epyphylla/JP
ML 313/DJN 251/Puccinia or Uredo sp./JP
ML 98/U-484/Melampsora sp./Germany
ML 314/DJN 254/Uredo ioenensis/JP
ML 312/DJN 250/Coleosporium neocacaliae/JP
ML 274/DJN 191/Melampsora tremuloides/JP
ML 334/U-1203/Puccinia sp./USA_TN
ML 292/DJN 217/Puccinia tanaceti var. tanaceti/JP
ML 298/DJN 226/Uredo ioensis/JP
ML 270/DJN 187/Coleosporium phellodendri/JP
ML 244/DJN 132/Puccinia oxalidis/JP
89
ML 305/DJN 236/Coleosporium asterum/JP
ML 280/DJN 197/Puccinia nanbuana/JP
ML 84/YUN 070/Coleosporium sp./China_Yunan
ML 82/YUN 027/UNK/China_Yunan
13
ML 100/U-489/Tranzschelia sp./Germany
ML 105/U-567/Melampsora sp./USA_WA
ML 104/U-557/Melampsora epitea complex/USA_WA
ML 269/DJN 185/Powdery mildew/JP
ML 126/U-1306/Gymnosporangium juniperi-virginianae/USA_MS
ML 49/MCA 3474/Coleosporium sp./USA_LA
ML 50/MCA 3475/Kuehneola sp./USA_LA
ML 94/U-798/Puccinia cf. poarum/USA_TN
ML 45/MCA 3578/Puccinia sp./USA_MS
ML 276/DJN 193/Coleosporium clematis-apiifoliae/JP
ML 123/U-1287/Puccinia sp./USA_ID
62
ML 210/MCA 4196/Coleosporium ipomoeae/USA_LA
ML 142/U-1447/Gymnoconia sp./USA_VA
82
ML 141/U-1446/Puccinia sp./USA_VA
ML 88/U-748/Pucciniosira cf. tuberculata/USA_FL
ML 106/U-610/Pucciniastrum cf. americanum/USA_MN
ML 86/U-686/UNK/USA_MD
ML 37/MCA 3204/Urediniopsis sp./Canada_Quebec
ML 36/MCA 3200/Melampsora sp./Canada_Quebec
ML 23/MCA 3888/Gymnoconia sp./UNK
ML 13/MCA 4196/Coleosporium ipomoeae/USA_LA
ML 66/MCA 3889/Gymnoconia peckiana/USA_LA
ML 35/MCA3198/UNK/Canada_Quebec
ML 97/U-402/Coleosporium sp./USA_IL
14
ML 133/U-1387/Baeodromus eupatorii/Mexico
ML 167/YG2-22/Puccinia melanocephala/USA_LA
100
ML 223/DJN 119/UNK/USA_LA
ML 114/U-1099/Coleosporium sp./USA_WV
ML 194/TAR 168/Phakopsora pachyrizi/USA_LA
ML 44/MCA 3574/Gymnosporangium juniperi-virginianae/USA_MS
15
100
ML 63/MCA 3815/Coleosporium ipomoeae/USA_MS
ML 64/MCA 3814/Coleosporium sp./USA_MS
16
ML 286/DJN 206/Melampsora larisi-populina/JP
ML 24/MCA 3892/Puccinia arundinania/UNK
ML 226/DJN 120/UNK/USA_LA
ML 56/MCA 3871/Puccinia smilacis/USA_LA
ML 51/MCA 3476/Puccinia lygodii/USA_LA
ML 173/TAR 146/Uromyces sp./USA_LA
ML 180/TAR 212/UNK/USA_LA
ML 257/DJN 156/Puccinia nipponica/JP
ML 188/TAR188/Phakopsora pachyrizi/USA_GA
ML 187/TAR 167/Phakopsora pachyrizi/USA_LA
ML 230/DJN 122/Puccinia lygodii/USA_LA
ML 307/DJN 244/Melampsoridium hiratsukanum/JP
ML 59/MCA 3748/Coleosporium sp./USA_LA
ML 47/MCA 3472/Puccinia lygopodii/USA_LA
93
ML 177/TAR 193/Phakopsora pachyrizi/USA_GA
ML 183/TAR 184/UNK/USA_LA
17
ML 147/YG1/Puccinia melanocephala/USA_LA
ML 189/TAR 127/Phakopsora pachyrizi/USA_LA
ML 271/DJN 188/Coleosporium sp./JP
ML 249/DJN 139/UNK/JP
ML 288/DJN 210/Melampsora capricarum/JP
ML 62/MCA 3852/Puccinia lygodii/USA_LA
ML 161/U-1420/Coleosporium plumeriae/USA_LA
ML 57/MCA 3870/Kuehneola uredinis/USA_LA
ML 43/YG2-47/UNK/UNK
ML 195/TAR 198/Phakopsora pachyrizi/USA_LA
ML 159/MCA 3793/Puccinia sparaginoides/USA_LA
0.04

Figure 5. Maximum likelihood phylogenetic analysis of concatenated 28S and COI sequence data from 206 *Mycodiplosis* larval samples. Analysis resolves 97 of 206 samples into 17 clades with 50% or greater bootstrap support. Clades are identified by number. Taxa labels contain larval sample number/rust collection number/location information respectively.

Mayetiola destructor
ML 300/DJN 228/Puccinia argentata/JP
ML 260/DJN 162/Puccinia nanbuana/JP
ML 256/DJN 155/Pucciniastrum bohemeriae/JP
ML 301/DJN 232/Uredo ioencis/JP
ML 251/DJN 149/Coleosporium asterum/JP
ML 138/U-1421/Cerotelium fici/USA/LA
89
ML 193/TAR 105/Phakopsora pachyrizi/USA_LA
86
ML 185/TAR 101/Coleosporium ipomoeae/USA_LA
ML 38/MCA 3230/UNK/USA_FL
1
ML 39/MCA 3341/Puccinia pimpinellae/USA_TN
ML 110/U-1014/Uromyces geranii/Germany
ML 26/MCA 2864/Puccinia sp./USA_VA
ML 196/TAR 143/Phakopsora pachyrizi/USA_LA
ML 253/DJN 151/Coleosporium sp./JP
ML 289/DJN 211/Puccinia cnici-oleracei &Phakopsora artemisiae/JP
80
ML 297/DJN 224/Phragmidium griseum/JP
ML 261/DJN 170/ Pucciniastrum kusanoi/JP
2
ML 277/DJN 194/Puccinia miscanthi/JP
ML 27/MCA 2531/Coleosporium sp./Equador
ML 199/MCA 4196/Coleosporium ipomoeae/USA_LA
100
ML 165/YG2-34/Puccinia melanocephala/USA_LA
ML 232/DJN 122/Puccinia lygodii/USA_LA
ML 208/MCA 4196/Coleosporium ipomoeae/USA_LA
ML 220/DJN 118/UNK/USA_LA
ML 149/YG2-6/Puccinia melanocephala/USA_LA
3
ML 266/DJN 182/Puccinia coronata var. coronate/JP
ML 287/DJN 209/Puccinia sp./JP
ML 303/DJN 234/Sphaerotheca macularis/JP
ML 272/DJN 189/Uromyces lespedezae-procumbentis var. lespedezae-procumbentis/JP
55
ML 58/MCA 3768/Phragmidium sp./USA_AK
99
ML 131/U-1381/Puccinia sp.?/USA_ID
ML 157/AR 18/Gymnoconia nitens/USA_LA
ML 119/U-1206/Puccinia violae/USA_TN
4
ML 258/DJN 158/Ochropsora kraunhiae/JP
ML 308/DJN 245/Pucciniastrum hydrangese-petiolaris/JP
92
ML 252/DJN 150/Coleosporium sp./JP
ML 267/DJN 183/Puccinia lantanae/JP
5
ML 285/DJN 204/Melampsora epyphylla/JP
ML 313/DJN 251/Puccinia or Uredo sp./JP
ML 98/U-484/Melampsora sp./Germany
ML 314/DJN 254/Uredo ioenensis/JP
ML 312/DJN 250/Coleosporium neocacaliae/JP
ML 274/DJN 191/Melampsora tremuloides/JP
ML 292/DJN 217/Puccinia tanaceti var. tanaceti/JP
ML 298/DJN 226/Uredo ioensis/JP
ML 334/U-1203/Puccinia sp./USA_TN
ML 82/YUN 027/UNK/China_Yunan
ML 84/YUN 070/Coleosporium sp./China_Yunan
ML 280/DJN 197/Puccinia nanbuana/JP
ML 244/DJN 132/Puccinia oxalidis/JP
ML 305/DJN 236/Coleosporium asterum/JP
ML 311/DJN 249/Uredinopsis sp./JP
ML 120/U-1207/Puccinia sp./USA_TN
ML 112/U-1201/Puccinia sp./USA_TN
ML 263/DJN 173/Puccinia dieteliana/JP
ML 46/MCA 3463/UNK/Croatia
ML 71/MCA 4152/Coleosporium cacaliae/Switzerland
ML 70/MCA 4143/Coleosporium tussilaginis/Scotland
ML 254/DJN 153/Puccinia orbicular/JP
ML 284/DJN 203/Puccinia sp./JP
100
ML 154/AR 20/Puccinia cf. recondita/USA_LA
ML 19/MCA 4220/Kuehneola uredinis/USA_LA
6
ML 281/DJN 199/Sphaerotheca macularis/JP
ML 122/U-1268/Puccinia sp./USA_TN
ML 275/DJN 192/Coleosporium lycopi/JP
ML 304/DJN 235/Puccinia violae/JP
ML 250/DJN 149/Coleosporium asterum/JP
ML 273/DJN 190/Coleosporium phellodendri/JP
ML 278/DJN 195/Puccinia brachypodii/JP
ML 290/DJN 215/Puccinia tokyensis/JP
ML 108/U-984/Phragmidium sp./Spain
ML 241/MCA 2832/Uromyces junci-effusus/USA_NC
ML 124/U-1297/Aecidium sp./Mexico
64
ML 264/DJN 174/Puccinia oxalidis/JP
ML 268/DJN 184/Melampsora tremuloides/JP
ML 79/MCA 2475/Puccinia fallax/Guyana
ML 322/PUR 136/Ravenelia sp./Nigeria
ML 68/MCA 4164/Melampsora sp./Switzerland
ML 283/DJN 202/Melampsoridium hiratsukanum/JP
ML 323/U-1203/Puccinia sp./USA_TN
ML 99/U-488/Puccinia sp./Germany
7
ML 310/DJN 248/Melampsora kusanoi/JP
100
ML 64/MCA 3814/Coleosporium sp./USA_MS
ML 63/MCA 3815/Coleosporium ipomoeae/USA_MS
8
ML 133/U-1387/Baeodromus eupatorii/Mexico
ML 132/U-1386/Baeodromus eupatorii/Mexico
ML 299/DJN 227/Coleosporium clematidis-apiifoliae/JP
ML 109/U-985/Phragmidium mucronatum/Spain
ML 167/YG2-22/Puccinia melanocephala/USA_LA
100
ML 223/DJN 119/UNK/USA_LA
ML 114/U-1099/Coleosporium sp./USA_WV
ML 194/TAR 168/Phakopsora pachyrizi/USA_LA
ML 44/MCA 3574/Gymnosporangium juniperi-virginianae/USA_MS
9
ML 105/U-567/Melampsora sp./USA_WA
ML 100/U-489/Tranzschelia sp./Germany
ML 104/U-557/Melampsora epitea complex/USA_WA
ML 269/DJN 185/Powdery mildew/JP
ML 126/U-1306/Gymnosporangium juniperi-virginianae/USA_MS
ML 94/U-798/Puccinia cf. poarum/USA_TN
ML 45/MCA 3578/Puccinia sp./USA_MS
ML 50/MCA 3475/Kuehneola sp./USA_LA
ML 49/MCA 3474/Coleosporium sp./USA_LA
ML 276/DJN 193/Coleosporium clematis-apiifoliae/JP
ML 123/U-1287/Puccinia sp./USA_ID
62
ML 142/U-1447/Gymnoconia sp./USA_VA
81
ML 210/MCA 4196/Coleosporium ipomoeae/USA_LA
ML 141/U-1446/Puccinia sp./USA_VA
ML 97/U-402/Coleosporium sp./USA_IL
ML 13/MCA 4196/Coleosporium ipomoeae/USA_LA
ML 35/MCA3198/UNK/Canada_Quebec
ML 66/MCA 3889/Gymnoconia peckiana/USA_LA
ML 86/U-686/UNK/USA_MD
ML 37/MCA 3204/Urediniopsis sp./Canada_Quebec
ML 106/U-610/Pucciniastrum cf. americanum/USA_MN
ML 88/U-748/Pucciniosira cf. tuberculata/USA_FL
ML 36/MCA 3200/Melampsora sp./Canada_Quebec
ML 23/MCA 3888/Gymnoconia sp./UNK
10
Concatenated tree continued (next page)
0.03


Concatenated tree continued (previous page)
ML 279/DJN 196/Coleosporium asterum/JP
ML 191/TAR 116/Coleosporium ipomoea/USA_LA
ML 51/MCA 3476/Puccinia lygodii/USA_LA
ML 56/MCA 3871/Puccinia smilacis/USA_LA
ML 226/DJN 120/UNK/USA_LA
ML 286/DJN 206/Melampsora larisi-populina/JP
ML 24/MCA 3892/Puccinia arundinania/UNK
ML 173/TAR 146/Uromyces sp./USA_LA
ML 180/TAR 212/UNK/USA_LA
ML 188/TAR188/Phakopsora pachyrizi/USA_GA
ML 187/TAR 167/Phakopsora pachyrizi/USA_LA
89
ML 183/TAR 184/UNK/USA_LA
ML 177/TAR 193/Phakopsora pachyrizi/USA_GA
ML 47/MCA 3472/Puccinia lygopodii/USA_LA
ML 59/MCA 3748/Coleosporium sp./USA_LA
ML 189/TAR 127/Phakopsora pachyrizi/USA_LA
ML 57/MCA 3870/Kuehneola uredinis/USA_LA
ML 43/YG2-47/UNK/UNK
ML 161/U-1420/Coleosporium plumeriae/USA_LA
ML 159/MCA 3793/Puccinia sparaginoides/USA_LA
ML 147/YG1/Puccinia melanocephala/USA_LA
ML 195/TAR 198/Phakopsora pachyrizi/USA_LA
ML 62/MCA 3852/Puccinia lygodii/USA_LA
ML 249/DJN 139/UNK/JP
ML 230/DJN 122/Puccinia lygodii/USA_LA
ML 270/DJN 187/Coleosporium phellodendri/JP
ML 307/DJN 244/Melampsoridium hiratsukanum/JP
58
ML 306/DJN 242/Uromyces veratri/JP
ML 257/DJN 156/Puccinia nipponica/JP
ML 288/DJN 210/Melampsora capricarum/JP
ML 271/DJN 188/Coleosporium sp./JP
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ML 168/YG2-26/Puccinia melanocephala/USA_LA
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ML 152/YG2-42/Puccinia melanocephala/USA_LA
ML 169/YG2-36/Puccinia melanocephala/USA_LA
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ML 172/TAR 140/ Uromyces sp./USA_LA
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ML 162/YG2-43/Puccinia melanocephala/USA_LA
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67
ML 320/JRH2003-113/Cerotelium sabiceae/Guyana
ML 5/MCA 4196/Coleosporium ipomoeae/USA_LA
ML 9/MCA 4196/Coleosporium ipomoeae/USA_LA
ML 211/MCA 4196/Coleosporium ipomoeae/USA_LA
ML 332/PUR 136/Ravenelia sp./Nigeria
ML 318/DJN 260/Cerotelium fici/USA_LA
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ML 186/TAR 118/Uromyces sp. /USA_LA
ML 205/MCA 4196/Coleosporium ipomoeae/USA_LA
ML 315/DJN 260/Cerotelium fici/USA_LA
ML 317/DJN 260/Cerotelium fici/USA_LA
ML 239/U-1451/Coleosporium ipomoeae/UNK
ML 209/MCA 4196/Coleosporium ipomoeae/USA_LA
ML 200/MCA 4196/Coleosporium ipomoeae/USA_LA
ML 204/MCA 4196/Coleosporium ipomoeae/USA_LA
ML 12/MCA 4196/Coleosporium ipomoeae/USA_LA
98
ML 29/MCA 2554/Puccinia sp./Equador
87
ML 28/MCA 2551/UNK/Equador
64
ML 140/U-1460/Puccinia psidii/Puerto Rico
ML 78/MCA 2453/Coleosporium vernoniae/Guyana
ML 233/DJN 123/Cerotelium fici/USA_LA
ML 282/DJN 201/Melampsora tremuloides/JP
96
ML 225/DJN 119/UNK/USA_LA
100
ML 42/MCA 3343/Puccinia melanocephala/USA_LA
ML 54/MCA 3620/Coleosporium sp./USA_LA
ML 111/U-1063/Coleosporium sp./USA_MD
ML 150/YG2-7/Puccinia melanocephala/USA_LA
ML 176/TAR 112/UNK/USA_LA
73
ML 31/MCA 2888/Phakopsora meibomiae/Costa Rica
ML 87/U-688/Prospodium sp.?/Guam
ML 93/U-421/Uredo sp.?/Guam
ML 197/TAR 105/Phakopsora pachyrizi/USA_LA
ML190
ML 222/DJN 118/UNK/USA_LA
ML 61/MCA 3756/Puccinia sp./USA_LA
ML 179/TAR 148/Puccinia poaceae/USA_LA
ML 238/DJN 123/Cerotelium fici/USA_LA
ML 175/TAR 144/Tranzshelia arthuri?/USA_LA
ML 184/TAR 166/UNK/USA_LA
ML 52/MCA 3478/Puccinia sp./USA_LA
ML 236/DJN 123/Cerotelium fici/USA_LA
ML 237/DJN 123/Cerotelium fici/USA_LA
ML 17/MT 8/Puccinia sp./USA_LA
ML 69/MCA 4228/Puccinia cf. malvacearum/USA_LA
ML 235/DJN 123/Cerotelium fici/USA_LA
ML 174/TAR 141/Puccinia similuncis/USA_LA
ML 160/AR/Cerotelium fici/UNK (USA_LA)
ML 18/MCA 4207/Puccinia hemerocalliidis/USA_LA
ML 55/MCA 3634/Cerotelium fici/USA_LA
11
12
13
14
15
16
17
0.03

3.3 Distribution and specificity of *Mycodiplosis* larvae on rust fungi

3.3.1 Data collection

Of 1350 collections examined, *Mycodiplosis* larvae were found on 261 collections (Appendix A, Table A-1 page 57). Collections with larvae were found in 25 of 44 countries in the survey data (Appendix B, Table B-12 page 149). Larvae occurred on 127 identified rusts from 22 countries. A database of collection information was recorded for analysis of significance in the distribution of these larvae. Field notebooks were obtained in an effort to procure missing data for examined collections. Some collections did not contain complete records and were not used in the statistical analysis of larval distribution. Those collections for which complete data was available were then used in principal component analysis (Appendix B, Table B-1 page 113).

3.3.2 PCA analysis of larval occurrence

Principal component analysis (PCA) was done with scored data for selected factors in a 224 sample subset of collections (Appendix B, Table B-2 page 124). PCA in R found principal components 1-3 to be responsible for >95% of variation in the scored multivariate matrix (Figure 6). Rust species and host species variables are responsible for most of the variation in the scored dataset (Table 2 & Figure 7). Occurrence of larvae was plotted against rust species and host species but no clustering of larval presence was found (Figure 8) in the subset data. Rust species and host species showed a linear relationship in the pairwise comparison.

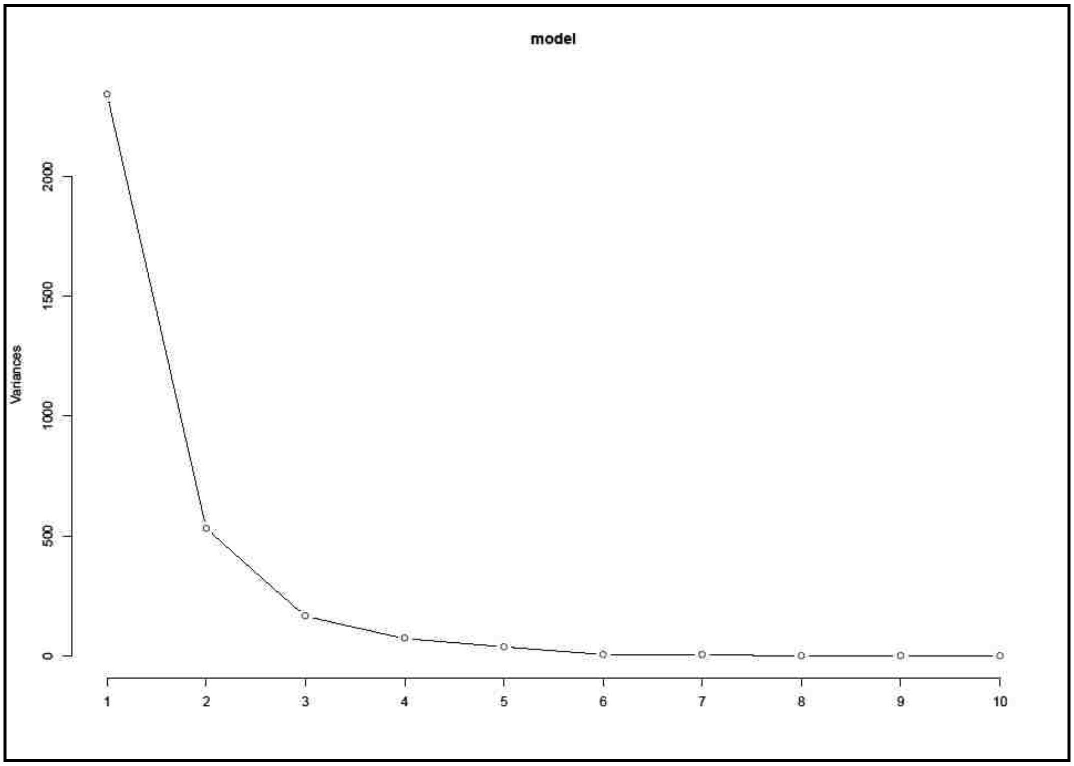

Figure 6. Line plot of principal components responsible for variation in the scored data set. >95% of variance in the data is explained by components 1-3.

Table 2. Principal components 1-3 provide >95% of the variation in scored data from collections with components 1 and 2 providing 91% of cumulative variance. Rust species and host species factors provide the most variation in the data matrix.

Factor	**PC1**	**PC2**	**PC3**
Month	0.004269	-0.00908	0.00571
Year	-0.0241	-0.07544	0.182357
Season	-0.0003	-0.00266	0.001455
Amount of material	-0.0024	-0.00303	0.005146
Rust species	0.631101	-0.77414	-0.01127
Rust family	0.040009	0.058756	-0.02207
Host species	0.772342	0.624387	-0.05251
Host family	0.053036	0.039567	0.978401
Hemisphere (E/W)	-0.00053	0.001255	-0.00828
Hemisphere (N/S)	9.76E-05	0.001358	0.001035
Continent	-0.00181	-0.0009	-0.01819
Country	-0.01333	-0.00618	-0.07513
Larvae (Y/N)	0.00053	-0.00051	0.000311
Cumulative Proportion of variance	0.7415	0.91	0.9623

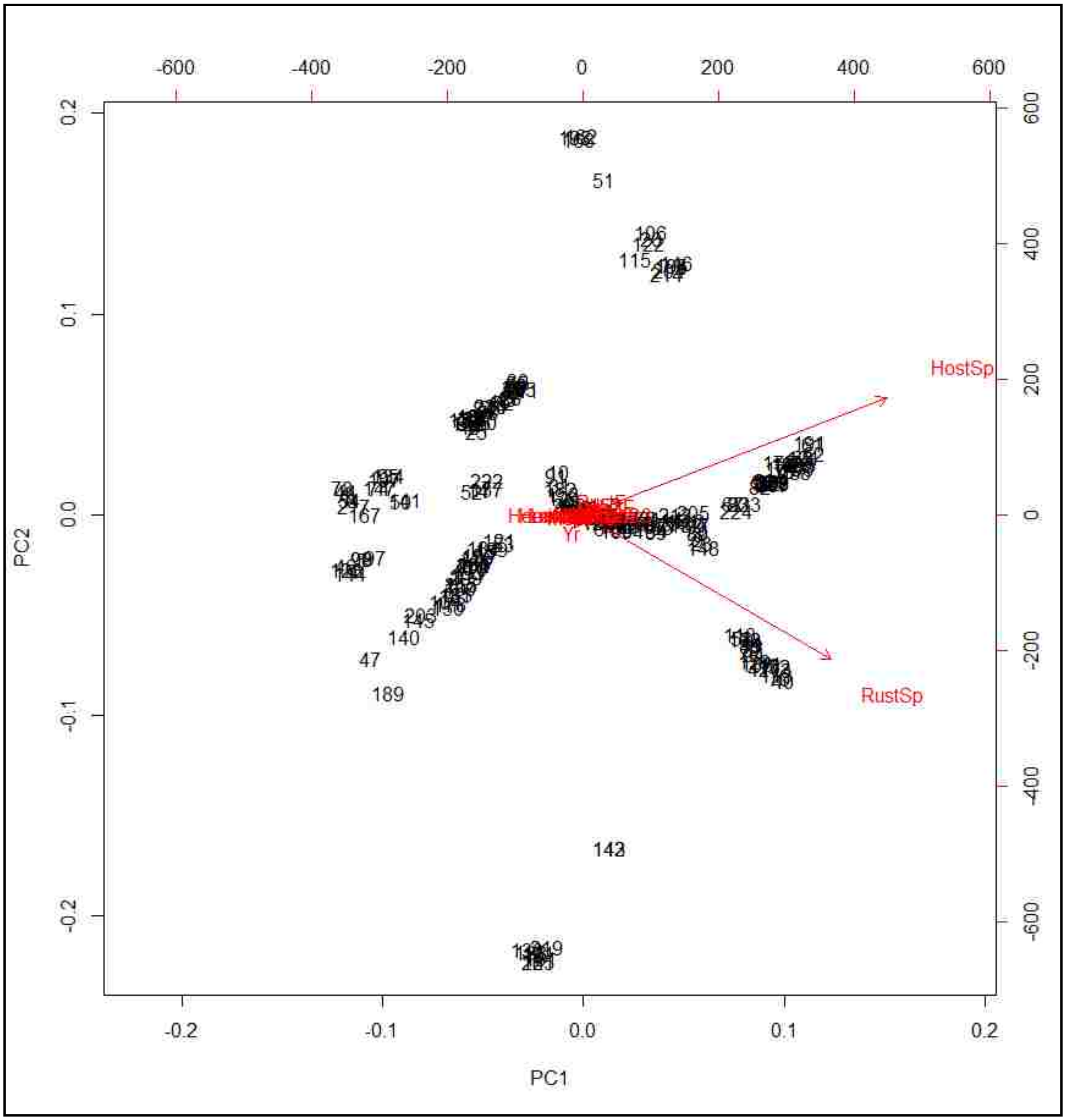

Figure 7. Plot of principal components 1 and 2 showing trend lines for the factors Rust species and Host species are responsible for variation in the scored data set. All other factors contain near zero variance in PCA analysis.

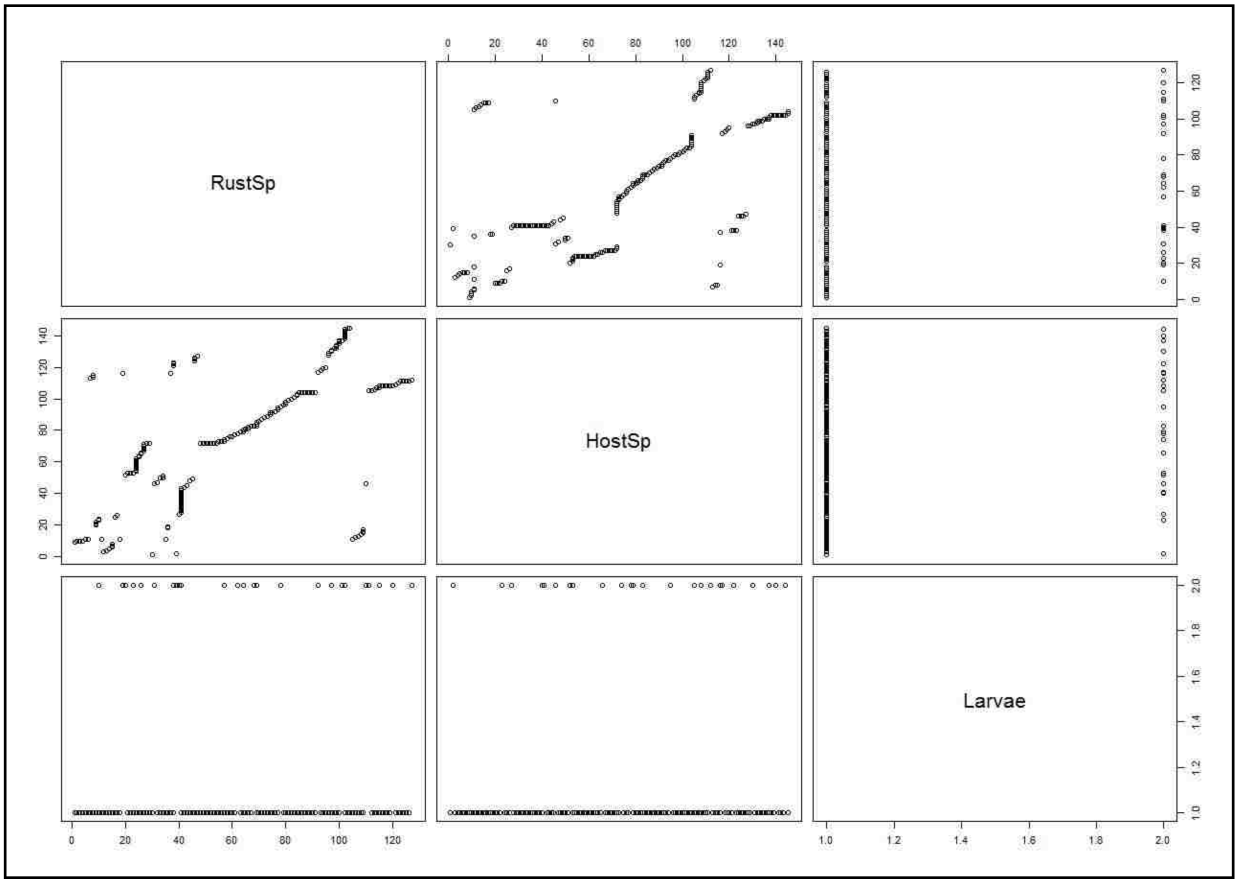

Figure 8. Paired plot of scored data from collections. Rust species and host species exhibit an expected correlation as many rust fungi are known to be host specific. Larval absence/presence, scored 1 and 2 respectively, does not correlate more strongly with either rust or host data.

Fisher's exact test was then conducted on the presence/absence of larvae by known rust species (Appendix B, Table B-5 page 137). Comparison of the proportions of presence/absence counts amongst rust species showed at least one proportion dependent on rust species (p = 0.00009). A binomial test ($\alpha = 0.05$) of larval frequency was done to determine which rust species contained proportions that were significantly different from the overall sample proportion (27.8%) (Table 3). Collections of *Cerotelium fici* were obtained between 2008 and 2012, and included specimens that were examined for *Mycodiplosis* prior to pressing and drying of plant material. The remaining identified rust species were collected in Japan and examined for larvae prior to pressing and drying the collections.

Table 3. Proportional data for rust species identified as significant in the distribution of larvae by binomial probability. Although the sample size was small, five species of rusts identified as having proportions of larval occurrence significantly different than the observed occurrence within surveyed rust collections.

Rust Species	Total Collections	Total with *Mycodiplosis*	% with *Mycodiplosis* larvae
Cerotelium fici	7	6	85.7
Melampsora tremuloides	3	3	100.0
Melampsoridium hiratsukanum	3	3	100.0
Puccinia oxalidis	5	4	80.0
Uredo ierensis	3	3	100.0

Fisher's exact test was run on the frequency of larvae by country to assess if there were geographic differences in the distribution of *Mycodiplosis.* Larval frequency comparison based on country showed at least one proportion to be dependent on the country in which the samples were collected (p = 0.00009) supporting geographical differences in the distribution of larvae. A binomial test of larval frequencies was then done in order to determine which countries have larval dependence (Table 4). All Japanese collections were examined for larvae prior to preservation of plant material. Collections from India and Nigeria ranged in age from 4-27 years while collections from Spain consisted of mostly telial stage rusts (Appendix A, Table A-1 page 57; M. C. Aime, pers. comm.).

Table 4. Results of binomial probability test of larval occurrence by country of collection. Four locations were identified as having proportions of larval occurrence significantly different than the observed occurrence within surveyed rust collections. 95% confidence that the proportion of collections with larvae is significantly different than the overall sample proportion (19.8%).

Country	Total Collections	Total with *Mycodiplosis*	% with *Mycodiplosis* larvae
India	38	2	5.3
Japan	119	68	57.1
Nigeria	45	2	4.4
Spain	51	3	5.9

3.3.3 Chi Square and Fisher's exact test of the distribution of supported clades

Once phylogenetic analyses were conducted and species-level clades of *Mycodiplosis* samples were determined, additional distributional statistics were done based on the results of PCA analysis identifying rust taxon as potentially predictive of larvae. Country and continent of collection was also examined as a proxy for geographical distribution of potential fly species. Factors not identified as potentially predictive of larvae in PCA analysis were not examined in larval clade distributional analyses. Chi-square and Fisher's exact tests were done on the frequency of phylogenetic fly species occurrence on rust species, genus, and family as well as by country (Appendix B, Table B-11 page 141). Fly clades from gene tree analysis of the sample data show no significant dependence in distribution to taxonomic levels of rust fungi, but appear to be significantly dependent on geographic factors (Table 7). The geographic distribution of *Mycodiplosis* clades shows some fly groups are specific to certain countries and continents, while clade 7 appears to be globally distributed (Figure 12).

Table 5. Summary of statistical analyses of dependence in the distribution of phylogenetic fly clades based on rust fungal taxonomic levels, country and continent of collection. No dependence on rust fungi is apparent in the sample data.

Comparison	**X-squared**	**df**	**p-value**	**Fisher's exact test p-value**
Fly clades by Rust species	681.3055	NA	0.5010	0.1449
Fly clades by Rust genus	267.2696	NA	0.5765	0.2276
Fly clades by Rust family	146.7708	NA	0.4360	0.1605
Fly clades by Country	260.2104	NA	0.0021	0.00009
Fly clades by Continent	97.2610	NA	0.0171	0.00009

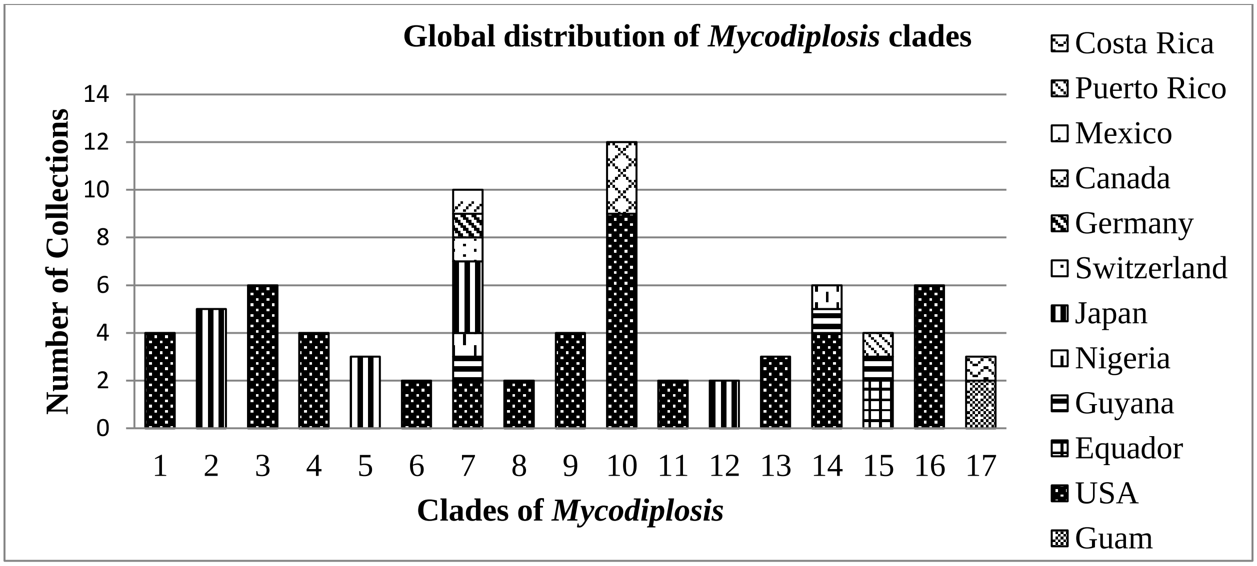

Figure 9. The geographic distribution of *Mycodiplosis* clades determined by phylogenetic analysis. Distribution of fly clades was found to be significantly dependent upon the location where rust was collected in the sample dataset. 12 of 17 *Mycodiplosis* clades are found in the United States, with 10 exclusive to the North American continent (the U.S. and Canada). Clade 7 occurs in countries of the Americas, Africa, Europe, and Asia.

Chapter 4. Discussion

4.1 Phylogenetic diversity estimates

Phylogenetic analyses of 28S and COI genes had potential to provide evidence of diversity in *Mycodiplosis* based on previous studies in the Diptera (Bertone, et al. 2008; Henk, et al. 2011; Joy and Crespi 2007; Shin, et al. 2013; Stireman, et al. 2012; Stireman, et al. 2010). If there are multiple *Mycodiplosis* species present in surveyed rust-infected plants, then there should be supported species-level clades in the topology of a phylogenetic tree.

The nuclear 28S ribosomal RNA gene region was used in a preliminary study to explore genetic diversity in *Mycodiplosis* (Henk, et al. 2011). There are 49 published species of *Mycodiplosis* based on morphology (Gagné 2004). In the current study, phylogenetic analyses using 28S sequence data from *Mycodiplosis* larvae sampled from collections of rust infected plant material provide a conservative estimation of species divergence. Analysis of nucleotide content for the 407bp amplicons of the D7 region of 28S showed a single variable 30bp region with two motifs. The range of pairwise genetic distance in 28S, from 0 to 2.6%, is contained in this region with 41/413 variable sites. The use of 28S sequence data for below family level phylogenetic analysis is contentious, with some support and some disagreement as to the utility of this region for differentiating between closely related species (Friedrich and Tautz 1997; Hasegawa and Kasuya 2006; Hillis and Davis 1987; Hillis and Dixon 1991; Hwang and Kim 1999; Joy and Crespi 2007). Utility of 28S appears to be time dependent, with species lineages discernable between 500 and 100mya among some amphibian species studied (Hillis and Davis 1987; Hillis and Dixon 1991). Recently published 28S sequence for members of Sciaridae (Shin, et al. 2013), a sister family to Cecidomyiidae, allowed for a test of the utility of identical regions of 28S to assign species clades accurately within a genus of related flies. Sequences for an identical region of 28S from *Bradysia* species were obtained from GenBank and used in test analysis of this locus to resolve species clades. Genetic distance in these test sequences had a range of 3.2% and sequences had 27/393 variable sites.

The test analysis using sequences from the same region of 28S for multiple *Bradysia* species within family Sciaridae (Figure 1) shows that this region can underestimate the number of species present. The underestimation of species at this locus is an important finding as it has implications for both future molecular studies of *Mycodiplosis* as well as the previous work by Henk using 28S to explore sequence diversity (2011). Potentially, there could be even more diversity than the previous study suggested. The gene tree for *Mycodiplosis* 28S sequences had 7 potential clades with 50% or more bootstrap support (Figure 3), but may not represent true species-level clades based on the underestimation of species in the test analysis. 28S is still potentially useful for concatenated analysis with COI, and for verification that sampled larvae are within the genus *Mycodiplosis* by BLAST search maximum identity closest to the sequences provided by the previous study. Additionally, 28S sequences generated from this research will also be useful for future researchers interested in higher level phylogenetic questions in Diptera.

Maternally inherited mitochondrial DNA such as COI, has variation in nucleotides between individuals of the same species as well as between individuals of closely related species (Hebert, et al. 2003; Stireman, et al. 2012). COI has been used for species identification through species barcoding (Frézal and Leblois 2008; van Nieukerken, et al. 2012). In addition to barcoding, COI can be used for phylogenetic analysis of recently diverged species (Simon, et al. 1994; Stireman, et al. 2012; Stireman, et al. 2010). COI sequence data for *Mycodiplosis* samples represents a suitable locus to infer species-level differentiation with phylogenetic analysis in this study based on the literature as well as the test analysis using COI sequence from previously published research. In addition, COI sequences from this research represent the first mitochondrial sequences generated for the study of *Mycodiplosis* and primers developed for this project represent a first effort at specific mtDNA primers for the genus.

Analysis of COI sequence characteristics from the *Asteromyia* test data, a genus in the Cecidomyiidae family with *Mycodiplosis,* showed a 4.5% range of genetic distance and 98/304 variable sites. Compared to 2.6% genetic distance and 99/300 variable sites in *Mycodiplosis* sequences. As a result of the difference in pairwise genetic distances, branch lengths in the phylogeny of *Mycodiplosis* COI sequences were found to be shorter than those in the test tree. Results of a test phylogenetic analysis using homologous COI data from Stireman et al (2010) show an overestimation of species-level clades (Figure 2). Based on *Asteromyia* sequence information and trial phylogenetic analysis, the *Mycodiplosis* sample COI analysis was expected to overestimate species clades in maximum likelihood (ML) analysis. Phylogenetic analysis of COI sequences from *Mycodiplosis* provided 17 clades with 50% or greater bootstrap support (Figure 4). Concatenation of 28S and COI sequences for larval samples was done to overcome the underestimation and overestimation of species provided in the individual analyses of 28S and COI respectively (Figure 5).

The topology and support values of the concatenated analysis closely resemble that of the COI analysis (Figures 4 & 5). A total of 17 supported clades consisting of 97 samples were resolved in the concatenated analysis (Figure 5). There were 110 *Mycodiplosis* samples in 16 unsupported clades in the concatenated tree. Based on test analyses of both loci, the concatenation of sequences was expected to resolve *Mycodiplosis* samples into supported potential species clades. The limited range of genetic distance compared to test data sets between sample sequences for both 28S and COI could be responsible for the lack of resolution in the analyses based on comparison with the test analyses (Figures 1 & 2). This is an important result suggesting the need for additional loci or longer sequence from 28S and COI for phylogenetic analysis of species diversity in *Mycodiplosis*.

Of the 49 *Mycodiplosis* species described, 21 were identified as mycophagous on rust fungi (Gagné 2004). In this analysis 17 potential species level clades were found feeding on rust fungi. Larval samples from supported clades in the concatenated tree did not correspond with the country of origin and rust species associated with any described species in the Cecidomyiidae catalog (Gagné 2004). With an additional 110 samples yet to be resolved into supported clades, there is potential for many more rust-feeding *Mycodiplosis* species than are currently described.

4.2 Host Specificity and Distribution of *Mycodiplosis*

Distribution of larvae found on collections of rust-infected plant material may be dependent on host rust or geography. Statistical analysis of collection information for larvae-positive specimens can identify the important factors in the distribution of *Mycodiplosis* larvae. Further analysis of factors influencing the distribution of phylogenetic *Mycodiplosis* species helps to describe the ecological characteristics of those species.

Principal component analysis of collection data showed that rust species and host species variables were most responsible for variance in the collections (Table 2 and Figure 7). This multivariate analysis is independent of the presence or absence of larvae, but points to the factors with the highest probability of predictive value in the matrix data by analysis of the primary principal components (PC1 and PC2 in this analysis) (Jolliffe 2005). Plotting of paired data showed a linear correlation between rust species and host species, and no apparent clustering of larval presence/absence values (Figure 8). Rust fungi are host specific obligate phytopathogens (Cummins and Hiratsuka 2003). Due to the tight linear correlation between rust and host plant, the analysis of independence of larval presence/absence frequency was only necessary against rust fungi. Frequency of larval occurrence was then analyzed for significance with rust species.

The results of these analyses support that *Mycodiplosis* infestation is more frequent on five rust species (Table 3) among 587 collections of 262 identified species of rust fungi. The sampling strategy for collecting data was to survey all available material. As has been pointed out by Henk et al. (2011), there may be inherent negative bias in herbarium collections as the principle effort is the preservation of plant and mycological specimens. Collectors are most likely unaware that they may be losing valuable entomological specimens during the drying and handling of collected material. Additionally, there may have been unknown bias in the herbarium collections based on collector preferences or area of scientific interest. Sample size of rust-infected plant material for the identified rust species ranged from 1 to 57, and all five rust species significantly correlated with larval infestation: *Cerotelium fici, Melampsora tremuloides, Melampsoridium hiratsukanum, Puccinia oxalidis,* and *Uredo ierensis* had sample sizes of seven or less. With the exception of *Cerotelium fici*, all rust species found significantly correlated with larval presence were from fresh collections in Japan surveyed for larvae prior to pressing and drying of plant material.

Location data were not identified as a primary source of variation in the data with principal component analysis (Appendix B, Table B-3 page 128). Even so, what is known of the life history of *Mycodiplosis* suggests that species may be limited in range (Gagné 1994; Kaushal, et al. 2001). The distribution of larvae was then assessed based on country of sample origin. Four countries were found to be significant predictors of larval frequency on rust collections (Table 4) with large sample sizes from each. Interestingly, India, Spain, and Nigeria are less likely to have *Mycodiplosis* infestations of rust fungi while in Japan the rate of larval occurrence is 57%.

Collections from India and Nigeria are up to 27 years old, and Spain collections were mostly telial stage rusts (Appendix A, Table A-1 page 57; M. C. Aime pers. comm.). In the recent study by Henk et al. (2011), they found larva feeding only on the aeciospores and urediniospores of surveyed rusts. The telial stage rusts from Spanish collections may then underestimate the occurrence of larvae on rust in that region. The age of herbarium specimens from India and Nigeria may also underestimate the occurrence of larvae as collections potentially lose larvae during handling over time (Henk et al. 2011). The larger frequency of occurrence in Japanese collections was potentially caused by collection bias from examining fresh collections. Japanese collections were examined for larvae prior to pressing and drying, which may actually represent a more accurate assessment of larval occurrence on rust in that region.

Distribution of phylogenetic *Mycodiplosis* species was also assessed for significant factors. Clades of potential fly species were statistically tested for significance in their occurrence on rust fungal species, genera, and families. The result of this analysis showed no dependence on rust taxon (Table 5). The frequency of larvae in general appears significantly associated with five rust species while larval species, as defined by molecular phylogenetic analyses, were not significantly dependent on any taxonomic level of rust fungi. This result supports a hypothesis of *Mycodiplosis* species as generalist feeders on rust fungal spores, with some potential preference for certain rust fungi by the entire fly genus. This could be the result of sampling bias from a comparison of larval occurrence on herbarium and fresh collections.

Geographic influence in the distribution of potential *Mycodiplosis* species clades was also tested and found to be significant (Table 5). Country and continent were used in the analysis as an indicator of spatial distribution for larval clades. Count data for potential *Mycodiplosis* species clades found in each country was plotted (Figure 9), and shows clade 7 occurring on all five continents where supported clades were found. No supported clade was found in Australia, which had only one of 12 total collections infested with larvae. Clade 7 represents a potential species of *Mycodiplosis* which is broadly dispersed. This could imply that human activities played a role in the distribution of this potential species. Another Cecidomyiid fly, *Mayetiola destructor*, is a globally distributed pest on wheat that is suspected of being introduced by humans (Johnson et. al 2004). Global trade in crops which may contain *Mycodiplosis* and rust fungi could be one explanation for this cosmopolitan clade.

Twelve of 17 clades of potential fly species in the phylogenetic analysis were found in North America, nine of which were located in the United States alone. This is of significant interest because the current catalog of *Mycodiplosis* contains seven *Mycodiplosis* species occurring in the United States, two of which are cosmopolitan in occurrence (Gagné 2004). Potentially, the results of this study have provided molecular phylogenetic evidence of additional *Mycodiplosis* species occurring in the United States that have yet to be described.

Rust collections from the United States are 47.4% of total collections considered in the geographic distribution analysis (Appendix B, Table B-12 page 149). Of all 44 countries represented in the survey of rust-infected plant material, only the U.S., Japan, Spain, and Guyana had 50 or more collections. This suggests that increased sampling of rust infected plants outside of North America may capture additional *Mycodiplosis* species.

Chapter 5. Conclusions

There is evidence of potential unexplored species diversity in *Mycodiplosis* (Figure 5). However, the largely unresolved gene tree suggests that additional loci are needed to thoroughly resolve species within this genus (Hudson and Coyne 2002). In future work, a comprehensive random sampling strategy of fresh collected rust-infected plant material should be developed to remove the negative bias inherent in examining preserved herbarium specimens and determine a more accurate rate of larval occurrence. This method would also serve as an opportunity to obtain living larval specimens to subsequently rear and characterize morphologically.

Comprehensive sampling from multiple locations, rearing of larvae to adulthood for morphological identification, and additional DNA sequence information are needed to verify species diversity. Potentially informative additional loci for phylogenetic questions ranging from intrageneric to order level have been proposed (Caterino, et al. 2000). In addition to COI, Caterino, et al. suggested the use of 18S ribosomal RNA (rRNA), 16S small subunit rRNA, and Elongation Factor 1 alpha for insect phylogenetics. These loci may help to resolve additional clades that were unsupported in this analysis. With 49 species in the latest Cecidomyiidae catalog (Gagné 2004), and 17 supported potential species level clades in this work, there is potentially more *Mycodiplosis* species yet to be uncovered with additional phylogenetic analyses.

The global distribution of clade 7 and the broad distribution of clades 14 & 15 (Figure 9) raise interesting questions about the geographic distribution of members in this genus. Could more species be globally distributed? How are these species being introduced? From where do they originate? Analysis of haplotype data for COI, as done in a recent study of *Mayetiola destructor* distribution (Johnson, et al. 2004) may begin to answer these questions. Larval clades in this analysis were assessed based on country of collection as a proxy for spatial distribution patterns of potential species. This does not represent a biologically meaningful level of distributional analysis, and future work should consist of georeferencing collection data to assess the influence of physical and climatic factors in the distribution of fly species. Is the distribution of *Mycodiplosis* species explained by these factors, or is the limit of species dispersal moreso dependent on the availability of their rust food source?

Based on this study, no evidence for specificity of larval clades on rust species, genera, or famlies was evident (Table 5). There is evidence, however, that larvae do appear more frequently on certain rust species, but the specificity occurs at the genus level (Table 3) and not the species level. Knowledge of insect diversity and association may be a benefit to future researchers interested in the effect of larvae on the number of rust spores per unit area. Do larvae from different species feed at different rates? Do they require different quantities of food to reach maturity? Do larvae function to reduce rust fungal inoculum or do they function as a vector of spore transmission to healthy plant tissue? Greenhouse studies should be done to assess the potential of *Mycodiplosis* larvae as biological control organisms for use against rust fungi.

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Appendix A. Collection Survey Supplementary Data

Table A-1. Collections examined for the presence of *Mycodiplosis* larvae. 1350 collections examined. Unknown data for collections denoted with "UNK".

Date	Collection Number	Larvae (+/-)	Larval Sample #	28S Sequence (Y/N) & BLAST ID	COI Sequence (Y/N) & BLAST ID	Supported Clades by tree (28S\COI\Concat.)	Rust Identification	Host Identification	Country
18-Sep-10	AR	+	ML160	(Y) Cecidomyiidae	(Y) *Asteromyia*	6\NA\NA	*Cerotelium fici*	*Ficus* sp.	UNK
3-Mar-11	AR16	+	ML156	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Puccinia waldsteiniae*	*Waldsteinia sp.*	USA
3-Mar-11	AR18	+	ML157	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\11\4	*Gymnoconia nitens*	*Rubus* sp.	USA
3-Mar-11	AR20	+	ML154	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\12\6	*Puccinia* cf. *recondita*	*Nemophila aphylla*	USA
16-Jun-12	DJN118	+	ML222	(Y) Cecidomyiidae	(Y) *Asteromyia*	6\4\NA	UNK	UNK	USA
16-Jun-12	DJN118	+	ML220	(Y) Cecidomyiidae	(Y) *Asteromyia*	NA\7\3	UNK	UNK	USA
16-Jun-12	DJN118	+	ML221	(Y) Cecidomyiidae	(Y) *Asteromyia*	NA\NA\NA	UNK	UNK	USA
16-Jun-12	DJN119	+	ML225	(Y) Cecidomyiidae	(Y) *Asteromyia*	5\1\16	UNK	UNK	USA
16-Jun-12	DJN119	+	ML223	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\15\9	UNK	UNK	USA
16-Jun-12	DJN119	+	ML224	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	UNK	UNK	USA
16-Jun-12	DJN120	+	ML226	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	UNK	UNK	USA
16-Jun-12	DJN120	+	ML227	(Y) *Mycodiplosis*	(N)	NA\NA\NA	UNK	UNK	USA
16-Jun-12	DJN120	+	ML228	(Y) Cecidomyiidae	(N)	NA\NA\NA	UNK	UNK	USA
16-Jun-12	DJN121	+	ML229	(Y) Cecidomyiidae	(Y) *Asteromyia*	NA\NA\NA	UNK	UNK	USA
16-Jun-12	DJN122	+	ML232	(Y) Cecidomyiidae	(Y) *Asteromyia*	NA\7\3	*Puccinia lygodii*	*Lygodium japonicum*	USA

(**Table A-1.** Continued.)

Date	Collection Number	Larvae (+/-)	Larval Sample #	28S Sequence (Y/N) & BLAST ID	COI Sequence (Y/N) & BLAST ID	Supported Clades by tree (28S\COI\Concat.)	Rust Identification	Host Identification	Country
16-Jun-12	DJN122	+	ML230	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Puccinia lygodii*	*Lygodium japonicum*	USA
16-Jun-12	DJN122	+	ML231	(Y) *Mycodiplosis*	(Y) ***Megaselia scalaris***	NA\NA\NA	*Puccinia lygodii*	*Lygodium japonicum*	USA
16-Jun-12	DJN123	+	ML235	(Y) Cecidomyiidae	(Y) *Asteromyia*	6\NA\NA	*Cerotelium fici*	*Ficus carica*	USA
16-Jun-12	DJN123	+	ML236	(Y) Cecidomyiidae	(Y) *Asteromyia*	6\NA\NA	*Cerotelium fici*	*Ficus carica*	USA
16-Jun-12	DJN123	+	ML237	(Y) Cecidomyiidae	(Y) *Asteromyia*	6\NA\NA	*Cerotelium fici*	*Ficus carica*	USA
16-Jun-12	DJN123	+	ML238	(Y) Cecidomyiidae	(Y) *Asteromyia*	6\NA\NA	*Cerotelium fici*	*Ficus carica*	USA
16-Jun-12	DJN123	+	ML233	(Y) Cecidomyiidae	(Y) *Asteromyia*	NA\NA\NA	*Cerotelium fici*	*Ficus carica*	USA
16-Jun-12	DJN123	+	ML234	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Cerotelium fici*	*Ficus carica*	USA
23-Jul-12	DJN126	+	ML243	(Y) *Mycodiplosis*	(N)	NA\NA\NA	*Puccinia oxalidis*	*Oxalis corymbosa*	Japan
25-Jul-12	DJN132	+	ML244	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Puccinia oxalidis*	*Oxalis corymbosa*	Japan
25-Jul-12	DJN133	+	ML245	(N)	(Y) *Asteromyia*	NA\NA\NA	*Puccinia kusanoi*	*Pleioblastus pygmaeus*	Japan
25-Jul-12	DJN134	+	ML246	(N)	(Y) *Asteromyia*	NA\NA\NA	*Ochropsora kraunhiae*	*Wisteria floribunda*	Japan
25-Jul-12	DJN135	+	ML247	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Phragmidium* sp.	*Rosa rugosa*	Japan
27-Jul-12	DJN138	+	ML248	(Y) *Mycodiplosis*	(N)	NA\NA\NA	UNK	UNK	Japan
27-Jul-12	DJN139	+	ML249	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	UNK	*Elymus* sp.	Japan
27-Jul-12	DJN144	+	ML250	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	Powdery mildew: *Phyllactinia morii*	*Morus australus*	Japan
1-Aug-12	DJN149	+	ML251	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Coleosporium asterum*	*Aster* sp.	Japan
1-Aug-12	DJN150	+	ML252	(Y) *Mycodiplosis*	(Y) *Asteromyia*	3\10\5	*Coleosporium* sp.	*Solidago virga-aurea*	Japan
1-Aug-12	DJN151	+	ML253	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\6\2	*Coleosporium* sp.	*Solidago virga-aurea*	Japan

(**Table A-1.** Continued.)

Date	Collection Number	Larvae (+/-)	Larval Sample #	28S Sequence (Y/N) & BLAST ID	COI Sequence (Y/N) & BLAST ID	Supported Clades by tree (28S\COI\Concat.)	Rust Identification	Host Identification	Country
1-Aug-12	DJN153	+	ML254	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Puccinia orbicula*	*Prenanthes acerifolia*	Japan
1-Aug-12	DJN154	+	ML255	(N)	(Y) *Asteromyia*	NA\NA\NA	*Puccinia tokyensis*	*Cryptotaenia japonica*	Japan
1-Aug-12	DJN155	+	ML256	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Pucciniastrum bohemeriae*	*Bohemeria* cf. *longispica*	Japan
1-Aug-12	DJN156	+	ML257	(Y) *Mycodiplosis*	(Y) *Asteromyia*	3\NA\12	*Puccinia nipponica*	*Salvia* sp.	Japan
1-Aug-12	DJN158	+	ML258	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Ochropsora kraunhiae*	*Wisteria floribunda*	Japan
1-Aug-12	DJN161	+	ML259	(Y) *Mycodiplosis*	(N)	NA\NA\NA	*Pucciniastrum bohemeriae*	*Bohemeria spicata*	Japan
1-Aug-12	DJN162	+	ML260	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Puccinia nanbuana*	*Angelica polymorpha*	Japan
3-Aug-12	DJN170	+	ML261	(Y) *Mycodiplosis*	(Y) *Asteromyia*	1\6\2	*Pucciniastrum kusanoi*	*Clethra barbinervis*	Japan
3-Aug-12	DJN172	+	ML262	(N)	(Y) *Asteromyia*	NA\NA\NA	*Puccinia suzutake*	*Hydrangia hirta*	Japan
3-Aug-12	DJN173	+	ML263	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Puccinia dieteliana*	*Lysimachia clethroides*	Japan
3-Aug-12	DJN174	+	ML264	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\7	*Puccinia oxalidis*	*Oxalis* cf. *corymbosa*	Japan
7-Aug-12	DJN180	+	ML265	(N)	(Y) *Asteromyia*	NA\NA\NA	*Hyalopsora polypodii*	*Athyrium niponicum*	Japan
7-Aug-12	DJN182	+	ML266	(Y) Cecidomyiidae	(Y) *Asteromyia*	NA\NA\NA	*Puccinia coronata* var. *coronata*	*Festuca arundinacea*	Japan
7-Aug-12	DJN183	+	ML267	(Y) *Mycodiplosis*	(Y) *Asteromyia*	3\10\5	*Puccinia lantanae*	*Justica procumbus var. leucantha*	Japan
7-Aug-12	DJN184	+	ML268	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\7	*Melampsora tremuloides?*	*Populus seiboldii*	Japan
7-Aug-12	DJN185	+	ML269	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Powdery mildew*	*Castanea crenata*	Japan
7-Aug-12	DJN187	+	ML270	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Coleosporium phellodendri*	*Phellodendron amurense*	Japan
7-Aug-12	DJN188	+	ML271	(N)	(Y) *Asteromyia*	NA\NA\NA	*Coleosporium* sp.	*Solidago altissima*	Japan
7-Aug-12	DJN189	+	ML272	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Uromyces lespedezae-procumbentis* var. *lespedezae-procumbentis*	*Lespedeza cyrtobotrya*	Japan

(**Table A-1.** Continued.)

Date	Collection Number	Larvae (+/-)	Larval Sample #	28S Sequence (Y/N) & BLAST ID	COI Sequence (Y/N) & BLAST ID	Supported Clades by tree (28S\COI\Concat.)	Rust Identification	Host Identification	Country
8-Aug-12	DJN190	+	ML273	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Coleosporium phellodendri*	*Phellodendron* sp.	Japan
8-Aug-12	DJN191	+	ML274	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Melampsora tremuloides?*	*Populus seiboldii*	Japan
8-Aug-12	DJN192	+	ML275	(Y) Cecidomyiidae	(Y) *Asteromyia*	NA\NA\NA	*Coleosporium lycopi*	*Adenophora triphylla var. japonica*	Japan
8-Aug-12	DJN193	+	ML276	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Coleosporium clematis-apiifoliae*	*Clematis apiifolia*	Japan
8-Aug-12	DJN194	+	ML277	(Y) Cecidomyiidae	(Y) *Asteromyia*	NA\6\2	*Puccinia miscanthi*	*Mescanthus sinensis*	Japan
8-Aug-12	DJN195	+	ML278	(Y) *Mycodiplosis*	(N)	NA\NA\NA	*Puccinia brachypodii*	*Brachypodium sylvaticum*	Japan
8-Aug-12	DJN196	+	ML279	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Coleosporium asterum*	*Aster glehnii* var. *hondoensis*	Japan
8-Aug-12	DJN197	+	ML280	(Y) *Mycodiplosis*	(Y) *Asteromyia*	3\13\NA	*Puccinia nanbuana*	*Angelica* cf. *edulis*	Japan
8-Aug-12	DJN199	+	ML281	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	Powdery mildew: *Sphaerotheca macularis*	*Humulus lupulus* var. *cordifolius*	Japan
8-Aug-12	DJN201	+	ML282	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Melampsora tremuloides?*	*Populus seiboldii*	Japan
8-Aug-12	DJN202	+	ML283	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\7	*Melampsoridium hiratsukanum*	*Alnus hirsuta*	Japan
8-Aug-12	DJN203	+	ML284	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Puccinia* sp.	*Carex* sp.	Japan
8-Aug-12	DJN204	+	ML285	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Melampsora epyphylla*	*Salix sachalinensis*	Japan
8-Aug-12	DJN206	+	ML286	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Melampsora larisi-populina*	*Populus* cf. *maximovich*	Japan
8-Aug-12	DJN209	+	ML287	(Y) *Mycodiplosis*	(N)	NA\NA\NA	*Puccinia* sp.	*Carex* sp.	Japan
8-Aug-12	DJN210	+	ML288	(Y) Cecidomyiidae	(Y) *Asteromyia*	2\NA\NA	*Melampsora capricarum*	*Salix bakko*	Japan
8-Aug-12	DJN211	+	ML289	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\6\2	*Puccinia cnici-oleracei AND Phakopsora artemisiae*	*Artemisia montana*	Japan

(**Table A-1.** Continued.)

Date	Collection Number	Larvae (+/-)	Larval Sample #	28S Sequence (Y/N) & BLAST ID	COI Sequence (Y/N) & BLAST ID	Supported Clades by tree (28S\COI\Concat.)	Rust Identification	Host Identification	Country
8-Aug-12	DJN215	+	ML290	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Puccinia tokyensis*	*Cryptotaenia japonica*	Japan
8-Aug-12	DJN216	+	ML291	(N)	(Y) *Asteromyia*	NA\NA\NA	*Ochropsora krauniae*	*Wisteria floribunda*	Japan
8-Aug-12	DJN217	+	ML292	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Puccinia tanaceti var. tanaceti*	*Artemisia princeps*	Japan
8-Aug-12	DJN219	+	ML293	(N)	(Y) *Asteromyia*	NA\NA\NA	*Melampsoridium hiratsukanum*	*Alnus hirsuta*	Japan
8-Aug-12	DJN220	+	ML294	(Y) *Mycodiplosis*	(N)	NA\NA\NA	*Melampsoridium alni*	*Alnus firma*	Japan
8-Aug-12	DJN221	+	ML295	(Y) *Mycodiplosis*	(N)	NA\NA\NA	*Uredinopsis* sp.	*Thelypteris hipponica*	Japan
8-Aug-12	DJN222	+	ML296	(N)	(Y) *Asteromyia*	NA\NA\NA	*Puccinia violae*	*Viola sp.*	Japan
8-Aug-12	DJN224	+	ML297	(Y) *Mycodiplosis*	(Y) *Asteromyia*	1\6\2	*Phragmidium griseum*	*Rubus wrightii*	Japan
9-Aug-12	DJN226	+	ML298	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Uredo ioensis*	*Viola grypoceras*	Japan
9-Aug-12	DJN227	+	ML299	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Coleosporium clematidis-apiifoliae*	*Clematis apiifolia*	Japan
9-Aug-12	DJN228	+	ML300	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Puccinia argentata*	*Impatiens nolitangere*	Japan
9-Aug-12	DJN232	+	ML301	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\2\NA	*Uredo ioencis*	*Viola* cf. *collina*	Japan
9-Aug-12	DJN233	+	ML302	(Y) *Mycodiplosis*	(N)	NA\NA\NA	*Puccinia brachypodii*	*Brachypodium sylvaticum*	Japan
9-Aug-12	DJN234	+	ML303	(Y) *Mycodiplosis*	(N)	NA\NA\NA	*Powdery mildew: Sphaerotheca macularis*	*Humulus lupulus* var. *cordifolius*	Japan
9-Aug-12	DJN235	+	ML304	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Puccinia violae*	*Viola* cf. *collina*	Japan
9-Aug-12	DJN236	+	ML305	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\13\NA	*Coleosporium asterum*	*Aster ageratoides* var. *harai f. leucanthus*	Japan
9-Aug-12	DJN242	+	ML306	(Y) *Mycodiplosis*	(Y) *Xanthogramma*	3\NA\12	*Uromyces veratri*	*Varatrum album* subsp. *Orysepalum*	Japan
9-Aug-12	DJN244	+	ML307	(Y) *Mycodiplosis*	(Y) *Asteromyia*	1\NA\NA	*Melampsoridium hiratsukanum*	*Alnus hirsuta* var. *sibirica*	Japan

(**Table A-1.** Continued.)

Date	Collection Number	Larvae (+/-)	Larval Sample #	28S Sequence (Y/N) & BLAST ID	COI Sequence (Y/N) & BLAST ID	Supported Clades by tree (28S\COI\Concat.)	Rust Identification	Host Identification	Country
9-Aug-12	DJN245	+	ML308	(Y) Cecidomyiidae	(Y) *Asteromyia*	NA\10\5	*Pucciniastrum hydrangese-petiolaris*	*Schizophragma hydrangioides*	Japan
9-Aug-12	DJN246	+	ML309	(Y) *Mycodiplosis*	(N)	NA\NA\NA	*Phragmidium rubi-oldhamii*	*Rubus pungens* var. *oldhamii*	Japan
9-Aug-12	DJN248	+	ML310	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Melampsora kusanoi*	*Hypericum ascyron*	Japan
9-Aug-12	DJN249	+	ML311	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Uredinopsis* sp.	*Thelypteris* sp.	Japan
9-Aug-12	DJN250	+	ML312	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Coleosporium neocacaliae*	*Senecio nemorensis*	Japan
9-Aug-12	DJN251	+	ML313	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Puccinia or Uredo*	*Carex incisa?*	Japan
9-Aug-12	DJN254	+	ML314	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Uredo ioenensis*	*Viola grypoceras*	Japan
24-Aug-12	DJN260	+	ML315	(Y) Cecidomyiidae	(Y) *Asteromyia*	NA\8\14	*Cerotelium fici*	*Ficus carica*	USA
24-Aug-12	DJN260	+	ML317	(Y) Cecidomyiidae	(Y) *Asteromyia*	NA\8\14	*Cerotelium fici*	*Ficus carica*	USA
24-Aug-12	DJN260	+	ML318	(Y) Cecidomyiidae	(Y) *Asteromyia*	NA\8\14	*Cerotelium fici*	*Ficus carica*	USA
24-Aug-12	DJN260	+	ML316	(Y) Cecidomyiidae	(N)	NA\NA\NA	*Cerotelium fici*	*Ficus carica*	USA
4-Oct-12	DJN261	+	ML327	(N)	(Y) *Asteromyia*	NA\NA\NA	*Coleosporium ipomoeae*	*Ipomoea* sp.	USA
4-Oct-12	DJN262	+	ML328	(N)	(Y) *Asteromyia*	NA\NA\NA	*Cerotelium fici*	*Ficus carica*	USA
4-Jul-03	JRH2003-113	+	ML320	(Y) Cecidomyiidae	(Y) *Asteromyia*	NA\8\14	Cerotelium sabiceae	*Sabicea glabrescens*	Guyana
4-Jul-03	JRH2003-113	+	ML329	(Y) *Mycodiplosis*	(N)	NA\NA\NA	Cerotelium sabiceae	*Sabicea glabrescens*	Guyana
4-Jul-03	JRH2003-113	+	ML72	(N)	(N)	NA\NA\NA	Cerotelium sabiceae	*Sabicea glabrescens*	Guyana
4-Jul-03	JRH2003-114	+	ML73	(Y) Cecidomyiidae	(Y) *Asteromyia*	NA\NA\NA	*Malupa pakaraimensis*	*Ficus* sp.	Guyana
7-Jul-03	JRH2003-120	+	ML74	(N)	(Y) *Asteromyia*	NA\NA\NA	*Uredo baruensis*	*Chrysophyllum sparsiflorum*	Guyana

(**Table A-1.** Continued.)

Date	Collection Number	Larvae (+/-)	Larval Sample #	28S Sequence (Y/N) & BLAST ID	COI Sequence (Y/N) & BLAST ID	Supported Clades by tree (28S\COI\Concat.)	Rust Identification	Host Identification	Country
11-Jul-03	JRH2003-125	+	ML75	(N)	(Y) *Asteromyia*	NA\NA\NA	*Puccinia fallax*	*Palicourea* sp.	Guyana
3-Jul-03	MCA2305	+	ML76	(Y) Cecidomyiidae	(Y) *Asteromyia*	NA\NA\NA	*Puccinia fallax*	*Palicourea* sp.	Guyana
4-Jan-04	MCA2430	+	ML321	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Puccinia arechavaletae*	*Serjania* sp.	Guyana
4-Jan-04	MCA2430	+	ML331	(N)	(Y) *Asteromyia*	NA\NA\NA	*Puccinia arechavaletae*	*Serjania* sp.	Guyana
4-Jan-04	MCA2430	+	ML77	(N)	(N)	NA\NA\NA	*Puccinia arechavaletae*	*Serjania* sp.	Guyana
8-Jan-04	MCA2453	+	ML78	(Y) Cecidomyiidae	(Y) *Asteromyia*	6\5\15	*Coleosporium vernoniae*	*Elephantopus mollis*	Guyana
9-Jan-04	MCA2475	+	ML79	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\7	*Puccinia fallax*	*Palicourea* sp.	Guyana
3-May-04	MCA2531	+	ML27	(Y) Cecidomyiidae	(Y) *Asteromyia*	NA\NA\3	*Coleosporium?*	UNK	Equador
4-May-04	MCA2551	+	ML28	(Y) Cecidomyiidae	(Y) *Asteromyia*	7\5\15	UNK	UNK	Equador
4-May-04	MCA2554	+	ML29	(Y) Cecidomyiidae	(Y) *Asteromyia*	7\5\15	*Puccinia* sp.	UNK	Equador
10-Sep-04	MCA2832	+	ML241	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\7	*Uromyces junci-effusus*	*Juncus effusus*	USA
10-Sep-04	MCA2832	+	ML25	(N)	(Y) *Asteromyia*	NA\NA\NA	*Uromyces junci-effusus*	*Juncus effusus*	USA
3-Oct-04	MCA2864	+	ML26	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\8\NA	*Puccinia* sp.	*Helianthus*	USA
31-Dec-04	MCA2876	+	Lost larva				*Uromyces* sp.	*Herissantia crispa*	USA
24-Feb-05	MCA2888	+	ML31	(Y) Cecidomyiidae	(Y) *Asteromyia*	6\3\17	*Phakopsora meibomiae?*	Fabaceae	Costa Rica
24-Feb-05	MCA2889	+	ML32	(Y) Cecidomyiidae	(Y) *Asteromyia*	NA\NA\NA	*Puccinia* cf. *gouania*	Asteraceae	Costa Rica
24-Sep-05	MCA2994	+	ML33	(N)	(Y) *Asteromyia*	NA\NA\NA	*Puccinia* sp.	Asteraceae	USA
3-Aug-06	MCA3085	+	ML34	(Y) Cecidomyiidae	(Y) *Asteromyia*	NA\NA\NA	*Kuehneola uredinis*	*Rubus*	Canada
4-Aug-06	MCA3198	+	ML35	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\14\10	UNK	*Epilobium* sp.	Canada
4-Aug-06	MCA3200	+	ML36	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\14\10	*Melampsora* sp.	*Salix*	Canada

(**Table A-1.** Continued.)

Date	Collection Number	Larvae (+/-)	Larval Sample #	28S Sequence (Y/N) & BLAST ID	COI Sequence (Y/N) & BLAST ID	Supported Clades by tree (28S\COI\Concat.)	Rust Identification	Host Identification	Country
4-Aug-06	MCA3204	+	ML37	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\14\10	*Urediniopsis* sp.	*Fern*	Canada
10-Sep-06	MCA3230	+	ML38	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\9\1	UNK	Asteraceae	USA
28-Oct-06	MCA3260	+	ML41	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Phakopsora* sp.	UNK	Uganda
28-Oct-06	MCA3261	+	ML40	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Hemileia* sp.	Rubiaceae	Uganda
29-Jun-07	MCA3341	+	ML39	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Puccinia pimpinellae*	*Osmorhiza*	USA
5-Jul-07	MCA3343	+	ML42	(Y) Cecidomyiidae	(Y) *Asteromyia*	5\1\16	*Puccinia melanocephala*	Sugarcane	USA
21-Sep-07	MCA3463	+	ML46	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	UNK	UNK	Croatia
16-Nov-07	MCA3472	+	ML47	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Puccinia lygopodii*	*Lygodium japonicum*	USA
22-Nov-07	MCA3473	+	ML48	(N)	(Y) ***Dohrniphora porrasae***	NA\NA\NA	*Coleosporium*	*Solidago*	USA
22-Nov-07	MCA3474	+	ML49	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Coleosporium*	*Elephantopus*	USA
22-Nov-07	MCA3475	+	ML50	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Kuehneola*	*Rubus*	USA
22-Nov-07	MCA3476	+	ML51	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Puccinia lygodii*	*Lygodium japonicum*	USA
22-Nov-07	MCA3478	+	ML52	(Y) Cecidomyiidae	(Y) *Asteromyia*	6\NA\NA	*Puccinia*	Asteraceae	USA
23-Mar-08	MCA3567	+	ML158	(N)	(Y) *Asteromyia*	NA\NA\NA	*Puccinia oxalidis*	*Oxalis* sp.	USA
10-Apr-08	MCA3574	+	ML44	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\15\9	*Gymnosporangium juniperi-virginianae*	*Juniperus virginiana*	USA
10-Apr-08	MCA3578	+	ML45	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Puccinia* sp.	Asteraceae	USA
12-Jul-08	MCA3614	+	ML53	(N)	(Y) *Asteromyia*	NA\NA\NA	*Coleosporium*	*Solidago*	USA
18-Jul-08	MCA3620-2	+	ML54	(Y) Cecidomyiidae	(Y) *Asteromyia*	5\1\16	*Coleosporium*	*Solidago*	USA

(**Table A-1.** Continued.)

Date	Collection Number	Larvae (+/-)	Larval Sample #	28S Sequence (Y/N) & BLAST ID	COI Sequence (Y/N) & BLAST ID	Supported Clades by tree (28S\COI\Concat.)	Rust Identification	Host Identification	Country
6-Sep-08	MCA3634	+	ML55	(Y) Cecidomyiidae	(Y) *Asteromyia*	6\NA\NA	*Cerotelium fici*	*Ficus* sp.	USA
12-May-09	MCA3748	+	ML59	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Coleosporium*	*Solidago*	USA
1-May-09	MCA3749	+	ML60	(Y) Cecidomyiidae	(Y) *Asteromyia*	6\8\14	*Gymnosporangium*	*Pyrus*	USA
16-May-09	MCA3756	+	ML61	(Y) *Mycodiplosis*	(Y) *Asteromyia*	6\4\NA	*Puccinia* sp.	Poaceae	USA
20-Jun-09	MCA3768	+	ML58	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\11\4	*Phragmidium*	*Rosa*	USA
16-Jul-09	MCA3793	+	ML159	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Puccinia sparaginoides*	*Spartina alterniflora*	USA
7-Aug-09	MCA3813	+	ML64	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\16\8	*Coleosporium*	*Elephantopus*	USA
7-Aug-09	MCA3815	+	ML63	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\16\8	*Coleosporium ipomoea*	UNK	USA
18-Oct-09	MCA3852	+	ML62	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Puccinia lygodii*	*Lygodium*	USA
27-Nov-09	MCA3870	+	ML57	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Kuehneola uredinis*	*Rubus*	USA
27-Nov-09	MCA3871	+	ML56	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Puccinia smilacis*	*Smilax*	USA
15-Apr-10	MCA3888	+	ML23	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\14\10	*Gymnoconia* sp.	*Rubus*	UNK
15-Apr-10	MCA3889	+	ML66	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\14\10	*Gymnoconia peckiana*	*Rubus*	USA
18-Apr-10	MCA3892	+	ML24	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Puccinia arundinania*	*Arundinaria*	UNK
1-Aug-10	MCA4143	+	ML70	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Coleosporium tussilaginis*	*Petasites albus*	Scotland
11-Aug-10	MCA4152	+	ML71	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Coleosporium cacaliae*	*Adenostyles*	Switzerland
11-Aug-10	MCA4153	+	ML65	(Y) ***Mayetiola destructor***	(Y) ***Mayetiola destructor***	NA\NA\NA	*Puccinia* sp.	*Cirsium*	Switzerland
11-Aug-10	MCA4158	+	ML67	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Phragmidium potentillae*	*Potentilla*	Switzerland

(**Table A-1.** Continued.)

Date	Collection Number	Larvae (+/-)	Larval Sample #	28S Sequence (Y/N) & BLAST ID	COI Sequence (Y/N) & BLAST ID	Supported Clades by tree (28S\COI\Concat.)	Rust Identification	Host Identification	Country
11-Aug-10	MCA4164	+	ML68	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\7	*Melampsora* sp.	*Salix lapathifolia*	Switzerland
8-Sep-10	MCA4196	+	ML13	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\14\10	*Coleosporium ipomoea*	*Ipomoea*	USA
8-Sep-10	MCA4196	+	ML210	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\14\10	*Coleosporium ipomoea*	*Ipomoea*	USA
8-Sep-10	MCA4196	+	ML199	(Y) Cecidomyiidae	(Y) *Asteromyia*	NA\7\3	*Coleosporium ipomoea*	*Ipomoea*	USA
8-Sep-10	MCA4196	+	ML208	(Y) Cecidomyiidae	(Y) *Asteromyia*	NA\7\3	*Coleosporium ipomoea*	*Ipomoea*	USA
8-Sep-10	MCA4196	+	ML12	(Y) Cecidomyiidae	(Y) *Asteromyia*	NA\8\14	*Coleosporium ipomoea*	*Ipomoea*	USA
8-Sep-10	MCA4196	+	ML200	(Y) Cecidomyiidae	(Y) *Asteromyia*	NA\8\14	*Coleosporium ipomoea*	*Ipomoea*	USA
8-Sep-10	MCA4196	+	ML202	(Y) Cecidomyiidae	(Y) *Asteromyia*	NA\8\14	*Coleosporium ipomoea*	*Ipomoea*	USA
8-Sep-10	MCA4196	+	ML204	(Y) Cecidomyiidae	(Y) *Asteromyia*	NA\8\14	*Coleosporium ipomoea*	*Ipomoea*	USA
8-Sep-10	MCA4196	+	ML205	(Y) Cecidomyiidae	(Y) *Asteromyia*	NA\8\14	*Coleosporium ipomoea*	*Ipomoea*	USA
8-Sep-10	MCA4196	+	ML209	(Y) Cecidomyiidae	(Y) *Asteromyia*	NA\8\14	*Coleosporium ipomoea*	*Ipomoea*	USA
8-Sep-10	MCA4196	+	ML211	(Y) Cecidomyiidae	(Y) *Asteromyia*	NA\8\14	*Coleosporium ipomoea*	*Ipomoea*	USA
8-Sep-10	MCA4196	+	ML1	(Y) Cecidomyiidae	(Y) *Asteromyia*	NA\NA\NA	*Coleosporium ipomoea*	*Ipomoea*	USA
8-Sep-10	MCA4196	+	ML11	(Y) Cecidomyiidae	(Y) *Asteromyia*	NA\NA\NA	*Coleosporium ipomoea*	*Ipomoea*	USA
8-Sep-10	MCA4196	+	ML14	(Y) Cecidomyiidae	(Y) *Asteromyia*	NA\NA\NA	*Coleosporium ipomoea*	*Ipomoea*	USA
8-Sep-10	MCA4196	+	ML201	(Y) Cecidomyiidae	(Y) *Asteromyia*	NA\NA\NA	*Coleosporium ipomoea*	*Ipomoea*	USA
8-Sep-10	MCA4196	+	ML207	(Y) Cecidomyiidae	(Y) ***Leptacis***	NA\NA\NA	*Coleosporium ipomoea*	*Ipomoea*	USA
8-Sep-10	MCA4196	+	ML212	(Y) Cecidomyiidae	(Y) *Asteromyia*	NA\NA\NA	*Coleosporium ipomoea*	*Ipomoea*	USA

(**Table A-1.** Continued.)

Date	Collection Number	Larvae (+/-)	Larval Sample #	28S Sequence (Y/N) & BLAST ID	COI Sequence (Y/N) & BLAST ID	Supported Clades by tree (28S\COI\Concat.)	Rust Identification	Host Identification	Country
8-Sep-10	MCA4196	+	ML219	(Y) Cecidomyiidae	(Y) *Asteromyia*	NA\NA\NA	*Coleosporium ipomoea*	*Ipomoea*	USA
8-Sep-10	MCA4196	+	ML5	(Y) Cecidomyiidae	(Y) *Asteromyia*	NA\8\14	*Coleosporium ipomoea*	*Ipomoea*	USA
8-Sep-10	MCA4196	+	ML9	(Y) Cecidomyiidae	(Y) *Asteromyia*	NA\8\14	*Coleosporium ipomoea*	*Ipomoea*	USA
8-Sep-10	MCA4196	+	ML15	(Y) Cecidomyiidae	(N)	NA\NA\NA	*Coleosporium ipomoea*	*Ipomoea*	USA
8-Sep-10	MCA4196	+	ML2	(N)	(Y) *Asteromyia*	NA\NA\NA	*Coleosporium ipomoea*	*Ipomoea*	USA
8-Sep-10	MCA4196	+	ML203	(Y) Cecidomyiidae	(N)	NA\NA\NA	*Coleosporium ipomoea*	*Ipomoea*	USA
8-Sep-10	MCA4196	+	ML206	(Y) Cecidomyiidae	(N)	NA\NA\NA	*Coleosporium ipomoea*	*Ipomoea*	USA
8-Sep-10	MCA4196	+	ML213	(N)	(N)	NA\NA\NA	*Coleosporium ipomoea*	*Ipomoea*	USA
8-Sep-10	MCA4196	+	ML214	(N)	(N)	NA\NA\NA	*Coleosporium ipomoea*	*Ipomoea*	USA
8-Sep-10	MCA4196	+	ML215	(N)	(N)	NA\NA\NA	*Coleosporium ipomoea*	*Ipomoea*	USA
8-Sep-10	MCA4196	+	ML216	(N)	(N)	NA\NA\NA	*Coleosporium ipomoea*	*Ipomoea*	USA
8-Sep-10	MCA4196	+	ML217	(N)	(N)	NA\NA\NA	*Coleosporium ipomoea*	*Ipomoea*	USA
8-Sep-10	MCA4196	+	ML218	(N)	(N)	NA\NA\NA	*Coleosporium ipomoea*	*Ipomoea*	USA
8-Sep-10	MCA4196	+	ML3	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Coleosporium ipomoea*	*Ipomoea*	USA
8-Sep-10	MCA4196	+	ML4	(N)	(Y) *Asteromyia*	NA\NA\NA	*Coleosporium ipomoea*	*Ipomoea*	USA
8-Sep-10	MCA4196	+	ML6	(N)	(Y) *Asteromyia*	NA\NA\NA	*Coleosporium ipomoea*	*Ipomoea*	USA
8-Sep-10	MCA4196	+	ML7	(Y) Cecidomyiidae	(Y) *Asteromyia*	NA\NA\NA	*Coleosporium ipomoea*	*Ipomoea*	USA
8-Sep-10	MCA4196	+	ML8	(Y) Cecidomyiidae	(Y) *Asteromyia*	NA\NA\NA	*Coleosporium ipomoea*	*Ipomoea*	USA
27-Nov-10	MCA4207	+	ML18	(Y) Cecidomyiidae	(Y) *Asteromyia*	6\NA\NA	*Puccinia hemerocalliidis*	*Hemerocallis*	USA
3-Mar-11	MCA4219	+	ML16	(Y) Cecidomyiidae	(Y) *Asteromyia*	NA\NA\NA	*Frommeela mexicana*	*Potentilla*	USA
3-Mar-11	MCA4220	+	ML19	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\12\6	*Kuehneola uredinis*	*Rubus*	USA
	MCA4220	+	ML155	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA			

(**Table A-1.** Continued.)

Date	Collection Number	Larvae (+/-)	Larval Sample #	28S Sequence (Y/N) & BLAST ID	COI Sequence (Y/N) & BLAST ID	Supported Clades by tree (28S\COI\Concat.)	Rust Identification	Host Identification	Country
9-May-11	MCA4228	+	ML69	(Y) Cecidomyiidae	(Y) *Asteromyia*	6\NA\NA	*Puccinia* cf. *malvacearum*	*Alcea*	USA
26-Jul-11	MCA4464	+	ML198	(N)	(Y) *Asteromyia*	NA\NA\NA	*Phakopsora pachyrizi*	*Glycine*	Taiwan
27-Jul-07	MCA4487	+	ML153	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Puccinia* sp.	Sugarcane	Taiwan
5-Aug-11	MT2	+	ML21	(N)	(Y) *Asteromyia*	NA\NA\NA	*Phragmidium* sp.	UNK	USA
5-Aug-11	MT2	+	ML240	(Y) Cecidomyiidae	(Y) ***Uroleucon rapunculoidis***	NA\NA\NA	*Phragmidium* sp.	UNK	USA
5-Aug-11	MT3	+	ML22	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Melampsora* sp.	UNK	USA
June, 2011	MT8	+	ML17	(Y) Cecidomyiidae	(Y) *Asteromyia*	6\NA\NA	*Puccinia* sp.	UNK	USA
11-Nov-01	PUR136	+	ML332	(Y) Cecidomyiidae	(Y) *Asteromyia*	NA\8\14	*Ravenelia* sp.	*Tephrosia sp.*	Nigeria
11-Nov-01	PUR136	+	ML322	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\7	*Ravenelia* sp.	*Tephrosia sp.*	Nigeria
11-Nov-01	PUR136	+	ML80	(N)	(N)	NA\NA\NA	*Ravenelia* sp.	*Tephrosia sp.*	Nigeria
8-Nov-01	PUR137	+	ML81	(N)	(Y) *Asteromyia*	NA\NA\NA	*Chaconia* sp.	*Baphia?*	Nigeria
31-Aug-09	TAR101	+	ML185	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\9\1	*Coleosporium ipomoea*	Morning glory	USA
31-Aug-09	TAR105	+	ML197	(Y) Cecidomyiidae	(Y) *Asteromyia*	6\NA\NA	*Phakopsora pachyrizi*	*Kudzu*	USA
31-Aug-09	TAR105	+	ML193	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\9\1	*Phakopsora pachyrizi*	*Kudzu*	USA
16-Sep-09	TAR112	+	ML176	(Y) Cecidomyiidae	(Y) *Asteromyia*	5\1\16	UNK	*Veronia gigantea*	USA
16-Sep-09	TAR115	+	ML190	(Y) Cecidomyiidae	(Y) *Asteromyia*	6\4\NA	UNK	*Cephalanthus occidentalis*	USA
16-Sep-09	TAR116	+	ML191	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Coleosporium ipomoea*	Morning glory	USA
21-Sep-09	TAR118	+	ML186	(Y) Cecidomyiidae	(Y) *Asteromyia*	NA\8\14	*Uromyces?*	*Desmodium* sp.	USA
16-Sep-09	TAR127	+	ML189	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Phakopsora pachyrizi*	*Glycine max*	USA
23-Sep-09	TAR134	+	ML181	(N)	(Y) *Asteromyia*	NA\NA\NA	*Phakopsora pachyrizi*	*Glycine max*	USA

(**Table A-1.** Continued.)

Date	Collection Number	Larvae (+/-)	Larval Sample #	28S Sequence (Y/N) & BLAST ID	COI Sequence (Y/N) & BLAST ID	Supported Clades by tree (28S\COI\Concat.)	Rust Identification	Host Identification	Country
29-Sep-09	TAR140	+	ML172	(Y) Cecidomyiidae	(Y) *Asteromyia*	NA\2\13	*Uromyces*	*Chamaesyce nutans*	USA
29-Sep-09	TAR141	+	ML174	(Y) Cecidomyiidae	(Y) *Asteromyia*	6\NA\NA	*Puccinia similuncis*	*Smilax rotundifolia*	USA
29-Sep-09	TAR143	+	ML196	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Phakopsora pachyrizi*	*Glycine max*	USA
29-Sep-09	TAR144	+	ML175	(Y) Cecidomyiidae	(Y) *Asteromyia*	6\NA\NA	*Tranzshelia arthuri?*	*Prunus serotina*	USA
30-Sep-09	TAR146	+	ML173	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Uromyces*	*Chamaesyce nutans*	USA
2-Oct-09	TAR148	+	ML179	(Y) Cecidomyiidae	(Y) *Asteromyia*	6\NA\NA	Puccinia poaceae	*Paspalum*	USA
11-Oct-09	TAR166	+	ML184	(Y) Cecidomyiidae	(Y) *Asteromyia*	6\NA\NA	UNK	UNK	USA
8-Oct-09	TAR167	+	ML187	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Phakopsora pachyrizi*	*Kudzu*	USA
7-Oct-09	TAR168	+	ML194	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\15\9	*Phakopsora pachyrizi*	*Kudzu*	USA
27-May-10	TAR184	+	ML183	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\17\11	UNK	*Modiola caroliniana*	USA
10-Oct-09	TAR188	+	ML188	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Phakopsora pachyrizi*	*Glycine max*	USA
10-Oct-09	TAR189	+	ML182	(Y) Cecidomyiidae	(Y) *Asteromyia*	NA\2\13	*Phakopsora pachyrizi*	*Glycine max*	USA
11-Oct-09	TAR192	+	ML178	(N)	(N)	NA\NA\NA	*Phakopsora pachyrizi*	*Glycine max*	USA
	TAR192	+	ML339	(N)	(Y) *Asteromyia*	NA\NA\NA			
11-Oct-09	TAR193	+	ML177	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\17\11	*Phakopsora pachyrizi*	*Glycine max*	USA
25-Oct-09	TAR198	+	ML195	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Phakopsora pachyrizi*	*Glycine max*	USA
27-Mar-10	TAR203	+	ML192	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Kuehneola* sp.	*Rubus trivialis*	USA
UNK	TAR212	+	ML180	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	UNK	*Carex glaucescens*	USA
28-Jun-03	U-1049	+	ML110	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Uromyces geranii*	*Geranium pratense*	Germany

(**Table A-1.** Continued.)

Date	Collection Number	Larvae (+/-)	Larval Sample #	28S Sequence (Y/N) & BLAST ID	COI Sequence (Y/N) & BLAST ID	Supported Clades by tree (28S\COI\Concat.)	Rust Identification	Host Identification	Country
4-Sep-06	U-1063	+	ML111	(Y) Cecidomyiidae	(Y) *Asteromyia*	5\1\16	*Coleosporium*	*Solidago*	USA
UNK	U-1096	+	Larva lost				*Uromyces inaequialtus?*	*Silene dioica*	UNK
1-Sep-06	U-1099	+	ML114	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\15\9	*Coleosporium*	Asteraceae	USA
14-Sep-06	U-1114	+	ML115	(Y) Cecidomyiidae	(Y) *Asteromyia*	NA\NA\NA	*Uromyces* sp.	*Ficus bengalensis*	India
14-Sep-06	U-1115	+	ML116	(N)	(Y) *Asteromyia*	NA\NA\NA	*Uredo* sp.	*Terminalia chebula*	India
19-Feb-81	U-1198	+	Larva lost				*Phragmidium rubi-idaei*	*Rubus rosaefolius*	UNK
18-May-06	U-1201	+	ML112	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Puccinia* sp.	*Osmorhiza claytonii*	USA
16-May-06	U-1203	+	ML323	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\7	*Puccinia* sp.	*Veratrum viride*	USA
16-May-06	U-1203	+	ML118	(N)	(N)	NA\NA\NA	*Puccinia* sp.	*Veratrum viride*	USA
16-May-06	U-1203	+	ML334	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Puccinia* sp.	*Veratrum viride*	USA
29-Apr-06	U-1206	+	ML119	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\11\4	*Puccinia violae*	*Viola hastata*	USA
29-Apr-06	U-1207	+	ML120	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Puccinia* sp.	*Geranium maculatum*	USA
Mar-05	U-1225	+	ML121	(N)	(N)	NA\NA\NA	*Gymnosporangium confusum*	*Juniperus oxycedrus*	France
Mar-05	U-1225	+	ML324	(N)	(Y) *Asteromyia*	NA\NA\NA	*Gymnosporangium confusum*	*Juniperus oxycedrus*	France
Mar-05	U-1225	+	ML335	(N)	(Y) *Asteromyia*	NA\NA\NA	*Gymnosporangium confusum*	*Juniperus oxycedrus*	France
6-May-07	U-1268	+	ML122	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Puccinia* sp.	*Trillium luteum*	USA
17-Jun-07	U-1287	+	ML123	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\14\10	*Puccinia* sp.	*Eriophyllum lanatum*	USA
17-Aug-07	U-1297	+	ML124	(Y) Cecidomyiidae	(Y) *Asteromyia*	2\NA\7	*Aecidium* sp.	*Ageratina* sp.	Mexico
16-Jun-72	U-1302	+	ML125	(N)	(N)	NA\NA\NA	*Gymnosporangium cumminsii*	*Juniperus gamboana*	Mexico

(**Table A-1.** Continued.)

Date	Collection Number	Larvae (+/-)	Larval Sample #	28S Sequence (Y/N) & BLAST ID	COI Sequence (Y/N) & BLAST ID	Supported Clades by tree (28S\COI\Concat.)	Rust Identification	Host Identification	Country
16-Jun-72	U-1302	+	ML325	(N)	(Y) *Asteromyia*	NA\NA\NA	*Gymnosporangium cumminsii*	*Juniperus gamboana*	Mexico
16-Jun-72	U-1302	+	ML336	(N)	(Y) *Asteromyia*	NA\NA\NA	*Gymnosporangium cumminsii*	*Juniperus gamboana*	Mexico
10-Apr-08	U-1306	+	ML126	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Gymnosporangium juniperi-virginianae*	*Juniperus virginiana*	USA
31-May-08	U-1333	+	ML128	(N)	(Y) *Asteromyia*	NA\NA\NA	*Puccinia* sp.	*Cimicifuga racemosa*	USA
13-May-74	U-1338	+	ML127	(N)	(Y) *Asteromyia*	NA\NA\NA	*Gymnosporangium*	*Juniperus gamboana*	Mexico
29-May-08	U-1345	+	ML129	(Y) *Mycodiplosis*	(Y) ***Aphanomerus***	NA\NA\NA	*Hemileia scholzii*	*Clerodendrum glabrum*	South Africa
1-Aug-08	U-1358	+	ML130	(N)	(Y) *Asteromyia*	NA\NA\NA	*Puccina pritzeliana*	*Tremandra stelligera*	Australia
5-Jul-08	U-1381	+	ML131	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\11\4	*Puccinia?*	*Thalictrum occidentale*	USA
17-Oct-08	U-1386	+	ML132	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Baeodromus eupatorii*	*Ageratina* sp.	Mexico
17-Oct-08	U-1387	+	ML133	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Baeodromus eupatorii*	*Ageratina adenophora*	Mexico
7-Oct-08	U-1390	+	Larva lost				*Goplana*	Asteraceae	Mexico
17-Oct-08	U-1391	+	ML135	(Y) Cecidomyiidae	(N)	NA\NA\NA	*Aecidium* sp.	*Ageratina*	Mexico
30-Nov-08	U-1398	+	ML136	(N)	(Y) *Asteromyia*	NA\NA\NA	*Aecidium vangueriae*	*Vangueria infausta*	South Africa
15-Oct-08	U-1399	+	ML137	(Y) Cecidomyiidae	(Y) *Asteromyia*	NA\NA\NA	*Goplana?*	UNK	Mexico
Aug-09	U-1420	+	ML161	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Coleosporium plumeriae*	*Plumeria* sp.	USA
3-Sep-09	U-1421	+	ML138	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\9\1	*Cerotelium fici*	*Ficus* sp.	USA
4-Apr-90	U-1425	+	ML144	(N)	(Y) *Asteromyia*	NA\NA\NA	*Puccinia antirrhini*	*Antirrhinum*	USA
Oct-87	U-1426	+	ML145	(N)	(Y) ***Leptacis***	NA\NA\NA	*Tranzschelia discolor*	*Prunus persica*	USA
Dec-09	U-1437	+	ML139	(Y) Cecidomyiidae	(Y) *Asteromyia*	NA\NA\NA	*Phakopsora gossypii*	*Gossypium*	Brazil
21-May-10	U-1446	+	ML141	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\14\10	*Puccinia* sp.	*Cimicifuga?*	USA
21-May-10	U-1447	+	ML142	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\14\10	*Gymnoconia*	*Rubus* sp.	USA

(**Table A-1.** Continued.)

Date	Collection Number	Larvae (+/-)	Larval Sample #	28S Sequence (Y/N) & BLAST ID	COI Sequence (Y/N) & BLAST ID	Supported Clades by tree (28S\COI\Concat.)	Rust Identification	Host Identification	Country
22-Sep-10	U-1451	+	ML20	(Y) *Mycodiplosis*	(Y) ***Leptacis***	NA\NA\NA	*Coleosporium ipomoea*	*Ipomoea*	UNK
22-Sep-10	U-1451	+	ML239	(Y) Cecidomyiidae	(Y) *Asteromyia*	NA\8\14	*Coleosporium ipomoea*	*Ipomoea*	UNK
4-Apr-11	U-1460	+	ML140	(Y) Cecidomyiidae	(Y) *Asteromyia*	6\5\15	*Puccinia psidii*	*Syzygium jambus*	Puerto Rico
Aug-11	U-1466	+	ML143	(Y) Cecidomyiidae	(Y) *Asteromyia*	NA\NA\NA	*Puccinia kuehnii*	*Saccharum officinarum*	Equador
26-Jun-01	U-231	+	ML96	(N)	(Y) *Asteromyia*	NA\NA\NA	*Phragmidium rubi?*	*Rubus.* sp.	Turkey
10-Oct-04	U-399	+	ML90	(N)	(Y) *Asteromyia*	NA\NA\NA	*Coleosporium*	UNK	USA
22-Sep-04	U-402	+	ML97	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\14\10	*Coleosporium*	UNK	USA
1-Aug	U-410	+	ML91	(Y) Cecidomyiidae	(Y) *Asteromyia*	NA\NA\NA	Raveniliaceae	*Derris elliptica*	Guam
Sep-04	U-416	+	ML92	(N)	(Y) *Asteromyia*	NA\NA\NA	Raveniliaceae	*Derris elliptica*	Guam
2-Oct-04	U-421	+	ML93	(Y) Cecidomyiidae	(Y) *Asteromyia*	6\3\17	*Uredo?*	*Cassia surattensis*	Guam
25-Jun-04	U-484	+	ML98	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Melampsora*	*Salix* sp.	Germany
14-Aug-04	U-488	+	ML99	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\7	*Puccinia* sp.	*Pimpinella saxifraga*	Germany
17-Oct-04	U-489	+	ML100	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Tranzschelia* sp.	*Prunus domestica*	Germany
23-Sep-04	U-493	+	Larva lost				UNK	Asteraceae	Belarus
23-Sep-04	U-494	+	ML102	(N)	(Y) *Asteromyia*	NA\NA\NA	UNK	*Tussilago farfara*	Belarus
30-Aug-04	U-556	+	ML103	(N)	(N)	NA\NA\NA	UNK	*Epilobium angustifolium*	USA
3-Aug-04	U-557	+	ML104	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Melampsora epitea complex*	*Salix* sp.	USA
27-Aug-04	U-567	+	ML105	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Melampsora*	*Salix* sp.	USA
25-Jul-85	U-610	+	ML106	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\14\10	*Pucciniastrum* cf. *americanum*	*Rubus* sp.	USA
18-Jun-05	U-686	+	ML86	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\14\10	UNK	*Convolvulus?*	USA

(**Table A-1.** Continued.)

Date	Collection Number	Larvae (+/-)	Larval Sample #	28S Sequence (Y/N) & BLAST ID	COI Sequence (Y/N) & BLAST ID	Supported Clades by tree (28S\COI\Concat.)	Rust Identification	Host Identification	Country
Jun-05	U-688	+	ML87	(Y) Cecidomyiidae	(Y) *Asteromyia*	6\3\17	*Prospodium?*	*Tecoma stans*	Guam
17-Sep-05	U-748	+	ML88	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\14\10	*Pucciniosira* cf. *tuberculata*	Malvaceae	USA
19-Jun-05	U-798	+	ML94	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Puccinia* cf. *poarum*	*Elymus hystrix*	USA
1-May-06	U-890	+	ML333	(N)	(Y) *Asteromyia*	NA\NA\NA	*Puccinia* sp.	*Thalactrum*	USA
	U-890	+	ML95	(N)	(N)	NA\NA\NA			
23-Jan-06	U-895	+	ML89	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Aecidium* cf. *habunguense*	*Solanum panduriforme*	South Africa
27-May-06	U-932	+	ML107	(N)	(Y) *Asteromyia*	NA\NA\NA	*Phragmidium* sp.	*Rosa pouzina*	Spain
27-May-06	U-984	+	ML108	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Phragmidium* sp.	*Rosa pouzina*	Spain
27-May-06	U-985	+	ML109	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Phragmidium mucronatum*	*Rosa pouzina*	Spain
1-Jul-10	YG1	+	ML147	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Puccinia melanocephala*	Sugarcane	USA
5-Aug-10	YG2-10	+	ML164	(Y) Cecidomyiidae	(Y) *Asteromyia*	NA\NA\NA	*Puccinia melanocephala*	Sugarcane	USA
5-Aug-10	YG2-13	+	ML166	(Y) Cecidomyiidae	(Y) *Asteromyia*	NA\2\13	*Puccinia melanocephala*	UNK	USA
5-Aug-10	YG2-16	+	ML170	(Y) Cecidomyiidae	(Y) *Asteromyia*	NA\NA\NA	*Puccinia melanocephala*	UNK	USA
5-Aug-10	YG2-17	+	ML171	(N)	(N)	NA\NA\NA	*Puccinia melanocephala*	UNK	USA
5-Aug-10	YG2-17	+	ML326	(N)	(Y) *Asteromyia*	NA\NA\NA	*Puccinia melanocephala*	UNK	USA
5-Aug-10	YG2-17	+	ML338	(N)	(Y) *Asteromyia*	NA\NA\NA	*Puccinia melanocephala*	UNK	USA
5-Aug-10	YG2-22	+	ML167	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Puccinia melanocephala*	UNK	USA
5-Aug-10	YG2-26	+	ML168	(Y) Cecidomyiidae	(Y) *Asteromyia*	NA\2\13	*Puccinia melanocephala*	UNK	USA
5-Aug-10	YG2-30	+	ML146	(Y) Cecidomyiidae	(Y) *Asteromyia*	NA\NA\NA	*Puccinia melanocephala*	Sugarcane	USA

(**Table A-1.** Continued.)

Date	Collection Number	Larvae (+/-)	Larval Sample #	28S Sequence (Y/N) & BLAST ID	COI Sequence (Y/N) & BLAST ID	Supported Clades by tree (28S\COI\Concat.)	Rust Identification	Host Identification	Country
5-Aug-10	YG2-32	+	ML163	(Y) Cecidomyiidae	(Y) *Asteromyia*	NA\NA\NA	*Puccinia melanocephala*	Sugarcane	USA
5-Aug-10	YG2-33	+	ML148	(Y) Cecidomyiidae	(Y) *Asteromyia*	NA\2\13	*Puccinia melanocephala*	Sugarcane	USA
5-Aug-10	YG2-34	+	ML165	(Y) Cecidomyiidae	(Y) *Asteromyia*	NA\7\3	*Puccinia melanocephala*	UNK	USA
5-Aug-10	YG2-36	+	ML169	(Y) Cecidomyiidae	(Y) *Asteromyia*	NA\2\13	*Puccinia melanocephala*	UNK	USA
5-Aug-10	YG2-42	+	ML152	(Y) Cecidomyiidae	(Y) *Asteromyia*	NA\2\13	*Puccinia melanocephala*	Sugarcane	USA
5-Aug-10	YG2-43	+	ML162	(Y) Cecidomyiidae	(Y) *Asteromyia*	NA\2\13	*Puccinia melanocephala*	Sugarcane	USA
UNK	YG2-47	+	ML43	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	UNK	Sugarcane	UNK
5-Aug-10	YG2-6	+	ML149	(Y) Cecidomyiidae	(Y) *Asteromyia*	NA\7\3	*Puccinia melanocephala*	Sugarcane	USA
5-Aug-10	YG2-7	+	ML150	(Y) Cecidomyiidae	(Y) *Asteromyia*	5\1\16	*Puccinia melanocephala*	Sugarcane	USA
5-Aug-10	YG2-8	+	ML151	(N)	(N)	NA\NA\NA	*Puccinia melanocephala*	UNK	USA
5-Aug-10	YG2-8	+	ML337	(N)	(Y) *Asteromyia*	NA\NA\NA	*Puccinia melanocephala*	UNK	USA
27-Sep-11	YUN027	+	ML82	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\13\NA	UNK	Asteraceae	China
24-Sep-11	YUN040	+	ML83	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\NA\NA	*Coleosporium*	UNK	China
25-Sep-11	YUN070	+	ML84	(Y) *Mycodiplosis*	(Y) *Asteromyia*	NA\13\NA	*Coleosporium*	Ranunculaceae?	China
25-Sep-11	YUN073	+	ML85	(N)	(Y) *Asteromyia*	NA\NA\NA	*Coleosporium*	Asteraceae	China
UNK	AR1	-	-	-	-	-	UNK	UNK	USA
2-Sep-10	AR-1?	-	-	-	-	-	*Coleosporium ipomoeae*	Morning glory	UNK
UNK	AR10	-	-	-	-	-	UNK	*Solidago altissima*	USA
3-Mar-11	AR14	-	-	-	-	-	*Puccinia smilacis*	*Smilax*	USA
UNK	AR2	-	-	-	-	-	UNK	*Solidago altissima*	USA
2-Sep-10	AR-2?	-	-	-	-	-	*Puccinia smilacis*	*Smilax*	UNK

(**Table A-1.** Continued.)

Date	Collection Number	Larvae (+/-)	Larval Sample #	28S Sequence (Y/N) & BLAST ID	COI Sequence (Y/N) & BLAST ID	Supported Clades by tree (28S\COI\Concat.)	Rust Identification	Host Identification	Country
UNK	AR7	-	-	-	-	-	UNK	UNK	UNK
UNK	AR9	-	-	-	-	-	UNK	UNK	UNK
24-Jul-12	DJN127	-	-	-	-	-	*Endophyllum paederia*	*Paederia scandens*	Japan
24-Jul-12	DJN128	-	-	-	-	-	*Puccinia kusanoi*	*Pleioblastus* sp. *(simonii or chino)*	Japan
25-Jul-12	DJN130	-	-	-	-	-	*Ochropsora kraunhiae*	*Wisteria floribunda*	Japan
25-Jul-12	DJN131	-	-	-	-	-	*Endophyllum paederia*	*Paederia scandens* var. *mairei*	Japan
27-Jul-12	DJN140	-	-	-	-	-	*Puccinia kusanoi*	*Pleioblastus* sp.	Japan
27-Jul-12	DJN141	-	-	-	-	-	*Coleosporium* sp.	*Solidago altissima*	Japan
27-Jul-12	DJN142	-	-	-	-	-	UNK	*Carex* sp.	Japan
27-Jul-12	DJN145	-	-	-	-	-	Powdery Mildew	*Acer buergerianum*	Japan
27-Jul-12	DJN146	-	-	-	-	-	Powdery Mildew	*Quercus myrsinaefolia*	Japan
27-Jul-12	DJN147	-	-	-	-	-	Powdery mildew: *Cystotheca wrightii*	*Quercus myrsinaefolia*	Japan
1-Aug-12	DJN152	-	-	-	-	-	*Ochropsora kraunhiae*	*Wisteria floribunda*	Japan
1-Aug-12	DJN157	-	-	-	-	-	*Puccinia* cf. *nigroconoidea*	*Akebia trifoliata*	Japan
1-Aug-12	DJN160	-	-	-	-	-	*Aecidium mori*	*Morus* sp.	Japan
3-Aug-12	DJN168	-	-	-	-	-	*Puccinia suzutake*	*Hydrangia hirta*	Japan
3-Aug-12	DJN169	-	-	-	-	-	*Puccinia suzutake*	*Hydrangia hirta*	Japan
3-Aug-12	DJN171	-	-	-	-	-	*Coleosporium asterum*	*Aster* cf. *ageratoides*	Japan
3-Aug-12	DJN175	-	-	-	-	-	UNK	*Elaeagnus umbellata*	Japan
7-Aug-12	DJN176	-	-	-	-	-	*Melampsora hypericorum*	*Hypericum chinense*	Japan
7-Aug-12	DJN177	-	-	-	-	-	*Puccinia violae*	*Viola grypoceras*	Japan
7-Aug-12	DJN178	-	-	-	-	-	*Gymnosporangium yamadae*	*Apple tree*	Japan
7-Aug-12	DJN179	-	-	-	-	-	*Puccinia zoycea*	Poaceae	Japan
7-Aug-12	DJN181	-	-	-	-	-	*Puccinia dieteliana*	*Dietelia* sp.	Japan
7-Aug-12	DJN186	-	-	-	-	-	*Powdery mildew*	*Cherry*	Japan
8-Aug-12	DJN198	-	-	-	-	-	*Phragmidium rosae-multiflorae*	*Rosa monteflora*	Japan
8-Aug-12	DJN200	-	-	-	-	-	*Melampsora larisi-populina*	*Populus nigra*	Japan
8-Aug-12	DJN205	-	-	-	-	-	*Puccinia or Uromyces*	*Carex* sp.	Japan

(**Table A-1.** Continued.)

Date	Collection Number	Larvae (+/-)	Larval Sample #	28S Sequence (Y/N) & BLAST ID	COI Sequence (Y/N) & BLAST ID	Supported Clades by tree (28S\COI\Concat.)	Rust Identification	Host Identification	Country
8-Aug-12	DJN207	-	-	-	-	-	*Thakopsora guttata*	*Gallium trifoliforme* var. *trifoliforme*	Japan
8-Aug-12	DJN208	-	-	-	-	-	*Puccinia argentata*	*Impatiens textori*	Japan
8-Aug-12	DJN212	-	-	-	-	-	*Puccinia* sp.	*Carex* sp.	Japan
8-Aug-12	DJN213	-	-	-	-	-	*Puccinia coronata*	Poaceae	Japan
8-Aug-12	DJN214	-	-	-	-	-	*Puccinia or Uromyces*	*Carex* sp.	Japan
8-Aug-12	DJN218	-	-	-	-	-	*Puccinia or Uredo*	*Carex* sp.	Japan
8-Aug-12	DJN223	-	-	-	-	-	*Phragmidium griseum*	*Rubus wrightii*	Japan
9-Aug-12	DJN225	-	-	-	-	-	*Melampsora epyphylla*	*Salix sachalinensis*	Japan
9-Aug-12	DJN229	-	-	-	-	-	UNK	UNK	Japan
9-Aug-12	DJN230	-	-	-	-	-	*Puccinia*	UNK	Japan
9-Aug-12	DJN231	-	-	-	-	-	*Puccinia*	UNK	Japan
9-Aug-12	DJN237	-	-	-	-	-	GRASS ENDOPHYTE	UNK	Japan
9-Aug-12	DJN238	-	-	-	-	-	*Aecidium* sp.	*Enkianthus* sp. or *Menzesia* sp.	Japan
9-Aug-12	DJN239	-	-	-	-	-	*Puccinia majanthemi*	*Maianthemum dilatatum*	Japan
9-Aug-12	DJN240	-	-	-	-	-	*Exobasidium*	*Rhododendron*	Japan
9-Aug-12	DJN241	-	-	-	-	-	*Puccinia punctata*	*Gallium verum* var. *leiocarpum f. lacteum*	Japan
9-Aug-12	DJN243	-	-	-	-	-	*Puccinia linosyridis-coricis*	*Aster scaber*	Japan
9-Aug-12	DJN247	-	-	-	-	-	*Puccinia* sp.	UNK	Japan
9-Aug-12	DJN252	-	-	-	-	-	*Melampsora kusanoi*	*Sphaericum* sp.	Japan
9-Aug-12	DJN253	-	-	-	-	-	*Uromyces rudbeckiae*	*Solidago virga-aurea* subsp. *Asiatica*	Japan
9-Aug-12	DJN255	-	-	-	-	-	*Phragmidium miyakeanum*	*Rubus mesogaens*	Japan
9-Aug-12	DJN256	-	-	-	-	-	*Gymnosporangium miyabe & G. yamadae*	*Malus toringo* var. *koringo* subvar. *Vulgaris*	Japan
9-Aug-12	DJN257	-	-	-	-	-	*Melampsorella caryophyllacearum*	*Albies homalepis*	Japan
16-Aug-12	DJN258	-	-	-	-	-	UNK	UNK	Japan
24-Aug-12	DJN259	-	-	-	-	-	*Coleosporium ipomoeae*	*Ipomoea* sp.	USA

(**Table A-1.** Continued.)

Date	Collection Number	Larvae (+/-)	Larval Sample #	28S Sequence (Y/N) & BLAST ID	COI Sequence (Y/N) & BLAST ID	Supported Clades by tree (28S\COI\Concat.)	Rust Identification	Host Identification	Country
26-Jun-03	JRH2003-014	-	-	-	-	-	*Coleosporium vernoniae*	*Elephantopus mollis*	Guyana
22-Jun-03	JRH2003-051	-	-	-	-	-	*Phakopsora arthuriana*	*Jatropha gossypifolia*	Guyana
22-Jun-03	JRH2003-052	-	-	-	-	-	*Puccinia thaliae*	*Canna indica*	Guyana
24-Jun-03	JRH2003-054	-	-	-	-	-	*Puccinia obliquoseptata*	*Olyra micrantha*	Guyana
24-Jun-03	JRH2003-055	-	-	-	-	-	*Puccinia cnici-oleracei*	*Emilia sonchifolia*	Guyana
24-Jun-03	JRH2003-056	-	-	-	-	-	*Uromyces euphorbiae*	*Euphorbia hirta*	Guyana
24-Jun-03	JRH2003-057	-	-	-	-	-	*Puccinia duthiae*	*Bothriochloa bladhii*	Guyana
24-Jun-03	JRH2003-058	-	-	-	-	-	*Uromyces tenuicutis*	*Sporobolus jacquemontii*	Guyana
26-Jun-03	JRH2003-069	-	-	-	-	-	*Desmella aneimiae*	*Thelypteris* sp.	Guyana
26-Jun-03	JRH2003-076	-	-	-	-	-	*Cerotelium sabiceae*	*Sabicea glabrescens*	Guyana
26-Jun-03	JRH2003-078	-	-	-	-	-	*Desmella aneimiae*	*Thelypteris opulenta*	Guyana
28-Jun-03	JRH2003-081	-	-	-	-	-	*Puccinia subcoronata*	*Cyperus laxus*	Guyana
28-Jun-03	JRH2003-083	-	-	-	-	-	*Ravenelia guyanensis*	*Chamaecrista adiantifolia*	Guyana
28-Jun-03	JRH2003-085	-	-	-	-	-	*Batistopsora crucis-filii*	*Annona* sp.	Guyana
28-Jun-03	JRH2003-091	-	-	-	-	-	*Coleosporium vernoniae*	*Elephantopus mollis*	Guyana
29-Jun-03	JRH2003-095	-	-	-	-	-	*Puccinia mikaniae*	*Mikania psilostachya*	Guyana
30-Jun-03	JRH2003-098	-	-	-	-	-	*Puccinia obliquoseptata*	*Olyra micrantha*	Guyana
2-Jul-03	JRH2003-104	-	-	-	-	-	*Endophyllum stachytarphetae*	*Stachytarpheta cayennensis*	Guyana

(**Table A-1.** Continued.)

Date	Collection Number	Larvae (+/-)	Larval Sample #	28S Sequence (Y/N) & BLAST ID	COI Sequence (Y/N) & BLAST ID	Supported Clades by tree (28S\COI\Concat.)	Rust Identification	Host Identification	Country
3-Jul-03	JRH2003-106	-	-	-	-	-	*Puccinia scleriicola*	*Scleria secans*	Guyana
3-Jul-03	JRH2003-107	-	-	-	-	-	*Puccinia fallax*	*Palicourea* sp.	Guyana
4-Jul-03	JRH2003-110	-	-	-	-	-	*Chaconia ingae*	*Inga* sp.	Guyana
4-Jul-03	JRH2003-112	-	-	-	-	-	*Uromyces neotropicalis*	Cucurbitaceae undet.	Guyana
5-Jul-03	JRH2003-115	-	-	-	-	-	*Puccinia arechavaletae*	*Serjania membranacea*	Guyana
7-Jul-03	JRH2003-121	-	-	-	-	-	*Uromyces neotropicalis*	*Cayaponia selysioides*	Guyana
8-Jul-03	JRH2003-123	-	-	-	-	-	*Chaconia ingae*	*Inga* sp.	Guyana
11-Jul-03	JRH2003-126	-	-	-	-	-	*Puccinia scleriae*	*Passiflora garckei*	Guyana
11-Jul-03	JRH2003-127	-	-	-	-	-	*Desmella aneimiae*	*Thelypteris* sp.	Guyana
12-Jul-03	JRH2003-128	-	-	-	-	-	*Puccinia helianthi*	*Helianthus annuus*	Guyana
12-Jul-03	JRH2003-129	-	-	-	-	-	*Uromyces hedysari-paniculati*	*Desmodium* sp.	Guyana
12-Jul-03	JRH2003-130	-	-	-	-	-	*Coleosporium plumeriae*	*Plumeria rubra*	Guyana
12-Jul-03	JRH2003-131	-	-	-	-	-	*Puccinia commelinae*	*Commelina erecta*	Guyana
2-Jun-03	MCA2371	-	-	-	-	-	UNK	*Taraxacum*	Switzerland
8-Jun-03	MCA2372	-	-	-	-	-	UNK	*Clematis*	Italy
4-Jun-03	MCA2379	-	-	-	-	-	*Puccinia cf magnusiana*	Boraginaceae	Italy
3-Jun-03	MCA2382	-	-	-	-	-	UNK	*Berberis*	Italy
29-Jul-03	MCA2388	-	-	-	-	-	UNK	Poaceae	USA
29-Jul-03	MCA2389	-	-	-	-	-	*Coleosporium tussilaginis*	*Sonchus*	USA
29-Jul-03	MCA2390	-	-	-	-	-	UNK	*Eriogonum*	USA

(**Table A-1.** Continued.)

Date	Collection Number	Larvae (+/-)	Larval Sample #	28S Sequence (Y/N) & BLAST ID	COI Sequence (Y/N) & BLAST ID	Supported Clades by tree (28S\COI\Concat.)	Rust Identification	Host Identification	Country
29-Jul-03	MCA2392	-	-	-	-	-	*Coleosporium tussilaginis*	*Sonchus or Lactuca*	USA
4-Jan-04	MCA2429	-	-	-	-	-	*Coleosporium vernoniae*	*Elephantopus mollis*	Guyana
5-Jan-04	MCA2431	-	-	-	-	-	*Puccinia obliquoseptata*	*Olyra micrantha*	Guyana
12-Jan-04	MCA2493	-	-	-	-	-	*Puccinia obliquoseptata*	*Olyra micrantha*	Guyana
18-Apr-04	MCA2519	-	-	-	-	-	UNK	Fabaceae	UNK
1-May-04	MCA2529	-	-	-	-	-	*Puccinia pelargonii-zonalis?*	*Geranium*	Equador
3-May-04	MCA2530	-	-	-	-	-	*Coleosporium vernoniae*	UNK	Equador
3-May-04	MCA2532	-	-	-	-	-	UNK	Marantaceae	Equador
3-May-04	MCA2533	-	-	-	-	-	*Uromyces neotropicalis*	UNK	Equador
3-May-04	MCA2534	-	-	-	-	-	UNK	Melastomataceae	Equador
3-May-04	MCA2535	-	-	-	-	-	*Puccinia?*	Fabaceae	Equador
3-May-04	MCA2536	-	-	-	-	-	*Rust?*	UNK	Equador
3-May-04	MCA2537	-	-	-	-	-	*Rust?*	UNK	Equador
4-May-04	MCA2550	-	-	-	-	-	UNK	bamboo	Equador
4-May-04	MCA2552	-	-	-	-	-	UNK	*Heliconia*	Equador
4-May-04	MCA2553	-	-	-	-	-	*Uromyces novissimus*	UNK	Equador
4-May-04	MCA2555	-	-	-	-	-	UNK	UNK	Equador
4-May-04	MCA2556	-	-	-	-	-	UNK	UNK	Equador
4-May-04	MCA2557	-	-	-	-	-	UNK	UNK	Equador
5-May-04	MCA2558	-	-	-	-	-	UNK	*Poaceae?*	Equador
5-May-04	MCA2559	-	-	-	-	-	UNK	Poaceae?	Equador
5-May-04	MCA2560	-	-	-	-	-	UNK	Poaceae	Equador
6-May-04	MCA2564	-	-	-	-	-	UNK	*Carica papaya*	Equador
6-May-04	MCA2565	-	-	-	-	-	UNK	UNK	Equador
6-May-04	MCA2566	-	-	-	-	-	UNK	*Legume*	Equador
6-May-04	MCA2567	-	-	-	-	-	*Puccinia*	Poaceae	Equador
6-May-04	MCA2568	-	-	-	-	-	*Uromyces*	Cucurbitaceae undet.	Equador
15-Jun-04	MCA2572	-	-	-	-	-	*Aecidium apocyni?*	*Apocynum cannabinum*	USA
17-Jun-04	MCA2573	-	-	-	-	-	*Phragmidium?*	*Fragraria vesca*	USA
19-Jun-04	MCA2574	-	-	-	-	-	*Puccinia?*	*Viola adunca*	USA

(**Table A-1.** Continued.)

Date	Collection Number	Larvae (+/-)	Larval Sample #	28S Sequence (Y/N) & BLAST ID	COI Sequence (Y/N) & BLAST ID	Supported Clades by tree (28S\COI\Concat.)	Rust Identification	Host Identification	Country
19-Jun-04	MCA2575	-	-	-	-	-	*Puccinia*	Asteraceae	USA
19-Jun-04	MCA2578	-	-	-	-	-	*Puccinia recondita?*	*Thalactrium*	USA
20-Jun-04	MCA2591	-	-	-	-	-	*Puccinia?*	*Viola*	USA
20-Jun-04	MCA2593	-	-	-	-	-	*Puccinia*	Asteraceae	USA
20-Jun-04	MCA2593	-	-	-	-	-	*Puccinia*	Asteraceae	USA
20-Jun-04	MCA2594	-	-	-	-	-	*Puccinia*	*Geranium*	USA
20-Jun-04	MCA2595	-	-	-	-	-	*Puccinia recondita?*	*Thalactrium*	USA
20-Jun-04	MCA2597	-	-	-	-	-	*Uromyces* sp.	Apiaceae	USA
20-Jun-04	MCA2598	-	-	-	-	-	*Puccinia caricena?* Or *urticae-acutiformis?*	*Urtica*	USA
19-Jul-04	MCA2624	-	-	-	-	-	*Puccinia hieracii?*	*Taraxacum officionale?*	USA
28-Jun-04	MCA2766	-	-	-	-	-	*Puccinia*	Onagraceae	USA
2-Jul-04	MCA2767	-	-	-	-	-	UNK	*Apera interrupta?*	USA
28-Jun-04	MCA2768	-	-	-	-	-	*Phragmidium*	*Rosa*	USA
28-Jun-04	MCA2769	-	-	-	-	-	*Uromyces rosicola?*	*Rosa* sp.	USA
17-Jul-04	MCA2771	-	-	-	-	-	*Puccinia violae*	*Viola*	USA
9-Sep-04	MCA2813	-	-	-	-	-	*Puccinia?*	*Lobelia inflata*	USA
9-Sep-04	MCA2818	-	-	-	-	-	*Puccinia andropogonis*	*Amphicarpaea bracteata*	USA
10-Sep-04	MCA2836	-	-	-	-	-	UNK	*Solidago curtsii*	UNK
18-Sep-04	MCA2839	-	-	-	-	-	UNK	Poaceae	USA
18-Sep-04	MCA2840	-	-	-	-	-	*Puccinia*	Poaceae	USA
18-Sep-04	MCA2842	-	-	-	-	-	*Melampsora*	*Populus grandidentata?*	USA
18-Sep-04	MCA2843	-	-	-	-	-	UNK	Asteraceae	USA
18-Sep-04	MCA2844	-	-	-	-	-	UNK	Asteraceae	USA
11-Dec-04	MCA2870	-	-	-	-	-	*Uromyces*	Juncaceae	USA
31-Dec-04	MCA2875	-	-	-	-	-	UNK	*Borrichia arborescens?*	USA
20-Feb-05	MCA2878	-	-	-	-	-	*Phakopsora*	*Annona* sp.	UNK
23-Feb-05	MCA2879	-	-	-	-	-	*Kuehneola loeseneriana?*	*Mora silvestre*	UNK
23-Feb-05	MCA2880	-	-	-	-	-	UNK	UNK	UNK
23-Feb-05	MCA2882	-	-	-	-	-	*Puccinia nv. Poarum?*	Asteraceae	Costa Rica
23-Feb-05	MCA2883	-	-	-	-	-	UNK	UNK	Costa Rica
23-Feb-05	MCA2885	-	-	-	-	-	*Puccinia or Chrysocyclus cestri*	*Cestris?*	Costa Rica

(**Table A-1.** Continued.)

Date	Collection Number	Larvae (+/-)	Larval Sample #	28S Sequence (Y/N) & BLAST ID	COI Sequence (Y/N) & BLAST ID	Supported Clades by tree (28S\COI\Concat.)	Rust Identification	Host Identification	Country
23-Feb-05	MCA2886	-	-	-	-	-	*Puccinia graminis*	UNK	Costa Rica
24-Feb-05	MCA2890	-	-	-	-	-	UNK	UNK	Costa Rica
24-Feb-05	MCA2891	-	-	-	-	-	*Phakopsora*	Marantaceae	Costa Rica
24-Feb-05	MCA2892	-	-	-	-	-	*Cerotelium?*	*Ischnosiphon?*	Costa Rica
24-Feb-05	MCA2893	-	-	-	-	-	*Puccinia*	UNK	Costa Rica
24-Feb-05	MCA2894	-	-	-	-	-	UNK	Poaceae	Costa Rica
26-Feb-05	MCA2896	-	-	-	-	-	UNK	*Theobroma cacao*	Costa Rica
27-Feb-05	MCA2897	-	-	-	-	-	*Phakopsora?*	Fabaceae	Costa Rica
26-Feb-05	MCA2898	-	-	-	-	-	UNK	Poaceae	Costa Rica
27-Feb-05	MCA2899	-	-	-	-	-	UNK	UNK	Costa Rica
20-Apr-05	MCA2913	-	-	-	-	-	UNK	Poaceae	USA
20-Apr-05	MCA2915	-	-	-	-	-	*Puccinia*	Poaceae	USA
20-Apr-05	MCA2917	-	-	-	-	-	UNK	*Lactuca serriola*	USA
20-Apr-05	MCA2918	-	-	-	-	-	*Puccinia*	Asteraceae	USA
21-Apr-05	MCA2923	-	-	-	-	-	*Puccinia*	Poaceae	USA
21-Apr-05	MCA2925	-	-	-	-	-	UNK	Poaceae	USA
21-Apr-05	MCA2926	-	-	-	-	-	*Puccinia* cf. *reconata*	Poaceae	USA
21-Apr-05	MCA2927	-	-	-	-	-	UNK	Poaceae	USA
22-Apr-05	MCA2928	-	-	-	-	-	UNK	Poaceae	USA
22-Apr-05	MCA2929	-	-	-	-	-	UNK	*Carduus pycnocephalus*	USA
22-Apr-05	MCA2931	-	-	-	-	-	*Puccinia*	UNK	USA
22-Apr-05	MCA2932	-	-	-	-	-	*Phragmidium*	*Rosa*	USA
22-Apr-05	MCA2933	-	-	-	-	-	UNK	*Quercus berberidifolia*	USA
22-Apr-05	MCA2934	-	-	-	-	-	*Puccinia/Uromyces*	UNK	USA
22-Apr-05	MCA2935	-	-	-	-	-	UNK	UNK	USA
22-Apr-05	MCA2936	-	-	-	-	-	UNK	Poaceae	USA
22-Apr-05	MCA2937	-	-	-	-	-	UNK	Poaceae	USA
1-May-05	MCA2939	-	-	-	-	-	*Puccinia violae?*	*Wild Violets*	USA
26-May-05	MCA2945	-	-	-	-	-	*Puccinia podophylli*	*Podophyllum peltatum*	USA
28-Jun-05	MCA2948	-	-	-	-	-	*Puccinia circaea*	*Circaea alpina*	USA
28-Jun-05	MCA2949	-	-	-	-	-	*Puccinia violae?*	*Viola* sp.	USA
28-Jun-05	MCA2950	-	-	-	-	-	UNK	Poaceae	USA
8-Jul-05	MCA2951	-	-	-	-	-	*Puccinia hieracii?*	*Taraxacum officinale*	USA
6-Aug-05	MCA2967	-	-	-	-	-	*Puccinia*	Asteraceae	USA
6-Aug-05	MCA2968	-	-	-	-	-	*Uromyces setaria-italicae?*	Poaceae	USA

(**Table A-1.** Continued.)

Date	Collection Number	Larvae (+/-)	Larval Sample #	28S Sequence (Y/N) & BLAST ID	COI Sequence (Y/N) & BLAST ID	Supported Clades by tree (28S\COI\Concat.)	Rust Identification	Host Identification	Country
6-Aug-05	MCA2969	-	-	-	-	-	UNK	Poaceae	USA
6-Aug-05	MCA2970	-	-	-	-	-	UNK	Poaceae	USA
8-Aug-05	MCA2971	-	-	-	-	-	*Puccinia*	Malvaceae	USA
8-Aug-05	MCA2972	-	-	-	-	-	UNK	Poaceae	USA
7-Aug-05	MCA2973	-	-	-	-	-	UNK	Poaceae	USA
15-Sep-05	MCA2986	-	-	-	-	-	*Coleosporium*	Asteraceae	USA
12-Sep-05	MCA2990	-	-	-	-	-	*Puccinia?*	Poaceae	USA
15-Sep-05	MCA2991	-	-	-	-	-	UNK	Poaceae	USA
2-Aug-06	MCA3073	-	-	-	-	-	UNK	UNK	Canada
2-Aug-06	MCA3074	-	-	-	-	-	*Puccinia hordii?*	Poaceae	Canada
2-Aug-06	MCA3075	-	-	-	-	-	*Puccinia* sp.	Asteraceae	Canada
2-Aug-06	MCA3076	-	-	-	-	-	UNK	UNK	Canada
2-Aug-06	MCA3078	-	-	-	-	-	UNK	Asteraceae	Canada
2-Aug-06	MCA3079	-	-	-	-	-	*Puccinia* sp.	UNK	Canada
3-Aug-06	MCA3080	-	-	-	-	-	*Puccinia*	Asteraceae	Canada
3-Aug-06	MCA3082	-	-	-	-	-	*Puccinia* sp.	Asteraceae	Canada
3-Aug-06	MCA3083	-	-	-	-	-	*Phragmidium*	*Rubus odoratus*	Canada
3-Aug-06	MCA3084	-	-	-	-	-	UNK	*Amphicarpea*	Canada
3-Aug-06	MCA3086	-	-	-	-	-	*Uredinopsis osmundae*	Osmundaceae	Canada
3-Aug-06	MCA3088	-	-	-	-	-	UNK	*Milesina*	Canada
3-Aug-06	MCA3089	-	-	-	-	-	UNK	UNK	Canada
3-Aug-06	MCA3090	-	-	-	-	-	*Melampsora*	*Salix*	Canada
3-Aug-06	MCA3091	-	-	-	-	-	UNK	Asteraceae	Canada
3-Aug-06	MCA3093	-	-	-	-	-	*Uredinopsis*	Balsam fir	Canada
3-Aug-06	MCA3094	-	-	-	-	-	*Melampsora*	*Populus*	Canada
3-Aug-06	MCA3095	-	-	-	-	-	*Chrysomyxa*	Spruce?	Canada
4-Aug-06	MCA3096	-	-	-	-	-	UNK	UNK	Canada
4-Aug-06	MCA3097	-	-	-	-	-	UNK	*Epilobium angustifolia*	Canada
4-Aug-06	MCA3098	-	-	-	-	-	UNK	*Ribes*	Canada
26-Jun-06	MCA3103	-	-	-	-	-	UNK	Melastomataceae	Guyana
30-Jun-06	MCA3132	-	-	-	-	-	UNK	*Macrolobium* sp.	Guyana
4-Aug-06	MCA3192	-	-	-	-	-	UNK	Asteraceae	Canada
4-Aug-06	MCA3193	-	-	-	-	-	*Puccinia* sp.	Asteraceae	Canada
4-Aug-06	MCA3194	-	-	-	-	-	*Melampsora*	UNK	Canada
4-Aug-06	MCA3195	-	-	-	-	-	*Puccinia* sp.	Poaceae	Canada
4-Aug-06	MCA3197	-	-	-	-	-	*Puccinia* sp.	UNK	Canada

(**Table A-1.** Continued.)

Date	Collection Number	Larvae (+/-)	Larval Sample #	28S Sequence (Y/N) & BLAST ID	COI Sequence (Y/N) & BLAST ID	Supported Clades by tree (28S\COI\Concat.)	Rust Identification	Host Identification	Country
4-Aug-06	MCA3199	-	-	-	-	-	*Chrysomyxa*	UNK	Canada
4-Aug-06	MCA3201	-	-	-	-	-	UNK	UNK	Canada
4-Aug-06	MCA3202	-	-	-	-	-	UNK	UNK	Canada
4-Aug-06	MCA3203	-	-	-	-	-	*Melampsora*	UNK	Canada
4-Aug-06	MCA3207	-	-	-	-	-	UNK	Sedge	Canada
4-Aug-06	MCA3208	-	-	-	-	-	*Gymnosporangium*	*Sorbus canada*	Canada
5-Aug-06	MCA3209	-	-	-	-	-	*Phragmidium*	*Rosa*	Canada
5-Aug-06	MCA3212	-	-	-	-	-	UNK	Asteraceae	Canada
5-Aug-06	MCA3213	-	-	-	-	-	*Puccinia* sp.	UNK	Canada
6-Aug-06	MCA3214	-	-	-	-	-	*Puccinia* sp.	Poaceae	Canada
5-Aug-06	MCA3216	-	-	-	-	-	UNK	UNK	Canada
10-Aug-06	MCA3217	-	-	-	-	-	*Gymnosporangium*	*Malus*	USA
22-Aug-06	MCA3224	-	-	-	-	-	UNK	Asteraceae	USA
22-Aug-06	MCA3225	-	-	-	-	-	*Puccinia violae*	*Violet*	USA
10-Aug-06	MCA3226	-	-	-	-	-	*Phragmidium*	*Rosa*	USA
10-Sep-06	MCA3231	-	-	-	-	-	UNK	Convolvulaceae	USA
10-Sep-06	MCA3232	-	-	-	-	-	*Puccinia* sp.	Poaceae	USA
10-Sep-06	MCA3233	-	-	-	-	-	*Pileolaria?*	UNK	USA
13-Oct-06	MCA3240	-	-	-	-	-	UNK	Poaceae	Nigeria
13-Oct-06	MCA3241	-	-	-	-	-	UNK	UNK	Nigeria
13-Oct-06	MCA3242	-	-	-	-	-	UNK	Poaceae	Nigeria
15-Oct-06	MCA3243	-	-	-	-	-	*Puccinia* sp.	sedge	Nigeria
16-Oct-06	MCA3244	-	-	-	-	-	*NOT A RUST*	Cyperaceae	Nigeria
16-Oct-06	MCA3245	-	-	-	-	-	UNK	Euphorbiaceae	Nigeria
16-Oct-06	MCA3246	-	-	-	-	-	UNK	Asteraceae	Nigeria
16-Oct-06	MCA3247	-	-	-	-	-	UNK	UNK	Nigeria
16-Oct-06	MCA3249	-	-	-	-	-	UNK	*Monocot*	Nigeria
17-Oct-06	MCA3251	-	-	-	-	-	UNK	Euphorbiaceae	Nigeria
25-Oct-06	MCA3259	-	-	-	-	-	UNK	Poaceae	Uganda
28-Oct-06	MCA3262	-	-	-	-	-	UNK	Poaceae	Uganda
28-Oct-06	MCA3263	-	-	-	-	-	*Puccinia* sp.	*Papyrus*	Uganda
31-Oct-06	MCA3268	-	-	-	-	-	UNK	Poaceae	Uganda
15-Oct-06	MCA3269	-	-	-	-	-	UNK	UNK	Nigeria
23-Nov-06	MCA3270	-	-	-	-	-	*Puccinia* sp.	Poaceae	USA
23-Nov-06	MCA3271	-	-	-	-	-	*Puccinia* sp.	Poaceae	USA
23-Mar-07	MCA3290	-	-	-	-	-	*Gymnosporangium*	*Juniperus*	USA

(**Table A-1.** Continued.)

Date	Collection Number	Larvae (+/-)	Larval Sample #	28S Sequence (Y/N) & BLAST ID	COI Sequence (Y/N) & BLAST ID	Supported Clades by tree (28S\COI\Concat.)	Rust Identification	Host Identification	Country
31-Mar-07	MCA3324	-	-	-	-	-	*Frommeella?*	*Potentilla?*	USA
12-May-07	MCA3331	-	-	-	-	-	*Puccinia sparaganioides*	Oliveaceae	USA
12-May-07	MCA3332	-	-	-	-	-	*Puccinia striniformis?*	*Poa*	USA
12-May-07	MCA3333	-	-	-	-	-	UNK	Poaceae	USA
12-May-07	MCA3334	-	-	-	-	-	*Puccinia?*	*Carex* sp.	USA
27-Jun-07	MCA3335	-	-	-	-	-	UNK	UNK	USA
27-Jun-07	MCA3337	-	-	-	-	-	*Gymnosporangium*	*Hawthorn*	USA
29-Jun-07	MCA3338	-	-	-	-	-	UNK	*Hypericum*	USA
29-Jun-07	MCA3339	-	-	-	-	-	UNK	*Trifolium*	USA
29-Jun-07	MCA3340	-	-	-	-	-	UNK	*Amphicarpea*	USA
29-Jun-07	MCA3342	-	-	-	-	-	UNK	*Carex*	USA
29-Jun-07	MCA3344	-	-	-	-	-	UNK	*Prenanthes*	USA
29-Jun-07	MCA3345	-	-	-	-	-	UNK	*Sanicula*	USA
5-Jul-07	MCA3346	-	-	-	-	-	*Puccinia melanocephala*	Sugarcane	USA
5-Jul-07	MCA3346	-	-	-	-	-	*Puccinia melanocephala*	UNK	USA
5-Jul-07	MCA3347	-	-	-	-	-	*Puccinia melanocephala*	Sugarcane	USA
Spring 2007	MCA3349	-	-	-	-	-	*Puccinia* sp.	Cutleaf purskene	USA
16-Aug-07	MCA3350	-	-	-	-	-	UNK	Cyperaceae	Belize
16-Aug-07	MCA3351	-	-	-	-	-	UNK	*Protea*	Belize
18-Aug-07	MCA3353	-	-	-	-	-	UNK	*Mikania* sp.	Belize
20-Aug-07	MCA3377	-	-	-	-	-	UNK	*Gerania*	Belize
21-Aug-07	MCA3401	-	-	-	-	-	UNK	*Asplundia*	Belize
23-Aug-07	MCA3418	-	-	-	-	-	UNK	*Synechanthus*	Belize
24-Aug-07	MCA3425	-	-	-	-	-	UNK	*Smilax*	Belize
24-Aug-07	MCA3426	-	-	-	-	-	UNK	*Psychotria elata*	Belize
25-Aug-07	MCA3450	-	-	-	-	-	UNK	*Cyperaceae*	Belize
25-Aug-07	MCA3451	-	-	-	-	-	UNK	Cyperaceae	Belize
26-Aug-07	MCA3452	-	-	-	-	-	UNK	Rubiaceae	Belize
27-Aug-07	MCA3454	-	-	-	-	-	UNK	*Gurania*	Belize
29-Aug-07	MCA3455	-	-	-	-	-	*Puccinia cnici-oleracei*	*Eclipta alba*	Belize
12-Sep-07	MCA3456	-	-	-	-	-	*Gymnosporangium*	*Pyrus*	Denmark

(**Table A-1.** Continued.)

Date	Collection Number	Larvae (+/-)	Larval Sample #	28S Sequence (Y/N) & BLAST ID	COI Sequence (Y/N) & BLAST ID	Supported Clades by tree (28S\COI\Concat.)	Rust Identification	Host Identification	Country
13-Sep-07	MCA3457	-	-	-	-	-	UNK	Poaceae	Denmark
16-Sep-07	MCA3458	-	-	-	-	-	*Phragmidium*	*Rubus*	Denmark
18-Sep-07	MCA3459	-	-	-	-	-	*Phragmidium*	*Rubus*	Germany
18-Sep-07	MCA3460	-	-	-	-	-	*Phragmidium*	*Rosa*	Germany
18-Sep-07	MCA3461	-	-	-	-	-	UNK	*Rumex*	Germany
21-Sep-07	MCA3462	-	-	-	-	-	*Coleosporium*	Asteraceae	Croatia
21-Sep-07	MCA3464	-	-	-	-	-	*Puccinia striniformis*	Poaceae	Slovenia
21-Sep-07	MCA3465	-	-	-	-	-	UNK	Poaceae	Slovenia
22-Sep-07	MCA3466	-	-	-	-	-	*Phragmidium*	*Rosa*	Croatia
22-Sep-07	MCA3467	-	-	-	-	-	UNK	UNK	Croatia
12-Oct-07	MCA3468	-	-	-	-	-	*Puccinia canaliculata*	*Cyperus esculentus*	USA
16-Nov-07	MCA3470	-	-	-	-	-	*Coleosporium*	*Elephantopus* sp.	USA
16-Nov-07	MCA3471	-	-	-	-	-	*Puccinia*	Asteraceae	USA
22-Nov-07	MCA3477	-	-	-	-	-	*Pileolaria*	*Toxicodendrun*	USA
5-Dec-07	MCA3479	-	-	-	-	-	*Coleosporium plumeriae*	*Plumeria*	Malasia
9-Dec-07	MCA3480	-	-	-	-	-	*Coleosporium plumeriae*	*Plumeria*	Malasia
10-Dec-07	MCA3481	-	-	-	-	-	*Rust?*	UNK	Malasia
10-Dec-07	MCA3482	-	-	-	-	-	*Phakopsora apoda*	Poaceae	Malasia
10-Dec-07	MCA3483	-	-	-	-	-	*Hamaspora*	*Rubus*	Malasia
10-Dec-07	MCA3484	-	-	-	-	-	*Puccinia?*	Poaceae	Malasia
10-Dec-07	MCA3485	-	-	-	-	-	UNK	*Asplundia?*	Malasia
11-Dec-07	MCA3486	-	-	-	-	-	*Kwielingia divina*	*Bamboo*	Malasia
11-Dec-07	MCA3487	-	-	-	-	-	*Kwielingia divina*	*Bamboo*	Malasia
12-Dec-07	MCA3493	-	-	-	-	-	*Kwielingia divina*	*Bamboo*	Malasia
12-Dec-07	MCA3494	-	-	-	-	-	UNK	Poaceae	Malasia
12-Dec-07	MCA3495	-	-	-	-	-	UNK	*UNK*	Malasia
14-Dec-07	MCA3519	-	-	-	-	-	*Uromyces?*	*legume*	Malasia
3-Feb-08	MCA3522	-	-	-	-	-	*Melampsora*	*Salix*	USA
5-Feb-08	MCA3523	-	-	-	-	-	*Puccinia glecomitis?*	UNK	USA
16-Feb-08	MCA3528	-	-	-	-	-	*Puccinia hieracii?*	*dandelion*	USA
14-Mar-08	MCA3565	-	-	-	-	-	*Puccinia malvacearum*	*Modiala caroliniana*	UNK
18-Mar-08	MCA3566	-	-	-	-	-	*Puccinia hydrocotyles*	*Hydrocotyle*	UNK
23-Mar-08	MCA3568	-	-	-	-	-	UNK	Rosaceae?	USA
30-Mar-08	MCA3570	-	-	-	-	-	*Kuehneola uredinis*	*Rubus ursinus?*	USA

(**Table A-1.** Continued.)

Date	**Collection Number**	**Larvae (+/-)**	**Larval Sample #**	**28S Sequence (Y/N) & BLAST ID**	**COI Sequence (Y/N) & BLAST ID**	**Supported Clades by tree (28S\COI\Concat.)**	**Rust Identification**	**Host Identification**	**Country**
27-Mar-08	MCA3571	-	-	-	-	-	*Puccinia triticina*	*Triticum aestivum*	USA
1-Apr-08	MCA3572	-	-	-	-	-	*Puccinia triticina*	*Triticum aestivum*	USA
10-Apr-08	MCA3575	-	-	-	-	-	*Gymnosporangium clavipes*	*Hawthorn*	USA
10-Apr-08	MCA3576	-	-	-	-	-	*Puccinia smilacis*	*Smilax* sp.	USA
10-Apr-08	MCA3577	-	-	-	-	-	UNK	Poaceae	USA
12-Apr-08	MCA3579	-	-	-	-	-	UNK	Asteraceae	USA
21-Apr-08	MCA3581	-	-	-	-	-	*Melampsora*	*Salix matsudana*	USA
1-May-08	MCA3584	-	-	-	-	-	*Puccinia*	*Rye Grass*	USA
24-Apr-08	MCA3585	-	-	-	-	-	*Gymnosporangium*	UNK	USA
13-May-08	MCA3587	-	-	-	-	-	*Puccinia coronata*	*Lolium* sp.	USA
10-May-08	MCA3588	-	-	-	-	-	*Tranzschelia*	*Prunus serotina?*	USA
14-May-08	MCA3589	-	-	-	-	-	*Puccinia malvacearum*	Malvaceae	USA
9-May-08	MCA3590	-	-	-	-	-	*Puccinia zoysiae*	*Zoysia*	USA
12-Jul-08	MCA3613	-	-	-	-	-	*Puccinia*	*Bamboo*	USA
12-Jul-08	MCA3615	-	-	-	-	-	*Coleosporium*	*Elephantopus*	USA
1-Jul-08	MCA3616	-	-	-	-	-	UNK	Poaceae	USA
18-Jul-08	MCA3618	-	-	-	-	-	*Cronartium*	*Quercus*	USA
18-Jul-08	MCA3619	-	-	-	-	-	UNK	UNK	USA
18-Jul-08	MCA3620	-	-	-	-	-	*Coleosporium*	*Solidago*	USA
18-Jul-08	MCA3621	-	-	-	-	-	*Cronartium*	*Quercus*	USA
3-Aug-08	MCA3622	-	-	-	-	-	*Puccinia arundinania*	*Arundinaria*	USA
11-Aug-08	MCA3623	-	-	-	-	-	*Puccinia violacea*	*Viola sp.*	USA
21-Aug-08	MCA3625	-	-	-	-	-	UNK	UNK	USA
19-Aug-08	MCA3626	-	-	-	-	-	SMUT	UNK	USA
18-Aug-08	MCA3627	-	-	-	-	-	UNK	Cyperaceae	UNK
29-Aug-08	MCA3633	-	-	-	-	-	SMUT	UNK	USA
26-Sep-08	MCA3641	-	-	-	-	-	*Puccinia Thaliae*	UNK	USA
26-Sep-08	MCA3642	-	-	-	-	-	*Coleosporium*	UNK	USA
30-Sep-08	MCA3644	-	-	-	-	-	*Puccinia Thaliae*	*Canna lilly*	USA
1-Oct-08	MCA3645	-	-	-	-	-	SMUT	UNK	USA
1-Oct-08	MCA3646	-	-	-	-	-	SMUT	UNK	USA
2008, July	MCA3647	-	-	-	-	-	*Gymnosporangium*	*Malus*	USA
8-Nov-08	MCA3655	-	-	-	-	-	UNK	Convolvulaceae	USA
8-Nov-08	MCA3656	-	-	-	-	-	UNK	*Johnson grass*	USA
12-Nov-08	MCA3657	-	-	-	-	-	*Phakopsora pachyrhizi*	*Kudzu*	USA

(**Table A-1.** Continued.)

Date	Collection Number	Larvae (+/-)	Larval Sample #	28S Sequence (Y/N) & BLAST ID	COI Sequence (Y/N) & BLAST ID	Supported Clades by tree (28S\COI\Concat.)	Rust Identification	Host Identification	Country
8-Oct-13	MCA3667	-	-	-	-	-	*Melampsora medusae*	*Populus deltoides*	USA
2-Nov-08	MCA3668	-	-	-	-	-	*Coleosporium plumeriae*	*Plumeria*	USA
30-Dec-08	MCA3670	-	-	-	-	-	*Kuehneola?*	*Rubus*	Ireland
22-Jan-09	MCA3671	-	-	-	-	-	*Puccinia malvacearum*	Malvaceae	USA
22-Jan-09	MCA3672	-	-	-	-	-	*Puccinia hemenocallidir*	*Lily*	USA
7-Mar-09	MCA3675	-	-	-	-	-	*Puccinia* sp.	Asteraceae	USA
7-Mar-09	MCA3676	-	-	-	-	-	*Puccinia* sp.	Asteraceae	USA
26-Mar-09	MCA3677	-	-	-	-	-	UNK	*Day Lily*	USA
22-Mar-09	MCA3679	-	-	-	-	-	*Puccinia*	Asteraceae	USA
26-Mar-09	MCA3680	-	-	-	-	-	*Puccinia*	Malvaceae	USA
8-Apr-09	MCA3682	-	-	-	-	-	UNK	*Rubus*	USA
8-Apr-09	MCA3683	-	-	-	-	-	UNK	Poaceae	USA
1-Apr-09	MCA3701	-	-	-	-	-	*Puccinia cynodonis*	*Cynodon dactylon*	USA
18-Apr-09	MCA3702	-	-	-	-	-	UNK	*Trifolium?*	USA
18-Apr-09	MCA3703	-	-	-	-	-	UNK	Poaceae	USA
16-Apr-09	MCA3714	-	-	-	-	-	SMUT *(Anthracoidea)*	*Carex hyalinolepis*	USA
2-May-09	MCA3715	-	-	-	-	-	*Coleosporium*	*Solidago*	USA
2-May-09	MCA3716	-	-	-	-	-	UNK	Poaceae	USA
4-May-09	MCA3717	-	-	-	-	-	*Puccinia malvacearum*	Malvaceae	USA
4-May-09	MCA3718	-	-	-	-	-	*Coleosporium*	*Solidago*	USA
4-May-09	MCA3719	-	-	-	-	-	*Puccinia oxalis*	*Oxalis*	USA
4-May-09	MCA3720	-	-	-	-	-	*Puccinia malvacearum?*	UNK	USA
5-May-09	MCA3721	-	-	-	-	-	SMUT *(Tilletia?)*	UNK	USA
29-Apr-09	MCA3722	-	-	-	-	-	SMUT *(Leucocintractia)*	*Rhynchospora careyana*	USA
12-May-09	MCA3742	-	-	-	-	-	*Phragmidiaceae*	*Rubus*	USA
12-May-09	MCA3743	-	-	-	-	-	UNK	Poaceae	USA
12-May-09	MCA3744	-	-	-	-	-	UNK	Fabaceae	USA
12-May-09	MCA3745	-	-	-	-	-	UNK	Poaceae	USA
12-May-09	MCA3746	-	-	-	-	-	UNK	Poaceae	USA
12-May-09	MCA3747	-	-	-	-	-	*Puccinia lygodii*	UNK	USA
31-May-09	MCA3758	-	-	-	-	-	*Puccinia sparaganioides*	*Fraxinus*	UNK

(**Table A-1.** Continued.)

Date	Collection Number	Larvae (+/-)	Larval Sample #	28S Sequence (Y/N) & BLAST ID	COI Sequence (Y/N) & BLAST ID	Supported Clades by tree (28S\COI\Concat.)	Rust Identification	Host Identification	Country
22-Jun-09	MCA3761	-	-	-	-	-	*Uromyces*	*Vicia* cf. *villosa*	USA
22-Jun-09	MCA3762	-	-	-	-	-	*Melampsora*	*Salix* sp.	USA
22-Jun-09	MCA3763	-	-	-	-	-	*Chrysomyxa* cf. *ledecola*	*Ledum*	USA
22-Jun-09	MCA3764	-	-	-	-	-	*Phragmidium*	*primrose*	USA
22-Jun-09	MCA3765	-	-	-	-	-	Phragmidiaceae	UNK	USA
22-Jun-09	MCA3766	-	-	-	-	-	UNK	UNK	USA
22-Jun-09	MCA3767	-	-	-	-	-	*Melampsora*	*Salix*	USA
8-Jun-09	MCA3769	-	-	-	-	-	*Puccinia anindinaria*	*Bamboo*	USA
11-Jul-09	MCA3792	-	-	-	-	-	*Coleosporium*	Asteraceae	USA
30-Jul-09	MCA3795	-	-	-	-	-	SMUT *(Tilletia?)*	Poaceae	USA
30-Jul-09	MCA3796	-	-	-	-	-	*Puccinia similis?*	*Artemisia tridentata?*	USA
30-Jul-09	MCA3797	-	-	-	-	-	*Puccinia*	Poaceae	USA
26-Jul-09	MCA3798	-	-	-	-	-	*Melampsora salix*	*Salix*	USA
7-Aug-09	MCA3812	-	-	-	-	-	UNK	Fabaceae	USA
7-Aug-09	MCA3814	-	-	-	-	-	UNK	UNK	USA
7-Aug-09	MCA3816	-	-	-	-	-	*Coleosporium asterum*	*Solidago*	USA
7-Aug-09	MCA3817	-	-	-	-	-	UNK	UNK	USA
7-Aug-09	MCA3818	-	-	-	-	-	*Gymnosporangium*	Grossulariaceae	USA
7-Aug-09	MCA3819	-	-	-	-	-	*Coleosporium*	UNK	USA
Sep-13	MCA3842	-	-	-	-	-	*Coleosporium plumeriae*	*Vinca*	USA
8-Sep-09	MCA3853	-	-	-	-	-	*Coleosporium ipomoea*	UNK	USA
22-Oct-09	MCA3854	-	-	-	-	-	*Puccinia* cf. *malvacearum*	*Modiola caroliniana*	UNK
28-Nov-09	MCA3868	-	-	-	-	-	*Gymnosporangium trachysorum?*	*Crataegus*	USA
28-Nov-09	MCA3869	-	-	-	-	-	*Puccinia lygodii*	*Lygodium*	USA
27-Nov-09	MCA3875	-	-	-	-	-	*Puccinia*	Poaceae	USA
20-Mar-10	MCA3886	-	-	-	-	-	*Cronartium*	*Pine*	USA
10-Apr-10	MCA3887	-	-	-	-	-	*Gymnoconia*	*Rubus*	USA
20-Apr-10	MCA3894	-	-	-	-	-	*Coleosporium*	*Pinus palustris*	USA
12-May-10	MCA3896	-	-	-	-	-	SMUT	*Dactyloctenium*	Guyana
12-May-10	MCA3897	-	-	-	-	-	UNK	*Miconia*	Guyana
13-May-10	MCA3898	-	-	-	-	-	UNK	*Miconia*	Guyana
26-Jun-10	MCA4131	-	-	-	-	-	UNK	*Juncus effusus*	USA

(**Table A-1.** Continued.)

Date	Collection Number	Larvae (+/-)	Larval Sample #	28S Sequence (Y/N) & BLAST ID	COI Sequence (Y/N) & BLAST ID	Supported Clades by tree (28S\COI\Concat.)	Rust Identification	Host Identification	Country
26-Jun-10	MCA4132	-	-	-	-	-	*Cronartium auercum*	*Quercus nigra*	USA
26-Jun-10	MCA4133	-	-	-	-	-	*Cronartium quercum*	*Quercus pagoda*	USA
26-Jun-10	MCA4134	-	-	-	-	-	*Puccinia bolleyana?*	*Carex* sp.	USA
26-Jun-10	MCA4135	-	-	-	-	-	*Cronartium quercum*	*Quercus nigra*	USA
1-Aug-10	MCA4142	-	-	-	-	-	*Uromyces*	*Geranium*	Scotland
1-Aug-10	MCA4144	-	-	-	-	-	UNK	*Fern*	Scotland
1-Aug-10	MCA4145	-	-	-	-	-	SMUT	*Rumex*	Scotland
1-Aug-10	MCA4146	-	-	-	-	-	*Phragmidium*	*Rubus*	Scotland
1-Aug-10	MCA4147	-	-	-	-	-	UNK	*Fern*	Scotland
11-Aug-10	MCA4151	-	-	-	-	-	*Uredinopsis*	*Thelypteris phegopteris*	Switzerland
11-Aug-10	MCA4154	-	-	-	-	-	UNK	Asteraceae	Switzerland
11-Aug-10	MCA4155	-	-	-	-	-	*Puccinia caracis?*	*Carex* sp.	Switzerland
11-Aug-10	MCA4156	-	-	-	-	-	*Puccinia obscura?*	*Carex* sp.	Switzerland
11-Aug-10	MCA4157	-	-	-	-	-	*Puccinia coronata*	*Festuca*	Switzerland
11-Aug-10	MCA4159	-	-	-	-	-	*Gymnosporangium?*	*Pyrus*	Switzerland
11-Aug-10	MCA4160	-	-	-	-	-	*Phragmidium*	*Rosa*	Switzerland
11-Aug-10	MCA4161	-	-	-	-	-	*Coleosporium*	*Rhinanthus aristatus*	Switzerland
11-Aug-10	MCA4162	-	-	-	-	-	*Phragmidium*	*Sanguisorba* sp.	Switzerland
11-Aug-10	MCA4163	-	-	-	-	-	*Gymnosporangium cornutum*	*Sorbus*	Switzerland
11-Aug-10	MCA4165	-	-	-	-	-	*Cronartium*	*Vincetoxicum hirundinaria*	Switzerland
11-Aug-10	MCA4166	-	-	-	-	-	*Puccinia*	*Prenanthes purpurea*	Switzerland
11-Aug-10	MCA4167	-	-	-	-	-	UNK	*Umbelliferae*	Switzerland
16-May-10	MCA4168	-	-	-	-	-	UNK	*Ischnosiphon*	Guyana
16-May-10	MCA4169	-	-	-	-	-	UNK	*Cassia*	Guyana
15-May-10	MCA4170	-	-	-	-	-	*Puccinia obliquoseptata*	*Olyra*	Guyana
15-May-10	MCA4170	-	-	-	-	-	*Puccinia obliquo-septata*	*Olyra*	Guyana
18-Aug-10	MCA4172	-	-	-	-	-	*Puccinia*	*Zea mays*	USA
3-Aug-10	MCA4184	-	-	-	-	-	SMUT	*Anemone nemorosa*	Scotland
1-Sep-10	MCA4195	-	-	-	-	-	*Puccinia?*	Asteraceae	USA
8-Sep-10	MCA4197	-	-	-	-	-	*Coleosporium ipomoea*	Morning glory	USA
25-Nov-48	MCA4199	-	-	-	-	-	*Crepidotus* - NOT A RUST	UNK	Brazil

(**Table A-1.** Continued.)

Date	Collection Number	Larvae (+/-)	Larval Sample #	28S Sequence (Y/N) & BLAST ID	COI Sequence (Y/N) & BLAST ID	Supported Clades by tree (28S\COI\Concat.)	Rust Identification	Host Identification	Country
28-Sep-10	MCA4201	-	-	-	-	-	*Kuehneola*	*Rubus*	USA
12-Sep-10	MCA4202	-	-	-	-	-	*Puccinia heinerocallidis*	*Daylilly*	USA
15-Oct-10	MCA4216	-	-	-	-	-	UNK	Asteraceae	USA
12-Feb-11	MCA4217	-	-	-	-	-	*Kuehneola*	*Rubus*	USA
2-Mar-11	MCA4218	-	-	-	-	-	*Puccinia*	*Packera*	USA
13-Apr-11	MCA4226	-	-	-	-	-	*Puccinia chloridis*	*Milk weed*	USA
28-Apr-11	MCA4227	-	-	-	-	-	*Tranzschelia?*	*Prunus*	USA
28-May-11	MCA4328	-	-	-	-	-	*Rust?*	Melastomataceae?	Guyana
27-Jul-07	MCA4486	-	-	-	-	-	UNK	Sugarcane	Taiwan
20-Jun-07	PDD92565	-	-	-	-	-	UNK	*Myosotidium hortensia*	New Zealand
5-Dec-01	PUR102	-	-	-	-	-	*Sphaerophragrium longicorne*	*Dalbergia hostilis*	Nigeria
18-Feb-00	PUR103	-	-	-	-	-	UNK	*Sterculia* sp.	Nigeria
5-Dec-00	PUR104	-	-	-	-	-	*Hemileia* sp.	*Clerodendrum* sp.	Nigeria
12-Nov-00	PUR105	-	-	-	-	-	*Hemileia* sp.	*Mussaenda elegans*	Nigeria
15-Dec-00	PUR106	-	-	-	-	-	*Sphaerophragrium acaciae*	*Albizia lebbeck*	Nigeria
UNK	PUR107	-	-	-	-	-	*Hapalophragmium* sp.	*Baphia or Milletia?*	UNK
UNK	PUR108	-	-	-	-	-	UNK	*Bridelia* sp.	Nigeria
UNK	PUR109	-	-	-	-	-	UNK	*Calopogonium mucinoides*	Nigeria
UNK	PUR110	-	-	-	-	-	UNK	UNK	Nigeria
UNK	PUR111	-	-	-	-	-	UNK	*Strychnos* sp.	Nigeria
UNK	PUR112	-	-	-	-	-	UNK	*Fadogia?*	Nigeria
10-Aug-98	PUR113	-	-	-	-	-	UNK	*Senna jaegen*	Nigeria
9-Jan-01	PUR114	-	-	-	-	-	*Hemileia* sp.	*Tacazzea apiculata*	Nigeria
UNK	PUR115	-	-	-	-	-	UNK	*Orchid*	Nigeria
1985	PUR116	-	-	-	-	-	UNK	*Legume*	Nigeria
1-Aug-01	PUR117	-	-	-	-	-	*Uromyces* sp.	*Mucuna* sp.	Nigeria
1-Sep-01	PUR118	-	-	-	-	-	*Puccinia mogiphanis?*	*Alternanthera brasiliana*	Nigeria
8-Mar-85	PUR119	-	-	-	-	-	UNK	*Pennisetum pedicellatum*	Nigeria

(**Table A-1.** Continued.)

Date	Collection Number	Larvae (+/-)	Larval Sample #	28S Sequence (Y/N) & BLAST ID	COI Sequence (Y/N) & BLAST ID	Supported Clades by tree (28S\COI\Concat.)	Rust Identification	Host Identification	Country
8-Mar-85	PUR120	-	-	-	-	-	*Puccinia agrophila*	*Schizachyrium or Adropogon?*	Nigeria
8-Mar-85	PUR121	-	-	-	-	-	*Puccinia advena*	*Oplismenus hirtellus*	Nigeria
8-Mar-85	PUR122	-	-	-	-	-	UNK	*Hyparrhenia cymbaria?*	Nigeria
8-Mar-85	PUR123	-	-	-	-	-	UNK	Poaceae	Nigeria
1-Aug-01	PUR124	-	-	-	-	-	UNK	*Graminae*	Nigeria
23-Aug-01	PUR125	-	-	-	-	-	*Puccinia nakanishiki*	*Cymbopogon citratus*	Nigeria
18-Aug-01	PUR126	-	-	-	-	-	*Uromyces* sp.	*Commelina* sp.	Nigeria
20-Aug-01	PUR127	-	-	-	-	-	*Puccinia* sp.	*Panicum maximum*	Nigeria
20-Aug-01	PUR128	-	-	-	-	-	UNK	Poaceae	Nigeria
1-Sep-01	PUR129	-	-	-	-	-	*Puccinia* sp.	*Sorghum*	Nigeria
1-Sep-01	PUR130	-	-	-	-	-	*Endophyllum*	*Codiaeum variegatum*	Nigeria
UNK	PUR131	-	-	-	-	-	UNK	UNK	UNK
1-Sep-01	PUR132	-	-	-	-	-	UNK	UNK	Nigeria
1-Sep-01	PUR133	-	-	-	-	-	UNK	UNK	Nigeria
31-Dec-01	PUR134	-	-	-	-	-	*Newinia* sp.	*Kigelia africana?*	Nigeria
7-Nov-01	PUR135	-	-	-	-	-	*Puccinia* sp.	*Imperata cylindrica*	Nigeria
11-Nov-01	PUR138	-	-	-	-	-	*Sorataea* sp.	*Baphia?*	Nigeria
12-May-10	RK02	-	-	-	-	-	*Gymnosporangium*	*Pyrus*	USA
15-Apr-11	TAR	-	-	-	-	-	*Puccinia farinacea*	*Salvia farinacea*	UNK
31-Aug-09	TAR100	-	-	-	-	-	*Coleosporium ipomoea*	Morning glory	USA
31-Aug-09	TAR102	-	-	-	-	-	*Phakopsora pachyrizi*	*Kudzu*	USA
31-Aug-09	TAR104	-	-	-	-	-	UNK	*Duchesnea indica*	USA
31-Aug-09	TAR106	-	-	-	-	-	*Phakopsora pachyrizi*	Morning glory	USA
7-Sep-09	TAR107	-	-	-	-	-	UNK	UNK	USA
8-Sep-09	TAR108	-	-	-	-	-	UNK	*Canna indica*	USA
8-Sep-09	TAR109	-	-	-	-	-	UNK	*Canna generalis*	USA
8-Sep-09	TAR110	-	-	-	-	-	*Coleosporium ipomoea*	Morning glory	USA
16-Sep-09	TAR111	-	-	-	-	-	UNK	UNK	USA
16-Sep-09	TAR113	-	-	-	-	-	UNK	*Veronia gigantea*	USA
16-Sep-09	TAR114	-	-	-	-	-	*Puccinia smilacis*	*Smilax rotundifolia*	USA
16-Sep-09	TAR117	-	-	-	-	-	UNK	*Veronica gigantea*	USA
11-Sep-09	TAR119	-	-	-	-	-	*Phakopsora pachyrizi*	*Glycine max*	USA
16-Sep-09	TAR120	-	-	-	-	-	*Phakopsora pachyrizi*	*Glycine max*	USA
3-Sep-09	TAR121	-	-	-	-	-	*Phakopsora pachyrizi*	*Glycine max*	USA
16-Sep-09	TAR122	-	-	-	-	-	*Phakopsora pachyrizi*	*Glycine max*	USA

(**Table A-1.** Continued.)

Date	Collection Number	Larvae (+/-)	Larval Sample #	28S Sequence (Y/N) & BLAST ID	COI Sequence (Y/N) & BLAST ID	Supported Clades by tree (28S\COI\Concat.)	Rust Identification	Host Identification	Country
3-Sep-09	TAR123	-	-	-	-	-	*Phakopsora pachyrizi*	*Glycine max*	USA
15-Sep-09	TAR124	-	-	-	-	-	*Phakopsora pachyrizi*	*Glycine max*	USA
15-Sep-09	TAR125	-	-	-	-	-	*Phakopsora pachyrizi*	*Glycine max*	USA
16-Sep-09	TAR126	-	-	-	-	-	*Phakopsora pachyrizi*	*Glycine max*	USA
16-Sep-09	TAR128	-	-	-	-	-	*Phakopsora pachyrizi*	*Glycine max*	USA
18-Sep-09	TAR129	-	-	-	-	-	*Phakopsora pachyrizi*	*Glycine max*	USA
18-Sep-09	TAR130	-	-	-	-	-	*Phakopsora pachyrizi*	*Glycine max*	USA
10-Sep-09	TAR131	-	-	-	-	-	*Phakopsora pachyrizi*	*Glycine max*	USA
2-Sep-09	TAR132	-	-	-	-	-	*Phakopsora pachyrizi*	*Glycine max*	USA
16-Sep-09	TAR133	-	-	-	-	-	*Phakopsora pachyrizi*	*Glycine max*	USA
23-Sep-09	TAR135	-	-	-	-	-	UNK	*Acmella oppositifolia*	USA
23-Sep-09	TAR136	-	-	-	-	-	*NO RUST*	*Triadica sebifera*	USA
23-Sep-09	TAR137	-	-	-	-	-	*Puccinia*	*Paspalum urvillei*	USA
23-Sep-09	TAR138	-	-	-	-	-	*Puccinia*	Poaceae	USA
23-Sep-09	TAR139	-	-	-	-	-	*Coleosporium asterum*	*Vernonia*	USA
23-Sep-09	TAR140	-	-	-	-	-	*Uromyces*	*Chamaesyce nutans*	USA
29-Sep-09	TAR142	-	-	-	-	-	*Puccinia*	*Euphorbia heterophyll*	USA
29-Sep-09	TAR145	-	-	-	-	-	*Cerotelium fici*	*Ficus* sp.	USA
30-Sep-09	TAR147	-	-	-	-	-	*Puccinia*	UNK	USA
2-Oct-09	TAR149	-	-	-	-	-	*Puccinia*	*Ruellia nudata*	USA
30-Sep-09	TAR150	-	-	-	-	-	*Uromyces* sp.	*Phyllanthus carolinensis*	USA
30-Sep-09	TAR151	-	-	-	-	-	*Uromyces trifolina*	*Trifolium repens*	USA
2-Oct-09	TAR152	-	-	-	-	-	UNK	*Senna obtusifolia*	USA
2-Oct-09	TAR153	-	-	-	-	-	UNK	*Mikania scandens*	USA
2-Oct-09	TAR154	-	-	-	-	-	UNK	*Mikania scandens*	USA
1-Oct-09	TAR155	-	-	-	-	-	*Uromyces?*	*Vigna unguiculata*	USA
29-Sep-09	TAR156	-	-	-	-	-	UNK	*Chamaesyce*	USA
27-Sep-09	TAR157	-	-	-	-	-	*Phakopsora pachyrizi*	*Glycine max*	USA
25-Sep-09	TAR158	-	-	-	-	-	*Phakopsora pachyrizi*	*Glycine max*	USA
28-Sep-09	TAR159	-	-	-	-	-	*Phakopsora pachyrizi*	*Glycine max*	USA
1-Oct-09	TAR160	-	-	-	-	-	*Phakopsora pachyrizi*	*Kudzu*	USA
1-Oct-09	TAR161	-	-	-	-	-	*Phakopsora pachyrizi*	*Kudzu*	USA
1-Oct-09	TAR162	-	-	-	-	-	*Phakopsora pachyrizi*	*Kudzu*	USA
1-Oct-09	TAR163	-	-	-	-	-	*Phakopsora pachyrizi*	*Kudzu*	USA
30-Sep-09	TAR164	-	-	-	-	-	*Phakopsora pachyrizi*	*Glycine max*	USA

(**Table A-1.** Continued.)

Date	Collection Number	Larvae (+/-)	Larval Sample #	28S Sequence (Y/N) & BLAST ID	COI Sequence (Y/N) & BLAST ID	Supported Clades by tree (28S\COI\Concat.)	Rust Identification	Host Identification	Country
1-Oct-09	TAR165	-	-	-	-	-	UNK	*Quercus alba*	USA
7-Oct-09	TAR169	-	-	-	-	-	*Phakopsora pachyrizi*	*Kudzu*	USA
7-Oct-09	TAR170	-	-	-	-	-	*Phakopsora pachyrizi*	*Kudzu*	USA
23-Sep-09	TAR171	-	-	-	-	-	*Coleosporium solidago*	*Solidago altissima*	USA
10-Oct-09	TAR172	-	-	-	-	-	*Phakopsora pachyrizi*	*Glycine max*	USA
10-Oct-09	TAR173	-	-	-	-	-	UNK	*Chamaesyce* sp.	USA
11-Oct-09	TAR174	-	-	-	-	-	UNK	*Chamaesyce* sp.	USA
11-Oct-09	TAR175	-	-	-	-	-	UNK	*Prunus serotina*	USA
16-Oct-09	TAR176	-	-	-	-	-	*Coleosporium pumalarium*	*Magnolia solangiana*	USA
1-Mar-10	TAR181	-	-	-	-	-	*Puccinia salvina*	*Lamium amplexicalue*	USA
1-Mar-10	TAR182	-	-	-	-	-	UNK	*Modiola caroliniana*	USA
27-May-10	TAR183	-	-	-	-	-	UNK	*Veronica altissima*	USA
27-May-10	TAR185	-	-	-	-	-	UNK	*Juncus sp*	USA
27-May-10	TAR186	-	-	-	-	-	UNK	*Juncus sp*	USA
27-May-10	TAR187	-	-	-	-	-	*Puccinia* sp.	Poaceae	USA
12-Oct-09	TAR190	-	-	-	-	-	*Phakopsora pachyrizi*	*Glycine max*	USA
13-Oct-09	TAR191	-	-	-	-	-	*Phakopsora pachyrizi*	*Glycine max*	USA
19-Oct-09	TAR194	-	-	-	-	-	*Puccinia* sp.	*Cyperus esculentus*	USA
19-Oct-09	TAR195	-	-	-	-	-	*Puccinia* sp.	*Paspalum urvillei*	USA
25-Oct-09	TAR196	-	-	-	-	-	*Puccinia polysora*	*Setaria pumila*	USA
UNK	TAR197	-	-	-	-	-	UNK	*Plumeria* sp.	USA
UNK	TAR199	-	-	-	-	-	*Puccinia hemacalus*	*Day lily*	USA
19-Oct-09	TAR200	-	-	-	-	-	*Puccinia*	*Paspalum urvillei*	USA
8-Nov-09	TAR201	-	-	-	-	-	*Coleosporium* sp.	*Solidago* sp.	USA
17-Nov-10	TAR202	-	-	-	-	-	UNK	*Hibiscus syriacus*	USA
10-May-10	TAR204	-	-	-	-	-	*Uromyces stratis*	*Medicago*	USA
31-Mar-10	TAR205	-	-	-	-	-	*Puccinia*	*Anagallis arvensis*	USA
27-Mar-10	TAR206	-	-	-	-	-	UNK	*Ruellia* sp.	USA
27-Apr-10	TAR207	-	-	-	-	-	UNK	*Juncus dichotomus*	USA
17-May-10	TAR208	-	-	-	-	-	*Uromyces straiatus*	*Medicago lupulina*	USA
17-May-10	TAR209	-	-	-	-	-	UNK	*Crotalaria pumila*	USA
UNK	TAR210	-	-	-	-	-	UNK	*Juncus effusus*	USA
UNK	TAR211	-	-	-	-	-	UNK	*Juncus effusus*	USA
11-Apr-11	TAR250	-	-	-	-	-	UNK	UNK	USA
2-Jul-06	U-1000	-	-	-	-	-	UNK	*Chondrilla juncea*	Spain

(**Table A-1.** Continued.)

Date	Collection Number	Larvae (+/-)	Larval Sample #	28S Sequence (Y/N) & BLAST ID	COI Sequence (Y/N) & BLAST ID	Supported Clades by tree (28S\COI\Concat.)	Rust Identification	Host Identification	Country
9-Jun-03	U-1011	-	-	-	-	-	*Tranzschelia fusca*	*Anemone quinquefolia*	USA
8-Jun-03	U-1012	-	-	-	-	-	*Tranzschelia fusca*	*Anemone quinquefolia*	USA
30-May-04	U-1013	-	-	-	-	-	*Tranzschelia fusca*	*Anemone quinquefolia*	UNK
7-Jan-15	U-1014	-	-	-	-	-	*Tranzschelia pruni-spinosae*	*Prunus* sp.	Guatemala
8-Jun-03	U-1015	-	-	-	-	-	*Tranzschelia pruni-spinosae*	*Anemone quinquefolia*	USA
1-May	U-1016	-	-	-	-	-	*Tranzschelia pruni-spinosae*	*Anemone quinquefolia*	USA
15-Sep-02	U-1017	-	-	-	-	-	*Tranzschelia pruni-spinosae*	*P. pensylvanica*	USA
4-Jun-03	U-1018	-	-	-	-	-	*Tranzschelia pruni-spinosae*	*Anemone quinquefolia*	USA
9-Jun-03	U-1019	-	-	-	-	-	*Tranzschelia pruni-spinosae*	*Anemone quinquefolia*	USA
1-Aug-76	U-1020	-	-	-	-	-	*Cerradoa palmaea*	*Attalea ceraensis*	Brazil
1-Sep-05	U-1021	-	-	-	-	-	*Uredo scabies*	*Vanilla planifolia*	Guatemala
25-Jul-03	U-1022	-	-	-	-	-	*Nyssopsora echinata*	*Meum athamanticum*	Germany
3-Jun-05	U-1023	-	-	-	-	-	*Uromyces aecidiiformis*	*Lilium candidum*	Germany
18-May-05	U-1024	-	-	-	-	-	*Uromyces ambiguus*	*Allium sphaerocephalon*	Germany
16-Jun-05	U-1025	-	-	-	-	-	*Uromyces dactylidis*	*Dactylis glomerata*	Germany
20-Apr-06	U-1026	-	-	-	-	-	*Uromyces ficariae*	*Ranunculus ficaria*	Germany
13-Apr-05	U-1027	-	-	-	-	-	*Uromyces ficariae*	*Ranunculus ficaria*	Germany
21-Apr-06	U-1028	-	-	-	-	-	*Uromyces ficariae*	*Ranunculus ficaria*	Germany
26-Apr-03	U-1029	-	-	-	-	-	*Uromyces gageae*	*Gagea lutea*	Germany
31-Oct-03	U-103	-	-	-	-	-	UNK	*Dichostenma glaucescens*	Cameroon
21-Apr-06	U-1030	-	-	-	-	-	*Uromyces muscari*	*Muscari neglectum*	Germany
30-Sep-04	U-1031	-	-	-	-	-	*Uromyces polygoni*	*Fallopia dumetorum*	Germany
20-Apr-04	U-1032	-	-	-	-	-	*Uromyces poae*	*Ranunculus ficaria*	Germany
30-Sep-04	U-1033	-	-	-	-	-	*Uromyces rumicis*	*Rumex obtusifolius*	Germany
26-Jul-03	U-1034	-	-	-	-	-	*Uromyces silphii*	*Juncus tenuis*	Germany
13-Jun-86	U-1035	-	-	-	-	-	*Ochropsora ariae*	*Anemone rivularis*	China
20-Apr-06	U-1036	-	-	-	-	-	*Ochropsora ariae*	*Anemone nemorosa*	Germany

(**Table A-1.** Continued.)

Date	Collection Number	Larvae (+/-)	Larval Sample #	28S Sequence (Y/N) & BLAST ID	COI Sequence (Y/N) & BLAST ID	Supported Clades by tree (28S\COI\Concat.)	Rust Identification	Host Identification	Country
14-Sep-96	U-1037	-	-	-	-	-	*Tranzschelia pruni-spinosae*	*Prunus spinosa*	Germany
26-Sep-92	U-1038	-	-	-	-	-	*Tranzschelia pruni-spinosae*	*Prunus spinosa*	Germany
20-Apr-06	U-1039	-	-	-	-	-	*Tranzschelia anemones*	*Anemone nemorosa*	Germany
30-Oct-03	U-104	-	-	-	-	-	*Aecidium?*	*Diospyros gabonensis*	Cameroon
12-Sep-64	U-1040	-	-	-	-	-	*Tranzschelia asiatica*	*Prunus grayana*	Japan
17-Jul-92	U-1041	-	-	-	-	-	*Tranzschelia asiatica*	*Prunus grayana*	Japan
9-Jul-92	U-1042	-	-	-	-	-	*Tranzschelia asiatica*	*Prunus grayana*	Japan
18-Sep-92	U-1043	-	-	-	-	-	*Tranzschelia asiatica*	*Prunus grayana*	Japan
1-Oct-93	U-1044	-	-	-	-	-	*Tranzschelia asiatica*	*Prunus grayana*	Japan
17-May-86	U-1045	-	-	-	-	-	*Tranzschelia pulsatillae*	*Pulsatilla chinensis*	China
10-Jun-80	U-1046	-	-	-	-	-	*Tranzschelia pulsatillae*	*Pulsatilla* sp.	China
14-Jun-75	U-1047	-	-	-	-	-	*Tranzschelia* sp.	*Pulsatilla chinensis*	China
18-Oct-98	U-1048	-	-	-	-	-	*Tranzschelia* sp.	*Prunus salicina*	China
1-Sep-05	U-1050	-	-	-	-	-	*Olivea tectonea*	*Tectona grandis*	Guatemala
18-Jul-06	U-1057	-	-	-	-	-	*Puccinia* sp. Nov.	*Berkheya bipinnatifida* ssp. *Bipinnatifida*	South Africa
20-Mar-06	U-1058	-	-	-	-	-	*Puccinia* sp. Nov.	*Berkheya bipinnatifida* ssp. *Bipinnatifida*	South Africa
4-Sep-06	U-1064	-	-	-	-	-	*Coleosporium*	*Solidago*	USA
UNK	U-1069	-	-	-	-	-	UNK	Fabaceae	Portugal
31-Aug-06	U-1109	-	-	-	-	-	*Melampsora*	*Salix* cf. *discolor*	USA
14-Sep-06	U-1113	-	-	-	-	-	*Coleosporium*	*Plumeria rubra*	India
19-Dec-01	U-1116	-	-	-	-	-	*Maravalia ichinocarpi*	*Ichnocarpus frutescens*	India
7-Feb-04	U-1117	-	-	-	-	-	*Aecidium meliosmae-myrianthe*	*Meliosma symplicifolia*	India
7-Feb-04	U-1118	-	-	-	-	-	*Aecidium* sp.	*Meliosma pinnata*	India
UNK	U-1119	-	-	-	-	-	*Aecidium mori*	*Morus alba*	India
4-Feb-04	U-1120	-	-	-	-	-	*Aecidium* sp.	*Pavetta indica*	India
30-Aug-06	U-1121	-	-	-	-	-	UNK	*Canthium angustifolium*	India
25-Feb-04	U-1122	-	-	-	-	-	*Cerotelium* sp.	*Flacourtia montana*	India
25-Feb-04	U-1123	-	-	-	-	-	*Cerotelium* sp.	*Flacourtia indica*	India
25-Feb-04	U-1124	-	-	-	-	-	*Cerotelium* sp.	*Flacourtia indica*	India
25-May-04	U-1125	-	-	-	-	-	*Uredo* sp.	*Terminalia chebula*	India

(**Table A-1.** Continued.)

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26-Feb-04	U-1126	-	-	-	-	-	*Uredo* sp.	*Heritiera papilio*	India
7-Feb-04	U-1127	-	-	-	-	-	*Uredo* sp.	*Salacia fruiticosa*	India
7-Feb-04	U-1128	-	-	-	-	-	UNK	*Hedyotis wynadensis*	India
7-Feb-04	U-1129	-	-	-	-	-	*Puccinia* sp.	*Jasminum anguistifolium*	India
4-Feb-04	U-1130	-	-	-	-	-	*Puccinia* sp.	*Justicia gendarussa*	India
7-Feb-04	U-1131	-	-	-	-	-	*Puccinia* sp.	*Persicaria chinensis*	India
12-Oct-04	U-1132	-	-	-	-	-	*Puccinia* sp.	*Plectranthus malabaricus*	India
4-Feb-04	U-1133	-	-	-	-	-	UNK	*Persea macrantha*	India
15-May-03	U-1134	-	-	-	-	-	*Ravenalia emblicae*	*Phyllanthus emblica*	India
20-Dec-01	U-1135	-	-	-	-	-	*Ravenelia* sp.	*Phyllanthus emblica*	India
13-Sep-06	U-1136	-	-	-	-	-	*Uredo* sp.	*Phyllanthus emblica*	India
5-Jul-04	U-1137	-	-	-	-	-	*Uromyces* sp.	*Xylia xylocarpa*	India
7-Feb-04	U-1138	-	-	-	-	-	*Aecidium* sp.	*Strobilanthes ciliatus*	India
26-Feb-04	U-1139	-	-	-	-	-	*Aecidium* sp.	*Strobilanthes luridis*	India
7-Feb-04	U-1140	-	-	-	-	-	*Ravenelia* sp.	*Premna tomentosa*	India
29-Jun-02	U-1142	-	-	-	-	-	UNK	*Hopea parviflora*	India
4-Feb-04	U-1143	-	-	-	-	-	*Aecidium* sp.	*Pavetta tomentosa*	India
9-Dec-01	U-1144	-	-	-	-	-	UNK	*Hopea parviflora*	India
25-Feb-04	U-1145	-	-	-	-	-	*Cerotelium* sp.	*Flacourtia* sp.	India
8-Jan-03	U-1146	-	-	-	-	-	UNK	*Strobilanthes*	India
15-May-06	U-1165	-	-	-	-	-	UNK	*Rosa* sp.	USA
UNK	U-1166	-	-	-	-	-	UNK	UNK	USA
13-May-06	U-1167	-	-	-	-	-	UNK	*Rosa* sp.	Canada
14-Nov-06	U-1188	-	-	-	-	-	UNK	*Athyrium filix-femina*	USA
14-Nov-06	U-1189	-	-	-	-	-	UNK	*Athyrium filix-femina*	USA
2-Nov-06	U-1193	-	-	-	-	-	*Melampsora*	*Salix* sp.	USA
11-Dec-06	U-1194	-	-	-	-	-	UNK	*Rubus*	USA
14-Sep-06	U-1208	-	-	-	-	-	UNK	*Aster occidentalis*	USA
12-Aug-06	U-1209	-	-	-	-	-	UNK	*Aster laevis*	USA
24-Jul-06	U-1210	-	-	-	-	-	UNK	*Saxifraga arguta*	USA
13-Aug-06	U-1211	-	-	-	-	-	UNK	*Rosa woodsii*	USA
26-Jul-06	U-1213	-	-	-	-	-	UNK	*Thalictrum occidentale*	USA
26-Jul-06	U-1214	-	-	-	-	-	UNK	*Agoseris aurantiaca*	USA
23-Jul-06	U-1215	-	-	-	-	-	UNK	*Senecio integerrimus*	USA

(**Table A-1.** Continued.)

Date	Collection Number	Larvae (+/-)	Larval Sample #	28S Sequence (Y/N) & BLAST ID	COI Sequence (Y/N) & BLAST ID	Supported Clades by tree (28S\COI\Concat.)	Rust Identification	Host Identification	Country
13-Aug-06	U-1217	-	-	-	-	-	UNK	*Shepherdia canadensis*	USA
UNK	U-1223	-	-	-	-	-	*Gymnosporangium*	UNK	France
Oct-06	U-1224	-	-	-	-	-	*Gymnosporangium*	UNK	France
UNK	U-1229	-	-	-	-	-	*Melampsora*	*Salix*	USA
UNK	U-1230	-	-	-	-	-	*Melampsora*	*Salix discolor*	USA
UNK	U-1231	-	-	-	-	-	*Melampsora*	*Salix laevigata*	USA
UNK	U-1232	-	-	-	-	-	*Melampsora*	*Salix negra*	USA
UNK	U-1233	-	-	-	-	-	*Melampsora*	*Salix exigua*	USA
UNK	U-1234	-	-	-	-	-	*Melampsora*	*Salix laevigata*	USA
21-Oct-88	U-1236	-	-	-	-	-	*Puccinia salicis-tetraspermae*	*Salix tetraspermae*	Pakistan
20-Aug-90	U-1237	-	-	-	-	-	*Puccinia saussureae-lappae*	*Saussurea lappa*	Pakistan
Aug-64	U-1238	-	-	-	-	-	*Puccinia inulae-acuminata*	*Inula acuminata*	UNK
14-Jul-03	U-1239	-	-	-	-	-	*Puccinia strobilanthis-urticifoliae*	*Strobilanthes urticifolia*	Pakistan
9-Mar-07	U-1243	-	-	-	-	-	UNK	*Rosa* sp.	Spain
11-Mar-07	U-1244	-	-	-	-	-	UNK	*Rosa* sp.	Spain
13-Mar-07	U-1245	-	-	-	-	-	UNK	*Juniperus oxycedrus*	Spain
20-Mar-07	U-1246	-	-	-	-	-	UNK	*Bromus diandrus*	Spain
20-Mar-07	U-1247	-	-	-	-	-	UNK	*Rosa* sp.	Spain
25-Mar-07	U-1248	-	-	-	-	-	UNK	*Mercurialis ambigua*	Spain
24-Mar-07	U-1249	-	-	-	-	-	UNK	*Juniperus oxycedrus*	Spain
25-Mar-07	U-1250	-	-	-	-	-	UNK	*Poa annua*	Spain
8-Apr-07	U-1251	-	-	-	-	-	UNK	*Allium ampeloprasum* var. *parrum*	Spain
8-Apr-07	U-1252	-	-	-	-	-	UNK	*Allium sativum*	Spain
8-Apr-07	U-1253	-	-	-	-	-	UNK	*Mercuriales ambigua*	Spain
14-Apr-07	U-1254	-	-	-	-	-	UNK	*Avena barbata*	Spain
15-Apr-07	U-1255	-	-	-	-	-	UNK	*Dactylis glomerata* var. *hispanica*	Spain
15-Apr-07	U-1256	-	-	-	-	-	UNK	*Smyrnium olustratum*	Spain
22-Apr-07	U-1257	-	-	-	-	-	UNK	*Malva nicaeensis*	Spain
17-Apr-07	U-1258	-	-	-	-	-	UNK	*Alcea rosae*	Spain
22-Apr-07	U-1259	-	-	-	-	-	UNK	*Muscari comosum*	Spain

(**Table A-1.** Continued.)

Date	Collection Number	Larvae (+/-)	Larval Sample #	28S Sequence (Y/N) & BLAST ID	COI Sequence (Y/N) & BLAST ID	Supported Clades by tree (28S\COI\Concat.)	Rust Identification	Host Identification	Country
24-Apr-07	U-1260	-	-	-	-	-	*Uromyces viciae-fabae*	*Vicia lutea* subsp. *Vestita*	Spain
24-Apr-07	U-1261	-	-	-	-	-	*Puccinia*	*Elymus repens*	Spain
27-Apr-07	U-1262	-	-	-	-	-	*Puccinia allii*	*Allium ampeloprasum* var. *parrum*	Spain
22-May-07	U-1263	-	-	-	-	-	*Puccinia*	*Actaea racemosa*	USA
20-Mar-07	U-1265	-	-	-	-	-	*Puccinia mariae-wilsoniae*	*Claytonia caroliniana*	USA
6-May-07	U-1266	-	-	-	-	-	UNK	*Xanthorhiza simplicissima*	USA
6-May-07	U-1267	-	-	-	-	-	*Aecidium hydnoideum*	*Dirca palustris*	USA
15-May-07	U-1269	-	-	-	-	-	*Melampsora*	*Salix babylonica*	USA
UNK	U-1270	-	-	-	-	-	*Puccinia heucherae*	UNK	UNK
UNK	U-1274	-	-	-	-	-	UNK	*Pistacia therebiutus*	Spain
UNK	U-1275	-	-	-	-	-	UNK	*Pistacia therebiutus*	Spain
UNK	U-1276	-	-	-	-	-	*Uromyces eragrostidis*	*Eragrostis tef*	UNK
UNK	U-1277	-	-	-	-	-	*Puccinia malvacearum*	*Malva neglecta*	UNK
UNK	U-1278	-	-	-	-	-	*Puccinia graminis*	*Poa pratensis*	UNK
UNK	U-1279	-	-	-	-	-	*Puccinia similis*	*Salvia* sp.	UNK
27-Dec-06	U-1280	-	-	-	-	-	*Uromyces*	*Cyperus albostriatus*	South Africa
5-Jun-06	U-1281	-	-	-	-	-	*Uromyces*	*Cyperus albostriatus*	South Africa
UNK	U-1282	-	-	-	-	-	UNK	UNK	UNK
UNK	U-1283	-	-	-	-	-	UNK	UNK	UNK
4-Aug-07	U-1284	-	-	-	-	-	UNK	*Pinus contorta*	USA
23-Jun-07	U-1285	-	-	-	-	-	UNK	*Allium cepa*	USA
22-Jul-07	U-1286	-	-	-	-	-	UNK	*Arctostaphylos uva-ursi*	USA
8-Sep-07	U-1288	-	-	-	-	-	*Melampsora*	*Populus tremuloides*	USA
10-Jul-07	U-1289	-	-	-	-	-	UNK	*Trifolium pratense*	USA
17-Jun-07	U-1290	-	-	-	-	-	UNK	*Clematis ligusticifolia*	USA
2-Oct-91	U-1291	-	-	-	-	-	*Gymnosporangium clavariaeforme*	*Cotoneaster* sp.	Pakistan
30-Nov-07	U-1292	-	-	-	-	-	*Ceratocoma jacksoniae*	Fabaceae	Australia
27-Nov-07	U-1293	-	-	-	-	-	*Puccinia boroniae*	*Chorilaena quercifolia*	Australia
27-Nov-07	U-1294	-	-	-	-	-	*Uredo spyridii*	*Trymalium floribundum*	Australia
27-Nov-07	U-1295	-	-	-	-	-	*Uredo spyridii?*	*Spyridium globulosum*	Australia

(**Table A-1.** Continued.)

Date	Collection Number	Larvae (+/-)	Larval Sample #	28S Sequence (Y/N) & BLAST ID	COI Sequence (Y/N) & BLAST ID	Supported Clades by tree (28S\COI\Concat.)	Rust Identification	Host Identification	Country
15-Aug-07	U-1296	-	-	-	-	-	*Aecidium* sp.	*Ageratina* sp.	Mexico
17-Aug-07	U-1298	-	-	-	-	-	*Aecidium* sp.	*Ageratina* sp.	Mexico
16-Aug-07	U-1299	-	-	-	-	-	*Baeodromus eupatorii*	*Ageratina* sp.	Mexico
28-Mar-72	U-1300	-	-	-	-	-	*Gymnosporangium cumminsii*	*Juniperus coahuilensis*	Mexico
18-Apr-74	U-1301	-	-	-	-	-	*Gymnosporangium cumminsii*	*Juniperus flaceida*	Mexico
11-Jun-07	U-1303	-	-	-	-	-	*Gymnosporangium clavariiforme*	*Juniperus communis*	USA
21-May-06	U-1304	-	-	-	-	-	*Gymnosporangium clavariiforme*	*Juniperus communis*	USA
3-Jun-05	U-1305	-	-	-	-	-	*Gymnosporangium clavariiforme*	*Juniperus communis*	USA
8-Apr-08	U-1307	-	-	-	-	-	*Gymnosporangium floriforme*	*Juniperus virginiana*	USA
9-Apr-08	U-1308	-	-	-	-	-	*Gymnosporangium floriforme*	*Juniperus virginiana*	USA
UNK	U-1309	-	-	-	-	-	*Gymnosporangium clavariiforme*	UNK	France
24-May-01	U-131	-	-	-	-	-	*Puccinia*	*Carduus pycnocephalus*	Syria
	U-1310	-	-	-	-	-	*Gymnosporangium*	UNK	France
UNK	U-1311	-	-	-	-	-	*Gymnosporangium*	*Juniperus oxycedrus*	France
27-Apr-04	U-1312	-	-	-	-	-	*Gymnosporangium exiguum*	*Malus pumila*	USA
16-Apr-08	U-1313	-	-	-	-	-	*Gymnosporangium kernianum*	*Juniperus deppeana*	USA
20-Jul-04	U-1314	-	-	-	-	-	*Gymnosporangium exiguum*	*Juniperus deppeana*	USA
13-May-04	U-1315	-	-	-	-	-	*Gymnosporangium kernianum*	*Juniperus deppeana*	USA
4-Oct-05	U-1316	-	-	-	-	-	*Gymnosporangium exiguum*	*Juniperus deppeana*	USA
20-Jun-04	U-1317	-	-	-	-	-	*Gymnosporangium exiguum*	*Juniperus monosperma*	USA
2-May-99	U-1318	-	-	-	-	-	*Gymnosporangium exiguum*	*Juniperus deppeana*	USA

(**Table A-1.** Continued.)

Date	Collection Number	Larvae (+/-)	Larval Sample #	28S Sequence (Y/N) & BLAST ID	COI Sequence (Y/N) & BLAST ID	Supported Clades by tree (28S\COI\Concat.)	Rust Identification	Host Identification	Country
3-May-99	U-1319	-	-	-	-	-	*Gymnosporangium kernianum*	*Juniperus deppeana*	USA
10-May-99	U-1320	-	-	-	-	-	*Gymnosporangium kernianum*	*Juniperus occidentalis*	USA
21-Apr-05	U-1321	-	-	-	-	-	*Gymnosporangium kernianum*	*Juniperus deppeana*	USA
11-Apr-08	U-1322	-	-	-	-	-	*Gymnosporangium exiguum*	*Juniperus ashei*	USA
3-Sep-95	U-1323	-	-	-	-	-	*Gymnosporandium kernianum*	*Juniperus scopulorum*	USA
14-Apr-95	U-1324	-	-	-	-	-	*Gymnosporangium exiguum*	*Juniperus californica*	USA
19-Jun-04	U-1325	-	-	-	-	-	*Gymnosporangium kernianum*	*Juniperus californica*	USA
7-Jun-05	U-1326	-	-	-	-	-	*Gymnosporangium kernianum*	*Juniperus deppeana*	USA
6-Jun-05	U-1327	-	-	-	-	-	*Gymnosporangium exiguum*	*Juniperus deppeana*	USA
24-Apr-95	U-1328	-	-	-	-	-	*Gymnosporangium kernianum*	*Juniperus occidentalis*	USA
28-Jun-75	U-1329	-	-	-	-	-	*Gymnosporangium exiguum*	*Crataegus crus-galli*	USA
3-Oct-05	U-1330	-	-	-	-	-	*Gymnosporangium vauqueliniae*	*Vauquelinia californica*	USA
26-Apr-95	U-1331	-	-	-	-	-	*Gymnosporangium kernianum*	*Juniperus osteosperma*	USA
May-08	U-1332	-	-	-	-	-	*Gymnosporangium*	*Juniperus virginiana*	USA
19-Jun-08	U-1334	-	-	-	-	-	*Puccinia*	*Tabernaemontana*	Puerto Rico
23-Jul-06	U-1335	-	-	-	-	-	*Gymnosporangium clavariiforme*	*Amelanchier almifolia*	USA
18-Apr-74	U-1336	-	-	-	-	-	*Gymnosporangium cumminsii*	*Juniperus flaceida*	Mexico
18-Apr-74	U-1337	-	-	-	-	-	*Gymnosporangium cumminsii*	*Juniperus flaceida*	Mexico
23-Jun-74	U-1339	-	-	-	-	-	*Gymnosporangium*	*Juniperus deppeana*	Mexico

(**Table A-1.** Continued.)

Date	Collection Number	Larvae (+/-)	Larval Sample #	28S Sequence (Y/N) & BLAST ID	COI Sequence (Y/N) & BLAST ID	Supported Clades by tree (28S\COI\Concat.)	Rust Identification	Host Identification	Country
28-Mar-72	U-1340	-	-	-	-	-	*Gymnosporangium cumminsii*	*Juniperus coahuilensis*	Mexico
10-Jul-68	U-1341	-	-	-	-	-	*Gymnosporangium cumminsii*	*Malacomeles denticulata*	Mexico
9-Feb-08	U-1342	-	-	-	-	-	*Puccinia popowiae*	*Hexalobus monopetalus*	South Africa
27-May-08	U-1343	-	-	-	-	-	*Coleosporium ipomoea*	*Hewittia malabarica*	South Africa
29-May-08	U-1344	-	-	-	-	-	*Crossopora antidesimae*	*Antidesma venosum*	South Africa
9-Feb-08	U-1346	-	-	-	-	-	*Maravalia lonchocarpi*	*Lonchocarpus capassa*	South Africa
27-May-08	U-1347	-	-	-	-	-	*Phakopsora stratosa*	*Croton sylvaticus*	South Africa
29-May-08	U-1348	-	-	-	-	-	*Puccinia batatas*	*Ipomoea mauritiana*	South Africa
29-May-08	U-1349	-	-	-	-	-	*Puccinia krausiana*	*Smilax anceps*	South Africa
27-May-08	U-1350	-	-	-	-	-	*Puccinia dissotidis*	*Dissotis* sp.	South Africa
27-May-08	U-1351	-	-	-	-	-	*Uredo combreticola*	*Combretum*	South Africa
28-May-08	U-1352	-	-	-	-	-	*Aecidium garckeanum*	*Hibiscus cannabinus*	South Africa
29-May-08	U-1353	-	-	-	-	-	*Diorchidium woodii*	*Milletia grandis*	South Africa
10-Aug-08	U-1354	-	-	-	-	-	*Puccinia dampierae*	*Dampiera linearis*	Australia
10-Aug-08	U-1355	-	-	-	-	-	*Ceratocoma jacksoniae*	*Gastrolobium villosum*	Australia
8-Aug-08	U-1356	-	-	-	-	-	*Ceratocoma jacksoniae*	*Jacksonia horrida*	Australia
8-Aug-08	U-1357	-	-	-	-	-	*Uredo spyridii*	*Spyridium globulosum*	Australia
30-Jul-08	U-1359	-	-	-	-	-	*Ceratocoma jacksoniae*	UNK	Australia
4-Aug-08	U-1360	-	-	-	-	-	*Puccinia pritzeliana*	*Tremandra stelligera*	Australia
3-Aug-08	U-1361	-	-	-	-	-	*Puccinia* sp. Nov.	*Chorilaena quercifolia*	Australia
3-Aug-08	U-1362	-	-	-	-	-	*Uredo spyridii*	*Trymalium floribundum*	Australia
16-Sep-08	U-1363	-	-	-	-	-	*Cerotelium*	UNK	Equador
27-Jul-08	U-1364	-	-	-	-	-	*Uredopeltis chevalieri*	*Grewia hexamita*	South Africa
27-Jul-08	U-1365	-	-	-	-	-	*Masseeella flueggeae*	*Flueggea virosa*	South Africa
27-Jul-08	U-1366	-	-	-	-	-	*Maravalia lonchocarpi*	*Philenoptera violacea*	South Africa

(**Table A-1.** Continued.)

Date	Collection Number	Larvae (+/-)	Larval Sample #	28S Sequence (Y/N) & BLAST ID	COI Sequence (Y/N) & BLAST ID	Supported Clades by tree (28S\COI\Concat.)	Rust Identification	Host Identification	Country
26-Jul-08	U-1367	-	-	-	-	-	*Crossopsora ziziphi*	*Ziziphus mucronata*	South Africa
27-Jul-08	U-1368	-	-	-	-	-	*Phakopsora ziziphi-vulgaris*	*Ziziphus mucronata*	South Africa
27-Jul-08	U-1369	-	-	-	-	-	*Phakopsora*	*Combretum apiculatum*	South Africa
22-May-01	U-137	-	-	-	-	-	UNK	*Echinops gaillarodotii*	Syria
27-Jul-08	U-1370	-	-	-	-	-	*Uredo combreticola*	*Combretum hereroense*	South Africa
26-Jul-08	U-1371	-	-	-	-	-	*Uredopeltis*	*Grewia flavescens*	South Africa
27-Jul-08	U-1372	-	-	-	-	-	*Uredopeltis chevalieri*	*Grewia monticola*	South Africa
13-Oct-08	U-1373	-	-	-	-	-	*Uromyces*	*Pisum*	USA
Jul-08	U-1374	-	-	-	-	-	*Puccinia malvacearum*	Malvaceae	USA
30-Sep-08	U-1375	-	-	-	-	-	UNK	*Crateagus monogyna* var. *brevispina*	Spain
30-Sep-08	U-1376	-	-	-	-	-	UNK	*Pistacia therebiutus*	Spain
24-Oct-08	U-1377	-	-	-	-	-	UNK	*Populus alba*	Spain
27-Nov-08	U-1378	-	-	-	-	-	UNK	*Malva* sp.	Morocco
2-Nov-08	U-1379	-	-	-	-	-	UNK	*Pistacia therebinthus*	Spain
6-Jul-08	U-1380	-	-	-	-	-	*Cronartium*	*Pinus albicaulis*	USA
6-Jul-08	U-1382	-	-	-	-	-	UNK	*Osmorhiza occidentalis*	USA
Apr-09	U-1383	-	-	-	-	-	*Puccinia*	*Sphaeralcea grossulariae*	USA
Apr-09	U-1384	-	-	-	-	-	*Puccinia malvacearum*	*Alcea*	USA
Apr-09	U-1385	-	-	-	-	-	UNK	*Poa* sp.	USA
18-Oct-08	U-1388	-	-	-	-	-	*Baeodromus eupatorii*	*Ageratina* sp.	Mexico
18-Oct-08	U-1389	-	-	-	-	-	*Goplana*	Asteraceae	Mexico
15-Oct-08	U-1392	-	-	-	-	-	*Aecidium* sp.	*Ageratina*	Mexico
7-Oct-08	U-1393	-	-	-	-	-	*Prospodium appendiculatum*	*Tecoma staus* var. *staus*	Mexico
7-Oct-08	U-1394	-	-	-	-	-	*Prospodium appendiculatum*	*Tecoma staus* var. *staus*	Mexico
19-Oct-08	U-1395	-	-	-	-	-	*Prospodium appendiculatum*	*Tecoma staus* (var. *molle?)*	Mexico
11-Oct-08	U-1396	-	-	-	-	-	*Prospodium appendiculatum*	*Tecoma staus* var. *staus*	Mexico

(**Table A-1.** Continued.)

Date	Collection Number	Larvae (+/-)	Larval Sample #	28S Sequence (Y/N) & BLAST ID	COI Sequence (Y/N) & BLAST ID	Supported Clades by tree (28S\COI\Concat.)	Rust Identification	Host Identification	Country
30-Nov-08	U-1397	-	-	-	-	-	*Aecidium* sp.	*Gomphocarpus fruticosus*	South Africa
23-Apr-09	U-1400	-	-	-	-	-	*Uredo otholobii*	*Otholobium hirtum*	South Africa
19-Aug-07	U-1401	-	-	-	-	-	*Prospodium transformans*	*Tecoma staus*	Mexico
UNK	U-1402	-	-	-	-	-	*Prospodium transformans*	*Tecoma staus*	Mexico
UNK	U-1403	-	-	-	-	-	*Pea Rust*	*Pisum*	India
UNK	U-1404	-	-	-	-	-	*Pea Rust*	*Pisum*	India
UNK	U-1405	-	-	-	-	-	UNK	UNK	India
UNK	U-1406	-	-	-	-	-	UNK	*Digitaria*	India
UNK	U-1407	-	-	-	-	-	*Lentil Rust*	*Lens culinaris*	India
May-09	U-1408	-	-	-	-	-	*Puccinia jonesii*	*Lomatium dissectum*	USA
8-Jun-09	U-1409	-	-	-	-	-	*Puccinia jonesii?*	*Lomatium dissectum*	USA
10-Jun-09	U-1410	-	-	-	-	-	*Puccinia*	*Lygodium japonicum*	USA
10-Jun-09	U-1411	-	-	-	-	-	*Puccinia*	*Lygodium japonicum*	USA
May-09	U-1412	-	-	-	-	-	*Cronartium*	UNK	USA
12-Jun-09	U-1413	-	-	-	-	-	*Puccinia lygodii*	UNK	USA
13-Jun-09	U-1414	-	-	-	-	-	*Puccinia lygodii*	*Lygodium japonicum*	USA
8-Jul-09	U-1415	-	-	-	-	-	*Puccinia similis*	*Artemisia tridentata*	USA
1-Jun-08	U-1416	-	-	-	-	-	*Uromyces eragrostidis*	*Eragrostis*	USA
1-Jun-08	U-1417	-	-	-	-	-	*Puccinia*	*Poa pratensis*	USA
7-Jul-09	U-1418	-	-	-	-	-	*Uromyces intucatus*	*Eriogonum umbellatum*	USA
14-Aug-09	U-1419	-	-	-	-	-	*Phragmidium*	*Rosa woodsii*	USA
year 1985	U-1422	-	-	-	-	-	*Puccinia herici*	*Taraxacum officinale*	USA
Oct-87	U-1423	-	-	-	-	-	*Puccinia stenotaphri*	*st augustine grass*	USA
May-83	U-1424	-	-	-	-	-	UNK	*Prunus serotina*	USA
May-83	U-1427	-	-	-	-	-	*Puccinia antirrhini*	*snapdragon*	USA
6-Jun-82	U-1428	-	-	-	-	-	*Puccinia iridis*	*Iris*	USA
14-Sep-09	U-1429	-	-	-	-	-	UNK	*Acer glabrum var. douglasii*	USA
31-Aug-09	U-1430	-	-	-	-	-	UNK	*Amelanchier alnifolia*	USA
28-Jun-09	U-1431	-	-	-	-	-	UNK	*Chondrilla juncea*	USA
31-Aug-09	U-1432	-	-	-	-	-	UNK	*Crataegus douglasii*	USA
9-Aug-09	U-1433	-	-	-	-	-	UNK	*Wyethia helianthoides*	USA

(**Table A-1.** Continued.)

Date	Collection Number	Larvae (+/-)	Larval Sample #	28S Sequence (Y/N) & BLAST ID	COI Sequence (Y/N) & BLAST ID	Supported Clades by tree (28S\COI\Concat.)	Rust Identification	Host Identification	Country
29-May-09	U-1434	-	-	-	-	-	UNK	*Chondrilla juncea*	USA
1-Aug-09	U-1435	-	-	-	-	-	UNK	*Taraxacum officinale*	USA
UNK	U-1436	-	-	-	-	-	*Aecidium* sp.	*Berberis*	Iran
3-May-09	U-1440	-	-	-	-	-	*Puccinia sparganioides?*	*Ash tree*	USA
UNK	U-1441	-	-	-	-	-	*Aecidium* sp.	*Berberis vulgaris*	Iran
UNK	U-1442	-	-	-	-	-	*Aecidium* sp.	*Plantago*	Iran
UNK	U-1444	-	-	-	-	-	*Aecidium* sp.	*Plantago major*	Iran
UNK	U-1445	-	-	-	-	-	*Puccinia*	*Cynodon dactylon*	Iran
5-Apr-10	U-1448	-	-	-	-	-	*Gymnoconia*	*Rubus* sp.	USA
UNK	U-1449	-	-	-	-	-	*Phragmidium*	*Potentilla gracilis*	USA
UNK	U-1450	-	-	-	-	-	*Phragmidium*	*Potentilla recta*	USA
31-Jul-10	U-1455	-	-	-	-	-	UNK	*Potentialla gracilis*	USA
24-Jul-10	U-1456	-	-	-	-	-	UNK	*Thalictrum occidentale*	USA
2-Aug-07	U-1457	-	-	-	-	-	*Tranzschelia* sp.	*Prunus spinosa*	Germany
18-Oct-09	U-1458	-	-	-	-	-	*Tranzschelia* sp.	*Prunus spinosa*	Germany
23-Mar-11	U-1459	-	-	-	-	-	*Puccinia smilacis*	*Smilax*	USA
Jun-11	U-1463	-	-	-	-	-	*Phragmidium*	*Rosa woodsii*	UNK
UNK	U-1464	-	-	-	-	-	*Puccinia balsamorrhizae*	*Balsamorhiza sagittata*	UNK
Jun-11	U-1465	-	-	-	-	-	*Phragmidium rosae-acicularis*	*Rosa* sp.	USA
Aug-11	U-1467	-	-	-	-	-	*Puccinia melanocephala*	Sugarcane	Equador
1-Aug-11	U-1469	-	-	-	-	-	*Gymnosporangium libocedii?*	*Amelanchier alnifolia*	USA
25-Sep-11	U-1470	-	-	-	-	-	UNK	*Potentilla recta*	UNK
9-Sep-11	U-1471	-	-	-	-	-	UNK	*Potentilla recta*	USA
9-Sep-11	U-1472	-	-	-	-	-	UNK	*Potentilla recta*	USA
10-Sep-11	U-1473	-	-	-	-	-	UNK	*Rosa woodsii*	USA
10-Sep-11	U-1474	-	-	-	-	-	UNK	*Potentilla gracilis*	USA
19-Jun-02	U-205	-	-	-	-	-	*Puccinia*	*Notobasis*	Turkey
18-May-01	U-208	-	-	-	-	-	*Puccinia?*	*Plantago lanceolata*	Turkey
7-Jun-01	U-210	-	-	-	-	-	*Puccinia?*	*Tragopogon latifolius*	Turkey
13-Jun-01	U-211	-	-	-	-	-	*Aecidium?*	*Salsola* sp.	Turkey
30-May-01	U-212	-	-	-	-	-	*Puccinia?*	*Crepis foetida*	Turkey

(**Table A-1.** Continued.)

Date	Collection Number	Larvae (+/-)	Larval Sample #	28S Sequence (Y/N) & BLAST ID	COI Sequence (Y/N) & BLAST ID	Supported Clades by tree (28S\COI\Concat.)	Rust Identification	Host Identification	Country
6-Jun-02	U-213	-	-	-	-	-	*Puccinia?*	*Crepis alpina*	Turkey
31-May-01	U-230	-	-	-	-	-	UNK	*Sanguisorba* sp.	Turkey
6-Jun-02	U-233	-	-	-	-	-	UNK	*Bromus* sp.	Turkey
19-Jun-01	U-239	-	-	-	-	-	UNK	*Secale cereale*	Turkey
18-Jun-02	U-241	-	-	-	-	-	UNK	*Elymus* sp.	Turkey
14-Jan-03	U-258	-	-	-	-	-	*Puccinia*	*Helichrysum* sp.	South Africa
30-Apr-04	U-274	-	-	-	-	-	*Cerotelium dicentrae*	UNK	USA
20-May-04	U-287	-	-	-	-	-	UNK	*Eustachys petraea*	Guam
UNK	U-325	-	-	-	-	-	*Puccinia*	*Phragmites australis*	Greece
2-Jul-04	U-328	-	-	-	-	-	*Puccinia hieracii?*	*Hieracium scouleri*	Canada
18-Jun-04	U-330	-	-	-	-	-	*Puccinia rubefaciens?*	*Galium boreale*	Canada
23-Jul-04	U-333	-	-	-	-	-	*Phragmidium fusiforme?*	*Rosa woodsii*	Canada
19-Aug-04	U-358	-	-	-	-	-	*Puccinia hieracii?*	*Taraxicum officinale*	USA
4-Sep-04	U-359	-	-	-	-	-	UNK	UNK	USA
1-Aug-04	U-376	-	-	-	-	-	*Ravenelia* sp.	*Acacia karroo*	South Africa
8-Oct-04	U-401	-	-	-	-	-	*Melampsora medusae?*	*Populus trichocarpa*	USA
May-04	U-408	-	-	-	-	-	UNK	*Calopogonium mucinoides*	Guam
Apr-04	U-409	-	-	-	-	-	UNK	*Cassia surattensis*	Guam
Jul-04	U-411	-	-	-	-	-	UNK	*Ipomoea indica*	Guam
Jun-04	U-412	-	-	-	-	-	*Puccinia*	*Youngia japonica*	Guam
Sep-04	U-413	-	-	-	-	-	*Puccinia*	*Cyperus rotundus*	Guam
Sep-04	U-414	-	-	-	-	-	UNK	*Youngia japonica*	Guam
10-Oct-04	U-420	-	-	-	-	-	UNK	*Eustachys petraea*	Guam
14-Oct-04	U-425	-	-	-	-	-	*Puccinia coronata*	*Poa pratensis*	USA
14-Oct-04	U-426	-	-	-	-	-	*Melampsora*	*Populus tremuloides*	USA
17-Oct-04	U-431	-	-	-	-	-	UNK	Asteraceae	USA
20-Sep-04	U-446	-	-	-	-	-	*Uromyces* sp.	*Massonia pustulata*	South Africa
14-Sep-04	U-454	-	-	-	-	-	*Uredopeltis* sp. Nov.?	*Grewia flavescens*	South Africa
23-Sep-04	U-468	-	-	-	-	-	*Uredinales = Pucciniales*	*Geranium* sp.	Belarus

(**Table A-1.** Continued.)

Date	Collection Number	Larvae (+/-)	Larval Sample #	28S Sequence (Y/N) & BLAST ID	COI Sequence (Y/N) & BLAST ID	Supported Clades by tree (28S\COI\Concat.)	Rust Identification	Host Identification	Country
20-May-04	U-473	-	-	-	-	-	*Uredinales = Pucciniales*	*Narcissus* sp.	Germany
22-Jun-03	U-475	-	-	-	-	-	*Uredinales = Pucciniales*	*Symphytum officinale*	Germany
19-Jun-04	U-477	-	-	-	-	-	*Uredinales = Pucciniales*	*Tussilago farfara*	Germany
25-Jun-04	U-481	-	-	-	-	-	*Uredinales = Pucciniales*	*Ribes rubrum*	Germany
16-Jun-04	U-487	-	-	-	-	-	*Uredinales = Pucciniales*	*Rosa hort.*	Germany
6-Aug-04	U-491	-	-	-	-	-	*Uredinales = Pucciniales*	*Hypericum* sp.	Germany
31-Aug-04	U-492	-	-	-	-	-	*Puccinia antirrhini*	*Antirrhinum majus*	Germany
4-Oct-04	U-495	-	-	-	-	-	*Puccinia*	*Phragmites communis*	Austria
1-Aug-04	U-496	-	-	-	-	-	*Uredinales = Pucciniales*	*Geranium nodosum*	Germany
30-Sep-04	U-519	-	-	-	-	-	*Puccinia*	*Carex debilis*	USA
12-Oct-04	U-522	-	-	-	-	-	*Puccinia*	*Carex* sp.	USA
12-Oct-04	U-523	-	-	-	-	-	*Puccinia*	*Carex debilis*	USA
12-Sep-04	U-524	-	-	-	-	-	UNK	*Fraxinus americana*	USA
11-Aug-02	U-532	-	-	-	-	-	*Puccinia*	*Geranium* sp.	Kazakhstan
14-Dec-04	U-545	-	-	-	-	-	*Uredo*	*Tarchonanthus littoralis*	South Africa
2-Dec-04	U-548	-	-	-	-	-	*Aecidium* sp.	*Solanum panduriforme*	South Africa
3-Dec-04	U-549	-	-	-	-	-	*Aecidium* sp.	*Solanum* sp.	South Africa
29-Dec-04	U-550	-	-	-	-	-	*Aecidium* sp.	*Solanum* sp.	South Africa
29-Dec-04	U-551	-	-	-	-	-	*Aecidium* sp.	UNK	South Africa
4-Mar-05	U-554	-	-	-	-	-	*Puccinia* sp.	*Asclepias* sp.	Mexico
3-Aug-04	U-558	-	-	-	-	-	UNK	*Sorbus sitchensis*	USA
27-Jul-04	U-559	-	-	-	-	-	*Melampsora*	*Salix* sp.	USA
2-Sep-04	U-562	-	-	-	-	-	*Melampsora*	*Salix* sp.	USA
2-Aug-04	U-566	-	-	-	-	-	UNK	*Aster ledophyllus*	USA
26-Aug-04	U-568	-	-	-	-	-	UNK	*Senecio traingularis*	USA
19-Aug-04	U-569	-	-	-	-	-	UNK	*Potentilla flabellifolia*	USA

(**Table A-1.** Continued.)

Date	Collection Number	Larvae (+/-)	Larval Sample #	28S Sequence (Y/N) & BLAST ID	COI Sequence (Y/N) & BLAST ID	Supported Clades by tree (28S\COI\Concat.)	Rust Identification	Host Identification	Country
22-Jul-04	U-570	-	-	-	-	-	UNK	*Senecio traingularis*	USA
21-Jul-04	U-572	-	-	-	-	-	UNK	*Salix sitchensis*	USA
15-Aug-04	U-580	-	-	-	-	-	*Puccinia* sp.	*Althaea rosea*	USA
6-Aug-83	U-585	-	-	-	-	-	*Pucciniastrum epilobii?*	*Epilobium* sp.	USA
12-Jul-85	U-606	-	-	-	-	-	*Puccinia rubefaciens?*	*Galium boreale*	USA
1-Apr-05	U-619	-	-	-	-	-	UNK	*Bidens alba*	USA
1-Apr-05	U-621	-	-	-	-	-	UNK	UNK	USA
12-Sep-01	U-623	-	-	-	-	-	*Phragmidium* sp.	*Rosa acicularis*	USA
6-May-05	U-636	-	-	-	-	-	UNK	*Crataegus*	USA
30-Aug-98	U-647	-	-	-	-	-	*Tranzschelia* sp.	*Cerasus mahaleb*	Iran
1-Oct-98	U-648	-	-	-	-	-	*Tranzschelia asiatica*	*Prunus grayana*	Japan
3-Apr-05	U-649	-	-	-	-	-	*Tranzschelia anemones*	*Anemone nemorosa*	Germany
11-Jan-05	U-650	-	-	-	-	-	*Tranzschelia iranica*	*Amygdalus* sp.	Iran
1-Jan-98	U-651	-	-	-	-	-	*Tranzschelia iranica*	*Amygdalus* sp.	Iran
12-Sep-93	U-652	-	-	-	-	-	*Tranzschelia microcerasi*	*Cerasus microcarpa*	Iran
28-Sep-96	U-653	-	-	-	-	-	*Tranzschelia discolor*	*Prunus persica*	Japan
4-Aug-04	U-654	-	-	-	-	-	*Tranzschelia anemones*	Thalictrum aquilegiifolium (Ranunculaceae)	Germany
27-Jul-03	U-655	-	-	-	-	-	*Ochropsora ariae*	*Sorbus aucuparia*	Germany
6-Aug-00	U-656	-	-	-	-	-	*Tranzschelia pruni-spinosae*	*Prunus grayana*	Japan
24-Jun-95	U-657	-	-	-	-	-	*Tranzschelia discolor*	*Amygdalus communis*	Iran
21-Oct-00	U-658	-	-	-	-	-	*Tranzschelia arthurii*	*Prunus serotina*	USA
20-Oct-04	U-659	-	-	-	-	-	*Tranzschelia pruni-spinosae*	*Prunus cerasifera*	Iran
8-Jun-01	U-662	-	-	-	-	-	*Tranzschelia anemones*	*Thalactrum minus*	Germany
28-May-00	U-663	-	-	-	-	-	*Tranzschelia suffusca*	*Pulsatilla vulgaris*	Germany
30-May-05	U-664	-	-	-	-	-	UNK	*Sporobolus cryptardrus*	USA
30-May-05	U-665	-	-	-	-	-	UNK	*Bouteloua eriopoda*	USA
13-May-05	U-669	-	-	-	-	-	*Kuehneola flacourtiae*	*Flacourtia indica*	Zambia
13-Feb-05	U-683	-	-	-	-	-	*Coleosporium asterum?*	Asteraceae	USA
12-Feb-05	U-684	-	-	-	-	-	UNK	*Sabel palmetto*	USA
1-May	U-687	-	-	-	-	-	UNK	*Macroptilium atropurpureum*	Guam

(**Table A-1.** Continued.)

Date	Collection Number	Larvae (+/-)	Larval Sample #	28S Sequence (Y/N) & BLAST ID	COI Sequence (Y/N) & BLAST ID	Supported Clades by tree (28S\COI\Concat.)	Rust Identification	Host Identification	Country
10-Jun-05	U-695	-	-	-	-	-	UNK	*Geranium*	Russia
14-Jun-05	U-696	-	-	-	-	-	UNK	*Sorbus aucuparia*	Russia
22-Aug-05	U-701	-	-	-	-	-	*Gymnosporangium*	*Malus*	USA
16-Aug-05	U-702	-	-	-	-	-	*Gymnosporangium*	*Sorbus sitchensis*	USA
12-Aug-05	U-704	-	-	-	-	-	*Phragmidium*	*Rosa* sp.	USA
13-Aug-05	U-705	-	-	-	-	-	UNK	*Hieracium* sp.	USA
25-Aug-05	U-708	-	-	-	-	-	*Melampsora* sp.	*Salix* sp.	USA
25-Aug-05	U-709	-	-	-	-	-	*Melampsora medusae?*	*Populus*	USA
3-Sep-05	U-712	-	-	-	-	-	UNK	UNK	USA
UNK	U-716	-	-	-	-	-	*Uromyces euphorbieae?*	*Euphorbia*	USA
1-Jan-05	U-730	-	-	-	-	-	*Uromyces appendiculatus*	*Phaseolus*	Mexico
15-Nov-05	U-732	-	-	-	-	-	*Melampsora?*	*Willow?*	USA
1-Aug-05	U-741	-	-	-	-	-	*Endoraecium*	*Acacia koa*	USA
4-Jul-05	U-770	-	-	-	-	-	UNK	*Arnica* sp.	USA
19-Aug-05	U-772	-	-	-	-	-	UNK	*Agoseris glauca?*	USA
14-Sep-05	U-775	-	-	-	-	-	UNK	*Penstemon procerus*	USA
27-Aug-05	U-780	-	-	-	-	-	*Melampsora medusae?*	*Populus tremuloides*	USA
17-Sep-05	U-781	-	-	-	-	-	*Melampsora*	*Populus trichocarpa*	USA
11-Aug-05	U-806	-	-	-	-	-	UNK	*Acer pensylvanicum*	USA
14-Jun-05	U-809	-	-	-	-	-	*Phragmidium*	*Rosa* sp.	USA
14-Jun-05	U-810	-	-	-	-	-	*Phragmidium*	*Rosa* sp.	USA
16-Jun-05	U-811	-	-	-	-	-	*Puccinia recondita*	*Clematis peniculata*	USA
6-Sep-05	U-815	-	-	-	-	-	*Melampsora*	*Salix* sp.	USA
5-Sep-86	U-817	-	-	-	-	-	*Phragmidium*	*Rosa* sp.	USA
22-Sep-05	U-833	-	-	-	-	-	*Puccinia helianthi*	*Helianthus* sp.	USA
27-Aug-05	U-843	-	-	-	-	-	*Puccinia virgata*	*Sorghastrum nutans*	USA
22-Sep-05	U-851	-	-	-	-	-	*Melampsora*	*Salix amygdaloides*	USA
22-Sep-05	U-852	-	-	-	-	-	*Melampsora*	*Salix interior*	USA
1-May-06	U-879	-	-	-	-	-	*Maravalia lucumae?*	UNK	Mexico
1-May-06	U-891	-	-	-	-	-	UNK	UNK	USA
1-May-06	U-892	-	-	-	-	-	*Tranzschelia*	*Thalictrum*	USA
23-Jun-06	U-912	-	-	-	-	-	*Phragmidiaceae*	*Rosa*	France
19-May-06	U-927	-	-	-	-	-	UNK	*Triticum aestivum*	Spain

(**Table A-1.** Continued.)

Date	Collection Number	Larvae (+/-)	Larval Sample #	28S Sequence (Y/N) & BLAST ID	COI Sequence (Y/N) & BLAST ID	Supported Clades by tree (28S\COI\Concat.)	Rust Identification	Host Identification	Country
19-May-06	U-930	-	-	-	-	-	UNK	*Polypogon monspeliensis*	Spain
27-May-06	U-933	-	-	-	-	-	*Phragmidiaceae*	*Rosa pouzina*	Spain
27-May-06	U-938	-	-	-	-	-	UNK	*Elymus farctus*	Spain
30-May-06	U-940	-	-	-	-	-	UNK	*Elymus repens*	Spain
7-Jun-06	U-944	-	-	-	-	-	*Melampsora*	*Populus alba*	Spain
9-Jun-06	U-946	-	-	-	-	-	*Uromyces*	*Glycyrrhiza glabra*	Spain
9-Jun-06	U-947	-	-	-	-	-	Phragmidiaceae	*Rosa canina*	Spain
13-May-06	U-952	-	-	-	-	-	*Melampsora*	*Salix atrocinerae*	Spain
13-May-06	U-953	-	-	-	-	-	UNK	*Trisetaria panicea*	Spain
13-May-06	U-966	-	-	-	-	-	*Melampsora*	*Salix atrocinerae*	Spain
13-May-06	U-967	-	-	-	-	-	UNK	*Trisetaria panicea*	Spain
19-May-06	U-979	-	-	-	-	-	UNK	*Triticium aestivum*	Spain
19-May-06	U-982	-	-	-	-	-	UNK	*Polypogon monspeliensis*	Spain
27-May-06	U-983	-	-	-	-	-	UNK	*Rubus ulmifolius*	Spain
27-May-06	U-990	-	-	-	-	-	UNK	*Elymus farctus*	Spain
30-May-06	U-992	-	-	-	-	-	UNK	*Elymus repens*	Spain
7-Jun-06	U-996	-	-	-	-	-	*Melampsora*	*Populus alba*	Spain
9-Jun-06	U-997	-	-	-	-	-	UNK	*Glycyrrhiza glabra*	Spain
9-Jun-06	U-998	-	-	-	-	-	UNK	*Rosa*	Spain
2-Jul-06	U-999	-	-	-	-	-	UNK	*Chondrilla juncea*	Spain
5-Aug-10	YG2-1	-	-	-	-	-	*Puccinia Kuehnii?*	Sugarcane	USA
5-Aug-10	YG2-11	-	-	-	-	-	*Puccinia melanocephala*	UNK	USA
5-Aug-10	YG2-12	-	-	-	-	-	*Puccinia melanocephala*	UNK	USA
5-Aug-10	YG2-14	-	-	-	-	-	*Puccinia melanocephala*	UNK	USA
5-Aug-10	YG2-15	-	-	-	-	-	*Puccinia melanocephala*	UNK	USA
5-Aug-10	YG2-18	-	-	-	-	-	*Puccinia melanocephala*	UNK	USA
5-Aug-10	YG2-19	-	-	-	-	-	*Puccinia melanocephala*	UNK	USA

(**Table A-1.** Continued.)

Date	Collection Number	Larvae (+/-)	Larval Sample #	28S Sequence (Y/N) & BLAST ID	COI Sequence (Y/N) & BLAST ID	Supported Clades by tree (28S\COI\Concat.)	Rust Identification	Host Identification	Country
5-Aug-10	YG2-2	-	-	-	-	-	*Puccinia melanocephala*	UNK	USA
5-Aug-10	YG2-20	-	-	-	-	-	*Puccinia melanocephala*	UNK	USA
5-Aug-10	YG2-21	-	-	-	-	-	*Puccinia melanocephala*	UNK	USA
5-Aug-10	YG2-23	-	-	-	-	-	*Puccinia melanocephala*	Sugarcane	USA
5-Aug-10	YG2-24	-	-	-	-	-	*Puccinia melanocephala*	UNK	USA
5-Aug-10	YG2-25	-	-	-	-	-	*Puccinia melanocephala*	UNK	USA
5-Aug-10	YG2-27	-	-	-	-	-	*Puccinia melanocephala*	UNK	USA
5-Aug-10	YG2-29	-	-	-	-	-	*Puccinia melanocephala*	UNK	USA
5-Aug-10	YG2-3	-	-	-	-	-	*Puccinia melanocephala*	Sugarcane	USA
5-Aug-10	YG2-31	-	-	-	-	-	*Puccinia melanocephala*	UNK	USA
5-Aug-10	YG2-35	-	-	-	-	-	*Puccinia melanocephala*	UNK	USA
5-Aug-10	YG2-37	-	-	-	-	-	*Puccinia melanocephala*	UNK	USA
5-Aug-10	YG2-38	-	-	-	-	-	*Puccinia melanocephala*	UNK	USA
5-Aug-10	YG2-39	-	-	-	-	-	*Puccinia melanocephala*	UNK	USA
5-Aug-10	YG2-4	-	-	-	-	-	*Puccinia melanocephala*	Sugarcane	USA
5-Aug-10	YG2-40	-	-	-	-	-	*Puccinia melanocephala*	UNK	USA
5-Aug-10	YG2-41	-	-	-	-	-	*Puccinia melanocephala*	Sugarcane	USA
5-Aug-10	YG2-44	-	-	-	-	-	*Puccinia melanocephala*	UNK	USA

(**Table A-1.** Continued.)

Date	Collection Number	Larvae (+/-)	Larval Sample #	28S Sequence (Y/N) & BLAST ID	COI Sequence (Y/N) & BLAST ID	Supported Clades by tree (28S\COI\Concat.)	Rust Identification	Host Identification	Country
5-Aug-10	YG2-45	-	-	-	-	-	*Puccinia melanocephala*	UNK	USA
5-Aug-10	YG2-46	-	-	-	-	-	*Puccinia melanocephala*	UNK	USA
UNK	YG2-47	-	-	-	-	-	UNK	UNK	UNK
5-Aug-10	YG2-5	-	-	-	-	-	*Puccinia melanocephala*	Sugarcane	USA
5-Aug-10	YG2-8	-	-	-	-	-	*Puccinia melanocephala*	Sugarcane	USA
5-Aug-10	YG2-9	-	-	-	-	-	*Puccinia melanocephala*	UNK	USA
1-Aug-10	YG3	-	-	-	-	-	*Puccinia melanocephala*	UNK	UNK
1-Jul-11	YG4-1	-	-	-	-	-	*Puccinia melanocephala*	Sugarcane	China
1-Jul-11	YG4-2	-	-	-	-	-	*Puccinia melanocephala*	Sugarcane	China
1-Jul-11	YG4-3	-	-	-	-	-	*Puccinia melanocephala*	Sugarcane	China
1-Jul-11	YG4-4	-	-	-	-	-	*Puccinia melanocephala*	Sugarcane	China
1-Jul-11	YG5	-	-	-	-	-	*Puccinia melanocephala*	UNK	China
22-Sep-11	YUN025	-	-	-	-	-	UNK	*Fern = Pteridophyta*	China
24-Sep-11	YUN026	-	-	-	-	-	UNK	Asteraceae	China
21-Sep-11	YUN030	-	-	-	-	-	*Coleosporium*	Asteraceae	China
22-Sep-11	YUN034	-	-	-	-	-	*Phragmidium*	Rosaceae	China
21-Sep-11	YUN058	-	-	-	-	-	*Coleosporium*	Asteraceae	China
21-Sep-11	YUN059	-	-	-	-	-	*Coleosporium*	Asteraceae	China
21-Sep-11	YUN062	-	-	-	-	-	*Coleosporium*	Asteraceae	China
27-Sep-11	YUN078	-	-	-	-	-	*Coleosporium*	*Ipomoea?*	China
23-Sep-11	YUN082	-	-	-	-	-	*Coleosporium*	UNK	China
24-Sep-11	YUN083	-	-	-	-	-	*Coleosporium*	UNK	China
6-May-08	ZT169	-	-	-	-	-	*Gymnosporangium fuscum*	UNK	UNK

(**Table A-1.** Continued.)

Date	**Collection Number**	**Larvae (+/-)**	**Larval Sample #**	**28S Sequence (Y/N) & BLAST ID**	**COI Sequence (Y/N) & BLAST ID**	**Supported Clades by tree (28S\COI\Concat.)**	**Rust Identification**	**Host Identification**	**Country**
6-May-08	ZT172	-	-	-	-	-	*Gymnosporangium confusum*	*Juniperus sabina*	UNK
5-May-08	ZT173	-	-	-	-	-	*Gymnosporangium tremelloides*	*Juniperus communis*	UNK
16-Sep-09	TAR114	-	-	-	-	-	UNK	*Smilax rotunifolia*	USA
9-Sep-04	MCA2815		-	-	-	-	*Puccinia*	*Cirsium discolor*	USA

Appendix B. Statistical Analyses Supplementary Data

Table B-1. Information from 224 collections used in PCA analysis of 12 variables on the presence or absence of larvae on rust-infected plant material. Remainder of collections examined were missing data in for one or more variables.

Month	Year	Season	Material amount (1-3)	Rust species	Rust family	Host species	Host family	Country	Continent	Hemisphere (E/W)	Hemisphere (N/S)	Larvae (Y/N)
Jun	04	Su	2	*Aecidium apocyni*	Incertae sedis	*Apocynum cannabinum*	Apocynaceae	USA	North America	W	N	N
May	08	F	2	*Aecidium garckeanum*	Incertae sedis	*Hibiscus cannabinus*	Malvaceae	South Africa	Africa	E	S	N
Jan	06	Su	2	*Aecidium habunguense*	Incertae sedis	*Solanum panduriforme*	Solanaceae	South Africa	Africa	E	S	Y
May	07	Sp	3	*Aecidium hydnoideum*	Incertae sedis	*Dirca palustris*	Thymelaeaceae	USA	North America	W	N	N
Feb	04	W	2	*Aecidium meliosmae-myrianthe*	Incertae sedis	*Meliosma symplicifolia*	Sabiaceae	India	Asia	E	N	N
Nov	08	F	2	*Aecidium vangueriae*	Incertae sedis	*Vangueria infausta*	Rubiaceae	South Africa	Africa	E	S	Y
Oct	08	F	2	*Baeodromus eupatorii*	Pucciniosiraceae	*Ageratina adenophora*	Asteraceae	Mexico	North America	W	N	Y
Aug	08	W	2	*Ceratocoma jacksoniae*	Pucciniosiraceae	*Gastrolobium villosum*	Fabaceae	Australia	Australia	W	S	N
Aug	08	W	2	*Ceratocoma jacksoniae*	Pucciniosiraceae	*Jacksonia horrida*	Fabaceae	Australia	Australia	W	S	N
Aug	12	Su	3	*Cerotelium fici*	Phakopsoraceae	*Ficus carica*	Moraceae	USA	North America	W	N	Y
Jun	12	Su	3	*Cerotelium fici*	Phakopsoraceae	*Ficus carica*	Moraceae	USA	North America	W	N	Y
Oct	12	F	3	*Cerotelium fici*	Phakopsoraceae	*Ficus carica*	Moraceae	USA	North America	W	N	Y
Jul	03	Su	1	*Cerotelium sabiceae*	Phakopsoraceae	*Sabicea glabrescens*	Rubiaceae	Guyana	South America	W	N	Y
Jun	03	Su	1	*Cerotelium sabiceae*	Phakopsoraceae	*Sabicea glabrescens*	Rubiaceae	Guyana	South America	W	N	N
Aug	76	W	2	*Cerradoa palmaea*	Incertae sedis	*Attalea ceraensis*	Arecaceae	Brazil	South America	W	S	N
May	08	F	2	*Coleosporium ipomoeae*	Coleosporiaceae	*Hewittia malabarica*	Convolvulaceae	South Africa	Africa	E	S	N
Jul	03	Su	1	*Coleosporium plumeriae*	Coleosporiaceae	*Plumeria rubra*	Apocynaceae	Guyana	South America	W	N	N
Aug	10	Su	2	*Coleosporium tussilaginis*	Coleosporiaceae	*Petasites albus*	Asteraceae	Scotland	Europe	W	N	Y

(**Table B-1.** Continued.)

Month	Year	Season	Material amount (1-3)	Rust species	Rust family	Host species	Host family	Country	Continent	Hemisphere (E/W)	Hemisphere (N/S)	Larvae (Y/N)
Jun	03	Su	1	*Coleosporium vernoniae*	Coleosporiaceae	*Elephantopus mollis*	Asteraceae	Guyana	South America	W	N	N
Jun	03	Su	1	*Coleosporium vernoniae*	Coleosporiaceae	*Elephantopus mollis*	Asteraceae	Guyana	South America	W	N	N
Jan	04	W	1	*Coleosporium vernoniae*	Coleosporiaceae	*Elephantopus mollis*	Asteraceae	Guyana	South America	W	N	Y
Jan	04	W	2	*Coleosporium vernoniae*	Coleosporiaceae	*Elephantopus mollis*	Asteraceae	Guyana	South America	W	N	N
May	08	F	2	*Crossopsora antidesimae*	Phakopsoraceae	*Antidesma venosum*	Phyllanthaceae	South Africa	Africa	E	S	N
Jul	08	W	2	*Crossopsora ziziphi*	Phakopsoraceae	*Ziziphus mucronata*	Rhamnaceae	South Africa	Africa	E	S	N
Jun	03	Su	2	*Desmella aneimiae*	Incertae sedis	*Thelypteris opulenta*	Thelypteridaceae	Guyana	South America	W	N	N
May	08	F	3	*Diorchidium woodii*	Raveneliaceae	*Milletia grandis*	Fabaceae	South Africa	Africa	E	S	N
Jul	03	Su	2	*Endophyllum stachytarphetae*	Pucciniaceae	*Stachytarpheta cayennensis*	Verbenaceae	Guyana	South America	W	N	N
Jun	05	Su	1	*Gymnosporangium clavariiforme*	Pucciniaceae	*Juniperus communis*	Cupressaceae	USA	North America	W	N	N
Jul	06	Su	1	*Gymnosporangium clavariiforme*	Pucciniaceae	*Amelanchier alnifolia*	Rosaceae	USA	North America	W	N	N
May	06	Sp	1	*Gymnosporangium clavariiforme*	Pucciniaceae	*Juniperus communis*	Cupressaceae	USA	North America	W	N	N
Jun	07	Su	1	*Gymnosporangium clavariiforme*	Pucciniaceae	*Juniperus communis*	Cupressaceae	USA	North America	W	N	N
Mar	05	Sp	1	*Gymnosporangium confusum*	Pucciniaceae	*Juniperus oxycedrus*	Cupressaceae	France	Europe	W	N	Y
Jul	68	Su	2	*Gymnosporangium cumminsii*	Pucciniaceae	*Malacomeles denticulata*	Rosaceae	Mexico	North America	W	N	N
Jun	72	Su	1	*Gymnosporangium cumminsii*	Pucciniaceae	*Juniperus gamboana*	Cupressaceae	Mexico	North America	W	N	Y
Mar	72	Sp	1	*Gymnosporangium cumminsii*	Pucciniaceae	*Juniperus coahuilensis*	Cupressaceae	Mexico	North America	W	N	N
Mar	72	Sp	1	*Gymnosporangium cumminsii*	Pucciniaceae	*Juniperus coahuilensis*	Cupressaceae	Mexico	North America	W	N	N
Apr	74	Sp	1	*Gymnosporangium cumminsii*	Pucciniaceae	*Juniperus flaceida*	Cupressaceae	Mexico	North America	W	N	N
Apr	74	Sp	1	*Gymnosporangium cumminsii*	Pucciniaceae	*Juniperus flaceida*	Cupressaceae	Mexico	North America	W	N	N
Apr	74	Sp	1	*Gymnosporangium cumminsii*	Pucciniaceae	*Juniperus flaceida*	Cupressaceae	Mexico	North	W	N	N

(**Table B-1.** Continued.)

Month	Year	Season	Material amount (1-3)	Rust species	Rust family	Host species	Host family	Country	Continent	Hemisphere (E/W)	Hemisphere (N/S)	Larvae (Y/N)
									America			
Jun	75	Su	1	*Gymnosporangium exiguum*	Pucciniaceae	*Crataegus crus-galli*	Rosaceae	USA	North America	W	N	N
Apr	95	Sp	1	*Gymnosporangium exiguum*	Pucciniaceae	*Juniperus californica*	Cupressaceae	USA	North America	W	N	N
May	99	Sp	1	*Gymnosporangium exiguum*	Pucciniaceae	*Juniperus deppeana*	Cupressaceae	USA	North America	W	N	N
Apr	04	Sp	1	*Gymnosporangium exiguum*	Pucciniaceae	*Malus pumila*	Rosaceae	USA	North America	W	N	N
Jul	04	Su	1	*Gymnosporangium exiguum*	Pucciniaceae	*Juniperus deppeana*	Cupressaceae	USA	North America	W	N	N
Jun	04	Su	1	*Gymnosporangium exiguum*	Pucciniaceae	*Juniperus monosperma*	Cupressaceae	USA	North America	W	N	N
Jun	05	Su	1	*Gymnosporangium exiguum*	Pucciniaceae	*Juniperus deppeana*	Cupressaceae	USA	North America	W	N	N
Oct	05	F	1	*Gymnosporangium exiguum*	Pucciniaceae	*Juniperus deppeana*	Cupressaceae	USA	North America	W	N	N
Apr	08	Sp	1	*Gymnosporangium exiguum*	Pucciniaceae	*Juniperus ashei*	Cupressaceae	USA	North America	W	N	N
Apr	08	Sp	1	*Gymnosporangium floriforme*	Pucciniaceae	*Juniperus virginiana*	Cupressaceae	USA	North America	W	N	N
Apr	08	Sp	1	*Gymnosporangium floriforme*	Pucciniaceae	*Juniperus virginiana*	Cupressaceae	USA	North America	W	N	N
Apr	08	Sp	1	*Gymnosporangium juniperi-virginianae*	Pucciniaceae	*Juniperus virginiana*	Cupressaceae	USA	North America	W	N	Y
Apr	08	Sp	3	*Gymnosporangium juniperi-virginianae*	Pucciniaceae	*Juniperus virginiana*	Cupressaceae	USA	North America	W	N	Y
Apr	95	Sp	1	*Gymnosporangium kernianum*	Pucciniaceae	*Juniperus occidentalis*	Cupressaceae	USA	North America	W	N	N
Apr	95	Sp	2	*Gymnosporangium kernianum*	Pucciniaceae	*Juniperus osteosperma*	Cupressaceae	USA	North America	W	N	N
May	99	Sp	1	*Gymnosporangium kernianum*	Pucciniaceae	*Juniperus deppeana*	Cupressaceae	USA	North America	W	N	N
May	99	Sp	1	*Gymnosporangium kernianum*	Pucciniaceae	*Juniperus occidentalis*	Cupressaceae	USA	North America	W	N	N
Jun	04	Su	1	*Gymnosporangium kernianum*	Pucciniaceae	*Juniperus californica*	Cupressaceae	USA	North America	W	N	N
May	04	Sp	1	*Gymnosporangium kernianum*	Pucciniaceae	*Juniperus deppeana*	Cupressaceae	USA	North America	W	N	N
Apr	05	Sp	1	*Gymnosporangium kernianum*	Pucciniaceae	*Juniperus deppeana*	Cupressaceae	USA	North America	W	N	N

(**Table B-1.** Continued.)

Month	Year	Season	Material amount (1-3)	Rust species	Rust family	Host species	Host family	Country	Continent	Hemisphere (E/W)	Hemisphere (N/S)	Larvae (Y/N)
Jun	05	Su	2	*Gymnosporangium kernianum*	Pucciniaceae	*Juniperus deppeana*	Cupressaceae	USA	North America	W	N	N
Apr	08	Sp	1	*Gymnosporangium kernianum*	Pucciniaceae	*Juniperus deppeana*	Cupressaceae	USA	North America	W	N	N
Aug	11	Su	3	*Gymnosporangium libocedii*	Pucciniaceae	*Amelanchier alnifolia*	Rosaceae	USA	North America	W	N	N
Oct	05	F	1	*Gymnosporangium vauqueliniae*	Pucciniaceae	*Vauquelinia californica*	Rosaceae	USA	North America	W	N	N
May	08	F	2	*Hemileia scholzii*	Chaconiaceae	*Clerodendrum glabrum*	Lamiaceae	South Africa	Africa	E	S	Y
May	05	F	2	*Kuehneola flacourtiae*	Phragmidiaceae	*Flacourtia indica*	Salicaceae	Zambia	Africa	E	S	N
Mar	08	Sp	3	*Kuehneola uredinis*	Phragmidiaceae	*Rubus ursinus*	Rosaceae	USA	North America	W	N	N
Dec	01	W	2	*Maravalia ichnocarpi*	Pileolariaceae	*Ichnocarpus frutescens*	Apocynaceae	India	Asia	E	N	N
Feb	08	Su	1	*Maravalia lonchocarpi*	Pileolariaceae	*Lonchocarpus capassa*	Fabaceae	South Africa	Africa	E	S	N
Jul	08	W	3	*Maravalia lonchocarpi*	Pileolariaceae	*Philenoptera violacea*	Fabaceae	South Africa	Africa	E	S	N
Jul	08	W	2	*Masseeella flueggeae*	Incertae sedis	*Flueggea virosa*	Phyllanthaceae	South Africa	Africa	E	S	N
Oct	04	F	3	*Melampsora medusae*	Melampsoraceae	*Populus trichocarpa*	Salicaceae	USA	North America	W	N	N
Aug	05	Su	3	*Melampsora medusae*	Melampsoraceae	*Populus tremuloides*	Salicaceae	USA	North America	W	N	N
Jul	03	Su	1	*Nyssopsora echinata*	Raveneliaceae	*Meum athamanticum*	Apiaceae	Germany	Europe	E	N	N
Jun	86	Su	1	*Ochropsora ariae*	Uropyxidaceae	*Anemone rivularis*	Ranunculaceae	China	Asia	E	N	N
Jul	03	Su	1	*Ochropsora ariae*	Uropyxidaceae	*Sorbus aucuparia*	Rosaceae	Germany	Europe	E	N	N
Apr	06	Sp	2	*Ochropsora ariae*	Uropyxidaceae	*Anemone nemorosa*	Ranunculaceae	Germany	Europe	E	N	N
Sep	05	F	3	*Olivea tectonea*	Chaconiaceae	*Tectona grandis*	Lamiaceae	Guatemala	North America	W	N	N
Jun	03	Su	1	*Phakopsora arthuriana*	Phakopsoraceae	*Jatropha gossypifolia*	Euphorbiaceae	Guyana	South America	W	N	N
Nov	08	F	2	*Phakopsora pachyrhizi*	Phakopsoraceae	*Pueraria lobata*	Fabaceae	USA	North America	W	N	N
Aug	09	Su	1	*Phakopsora pachyrhizi*	Phakopsoraceae	*Pueraria lobata*	Fabaceae	USA	North America	W	N	N
Aug	09	Su	2	*Phakopsora pachyrhizi*	Phakopsoraceae	*Pueraria lobata*	Fabaceae	USA	North America	W	N	Y

(**Table B-1.** Continued.)

Month	Year	Season	Material amount (1-3)	Rust species	Rust family	Host species	Host family	Country	Continent	Hemisphere (E/W)	Hemisphere (N/S)	Larvae (Y/N)
Oct	09	F	2	*Phakopsora pachyrhizi*	Phakopsoraceae	*Pueraria lobata*	Fabaceae	USA	North America	W	N	N
Oct	09	F	2	*Phakopsora pachyrhizi*	Phakopsoraceae	*Pueraria lobata*	Fabaceae	USA	North America	W	N	N
Oct	09	F	2	*Phakopsora pachyrhizi*	Phakopsoraceae	*Pueraria lobata*	Fabaceae	USA	North America	W	N	N
Oct	09	F	3	*Phakopsora pachyrhizi*	Phakopsoraceae	*Glycine max*	Fabaceae	USA	North America	W	N	N
Oct	09	F	3	*Phakopsora pachyrhizi*	Phakopsoraceae	*Glycine max*	Fabaceae	USA	North America	W	N	Y
Oct	09	F	3	*Phakopsora pachyrhizi*	Phakopsoraceae	*Pueraria lobata*	Fabaceae	USA	North America	W	N	Y
Sep	09	F	1	*Phakopsora pachyrhizi*	Phakopsoraceae	*Glycine max*	Fabaceae	USA	North America	W	N	N
Sep	09	F	1	*Phakopsora pachyrhizi*	Phakopsoraceae	*Glycine max*	Fabaceae	USA	North America	W	N	N
Sep	09	F	1	*Phakopsora pachyrhizi*	Phakopsoraceae	*Glycine max*	Fabaceae	USA	North America	W	N	N
Sep	09	F	1	*Phakopsora pachyrhizi*	Phakopsoraceae	*Glycine max*	Fabaceae	USA	North America	W	N	N
Sep	09	F	2	*Phakopsora pachyrhizi*	Phakopsoraceae	*Glycine max*	Fabaceae	USA	North America	W	N	N
Sep	09	F	2	*Phakopsora pachyrhizi*	Phakopsoraceae	*Glycine max*	Fabaceae	USA	North America	W	N	N
Sep	09	F	2	*Phakopsora pachyrhizi*	Phakopsoraceae	*Glycine max*	Fabaceae	USA	North America	W	N	N
Sep	09	F	3	*Phakopsora pachyrhizi*	Phakopsoraceae	*Glycine max*	Fabaceae	USA	North America	W	N	N
Sep	09	F	3	*Phakopsora pachyrhizi*	Phakopsoraceae	*Glycine max*	Fabaceae	USA	North America	W	N	N
Sep	09	F	3	*Phakopsora pachyrhizi*	Phakopsoraceae	*Glycine max*	Fabaceae	USA	North America	W	N	Y
May	08	F	2	*Phakopsora stratosa*	Phakopsoraceae	*Croton sylvaticus*	Euphorbiaceae	South Africa	Africa	E	S	N
Jul	08	W	1	*Phakopsora ziziphi-vulgaris*	Phakopsoraceae	*Ziziphus mucronata*	Rhamnaceae	South Africa	Africa	E	S	N
Jul	04	Su	1	*Phragmidium fusiforme*	Phragmidiaceae	*Rosa woodsii*	Rosaceae	Canada	North America	W	N	N
May	06	Sp	2	*Phragmidium mucronatum*	Phragmidiaceae	*Rosa pouzina*	Rosaceae	Spain	Europe	W	N	Y
Oct	08	F	2	*Prospodium appendiculatum*	Uropyxidaceae	*Tecoma stans* var. *molle*	Bignoniaceae	Mexico	North America	W	N	N

(**Table B-1.** Continued.)

Month	Year	Season	Material amount (1-3)	Rust species	Rust family	Host species	Host family	Country	Continent	Hemisphere (E/W)	Hemisphere (N/S)	Larvae (Y/N)
Oct	08	F	2	*Prospodium appendiculatum*	Uropyxidaceae	*Tecoma stans* var. *stans*	Bignoniaceae	Mexico	North America	W	N	N
Oct	08	F	2	*Prospodium appendiculatum*	Uropyxidaceae	*Tecoma stans* var. *stans*	Bignoniaceae	Mexico	North America	W	N	N
Oct	08	F	3	*Prospodium appendiculatum*	Uropyxidaceae	*Tecoma stans* var. *stans*	Bignoniaceae	Mexico	North America	W	N	N
Aug	07	Su	1	*Prospodium transformans*	Uropyxidaceae	*Tecoma stans*	Bignoniaceae	Mexico	North America	W	N	N
Jun	05	Su	2	*Puccinia poarum*	Pucciniaceae	*Elymus hystrix*	Poaceae	USA	North America	W	N	Y
Mar	85	Sp	2	*Puccinia advena*	Pucciniaceae	*Oplismenus hirtellus*	Poaceae	Nigeria	Africa	E	N	N
Apr	07	Sp	2	*Puccinia allii*	Pucciniaceae	*Allium ampeloprasum var. parrum*	Amaryllidaceae	Spain	Europe	W	N	N
Sep	04	F	2	*Puccinia andropogonis*	Pucciniaceae	*Amphicarpaea bracteata*	Fabaceae	USA	North America	W	N	N
Aug	04	Su	2	*Puccinia antirrhini*	Pucciniaceae	*Antirrhinum majus*	Plantaginaceae	Germany	Europe	E	N	N
Jul	03	Su	1	*Puccinia arechavaletae*	Pucciniaceae	*Serjania membranacea*	Sapindaceae	Guyana	South America	W	N	N
May	08	F	2	*Puccinia batatas*	Pucciniaceae	*Ipomoea mauritiana*	Convolvulaceae	South Africa	Africa	E	S	N
Nov	07	Sp	2	*Puccinia boroniae*	Pucciniaceae	*Chorilaena quercifolia*	Rutaceae	Australia	Australia	W	S	N
Jun	05	Su	2	*Puccinia circaeae*	Pucciniaceae	*Circaea alpina*	Onagraceae	USA	North America	W	N	N
Jun	03	Su	1	*Puccinia cnici-oleracei*	Pucciniaceae	*Emilia sonchifolia*	Asteraceae	Guyana	South America	W	N	N
Aug	07	Su	1	*Puccinia cnici-oleracei*	Pucciniaceae	*Eclipta alba*	Asteraceae	Belize	North America	W	N	N
Jul	03	Su	1	*Puccinia commelinae*	Pucciniaceae	*Commelina erecta*	Commelinaceae	Guyana	South America	W	N	N
Oct	04	F	1	*Puccinia coronata*	Pucciniaceae	*Poa pratensis*	Poaceae	USA	North America	W	N	N
Apr	09	Sp	2	*Puccinia cynodonis*	Pucciniaceae	*Cynodon dactylon*	Poaceae	USA	North America	W	N	N
Aug	08	W	2	*Puccinia dampierae*	Pucciniaceae	*Dampiera linearis*	Goodeniaceae	Australia	Australia	W	S	N
Jun	03	Su	1	*Puccinia duthiae*	Pucciniaceae	*Bothriochloa bladhii*	Poaceae	Guyana	South America	W	N	N
Jul	03	Su	1	*Puccinia helianthi*	Pucciniaceae	*Helianthus annuus*	Asteraceae	Guyana	South America	W	N	N

(**Table B-1.** Continued.)

Month	Year	Season	Material amount (1-3)	Rust species	Rust family	Host species	Host family	Country	Continent	Hemisphere (E/W)	Hemisphere (N/S)	Larvae (Y/N)
Aug	04	Su	2	*Puccinia hieracii*	Pucciniaceae	*Taraxacum officinale*	Asteraceae	USA	North America	W	N	N
Jul	04	Su	1	*Puccinia hieracii*	Pucciniaceae	*Hieracium scouleri*	Asteraceae	Canada	North America	W	N	N
Jul	04	Su	2	*Puccinia hieracii*	Pucciniaceae	*Taraxacum officinale*	Asteraceae	USA	North America	W	N	N
Jul	05	Su	2	*Puccinia hieracii*	Pucciniaceae	*Taraxacum officinale*	Asteraceae	USA	North America	W	N	N
Aug	64	Su	1	*Puccinia inulae-acuminata*	Pucciniaceae	*Inula acuminata*	Asteraceae	Pakistan	Asia	E	N	N
Jun	09	Su	2	*Puccinia jonesii*	Pucciniaceae	*Lomatium dissectum*	Apiaceae	USA	North America	W	N	N
May	09	Sp	1	*Puccinia jonesii*	Pucciniaceae	*Lomatium dissectum*	Apiaceae	USA	North America	W	N	N
May	08	F	2	*Puccinia kraussiana*	Pucciniaceae	*Smilax anceps*	Smilacaceae	South Africa	Africa	E	S	N
Aug	11	Su	3	*Puccinia kuehnii*	Pucciniaceae	*Saccharum officinarum*	Poaceae	Equador	South America	W	Eq	Y
Nov	07	F	3	*Puccinia lygodii*	Pucciniaceae	*Lygodium japonicum*	Lygodiaceae	USA	North America	W	N	Y
Nov	07	F	3	*Puccinia lygodii*	Pucciniaceae	*Lygodium japonicum*	Lygodiaceae	USA	North America	W	N	Y
Jun	09	Su	3	*Puccinia lygodii*	Pucciniaceae	*Lygodium japonicum*	Lygodiaceae	USA	North America	W	N	N
Jun	12	Su	3	*Puccinia lygodii*	Pucciniaceae	*Lygodium japonicum*	Lygodiaceae	USA	North America	W	N	Y
May	07	Sp	2	*Puccinia mariae-wilsoniae*	Pucciniaceae	*Claytonia caroliniana*	Montiaceae	USA	North America	W	N	N
Jun	03	Su	1	*Puccinia mikaniae*	Pucciniaceae	*Mikania psilostachya*	Asteraceae	Guyana	South America	W	N	N
Sep	01	F	3	*Puccinia mogiphanis*	Pucciniaceae	*Alternanthera brasiliana*	Amaranthaceae	Nigeria	Africa	E	N	N
Aug	01	Su	2	*Puccinia nakanishiki*	Pucciniaceae	*Cymbopogon citratus*	Poaceae	Nigeria	Africa	E	N	N
Jun	03	Su	1	*Puccinia obliquoseptata*	Pucciniaceae	*Olyra micrantha*	Poaceae	Guyana	South America	W	N	N
Jun	03	Su	1	*Puccinia obliquoseptata*	Pucciniaceae	*Olyra micrantha*	Poaceae	Guyana	South America	W	N	N
Jan	04	W	1	*Puccinia obliquoseptata*	Pucciniaceae	*Olyra micrantha*	Poaceae	Guyana	South America	W	N	N
Jan	04	W	1	*Puccinia obliquoseptata*	Pucciniaceae	*Olyra micrantha*	Poaceae	Guyana	South America	W	N	N

(**Table B-1.** Continued.)

Month	Year	Season	Material amount (1-3)	Rust species	Rust family	Host species	Host family	Country	Continent	Hemisphere (E/W)	Hemisphere (N/S)	Larvae (Y/N)
May	05	Sp	3	*Puccinia podophylli*	Pucciniaceae	*Podophyllum peltatum*	Berberidaceae	USA	North America	W	N	N
Feb	08	Su	1	*Puccinia popowiae*	Pucciniaceae	*Hexalobus monopetalus*	Annonaceae	South Africa	Africa	E	S	N
Aug	08	W	2	*Puccinia pritzeliana*	Pucciniaceae	*Tremandra stelligera*	Elaeocarpaceae	Australia	Australia	W	S	N
Aug	08	W	2	*Puccinia pritzeliana*	Pucciniaceae	*Tremandra stelligera*	Elaeocarpaceae	Australia	Australia	W	S	Y
Apr	11	Sp	3	*Puccinia psidii*	Pucciniaceae	*Syzygium jambus*	Myrtaceae	Puerto Rico	North America	W	N	Y
Jun	05	Su	3	*Puccinia recondita*	Pucciniaceae	*Clematis peniculata*	Ranunculaceae	USA	North America	W	N	N
Jul	85	Su	3	*Puccinia rubefaciens*	Pucciniaceae	*Galium boreale*	Rubiaceae	USA	North America	W	N	N
Jun	04	Su	1	*Puccinia rubefaciens*	Pucciniaceae	*Galium boreale*	Rubiaceae	Canada	North America	W	N	N
Oct	88	F	1	*Puccinia salicis-tetraspermae*	Pucciniaceae	*Salix tetraspermae*	Salicaceae	Pakistan	Asia	E	N	N
Aug	90	Su	1	*Puccinia saussureae-lappae*	Pucciniaceae	*Saussurea lappa*	Asteraceae	Pakistan	Asia	E	N	N
Jul	03	Su	1	*Puccinia scleriae*	Pucciniaceae	*Passiflora garckei*	Passifloraceae	Guyana	South America	W	N	N
Jul	09	Su	1	*Puccinia similis*	Pucciniaceae	*Artemisia tridentata*	Asteraceae	USA	North America	W	N	N
Jul	09	Su	3	*Puccinia similis*	Pucciniaceae	*Artemisia tridentata*	Asteraceae	USA	North America	W	N	N
Oct	87	F	1	*Puccinia stenotaphri*	Pucciniaceae	*Stenotaphrum secundatum*	Poaceae	USA	North America	W	N	N
Jul	03	Su	2	*Puccinia strobilanthis-urticifoliae*	Pucciniaceae	*Strobilanthes urticifolia*	Acanthaceae	Pakistan	Asia	E	N	N
Jun	03	Su	1	*Puccinia subcoronata*	Pucciniaceae	*Cyperus laxus*	Cyperaceae	Guyana	South America	W	N	N
Jun	03	Su	1	*Puccinia thaliae*	Pucciniaceae	*Canna indica*	Cannaceae	Guyana	South America	W	N	N
Mar	08	Sp	2	*Puccinia triticina*	Pucciniaceae	*Triticum aestivum*	Poaceae	USA	North America	W	N	N
Apr	06	Sp	3	*Puccinia violae*	Pucciniaceae	*Viola hastata*	Violaceae	USA	North America	W	N	Y
Aug	05	Su	3	*Puccinia virgata*	Pucciniaceae	*Sorghastrum nutans*	Poaceae	USA	North America	W	N	N
May	03	Sp	2	*Ravenalia emblicae*	Raveneliaceae	*Phyllanthus emblica*	Phyllanthaceae	India	Asia	E	N	N
Jun	03	Su	2	*Ravenelia guyanensis*	Raveneliaceae	*Chamaecrista*	Fabaceae	Guyana	South	W	N	N

(**Table B-1.** Continued.)

Month	Year	Season	Material amount (1-3)	Rust species	Rust family	Host species	Host family	Country	Continent	Hemisphere (E/W)	Hemisphere (N/S)	Larvae (Y/N)
						adiantifolia			America			
Dec	00	W	3	*Sphaerophragmium acaciae*	Raveneliaceae	*Albizia lebbeck*	Fabaceae	Nigeria	Africa	E	N	N
Dec	01	W	2	*Sphaerophragmium longicorne*	Raveneliaceae	*Dalbergia hostilis*	Fabaceae	Nigeria	Africa	E	N	N
Jun	03	Su	1	*Tranzchelia fusca*	Uropyxidaceae	*Anemone quinquefolia*	Ranunculaceae	USA	North America	W	N	N
Jun	03	Su	1	*Tranzchelia fusca*	Uropyxidaceae	*Anemone quinquefolia*	Ranunculaceae	USA	North America	W	N	N
Jun	01	Su	1	*Tranzschelia anemones*	Uropyxidaceae	*Thalictrum minus*	Ranunculaceae	Germany	Europe	E	N	N
Aug	04	Su	1	*Tranzschelia anemones*	Uropyxidaceae	*Thalictrum aquilegiifolium*	Ranunculaceae	Germany	Europe	E	N	N
Apr	05	Sp	1	*Tranzschelia anemones*	Uropyxidaceae	*Anemone nemorosa*	Ranunculaceae	Germany	Europe	E	N	N
Apr	06	Sp	2	*Tranzschelia anemones*	Uropyxidaceae	*Anemone nemorosa*	Ranunculaceae	Germany	Europe	E	N	N
Oct	00	F	1	*Tranzschelia arthurii*	Uropyxidaceae	*Prunus serotina*	Rosaceae	USA	North America	W	N	N
Sep	64	F	1	*Tranzschelia asiatica*	Uropyxidaceae	*Prunus grayana*	Rosaceae	Japan	Asia	E	N	N
Jul	92	Su	1	*Tranzschelia asiatica*	Uropyxidaceae	*Prunus grayana*	Rosaceae	Japan	Asia	E	N	N
Jul	92	Su	1	*Tranzschelia asiatica*	Uropyxidaceae	*Prunus grayana*	Rosaceae	Japan	Asia	E	N	N
Sep	92	F	1	*Tranzschelia asiatica*	Uropyxidaceae	*Prunus grayana*	Rosaceae	Japan	Asia	E	N	N
Oct	93	F	1	*Tranzschelia asiatica*	Uropyxidaceae	*Prunus grayana*	Rosaceae	Japan	Asia	E	N	N
Oct	98	F	1	*Tranzschelia asiatica*	Uropyxidaceae	*Prunus grayana*	Rosaceae	Japan	Asia	E	N	N
Oct	87	F	3	*Tranzschelia discolor*	Uropyxidaceae	*Prunus persica*	Rosaceae	USA	North America	W	N	Y
Jun	95	Su	1	*Tranzschelia discolor*	Uropyxidaceae	*Amygdalus communis*	Rosaceae	Iran	Asia	E	N	N
Sep	96	F	1	*Tranzschelia discolor*	Uropyxidaceae	*Prunus persica*	Rosaceae	Japan	Asia	E	N	N
Sep	93	F	1	*Tranzschelia microcerasi*	Uropyxidaceae	*Cerasus microcarpa*	Rosaceae	Iran	Asia	E	N	N
Sep	92	F	3	*Tranzschelia pruni-spinosae*	Uropyxidaceae	*Prunus spinosa*	Rosaceae	Germany	Europe	E	N	N
Sep	96	F	1	*Tranzschelia pruni-spinosae*	Uropyxidaceae	*Prunus spinosa*	Rosaceae	Germany	Europe	E	N	N
Aug	00	Su	1	*Tranzschelia pruni-spinosae*	Uropyxidaceae	*Prunus grayana*	Rosaceae	Japan	Asia	E	N	N
May	02	Sp	1	*Tranzschelia pruni-spinosae*	Uropyxidaceae	*Anemone quinquefolia*	Ranunculaceae	USA	North America	W	N	N
Jun	03	Su	1	*Tranzschelia pruni-spinosae*	Uropyxidaceae	*Anemone quinquefolia*	Ranunculaceae	USA	North America	W	N	N
Jun	03	Su	1	*Tranzschelia pruni-spinosae*	Uropyxidaceae	*Anemone quinquefolia*	Ranunculaceae	USA	North America	W	N	N
Jun	03	Su	1	*Tranzschelia pruni-spinosae*	Uropyxidaceae	*Anemone quinquefolia*	Ranunculaceae	USA	North America	W	N	N

(**Table B-1.** Continued.)

Month	Year	Season	Material amount (1-3)	Rust species	Rust family	Host species	Host family	Country	Continent	Hemisphere (E/W)	Hemisphere (N/S)	Larvae (Y/N)
Oct	04	F	1	*Tranzschelia pruni-spinosae*	Uropyxidaceae	*Prunus cerasifera*	Rosaceae	Iran	Asia	E	N	N
May	86	Sp	1	*Tranzschelia pulsatillae*	Uropyxidaceae	*Pulsatilla chinensis*	Ranunculaceae	China	Asia	E	N	N
May	00	Sp	1	*Tranzschelia suffusca*	Uropyxidaceae	*Pulsatilla vulgaris*	Ranunculaceae	Germany	Europe	E	N	N
Jul	03	Su	1	*Uredo baruensis*	Incertae sedis	*Chrysophyllum sparsiflorum*	Sapotaceae	Guyana	South America	W	N	Y
Jul	08	W	1	*Uredo combreticola*	Incertae sedis	*Combretum hereroense*	Combretaceae	South Africa	Africa	E	S	N
Apr	09	F	1	*Uredo otholobii*	Incertae sedis	*Otholobium hirtum*	Fabaceae	South Africa	Africa	E	S	N
Sep	05	F	1	*Uredo scabies*	Incertae sedis	*Vanilla planifolia*	Orchidaceae	Guatemala	North America	W	N	N
Nov	07	Sp	2	*Uredo spyridii*	Incertae sedis	*Spyridium globulosum*	Rhamnaceae	Australia	Australia	W	S	N
Nov	07	Sp	3	*Uredo spyridii*	Incertae sedis	*Trymalium floribundum*	Rhamnaceae	Australia	Australia	W	S	N
Aug	08	W	2	*Uredo spyridii*	Incertae sedis	*Trymalium floribundum*	Rhamnaceae	Australia	Australia	W	S	N
Aug	08	W	3	*Uredo spyridii*	Incertae sedis	*Spyridium globulosum*	Rhamnaceae	Australia	Australia	W	S	N
Jul	08	W	2	*Uredopeltis chevalieri*	Phakopsoraceae	*Grewia hexamita*	Malvaceae	South Africa	Africa	E	S	N
Jul	08	W	2	*Uredopeltis chevalieri*	Phakopsoraceae	*Grewia monticola*	Malvaceae	South Africa	Africa	E	S	N
Jun	05	Su	1	*Uromyces aecidiiformis*	Pucciniaceae	*Lilium candidum*	Liliaceae	Germany	Europe	E	N	N
May	05	Sp	1	*Uromyces ambiguus*	Pucciniaceae	*Allium sphaerocephalon*	Amaryllidaceae	Germany	Europe	E	N	N
Jun	05	Su	2	*Uromyces dactylidis*	Pucciniaceae	*Dactylis glomerata*	Poaceae	Germany	Europe	E	N	N
Jun	03	Su	1	*Uromyces euphorbiae*	Pucciniaceae	*Euphorbia hirta*	Euphorbiaceae	Guyana	South America	W	N	N
Apr	05	Sp	2	*Uromyces ficariae*	Pucciniaceae	*Ranunculus ficaria*	Ranunculaceae	Germany	Europe	E	N	N
Apr	06	Sp	1	*Uromyces ficariae*	Pucciniaceae	*Ranunculus ficaria*	Ranunculaceae	Germany	Europe	E	N	N
Apr	06	Sp	2	*Uromyces ficariae*	Pucciniaceae	*Ranunculus ficaria*	Ranunculaceae	Germany	Europe	E	N	N
Apr	03	Sp	1	*Uromyces gageae*	Pucciniaceae	*Gagea lutea*	Liliaceae	Germany	Europe	E	N	N
Jun	03	Su	2	*Uromyces geranii*	Pucciniaceae	*Geranium pratense*	Geraniaceae	Germany	Europe	E	N	Y
Jul	09	Su	2	*Uromyces intricatus*	Pucciniaceae	*Eriogonum umbellatum*	Polygonaceae	USA	North America	W	N	N
Sep	04	F	2	*Uromyces junci-effusus*	Pucciniaceae	*Juncus effusus*	Juncaceae	USA	North America	W	N	Y

(**Table B-1.** Continued.)

Month	Year	Season	Material amount (1-3)	Rust species	Rust family	Host species	Host family	Country	Continent	Hemisphere (E/W)	Hemisphere (N/S)	Larvae (Y/N)
Apr	06	Sp	1	*Uromyces muscari*	Pucciniaceae	*Muscari neglectum*	Asparagaceae	Germany	Europe	E	N	N
Jul	03	Su	1	*Uromyces neotropicalis*	Pucciniaceae	*Cayaponia selysioides*	Cucurbitaceae	Guyana	South America	W	N	N
Apr	04	Sp	1	*Uromyces poae*	Pucciniaceae	*Ranunculus ficaria*	Ranunculaceae	Germany	Europe	E	N	N
Sep	04	F	2	*Uromyces polygoni*	Pucciniaceae	*Fopia dumetorum*	Polygonaceae	Germany	Europe	E	N	N
Sep	04	F	1	*Uromyces rumicis*	Pucciniaceae	*Rumex obtusifolius*	Polygonaceae	Germany	Europe	E	N	N
Jul	03	Su	1	*Uromyces silphii*	Pucciniaceae	*Juncus tenuis*	Juncaceae	Germany	Europe	E	N	N
Jun	03	Su	1	*Uromyces tenuicutis*	Pucciniaceae	*Sporobolus jacquemontii*	Poaceae	Guyana	South America	W	N	N
Apr	07	Sp	3	*Uromyces viciae-fabae*	Pucciniaceae	*Vicia lutea sub Vestita*	Fabaceae	Spain	Europe	W	N	N

Table B-2. Scored data for PCA analysis of 12 variables on the presence or absence of larvae on rust-infected plant material.

Mo(1-12)	Yr	Ssn	AmtMat	Rust Sp	Rust F	Host Sp	Host F	HemiEW (1or2)	HemiNS (1or2or3)	Cont	Ctry	Larvae (1or2)
6	2004	3	2	1	3	9	41	1	2	2	12	1
5	2008	1	2	2	3	10	39	1	2	4	8	1
1	2006	3	2	3	3	10	39	1	2	4	8	1
5	2007	2	3	4	3	10	39	1	2	4	8	1
2	2004	4	2	5	3	11	39	2	2	5	21	1
11	2008	1	2	6	3	11	39	2	2	5	21	1
10	2008	1	2	7	9	113	41	2	2	5	4	1
8	2008	4	2	8	9	115	38	1	2	4	8	1
8	2008	4	2	8	9	114	41	2	2	5	21	1
6	2012	3	3	9	5	21	21	2	2	6	10	1
8	2012	3	3	9	5	20	41	1	2	2	12	1
10	2012	1	3	9	5	22	43	2	3	3	1	1
6	2003	3	1	10	5	24	32	2	2	5	21	1
7	2003	3	1	10	5	23	47	2	2	6	10	2
8	1976	4	2	11	3	11	39	2	2	5	21	1
5	2008	1	2	12	2	3	21	1	2	1	15	1
7	2003	3	1	13	2	4	3	2	2	4	20	1
8	2010	3	2	14	2	5	3	1	2	4	8	1
1	2004	4	1	15	2	6	2	1	2	1	15	1
1	2004	4	2	15	2	8	21	2	2	5	21	1
6	2003	3	1	15	2	7	41	2	2	5	21	1
6	2003	3	1	15	2	7	41	2	2	5	21	1
5	2008	1	2	16	5	25	29	2	2	5	21	1
7	2008	4	2	17	5	26	39	2	2	5	21	1
6	2003	3	2	18	3	11	39	2	2	5	21	1
5	2008	1	3	19	10	116	42	2	2	6	10	2
7	2003	3	2	20	8	52	22	1	2	4	8	2
5	2006	2	1	21	8	53	21	2	2	5	21	1
6	2007	3	1	21	8	53	21	2	2	5	21	1
6	2005	3	1	21	8	53	21	2	2	5	21	1
7	2006	3	1	21	8	53	21	2	2	5	21	1
3	2005	2	1	22	8	53	21	2	2	5	21	1
3	1972	2	1	23	8	53	21	2	2	5	21	1
3	1972	2	1	23	8	53	21	2	2	5	21	1
4	1974	2	1	23	8	53	21	2	2	5	21	1
4	1974	2	1	23	8	53	21	2	2	5	21	1
4	1974	2	1	23	8	53	21	2	2	5	21	1
6	1972	3	1	23	8	53	21	2	2	5	21	2
7	1968	3	2	23	8	53	21	2	2	5	21	2
4	2004	2	1	24	8	56	9	2	2	6	10	1
4	2008	2	1	24	8	54	28	1	3	1	19	1
4	1995	2	1	24	8	55	28	1	3	1	19	1
5	1999	2	1	24	8	61	6	1	2	2	11	1
6	2004	3	1	24	8	60	9	2	2	5	4	1
6	1975	3	1	24	8	58	4	1	3	1	19	1
6	2005	3	1	24	8	59	28	1	3	1	19	1
7	2004	3	1	24	8	57	15	1	3	1	19	1
10	2005	1	1	24	8	62	9	1	2	2	16	1
4	2008	2	1	25	8	64	21	2	3	3	1	1

(**Table B-2.** Continued.)

Mo(1-12)	Yr	Ssn	AmtMat	Rust Sp	Rust F	Host Sp	Host F	HemiEW (1or2)	HemiNS (1or2or3)	Cont	Ctry	Larvae (1or2)
4	2008	2	1	25	8	63	15	1	3	1	19	1
4	2008	2	1	26	8	65	20	2	2	6	10	1
4	2008	2	3	26	8	66	24	2	2	5	21	2
4	2005	2	1	27	8	67	24	1	2	4	8	1
4	2008	2	1	27	8	68	17	2	2	5	21	1
4	1995	2	1	27	8	69	17	2	2	5	21	1
4	1995	2	2	27	8	71	17	2	2	5	21	1
5	1999	2	1	27	8	70	17	2	2	5	14	1
5	2004	2	1	27	8	70	17	2	2	5	14	1
5	1999	2	1	27	8	71	17	2	2	5	21	1
6	2004	3	1	27	8	69	17	2	2	5	21	1
6	2005	3	2	27	8	71	17	2	2	5	21	1
8	2011	3	3	28	8	72	17	2	2	5	21	1
10	2005	1	1	29	8	72	17	2	2	5	21	1
5	2008	1	2	30	1	1	6	2	2	5	21	1
5	2005	1	2	31	6	46	30	2	2	5	21	2
3	2008	2	3	32	6	47	45	1	3	1	22	1
12	2001	4	2	33	7	50	42	2	2	5	4	1
2	2008	3	1	34	7	50	42	2	2	5	21	1
7	2008	4	3	34	7	51	21	2	3	3	1	1
7	2008	4	2	35	3	11	39	2	2	5	21	1
8	2005	3	3	36	4	18	12	2	2	6	10	1
10	2004	1	3	36	4	19	16	2	2	6	10	1
7	2003	3	1	37	10	116	42	2	2	6	10	1
4	2006	2	2	38	11	123	41	1	2	4	8	1
6	1986	3	1	38	11	122	49	1	3	1	19	2
7	2003	3	1	38	11	121	48	1	3	1	19	1
9	2005	1	3	39	1	2	9	2	2	5	14	2
6	2003	3	1	40	5	27	25	1	3	1	19	2
8	2009	3	1	41	5	28	13	1	3	1	19	1
8	2009	3	2	41	5	33	37	2	2	5	21	1
9	2009	1	2	41	5	39	9	2	2	5	2	1
9	2009	1	3	41	5	42	9	2	2	6	10	1
9	2009	1	1	41	5	29	14	2	2	6	10	1
9	2009	1	1	41	5	32	37	1	2	1	15	1
9	2009	1	1	41	5	31	20	1	3	1	19	1
9	2009	1	3	41	5	43	38	2	2	5	21	1
9	2009	1	1	41	5	30	41	2	2	5	21	1
9	2009	1	2	41	5	38	51	2	2	5	21	1
9	2009	1	2	41	5	40	9	2	2	6	10	2
9	2009	1	3	41	5	41	37	2	2	5	21	2
10	2009	1	2	41	5	37	23	2	3	3	1	1
10	2009	1	2	41	5	35	37	1	2	4	8	1
10	2009	1	3	41	5	40	9	2	2	6	10	1
10	2009	1	3	41	5	40	9	2	2	6	10	1
10	2009	1	3	41	5	40	9	2	2	6	10	1
10	2009	1	2	41	5	36	21	1	2	1	15	1
11	2008	1	2	41	5	34	18	2	2	6	10	1
5	2008	1	2	42	5	44	20	2	2	6	10	1
7	2008	4	1	43	5	45	38	1	2	4	8	1
7	2004	3	1	44	6	48	35	1	3	1	19	1
5	2006	2	2	45	6	49	26	1	2	4	8	1
10	2008	1	2	46	11	126	40	2	3	3	1	1

(**Table B-2.** Continued.)

Mo(1-12)	**Yr**	**Ssn**	**AmtMat**	**Rust Sp**	**Rust F**	**Host Sp**	**Host F**	**HemiEW (1or2)**	**HemiNS (1or2or3)**	**Cont**	**Ctry**	**Larvae (1or2)**
10	2008	1	3	46	11	126	40	2	3	3	1	1
10	2008	1	2	46	11	125	37	2	2	6	10	1
10	2008	1	2	46	11	124	37	2	2	5	21	1
8	2007	3	1	47	11	127	52	2	2	6	10	1
6	2005	3	2	48	8	72	17	2	2	5	21	1
3	1985	2	2	49	8	72	17	2	2	5	21	1
4	2007	2	2	50	8	72	17	2	2	5	21	1
9	2004	1	2	51	8	72	17	2	2	5	21	1
8	2004	3	2	52	8	72	17	2	2	5	21	1
7	2003	3	1	53	8	72	17	2	2	5	21	1
5	2008	1	2	54	8	72	17	2	2	5	21	1
11	2007	2	2	55	8	73	17	2	2	5	14	1
6	2005	3	2	56	8	73	17	2	2	5	14	1
6	2003	3	1	57	8	74	17	2	2	5	14	2
8	2007	3	1	57	8	73	17	2	2	5	14	1
7	2003	3	1	58	8	75	17	2	2	5	21	1
10	2004	1	1	59	8	76	17	2	2	5	21	1
4	2009	2	2	60	8	76	17	2	2	5	21	1
8	2008	4	2	61	8	77	17	2	2	5	21	1
6	2003	3	1	62	8	78	17	2	2	4	7	2
7	2003	3	1	63	8	79	17	2	2	5	21	1
7	2005	3	2	64	8	80	26	1	2	4	8	1
7	2004	3	1	64	8	79	17	2	2	5	21	1
7	2004	3	2	64	8	79	17	2	2	5	21	2
8	2004	3	2	64	8	79	17	2	2	5	21	2
8	1964	3	1	65	8	81	5	2	2	5	21	1
5	2009	2	1	66	8	81	5	2	2	5	21	1
6	2009	3	2	66	8	82	21	1	3	1	19	1
5	2008	1	2	67	8	83	27	2	2	5	21	1
8	2011	3	3	68	8	83	27	2	2	5	21	2
6	2009	3	3	69	8	83	27	2	2	5	21	2
6	2012	3	3	69	8	83	27	2	2	5	21	2
11	2007	1	3	69	8	84	41	2	2	5	14	1
11	2007	1	3	69	8	85	41	2	2	5	21	1
5	2007	2	2	70	8	86	44	1	2	2	11	1
6	2003	3	1	71	8	87	5	1	2	4	8	1
9	2001	1	3	72	8	88	9	2	2	6	10	1
8	2001	3	2	73	8	89	21	1	3	1	19	1
1	2004	4	1	74	8	90	8	1	2	4	8	1
1	2004	4	1	74	8	91	37	2	2	6	10	1
6	2003	3	1	74	8	91	37	2	2	6	10	1
6	2003	3	1	74	8	91	37	2	2	6	10	1
5	2005	2	3	75	8	91	37	2	2	6	10	1
2	2008	3	1	76	8	92	37	1	2	1	15	1
8	2008	4	2	77	8	94	34	2	2	6	10	1
8	2008	4	2	77	8	93	21	1	3	1	19	1
4	2011	2	3	78	8	95	9	2	2	4	18	2
6	2005	3	3	79	8	96	21	1	3	1	19	1
6	2004	3	1	80	8	97	35	1	2	2	11	1
7	1985	3	3	80	8	98	6	2	2	6	10	1
10	1988	1	1	81	8	99	37	2	2	5	21	1
8	1990	3	1	82	8	100	10	2	2	5	21	1
7	2003	3	1	83	8	101	45	2	2	5	21	1

(**Table B-2.** Continued.)

Mo(1-12)	Yr	Ssn	AmtMat	Rust Sp	Rust F	Host Sp	Host F	HemiEW (1or2)	HemiNS (1or2or3)	Cont	Ctry	Larvae (1or2)
7	2009	3	3	84	8	103	41	1	2	2	12	1
7	2009	3	1	84	8	102	45	2	2	5	21	1
10	1987	1	1	85	8	104	41	1	2	2	13	1
7	2003	3	2	86	8	104	41	1	2	2	13	1
6	2003	3	1	87	8	104	41	1	2	2	13	1
6	2003	3	1	88	8	104	41	1	2	2	13	1
3	2008	2	2	89	8	104	41	1	2	2	13	1
4	2006	2	3	90	8	104	41	1	2	2	13	1
8	2005	3	3	91	8	104	41	1	2	2	13	1
5	2003	2	2	92	10	117	37	2	1	6	6	2
6	2003	3	2	93	10	118	45	1	2	2	16	1
12	2000	4	3	94	10	119	9	1	2	2	16	1
12	2001	4	2	95	10	120	46	2	2	6	10	1
6	2003	3	1	96	11	129	1	1	2	2	16	1
6	2003	3	1	96	11	128	37	2	2	5	21	1
4	2006	2	2	97	11	131	9	2	2	5	21	1
4	2005	2	1	97	11	130	31	2	2	5	17	2
6	2001	3	1	97	11	131	9	2	2	5	21	1
8	2004	3	1	97	11	131	9	2	2	5	21	1
10	2000	1	1	98	11	132	11	2	2	5	14	1
7	1992	3	1	99	11	132	11	2	2	5	14	1
7	1992	3	1	99	11	132	11	2	2	5	14	1
9	1992	1	1	99	11	134	39	1	2	4	8	1
9	1964	1	1	99	11	133	25	2	2	5	9	1
10	1998	1	1	99	11	132	11	2	2	5	14	1
10	1993	1	1	99	11	132	11	2	2	5	14	1
6	1995	3	1	100	11	135	39	1	2	4	8	1
9	1996	1	1	100	11	136	50	2	2	6	10	1
10	1987	1	3	100	11	137	19	2	3	3	1	1
9	1993	1	1	101	11	137	19	2	3	3	1	2
5	2002	2	1	102	11	143	21	2	2	4	20	1
6	2003	3	1	102	11	141	33	2	2	5	9	1
6	2003	3	1	102	11	142	41	2	2	5	21	1
6	2003	3	1	102	11	140	42	1	3	1	19	2
8	2000	3	1	102	11	138	37	2	2	5	21	1
9	1996	1	1	102	11	139	40	2	3	3	1	1
9	1992	1	3	102	11	144	53	2	2	5	21	2
10	2004	1	1	102	11	139	40	2	3	3	1	1
5	1986	2	1	103	11	145	40	1	3	1	19	1
5	2000	2	1	104	11	145	40	1	3	1	19	1
7	2003	3	1	105	3	11	39	2	2	5	21	1
7	2008	4	1	106	3	12	39	1	2	2	5	1
4	2009	1	1	107	3	13	35	1	3	1	19	1
9	2005	1	1	108	3	14	36	1	2	4	8	1
8	2008	4	3	109	3	16	7	2	3	6	3	1
8	2008	4	2	109	3	15	9	2	2	5	21	1
11	2007	2	3	109	3	17	37	2	2	6	10	1
11	2007	2	2	109	3	15	9	2	2	5	21	1
7	2008	4	2	110	5	46	30	2	2	5	21	2
7	2008	4	2	110	5	46	30	2	2	5	21	2
6	2005	3	1	111	8	105	41	2	2	5	21	2
5	2005	2	1	112	8	105	41	1	2	2	13	1
6	2005	3	2	113	8	106	41	2	2	5	21	1

(**Table B-2.** Continued.)

Mo(1-12)	Yr	Ssn	AmtMat	Rust Sp	Rust F	Host Sp	Host F	HemiEW (1or2)	HemiNS (1or2or3)	Cont	Ctry	Larvae (1or2)
6	2003	3	1	114	8	107	41	1	2	4	8	1
4	2006	2	1	115	8	107	41	1	2	4	8	1
4	2005	2	2	115	8	108	21	2	2	5	21	1
4	2006	2	2	115	8	108	21	2	2	5	21	2
4	2003	2	1	116	8	108	21	2	2	5	21	1
6	2003	3	2	117	8	108	21	2	2	5	21	1
7	2009	3	2	118	8	108	21	2	2	5	21	1
9	2004	1	2	119	8	108	21	2	2	5	21	1
4	2006	2	1	120	8	108	21	2	2	5	21	2
7	2003	3	1	121	8	109	39	1	2	2	5	1
4	2004	2	1	122	8	110	39	1	2	4	8	1
9	2004	1	2	123	8	111	39	1	2	4	8	1
9	2004	1	1	124	8	111	39	1	2	4	8	1
7	2003	3	1	125	8	111	39	1	2	4	8	1
6	2003	3	1	126	8	111	39	1	2	4	8	1
4	2007	2	3	127	8	112	41	2	2	4	20	2

Table B-3. Command line data for R to conduct principal component analysis and identify the factors in the data responsible for 95% of the variance in the data set. PC1-3 explain >95% of the variance, with rust and host identification the most significant factors.

```
>model<-prcomp(data, scale=F)
>plot(model, type="lines")
>summary (model)
Importance of components:
```

	PC1	PC2	PC3	PC4	PC5	PC6	PC7
Standard deviation	48.3979	23.0686	12.853	8.48505	6.09794	2.3179	1.57294
Proportion of Variance	0.7415	0.1685	0.0523	0.02279	0.01177	0.0017	0.00078
Cumulative Proportion	0.7415	0.91	0.9623	0.9851	0.99687	0.9986	0.99936

	PC8	PC9	PC10	PC11	PC12	PC13
Standard deviation	0.9306	0.74578	0.61543	0.33144	0.30209	0.17862
Proportion of Variance	0.00027	0.00018	0.00012	0.00003	0.00003	0.00001
Cumulative Proportion	0.99963	0.99981	0.99993	0.99996	0.99999	1

```
>loadings.model<-model$rotation
>loadings.model
```

	PC1	PC2	PC3	PC4	PC5
Mo	0.004269	-0.00908	0.00571	0.025012	-0.09439
Yr	-0.0241	-0.07544	0.182357	0.961702	0.186358
Ssn	-0.0003	-0.00266	0.001455	-0.00654	0.0264
AmtMat	-0.0024	-0.00303	0.005146	0.023011	-0.00746
RustSp	0.631101	-0.77414	-0.01127	-0.0425	-0.00369
RustF	0.040009	0.058756	-0.02207	-0.01019	0.00787
HostSp	0.772342	0.624387	-0.05251	0.075198	0.022892

(**Table B-3.** Continued.)

HostF	0.053036	0.039567	0.978401	-0.18959	0.042375
HemiEW	-0.00053	0.001255	-0.00828	-0.00195	0.013763
HemiNS	9.76E-05	0.001358	0.001035	0.000568	-0.007
Cont	-0.00181	-0.0009	-0.01819	0.000168	0.006469
Ctry	-0.01333	-0.00618	-0.07513	-0.1744	0.976156
Larvae	0.00053	-0.00051	0.000311	-0.00152	0.007214
	PC6	PC7	PC8	PC9	PC10
Mo	-0.96453	-0.19475	0.131735	-0.03815	0.048745
Yr	0.009459	0.001991	0.001741	-0.02772	0.002174
Ssn	0.126903	-0.00269	0.987578	0.069195	-0.04923
AmtMat	-0.08342	0.055263	-0.07082	0.699139	-0.68452
RustSp	0.0083	0.001868	-0.00286	-0.01365	-0.01414
RustF	-0.00223	-0.01367	0.017313	-0.70155	-0.69137
HostSp	-0.00288	0.001129	0.000918	0.049869	0.045957
HostF	-0.00733	0.017458	-0.00238	-0.01226	-0.00946
HemiEW	-0.06638	0.214755	-0.01555	-0.03377	-0.07184
HemiNS	0.009125	-0.14584	-0.01273	-0.04048	-0.1189
Cont	-0.18048	0.94313	0.035831	-0.05836	0.042882
Ctry	-0.09653	-0.02991	-0.01495	0.010214	0.0063
Larvae	0.00353	0.027118	-0.0095	0.053926	-0.15829
	PC11	PC12	PC13		
Mo	-0.01099	2.75E-02	-0.00521		
Yr	-0.00182	4.13E-04	0.00012		
Ssn	-0.00616	-2.03E-02	0.012982		
AmtMat	0.164055	6.37E-03	0.005644		
RustSp	0.002568	5.88E-05	0.000731		
RustF	0.115463	9.89E-02	0.02297		
HostSp	-0.00696	-5.63E-03	-0.00204		
HostF	0.001502	-2.03E-03	0.001372		
HemiEW	-0.27075	-5.70E-01	0.73785		
HemiNS	-0.22628	-7.29E-01	-0.61649		
Cont	0.042931	1.34E-02	-0.26268		
Ctry	0.008538	2.63E-03	-0.01356		
Larvae	-0.91275	3.64E-01	-0.0746		

```
>biplot(model)
>png ("PCAgraf.png", width=5000, height=5000)
```

Table B-4. Contingency table of presence and absence of *Mycodiplosis* larvae on 587 collections of 262 identified rust species for Fisher's exact test of the dependence of larval occurrence on rust species.

Rust species	Larvae absent	Larvae present
Aecidium apocyni	1	0
Aecidium garckeanum	1	0
Aecidium habunguense	0	1
Aecidium hydnoideum	1	0
Aecidium meliosmae-myrianthe	1	0
Aecidium mori	2	0
Aecidium vangueriae	0	1
Baeodromus eupatorii	2	2
Batistopsora crucis-filii	1	0
Ceratocoma jacksoniae	4	0
Cerotelium dicentrae	1	0
Cerotelium fici	1	6
Cerotelium sabiceae	1	1
Cerradoa palmaea	1	0
Chaconia ingae	2	0
Chrysomyxa ledecola	1	0
Coleosporium asterum	4	3
Coleosporium cacaliae	0	1
Coleosporium clematidis-apiifoliae	0	2
Coleosporium ipomoeae	6	7
Coleosporium lycopi	0	1
Coleosporium neocacaliae	0	1
Coleosporium phellodendri	0	2
Coleosporium plumeriae	6	1
Coleosporium solidago	1	0
Coleosporium tussilaginis	2	1
Coleosporium vernoniae	4	1
Cronartium quercum	3	0
Crossopsora antidesimae	1	0
Crossopsora ziziphi	1	0
Desmella aneimiae	3	0
Diorchidium woodii	1	0
Endophyllum paederia	2	0
Endophyllum stachytarphetae	1	0
Frommeella mexicana	0	1
Gymnoconia nitens	0	1
Gymnoconia peckiana	0	1

(**Table B-4.** Continued.)

Rust species	**Larvae absent**	**Larvae present**
Gymnosporangium clavariiforme	6	0
Gymnosporangium clavipes	1	0
Gymnosporangium confusum	1	1
Gymnosporangium cornutum	1	0
Gymnosporangium cumminsii	6	1
Gymnosporangium exiguum	9	0
Gymnosporangium floriforme	2	0
Gymnosporangium fuscum	1	0
Gymnosporangium juniperi-virginianae	0	2
Gymnosporangium kernianum	9	0
Gymnosporangium libocedii	1	0
Gymnosporangium miyabe and G. yamadae	1	0
Gymnosporangium trachysorum	1	0
Gymnosporangium tremelloides	1	0
Gymnosporangium vauqueliniae	1	0
Gymnosporangium yamadae	1	0
Hemileia scholzii	0	1
Hyalopsora polypodii	0	1
Kuehneola flacourtiae	1	0
Kuehneola loeseneriana	1	0
Kuehneola uredinis	1	3
Kwielingia divina	3	0
Malupa pakaraimensis	0	1
Maravalia ichnocarpi	1	0
Maravalia lonchocarpi	2	0
Maravalia lucumae	1	0
Masseeella flueggeae	1	0
Melampsora capricarum	0	1
Melampsora epitea complex	0	1
Melampsora epyphylla	1	1
Melampsora hypericorum	1	0
Melampsora kusanoi	0	1
Melampsora larisi-populina	1	1
Melampsora medusae	4	0
Melampsora salix	1	0
Melampsora tremuloides	0	3
Melampsorella caryophyllacearum	1	0
Melampsoridium alni	0	1
Melampsoridium hiratsukanum	0	3
Nyssopsora echinata	1	0

(**Table B-4.** Continued.)

Rust species	**Larvae absent**	**Larvae present**
Ochropsora ariae	3	0
Ochropsora kraunhiae	2	3
Olivea tectonea	1	0
Phakopsora apoda	1	0
Phakopsora arthuriana	1	0
Phakopsora gossypii	0	1
Phakopsora meibomiae	0	1
Phakopsora pachyrhizi	30	12
Phakopsora stratosa	1	0
Phakopsora ziziphi-vulgaris	1	0
Phragmidium fusiforme	1	0
Phragmidium griseum	1	1
Phragmidium miyakeanum	1	0
Phragmidium mucronatum	0	1
Phragmidium potentillae	0	1
Phragmidium rosae-acicularis	1	0
Phragmidium rosae-multiflorae	1	0
Phragmidium rosae-rugosae	0	1
Phragmidium rubi	0	1
Phragmidium rubi-idaei	0	1
Phragmidium rubi-oldhamii	0	1
Prospodium appendiculatum	4	0
Prospodium transformans	2	0
Puccinia gouania	0	1
Puccinia malvacearum	1	1
Puccinia poarum	0	1
Puccinia recondita	1	1
Puccinia advena	1	0
Puccinia agrophila	1	0
Puccinia allii	1	0
Puccinia andropogonis	1	0
Puccinia anindinaria	1	0
Puccinia antirrhini	2	1
Puccinia arechavaletae	1	1
Puccinia argentata	1	1
Puccinia arundinania	1	1
Puccinia balsamorrhizae	1	0
Puccinia batatas	1	0
Puccinia bolleyana	1	0
Puccinia boroniae	1	0

(**Table B-4.** Continued.)

Rust species	**Larvae absent**	**Larvae present**
Puccinia brachypodii	0	2
Puccinia canaliculata	1	0
Puccinia caricina	2	0
Puccinia cf magnusiana	1	0
Puccinia chloridis	1	0
Puccinia circaeae	1	0
Puccinia cnici-oleracei	2	0
Puccinia cnici-oleracei AND Phakopsora artemisiae	0	1
Puccinia commelinae	1	0
Puccinia coronata	4	0
Puccinia coronata var. coronata	0	1
Puccinia cynodonis	1	0
Puccinia dampierae	1	0
Puccinia dieteliana	1	1
Puccinia dissotidis	1	0
Puccinia duthiae	1	0
Puccinia fallax	1	3
Puccinia farinacea	1	0
Puccinia glecomitis	1	0
Puccinia graminis	2	0
Puccinia heinerocallidis	1	0
Puccinia helianthi	2	0
Puccinia hemacalus	1	0
Puccinia hemerocallidis	1	1
Puccinia heucherae	1	0
Puccinia hieracii	6	0
Puccinia hordei	1	0
Puccinia hydrocotyles	1	0
Puccinia inulae-acuminata	1	0
Puccinia iridis	1	0
Puccinia jonesii	2	0
Puccinia kraussiana	1	0
Puccinia kuehnii	1	1
Puccinia kusanoi	2	1
Puccinia lantanae	0	1
Puccinia linosyridis-coricis	1	0
Puccinia lygodii	4	4
Puccinia majanthemi	1	0
Puccinia malvacearum	8	0

(**Table B-4.** Continued.)

Rust species	**Larvae absent**	**Larvae present**
Puccinia mariae-wilsoniae	1	0
Puccinia melanocephala	39	18
Puccinia mikaniae	1	0
Puccinia miscanthi	0	1
Puccinia mogiphanis	1	0
Puccinia nakanishiki	1	0
Puccinia nanbuana	0	2
Puccinia nigroconoidea	1	0
Puccinia nipponica	0	1
Puccinia obliquoseptata	6	0
Puccinia obscura	1	0
Puccinia orbicula	0	1
Puccinia oxalidis	1	4
Puccinia pelargonii-zonalis	1	0
Puccinia pimpinellae	0	1
Puccinia poaceae	0	1
Puccinia poarum	1	0
Puccinia podophylli	1	0
Puccinia polysora	1	0
Puccinia popowiae	1	0
Puccinia pritzeliana	1	1
Puccinia psidii	0	1
Puccinia punctata	1	0
Puccinia recondita	3	0
Puccinia rubefaciens	2	0
Puccinia salicis-tetraspermae	1	0
Puccinia salvina	1	0
Puccinia saussureae-lappae	1	0
Puccinia scleriae	1	0
Puccinia scleriicola	1	0
Puccinia similis	3	0
Puccinia smilacis	5	2
Puccinia sparganioides	3	1
Puccinia stenotaphri	1	0
Puccinia striniformis	2	0
Puccinia strobilanthis-urticifoliae	1	0
Puccinia subcoronata	1	0
Puccinia suzutake	2	1
Puccinia tanaceti var. tanaceti	0	1
Puccinia thaliae	3	0

(**Table B-4.** Continued.)

Rust species	**Larvae absent**	**Larvae present**
Puccinia tokyensis	0	2
Puccinia triticina	2	0
Puccinia violacea	1	0
Puccinia violae	5	3
Puccinia virgata	1	0
Puccinia waldsteiniae	0	1
Puccinia zoysiae	2	0
Pucciniastrum americanum	0	1
Pucciniastrum bohemeriae	0	2
Pucciniastrum epilobii	1	0
Pucciniastrum hydrangese-petiolaris	0	1
Pucciniastrum kusanoi	0	1
Pucciniosira tuberculata	0	1
Ravenalia emblicae	1	0
Ravenelia guyanensis	1	0
Sphaerophragmium acaciae	1	0
Sphaerophragmium longicorne	1	0
Thekopsora guttata	1	0
Tranzchelia fusca	3	0
Tranzschelia anemones	4	0
Tranzschelia arthurii	1	1
Tranzschelia asiatica	6	0
Tranzschelia discolor	2	1
Tranzschelia iranica	2	0
Tranzschelia microcerasi	1	0
Tranzschelia pruni-spinosae	9	0
Tranzschelia pulsatillae	2	0
Tranzschelia suffusca	1	0
Uredinopsis osmundae	1	0
Uredo baruensis	0	1
Uredo combreticola	2	0
Uredo ierensis	0	3
Uredo otholobii	1	0
Uredo scabies	1	0
Uredo spyridii	4	0
Uredopeltis chevalieri	2	0
Uromyces aecidiiformis	1	0
Uromyces ambiguus	1	0
Uromyces appendiculatus	1	0
Uromyces dactylidis	1	0

(**Table B-4.** Continued.)

Rust species	**Larvae absent**	**Larvae present**
Uromyces eragrostidis	2	0
Uromyces euphorbiae	2	0
Uromyces ficariae	3	0
Uromyces gageae	1	0
Uromyces geranii	0	1
Uromyces hedysari-paniculati	1	0
Uromyces inaequialtus	0	1
Uromyces intricatus	1	0
Uromyces junci-effusus	0	1
Uromyces lespedezae-procumbentis var. lespedezae-procumbentis	0	1
Uromyces muscari	1	0
Uromyces neotropicalis	3	0
Uromyces novissimus	1	0
Uromyces poae	1	0
Uromyces polygoni	1	0
Uromyces rosicola	1	0
Uromyces rudbeckiae	1	0
Uromyces rumicis	1	0
Uromyces setaria-italicae	1	0
Uromyces silphii	1	0
Uromyces striatus	2	0
Uromyces tenuicutis	1	0
Uromyces trifolina	1	0
Uromyces veratri	0	1
Uromyces viciae-fabae	1	0

Table B-5. Command line data for R to conduct Fisher's exact test of the null hypothesis that proportions of larvae observed are independent of rust species. P-value indicates that proportion of larvae observed is dependent on rust species in at least one instance.

```
> fisher.test(LarvData, y = NULL, workspace = 200000, hybrid = FALSE, simulate.p.value =
TRUE, B = 10000)

        Fisher's Exact Test for Count Data with simulated p-value (based on 10000
        replicates)

data:  LarvData
p-value = 9.999e-05
alternative hypothesis: two.sided
```

Table B-6. Command line data for R to conduct a binomial test of proportion for presence/absence data on rust species collections. This test identified rust species whose proportion of larval presence/absence is significantly different in both Fisher's exact test and binomial analysis of distribution. Overall proportion of larvae present on collections is 27.7%.

```
> tmp <- read.table(loc,sep="\t",header=T)
> name <- as.vector(tmp[,1])
> data <- as.matrix(tmp[,2:3])
> apply(data,2,sum)
Absent Present
424     163
> p0 <- 424/(424+163)
> FUN1 <-
+function(x)binom.test(x[1],n=sum(x[1:2]),p=p0,alternative="two.sided")$p.value
> pv <- apply(data,1,FUN1)
> name[which(pv<=0.05)]
[1] "Cerotelium_fici"             "Melampsora_tremuloides"
[3] "Melampsoridium_hiratsukanum" "Puccinia_oxalidis"
[5] "Uredo_ierensis"
```

Table B-7. Matrix used in Fisher's exact test of phylogenetic clades by rust identification information for collections on which larvae were found.

Rust Identification	**Clade 1**	**Clade 2**	**Clade 3**	**Clade 4**	**Clade 5**	**Clade 6**	**Clade 7**	**Clade 8**	**Clade 9**	**Clade 10**	**Clade 11**	**Clade 12**	**Clade 13**	**Clade 14**	**Clade 15**	**Clade 16**	**Clade 17**
Cerotelium fici	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Phakopsora pachyrizi	1	0	0	0	0	0	0	0	1	0	1	0	1	0	0	0	0
Coleosporium ipomoea	1	0	2	0	0	0	0	1	0	2	0	0	0	2	0	0	0
Coleosporium sp.	0	1	1	0	1	0	0	1	1	1	0	0	0	0	0	2	0
Puccinia cnici-oleracei	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phakopsora artemisiae	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phragmidium griseum	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pucciniastrum kusanoi	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Puccinia miscanthi	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Puccinia melanocephala	0	0	2	0	0	0	0	0	0	0	0	0	1	0	0	2	0
Puccinia lygodii	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phragmidium sp.	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Puccinia sp.	0	0	0	1	0	0	2	0	0	1	0	0	0	0	1	0	0
Gymnoconia nitens	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Puccinia violae	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Pucciniastrum hydrangese-petiolaris	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Puccinia lantanae	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Puccinia cf. recondita	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Kuehniola uredinis	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Uromyces junci-effusus	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Aecidium sp.	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0

(**Table B-7.** Continued.)

Rust Identification	**Clade 1**	**Clade 2**	**Clade 3**	**Clade 4**	**Clade 5**	**Clade 6**	**Clade 7**	**Clade 8**	**Clade 9**	**Clade 10**	**Clade 11**	**Clade 12**	**Clade 13**	**Clade 14**	**Clade 15**	**Clade 16**	**Clade 17**
Puccinia oxalidis	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Melampsora tremuloides	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Puccinia fallax	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Raveneliasp.	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0
Melampsora sp.	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0
Melampsoridium hiratsukanum	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Gymnosporangium juniper-virginianae	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Gymnoconia sp.	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
Uredinopsis sp.	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Pucciniastrum cf. americanum	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Pucciniosira cf. tuberculata	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Uromyces veratri	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Puccinia nipponica	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Uromyces sp.	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Gymnosporangium sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Cerotelium sabiceae	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Puccinia psidii	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Coleosporium vernoniae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Phakopsora meibomiae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Prospodium sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Uredosp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Gymnoconia peckiana	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0

Table B-8. Matrix used in Fisher's exact test of phylogenetic clades by rust genera for collections on which larvae were found.

Rust Genera	**Clade 1**	**Clade 2**	**Clade 3**	**Clade 4**	**Clade 5**	**Clade 6**	**Clade 7**	**Clade 8**	**Clade 9**	**Clade 10**	**Clade 11**	**Clade 12**	**Clade 13**	**Clade 14**	**Clade 15**	**Clade 16**	**Clade 17**
Prospodium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Uredo	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Puccinia	0	2	3	2	1	1	4	0	0	1	0	1	1	0	2	2	0
Coleosporium	1	1	3	0	1	0	0	2	1	3	0	0	0	2	1	2	0
Phakopsora	1	1	0	0	0	0	0	0	1	0	1	0	1	0	0	0	1
Uromyces	0	0	0	0	0	0	1	0	0	0	0	1	1	0	0	0	0
Cerotelium	1	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0
Ravenelia	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0
Gymnoconia	0	0	0	1	0	0	0	0	0	3	0	0	0	0	0	0	0
Phragmidium	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Melampsora	0	0	0	0	0	0	2	0	0	1	0	0	0	0	0	0	0
Gymnosporangium	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0
Pucciniosira	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Pucciniastrum	0	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0
Uredinopsis	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Kuehneola	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Aecidium	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Melampsoridium	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0

Table B-9. Matrix used in Fisher's exact test of phylogenetic clades by rust families for collections on which larvae were found.

Rust Family	**Clade 1**	**Clade 2**	**Clade 3**	**Clade 4**	**Clade 5**	**Clade 6**	**Clade 7**	**Clade 8**	**Clade 9**	**Clade 10**	**Clade 11**	**Clade 12**	**Clade 13**	**Clade 14**	**Clade 15**	**Clade 16**	**Clade 17**
Uropyxidaceae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Incertae cedis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Pucciniaceae	0	2	3	2	1	1	6	0	1	1	0	2	2	1	2	2	0
Coleosporeaceae	1	1	3	0	1	0	0	2	1	3	0	0	0	2	1	2	0
Phakopsoraceae	2	1	0	0	0	0	0	0	1	0	1	0	1	2	0	0	1
Raveneliaceae	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0
Phragmidiaceae	0	1	0	2	0	1	0	0	0	3	0	0	0	0	0	0	0
Melampsoraceae	0	0	0	0	0	0	2	0	0	1	0	0	0	0	0	0	0
Pucciniosiraceae	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Pucciniastraceae	0	1	0	0	1	0	1	0	0	2	0	0	0	0	0	0	0

Table B-10. Matrix used in Fisher's exact test of phylogenetic clades by country for collections on which larvae were found.

Country	Clade 1	Clade 2	Clade 3	Clade 4	Clade 5	Clade 6	Clade 7	Clade 8	Clade 9	Clade 10	Clade 11	Clade 12	Clade 13	Clade 14	Clade 15	Clade 16	Clade 17
Guam	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
USA	4	0	6	4	0	2	2	2	4	9	2	0	3	4	0	6	0
Equador	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
Guyana	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	0	0
Nigeria	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0
Japan	0	5	0	0	3	0	3	0	0	0	0	2	0	0	0	0	0
Switzerland	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Germany	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Canada	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0
Mexico	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Puerto Rico	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Costa Rica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1

Table B-11. Command line data for R to conduct Pearson's Chi-squared and Fisher's exact test of the null hypothesis that occurrence of larval clades are independent of rust species, rust genus, rust family, country, and continent of collection. P-value indicates that occurrence of larval clades is dependent on country in at least one instance

*****Chi-Sq and Fisher's Exact Test for Rust species and Larval clades*****
> tmp <- read.table (loc,sep="\t",header=T)
> name <- as.vector(tmp[,1])
> data <- as.matrix(tmp[,-1])
>chisq.test(data,correct=F,simulate.p.value=T,B=10000)

(**Table B-11.** Continued.)

		Pearson's Chi-squared test with simulated p-value (based on 10000									
		replicates)									
data: data											
X-squared = 681.3055, df = NA, p-value = 0.501											
> fisher.test(data,y=NULL,workspace=200000,hybrid=TRUE,simulate.p.value=T,B=10000)											
		Fisher's Exact Test for Count Data with simulated p-value (based on									
		10000 replicates)									
data: data											
p-value = 0.1449											
alternative hypothesis:											

(**Table B-11.** Continued.)

two.sided											
*****CONCLUSION: Fail to reject the null hypothesis that Larval clades are independent of Rust species*****											
____											
*****Chi-Sq and Fisher's Exact Test for Rust genera and Larval clades*****											
> loc2 <- "D:/1-over xmas break 2012/Thesis/Stats/New Species Stats/By Genus.txt"											
> tmp2<- read.table(loc2,sep="\t",header=T)											
> name2<-as.vector(tmp2[,1])											
> data2<-as.matrix(tmp2[,-1])											
> chisq.test(data2,correct=F,simulate.p.value=T,B=10000)											
		Pearson's Chi-squared test with simulated p-value (based on 10000									
		replicates)									
data: data2											

(**Table B-11.** Continued.)

X-squared = 267.2696, df = NA, p-value = 0.5765											
> fisher.test(data2,y=NULL,workspace=200000,hybrid=TRUE,simulate.p.value=T,B=10000)											
		Fisher's Exact Test for Count Data with simulated p-value (based on									
		10000 replicates)									
data: data2											
p-value = 0.2276											
alternative hypothesis: two.sided											
*****CONCLUSION: Fail to reject the null hypothesis that Larval clades are independent of Rust genera*****											
____											
*****Chi-Sq and Fisher's Exact Test for Rust families and Larval clades*****											
> loc3 <- "D:/1-over xmas break 2012/Thesis/Stats/New Species Stats/By Family.txt"											

(**Table B-11.** Continued.)

> tmp3<- read.table(loc3,sep="\t",header=T)											
> name3<- as.vector(tmp3[,1])											
> data3<- as.matrix(tmp3[,-1])											
> chisq.test(data3,correct=F,simulate.p.value=T,B=10000)											
		Pearson's Chi-squared test with simulated p-value (based on 10000									
		replicates)									
data: data3											
X-squared = 146.7708, df = NA, p-value = 0.436											
> fisher.test(data3,y=NULL,workspace=200000,hybrid=TRUE,simulate.p.value=T,B=10000)											
		Fisher's Exact Test for Count Data with simulated p-value (based on									
		10000									

(**Table B-11.** Continued.)

		replicates)	
data: data3			
p-value = 0.1605			
alternative hypothesis: two.sided			
CONCLUSION: Fail to reject the null hypothesis that Larval clades are independent of Rust families			
____			
Chi-Sq and Fisher's Exact Test for Country and Larval clades			
> loc4 <- "D:/1-over xmas break 2012/Thesis/Stats/New Species Stats/By Country.txt"			
> tmp4<- read.table(loc4,sep="\t",header=T)			
> name4<- as.vector(tmp4[,1])			
> data4<- as.matrix(tmp4[,-1])			
> chisq.test(data4,correct=F,simulate.p.value=T,B=10000)			

(**Table B-11.** Continued.)

Pearson's Chi-squared test with simulated p-value (based on 10000 replicates)

data: data4

X-squared = 260.2104, df = NA, p-value = 0.0021

> fisher.test(data4,y=NULL,workspace=200000,hybrid=TRUE,simulate.p.value=T,B=10000)

Fisher's Exact Test for Count Data with simulated p-value (based on 10000 replicates)

data: data4

p-value = 9.999e-05

alternative hypothesis: two.sided

*****CONCLUSION: Reject the null hypothesis. Larval clades are dependent on Country in at least one of the 17 clades*****

(**Table B-11.** Continued.)

```
***Chi-Sq and Fisher's Exact Test for Continent and Larval clades***

> loc5 <- "E:/1-over xmas break 2012/Thesis/Stats/New Species Stats/By Continent.txt"

> tmp5<-read.table(loc5,sep="\t",header=T)

> name5<-as.vector(tmp5[,1])

> data5<-as.matrix(tmp5[,-1])

> chisq.test(data5,correct=F,simulate.p.value=T,B=10000)


        Pearson's Chi-squared test with simulated p-value (based on 10000

        replicates)


data:  data5

X-squared = 97.261, df = NA, p-value = 0.0171


> fisher.test(data5,y=NULL,workspace=200000,hybrid=TRUE,simulate.p.value=T,B=10000)


        Fisher's Exact Test for Count Data with simulated p-value (based on

        10000 replicates)


data:  data5

p-value = 9.999e-05

alternative hypothesis: two.sided

***CONCLUSION: Reject the null hypothesis. Larval clades are dependent on Continent in at least one

of the 17 clades***

________________________________________________________________________________
```

Table B-12. Number of collections surveyed by country of origin and the proportion of collections from each location with *Mycodiplosis* infestation. Some collections not included if location of origin was unknown.

Country	Larvae present	Larvae absent	Total collections	% infested
Australia	1	12	13	7.69
Austria	0	1	1	0.00
Belarus	2	1	3	66.67
Belize	0	13	13	0.00
Brazil	1	1	2	50.00
Cameroon	0	2	2	0.00
Canada	4	40	44	9.09
China	4	20	24	16.67
Costa Rica	2	12	14	14.29
Croatia	1	3	4	25.00
Denmark	0	3	3	0.00
Equador	4	25	29	13.79
France	1	6	7	14.29
Germany	4	35	39	10.26
Greece	0	1	1	0.00
Guam	4	9	13	30.77
Guatemala	0	3	3	0.00
Guyana	8	42	50	16.00
India	2	36	38	5.26
Iran	0	11	11	0.00
Ireland	0	1	1	0.00
Italy	0	3	3	0.00
Japan	68	51	119	57.14
Kazakhstan	0	1	1	0.00
Malasia	0	12	12	0.00
Mexico	8	22	30	26.67
Morocco	0	1	1	0.00
New Zealand	0	1	1	0.00
Nigeria	2	43	45	4.44
Pakistan	0	5	5	0.00
Portugal	0	1	1	0.00
Puerto Rico	1	1	2	50.00
Russia	0	2	2	0.00
Scotland	1	4	5	20.00
Slovenia	0	2	2	0.00
South Africa	3	35	38	7.89

(**Table B-12.** Continued.)

Country	Larvae present	Larvae absent	Total collections	% infested
Spain	3	48	51	5.88
Switzerland	4	14	18	22.22
Syria	0	2	2	0.00
Taiwan	2	1	3	66.67
Turkey	1	10	11	9.09
Uganda	2	4	6	33.33
USA	121	487	608	19.90
Zambia	0	1	1	0.00
All locations	254	1028	1282	19.81

Appendix C. DNA Extraction Protocol Information

Promega Wizard Genomic DNA Purification Kit (Promega Corporation, Madison, WI) protocol was modified based on standard laboratory protocols for DNA extraction of fungal material in the lab of Dr. M. C. Aime at Louisiana State University. Full protocol details are available at: http://www.promega.com/~/media/Files/Resources/Protocols/Technical%20Manuals/0/Wizard%20Genomic%20DNA%20Purification%20Kit%20Protocol.pdf.

Bio-Rad InstaGene Matrix (Bio-Rad Laboratories, Hercules, CA) protocol for DNA preparation from whole blood was modified to eliminate steps specific to the extraction of DNA from whole blood. Full protocol details are available at: http://www.bio-rad.com/webroot/web/pdf/lsr/literature/Bulletin_1810.pdf.

The *prep*GEM Insect DNA extraction kit (ZyGem Corporation Ltd, Hamilton, New Zealand) was modified to increase the concentration of DNA template in solution by decreasing the volume of reagents to 0.5 of protocol volumes. Full protocol details are available at: http://www.zygem.com/PDF/pg_insect_wqs.pdf.

Vita

Donald J. Nelsen was born in Bemidji, Minnesota. Donald served in the U.S. Navy as a Fire Control Technician from 2000 until 2006. He earned his B.S. in Biology with a focus on Ecology from Minnesota State University, Mankato in December 2010. While enrolled in his undergraduate institution he conducted wildlife ecology research examining the utility of wildlife underpasses to reduce over-the-road deer crossings. During the summer of 2010 he participated in a fungal biodiversity survey in Chiang Mai Province, Thailand. It was here that he developed a keen interest in fungal identification and diversity. Donald is an avid angler, having spent much of his youth fishing the lakes of Minnesota. He also enjoys hunting, hiking, and occasionally writing fiction.