

Microbiological and Chemical Exposure Assessment

EPA Technology for Mold Identification and Enumeration

The presence of molds in homes, schools and business is of growing concern in the United States. To begin to understand the significance of exposure to these organisms, a standardized technology is needed for their identification and quantification. In May of 2002, the EPA was granted patent 6,387,652 which describes mold DNA sequences that makes their identification and quantification possible. This relatively inexpensive technology has been licensed by firms in the U.S., Germany and the United Kingdom (below).

The patented technology teaches the best available DNA sequences to use for over 130 of the major indoor air fungi. It is particularly useful, in that a licensed company can employ a technician or robotic system to analyze samples and obtain highly reproducible results in only a few hours -- eliminating the need for plating and culturing or identifying and counting. Other analytical techniques may take days or week to complete. Most typical sampling systems can be adapted for use with this technology.

One of the problems with mold exposure estimates has been the lack of a standardized method for describing the mold burden in a home (Vesper 2010, in press). United States Environmental Protection Agency (US EPA) and Department of Housing and Urban Development (HUD) researchers have developed a metric called the Environmental Relative Moldiness Index (ERMI) to objectively describe the home mold burden (Vesper et al. 2007). A DNA-based analysis called Mold Specific Quantitative PCR (MSQPCR) of 36 molds including, the 26 Group 1 species associated with homes with water damage and the 10 Group 2 species which are found in homes independent of water damage, forms the basis of the ERMI. (Figure 1, click once for values, click 2-5 times for quartiles) If the Sum of the Logs of the Group 2 (SLG2) molds is subtracted from the Sum of the Logs of the Group 1 (SLG1) molds, a unit-less Environmental Relative Moldiness Index (ERMI) value is calculated which describes the mold burden in a home with a single numeric value relative to the National ERMI scale. The ERMI scale ranges from about -10 to 20 or even higher and is divided into quartiles. The homes in the lowest quartile have the lowest mold burden. Each higher quartile indicates more mold present in the home. The fourth quartile indicates homes with the highest mold burden (Vesper et al. 2007)

Literature references pertinent to this technology can be found at the end of this page.

Primers and Probes for Target Species

Absidia | *Acromonium* | *Alternaria* | *Aspergillus* | *Aureobasidium* | *Candida* | *Chaetomium* | *Cladosporium* | *Emericella* | *Eurotium* | *Epicoccum* | *Fusarium* | *Geotrichum* | *Memnoniella* | *Mucor* | *Myrothecium* | *Paecilomyces* | *Penicillium* | *Rhizomucor* | *Rhizopus* | *Scopulariopsis* | *Stachybotrys* | *Trichoderma* | *Ulocladium* | *Wallemia* | *Universal Penicillium, Aspergillus, Paecilomyces* |

Absidia corymbifera (assay name: Acory)

Forward Primer NS92F: 5'-CACCGCCCGTCGCTAC

Reverse Primer AcoryR1: 5'-GCAAAGCGTCCGAAGGACA

Probe AcoryP1: 5'-ATGGCACGAGCAAGCATTAGGGACG

Acromonium strictum (assay name: Astrc)

Forward Primer AstrcF1: 5'-CAACCCATTGTGAACCTACCAAAC

Reverse Primer AstrcR1: 5'-CGCCCCCTCAGAGAAATACGATT

Probe AstrcP1: 5'-TCAGCGCGCGGTGGCCTC

Alternaria alternata (assay name: Aaltr)

Forward Primer AaltrF1: 5'-GGCGGGCTGGAACCTC

Reverse Primer AaltrR1-1: 5'-GCAATTACAAAAGGTTTATGTTTGTCTGA

Probe AaltrP1: 5'-TTACAGCCTTGCTGAATTATCACCCCTTGCTCTT

Aspergillus auricomus (assay name: Aauri)

Forward Primer AauriF1: 5'-ATTACTGAGTGAGGGTCCCTCG

Reverse Primer AauriR1: 5'-GGCGGCCCGCGTAAAC

Probe AauriP1: 5'-CCCGCCGAAGCAACAAGGTACG

Aspergillus caespitosus (assay name: Acaes)

Forward Primer AcaesF1: 5'-CTCCACCCGTGAATACCTT

Reverse Primer AcaesR1: 5'-GGCTCAGACGCAACTCTACAAT

Probe AcaesP1: 5'-CACTGTTGCTTCGGCGAGGAGCC

Aspergillus candidus (assay name: Acand3)

Forward Primer AcandF1: 5'-TTACCGAGTGAGGGTTTCTCTGA

Reverse Primer AcandR2: 5'-CCCGCCGAAGCAACAG

Probe* PenAspP1 mgb: 5'-CCAACCTCCACCCGCTG

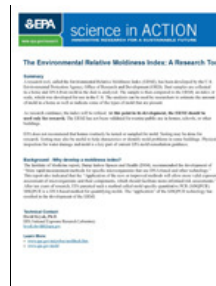
Aspergillus carbonarius (assay name: Acarb)

Forward Primer AcarbF1-1: 5'-CTTTGGGCCCAACCTCCTAC

Reverse Primer AcarbR1: 5'-CCCGAGGGCAGAGATG

Probe AspP1: 5'-TTGCTTCGGCGGGGCC

Related Links



[The Environmental Relative Moldiness Index: A Research Tool](#)



[EPA Scientists Develop Research Methods for Studying Mold](#)

Aspergillus cervinus (assay name: Acerv)

Forward Primer AcervF1: 5'-CCACCCGTGCTATTGTACCTTT

Reverse Primer AcervR1-1: 5'-CAACTCAGACTGCAATTCAGAACTGT

Probe AspP1: 5'-TTGCTTCGGCGGGCCC

Aspergillus clavatus/giganteus (assay name: Aclav)

Forward Primer AclavF1: 5'-CCCGCCGTCTTCGGA

Reverse Primer AclavR1: 5'-CCGTTGTTGAAAGTTTAACTGATTATG

Probe AfumiP1: 5'-CCCGCCGAAGACCCCAACATG

Aspergillus flavus/oryzae (assay name: Aflav)

Forward Primer AflavF1: 5'-CGAGTG TAGGGTTCCTAGCGA

Reverse Primer AflavR1: 5'-CCGGCGGCCATGAAT

Probe AflavP1: 5'-TCCCACCCGTGTTTACTGTACCTTAGTTGCT

Aspergillus fumigatus, Neosartorya fischeri (assay name: Afumi)

Forward Primer AfumiF1: 5'-GCCCGCCGTTTCGAC

Reverse Primer AfumiR1: 5'-CCGTTGTTGAAAGTTTAACTGATTAC

Probe AfumiP1: 5'-CCCGCCGAAGACCCCAACATG

Aspergillus flavipes (assay name: Aflvp2)

Forward Primer AflvpF1: 5'-CCACCCGTGACTACTGTACCAC

Reverse Primer AflvpR2: 5'-AGGCTTTCAGAAACAGTGTTCG

Probe AspP1: 5'-TTGCTTCGGCGGGCCC

Aspergillus niger/awamori/foetidus/phoenicis (assay name: Anigr)

Forward Primer AnigrF1: 5'-GCCGGAGACCCCAACAC-3'

Reverse Primer AnigrR1: 5'-TGTTGAAAGTTTAACTGATTGCATT-3'

Probe AnigrP1: 5'-AATCAACTCAGACTGCACGCTTTCAGACAG

Aspergillus niveus (assay name: Anive)

Forward Primer AniveF1: 5'-ACCCGTGCCTATTGTACCCCT

Reverse Primer AniveR1: 5'-TGCAAACAATCACACTCAGACAC

Probe AspP1: 5'-TTGCTTCGGCGGGCCC

Aspergillus ochraceus/ostianus (assay name: Aochr1)

Forward Primer AochrF1: 5'-AACCTCCCACCCGTGTATACC-3'

Reverse Primer AochrR1: 5'-CCGGCGAGCGCTGTG-3'

Probe AochrP1: 5'-ACCTTGTTGCTTCGGCGAGCCC

Aspergillus paradoxus (assay name: Apard)

Forward Primer ApardF1: 5'-CGGGGGGCTTACGCT

Reverse Primer ApardR1-1: 5'-GACTGCAACTTCATACAGAGTTGGT

Probe PenP2: 5'-CGCGCCCGCCGAAGACA

Aspergillus parasiticus/sojae (assay name: Apara)

Forward Primer AflavF1: 5'-CGAGTG TAGGGTTCCTAGCGA-3'

Reverse Primer AparaR3: 5'-GCCCGGGGCTGACG

Probe AflavP1: 5'-TCCCACCCGTGTTTACTGTACCTTAGTTGCT

Aspergillus penicilliioides (assay name: Apeni2)

Forward Primer ApeniF2: 5'-CGCCGAGACCTCAACC

Reverse Primer ApeniR2: 5'-TCCGTTGTTGAAAGTTTAAACGA

Probe ApeniP2: 5'-TGAACACTGTCTGAAGGTTGCAGTCTGAGTATG

Aspergillus puniceus (assay name: Apuni)

Forward Primer ApuniF1: 5'-CATTACCGAGTGCAGGCCTC

Reverse Primer AustsR1: 5'-GCCGAAGCAACGTTGGTC

Probe ApuniP1: 5'-CCCCACAGGCAGGCCTAACCTC

Aspergillus restrictus/caesillus/conicus (assay name: Arest)

Forward Primer ArestF1: 5'-GGGCCCCGCCTCAT-3'

Reverse Primer ArestR1: 5'-GTTGTTGAAAGTTTAAACGATTTTCT

Probe ArestP1: 5'-CCCGCCGAGACTCCAACATTG

Aspergillus sclerotiorum (assay name: Asclr)

Forward Primer AcircF1: 5'-ATTACTGAGTGAGGGTCCCTCG

Reverse Primer AsclrR1: 5'-CCTAGGGAGGGGGTTTGA

Probe AcircP1: 5'-CCCGCCGAAGCAACAAGGTACG

Aspergillus sydowii (assay name: Asydo3)

Forward Primer AsydoF1-1: 5'-CAACCTCCCACCCGAGAA

Reverse Primer AversR1-1: 5'-CCATTGTTGAAAGTTTTGACTGATcTTA
Probe versP1: 5'-AGACTGCATCACTCTCAGGCATGAAGTTCAG

Aspergillus tamarii (assay name: Atama2)

Forward Primer AflavF1: 5'-CGAGTGTAGGGTTCCCTAGCGA
Reverse Primer AtamaR2: 5'-CCCGCGCGCCTTAAAG
Probe AflavP1: 5'-TCCCACCCGTGTTTACTGTACCTTAGTTGCT

Aspergillus terreus (assay name: Aterr2)

Forward Primer AterrF1-1: 5'-ATCATTACCGAGTGCGTGTCTTTA
Reverse Primer AterrR2: 5'-CCCGCCGAAGCAACAAG
Probe AterrP2: 5'-CCCAACCTCCCACCCGTGACTATTG

Aspergillus unguis (assay name: Aungu)

Forward Primer AunguF1: 5'-CAACCTCCCACCCTTGAATACT
Reverse Primer AunguR1: 5'-TCACTCTCAGGCATGAAGTTCAG
Probe AcaesP1: 5'-CACTGTTGCTTCGGCGAGGAGCC

Aspergillus ustus (assay name: Austs2)

Forward Primer AustsF2-1: 5'-AAGGATCATTACCGAGTGCAcGT
Reverse Primer AustsR1: 5'-GCCGAAGCAACGTTGGTC
Probe AustsP1: 5'-CCCCCGGGCAGGCCTAACC

Aspergillus versicolor (assay name: Avers2-2)

Forward Primer AversF2 (5x): 5'-CGCGGGGAGCCCT
Reverse Primer AversR1-1: 5'-CCATTGTTGAAAGTTTTGACTGATcTTA
Probe versP1: 5'-AGACTGCATCACTCTCAGGCATGAAGTTCAG

Aspergillus wentii (assay name: Awent)

Forward Primer AwentF1: 5'-CATTACCGAGTGAGGACCTAACC
Reverse Primer AwentR1: 5'-CGCGGCCACGAAT
Probe AcircP1: 5'-CCCGCCGAAGCAACAAGGTACG

Aureobasidium pullulans (assay name: Apull)

Forward Primer ApullF1: 5'-GATCATTAAAGAGTAAGGGTGCTCA
Reverse Primer ApullR1: 5'-GCTCGCTGGGACGAATC
Probe ApullP1: 5'-CGCCCGACCTCCAACCCTTTG

Candida albicans (assay name: Calbi)

Forward Primer CalbF1: 5'-CTTGGTATTTTGCATGTTGCTCTC
Reverse Primer CalbR1: 5'-GTCAGAGGCTATAACACACAGCAG
Probe CalbP1: 5'-TTTACCGGGCCAGCATCGGTTT

Candida dubliniensis (assay name: Cdubl)

Forward Primer CdubF1: 5'-AGATCAGACTTGGTATTTTGCAAGTTA
Reverse Primer CdubR1: 5'-TAGGCTGGCAGTATCGTCAGA
Probe CdubP1: 5'-TTTACCGGGCCAGCATCGGTTT

Candida glabrata (assay name: Cglab)

Forward Primer Cglab F1: 5'-GCGCCCCTTGCCTCTC
Reverse Primer Cglab R1: 5'-CCCAGGGCTATAACACTCTACACC
Probe Cglab P1: 5'-TGGGCTTGGGACTCTCGCAGC

Candida (assay name: Pichia) *guilliermondii* (assay name: Cguil)

Forward Primer CguiF1: 5'-CCTTCGTGGCGGGGTG
Reverse Primer CguiR1: 5'-GCAGGCAGCATCAACGC
Probe CguiP1: 5'-CCGCAGCTTATCGGGCCAGC

Candida haemulonii, svar. 1 (assay name: Chaem1)

Forward Primer ChaefF1: 5'-GGAGCGACAACGAGCAGTC
Reverse Primer ChaefR1: 5'-AGGAGCCAGAAAGCAAGACG
Probe ChaefP1: 5'-ATGTAGTACAGCCCTCTGGGCTGTGCA

Candida haemulonii, svar. 2 (assay name: Chaem2)

Forward Primer Cha2F1: 5'-ATCGGGTGGAGCGGAACT
Reverse Primer Cha2R1: 5'-CGAAGCAGGAACCATCTGAGA
Probe Cha2P1: 5'-AAGTGGGAGCTGATGTAGCAACCCCC

Candida krusei (assay name: Ckrus)

Forward Primer CkruF1: 5'-CTCAGATTTGAAATCGTGCTTTG
Reverse Primer CkruR1: 5'-GGGGCTCTACCCTCCTG
Probe CkruP1: 5'-CACGAGTTGTAGATTGCAGGTTGGAGTCTG

Candida lipolytica (assay name: Clipo)

Forward Primer ClipF1: 5'-TAGCGAGACGAGGGTTACAAATG

Reverse Primer ClipR1: 5'-CGTCGGTGGCAGTGTGGA

Probe ClipP1: 5'-CCTTCGGGCGTCTCCCTAACC

Candida lusitanae (assay name: Clusi)

Forward Primer Clus F2: 5'-GGGAATTGTAATTTGAAGGTTTCGT-3'

Reverse Primer Clus R2: 5'-GTCGGCGTGCGCCATA-3'

Probe Clus P2: 5'-TCTGAGTCGGCCGCGCCC-3'

Candida maltosa (assay name: Cmalt)

Forward Primer CmalF1: 5'-GGCCAGCATCAGTTTGGAC

Reverse Primer CmalR1: 5'-TCTAGACTGGCAGTATCGACAGTG

Probe CmalP1: 5'-TAGGACAATTGCGGTGGAATGTGGC

Candida parapsilosis (assay name: Cpara)

Forward Primer CparF1: 5'-GATCAGACTTGGTATTTTGTATGTTACTCTC

Reverse Primer CparR1: 5'-CAGAGCCACATTCTTTGCAC

Probe CparP1: 5'-CCTCTACAGTTTACCGGGCCAGCATCA

Candida sojae (assay name: Csoja)

Forward Primer CsojF1: 5'-CGGTTGTGTATTATAGCCTTCGTA

Reverse Primer CsojR1: 5'-ATCATTATGCCAACATCCTAGGTAAT

Probe CtropP2: 5'-CGCAGTCCTCAGTCTAGGCTGGCAG

Candida tropicalis (assay name: Ctrop)

Forward Primer CtropF1: 5'-GCGGTAGGAGAATTGCGTT

Reverse Primer CtropR2: 5'-TCATTATGCCAACATCCTAGGTTTA

Probe CtropP2: 5'-CGCAGTCCTCAGTCTAGGCTGGCAG

Candida viswanathii (assay name: Cvisw)

Forward Primer CvisF1: 5'-CGGCAGGACAATCGCGT

Reverse Primer CvisR1: 5'-TCTAGGCTGGCAGTATCCACG

Probe CvisP1: 5'-AATGTGGCACGGCCTCGGC

Candida zeylanoides (assay name: Czeyl)

Forward Primer Czey F1: 5'-GTTGTAATTTGAAGAAGGTAACCTTGATT

Reverse Primer Czey R1: 5'-GACTCTTCGAAAGCACTTTACATGG

Probe Czey P1: 5'-CCTTGGAACAGGACGTACAGAGGGT

Chaetomium globosum (assay name: Cglob)

Forward Primer CglobF1: 5'-CCGCAGGCCCTGAAAAG

Reverse Primer CglobR1: 5'-CGCGGCGCGACCA

Probe CglobP1: 5'-AGATGTATGCTACTACGCTCGGTGCGACAG

Cladosporium cladosporioides, svar. 1 (assay name: Cclad1)

Forward Primer Cclad1F1: 5'-CATTACAAGTGACCCCGGTCTAAC

Reverse Primer CcladR1: 5'-CCCCGGAGGCAACAGAG

Probe CcladP1: 5'-CCGGGATGTTTCATAACCCCTTTGTTGTCC

Cladosporium cladosporioides, svar. 2 (assay name: Cclad2)

Forward Primer Cclad2F1: 5'-TACAAGTGACCCCGGCTACG

Reverse Primer CcladR1: 5'-CCCCGGAGGCAACAGAG

Probe CcladP1: 5'-CCGGGATGTTTCATAACCCCTTTGTTGTCC

Cladosporium herbarum (assay name: Cherb)

Forward Primer CherbF1: 5'-AAGAACGCCCGGGCTT

Reverse Primer CherbR1: 5'-CGCAAGAGTTTGAAGTGCCAC

Probe CherbP1: 5'-CTGGTTATTCATAACCCCTTTGTTGTCGACTCTG

Cladosporium sphaerospermum (assay name: Cspha)

Forward Primer CsphaF1: 5'-ACCGGCTGGGTCTTTTCG

Reverse Primer CsphaR1: 5'-GGGGTTGTTTTACGGCGTG

Probe CsphaP1: 5'-CCCGCGGCACCCTTTAGCGA

Emericella (Aspergillus) nidulans/rugulosa/quadrilineata (assay name: Anidu2)

Forward Primer AversF1: 5'-CAACCTCCCACCCGTGAC

Reverse Primer AniduR1-1: 5'-CCATTGTTGAAAGTTTTGACTGATaTGT

Probe versP1: 5'-AGACTGCATCACTCTCAGGCATGAAGTTCAG

Emericella (Aspergillus) varicolor (assay name: Avari)

Forward Primer AversF2: 5'-CGGCGGGGAGCCCT

Reverse Primer AvariR1-1: 5'-CCATTGTTGAAAGTTTGGACTAAATTCTC
Probe AvariP1: 5'-CATCACTACAGGCATGAAGTTCGGTGGT

Eurotium (Aspergillus) amstelodami/chevalieri/herbariorum/rubrum/repens (assay name: Eamst)

Forward Primer EamstF1: 5'-GTGGCGGCACCATGTCT

Reverse Primer EamstR1: 5'-CTGGTTAAAAAGATTGGTTGCGA

Probe EamstP1: 5'-CAGCTGGACCTACGGGAGCGGG

Epicoccum nigrum (assay name: Enigr)

Forward Primer EnigrF1: 5'-TTGTAGACTTCGGTCTGCTACCTCTT

Reverse Primer EnigrR1: 5'-TGCAACTGCAAAGGGTTTGAAT

Probe EnigrP1: 5'-CATGTCTTTTGAGTACCTTCGTTTCCTCGGC

Fusarium solani f.sp. *batatas* MP II (Fsola2)

Forward Primer FsolaF2: 5'-CGCCGCAGCTTCCAAT

Reverse Primer FsolaR2: 5'-GATTTCGAGGTCAACGTTCTAAAAGT

Probe* FsolaP1mgb: 5'-CGTAGTAGCTAACACCTC

Fusarium solani f.sp. *cucurbitae* MP I (Fsola1)

Forward Primer FsolaF1: 5'-CAGCCGCAGCTTCCAGT

Reverse Primer FsolaR1-1: 5'-CGTGGCCGAGCCtCTG

Probe* FsolaP1mgb: 5'-CGTAGTAGCTAACACCTC

Fusarium solani f.sp. *mori* MP III, *Fusarium solani* f.sp. *cucurbitae* MP V, *Fusarium solani* f.sp. *pisi* MP VI, *Fusarium solani* f.sp. *robiniae* MP VII (Fsola3)

Forward Primer FsolaF3: 5'-CGCCGCAGCTTCCATC

Reverse Primer FsolaR3: 5'-GATTTCGAGGTCAACTTCAGAAGAG

Probe* FsolaP1mgb: 5'-CGTAGTAGCTAACACCTC

Fusarium solani f.sp. *xanthoxyli* MP IV (Fsola4)

Forward Primer FsolaF4: 5'-CGCCGCAGCTTCCATT

Reverse Primer FsolaR4-1: 5'-GATTTCGAGGTCAACTTTCAGAtGT

Probe* FsolaP1mgb: 5'-CGTAGTAGCTAACACCTC

Geotrichum candidum strain UAMH 7863 (assay name: Geo - reference strain only)

Forward Primer GeoF1: 5'-GATATTCTTGTAATTGCAGAAAGTGA

Reverse Primer GeoR1: 5'-TTGATTGCAAATTTAGAAAGAGCAAA

Probe GeoP1: 5'-CAATTCCAAGAGAGAAACAACGCTCAAACAAG

Geotrichum candidum (assay name: Gcand2)

Forward Primer NS92F: 5'-CACCGCCCGTCGCTAC

Reverse Primer GcandR1: 5'-AGAAAAGTTGCCCTCTCCAGTT

Probe GeoP2: 5'-TCAATCCGGAAGCCTCACTAAGCCATT

Geotrichum klebahnii (assay name: Gkleb1)

Forward Primer GklebF1: 5'-GGGCGACTTTTCGGGC

Reverse Primer GklebR2: 5'-TGGCACAAATTCTCCTCTAATTTATTTA

Probe GklebP1: 5'-AAGCTAGTCAAACCTTGGTCATTTAGAGGAAGTAAAAGTC

Memnoniella echinata (assay name: Mem)

Forward Primer StacF4 5'-TCCCAAACCCTTATGTGAACC

Reverse Primer MemR1: 5'-TGTTTATACCACTCAGACGATACTCAAGT

Probe MemP1: 5'-CTCGGGCCCGGAGTCAGGC

Mucor amphibiorum/circinelloides/hiemalis/indicus/mucedo/racemosus/ramosissimus

and *Rhizopus azygosporus/homothalicus/microsporus/oligosporus/oryzae* (assay name: Muc1)

Forward Primer NS92F: 5'-CACCGCCCGTCGCTAC

Reverse Primer MucR1-1: 5'-CCTAGTTTGCCATAGTTCTCAGCAG

Probe MucP1: 5'-CCGATTGAATGGTTATAGTGAGCATATGGGATC

Myrothecium verrucaria (assay name: Mverr)

Forward Primer MyroF1: 5'-AGTTTACAACTCCCAAACCCTTT

Reverse Primer MyroR1: 5'-GTGTCACTCAGAGGAGAAAACCA

Probe MyroP1: 5'-CGCCTGGTTCCGGGCCC

Paecilomyces lilacinus (assay name: Plila)

Forward Primer PlilaF1: 5'-CCCACTGTGAACCTTACCTCAG

Reverse Primer PlilaR1: 5'-GCTTGTGCAACTCAGAGAAGAAAT

Probe PlilaP1: 5'-CCGCCCGCTGGGCGTAATG

Paecilomyces variotii (assay name: Pvari2)

Forward Primer PvariF2: 5'-CGAAGACCCCTGGAACG

Reverse Primer PvariR1: 5'-GTTGTTGAAAGTTTAAATTGATTGATTGT

Probe PvariP1: 5'-CTCAGACGGCAACCTTCCAGGCA

Penicillium aethiopicum (assay name: Paeth)

Forward Primer PaethF1-1: 5'-CGGGGGGCTCtCGCT

Reverse Primer PchryR1-1: 5'-GAAAGTTTAAATAATTTATTTTCACTCAGAgTA

Probe PenP2: 5'-CGCGCCCGCCGAAGACA

Penicillium atramentosum (assay name: Patra)

Forward Primer PgrisF1-1: 5'-ACCTGCGGAAGGATCATTtCT

Reverse Primer PatraR1: 5'-CCCCGGCGGCCATA

Probe PenP3: 5'-TCCAACCTCCCACCCGTGTTTATTT

Penicillium aurantiogriseum/freii/polonicum/tricolor/viridicatum (assay name: PenGrp1A)

Forward Primer PexpaF1-1: 5'-TTACCGAGTGAGGGCCgTT

Reverse Primer PauraR6: 5'-CCCGGCGGCCAGTA

Probe PenP3: 5'-TCCAACCTCCCACCCGTGTTTATTT

Penicillium aurantiogriseum/freii/hirsutum/polonicum/tricolor/viridicatum/verrucosum, svar. 2 (assay name: PenGrp1)

Forward Primer PauraF1: 5'-CGGGCCCGCCTTAC

Reverse Primer PauraR1-1: 5'-GAAAGTTTAAATAATTTATTTTCACTCAGAGTT

Probe PenP2: 5'-CGCGCCCGCCGAAGACA

Penicillium brevicompactum/stoloniferum (assay name: Pbrev)

Forward Primer PbrevF3: 5'-GGCGAGCCTGCCTTTTG

Reverse Primer PenR2: 5'-GATCCGTTGTTGAAAGTTTTAAATAATTATA

Probe PbrevP2: 5'-CTCGCCGAAGACACCTTAGAACTCTGTCTGA

Penicillium canescens (assay name: Pcan2)

Forward Primer PcanF1: 5'-TTACCGAGCGAGAATTCTCTGA

Reverse Primer PcanR2-1: 5'-CCGCCGAAGCAACAAGtTAC

Probe* PenAspP1mgb: 5'-CCAACCTCCCACCCGTG

Penicillium chrysogenum, svar. 2 (assay name: Pchry)

Forward Primer PchryF4-1: 5'-GCCTGTCCGAGCGTCACTT

Reverse Primer PchryR8: 5'-CCCCGGGATCGGAG

Probe PenP6: 5'-CCAACACACAAGCCGTGCTTGAGG

Penicillium chrysogenum/griseofulvum/glandicola/coprophilum/expansum

and *Eupenicillium crustaceum/egyptiacum* (assay name: PenGrp3)

Forward Primer PchryF1: 5'-CGGGCCCGCCTTAAC

Reverse Primer PchryR1-1: 5'-GAAAGTTTAAATAATTTATTTTCACTCAGAGTA

Probe PenP2: 5'-CGCGCCCGCCGAAGACA

Penicillium citreonigrum (Pcteo2)

Forward Primer PcteoF2-1: 5'-GGGGGCATCTGcTCTCTG

Reverse Primer PcteoR2-1: 5'-CCGTTGTTGAAAGTTTTAAGTTAtTAA

Probe* PenAspP1mgb: 5'-CCAACCTCCCACCCGTG

Penicillium citrinum/sartoryi/westlingi (Pcitr)

Forward Primer PcitrF1: 5'-CCGTGTTGCCGAACCTA

Reverse Primer PcitrR1: 5'-TTGTTGAAAGTTTTAACTAATTTCTGTTATAG

Probe PcitrP1: 5'-TGCAACTTCAGACAGCGTTCAGGGG

Penicillium coprophilum (assay name: Pcopr)

Forward Primer PcoprF1-1: 5'-GGGTCCAACCTCCCACtCA

Reverse Primer PchryR1-1: 5'-GAAAGTTTAAATAATTTATTTTCACTCAGAgTA

Probe PenP1: 5'-CGCCTTAACCTGGCCGCCGG

Penicillium corylophilum (assay name: Pcory)

Forward Primer PcoryF1: 5'-GTCCAACCTCCCACCCA

Reverse Primer PcoryR3-1: 5'-GCTCAGACTGCAATCTTCAGACTGT

Probe PcoryP1: 5'-CTGCCCTCTGGCCGCG

Penicillium crustosum/camembertii/commune/echinulatum/solium (assay name: PenGrp2)

Forward Primer PchryF1: 5'-CGGGCCCGCCTTAAC

Reverse Primer PauraR1-1: 5'-GAAAGTTTAAATAATTTATTTTCACTCAGAGTT

Probe PenP2: 5'-CGCGCCCGCCGAAGACA

Penicillium decumbens (assay name: Pdecu3)

Forward Primer PdecuF3: 5'-GGCCTCCGTCCTCCTTTG

Reverse Primer PdecuR4-1: 5'-GACCTACAGAGCGGGTGATGA

Probe PenP7: 5'-CCGAAAGCAGCGGCGGC

Penicillium digitatum (assay name: Pdigi)

Forward Primer PaethF1-1: 5'-CGGGGGGCTCtCGCT

Reverse Primer PdigiR1: 5'-CGTTGTTGAAAGTTTAAATAATTTCTG

Probe PenP2: 5'-CGCGCCCGCCGAAGACA

Penicillium expansum (assay name: Pexpa)

Forward Primer PexpaF1-1: 5'-TTACCGAGTGAGGGCCgTT

Reverse Primer PexpaR2-1: 5'-GCCCCCGGAAGCtACG

Probe PenP3: 5'-TCCAACCTCCCACCCGTGTTTATTT

Penicillium fellutanum/charlesii (assay name: Pfell2)

Forward Primer PfellF2: 5'- CTGAGTGCGGGCCCTCT

Reverse Primer PfellR2: 5'- CGCCGAAGCAACACTGTAAG

Probe* PenAspP1mgb: 5'-CCAACCTCCCACCCGTG

Penicillium glandicola (assay name: Pglan)

Forward Primer PglanF1-1: 5'-CCGGGGGGCTTtCGT

Reverse Primer PchryR1: 5'-GAAAGTTTAAATAATTTATATTTTCACTCAGACTA

Probe PenP2: 5'-CGCGCCCGCCGAAGACA

Penicillium griseofulvum (assay name: Pgris)

Forward Primer PgrisF1-1: 5'-ACCTGCGGAAGGATCATTtCT

Reverse Primer PchryR6: 5'-CCCGGCGGCCAGTT

Probe PenP3: 5'-TCCAACCTCCCACCCGTGTTTATTT

Penicillium implicatum (assay name: Pimpl)

Forward Primer PimplF1: 5'-GCCGAAGACCCCTGT

Reverse Primer PimplR1: 5'CGTTGTTGAAAGTTTGAAGTATTG

Probe PimplP1: 5'-AACGCTGTCTGAAGCTTGCAGTCTGAGC

Penicillium islandicum (assay name: Pisla)

Forward Primer PislaF1: 5'-CGAGTGCGGGTTCGACA

Reverse Primer PislaR1: 5'-GGCAACGCGTAACGGTAG

Probe PislaP1: 5'-AGCCCAACCTCCCACCCGTG

Penicillium italicum (assay name: Pital)

Forward Primer PitalF1-1: 5'-CTCCCACCCGTGTTTATTtCA

Reverse Primer PexpaR1: 5'-TCACTCAGACGACAATCTTCAGG

Probe PenP1: 5'-CGCCTTAAGTGGCCGCCGG

Penicillium melinii (assay name: Pmeli)

Forward Primer PmeliF1-1: 5'-CACGGCTTGTGTGTTGGtCT

Reverse Primer PmeliR1: 5'-GGGCTACAAGAGCGGAA

Probe PenP7: 5'-CCGAAAGGCAGCGCGCGC

Penicillium miczynskii (assay name: Pmicz)

Forward Primer PmiczF1-1: 5'-GTGTTTAACGAACCTTGTGCaTT

Reverse Primer PmiczR1-1: 5'-CTCAGACTGCATACTTCAGACaGA

Probe PsimpP1: 5'-CCGCCTCACGGCCGCC

Penicillium olsonii (assay name: Polsn)

Forward Primer PolsnF1: 5'-GGCGAGCCTGCCTTCG

Reverse Primer PenR2: 5'-GATCCGTTGTTGAAAGTTTAAATAATTATA

Probe PolsnP2: 5'-TCCGCGCTCGCCGAGAC

Penicillium oxalicum (assay name: Poxal)

Forward Primer PoxalF1: 5'-GGGCCCGCCTCACG

Reverse Primer PoxalR1: 5'-GTTGTTGAAAGTTTAACTGATTTAGTCAAGTA

Probe PoxalP1: 5'-ACAAGAGTCGTTTGTGTCTTCGGCG

Penicillium purpurogenum (assay name: Ppurp)

Forward Primer PpurpF1: 5'-AGGATCATTACTGAGTGCGGA

Reverse Primer PpurpR1: 5'-GCCAAAGCAACAGGGTATTTC

Probe PpurpP1: 5'-CCCTCGCGGGTCCAACCTCC

Penicillium raistrickii (assay name: Prais3)

Forward Primer PgrisF1-1: 5'-ACCTGCGGAAGGATCATTtCT

Reverse Primer PraisR2: 5'-CCGGCGGCTGACG

Probe PenP3: 5'-TCCAACCTCCCACCCGTGTTTATTT

Penicillium restrictum (assay name: Prest2)

Forward Primer PrestF2-1: 5'-CACGGCTTGTGTGTTGGtCCT

Reverse Primer PrestR1-1: 5'-CGGCCGGGCCTaCAA
Probe PenP7: 5'-CCGAAAGGCAGCGGCGGC

Penicillium roquefortii (assay name: Proqu)
Forward Primer PchryF1: 5'-CGGGCCCCGCTTAAC
Reverse Primer ProquR2: 5'-TTAAATAATTTATATTGTTCTCAGACTGCAT
Probe PenP2: 5'-CGCGCCCGCGAAGACA

Penicillium sclerotiorum (assay name: Psclr)
Forward Primer PsclrF1: 5'-TTCCCCGGGAACAGG
Reverse Primer PsclrR1: 5'-GCCCCATACGCTCGAGGAT
Probe PsclrP1: 5'-CCGAAAGGCAGTGGCGGCAC

Penicillium simplicissimum/ochrochloron (assay name: Psimp2)
Forward Primer PsimpF2-1: 5'-CGCCGAAGACACCATTGAtCT
Reverse Primer PsimpR4-1: 5'-CTGAATTCTGCAATTCACATaACG
Probe PsimpP2: 5'-TGTCTGAAGATTGCAGTCTGAGCGATTAGC

Penicillium glabrum/lividum/pupurescens/spinulosum/thomii (assay name: Pspin2)
Forward Primer PspinF2: 5'-CATTACTGAGTGAGGGCCCTCT
Reverse Primer PspinR2-1: 5'-CGTGAGGCGGGaGCA
Probe* PenAspP1mgb: 5'-CCAACCTCCCACCCGTG

Penicillium variable (assay name: Pvarb2)
Forward Primer PvarbF2-1: 5'-TTACCGAGTGCGGGTTCtAA
Reverse Primer PvarbR2: 5'-CGAGGCAACGCGGTAAC
Probe* PenAspP1mgb: 5'-CCAACCTCCCACCCGTG

Penicillium verrucosum, svar. 1 (assay name: Pverr)
Forward Primer PverrF2: 5'-CGGGCCCGCCTTTG
Reverse Primer PauraR1: 5'-GAAAGTTTTAAATAATTTATATTTCACTCAGACTT
Probe PenP2: 5'-CGCGCCCGCCGAAGACA

Rhizomucor meihei/pusillus/variabilis (assay name: Rmuc)
Forward Primer NS92F: 5'-CACCGCCCGTCGCTAC
Reverse Primer RmucR1: 5'-GTAGTTTGCCATAGTTCGGCTA
Probe RmucP1: 5'-TTGAATGGCTATAGTGAGCATATGGGAGGCT

Rhizopus stolonifer (assay name: Rstol)
Forward Primer NS92F: 5'-CACCGCCCGTCGCTAC
Reverse Primer RstolR1: 5'-GCTTAGTTTGCCATAGTTCTCTAAACA
Probe MucP1: 5'-CCGATTGAATGTTATAGTGAGCATATGGGATC

Scopulariopsis asperula (assay name: SCaspr)
Forward Primer SCbrvF1: 5'-CCCCTGCGTAGTAGATCCTACAT
Reverse Primer SCasprR1: 5'-TCCGAGGTCAAACCATGAGTAA
Probe ScopP1: 5'-TCGCATCGGGTCCCGGCG

Scopulariopsis brevicaulis/fusca (assay name: SCbrv)
Forward Primer SCbrvF1: 5'-CCCCTGCGTAGTAGATCCTACAT
Reverse Primer SCbrvR1: 5'-TCCGAGGTCAAACCATGAAATA
Probe ScopP1: 5'-TCGCATCGGGTCCCGGCG

Scopulariopsis brumptii (assay name: SCbrm)
Forward Primer SCbrmF1: 5'-CCCCTGCGTAGTAGTAAACCA
Reverse Primer SCbrmR1: 5'-CCGAGGTCAAACATCTTTGG
Probe ScopP1: 5'-TCGCATCGGGTCCCGGCG

Scopulariopsis chartarum (assay name: SCchr)
Forward Primer SCchrF1: 5'-CCCCTGCGTAGTAGTAAAGC
Reverse Primer SCchrR1: 5'-TCCGAGGTCAAACCATCAAG
Probe ScopP1: 5'-TCGCATCGGGTCCCGGCG

Scopulariopsis sphaerospora (assay name: SCsph)
Forward Primer SCsphF1: 5'-CCCCTGCGTAGTAGTTACAA
Reverse Primer SCsphR1: 5'-CCGAGGTCAAACCATCAAAAG
Probe ScopP1: 5'-TCGCATCGGGTCCCGGCG

Stachybotrys chartarum (assay name: Stac)
Forward Primer StacF4: 5'-TCCCAAACCTTATGTGAACC
Reverse Primer StacR5: 5'-GTTTGCCACTCAGAGAATACTGAAA
Probe StacP2: 5'-CTGCGCCCGGATCCAGGC

Trichoderma asperellum/hamatum (assay name: Taspr1)

Forward Primer TasprF1: 5'-CCCAAACCCAATGTGAACGT

Reverse Primer TasprR2-1: 5'-GGACTACAGAAAGAGTTTGGTTGCTT

Probe TridP1: 5'-CCAAACTGTTGCCTCGGCGGG

Trichoderma harzianum (assay name: Tharz)

Forward Primer TharzF1: 5'-TTGCCTCGGCGGGAT

Reverse Primer TharzR1: 5'-ATTTTCGAAACGCCACGAGA

Probe TharzP1: 5'-CTGCCCCGGGTGCGTCG

Trichoderma longibrachiatum/citrinoviride (assay name: Tlong)

Forward Primer TlongF1: 5'-TGCCTCGGCGGGATTC

Reverse Primer TlongR1: 5'-CGAGAAAGGCTCAGAGCAAAAAT

Probe TlongP1: 5'-TCGCAGCCCCGGATCCCA

Trichoderma viride/atroviride/koningii (assay name: Tviri)

Forward Primer TviriF1: 5'-CCCAAACCCAATGTGAACCA

Reverse Primer TviriR1: 5'-TCCGCGAGGGGACTACAG

Probe TridP1: 5'-CCAAACTGTTGCCTCGGCGGG

Ulocladium atrum (assay name: Uatrm)

Forward Primer UatrmF2: 5'-CGGGCTGGCATCCTTC

Reverse Primer UatrmR2: 5'-CTGATTGCAATTACAAAAGGTTTATG

Probe UloP1: 5'-TGAATTATTCACCCGTGTCTTTTGCCTACTTCT

Ulocladium botrytis (assay name: Ubotr)

Forward Primer UbotrF1: 5'-CCCCCAGCAGTGCGTT

Reverse Primer UbotrR1: 5'-CTGATTGCAATTACAAAAGGTTTATG

Probe UloP1: 5'-TGAATTATTCACCCGTGTCTTTTGCCTACTTCT

Ulocladium chartarum (assay name: Uchar)

Forward Primer UcharF1-1: 5'-AGCGGGCTGGAATCCaTT

Reverse Primer UcharR1-1: 5'-CTGATTGCAATTACAAAAGGTTgAAT

Probe UloP1: 5'-TGAATTATTCACCCGTGTCTTTTGCCTACTTCT

Wallemia sebi (assay name: Wsebi)

Forward Primer WsebiF1: 5'-GGCTTAGTGAATCCTTCGGAG

Reverse Primer WsebiR1: 5'-GTTTACCCAACCTTTCAGTCCA

Probe WsebiP1: 5'-TGTGCCGTTGCCGGCTCAAATAG

Universal *Penicillium*, *Aspergillus* and *Paecilomyces varioti* (assay name: PenAsp1mgb)

Forward Primer PenAspF1: 5'-CGGAAGGATCATTACTGAGTG

Reverse Primer PenAspR1: 5'-GCCCGCCGAAGCAAC

Probe* PenAspP1mgb: 5'-CCAACCTCCCACCCGTG

* Applied Biosystems MGB probe, labeled with 6FAM reporter and black hole quencher. Suggest labeling of all other probes with 6FAM reporter and TAMRA or black hole quencher.

Suggested probe and primer concentrations for all assays is 80 nM probe, 1000 nM primers. Primers with (5x) designations indicate suggested use of 5x higher concentration.

Lower case letters in primer sequences denote deliberate mismatches with target sequences.

Environmental Relative Moldiness Index (ERMI) Research Tool (Fact Sheet)

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