Long-Term Preservation of Fungal Cultures in All-Russian Collection of Microorganisms (VKM): Protocols and Results

3

Svetlana M. Ozerskaya, Natalya E. Ivanushkina, Galina A. Kochkina, Svetlana S. Eremina, Alexander N. Vasilenko, and Nadezhda I. Chigineva

Abstract

Results of successful preservation experience are given for the taxonomic groups of fungi preserved in All-Russian Collection of Microorganisms (VKM): the species names, conservation methods, storage time estimates.

Keywords

Fungi • Culture collection • Storage time • Survival • Lyophilization • Freeze-drying • Cryopreservation • Sterile soil

Introduction

Preservation and long-term storage of type, authentic, and other kinds of fungal cultures in a living state is of high importance both for the fundamental and practical mycology.

Long-time storage of strains is performed in microbiological culture collections (biological resource centers). Various methods of preservation of fungal cultures have been reported [1–3].

Freeze-drying (lyophilization) and cryopreservation methods are utilized for thousands of fungal strains in microbial collections all over the world [4–6]. Nevertheless, it is clear that the fungal strains of different species vary in ability to survive after the long-time storage preservation under laboratory conditions. Some of them are very difficult to maintain *ex situ*, whereas others could be easily and successfully preserved alive by using almost any conservation technique. Available information on the maximal time periods in which the reliable storage of different fungal species are ensured does not cover those for the diversity of fungi maintained in culture collections. This chapter presents the methods of cryopreservation, freeze-drying, and preservation in sterile soil that are utilized in VKM fungal collection, accompanied by data on maximal storage time registered. The methods take into consideration the special features of cultures preserved as well as the equipment used.

VKM fungal collection (All-Russian Collection of Microorganisms, Russia) was established in 1955 and has a long-term experience for preservation and storage of fungal

S.M. Ozerskaya (✉) • N.E. Ivanushkina • G.A. Kochkina
S.S. Eremina • A.N. Vasilenko • N.I. Chigineva
G. K. Skryabin Institute of Biochemistry and Physiology of Microorganisms, Russian Academy of Science, prospekt Nauki, 5, Pushchino, Moscow Region 142290, Russia
e-mail: smo@dol.ru

V.K. Gupta et al. (eds.), *Laboratory Protocols in Fungal Biology: Current Methods in Fungal Biology*, Fungal Biology, DOI 10.1007/978-1-4614-2356-0_3,

cultures. Collection of filamentous fungi is currently composed of approximately 5,000 strains (545 genera, 1,450 species) belonging to species of the kingdoms Chromista (*Oomycetes*) and Fungi (*Zygomycetes, Ascomycetes,* and *Basidiomycetes*). The current use of different preservation methods for more than 3,800 strains maintained in VKM for more than 40 years was analyzed using a specially designed database. The database keeps the protocols of conservation methods, storage conditions, the calculated time of reliable storage, special requirements of growth, and other information related to the issue. Data presented in this chapter are derived from this database. The information on preservation methods is also available in VKM catalogue (http://www.vkm.ru/Catalogue.htm), in data sheet for each strain.

Cryopreservation of Filamentous Fungi

According to published data, the fast cooling rates followed by storage in liquid nitrogen at −196°C allow secure and long-term preservation of some fungal cultures [7]. However, the ability to resist damage by freezing and warming differs considerably among genera/species and depends on their particular features (presence and type of sporulation, chemical composition of cytoplasmic membrane and cell wall, physiological state, etc.). Selection of optimal cryoprotectants, rates of cooling and warming has enabled increasing the number and diversity of taxa preserved by this method [8, 9].

More than 70% filamentous fungal of VKM (2,714 strains belonging to 1,148 species and 405 genera) are stored using various cryopreservation protocols. Cultures with abundant sexual and nonsexual sporulation usually were preserved by using fast cooling rates followed by storage either in liquid nitrogen or in ultra-low temperature freezers at −80°C.

It was noticed that some cultures of *Zygomycetes* belonging to the genera *Mortierella*, *Basidiobolus*, *Coemansia*, and *Lobosporangium* (syn. *Echinosporangium*) do not survive the ultrarapid freezing procedure even if they have abundant sporulation. Successful preservation of such strains was achieved by modification of the cryopreservation regime, for example using slow programmed freezing. The same method was used either for nonsporulating fungi or zoospore-forming ones (*Basidiomycetes, Oomycetes*).

According to our data, some part of strains of *Oomycetes* (20%), *Basidiomycetes* (4%), *Zygomycetes* (1%), and *Ascomycetes* (1%) did not survive cryopreservation at all freezing regimes and modification applied [10]. The strains most difficult to maintain belong to genera *Brevilegnia*, *Dictyuchus*, *Phytophthora*, and to some species of *Achlya* and *Saprolegnia*. Similar situations have also been seen with some species of *Basidiomycetes* (*Suillus*, *Amanita*, *Dictyophora*, *Mutinus*, etc.). They are usually maintained by subculturing and preservation under mineral oil.

It has been suggested that those microbial cultures that are able to survive the freezing and a short storage will permanently stay in the vital state after any length of storage [11]. According to our data this is not quite true: some strains of *Achlya colorata*, *Antrodia serialis*, *Armillaria cepistipes*, *Athelia rolfsii*, *Ceratellopsis equiseticola*, *Choanephora conjuncta*, *Clitocybe nuda*, *Coemansia aciculifera*, *Collybia butyracea*, *Conidiobolus thromboides*, *Exobasidium karstenii*, *E. splendidum*, *Kickxella alabastrina*, *Lactarius deliciosus*, *Marasmius oreades*, *Mortierella gamsii*, *M. humilis*, *Mycena pura*, *Phallus impudicus*, *Rhizoctonia solani*, *Sclerotium tuliparum*, *Suillus variegatus*, and *Ustilago scabiosae* have lost their ability to grow after 5–7 years of storage in liquid nitrogen, although they were in the vital state after 24 h of storage. The reason is not yet known. Nevertheless, the viability test showed that 350 strains of fungi remain alive after 19.5 years of storage (Table 3.1).

The cooling equipment being used in VKM is storage tanks “Bioproducts-0.5” with capacity of 500 liters of liquid nitrogen and ultra-low temperature freezers (−80°C, Sanyo, Japan).

Table 3.1 Storage time of VKM fungal cultures

Sr. No.	Name of species	Cryopreservation		Freeze-Drying		Soil	
		Number of strains	Storage time (years)	Number of strains	Storage time (years)	Number of strains	Storage time (years)
1	*Absidia blakesleeana* Lendner 1924	1	19.30	4	32.91	3	27.14
2	*A. coerulea* Bainier 1889	2	19.69	5	29.67	5	12.42
3	*A. cuneospora* G.F.Orr et Plunkett 1959	1	19.69	1	27.38	0	
4	*A. cylindrospora* Hagem 1908			2	24.02	2	16.24
5	*A. glauca* Hagem 1908	4	19.37	10	36.13	5	28.45
6	*A. hyalospora* (Saito 1906) Lendner 1908	1	19.37	1	31.10	1	15.58
7	*A. repens* van Tieghem 1878	1	19.24	1	22.36		
8	*A. spinosa* Lendner 1907	1	12.28	2	19.46	2	11.64
9	*A. bisexualis* Coker et Couch 1927	2	0.51				
10	*Achlya bonariensis* Beroqui 1969	1	0.16				
11	*A. colorata* Pringsheim 1882	2	6.33				
12	*A. intricata* Beneke 1948	1	0.15				
13	*A. sparrowii* Reischer 1949	1	1.11				
14	*Acladium curvatum* Bonorden 1851			1	32.40		
15	*Acremonium alternatum* Link 1809	1	0.58	2	27.04		
16	*A. arxii* W.Gams 1971	1	19.44	3	27.32		
17	*A. atrogriseum* (Panasenko 1964) W.Gams 1971	1	17.46	2	32.65		
18	*A. bacillisporum* (Onions et G.L. Barron 1967) W.Gams 1971			1	15.50		
19	*A. bactrocephalum* W.Gams 1971			3	24.26		
20	*A. berkeleyanum* (P.Karsten 1891) W.Gams 1982	1	19.49	3	30.12		
21	*A. biseptum* W.Gams 1971			1	25.30		
22	*A. breve* (Sukapure et Thirumalachar 1966) W.Gams 1971	3	19.29	4	27.78		
23	*A. cavaraeanum* (Jasevoli 1924) W.Gams 1971	1	19.92	1	6.05		
24	*A. charticola* (J.Lindau 1907) W.Gams 1971	2	19.56	3	25.98		
25	*A. crotocinigenum* (Schol-Schwarz 1965) W.Gams 1971			4	32.50		
26	*A. cymosum* W.Gams 1971	1	6.52	1	28.44		
27	*A. domschii* W.Gams 1971			2	28.36		
28	*A. egyptiacum* (J.F.H.Beyma 1933) W.Gams 1971	1	19.77	1	29.72		

(continued)

Table 3.1 (continued)

Sr. No.	Name of species	Cryopreservation		Freeze-Drying		Soil	
		Number of strains	Storage time (years)	Number of strains	Storage time (years)	Number of strains	Storage time (years)
29	*A. gamsii* Tichelaar 1971			1	7.06		
30	A. *hennebertii* W.Gams 1971			1	31.29		
31	*A. hyalinulum* (Saccardo 1879) W.Gams 1971			1	3.23		
32	*A. implicatum* (J.C.Gilman et E.V.Abbott 1927) W.Gams 1975	2	19.75	3	27.42		
33	*A. incrustatum* W.Gams 1971	1	17.71	1	25.80		
34	*A. kiliense* Gruetz 1925	3	20.27	4	26.11		
35	*A. lichenicola* W.Gams 1971			1	24.26		
36	*A. persicinum* (Nicot 1958) W.Gams 1971	2	19.36	2	30.12		
37	*A. polychromum* (J.F.H.Beyma 1928) W.Gams 1971	2	19.92	3	25.34		
38	*A. rutilum* W.Gams 1971	1	8.01	3	19.10		
39	*A. salmoneum* W.Gams et Lodha 1975			3	2.70		
40	*A. sclerotigenum* (Moreau et R.Moreau 1941 ex Valenta 1948) W.Gams 1971	1	5.09	3	24.26		
41	*A. strictum* W.Gams 1971	14	19.79	20	39.59	1	9.71
42	*A. tubakii* W. Gams 1971			1	6.25		
43	*Acrophialophora fusispora* (S.B.Saksena 1953) Samson 1970	1	17.48	1	6.36		
44	*Acrostalagmus albus* Preuss 1851	1	19.58	1	18.18		
45	*A. luteoalbus* (Link 1809) Zare et al. 2004	2	19.34	8	27.50	3	13.56
46	*Acrothecium robustum* J.C.Gilman et E.V.Abbott 1927	1	19.28	1	22.40		
47	*Actinomucor elegans* (Eidam 1884) C.R.Benjamin et Hesseltine 1957			7	35.32	7	28.66
48	*Agaricus arvensis* Schaeffer 1774	2	20.03				
49	*A. bisporus* (J.Lange 1926) Imbach 1946	19	20.93				
50	*Albonectria rigidiuscula* (Berkeley et Broome 1875) Rossman et Samuels 1999	1	19.84	1	13.21	1	7.45
51	*Alternaria alternata* (Fries 1832) Keissler 1912	1	19.28	11	29.77		
52	*A. brassicae* (Berkeley 1836) Saccardo 1880	1	19.76				
53	*A. brassicicola* (Schweinitz 1832) Wiltshire 1947	1	19.27	2	24.42		
54	*A. cheiranthi* (Libert 1827) P.C.Bolle 1924	1	19.78	1	16.13		
55	*A. chrysanthemi* E.G.Simmons et Crosier 1965	1	19.76	1	24.95		

56	*A. cucumerina* (Ellis et Everhart 1895) J.A.Elliott 1917 var. *cucumerina*	1	19.78				
57	*A. dauci* (J.G.Kuehn 1855) J.W.Groves et Skolko 1944	1	19.78				
58	*A. dianthicola* Neergaard 1945	1	19.76				
59	*A. geophila* Daszewska 1912	1	12.56				
60	*A. godetiae* (Neergaard 1933) Neergaard 1945	1	12.56				
61	*A. macrospora* Zimmermann 1904	1	12.56	2	14.87		
62	*A. multirostrata* E.G.Simmons et C.R.Jackson 1968	1	17.79	1	11.28		
63	*A. nobilis* (Vize 1877) E.G. Simmons 2002	1	19.76				
64	*A. radicina* Meier et al. 1922	1	17.59	1	22.55		
65	*A. raphani* J.W.Groves et Skolko 1944	1	19.30	1	27.64		
66	*A. solani* Sorauer 1896	1	19.76	1	11.82		
67	*A. tenuissima* (Kunze 1818) Wiltshire 1933			2	8.64		
68	*Amauroascus aureus* (Eidam 1887) von Arx 1971	1	6.18	1	17.43		
69	*Amblyosporium botrytis* Fresenius 1863	1	15.33	1	31.28	1	12.18
70	*Amerosporium concinnum* Petrak 1953	1	19.52	1	5.32		
71	*Ampelomyces artemisiae* (Voglino 1905) Rudakov 1979	1	12.57	1	11.42		
72	*A. heraclei* (Dejeva 1967) Rudakov 1979	1	12.18	1	13.21		
73	*A. humuli* (Fautrey 1890) Rudakov 1979	1		1	16.55		
74	*A. polygoni* (Potebnia 1907) Rudakov 1979	1	12.28	2	13.12		
75	*A. quisqualis* Cesati 1852	1	12.57	2	18.13		
76	*A. ulicis* (Adams 1907) Rudakov 1979	1	12.37	1	18.54		
77	*A. uncinulae* (Fautrey 1893) Rudakov 1979	1	12.57	1	10.41		
78	*Anthurus archeri* (Berkeley 1859) E. Fisch. 1886	1	1.64				
79	*Aphanoascus fulvescens* (Cooke 1879) Apinis 1968	1	20.37	1	20.62		
80	*Aphanocladium album* (Preuss 1848) W.Gams 1971	3	17.71	3	24.20		
81	*Aphanomyces helicoides* Minden 1915	1	9.93				
82	*Apiospora montagnei* Saccardo 1875			1	1.63		
83	*Aplanes treleaseanus* (Humphrey 1893) Coker 1927	1	15.93				
84	*Aposphaeria caespitosa* (Fuckel 1869) Jaczewski 1917	1	19.19	1	20.57		
85	*Arachniotus aurantiacus* (Kamyschko 1967) von Arx 1971	1	12.44	1	20.62		
86	*Armillaria bulbosa* (Barla 1887) Kill et Watling 1983	1	12.01				
87	*A. gallica* H.Marxmueller et Romagn. 1987	1	0.79				

(continued)

Table 3.1 (continued)

Sr. No.	Name of species	Cryopreservation		Freeze-Drying		Soil	
		Number of strains	Storage time (years)	Number of strains	Storage time (years)	Number of strains	Storage time (years)
88	*A. mellea* (Vahl 1792) Kummer 1871	3	19.93				
89	*Arthrinium arundinis* (Corda 1838) Dyko et Sutton 1981	1	12.57	3	10.13		
90	*A. saccaricola* F. Stevens 1917			1	16.91		
91	*A. sphaerospermum* Fuckel 1874	1	19.19	1	20.82	1	3.85
92	*Arthrobotrys arthrobotryoides* (Berlese 1888) J.Lindau 1907	1	19.30			1	3.91
93	*A. cladodes* Drechsler 1937	1	15.73	1	23.73	1	3.91
94	*A. conoides* Drechsler 1937	2	19.30	1	9.44	2	3.91
95	*A. longa* Mekhtieva 1973	1	10.64	1	9.42		
96	*A. longispora* Press 1853	1	15.63			1	3.91
97	*A. oligospora* Fresenius 1850	4	21.21	5	22.24	1	2.55
98	*A. robusta* Duddington 1951	1	19.40	1	27.06	1	3.91
99	*A. superba* Corda 1839	1	19.25	1	18.25	2	3.91
100	*Ascochyta bohemica* Kabat et Bubak 1905	1	20.32				
101	*A. boltshauseri* Saccardo 1891	1	20.32	1	27.54		
102	*A. cucumeris* Fautrey et Roumeguere 1891	1	20.32	1	27.91		
103	*A. malvicola* Saccardo 1878	1	19.21				
104	*A. pinodes* L.K.Jones 1927	1	19.21	1	22.41		
105	*A. pisi* Libert 1830	1	19.44	1	23.61	1	8.67
106	*A. viciae* Libert 1837	1	20.30	1	26.76		
107	*Ascotricha chartarum* Berkeley 1838	1	18.95	1	10.75		
108	*Aspergillus alliaceus* Thom et Church 1926			3	21.91	2	20.77
109	*A. amylovorus* Panasenko 1964 ex Samson 1979	1	12.45	1	14.96	1	20.73
110	*A. aureolatus* Muntanola-Cvetkovic et Bata 1964			1	9.61	1	9.58
111	*A. awamori* Nakazawa 1915			6	28.56	4	20.73
112	*A. awamori* Nakazawa 1915 var. *fumeus* Nakazawa et al. 1936			1	17.96	1	20.91
113	*A. brasiliensis* Varga et al. 2007			1	31.96	1	22.13
114	*A. caespitosus* Raper et Thom 1944			1	9.66	1	9.58
115	*A. candidus* Link 1809			5	38.93	5	20.87
116	*A. carbonarius* (Bainier 1880) Thom 1916			2	20.02	1	20.87
117	*A. carneus* Blochwitz 1933			1	16.12		

118	*A. clavatus* Desmazieres 1834			7	30.13	7	27.41
119	*A. echinulatus* (Delacroix 1893) Thom et Church 1926			1	9.60	1	9.58
120	*A. ficuum* (Reichardt 1867) Thom et Currie 1916			1	13.22	2	1.53
121	*A. fischeri* Wehmer 1907			4	27.20	3	27.41
122	*A. flavipes* (Bainier et R.Sartory 1911) Thom et Church 1926			4	31.64	4	20.90
123	*A. flavus* Link 1809			13	39.07	9	20.87
124	*A. flavus* Link 1809 var. *columnaris* Raper et Fennell 1965			1	26.98	1	8.69
125	*A. foetidus* Thom et Raper 1945			1	14.18	1	8.08
126	*A. fumigatus* Fresenius 1863			12	38.91		28.72
127	*A. giganteus* Wehmer 1901			2	16.87	2	17.90
128	*A. heteromorphus* Batista et H. Maia 1957			1	15.87		
129	*A. insuetus* (Bainier 1908) Thom et Church 1929			1	15.90	1	11.41
130	*A. janus* Raper et Thom 1944			1	36.04	1	20.92
131	*A. japonicus* Saito 1906			4	24.93	2	20.66
132	*A. kanagawaensis* Nehira 1951			2	39.62	2	16.06
133	*A. melleus* Yukawa 1911			3	39.08	1	1.91
134	*A. niger* van Tieghem 1867			26	27.30	18	27.41
135	*A. niveus* Blochwitz 1929			3	28.54	2	37.78
136	*A. nutans* McLennan et Ducker 1954			1	37.39	1	11.74
137	*A. ochraceus* G.Wilhelm 1877			8	24.89	7	20.89
138	*A. oryzae* (Ahlburg 1878) E.Cohn 1884			21	30.35	19	23.11
139	*A. oryzae* (*Ahlburg 1878*) E.Cohn 1884 var. *effusus* (Tiraboschi 1908) Y.Ohara 1951			1	12.34	1	9.58
140	*A. pallidus* Kamyschko 1963	1	12.45	1	18.59	1	21.90
141	*A. parvulus* G.Smith 1961			1	37.39	1	4.65
142	*A. penicilliformis* Kamyschko 1963			3	38.97	2	21.72
143	*A. phoenicis* (Corda 1840) Thom et Currie 1916			1	14.94	1	7.66
144	*A. pseudodeflectus* Samson et Mouchacca 1975			1	36.19		
145	*A. puniceus* Kwon-Chung et Fennell 1965			1	9.87	1	4.32
146	*A. repens* (Corda 1842) Saccardo 1882			9	38.67	8	27.41
147	*A. restrictus* G. Smith 1931			1	15.70	1	2.24
148	*A. sclerotiorum* G.A.Huber 1933			2	21.13	1	2.05
149	*A. silvaticus* Fennell et Raper 1955			1	27.29	1	8.08

(continued)

Table 3.1 (continued)

Sr. No.	Name of species	Cryopreservation		Freeze-Drying		Soil	
		Number of strains	Storage time (years)	Number of strains	Storage time (years)	Number of strains	Storage time (years)
150	*A. subsessilis* Raper et Fennell 1965	1	12.43	1	24.42	1	10.82
151	*A. sulphureus* (Fresenius 1863) Thom et Church 1926			1	17.11	1	22.65
152	*A. sydowii* (Bainier et R.Sartory 1913) Thom et Church 1926			6	25.86	4	21.01
153	*A. tamarii* Kita 1913			1	38.72	1	20.73
154	*A. terreus* Thom 1918	1	6.67	17	35.75	15	34.79
155	*A. terreus* Thom 1918 var. *africanus* Fennell et Raper 1955	1		1	14.73	1	7.74
156	*A. terreus* Thom 1918 var. *aureus* Thom 1918 Thom et Raper 1945			1	14.73	1	7.22
157	*A. terricola* Marchal et É.J. Marchal 1893			3	17.41	3	20.92
158	*A. terricola* Marchal et É.J. Marchal 1893 var. *americanus* Marchal et É.J. Marchal 1921			1	21.47	1	7.74
159	*A. tubingensis* Mosseray 1934			1	7.19	1	
160	*A. umbrosus* Bainier et Sartory 1912			3	38.97	2	21.03
161	*A. unguis* (Weill et L.Gaudin 1919) Thom et Raper 1939	1	12.45	5	22.22	5	16.58
162	*A. ustus* (Bainier 1881) Thom et Church 1926			11	24.75	6	20.89
163	*A. varians* Wehmer 1897			1	18.57		
164	*A. versicolor* (Vuillemin 1903) Tiraboschi 1908			11	29.25	11	22.34
165	*A. wentii* Wehmer 1896			3	26.56	3	7.69
166	*Athelia rolfsii* (Curzi 1932) C.C.Tu et Kimbrough 1978	1	8.63				
167	*Aureobasidium microstictum* (Bubak 1907) W.B.Cooke 1962	1	19.84	1	26.42		
168	*A. pullulans* (de Bary 1866) G.Arnaud 1918 var. *melanigenum* Hermanides-Nijhof 1977	1	6.76	6	27.81	2	12.60
169	*A. pullulans* (de Bary 1866) G.Arnaud 1918 var. *pullulans*	1	20.20	10	31.03	1	3.76
170	*Backusella circina* J.J. Ellis et Hesseltine 1969			2	31.44		
171	*B. lamprospora* (Lendner 1908) Benny et R.K.Benjamin 1975	2	19.63	4	39.34	2	8.78
172	*Bactridium equiseticola* Milko et Dunaev			1	10.24		
173	*Basidiobolus magnus* Drechsler 1964	1	20.05				
174	*B. meristosporus* Drechsler 1955	1	20.20				
175	*Beauveria bassiana* (Balsamo-Crivelli 1835) Vuillemin 1912	3	20.39	6	30.68		
176	*B. brongniartii* (Saccardo 1892) Petch 1924	4	20.39	5	31.16	1	10.92

177	*Benjaminiella poitrasii* (R.K.Benjamin 1960) von Arx 1981	1	19.54	2	16.91	2	24.89
178	*Bionectria ochroleuca* (Schweinitz 1832) Schroers et Samuels 1997			1	26.61		
179	*Bipolaris australiensis* (M.B.Ellis 1971) Tsuda et Ueyama 1981	2	19.28	5	19.06	2	8.53
180	*B. bicolor* (Mitra 1931) Shoemaker 1959			1	6.61		
181	*B. cynodontis* (Marignoni 1909) Shoemaker 1959	1	19.11	3	25.93	1	8.43
182	*B. kusanoi* (Y.Nisikado 1928) Shoemaker 1959			1	7.04		
183	*B. nodulosa* (Berkeley et M.A.Curtis 1886) Shoemaker 1959			1	5.45		
184	*B. sorokiniana* (Saccardo 1890) Shoemaker 1959	1	19.34	3	19.77		
185	*B. spicifera* (Bainier 1908) Subramanian 1971			1	5.40		
186	*B. victoriae* (F. Meehan et H.C. Murphy 1946) Shoemaker 1959	1	17.46	1	16.28		
187	*Biscogniauxia nummularia* (Bulliard 1790) Kuntze 1891	1	19.31	1	0.66		
188	*Bispora antennata* (Persoon 1801) E.W. Mason 1953	2	19.15	2	27.07		
189	*B. betulina* (Corda 1838) S.Hughes 1958	1	17.44	2	8.96		
190	*B. effusa* Peck 1891	1	20.20	1	15.09		
191	*Bjerkandera adusta* (Willdenow 1787) P.Karsten 1879	2	8.31				
192	*Blakeslea trispora* Thaxter 1914	8	19.56	17	40.03	4	11.74
193	*Blumeriella jaapii* (Rehm 1907) Arx 1961	2	8.60	3	8.36		
194	*Botryosphaeria rhodina* (Berkeley et M.A.Curtis 1889) von Arx 1970	1	19.96	1	26.19		
195	*Botryosporium longibrachiatum* (Oudemans 1890) Maire 1903			1	2.01		
196	*Botryotinia narcissicola* (P.H.Gregory 1941) N.F.Buchwald 1949	1	18.95	1	5.39		
197	*B. polyblastis* (P.H.Gregory 1938) N.F.Buchwald 1949			1	19.35		
198	*Botryotrichum piluliferum* Saccardo et Marchal 1885	1	19.21	4	27.64		
199	*Botryoxylon geniculatum* (Corda 1839) Ciferri 1962			2	28.41		
200	*Botrytis aclada* Fresenius 1850	1	19.29	2	17.59		
201	*B. anthophila* Bondartsev 1913	1	19.19	1	22.52		
202	*B. bifurcata* J.H. Mill., Giddens et A.A. Foster 1958			1	6.88		
203	*B. cinerea* Persoon 1794	1	19.39	15	22.56		
204	*B. convallariae* (Klebahn 1930) Ondrej 1972 ex Boerema et Hamers 1988			2	3.56		
205	*B. convoluta* Whetzel et Drayton 1932	1	19.21	2	17.62		
206	*B. elliptica* (Berkeley 1881) Cooke 1901	1	19.39				

(continued)

Table 3.1 (continued)

Sr. No.	Name of species	Cryopreservation		Freeze-Drying		Soil	
		Number of strains	Storage time (years)	Number of strains	Storage time (years)	Number of strains	Storage time (years)
207	*B. fabae* Sardina 1929	1	19.11				
208	*B. galanthina* (Berkeley et Broome 1873) Saccardo 1886	1	19.21	1	9.62		
209	*B. gladiolorum* Timmermans 1941	1	19.29	2	23.47		
210	*B. hyacinthi* Westerdijk et J.F.H.Beyma 1928	1	19.19				
211	*B. lutescens* Saccardo et Roumeguere 1882	1	19.19				
212	*B. squamosa* J.C.Walker 1925	1	19.31				
213	*B. tulipae* (Libert 1830) Lind 1913	1	19.48	1	13.16		
214	*Brachysporium nigrum* (Link 1824) S. Hughes 1958			1	26.08		
215	*Burgoa anomala* (Hotson 1912) Goidanich 1937	1	19.86	1	8.98		
216	*Byssochlamys nivea* Westling 1909	2	19.42	2	30.50	1	22.83
217	*Cadophora fastigiata* Lagerberg et Melin 1928	1	19.39	2	21.47	1	
218	*C. malorum* (Kidd et Beaumont 1924) W. Gams 2000	4	19.74	4	19.27		
219	*C. melinii* Nannfeldt 1934	1	19.47	1	22.91		
220	*Calcarisporium arbuscula* Preuss 1851	1	1.93	3	28.45		
221	*C. griseum* Spegazzini 1902	1	7.62	2	27.88		
222	*Calocera viscosa* (Persoon 1794) Fries 1828	1	0.10				
223	*Ceratellopsis aquiseticola* (Boudier 1917) Corner 1950	1	12.06				
224	*Ceratocystis paradoxa* (Dade 1928) C.Moreau 1952	2	19.84	2	17.43	1	6.47
225	*C. pilifera* (Fries 1822) C.Moreau 1952	1	18.85	1	25.82		
226	*Cercospora armoraciae* Saccardo 1876	1	20.32	1	11.89		
227	*C. beticola* Saccardo 1876			2	15.29		
228	*C. carotae* (Passerini 1887) Kaznowski et Siemaszko 1929	1	20.32	1	12.70		
229	*C. rosicola* Passerini 1875	1	16.65				
230	*C. violae* Saccardo 1876			1	12.67		
231	*Ceriporiopsis gilvescens* (Bresadola 1908) Domanski 1963	1	12.57				
232	*Cerrena unicolor* (Bulliard 1788) Murrill 1903	1	12.58				
233	*Chaetocladium brefeldii* van Tieghem et G.Le Monnier 1873	1	17.58	2	33.55	1	16.98
234	*C. jonesii* (Berkeley et Broome 1854) Fresenius 1863	1	17.58	1	27.42		
235	*Chaetocytostroma* sp.			1	20.53		
236	*Chaetomidium pilosum* (C.Booth et Shipton 1966) von Arx 1975	1	14.44	1	18.28	1	3.11

237	*Chaetomium amesii* Sergeeva 1965	1	19.27	1	31.01		
238	*C. angustispirale* Sergeeva 1956	1	19.27	1	17.37		
239	*C. aureum* Chivers 1912	2	20.50	2	15.45		
240	*C. crispatum* (Fuckel 1867) Fuckel 1870	1	19.27	1	20.34		
241	*C. elatum* Kunze 1817	3	20.50	3	27.68	1	11.03
242	*C. fieberi* Corda 1837			1	9.05	1	10.68
243	*C. funicola* Cooke 1873	1	19.27	1	26.15		
244	*C. globosum* Kunze 1817	7	19.42	11	31.21	3	10.68
245	*C. homopilatum* Omvik 1953	1	19.32	1	10.66		
246	*C. indicum* Corda 1840	1	19.27	2	17.66		
247	*C. megalocarpum* Bainier 1910	2	19.27	2	17.39		
248	*C. nozdrenkoae* Sergeeva 1961	1	18.85	1	35.25		
249	*C. perlucidum* Sergeeva 1956	1	19.27	1	35.29		
250	*C. semenis-citrulli* Sergeeva 1956	1	19.27	1	17.35		
251	*C. spirale* Zopf 1881	1	19.27	1	11.07		
252	*C. subaffine* Sergeeva 1961	1	19.27	1	35.29		
253	*C. subspirilliferum* Sergeeva 1960	1	20.37	1	25.61		
254	*C. trilaterale* Chivers 1912			1	11.80		
255	*Chaunopycnis alba* W. Gams 1979			1	2.01		
256	*Chloridium virescens* (Persoon 1797) W.Gams et Holubova-Jechova 1976 var. *caudigerum* (Hoehnel 1903) W.Gams et Holubova-Jechova 1976	1	19.66	1	21.35		
257	*Choanephora circinans* (H.Naganishi et N.Kawakami 1955) Hesseltine et C.R.Benjamin 1957	1	20.06	1	27.36		
258	*C. conjuncta* Couch 1925	2	5.81	1	8.64		
259	*C. cucurbitarum* (Berkeley et Ravenel 1875) Thaxter 1903	1	20.19	1	20.93		
260	*C. infundibulifera* (Currey 1873) Saccardo 1891	1	19.07	1	26.29		
261	*Chondrostereum purpureum* (Persoon 1794) Pouzar 1959	1	20.09				
262	*Chrysonilia sitophila* (Mont. 1843) Arx 1981			1	19.81	1	9.02
263	*Chrysosporium carmichaelii* Oorschot 1980			1	22.10		
264	*C. keratinophilum* D.Frey 1959 ex J.W.Carmichael 1962	1	9.56	2	19.07	1	5.95
265	*C. lobatum* Scharapov 1978			1	31.11	1	5.87
266	*C. lucknowense* Garg 1966	4	5.61	5	8.59		

(continued)

Table 3.1 (continued)

Sr. No.	Name of species	Cryopreservation		Freeze-Drying		Soil	
		Number of strains	Storage time (years)	Number of strains	Storage time (years)	Number of strains	Storage time (years)
267	*C. merdarium* (Link 1818 ex Greville 1823) J.W.Carmichael 1962			2	25.63	1	5.87
268	*C. queenslandicum* Apinis et R.G.Rees 1976	2	19.81	2	31.15	1	6.07
269	*C. tropicum* J.W.Carmichael 1962	1	9.08	1	24.13		
270	*Circinella muscae* (Sorokin 1870) Berlese et de Toni 1888	1	2.81	5	28.07	4	28.66
271	*C. rigida* G.Smith 1951	1	19.67	1	26.96	1	16.39
272	*C. umbellata* van Tieghem et G.Le Monnier 1873	1	19.67	1	6.91	1	19.35
273	*Cladobotryum binatum* Preuss 1851			1	29.01		
274	*C. dendroides* (Bulliard 1791) W.Gams et Hoozemans 1970			3	25.88		
275	*C. multiseptatum* de Hoog 1978			1	9.00		
276	*C. varium* Nees 1816	1	1.20	3	27.38		
277	*C. verticillatum* (Link 1809) S. Hughes 1958			2	28.41		
278	*Cladophialophora chaetospira* (Grove 1886) Crous et Arzanlou 2007			1	17.82		
279	*Cladosporium aecidiicola* Thuemen 1876	1	19.19	1	5.95		
280	*C. brevicompactum* Pidoplichko et Deniak 1941			2	27.73		
281	*C. bruhnei* Linder 1947			1	9.30		
282	*C. cladosporioides* (Fresenius 1850) G. A. de Vries 1952	2	19.51	15	37.72	3	6.72
283	*C. colocasiae* Sawada 1916	1	19.34	1	18.35		
284	*C. cucumerinum* Ellis et Arthur 1889			1	18.62		
285	*C. elegantulum* Pidoplichko et Deniak 1938			2	26.47	1	7.58
286	*C. gossypiicola* Pidoplichko et Deniak 1941			2	34.83		
287	*C. halotolerans* Zalar et al. 2007			1	13.43		
288	*C. herbarum* (Persoon 1794) Link 1816			31	36.58	8	5.76
289	*C. macrocarpum* Preuss 1848	1	18.99	3	17.54		
290	*C. sphaerospermum* Penzig 1882	1	19.29	7	26.65	2	14.36
291	*C. straminicola* Pidoplichko et Deniak 1938			1	26.05		
292	*C. transchelii* Pidoplichko et Deniak 1938			1	13.10		
293	*Clavariadelphus pistillaris* (Fries 1753) Donk 1933	2	2.16				
294	*Claviceps paspali* F.Stevens et J.G.Hall 1910	3	18.93				
295	*C. purpurea* (Fries 1823) Tulasne 1853	3	18.93	1	4.55		

296	*Clitocybe odora* (Bulliard 1784) P.Kummer 1871	1	0.01				
297	*Clonostachys rosea* (Link 1816) Schroers, Samuels, Seifert et W.Gams 1999	14	19.85	23	37.79	16	19.96
298	*C. solani* (Harting 1846) Schroers et W.Gams 2001	1	18.89	3	32.42		
299	*Coemansia aciculifera* Linder 1943	1	8.85				
300	*Cokeromyces recurvatus* Poitras 1950	2	20.14	3	27.13	1	22.74
301	*Colletoconis aecidiophila* (Spegazzini 1886) de Hoog et al. 1978	1	16.86	1	9.68		
302	*Colletotrichum coccodes* (Wallroth 1833) S.Hughes 1958			3	6.41		
303	*C. gloeosporioides* (Penzig 1880) Saccardo 1882	1	19.32	2	37.54		
304	*C. lindemuthianum* (Saccardo et Magnus 1878) Briosi et Cavara 1889			1	9.42		
305	*C. musae* (Berkeley et M.A.Curtis 1874) Arx 1957	1	19.30	1	24.90		
306	*Collybia butyracea* (Bulliard 1792) P.Kummer 1871	1	2.82				
307	*Colpoma quercinum* (Persoon 1796) Wallroth 1823			1	10.61		
308	*Conidiobolus coronatus* (Costantin 1897) Batko 1964	4	15.93				
309	*C. thromboides* Drechsler 1953	1	6.78				
310	*Coniochaeta verticillata* (van Emden 1973) Dania García, Stchigel et Guarro 2006	1	18.95	1	14.79		
311	*Coniophora puteana* (Schumacher 1803) P.Karsten 1868	4	12.01				
312	*Coniothyrium concentricum* (Desmazieres 1840) Saccardo 1878	1	18.99	1	12.63		
313	*C. fuckelii* Saccardo 1878			1	9.65		
314	*C. hellebori* Cooke et Massee 1886	1	17.68	1	16.15		
315	*C. rosarum* Cooke et Harkness 1882	1	19.39	2	16.28		
316	*C. wernsdorffiae* Laubert 1905	1	18.99	1	16.61		
317	*Coprinus atramentarius* (Bulliard 1783) Fries 1838	1	6.11				
318	*C. comatus* (O.F. Mueller 1780) Persoon 1797	2	12.05				
319	*C. disseminatus* (Persoon 1801) Gray 1821	1	3.82				
320	*C. domesticus* (Bolton 1788) Gray 1821	1	20.14				
321	*C. ephemerus* (Bulliard 1786) Fries 1838	1	18.86				
322	*C. micaceus* (Bulliard 1785) Fries 1838	2	18.82				
323	*C. radians* (Desmazieres 1828) Fries 1838	1	18.82				
324	*C. sterquilinus* (Fries 1821) Fries 1838	1	18.86				
325	*Corynascus sepedonium* (C.W.Emmons 1932) von Arx 1973	1	20.37	1	39.91		

(continued)

Table 3.1 (continued)

Sr. No.	Name of species	Cryopreservation		Freeze-Drying		Soil	
		Number of strains	Storage time (years)	Number of strains	Storage time (years)	Number of strains	Storage time (years)
326	*Cryphonectria parasitica* (Murrill 1906) M.E.Barr 1978	1	19.34	1	18.90		
327	*Cunninghamella blakesleeana* Lendner 1927	2	14.09			2	13.81
328	*C. echinulata* (Thaxter 1891) Thaxter 1905	7	19.42	15	35.33	12	29.23
329	*C. homothallica* Kominami et Tubaki 1952	1	20.07				
330	*C. japonica* (Saito 1905) Pidoplichko et Milko 1971	4	20.19	6	33.07	1	28.66
331	*C. vesiculosa* P.C.Misra 1966	1	14.09				
332	*Curvularia clavata* B.L.Jain 1962			1	0.65		
333	*C. comoriensis* Bouriquet et Jauffret 1955 ex M.B.Ellis 1966	1	17.79	1	13.83		
334	*C. geniculata* (Tracy et Earle 1896) Boedijn 1933	2	19.28	3	19.15		
335	*C. inaequalis* (Shear 1907) Boedijn 1933	3	19.74	3	20.46	1	4.33
336	*C. lunata* (Wakker 1898) Boedijn 1933	1	19.34	4	29.21		
337	*C. protuberata* Nelson et Hodges 1965			1	1.33		
338	*Cyathus olla* (Batsch 1783) Persoon 1801	1	0.46				
339	*Cylindrium cordae* Grove 1886			1	27.86		
340	*Cylindrocarpon album* (Saccardo 1877) Wollenweber 1917	1	17.66	1	29.98		
341	*C. chlamydospora* Schischkina et Tzanava 1973	1	19.96	1	11.89		
342	*C. congoense* J.A.Meyer 1958	1	19.54	1	18.45		
343	*C. destructans* (Zinssmeister 1918) Scholten 1964 var. *destructans*	1	15.66	1	14.82		
344	*C. didymum* (Hartig 1846) Wollenweber 1926	1	19.54	1	9.05		
345	*C. gracile* Bugnicourt 1939	1	15.58	2	11.58		
346	*C. heteronema* (Berkeley et Broome 1865) Wollenweber 1928	1	19.51	1	18.45		
347	*C. ianthothele* Wollenweber 1917 var. *minus* Reinking 1938	1	19.51				
348	*C. magnusianum* Wollenweber 1928	1	15.58	1	14.78	1	10.86
349	*C. obtusisporum* (Cooke et Harkness 1884) Wollenweber 1926	1	19.54	1	18.94	1	
350	*C. peronosporae* (Fautrey et Lambotte 1896) Rudakov 1981			1	32.16		
351	*C. stilbophilum* (Corda 1838) Rudakov 1981			2	29.51		
352	*C. theobromicola* C. Booth 1966			3	7.89		
353	*Cylindrocephalum stellatum* (Harz 1871) Saccardo 1886			1	27.87		
354	*Cylindrophora alba* Bonorden 1851			1	19.78		

355	*C. hoffmannii* Daszewska 1912	1	17.71	1	28.06	1	5.65
356	*Dacrymyces stillatus* Nees 1817	1	6.62				
357	*Dactylaria dimorphospora* Veenbaas-Rijks 1973	1	16.08	1	23.58		
358	*Dactylellina asthenopaga* (Drechsler 1937) M. Scholler, Hagedorn et A. Rubner 1999	1	19.28	1	0.08		
359	*Daedalea quercina* (Linnaeus 1753) Persoon 1801	2	20.11				
360	*Dendrodochium toxicum* Pidoplichko et Bilai 1947	1	19.31	1	28.29	1	4.79
361	*Dendrostilbella macrospora* W.Bally 1917	1	6.03	1	14.23		
362	*D. mycophila* (Persoon 1822) Seifert 1985			1	25.87		
363	*Dendryphion nanum* (Nees 1816) S.Hughes 1958			1	24.14		
364	*D. penicillatum* (Corda 1838) Fries 1849			2	15.59		
365	*Dichobotrys* sp.	1	19.26	1	18.88		
366	*Dichotomomyces cejpii* (Milko 1964) D.B. Scott 1970	1	18.95	1	19.72	1	1.51
367	*Dictyophora duplicata* (Bosc 1811) E.Fischer 1888	1	2.39				
368	*Dictyostelium discoideum* (Bosc 1811) E.Fischer 1888	1	5.74	1	10.34		
369	*Dictyuchus monosporus* Leitgeb 1869	1	12.56				
370	*Dicyma ampullifera* Boulanger 1897	1	19.19	1	12.36		
371	*D. olivacea* (Emoto et Tubaki 1970) Arx 1982	1	19.39	1	22.93		
372	*D. ovalispora* (S.Hughes 1951) Arx 1982	1	6.68	1	12.32		
373	*Didymopsis helvellae* (Corda 1854) Saccardo et Marchall 1885			1	28.44		
374	*Dimargaris bacillispora* R.K.Benjamin 1959	1	10.64	1	8.30		
375	*Dinemasporium strigosum* (Persoon 1801) Saccardo 1881	1	17.79	1	10.82		
376	*Diplocladium majus* Bonorden 1851			2	28.45		
377	*D. penicillioides* Saccardo 1886			2	27.21		
378	*Dipodascopsis tothii* (Zsolt 1963) L.R.Batra et Millner 1978			1	17.71		
379	*D. uninucleata* (Biggs 1937) L.R.Batra et Millner 1978 var. *uninucleata*	1	4.03	2	17.71		
380	*Dipodascus aggregatus* Francke-Grosmann 1952	1	18.86	1	17.71		
381	*Discula brunneotingens* E.I.Meyer 1953	1	20.30	1	14.78		
382	*D. pinicola* (Naumov 1926) Petrak 1927 var. *mammosa* Lagerberg et al. 1927	1	19.32	1	39.74		
383	*Dispira cornuta* van Tieghem 1875	1	12.31				
384	*Dissoacremoniella silvatica* Kirilenko 1970	1	19.43	1	22.90		

(continued)

Table 3.1 (continued)

Sr. No.	Name of species	Cryopreservation		Freeze-Drying		Soil	
		Number of strains	Storage time (years)	Number of strains	Storage time (years)	Number of strains	Storage time (years)
385	*Doratomyces purpureofuscus* (Schweinitz 1832) F.J.Morton et G.Smith 1963	1	19.38	1	20.31		
386	*D. stemonitis* (Persoon 1801) F.J.Morton et G.Smith 1963	1	19.39	3	24.58	1	5.68
387	*Drechmeria coniospora* (Drechsler 1941) W. Gams et H.-B. Jansson 1985			1	13.88		
388	*Drechslera avenacea* (M.A.Curtis ex Cooke 1889) Shoemaker 1959			2	22.21		
389	*D. biseptata* (Saccardo et Roumeguere 1881) M.J.Richardson et E.M.Fraser 1968	1	19.28	1	12.26	1	4.33
390	*D. campanulata* (Leveille 1841) B.Sutton 1976	1	19.37	2	5.32		
391	*D. poae* (Baudys 1916) Shoemaker 1962			1	18.20		
392	*Duddingtonia flagrans* (Duddington 1949) R.C.Cooke 1969	1	19.30				
393	*Echinobotryum rubrum* Sorokin ex Jaczewski 1917			1	25.93		
394	*Eladia saccula* (E.Dale 1926) G.Smith 1961	1	19.79	1	12.81		
395	*Emericella nidulans* (Eidam 1883) Vuillemin 1927			11	39.08	9	27.41
396	*E. quadrilineata* (Thom et Raper 1939) C.R. Benjamin 1955			3	26.90	2	11.42
397	*E. rugulosa* (Thom et Raper 1939) C.R. Benjamin 1955			4	37.09	4	16.74
398	*E. variecolor* Berkeley et Broome 1857			1	26.90	1	8.68
399	*Emericellopsis donezkii* Beliakova 1974	3	20.43	7	32.76		
400	*E. glabra* (J.F.H.Beyma 1940) Backus et Orpurt 1961	1	19.32	2	21.67		
401	*E. humicola* (Cain 1956) Gilman 1956	1	19.32	1	21.45		
402	*E. maritima* Beliakova 1970	1	14.87	1	14.81		
403	*E. minima* Stolk 1955	10	20.41	9	32.50		
404	*E. pallida* Beliakova 1974	1	20.43	1	22.93	1	9.64
405	*E. robusta* van Emden et W.Gams 1971			1	20.39		
406	*E. terricola* J.F.H.Beyma 1940	1	19.32	1	21.59		
407	*Engyodontium album* (Limber 1940) de Hoog 1978			3	11.56		
408	*Entomophthora dipterigena* (Thaxter 1888) Saccardo et Traverso 1891	1	13.91				
409	*E. pyriformis* Thoizon 1967	1	0.16				

410	*E. thaxteriana* I.M.Hall et J.Bell 1963	2	12.05				
411	*Entyloma gaillardianum* Vanky 1982	1	12.34	1	1.64		
412	*Epicoccum nigrum* Link 1815	1	19.80	2	21.78		
413	*Eremascus fertilis* Stoppel 1907	1	18.85	1	5.73		
414	*Eremothecium ashbyi* Guilliermond 1935	3	17.31				
415	*E. gossypii* (S.F.Ashby et W.Nowell 1926) Kurtzman 1995	3	16.31				
416	*Eupenicillium* javanicum (J.F.H.Beyma 1929) Stolk et D.B.Scott 1967 var. *javanicum*	1	18.30	1	20.18	1	24.83
417	*Eurotium amstelodami* (Mangin 1909) Thom et Church 1926	1	3.99	8	38.97	8	32.38
418	*E. chevalieri* L. Mangin 1909			5	36.93	4	20.75
419	*E. halophilicum* C.M.Christensen et al. 1959			1	28.92		
420	*E. herbariorum* (F.H.Wiggers 1780) Link 1809	1	18.86	1	37.95	1	21.57
421	*E. rubrum* Jos. König et al. 1901			7	32.45	5	11.24
422	*E. tonophilum* Ohtsuki 1962	1	19.32	1	39.91	1	19.77
423	*Evlachovaea kintrischica* B.Borisov et Tarasov 1999		1.00		15.54		
424	*Exobasidium bisporum* Sawada 1950			1	1.64		
425	*E. karstenii* Saccardo et Trotter 1912	2	9.02				
426	*E. myrtilli* Siegmund 1879	1	8.17	1	1.64		
427	*E. pachysporum* Nannfeldt 1981	1	2.04				
428	*E. vaccinii* (Fuckel 1861) Woronin 1867	2	12.19	1	1.81		
429	*E. warmingii* Rostrup 1888	1	18.48	1	1.64		
430	*Exophiala castellanii* Iwatsu et al. 1999	1	20.38	2	16.34		
431	*E. heteromorpha* (Nannfeldt 1934) de Hoog et Haase 2003	1	19.53	1	21.63		
432	*E. lecanii-corni* (Benedek et Specht 1933) Haase et de Hoog 1999			1	7.93		
433	*E. moniliae* de Hoog 1977			1	7.93		
434	*E. salmonis* J.W.Carmichael 1966	1	17.77	1	5.95		
435	*Exserohilum pedicellatum* (A.W. Henry 1924) K.J. Leonard et Suggs 1974	1	19.46	1	18.88		
436	*Farlowiella carmichaeliana* (Berkeley 1836) Saccardo 1891			1	26.00		
437	*Farrowia seminuda* (L.M.Ames 1949) D. Hawksworth 1975			1	10.72		
438	*Fennellomyces linderi* (Hesseltine et Fennell 1955) Benny et R.K.Benjamin 1975	1	19.63	1	15.02	1	25.98

(continued)

Table 3.1 (continued)

Sr. No.	Name of species	Cryopreservation		Freeze-Drying		Soil	
		Number of strains	Storage time (years)	Number of strains	Storage time (years)	Number of strains	Storage time (years)
439	*Fibroporia vaillantii* (de Candolle 1815) Parmasto 1968	1	20.09				
440	*Filobasidiella depauperata* (Petch 1932) R.A.Samson et al. 1983	1	7.57				
441	*Flammulina velutipes* (Curtis 1777) Singer 1951	5	20.01				
442	*Fomes fomentarius* (Linnaeus 1753) Fries 1849	1	20.05				
443	*Fomitopsis pinicola* (Swartz 1810) P.Karsten 1889	4	20.03				
444	*F. rosea* (Albertini et Schweinitz 1805) P.Karsten 1881	1	20.09				
445	*Fonsecaea pedrosoi* (Brumpt 1922) Negroni 1936	1	19.71	1	16.12		
446	*Funalia trogii* (Berkeley 1850) Bondartsev et Singer 1941	2	20.05				
447	*Fusarium agaricorum* Sarrazin 1887	1	17.66	1	27.21		
448	*F. aquaeductuum* (Rabenhorst et Radlkofer 1863) Lagerheim 1891	1	0.19	2	33.19		
449	*F. aquaeductuum* (Rabenhorst et Radlkofer 1863) Lagerheim 1891 var. *medium* Wollenweber 1931			1	23.04	1	5.64
450	*F. arthrosporioides* Sherbakoff 1915			1	10.16		
451	*F. avenaceum* (Fries 1832) Saccardo 1886	2	19.98	3	33.20	2	14.34
452	*F. avenaceum* (Fries 1832) Saccardo 1886 var. *herbarum* (Corda 1839) Saccardo 1886			1	26.39		
453	*F. cerealis* (Cooke 1878) Saccardo 1886	1	2.19	1	22.49		
454	*F. chlamydosporum* Wollenweber et Reinking 1925			2	29.57		
455	*F. concolor* Reinking 1935	2	1.88	1	5.10		
456	*F. culmorum* (W.G.Smith 1884) Saccardo 1895	1	17.66	3	25.41	2	11.43
457	*F. decemcellulare* Brick 1908	2	17.46	2	33.20	2	9.66
458	*F. episphaeria* (Tode 1791) Snyder et Hansen 1945			1	15.12	1	6.65
459	*F. epistroma* (Hoehnel 1909) C.Booth 1971			2	32.43		
460	*F. equiseti* (Corda 1838) Saccardo 1886	2	19.26	6	29.63	2	23.56
461	*F. expansum* Schlechtendal 1824			1	29.47		
462	*F. fujikuroi* Nirenberg 1976	1	7.64	1	21.06	1	21.87
463	*F. graminearum* Schwabe 1839	2	15.66	4	38.91	2	7.09
464	*F. heterosporum* Nees et T. Nees 1818			2	29.86	1	7.09
465	*F. heterosporum* Nees et T. Nees 1818 var. *pucciniophilum*	1	17.71	1	23.19		

466	*F. incarnatum* (Roberge 1849) Saccardo 1886	3	16.56	4	28.49		
467	*F. javanicum* Koorders 1907	2	19.85	2	32.16	2	6.59
468	*F. lateritium* Nees 1816	3	19.78	6	32.78	1	21.85
469	*F. merismoides* Corda 1838	1	7.68	2	33.20		
470	*F. merismoides* Corda 1838 var. *merismoides*			1	0.57		
471	*F. nivale* (Fries 1849) Cesati 1860 ex Saccardo 1886	2	17.66	3	27.70	1	5.97
472	*F. oxysporum* Schlechtendal 1824	9	19.86	20	33.20	8	23.93
473	*F. poae* (Peck 1903) Wollenweber 1913	2	17.71	3	31.70	1	12.68
474	*F. redolens* Wollenweber 1913			3	14.98		
475	*F. sambucinum* Fuckel 1869	3	7.68	9	30.03	3	13.96
476	*F. sambucinum* Fuckel 1869 var. *ossicola* (Berkeley et M.A.Curtis 1875) Bilai 1955			1	1.16		
477	*F. sarcochroum* (Desmazieres 1850) Saccardo 1879	1	4.98	1	21.31		
478	*F. solani* (Martius 1842) Saccardo 1881	2	16.15	14	32.19	4	16.90
479	*F. sporotrichioides* Sherbakoff 1915	1	17.71	4	32.12	1	15.85
480	*F. sporotrichioides* Sherbakoff 1915 var. *sporotrichioides*	1	17.71	2	31.70	1	12.84
481	*F. tricinctum* (Corda 1838) Saccardo 1886	2	17.46	4	32.19	1	4.75
482	*F. ventricosum* Appel et Wollenweber 1913			3	29.13	2	12.68
483	*F. verticillioides* (Saccardo 1882) Nirenberg 1976	15	19.98	21	38.76	16	23.65
484	*F. viride* (Lechm.) Wollenweber 1917	1	17.66	1	23.96		
485	*F. wolgense* Rodigin 1942			1	33.02		
486	*Fusicladium pomi* (Fries 1825) Lind 1913	1	19.81				
487	*Gabarnaudia betae* (Delacroix 1897) Samson et W.Gams 1974	1	10.01	3	27.06		
488	*Gaeumannomyces caricis* J.Walker 1980	1	5.61				
489	*Galactomyces geotrichum* (E.E.Butler et L.J.Petersen 1972) Redhead et Malloch 1977	3	19.26	3	21.10	1	3.45
490	*G. reessii* (van der Walt 1959) Redhead et Malloch 1977	1	19.26	1	20.12	1	3.45
491	*Ganoderma applanatum* (Persoon 1799) Patouillard 1889	3	12.63				
492	*Geastrum fimbriatum* Fries 1829	1	0.47				
493	*Geomyces pannorum* (Link 1824) Sigler et J.W.Carmichael 1976	2	19.45	14	33.38		
494	*Geosmithia lavendula* (Raper et Fennell 1948) Pitt 1980			1	20.84	1	5.31
495	*G. namyslowskii* (K.M.Zalessky 1927) Pitt 1980			1	21.00	1	15.07
496	*Geotrichum amycelicum* Redaelli et Ciferri 1935	1	18.85	1	11.15		

(continued)

Table 3.1 (continued)

Sr. No.	Name of species	Cryopreservation		Freeze-Drying		Soil	
		Number of strains	Storage time (years)	Number of strains	Storage time (years)	Number of strains	Storage time (years)
497	*G. bipunctatum* Rolland et Fautrey 1894			1	28.38		
498	*G. candidum* Link 1809	19	20.39	23	31.16	1	1.59
499	*G. fragrans* (Berkhout 1923) Morenz 1960 ex Morenz 1964	3	19.85	4	31.67		
500	*G. klebahnii* (Stautz 1931) Morenz 1964	2	19.77	3	29.62		
501	*Gibberella fujikuroi* (Sawada 1917) Wollenweber 1931	2	19.31	2	5.25	1	27.17
502	*G. zeae* (Schweinitz 1821) Petch 1936			2	8.72	1	5.60
503	*Gibellulopsis nigrescens* (Pethybridge 1919) Zare. W. Gams et Summerbell 2007	2	19.31	5	32.31	2	4.80
504	*Gilbertella persicaria* (E.D.Eddy 1925) Hesseltine 1960	1	11.41	1	27.13	1	27.09
505	*Gliocephalotrichum bulbilium* J.J.Ellis et Hesseltine 1962			1	11.92		
506	*Gliocladiopsis tenuis* (Bugnicourt 1939) Crous et M.J. Wingfeld 1993			1	14.46		
507	*Gliocladium album* (Preuss 1851) Petch 1926			2	26.90		
508	*G. ammoniphilum* Pidoplichko et Bilai 1953	1	19.25	1	28.55	1	9.57
509	*G. aurifilum* (W. Gerard 1874) Seifert, Samuels et W. Gams 1985	1	0.54	1	14.41		
510	*G. cholodnyi* Pidoplichko 1931	2	16.14	2	26.27	2	9.13
511	*G. comtus* Rudakov 1981			1	30.99		
512	*G. deliquescens* Sopp 1912			1	17.27		
513	*G. penicillioides* Corda 1840			2	28.51		
514	*G. viride* Matruchot 1893	1	7.80	4	32.23		
515	*Gliomastix cerealis* (P.Karsten 1887) C.H.Dickinson 1968	2	7.80	3	25.16	1	10.97
516	*G. inflata* C.H.Dickinson 1968			2	23.17		
517	*G. luzulae* (Fuckel 1870) E.W. Mason 1953 ex S.Hughes 1958	1	6.22	3	29.44		
518	*G. murorum* (Corda 1839) S. Hughes 1958 var. *felina* (Marchal 1895) S.Hughes 1958	4	19.90	5	32.53	1	9.25
519	*G. murorum* (Corda 1838) S. Hughes 1958 var. *murorum*	6	19.88	10	33.64	1	9.49
520	*Gloeophyllum odoratum* (von Wulfen 1788) Imazeki 1943	1	12.39				
521	*G. sepiarium* (von Wulfen 1786) P.Karsten 1879	5	20.09				
522	*Gongronella butleri* (Lendner 1926) Peyronel et Dal Vesko 1955	2	19.69	6	32.12	1	5.42
523	*G. lacrispora* Hesseltine et J.J.Ellis 1961	1	15.37	1	18.86		

524	*Gonytrichum caesium* Nees 1818			1	27.64		
525	*G. macrocladum* (Saccardo 1880) S.Hughes 1951	1	17.66	1	6.36		
526	*Graphium putredinis* (Corda 1839) S. Hughes 1958			1	23.88		
527	*Grifola frondosa* (Dickson 1785) Gray 1821	1	12.58				
528	*Guepiniopsis buccina* (Persoon 1801) L.L.Kennedy 1958	1	12.06				
529	*Gymnoascus reessii* Baranetzky 1872			1	36.56		
530	*Hansfordia pulvinata* (Berkeley et M.A.Curtis 1875) S.Hughes 1958	1	19.43	2	26.42		
531	*H. triumfettae* (Hahsford 1943) S. Hughes 1952			1	27.00		
532	*Haplaria repens* Bonorden 1851	1	12.55	1	14.08		
533	*Haplographium delicatum* Berkeley et Broome 1859	1	19.37	1	15.65		
534	*Haplotrichum capitatum* (Link 1809) Link 1824	2	19.56	2	28.92		
535	*Hapsidospora milkoi* Beliakova 1975	1	4.09	1	28.59		
536	*Harposporium lilliputanum* Dixon 1952	1	19.28	1	17.19		
537	*Harzia acremonioides* (Harz 1871) Costantin 1888	1	19.47	3	27.73		
538	*Harziella capitata* Costantin et Matr. 1899			1	3.02		
539	*Helicodendron tubulosum* (Riess 1853) Linder 1929	1	19.29	1	11.44		
540	*Helicostylum elegans* Corda 1842	1	17.58	1	39.15	1	15.39
541	*H. pulchrum* (Preuss 1851) Pidoplichko et Milko 1971			2	27.11	1	16.63
542	*Helminthosporium solani* Durieu et Montagne 1849	1	19.59	1	9.56		
543	*Hemicarpenteles ornatum* (Subramanian 1972) Arx 1974			1	39.58	1	2.64
544	*Hericium coralloides* (Scopoli 1772) Persoon 1794	4	12.56				
545	*H. erinaceus* (Bulliard 1791) Persoon 1797	2	12.63				
546	*Hesseltinella vesiculosa* H.P.Upadhyay 1970	1	6.83	1	15.88		
547	*Heterobasidion annosum* (Fries 1821) Brefeld 1888	1	20.09				
548	*Hirsutella thompsonii* F.E. Fischer 1950			1	15.26		
549	*Hormiactis alba* Preuss 1851			1	23.26		
550	*Hormoconis resinae* (Lindau 1906) von Arx et G.A. de Vries 1973	2	19.47	12	34.15	2	17.28
551	*Hormonema macrosporum* L.Voronin 1986	1	19.80	1	26.36		
552	*H. prunorum* (Dennis et Buhagiar 1973) Hermanides-Nijhof 1977	1	16.92	1	27.42		
553	*Humicola fuscoatra* Traaen 1914	1	19.56	2	22.56		
554	*H. grisea* Traaen 1914	1	19.28	2	27.50		

(continued)

Table 3.1 (continued)

Sr. No.	Name of species	Cryopreservation		Freeze-Drying		Soil	
		Number of strains	Storage time (years)	Number of strains	Storage time (years)	Number of strains	Storage time (years)
555	*H. grisea* Traaen 1914 var. *thermoidea* Cooney et Emerson 1964			1	11.62		
556	*H. insolens* Cooney et R. Emerson 1964			1	11.62		
557	*Hymenochaete tabacina* (Sowerby 1796) Levielle 1846	1	19.55				
558	*Hyphozyma sanguinea* (C.Ramirez 1952) de Hoog et M.T.Smith 1981	1	19.28	1	20.45		
559	*H. variabilis* de Hoog et M.T.Smith 1981 var. *odora* de Hoog et M.T.Smith 1981	1	19.28	1	21.64		
560	*H. variabilis* de Hoog et M.T.Smith 1981 var. *variabilis*	1	19.28	1	20.45		
561	*Hypomyces ochraceus* (Persoon 1801) Tulasne et C. Tulasne 1865			2	18.58		
562	*Hypsizygus ulmarius* (Bulliard 1790) Redhead 1984	1	8.54				
563	*Inonotus dryophilus* (Berkeley 1847) Murrill 1904	1	19.41				
564	*I. obliquus* (Ach. ex Persoon 1801) Pilat 1942	1	8.58				
565	*I. rheades* (Persoon 1825) Bondartsev et Singer 1941	2	12.29				
566	*Irpex lacteus* (Fries 1818) Fries 1828	1	12.39				
567	*Isaria farinosa* (Holmskjold 1781) Fries 1832	3	19.56	5	22.64	3	18.38
568	*I. fumosorosea* Wize 1904	2	19.51	5	27.38	1	2.32
569	*Itersonilia perplexans* Derx 1948	2	6.72	1	9.95		
570	*Kickxella alabastrina* Coemans 1862	1	6.69	1	6.46		
571	*Kuehneromyces lignicola* (Peck 1872) Redhead 1984	1	12.07				
572	*K. mutabilis* (Schaeffer 1774) Singer et A.H.Smith 1946	2	12.39				
573	*Laccaria bicolor* (Maire 1937) P.D.Orton 1960	1	0.84				
574	*Lactarius helvus* (Fries 1821) Fries 1838	1	12.58				
575	*Laetiporus sulphureus* (Bulliard 1788) Murrill 1920	3	19.97				
576	*Lasiodiplodia theobromae* (Pat. 1892) Griffon et Maublanc 1909	1	7.36				
577	*Lecanicillium fungicola* (Preus 1851) Zare et W. Gams 2008	1	4.90	3	27.16		
578	*L. fusisporum* (W.Gams 1971) Zare et W.Gams 2001			1	25.03		
579	*L. lecanii* (Zimmermann 1898) Zare et W. Gams 2001	2	19.83	2	31.78		
580	*L. muscarium* (Petch 1931) Zare et W. Gams 2001	3	19.86	6	29.49		
581	*L. psalliotae* (Treschew 1941) Zare et W. Gams 2001	1	19.28	9	29.57		
582	*Leccinum scabrum* (Bulliard 1783) Gray 1821	1	12.07				

583	*Lecythophora decumbens* (J.F.H.Beyma 1942) E. Weber et al. 2002	1	20.38	1	21.28		
584	*L. fasciculata* (J.F.H.Beyma 1939) E. Weber et al. 2002	1	20.38	1	19.35		
585	*L. hoffmannii* (J.F.H.Beyma 1939) W. Gams et McGinnis 1983	1	20.51	2	26.59		
586	*L. mutabilis* (J.F.H. Beyma 1944) Gams et McGinnis 1983	1	20.38	1	25.14		
587	*Lentinula edodes* (Berkeley 1878) Pegler 1975	2	8.52				
588	*Lentinus lepideus* (Fries 1815) Fries 1825	2	20.09				
589	*L. sulcatus* Berkeley 1845	1	12.12				
590	*L. tigrinus* (Bulliard 1781) Fries 1825	3	20.96				
591	*Lenzites betulina* (Linnaeus 1753) Fries 1838	1	12.32				
592	*Lepista luscina* (Fries 1818) Singer 1951	1	0.21				
593	*L. nuda* (Bulliard 1790) Cooke 1871	2	8.25				
594	*Leptographium lundbergii* Lagerberg et Melin 1927			1	1.56		
595	*Leptosphaeria coniothyrium* (Fuckel 1870) Saccardo 1875	1	18.95	1	6.03		
596	*Leucoagaricus leucothites* (Vittadini 1835) M.M. Moser ex Bon 1977	1	3.04				
597	*Linderina pennispora* Raper et Fennell 1952	1	6.92	1	17.15		
598	*Lobosporangium transversale* (Malloch) M.Blackwell et Benny 2004	1	7.16				
599	*Lycoperdon perlatum* Persoon 1796	1	8.02				
600	*L. pyriforme* Schaeffer 1763	1	20.03				
601	*Macrolepiota gracilenta* (Krombholz 1836) Wasser 1978	1	12.20				
602	*M. procera* (Scopoli 1772) Singer 1948	1	12.31				
603	*M. puellaris* (Fries 1863) M.M.Moser 1967	1	12.06				
604	*M. rhacodes* (Vittadini 1833) Singer 1948	1	12.01				
605	*Macrophoma mantegazziana* (Penzig 1882) Berlese et Voglino 1886	1	0.97	1	11.56		
606	*Magnusiomyces magnusii* (F.Ludwig 1886) de Hoog et M.T. Smith 2004			1	24.07		
607	*Malbranchea cinnamomea* (Libert) Oorschot et de Hoog 1984			1	22.25		
608	*Marasmius oreades* (Bolton 1792) Fries 1836	1	8.29				
609	*Mariannaea elegans* (Corda 1838) Samson 1974	2	19.40	5	32.69	2	9.56
610	*Melanconium apiocarpum* Link 1825			1	6.27		
611	*M. bicolor* Nees 1817			1	5.84		

(continued)

Table 3.1 (continued)

Sr. No.	Name of species	Cryopreservation		Freeze-Drying		Soil	
		Number of strains	Storage time (years)	Number of strains	Storage time (years)	Number of strains	Storage time (years)
612	*Melanocarpus albomyces* (Cooney et R.Emerson 1964) von Arx 1975	2	18.60	1	34.85		
613	*Melanospora betae* Panasenko 1938	1	4.06	1	21.47		
614	*M. damnosa* (Saccardo 1895) Lindau 1897	1	19.92	1	9.99		
615	*M. kurssanoviana* (Beliakova 1954) Czerepanova 1962	1	16.04				
616	*M. phaseoli* Roll-Hansen 1948	1	0.12	1	21.13		
617	*Memnoniella echinata* (Rivolta 1884) Galloway 1933	2	20.53	2	12.53		
618	*Menispora ciliata* Corda 1837	1	19.23	1	16.73		
619	*Merimbla ingelheimense* (J.F.H. Beyma 1942) Pitt 1980			1	15.95	1	18.03
620	*Metarhizium anisopliae* (Metschnikoff 1879) Sorokin 1883	2	19.54	2	22.25	1	15.82
621	*Microascus cirrosus* Curzi 1930	1	19.31				
622	*M. trigonosporus* C.W.Emmons et B.O.Dodge var. *terreus* Kamyschko 1966	1	20.37	1	36.69		
623	*Microbotryum silenes-inflatae* (de Candolle 1815 ex Liro 1924) G.Deml et Oberwinkler 1982	3	12.22	1	1.84		
624	*M. violaceum* (Persoon 1797) G.Deml et Oberwinkler 1982	2	12.18				
625	*Microdiplodia pruni* Diedicke 1914	1	19.89				
626	*Microsphaeropsis olivacea* (Bonorden 1869) Höhnell 1917	1	19.39	1	12.05		
627	*Mirandina corticola* G.Arnaud 1952 ex Matsushima 1975	1	19.25	1	23.42		
628	*Monascus* sp.			1	5.27		
629	*Monilia brunnea* J.C.Gilman et E.V.Abbott 1927	1	15.21	1	27.24		
630	*M. diversispora* J.F.H.Beyma 1933	1	15.21	1	35.69		
631	*M. medoacensis* (Saccardo 1913) J.F.H. Beyma 1933	1	19.43	1	28.21		
632	*M. megalospora* (Berkeley et M.A.Curtis 1869) Saccardo 1886			1	26.72		
633	*M. shawi* P.Filho	1	19.56	1	29.68	1	9.18
634	*Moniliella suaveolens* (Lindner 1895 ex Lindner 1906) von Arx 1972 var. *nigra* (Burri et Staub 1909) de Hoog 1979	4	19.54	3	23.99		
635	*M. suaveolens* (Lindner 1895 ex Lindner 1906) von Arx 1972 var. *suaveolens*	1	18.95	1	10.76		
636	*Monilinia fructigena* (Aderhold et Ruhland 1905) Honey 1936	1	20.02				

637	*Monocillium dimorphosporum* W.Gams 1971			1	17.12		
638	*M. indicum* S.B.Saksena 1955	1	16.31	1	15.10		
639	*M. nordinii* (Bourchier 1961) W.Gams 1971	1	19.83	1	22.59		
640	*M. tenue* W.Gams 1971			2	24.20		
641	*Monodictys levis* (Wiltshire 1938) S.Hughes 1958	1	17.77	2	21.23	1	25.87
642	*M. paradoxa* (Corda 1938) S.Hughes 1958	1	17.66	1	11.72		
643	*Monographella cucumerina* (Lindfors 1919) Arx 1984	1	3.81	2	17.75		
644	*Mortierella alliacea* Linnemann 1953	1	13.86				
645	*M. alpina* Peyronel 1913	2	13.93	2	21.97	2	21.91
646	*M. ambigua* B.S.Mehrotra 1963	1	11.73				
647	*M. angusta* Linnemann 1969	1	14.34				
648	*M. beljakovae* Milko 1973	1	12.12				
649	*M. bisporalis* (Thaxter 1914) Bjoerling 1936	2	11.19	1	2.74		
650	*M. capitata* Marchal 1891	1	13.86	1	21.28	1	13.30
651	*M. dichotoma* Linnemann 1936 ex W.Gams 1977	1	6.98	1	16.35	1	1.08
652	*M. elasson* Sideris et G.E.Paxton 1929	2	14.09				
653	*M. elongata* Linnemann 1941	2	15.97	1	4.40		
654	*M. exigua* Linnemann 1941	3	13.93	2	22.78		
655	*M. gamsii* Milko 1974	7	15.91				
656	*M. gemmifera* M.Ellis 1940	3	12.12	2	12.73	2	1.73
657	*M. globalpina* W.Gams et Veenbaas-Rijks 1976	1	13.86				
658	*M. globulifera* O.Rostrup 1916	2	13.14	1	2.76	1	1.61
659	*M. horticola* Linnemann 1941	2	13.99				
660	*M. humilis* Linnemann 1936 ex W.Gams 1977	5	14.09				
661	*M. hyalina* Harz 1871 var. *hyalina*	3	13.99	2	13.93	2	1.08
662	*M. jenkinii* (A.L.Smith 1898) Naumov 1935	3	13.28	3	32.53		
663	*M. lignicola* (G.W.Martin 1937) W.Gams et R.Moreau 1959	1	13.96	1	39.33	1	23.94
664	*M. longicollis* Dixon-Stewart 1932	2	19.42	4	35.06	4	28.66
665	*M. minutissima* van Tieghem 1878	4	13.99	1	14.31	1	1.00
666	*M. mutabilis* Linnemann 1941	1	6.84	1	14.53		
667	*M. nigrescens* van Tieghem 1878	1	3.17				
668	*M. oligospora* Bjoerling 1936	1	13.99	1	2.52	1	1.08
669	*M. parvispora* Linnemann 1941	5	19.07	5	22.80	1	0.79

(continued)

Table 3.1 (continued)

Sr. No.	Name of species	Cryopreservation		Freeze-Drying		Soil	
		Number of strains	Storage time (years)	Number of strains	Storage time (years)	Number of strains	Storage time (years)
670	*M. polycephala* Coemans 1863			1	21.31		
671	*M. pulchella* Linnemann 1941	1	13.99	1	6.83		
672	*M. pusilla* Oudemans 1902	1	16.82	1	7.16		
673	*M. reticulata* van Tieghem et G.Le Monnier 1873	1	6.98	1	39.26	1	24.34
674	*M. sarnyensis* Milko 1973	1	13.86				
675	*M. sclerotiella* Milko 1967	1	11.08				
676	*M. simplex* van Tieghem et G.Le Monnier 1873	1	11.95			1	20.46
677	*M. strangulata* van Tieghem 1875	1	3.79	1	21.01		
678	*M. stylospora* Dixon-Stewart 1932			1	15.95	1	25.98
679	*M. turficola* Y.Ling 1930	1	11.02				
680	*M. verticillata* Linnemann 1941	7	19.42	8	21.74	2	11.98
681	*M. zonata* Linnemann 1936 ex W.Gams 1977	1	13.95	1	5.09		
682	*M. zychae* Linnemann 1941	5	12.12	2	31.68	1	5.37
683	*Mucobasispora tarikii* Moustafa et Abdul-Wahid 1990			1	6.25		
684	*Mucor abundans* Povah 1917	1	17.79	1	29.37	1	5.99
685	*M. aligarensis* B.S.Mehrotra et B.R.Mehrotra 1969	1	20.18	1	23.28		
686	*M. amphibiorum* Shipper 1978	1	15.37	1	18.86		
687	*M. bacilliformis* Hesseltine 1954	1	5.84	1	28.79		
688	*M. bainieri* B.S.Mehrotra et Baijal 1963			1	32.41		
689	*M. circinelloides* van Tieghem 1875 var. *circinelloides*	4	19.54	17	33.63	13	28.04
690	*M. circinelloides* van Tieghem 1875 var. *griseocyanus* (Hagem 1908) Schipper 1976	1	11.98	3	22.46	3	24.30
691	*M. circinelloides* van Tieghem 1875 var. *janssenii* (Lendner 1907) Schipper 1976			7	32.18	6	27.75
692	*M. circinelloides* van Tieghem 1875 var. *lusitanicus* (Bruderlein 1916) Schipper 1976			8	35.15	3	28.44
693	*M. flavus* Bainier 1903	9	19.32	19	36.92	6	26.71
694	*M. fragilis* Bainier 1884	1	19.63	1	16.60	1	18.53
695	*M. fuscus* Bainier 1903	1	7.14	3	39.12	2	19.26
696	*M. genevensis* Lendner 1908	1	19.56	3	21.90		

697	*M. guilliermondii* Nadson et Philippow 1925	1	19.63	1	34.77	1	8.62
698	*M. hiemalis* Wehmer 1903 var. *corticolus* (Hagem 1910) Schipper 1973	1	0.14	3	18.48	1	9.59
699	*M. hiemalis* Wehmer 1903 var. *hiemalis*	4	19.67	17	40.19	5	28.13
700	*M. hiemalis* Wehmer 1903 var. *luteus* (Linnemann 1936) Schipper 1973			1	16.83	1	16.22
701	*M. hiemalis* Wehmer 1903 var. *silvaticus* (Hagem 1908) Schipper 1973			3	26.19	1	2.61
702	*M. inaequisporus* Dade 1937	1	19.63	1	14.72	1	0.09
703	*M. indicus* Lendner 1930	1	11.95	2	40.30	1	26.56
704	*M. laxorrhizus* Y.Ling 1930	3	19.58	5	31.36	2	20.52
705	*M. microsporus* Namyslowski 1910	1	19.56	1	19.44		
706	*M. mousanensis* Baijal et B.S.Mehrotra 1966	1	19.69	1	17.14	1	24.54
707	*M. mucedo* Linnaeus 1753	4	20.05	9	38.20	2	15.41
708	*M. oblongiellipticus* H.Naganishi, Hirahara et Seshita ex Pidoplichko et Milko 1971			1	34.63		
709	*M. odoratus* Treschew 1940	1	19.54	2	16.18		
710	*M. piriformis* A.Fischer 1892	4	18.69	5	27.32		
711	*M. plasmaticus* van Tieghem 1875	1	19.67	1	28.03	1	5.23
712	*M. plumbeus* Bonorden 1864	4	17.79	16	34.81	14	28.41
713	*M. psychrophilus* Milko 1971	1	20.14	1	14.88		
714	*M. racemosus* Fresenius 1850 var. *chibinensis* (Neophytova 1955) Schipper 1976	1	11.78	4	24.74	3	28.30
715	*M. racemosus* Fresenius 1850 var. *racemosus*	7	19.54	31	38.88	26	30.18
716	*M. racemosus* Fresenius 1850 var. *sphaerosporus* (Hagem 1908) Schipper 1970			3	32.34	2	28.30
717	*M. ramosissimus* Samoutsevitch 1927	1	19.63	1	17.67		
718	*M. recurvus* E.E.Butler 1952 var. *indicus* Baijal et B.S.Mehrotra 1965			1	19.87	1	18.75
719	*M. recurvus* E.E.Butler 1952 var. *recurvus*	1	19.63	1	15.92		
720	*M. saturninus* Hagem 1910			1	35.92	1	8.11
721	*M. sinensis* Milko et Beliakova 1971	1	6.83	2	25.58	2	23.61
722	*M. strictus* Hagem 1908			2	22.88	1	8.38
723	*M. tuberculisporus* Schipper 1978	1	19.63	1	20.64		

(continued)

Table 3.1 (continued)

Sr. No.	Name of species	Cryopreservation		Freeze-Drying		Soil	
		Number of strains	Storage time (years)	Number of strains	Storage time (years)	Number of strains	Storage time (years)
724	*M. ucrainicus* Milko 1971			1	17.38		
725	*M. variabilis* A.K.Sarbhoy 1965	1	19.58	1	14.04	1	19.25
726	*M. zonatus* Milko 1967	1	19.56	2	27.40	1	5.69
727	*M. zychae* Baijal et B.S.Mehrotra 1965 var. *zychae*	2	6.02	2	39.08		
728	*Mutinus caninus* (Hudson 1762) Fries 1849	1	12.30				
729	*M. ravenelii* (Berkeley et Curtis 1855) E.Fischer 1888	1	1.81				
730	*Myceliophthora fergusii* (Klopotek 1974) Oorschot 1977			1	1.98		
731	*M. lutea* Costantin 1892			1	29.47		
732	*M. thermophila* (Apinis 1962) van Oorschot 1977	2	20.49	3	20.37	1	19.25
733	*Mycena pura* (Persoon 1794) P.Kummer 1871	1	8.65				
734	*M. viscosa* Maire 1910	1	12.19				
735	*Mycocladus corymbifer* (Cohn 1884) Vanova 1991	6	19.54	18	29.84	17	28.66
736	*Mycogone cervina* Ditmar 1817	1	19.85				
737	*M. nigra* (Morgan 1895) C.N.Jensen 1912	1	19.53	4	27.93		
738	*M. rosea* Link 1809	1	19.37	4	23.30		
739	*Mycosticta cytosporicola* Frolov 1968	1	17.66	2	22.13		
740	*Mycotypha africana* R.O.Novak et Backus 1963			1	21.41		
741	*M. indica* P.M.Kirk et Benny 1985			1	13.81		
742	*Myrothecium cinctum* (Corda 1842) Saccardo 1886	2	19.28	2	16.86		
743	*M. roridum* Tode 1790	1	19.47	4	22.02		
744	*M. verrucaria* (Albertini et Schweinitz 1805) Ditmar 1813	3	19.82	4	31.60		
745	*Myxotrichum setosum* (Eidam 1882) G.F.Orr et Plunkett 1963			1	12.11		
746	*M. stipitatum* (Eidam 1882) G.F.Orr et Kuehn 1963	1	4.06	1	20.40		
747	*Nadsoniella nigra* Issatschenko 1914 var. *hesuelica* Lyakh et Ruban 1970	1	18.85	1	6.16		
748	*Nakataea sigmoidea* (Cavara 1889) Hara 1939	1	19.29				
749	*Nectria cosmariospora* Cesati et de Notaris 1863	2	18.93	2	23.42	2	3.45
750	*N. inventa* Pethybridge 1919			1	27.90		
751	*Nematogonum mycophilum* (Saccardo 1886) Rogerson et W. Gams 1981	1	0.54				

752	*Neocosmospora vasinfecta* E.F.Smith 1899 var. *africana* (von Arx 1955) Cannon et D.Hawksworth 1984	2	19.32	2	20.63		
753	*Neonectria galligena* (Bresadola 1901) Rossman et Samuels 1999	1	18.95				
754	*Neoscytalidium dimidiatum* (Penzig 1887) Crous et Slippers 2006	1	19.39				
755	*Neottiospora caricina* (Desmazieres 1836) Hoehnel 1924			1	15.69		
756	*Neovossia setariae* (Ling 1945) Yu et Lou 1962	1	15.20				
757	*Neurospora crassa* Shear et B.O.Dodge 1927	5	18.94	8	33.87		
758	*N. sitophila* Shear et B.O.Dodge 1927	1	19.42	4	25.64	4	9.02
759	*N. toroi* F.L.Tai 1935	1	18.95	1	17.57	1	9.02
760	*Newbya pascuicola* M.C.Vick et M.W.Dick 2002	1	4.39				
761	*Niesslia exilis* (Albertini et Schweinitz 1805) G.Winter 1887	1	18.95	1	7.35	1	4.37
762	*Nigrospora gossypii* Jaczewski 1929	1	17.46	1	27.64		
763	*Nigrospora oryzae* (Berkeley et Broome 1873) Petch 1924	2	19.45	4	18.56	1	26.03
764	*Nodulisporium verrucosum* (J.F.H.Beyma 1929) G. Smith 1954	1	19.71				
765	*Nomuraea rileyi* (Farlow 1883) Samson 1974	1	9.84	1	12.70		
766	*Ochrocladosporium elatum* (Harz 1871) Crous et U. Braun 2007	1	12.57	1	27.80	1	7.91
767	*Oedocephalum* sp. (Berkeley et Broome 1873) Petch 1924	1	15.55	1	28.99	1	15.98
768	*Oidiodendron cereale* (Thuemen 1880) G.L.Barron 1962	1	0.18	4	27.05		
769	*O. echinulatum* G.L.Barron 1962	1	19.57	1	7.85		
770	*O. tenuissimum* (Peck 1894) S. Hughes 1958			1	1.95		
771	*O. truncatum* G.L.Barron 1962			3	8.70		
772	*Olpitrichum* sp.	1	20.45	1	19.95		
773	*Oospora minor* Delitsch 1943	1	15.64	1	8.14		
774	*O. nicotianae* Pezzolato 1899	1	19.75	2	33.00		
775	*O. oryzae* Ferraris 1902	1	19.94	1	1.05		
776	*O. sajanica* Ogarkov 1979	1	16.10	1	25.73		
777	*O. sulphurea* (Preuss 1852) Saccardo et Voglino 1886	2	19.54	2	20.49		
778	*O. tenuis* (P.Maze 1910) Berkhout 1923	1	19.94	1	18.62		
779	*O. uvarum* Karamboloff 1931	1	15.64				
780	*O. variabilis* (Lindner 1898) J.Lindau 1907	1	19.85	1	14.69		
781	*Ophiostoma piceae* (Münch 1907) Syd. et P. Syd. 1919			2	10.07		
782	*Ostracoderma* sp.	1	1.88				

(continued)

Table 3.1 (continued)

Sr. No.	Name of species	Cryopreservation		Freeze-Drying		Soil	
		Number of strains	Storage time (years)	Number of strains	Storage time (years)	Number of strains	Storage time (years)
783	*Ovadendron sulphureo-ochraceum* (J.F.H.Beyma 1933) Sigler et J.W.Carmichael 1976	1	19.77	1	29.32		
784	*Paecilomyces borysthenicus* B.A. Borisov et Tarasov 1997			1	6.32		
785	*P. inflatus* (Burnside 1927) J.W.Carmichael 1962			3	2.00		
786	*P. lilacinus* (Thom 1910) Samson 1974	4	19.45	12	31.69	5	19.37
787	*P. marquandii* (Massee 1898) S.Hughes 1951	3	19.54	4	31.29	2	18.38
788	*P. puntonii* (Vuill 1930) Nann. 1934	1	16.39	1	11.91		
789	*P. variotii* Bainier 1907	12	19.40	19	32.02	13	33.89
790	*Papulaspora biformospora* Kirilenko 1971	1	19.63	1	20.69		
791	*Papulaspora* sp.	1	19.30	1	23.48	1	3.20
792	*Paraconiothyrium sporulosum* (W. Gams et Domsch 1969) Verkley 2004	1	19.39	2	16.28		
793	*Parasitella parasitica* (Bainier 1884) Sydow 1903	1	7.18	2	22.32		
794	*Passalora fulva* (Cooke 1883) U. Braun et Crous 2003	1	18.99	1	22.51		
795	*Paxillus panuoides* (Fries 1818) Fries 1838	2	20.01				
796	*Penicillium adametzii* K.M.Zalessky 1927			2	35.16	3	33.89
797	*P. albicans* Bainier 1907			1	22.03	1	7.15
798	*P. alicantinum* C.Ramirez et A.T.Martinez 1980			1	10.67	1	12.20
799	*P. anatolicum* Stolk 1968			1	14.02	1	15.32
800	*P. aragonense* C.Ramirez et A.T.Martinez 1981			1	10.66	1	12.20
801	*P. arenicola* Chalabuda 1950			1	14.54	1	17.92
802	*P. atramentosum* Thom 1910					1	2.57
803	*P. aurantioflammiferum* C.Ramirez et al. 1980			1	10.67	1	12.20
804	*P. aurantiogriseum* Dierckx 1901	2	20.50	31	34.27	28	34.84
805	*P. bilaiae* Chalabuda 1950			1	15.01	1	18.52
806	*P. brevicompactum* Dierckx 1901	2	20.48	12	28.04	9	18.10
807	*P. brunneum* Udagawa 1959	1		1	10.59	1	12.07
808	*P. camemberti* Thom 1906			10	35.42	9	24.37
809	*P. canescens* Sopp 1912	2	20.48	12	36.88	10	39.72
810	*P. capsulatum* Raper et Fennell 1948	2	19.49	3	17.24	3	18.17

811	*P. castellonense* C.Ramirez et A.T.Martinez 1981			1	17.69	1	12.20
812	*P. chermesinum* Biourge 1923			3	35.23	2	24.93
813	*P. chrysogenum* Thom 1910	4	19.34	29	35.75	22	43.04
814	*P. cinerascens* Biourge 1923			1	23.35	1	14.95
815	*P. citreonigrum* Dierckx 1901	1	18.94	10	25.87	10	33.89
816	*P. citrinum* Thom 1910	2	18.30	16	37.11	12	20.45
817	*P. commune* Thom 1910	1	2.51	6	20.26	6	18.03
818	*P. cordubense* C.Ramirez et A.T.Martinez 1981			1	10.65	1	12.20
819	*P. corylophilum* Dierckx 1901			1	28.97	1	15.77
820	*P. cyaneum* (Bainier et Sartory 1913) Biourge 1923 ex Thom 1930			1	21.73	1	9.56
821	*P. daleae* K.M.Zalessky 1927	1	2.26	1	5.73	1	18.10
822	*P. decumbens* Thom 1910	3	18.07	9	36.80	7	29.21
823	*P. dierckxii* Biourge 1923	2	18.30	6	20.27	6	20.45
824	*P. digitatum* (Persoon 1801) Saccardo 1881			3	17.59	2	21.28
825	*P. diversum* Raper et Fennell 1948			1	22.03	1	18.04
826	*P. dodgei* Pitt 1980			1	27.75	1	12.58
827	*P. duclauxii* Delacroix 1892			6	19.86	6	20.33
828	*P. expansum* Link 1809			5	30.96	5	38.34
829	*P. fagi* A.T.Martinez et C.Ramirez 1978			1	10.68	1	12.07
830	*P. funiculosum* Thom 1910	1	20.48	8	30.78	7	25.05
831	*P. glabrum* (Wehmer 1893) Westling 1911			9	34.77	9	24.90
832	*P. gladioli* Machacek 1928	1	20.44	2	35.58	2	12.07
833	*P. glaucum* Link 1805	1	20.50	1	15.50	1	25.04
834	*P. grancanariae* C.Ramirez et al. 1978			1	10.68	1	12.20
835	*P. granulatum* Bainier 1905			5	26.68	5	12.33
836	*P. griseofulvum* Dierckx 1901			6	19.61	5	24.88
837	*P. herqueri* Bainier et Sartory 1912			3	37.41	3	22.37
838	*P. hirsutum* Dierckx 1901 var. *hirsutum*			1	2.77	1	5.41
839	*P. hispanicum* C.Ramirez et al. 1978			1	10.68	1	12.07
840	*P. humuli* J.F.H.Beyma 1937			1	19.85	1	24.92
841	*P. ilerdanum* C.Ramirez et al. 1980			1	26.66	1	12.20
842	*P. indonesiae* Pitt 1980			2	29.58	2	14.21

(continued)

Table 3.1 (continued)

Sr. No.	Name of species	Cryopreservation		Freeze-Drying		Soil	
		Number of strains	Storage time (years)	Number of strains	Storage time (years)	Number of strains	Storage time (years)
843	*P. inflatum* Stolk et Malla 1971			1	2.95		
844	*P. insectivorum* (Sopp 1912) Biourge 1923			1	15.05	1	25.04
845	*P. islandicum* Sopp 1912	1	2.23	3	20.87	3	12.07
846	*P. italicum* Wehmer 1894	1	14.09	3	20.32	3	20.35
847	*P. janczewskii* K.M.Zalessky 1927			8	27.39	8	27.37
848	*P. jensenii* K.M.Zalessky 1927			8	37.45	8	26.06
849	*P. kirovogradum* Beliakova et al.	1	18.21	1	5.52	1	6.07
850	*P. lagena* (Delitsch 1943) Stolk et Samson 1983	2	19.44	2	24.97		
851	*P. lanosum* Westling 1911			3	33.03	3	15.57
852	*P. lapidosum* Raper et Fennell 1948			3	23.28	4	24.86
853	*P. lehmanii* Pitt 1980			2	30.40	2	24.94
854	*P. lineatum* Pitt 1980			1	10.51	1	11.55
855	*P. lividum* Westling 1911			2	15.45	1	15.33
856	*P. malacaense* C.Ramirez et A.T.Martinez 1980			1	10.65	1	12.20
857	*P. martensii* Biourge 1923 var. *moldavicum* Solovei 1975		2.26	1	10.48	1	10.71
858	*P. megasporum* Orpurt et Fennell 1955			2	15.78	3	20.33
859	*P. melinii* Thom 1930	1	3.99	4	27.39	4	20.45
860	*P. miczynskii* K.M.Zalessky 1927			7	30.90	6	24.92
861	*P. minioluteum* Dierckx 1901	1	9.07	6	10.72	2	12.20
862	*P. mirabile* Beliakova et Milko 1972	1	4.01	1	16.95	1	9.56
863	*P. mongoliae* Beliakova et al.	1	17.98	1	23.82	1	6.07
864	*P. multicolor* Grigorieva-Manoilova et Poradielova 1915			1	19.35		
865	*P. multicolor* Novobranova 1972			1	12.94	1	15.09
866	*P. murcianum* C.Ramirez et A.T.Martinez 1981			1	10.65	1	12.20
867	*P. novae-zeelandiae* J.F.H.Beyma 1940	1	19.47	5	22.02	5	9.70
868	*P. ochrochloron* Biourge 1923			6	36.27	4	17.51
869	*P. onobense* C.Ramirez et A.T.Martinez 1981			1	10.69	1	12.20
870	*P. ovetense* C.Ramirez et A.T.Martinez 1981			1	10.67	1	12.20
871	*P. oxalicum* Currie et Thom 1915			4	31.32	5	24.94
872	*P. palmense* C.Ramirez et al. 1978			1	10.68	1	12.20

873	*P. paxilli* Bainier 1907			7	27.21	5	18.52
874	*P. phoeniceum* J.F.H.Beyma 1933			3	20.27	3	15.02
875	*P. piceum* Raper et Fennell 1948	1	20.53	2	34.66	3	24.87
876	*P. pinophilum* Thom 1910			2	37.80	2	26.35
877	*P. poltaviae* Beliakova et al.	1	18.21	1	5.51	1	6.07
878	*P. purpurogenum* Stoll 1904	1	9.25	9	36.78	7	24.87
879	*P. quercetorum* Baghdadi 1968	1	4.06	1	20.52	1	20.45
880	*P. raistrickii* G.Smith 1933			3	36.68	3	20.13
881	*P. resticulosum* Birkinshaw et al. 1942			1	26.72	1	17.75
882	*P. restrictum* J.C.Gilman et E.V.Abbott 1927	2	18.30	9	37.65	7	24.92
883	*P. roqueforti* Thom 1906	2	3.99	9	21.05	9	24.87
884	*P. roseopurpureum* Dierckx 1901			4	22.90	4	15.41
885	*P. rubrum* Stoll 1904	4	20.48	12	31.53	12	24.99
886	*P. rugulosum* Thom 1910	1	18.07	14	36.65	14	25.04
887	*P. sclerotiorum* J.F.H.Beyma 1937			6	25.87	5	18.09
888	*P. senticosum* D.B.Scott 1968			1	20.73		15.32
889	*P. severskii* Schechovtsov 1981			1	11.10	1	5.72
890	*P. simplicissimum* (Oudemans 1903) Thom 1930	2	18.30	18	27.37	17	24.92
891	*P. solitum* Westling 1911 var. *crustosum* (Thom 1930) Bridge et al. 1989	2	3.99	7	33.56	6	24.90
892	*P. solitum* Westling 1911 var. *solitum*	2	17.98	8	34.70	8	24.92
893	*P. solocongelatus* Beliakova et al.	1	17.98	1	7.99	1	6.07
894	*P. spinulosum* Thom 1910	2	4.01	16	24.81	14	24.93
895	*P. terraconense* C.Ramirez et A.T.Martinez 1980			1	10.65	1	12.79
896	*P. thomii* Maire 1917	1	2.26	8	21.38	8	24.90
897	*P. turbatum* Westling 1911			1	17.63	1	20.12
898	*P. turolense* C.Ramirez et A.T.Martinez 1981			1	10.70	1	12.20
899	*P. umbonatum* Sopp 1912			1	32.95		
900	*P. valentinum* C.Ramirez et A.T.Martinez 1980			1	10.66	1	12.20
901	*P. vanbeymae* Pitt 1980			1	27.09		
902	*P. variabile* Sopp 1912			5	34.08	3	15.15
903	*P. vasconiae* C.Ramirez et A.T.Martinez 1980			1	10.63	1	12.20
904	*P. velutinum* J.F.H.Beyma 1935			9	26.62	9	20.16

(continued)

Table 3.1 (continued)

Sr. No.	Name of species	Cryopreservation		Freeze-Drying		Soil	
		Number of strains	Storage time (years)	Number of strains	Storage time (years)	Number of strains	Storage time (years)
905	*P. verrucosum* Dierckx 1901			5	35.63	3	19.24
906	*P. verruculosum* Peyronel 1913	2	18.07	4	31.53	3	18.52
907	*P. vinaceum* J.C.Gilman et E.V.Abbott 1927			4	34.62	4	25.05
908	*P. viridicatum* Westling 1911			7	21.31	5	24.93
909	*P. vulpinum* (Cooke et Massee 1888) Seifert et Samson 1985			8	37.02	9	24.80
910	*P. waksmanii* K.M.Zalessky 1927	1	2.26	5	36.82	5	34.08
911	*P. westlingii* K.M.Zalessky 1927			1	15.51	1	9.56
912	*P. zacinthae* C. Ramírez et A.T. Martínez 1981			1	26.64	1	12.20
913	*Penidiella strumelloidea* (Milko et Dunaev 1986) Crous et U. Braun 2007			1	14.15		
914	*Perenniporia medulla-panis* (Jacquin 1778) Donk 1967	1	18.54				
915	*Periconia macrospinosa* Lefebvre et Aar.G. Johnson 1949	2	19.47	1	16.13		
916	*Pestalotia macrotricha* Klebahn 1914	1	19.27				
917	*P. pezizoides* de Notaris 1841	1	19.85	2	20.58		
918	*Petriella sordida* (Zukal 1890) G.L. Barron et J.C. Gilman 1961			1	10.23		
919	*Phaeococcomyces nigricans* (Rich et Stern 1958) de Hoog 1979			1	23.58		
920	*Phaeoisaria hippocrepiformis* Milko et Dunaev	1	19.38	1	5.26		
921	*Phallus hadriani* Ventenat 1798	1	15.06				
922	*P. impudicus* Linnaeus 1753	1	1.76				
923	*Phanerochaete sanguinea* (Fries 1828) Pouzar 1973	1	3.24				
924	*Phellinus igniarius* (Linnaeus 1753) Quelet 1886	1	20.05				
925	*P. lundellii* Niemelae 1972	3	20.01				
926	*P. populicola* Niemelae 1975	3	20.01				
927	*Phialophora atrovirens* (J.F.H.Beyma 1935) Schol-Schwarz 1970	1	20.38	1	25.35		
928	*P. bubakii* (Laxa 1930) Schol-Schwarz 1970	1	20.40	3	15.42		
929	*P. cyclaminis* J.F.H. Beyma 1942			1	6.36		
930	*P. lagerbergii* (Melin et Nannfeldt 1934) Conant 1937	1	19.37				
931	*P. melinii* (Nannf. 1934) Conant 1937			3	5.86		
932	*P. verrucosa* Medlar 1915	1	19.74	1	19.52		

933	*Phlebia rufa* (Persoon 1801) M.P.Christiansen 1960	1	2.80				
934	*Phlebiopsis gigantea* (Fries 1815) Juelich 1978	2	20.03				
935	*Pholiota adiposa* (Batsch 1789) P.Kummer 1871	1	20.09				
936	*P. lenta* (Persoon 1801) Singer 1951	1	0.20				
937	*P. nameko* (T.Ito 1929) S.Ito et S.Imai apud S.Imai 1933	1	8.08				
938	*P. squarrosa* (Weigel 1771) P.Kummer 1871	1	12.19				
939	*Phoma betae* A.B.Frank 1892	1	17.46	2	24.02		
940	*P. destructiva* Plowright 1881			1	1.73		
941	*P. eupyrena* Saccardo 1879			1	5.21		
942	*P. glomerata* (Corda 1840) Wollenweber et Hochapfel 1936	1	19.30	6	25.47		
943	*P. hedericola* (Durieu et Mont. 1856) Boerema 1976			1	4.61		
944	*P. jolyana* Pirozynski et Morgan-Jones 1968 var. *circinata* (Kuznetzova 1971) Boerema et al. 1977	1	19.54	4	20.04		
945	*P. leveillei* Boerema et G.J.Bollen 1975			1	1.53		
946	*P. lingam* (Tode 1791) Desmazieres 1849			4	8.45		
947	*P. lycopersici* Cooke 1885			1	2.14		
948	*P. pinodella* (L.K. Jones 1927) Morgan-Jones et K.B. Burch 1987	1	20.52				
949	*P. pomorum* Thuemen 1879			1	7.21		
950	*P. sorghina* (Saccardo 1878) Boerema et al. 1973	1	19.45	2	20.14		
951	*P. tracheiphila* (Petri 1929) L.A. Kantschaweli et Gikaschvili 1948	1	12.55				
952	*Phomatospora* sp.	1	18.85	1	26.61		
953	*Phomopsis helianthi* Muntanola-Cvetcovic et al. 1981	1	8.01	1	5.68		
954	*Phycomyces blakesleeanus* Burgeff 1925	1	19.56	8	31.79	1	1.51
955	*P. nitens* (C.Agardh 1823) Kunze 1823	2	19.71	2	31.87		
956	*Phyllosticta pucciniospila* C. Massalongo 1900	1	11.44	1	23.98		
957	*Phytophthora cactorum* (Lebert et Cohn 1870) J.Schroeter 1886	1	17.04				
958	*P. capsici* Leonian 1922	2	15.93				
959	*P. cinnamomi* Rands 1922	4	13.13				
960	*P. cryptogea* Pethybridge et Lafferty 1919	1	0.18				
961	*P. drechsleri* Tucker 1931	3	4.16				
962	*P. megasperma* Drechsler 1931 var. *megasperma*	1	0.19				
963	*Pidoplitchkoviella terricola* Kirilenko 1975	1	19.44	1	15.30		

(continued)

Table 3.1 (continued)

Sr. No.	Name of species	Cryopreservation		Freeze-Drying		Soil	
		Number of strains	Storage time (years)	Number of strains	Storage time (years)	Number of strains	Storage time (years)
964	*Piedraia hortae* Fonseca et Leao 1928	1	19.34	1	15.70		
965	*P. hortae* Fonseca et Leao 1928 var. *paraguayensis* Fonseca et Leao 1928	1	19.34	1	7.90		
966	*P. sarmentoi* M.J.Pereira 1930	1	19.34	1	17.54		
967	*Pilaira anomala* (Cesati 1851) J.Schroeter 1886			1	26.00		
968	*P. caucasica* Milko 1970			1	16.20		
969	*P. moreaui* Y.Ling 1926	1	0.02	1	16.74		
970	*Pilobolus crystallinus* (F.H.Wiggers 1780) Tode 1784			1	15.64		
971	*P. longipes* van Tieghem 1878	1	3.68	1	15.64		
972	*P. umbonatus* Buller 1934			1	15.65		
973	*Piptoporus betulinus* (Bulliard 1786) P.Karsten 1881	3	12.39				
974	*Pirella circinans* Bainier 1882	1	19.32	1	27.13	1	14.40
975	*P. circinans* Bainier 1882 var. *volgogradensis* (Milko 1974) Benny et Schipper 1988			1	14.71		
976	*P. naumovii* (Milko 1970) Benny et Schipper 1992	1	19.30	1	15.35	1	25.59
977	*Pleurodesmospora coccorum* (Petch 1924) Samson, W. Gams et H.C. Evans 1980			1	28.25		
978	*Pleurophoma cava* (Schulzer 1871) Boerema 1996	1	19.80	3	23.72		
979	*Pleurotus cornucopiae* (Paulet 1793) Rolland 1910	1	20.01				
980	*P. eryngii* (De Candolle 1805) Quelet 1872	1	20.14				
981	*P. ostreatus* (Jacquin 1775) P.Kummer 1871	16	20.14				
982	*P. pulmonarius* (Fries 1821) Quelet 1872	2	8.15				
983	*Pochonia bulbillosa* (W. Gams et Malla 1971) Zare et W. Gams 2001	1	19.98	3	28.36		
984	*P. chlamydosporia* (Goddard 1913) Zare et W. Gams 2001	1	19.45	1	31.72		
985	*Polycephalomyces tomentosus* (Schrad. 1799) Seifert 1985	1	19.53	1	24.82		
986	*Polyscytalum pustulans* (M.N.Owen et Wakefield 1919) M.B. Ellis 1976	1	15.56	1	30.58		
987	*Preussia fleischhakii* (Auerswald 1866) Cain 1961			1	19.14		
988	*Protomyces macrosporus* Unger 1834	1	18.99				

989	*Pseudallescheria boydii* (Shear 1922) McGinnis et al. 1982	2	19.42	2	21.30	1	3.42
990	*Pseudeurotium bakeri* C.Booth 1961	1	20.43	1	21.45		
991	*P. desertorum* Mouchacca 1971	1	18.86	1	14.48		
992	*P. ovale* Stolk 1955 var. *milkoi* Belyakova 1969	2	20.43	2	20.65		
993	*P. ovale* Stolk 1955 var. *ovale*	1	19.32	1	22.82		
994	*P. zonatum* J.F.H.Beyma 1937	9	20.37	9	36.92	1	3.81
995	*Pseudogymnoascus caucasicus* Cejp et Milko 1966	1	19.32	1	16.38		
996	*P. roseus* Raillo 1929	2	19.32	2	20.63		
997	*Puccinia albescens* (Greville 1824) Plowright 1888	1	18.50	1	5.32		
998	*P. bupleuri* F.Rudolphi 1829	1	18.50	1	1.84		
999	*P. suaveolens* (Persoon 1801) Rostrup 1869	1	12.22				
1000	*Pycnidiella resinae* (Ehrenberg 1818) Hoehnel 1915			1	6.69		
1001	*Pycnoporus cinnabarinus* (Jacquin 1776) Fries 1881	2	12.34				
1002	*Pyricularia grisea* Saccardo 1880	3	15.82	1	13.76		
1003	*Pyronema omphalodes* (Bulliard 1791) Fuckel 1870	1	18.95	1	17.28		
1004	*Pythium heterothallicum* W.A.Campbell et F.F.Hendrix 1968	1	5.90				
1005	*P. intermedium* de Bary 1881	1	6.50				
1006	*P. mamillatum* Meurs 1928	1	17.04				
1007	*P. oedichilum* Drechsler 1930	1	15.98				
1008	*P. paroecandrum* Drechsler 1930	1	8.99				
1009	*P. spinosum* Sawada 1926	1	0.15				
1010	*P. sylvaticum* W.A.Campbell et F.F.Hendrix 1967	1	0.03				
1011	*Radiomyces embreei* R.K.Benjamin 1960			2	17.40	2	24.86
1012	*R. spectabilis* Embree 1959	1	19.69	1	20.91	1	24.89
1013	*Ramichloridium biverticillatum* Arzanlou et Crous 2007			1	5.98		
1014	*Rhinocladiella atrovirens* Nannfeldt 1934	1	17.68	1	12.15		
1015	*Rhinotrichum aureum* Cooke et Massee 1889			1	28.38		
1016	*R. lanosum* Cooke 1871	1	19.45	1	21.52		
1017	*Rhizoctonia crocorum* (Persoon 1801) De Candolle 1815	1	19.30			1	5.60
1018	*R. solani* J.G.Kuehn 1858	5	19.90	1	5.53	3	10.96
1019	*R. tuliparum* (Klebahn 1905) Whetzel et J.M. Arthur 1924			1	14.94		
1020	*Rhizomucor miehei* (Cooney et R.Emerson 1964) Schipper 1978	1	19.67	1	21.41	1	17.16
1021	*R. pusillus* (Lindt 1886) Schipper 1978	3	19.69	4	28.96	4	22.48

(continued)

Table 3.1 (continued)

Sr. No.	Name of species	Cryopreservation		Freeze-Drying		Soil	
		Number of strains	Storage time (years)	Number of strains	Storage time (years)	Number of strains	Storage time (years)
1022	*R. tauricus* (Milko et Schkurenko 1970) Schipper 1978	1	19.63	2	20.82	2	24.69
1023	*Rhizopus microsporus* van Tieghem 1875 var. *chinensis* (Saito 1904) Schipper et Stalpers 1984	3	11.63	5	34.24	5	27.09
1024	*R. microsporus* van Tieghem 1875 var. *microsporus*	3	19.71	10	36.72	10	28.45
1025	*R. microsporus* van Tieghem 1875 var. *oligosporus* van Tieghem 1875			2	22.07	2	28.09
1026	*R. microsporus* van Tieghem 1875 var. *rhizopodiformis* (Cohn 1884) Schipper et Stalpers 1984			4	8.70		
1027	*R. oryzae* Went et Prinsen Geerligs 1895	2	19.71	26	38.13	24	30.35
1028	*R. stolonifer* (Ehrenberg 1818) Vuillemin 1902 var. *stolonifer*	3	19.71	23	33.61	14	28.66
1029	*Robillarda sessilis* (Saccardo 1878) Saccardo 1880			1	6.61		
1030	*Rosellinia mammiformis* (Persoon 1801) Cesati et de Notaris 1863	1	19.27	1	10.72		
1031	*Rozites caperata* (Persoon 1796) P.Karsten 1879	1	12.09				
1032	*Russula decolorans* (Fries 1821) Fries 1838	1	12.02				
1033	*R. grisea* Fries 1838	1	20.01				
1034	*R. velutipes* Velenovsky 1920	1	12.30				
1035	*R. vesca* Fries 1838	1	8.81				
1036	*Rutola graminis* (Desmazieres 1834) J.L. Crane et Schoknecht 1977	1	19.39	1	6.87		
1037	*Saksenaea vasiformis* S.B.Saksena 1953	1	19.05				
1038	*Saprochaete gigas* (Smit et L.Meyer 1928) de Hoog et M.T.Smith 2004	1	19.86	1	16.65		
1039	*Saprolegnia asterophora* de Bary 1860	1	15.19				
1040	*S. blelhamensis* (M.W.Dick 1969) Milko 1979	2	13.34				
1041	*S. ferax* (Gruithuisen 1821) Nees 1843	1	13.80				
1042	*S. litoralis* Coker 1923	1	13.09				
1043	*S. mixta* de Bary 1883	1	0.17				
1044	*S. terrestris* Cookson 1937 ex R.L.Seymour 1970	1	0.17				
1045	*S. unispora* (Coker et Couch 1923) R.L.Seymour 1970	1	0.17				

1046	*Schizophyllum commune* Fries 1815	3	20.09				
1047	*Sclerotinia ricini* G.H.Godfrey 1919	1	18.95	1	5.10		
1048	*S. sclerotiorum* (Libert 1837) de Bary 1884	2	19.31				
1049	*Scopulariopsis acremonium* (Saccardo 1882) Bainier 1907	1	19.31	1	23.60	1	4.86
1050	*S. asperula* (Saccaardo 1882) Hughes 1958	1	19.25	1	26.22	1	9.56
1051	*S. brevicaulis* (Saccardo 1882) Bainier 1907	9	20.47	14	32.48	7	18.53
1052	*S. brumptii* Salvanet-Duval 1935	1	15.24	1	21.54		
1053	*S. coprophila* (Cooke et Massee 1887) W. Gams 1971			1	31.33		
1054	*S. flava* (Sopp 1912) F.J.Morton et G.Smith 1963	1	19.28	1	23.56	1	20.68
1055	*S. halophilica* Tubaki 1973	1	15.89				
1056	*S. koningii* (Oudemans 1902) Vuuillemin 1911	1	19.54				
1057	*Sepedonium ampullosporum* Damon 1952			1	6.85		
1058	*S. macrosporum* Saccardo et Cavara 1900	1	7.75	1	27.21	1	9.50
1059	*Septoria lycopersici* Spegazzini 1881	1	19.96				
1060	*Serpula lacrymans* (von Wulfen 1781) J.Schroeter 1888	2	18.87				
1061	*Simplicillium lamellicola* (F.E.W. Smith 1924) Zare et W. Gams 2001	1	19.56	3	24.26		
1062	*Sordaria fimicola* (Roberge ex Desmazières 1849) Cesati et de Notaris 1863	1	19.36	2	20.55	1	7.15
1063	*Spadicesporium acrosporum* V.N.Borisova et Dvoinos 1982	1	19.41	1	22.15		
1064	*S.acrosporum-majus* V.N.Borisova et Dvoinos 1982	1	19.41	1	11.45		
1065	*S.bifurcatum* V.N.Borisova et Dvoinos 1982	1	19.41	1	19.24		
1066	*S.bifurcatum-majus* V.N.Borisova et Dvoinos 1982	1	19.41	1	13.52		
1067	*S.copiosum* V.N.Borisova et Dvoinos 1982	1	19.41	1	13.52		
1068	*S.persistens* V.N.Borisova et Dvoinos 1982	1	19.41	1	22.24		
1069	*S.ramosum* V.N.Borisova et Dvoinos 1982	1	19.76	1	13.52		
1070	*Sparassis crispa* (von Wulfen 1781) Fries 1821	1	7.49				
1071	*Sphaerellopsis filum* (Bivona-Bernardi 1813–1816) Sutton 1977	1	12.66	1	5.76		
1072	*Sphaeropsis malorum* Peck 1883	1	19.98				
1073	*S. sapinea* (Fries 1823) Dyko et B. Sutton 1980	1	19.89				
1074	*Sporodiniopsis dichotoma* van Hoehnel 1903	1	15.89	1	15.95	1	10.80
1075	*Sporormiella australis* (Spegazzini 1887) S.I.Ahmed et Cain 1972			1	2.41	1	5.01

(continued)

Table 3.1 (continued)

Sr. No.	Name of species	Cryopreservation		Freeze-Drying		Soil	
		Number of strains	Storage time (years)	Number of strains	Storage time (years)	Number of strains	Storage time (years)
1076	*S. intermedia* (Auerswald 1868) S.I.Ahmed et Cain ex Kobayasi 1969			1	11.76		
1077	*Sporothrix fungorum* de Hoog et G.A. de Vries 1973			1	1.94		
1078	*Sporotrichum aeruginosum* Schweinitz 1886 var. *microsporum* Karsten 1905			1	32.35		
1079	*S. bombycinum* (Corda 1839) Rabenhorst 1844	1	19.29	3	29.59	1	27.59
1080	*S. gorlenkoanum* Kuritzina et Sizova 1967			1	23.64	1	20.27
1081	*S. laxum* Nees 1816	1	19.29	1	26.27		
1082	*S. mycophilum* Link 1818			1	27.68		
1083	*S. pruinosum* J.C.Gilman et E.V.Abbott 1927	6	19.81	8	31.16	1	5.84
1084	*S. roseolum* Oudemans et Beijerinck 1903	1	15.19	1	26.16		
1085	*Stachybotrys chartarum* (Ehrenberg 1818) S.Hughes 1958	1	19.30	11	26.67	2	9.56
1086	*S. cylindrospora* C.N.Jensen 1912			1	14.86		
1087	*Stachylidium variabile* Schaeffer et Saccardo			1	19.09		
1088	*Stagonospora paludosa* (Saccardo et Spegazzini 1879) Saccardo 1884	1	19.89				
1089	*Stemphyliomma* sp.			1	26.05	1	25.87
1090	*Stemphylium botryosum* Wallroth 1833	1	17.05	1	23.43		
1091	*S. sarciniforme* (Cavara 1890) Wiltshire 1938	1	17.79	3	23.43		
1092	*Stenocarpella maydis* (Berkeley 1847) B. Sutton 1980			1	11.57		
1093	*Stephanoma* sp.	1	16.23	1	16.03		
1094	*Stereum hirsutum* (Willdenow 1787) Persoon 1800	2	20.03				
1095	*S. sanguinolentum* (Albertini et Schweinitz 1805) Fries 1838	1	20.03				
1096	*Stigmina carpophila* (Leveille 1843) M.B. Ellis 1959	1	19.91				
1097	*Stilbella bulbicola* Hennings 1905	1	19.44	1	29.49		
1098	*Stilbotulasnella conidiophora* Bandoni et Oberwinkler 1982	1	12.54				
1099	*Strobilomyces strobilaceus* (Scopoli 1770) Berkeley 1851	1	15.10				
1100	*Stropharia rugosoannulata* Farlow ex Murrill 1922	1	12.20				
1101	*Syncephalastrum racemosum* Cohn ex J.Schroeter 1886	2	19.24	12	29.66	12	29.24
1102	*Syncephalis cornu* van Tieghem et G.Le Monnier 1873			1	20.64	1	24.09

1103	*S. nodosa* van Tieghem 1875			1	23.87	1	19.47
1104	*Taeniolella aquatilis* (Woronichin 1925) Milko 1985	1	19.31	1	9.74		
1105	*Talaromyces emersonii* Stolk 1965			1	21.01	1	11.55
1106	*T. flavus* (Kloecker 1902) Stolk et Samson 1972	1	18.07	4	15.44	4	24.86
1107	*T. luteus* (Zukal 1889) C.R. Benjamin 1955			8	37.03	7	18.17
1108	*T. stipitatus* (Thom 1935) C.R.Benjamin 1955			1	27.27	1	12.07
1109	*T. thermophilus* Stolk 1965			1	17.19	1	1.25
1110	*T. ucrainicus* Udagawa 1966	1	18.07	3	22.55	3	21.86
1111	*T. wortmannii* (Kloecker 1903) C.R.Benjamin 1955			2	22.58	2	12.07
1112	*Taphrina bergeniae* Döbbeler 1979	1	18.99				
1113	*T. carnea* Johanson 1886	1	8.12				
1114	*T. deformans* (Berkeley 1857) Tulasne 1866	1	7.17				
1115	*T. pruni* (Fuckel 1861) Tulasne 1866	1	18.99				
1116	*Tetraploa aristata* Berkeley et Broome 1850	1	19.28				
1117	*Thamnidium elegans* Link 1809	1	17.71	3	27.08	3	12.14
1118	*Thamnostylum piriforme* (Bainier 1880) Arx et H.P. Upadhyay 1970	3	19.69	4	29.92	4	28.16
1119	*Thelebolus polysporus* (P.Karsten 1871) Otani et Kanzawa 1970	1	19.83	1	25.82		
1120	*Thermomyces ibadanensis* Apinis et Eggins 1966			2	13.79		
1121	*Thielavia appendiculata* Srivastava et al. 1966	1	14.44	1	12.14		
1122	*T. hyrcaniae* Nicot 1961	1	4.06	1	17.91		
1123	*T. inaequalis* Pidoplichko et al. 1973	3	18.93	3	20.63		
1124	*T. ovispora* Pidoplichko et al. 1973	3	19.32	3	18.92		
1125	*T. pallidospora* Pidoplichko et al. 1973			1	17.81		
1126	*T. terrestris* (Apinis 1963) Malloch et Cain 1972	1	20.50				
1127	*T. terricola* (J.C.Gilman et E.V.Abbott 1927) Emmons 1930	3	19.23	3	33.99		
1128	*T. terricola* (J.C.Gilman et E.V.Abbott 1927) Emmons 1930 var. *minor* (Rayss et Borut 1958) C.Booth 1961	1	18.86	2	19.98	1	3.14
1129	*Thielaviopsis basicola* (Berkeley et Broome 1850) Ferraris 1912	1	19.49	2	18.54		
1130	*Thysanophora canadensis* Stolk et Hennebert 1968	1	17.68	1	7.31		
1131	*T. penicillioides* (Roumeguere 1890) W.B.Kendrick 1961	2	19.19	5	26.17		
1132	*Tilachlidium pinnatum* Preuss 1851			1	29.01		
1133	*Tilletia caries* (de Candolle 1815) Tulasne et C.Tulasne 1847	1	12.54	1	1.84		

(continued)

Table 3.1 (continued)

Sr. No.	Name of species	Cryopreservation		Freeze-Drying		Soil	
		Number of strains	Storage time (years)	Number of strains	Storage time (years)	Number of strains	Storage time (years)
1134	*Tilletiopsis albescens* Gokhale 1972	1	16.39	1	9.92		
1135	*T. washingtonensis* Nyland 1950	3	18.85	3	29.65		
1136	*Tolypocladium cylindrosporum* W.Gams 1971	1	19.83	1	23.58		
1137	*T. geodes* W.Gams 1971			3	6.25		
1138	*T. inflatum* W.Gams 1971	2	19.26	4	22.72		
1139	*Trametes hirsuta* (von Wulfen 1788) Pilat 1939	3	12.58				
1140	*T. pubescens* (Schumacher 1803) Pilat 1939	2	20.05				
1141	*T. versicolor* (Linnaeus 1753) Lloyd 1921	1	11.24				
1142	*T. zonatella* Ryvarden 1978	2	8.25				
1143	*Tricellula aquatica* J.Webster 1959	1	16.21	2	22.18		
1144	*Trichaptum abietinum* (Persoon ex J.F. Gmelin 1792) Ryvarden 1972	2	20.09				
1145	*Trichocladium asperum* Harz 1871	1	19.54	1	15.64		
1146	*T. opacum* (Corda 1837) S.Hughes 1952	1	19.41	3	13.52		
1147	*Trichoderma album* Preuss 1851	1	15.66	3	32.91		
1148	*T. aureoviride* Rifai 1969	3	19.81	3	28.44	2	11.75
1149	*T. citrinoviride* Bissett 1984			1	1.92		
1150	*T. flavofuscum* (J.H.Miller et al. 1957) Bissett 1991			1	14.25		
1151	*T. hamatum* (Bonorden 1851) Bainier 1906	2	19.98	3	31.34	1	10.01
1152	*T. harzianum* Rifai 1969	7	19.54	12	32.01	4	10.27
1153	*T. koningii* Oudemans 1902	6	19.81	6	31.37	5	14.29
1154	*T. longibrachiatum* Rifai 1969	3	19.40	8	28.10	2	11.90
1155	*T. parceramosum* Bissett 1991			1	14.21		
1156	*T. polysporum* (Link 1816) Rifai 1969	3	19.29	6	29.00		
1157	*T. pseudokoningii* Rifai 1969	2	19.79	3	27.88	1	6.33
1158	*T. reesei* Simmons 1968	4	19.81	5	28.41	4	5.05
1159	*T. saturnisporum* Hammill 1970	1	0.54	2	14.25		
1160	*T. virens* (J.H. Miller, Giddens et A.A. Foster 1957) Arx 1987	2	18.89	2	32.33	2	18.38
1161	*T. virgatum* Rifai			1	14.21		
1162	*T. viride* Persoon 1801	15	20.45	22	37.88	12	20.68

1163	*T. viride* Persoon 1801 var. *kizhanicum* Krapivina 1975			1	28.08		
1164	*Trichosporiella cerebriformis* (G.A. de Vries et Kleine-Natrop 1957) W. Gams 1971	1	19.58	1	19.22		
1165	*Trichosporon dulcitum* (Berkhout 1923) Weijman 1979	1	19.75	1	27.05		
1166	*Trichosporum herbarum* Jaap 1916	1	0.54	1	27.82		
1167	*Trichothecium plasmoparae* Viala 1932	1	19.28	1	26.16		
1168	*T. roseum* (Persoon 1801) Link 1809	5	20.41	9	39.07	4	8.98
1169	*Trichurus spiralis* Hasselbring 1900	1	17.68	1	6.37		
1170	*Tritirachium oryzae* (Vincens 1923) de Hoog 1972	3	19.86	5	32.87	1	3.38
1171	*Truncatella angustata* (Persoon 1801) S.Hughes 1958	1	19.45	1	20.34		
1172	*Tympanosporium parasiticum* W.Gams 1974			1	30.21		
1173	*Ugola praticola* (Pidoplichko 1950) Stalpers 1984			1	15.83	1	8.47
1174	*Ulocladium alternariae* (Cooke 1871) E.G. Simmons 1967	1	20.52	2	8.62		
1175	*U. atrum* Preuss 1852	1	19.59	6	24.79	1	8.34
1176	*U. botrytis* Preuss 1851	1	19.54	9	29.83	1	25.87
1177	*U. chartarum* (Preuss 1851) E.G.Simmons 1967	3	19.44	6	24.42		
1178	*U. consortiale* (Thuemen 1876) E.G.Simmons 1967	1	19.47	3	24.07		
1179	*U. oudemansii* E.G.Simmons 1967	1	19.30	2	24.59		
1180	*Umbelopsis isabellina* (Oudemans 1902) W.Gams 2003	5	19.42	7	35.00	7	28.33
1181	*U. nana* (Linnemann 1941) Arx 1984	3	14.34	2	16.85	2	17.20
1182	*U. ramanniana* (Moeller 1903) W.Gams 2003	3	19.42	11	23.76	11	28.66
1183	*U. vinacea* (Dixon-Stewart 1932) Arx 1984	1	6.83	3	29.13	2	21.06
1184	*Ustilago cordae* Liro 1924	1	18.50	1	1.84		
1185	*U. cynodontis* (Hennings 1892) Hennings 1893	1	12.13	1	1.64		
1186	*U. filiformis* (Schrank 1793) Rostrup 1890	1	9.32	1	1.64		
1187	*U. hordei* (Persoon 1801) Lagerheim 1889	1	12.31	1	1.81		
1188	*U. maydis* (de Candolle 1815) Corda 1842	1	0.20				
1189	*U. perennans* Rostrup 1890	1	18.50	1	1.64		
1190	*U. vinosa* (Berkeley 1847) Tulasne et C.Tulasne 1847	1	12.25	1	1.84		
1191	*Venturia* sp.			1	19.39		
1192	*Verticillium albo-atrum* Reinke et Berthold 1879	2	19.31	2	15.60	1	4.79
1193	*V. aspergillus* Berkeley et Broome 1873			1	33.19		
1194	*V. cellulosae* Dasz. 1912			1	9.19		

(continued)

Table 3.1 (continued)

Sr. No.	Name of species	Cryopreservation		Freeze-Drying		Soil	
		Number of strains	Storage time (years)	Number of strains	Storage time (years)	Number of strains	Storage time (years)
1195	*V. cercosporae* Petrak et Ciferri 1932			1	18.56		
1196	*V. dahliae* Klebahn 1913	12	19.75	15	31.61	12	7.96
1197	*V. epiphytum* Hansford 1943			1	21.55		
1198	*V. fumosum* Seman 1968	1	19.25	1	23.56	1	4.74
1199	*V. insectorum* (Petch 1931) W.Gams 1971			1	14.98		
1200	*V. lecanii* (Zimmermann 1898) Viegas 1939	3	19.36	7	26.42		
1201	*V. leptobactrum* W.Gams 1971	2	8.84	1	15.14		
1202	*V. nigrescens* Pethybridge 1919			1	4.67		
1203	*V. nubilum* Pethybridge 1919	1	19.31	1	23.64	1	4.82
1204	*V. sulphurellum* Saccardo 1882	1	19.26	1	14.76		
1205	*V. tricorpus* I.Isaac 1953	1	19.31	1	28.32		4.97
1206	*V. villosum* Rudakov 1981	1		1	27.38		
1207	*Viennotidia humicola* (Samson et W.Gams 1974) P.F.Cannon et D.Hawksworth 1982			1	5.05	1	5.01
1208	*Volutella ciliata* (Albertini et Schweinitz 1805) Fries 1832	1	19.83	1	21.53		
1209	*Wallemia sebi* (Fries 1832) Arx 1970	2	19.59	2	13.22		
1210	*Wallrothiella subiculosa* Hoehnel 1912			1	21.53		
1211	*Wardomyces anomalus* Brooks et Hansford 1923			1	1.11		
1212	*Westerdykella dispersa* (Clum 1955) Cejp et Milko 1964	1	19.34	1	19.68		
1213	*W. multispora* (Saito et Minoura ex Cain 1961) Cejp et Milko 1964	1	3.99	1	19.94		
1214	*Xeromyces bisporus* L.R.Fraser 1953	1	18.85	1	15.48		
1215	*Xylobolus frustulatus* (Persoon 1801) Boidin 1958	1	19.99				
1216	*Zygorhynchus exponens* Burgeff 1924	3	20.10	4	19.46		
1217	*Z. heterogamus* (Vuillemin 1886) Vuillemin 1903			1	27.33	1	1.66
1218	*Z.macrocarpus* Y.Ling 1930			1	9.93		
1219	*Z. moelleri* Vuillemin 1903	3	19.69	5	25.09	2	14.60
1220	*Zygosporium echinosporum* Bunting et E.W.Mason 1941	1	19.54	1	20.24	1	1.00
1221	*Z. mycophilum* (Vuillemin 1910) Saccardo 1911	1	19.54	1	10.79		

Freeze-Drying of Filamentous Fungi

Currently, freeze-drying is used to preserve approximately 80% of filamentous fungi maintained in VKM (2,991 strains, belonging to 1,010 species and 303 genera). Fungi from different taxonomical groups (*Zygomycetes, Ascomycetes*—both teleo- and anamorph) able to produce dormant structures (spores, sclerotia, etc.) usually survive freeze-drying [12]. According to our data, from 87 to 92% strains of these fungal groups remain alive in this method. We noticed that 57% of freeze-dried cultures stored at 5°C for more than 20 years were in a vital state, and cultures of more than 190 species have been sustained for even 30–40 years of storage. Some species did not survive freeze-drying even when the sporulation is abundant, those are: *Conidiobolus coronatus*, *C. obscurus* (syn. *Entomophthora thaxteriana*), *C. thromboides* (syn. *Entomophthora virulenta*), *Erynia conica* (syn. *Entomophthora conica*), *Pandora dipterigena* (syn. *Entomophthora dipterigena*), *Cunninghamella homothallica*, *Cunninghamella vesiculosa*. Species of genus *Botrytis* (*B. cinerea*, *B. fabae*, and *B. gladiolorum*), forming only sclerotia as a dormant structure, remain in vital state in freeze-drying only for rather a short time—less than 10 years [10].

Nonsporulating microorganisms from *Oomycetes* and *Basidiomycetes* are not stored in VKM by freeze-drying, since sterile mycelium generally do not remain viable. However, some ectomycorrhizal fungi (e.g., *Laccaria laccata*) could be successfully lyophilized. For the positive result preliminary slow freezing (to −32°C) of fungal material is required [13].

The equipment used in VKM for freeze-drying is centrifugal freeze-dryer system Micromodulyo (Edwards, UK).

Drying in Sterile Soil of Filamentous Fungi

This simple and popular method for preservation of fungi was applied in the beginning of the twentieth century [14]. Species of *Aspergillus*, *Penicillium* can be maintained by this way more effectively than other micromycetes. According to T.P. Suprun [15] who investigated preservation of 78 *Penicillium* species (more than 1,000 strains) in sterile soil for 7–10 years, the best preserved strains were representatives of *Assymmetrica* section. Less effectively preserved species were *Biverticillata-Symmetrica* and the lowest effectiveness was observed with strains of the section *Monoverticillata*.

Species of *Zygomycetes* could be stored in soil for periods ranging from 6 months (*Cunninghamella elegans*) to 5 years (*Rhizopus stolonifer* var. *stolonifer* [syn. *R. nigricans*]) [16].

This method is also efficient for preservation of some human, animal, and plant pathogens with retaining their virulence [7]. For example, *Alternaria japonica* (syn. *A. raphani*), *Fusarium oxysporum*, and the species of *Septoria* (*S. avenae*, *S. nodorum*, *S. passerinii*, *S. tritici*) have retained their ability to infect a plant host after 2–5 years of storage [17–19]. Some degraded strains of micromycetes partly recuperated their lost qualities after preservation in soil [15].

Species of *Alternaria*, *Pseudocercosporella*, *Septoria* are genetically more stabile compared with *Fusarium*, therefore they did not show these kinds of changes and can be effectively preserved in soil [3].

Protocols

Protocol of Cryopreservation

Preparation of Cryovials (2.0 mL Externally Threaded Polypropylene, Nunc, Denmark)

- Labelled (6 for each culture) with an index, a collection number of a strain and a date of cryopreservation (month, year).
- Sterilized by autoclaving, at 121°C for 20 min.

Preparation of Cryoprotectant: 10% (v/v) Glycerol

- Pour 5 mL of glycerol into 12 mL glass tubes.
- Sterilized by autoclaving at 121°C for 20 min.
- Stored at +5°C for no longer than a month.

Preparation of Cultures

- Grow *sporulating* fungal cultures on slant agar under optimal growth condition and on suitable medium (www.vkm.ru).
- Wash off spores from agar surface with 5 mL of cryoprotectant.
- Titer of spores' suspension should be not less than 10^6 spores/mL.
- Grow *nonsporulating* fungal cultures on Petri dishes under optimal growth condition and on suitable medium with agar concentration 5% (w/v). Incubate culture to get a mature colony.
- Cut mycelial plugs (5 mm diameter) from vigorously growing colony part.

Filling of Vials

- For sporulating cultures add 0.2-mL aliquots of suspension to each cryovial using a Pasteur pipet. This procedure is carried out under sterile aerobic conditions.
- For nonsporulating cultures place 4 mycelial plugs into each cryovial using transfer needle, and then add 0.2 mL of cryoprotectant.

Fast Cooling Rates Regime of Freezing (~400 grad/min)

- Place the cryovials with cultures (spore suspension) in special containers; thoroughly fixate a position of every vial.
- Immediately place cryovials with cultures in the vapour phase of liquid nitrogen or in ultra-low temperature freezer.

Programmed Regime of Freezing

The First Protocol

- Place 18 cryovials with cultures (mycelial plugs) in a special container "NALGENE™" (Cryo 1°C Freezing Container, Cat. No. 5100-0001).
- Fill the container with 250 mL of isopropanol.
- Place the container in a mechanical freezer (−80°C). Temperature in this container decreased by 1°C/min.
- When temperature achieves −70°C, transfer cryovials in special container (thoroughly fixate a position of every vial), and place in the vapour phase of liquid nitrogen or in the ultra-low temperature freezer.

The Second Protocol

- Place 18 cryovials with cultures (mycelial plugs) in a special metal container, thermostatic inside by expanded polystyrene (container made in VKM).
- Place the container in the ultra-low temperature freezer (−70°C). It was empirically shown in VKM that temperature in this container decreased by 0.4°C/min.
- When temperature achieves −70°C, transfer cryovials in a special container (thoroughly fixate a position of every vial), and place in the vapour phase of liquid nitrogen or in the ultra-low temperature freezer.

Thawing

- Pull out the cryovial of container, in which it was stored—either in cryogenic tank or in an ultra-low temperature freezer.
- Warm the cryovial rapidly by immersion in a shaking (for increase in heat exchange) water bath (37°C) for 1–2 min.

Control of Viability

- To estimate the viability of fungal culture before cryopreservation, place either one volume of the suspension (0.2 mL) or 4 plugs under optimal growth conditions on a suitable medium. This procedure is carried out under sterile aerobic conditions.
- To estimate the viability of fungal culture after cryopreservation, sterilize the thawing cryovials surface by wiping with 70% (v/v) ethanol. Asepticaly transfer the contents (spore suspension or mycelial plugs) using a Pasteur pipet or a transfer needle onto a suitable growth medium. This procedure is carried out under sterile aerobic conditions.

Protocol of Freeze-Drying

Preparation of Ampoules

Glass tubes (gray glass, diameter 7 mm, length 110 mm):

- Wash successively with detergent, tap water, and distilled water.
- Dry.

- Plug loosely with cotton wool to a depth of 1 cm.
- Label with an index, a collection number of a strain, and a date of freeze-drying (month, year).
- Sterilize in dry oven at 160°C for 2 h.

Preparation of Lyoprotectant Agent

- Pour 5 mL 10% (v/v) skimmed milk into each 12-mL glass tube.
- Sterilized by autoclaving at 105°C for 30 min.
- Stored at +5°C for no longer than a month.

Preparation of Cultures

- Grow sporulating fungal cultures on slant agar under optimal growth condition and on suitable medium (www.vkm.ru).
- Wash off spores from agar surface with 5 mL of skimmed milk.
- Titer of spores' suspension should be more, than 10^6 spores/mL.

Filling of Ampoules

- Add 0.2-mL aliquots of suspension to each ampoule using a Pasteur pipet. This procedure is carried out under sterile aerobic condition.

The First Stage (Primary Drying)

- Transfer the ampoules to the spin freeze-drier.
- Freeze (temperature in a refrigerator −45°C) under the reduced pressure of the ambient gas during centrifugation (30 min).
- Dry via water sublimation (temperature of a freeze dryer is −45°C) in vacuum (from 4×10^{-2} to 6×10^{-2} mbar) till the moisture level achieves 5–10%.
- Duration of the first stage is 3 h.
- Switch off the vacuum pump after the first stage. The system is filled with gas; the ampoules are removed from the centrifuge.

Preparation of Ampoules for the Second Stage of Freeze-Drying

- Constrict ampoules to diameter of 2–3 mm using an air/gas torch with horizontal flame preventing overheating of cultures just below the cotton wool plug (approximately 50 mm from the ampoule bottom)

The Second Stage (Secondary Drying)

- Attach the constricted ampoules via rubber tubes to the manifold connecting with the vacuum pump.
- Drying (vacuum 100 mm) till the moisture level reach 2%.
- Duration of the second stage is 2.5 h.
- Seal the ampoules across the constriction using an air/gas torch.

Vacuum Control

- Immediately after sealing, test vacuum in ampoules using a high-voltage spark tester.

Control of Culture Viability

- To estimate the viability of fungal strains prior to freeze-drying one volume of the spore suspension (0.2 mL) place under optimal growth condition on suitable medium. This procedure is carried out under sterile aerobic conditions.
- To estimate the viability of fungal culture after freeze-drying, test ampoules after 24 h storage.
- This procedure is carried out under sterile aerobic conditions.
- Sterilize a control ampoule's surface with 70% ethanol and open ampoules using a cutter.
- Reconstitute the dried suspension with sterile tap water (0.2–0.3 mL) using a Pasteur pipet.
- After 30 min (when rehydration is complete) transfer suspension under optimal growth condition on suitable medium.

Storage

- Store the ampoules d at +5–8°C in the dark.

Protocol of Drying in Sterile Soil

Preparation of Sterile Soil

- Place 5 g of finely cultivated (garden) soil into 12-mL glass tube.
- Sterilized by autoclaving, at 121°C for 30 min for three consecutive days.

Preparation of Cultures

- Grow sporulating fungal cultures on slant agar under optimal growth condition and on suitable medium (www.vkm.ru).
- Wash off spores from agar surface with 5 mL of sterile tap water.
- Titer of spores' suspension should be not less than 10^6 spores/mL.

Soil Inoculation

- Add 1 mL spore suspension to glass tubes with sterile air dry soil (moisture is under 20%).
- Incubate at room temperature till soil dry up (near 1 month).
- Store in the refrigerator at 4–7°C.

Control of Viability

- Transfer a few grains of soil onto fresh agar medium, add a little water and incubate under optimal conditions.

Result

The real storage time estimates obtained in VKM are given in Table 3.1. They are not final data: the cultures are still being stored, and we expect to get longer storage times later on. Some cells of the table are empty; this is the case if the culture is not stored this method.

Conclusion

The conservation techniques used in VKM presents effective preservation of the stock of filamentous fungi from different taxonomic groups. The possibility and practical time estimates of secure long-term storage of fungal cultures belonging to 1,221 species and 424 genera was shown. The represented information could be used as a reference for researchers intending to maintain pure cultures of microorganisms for a long time. The data produced are also accessible online on the VKM Web site.

Acknowledgements We thank Ludmila Evtushenko for constructive comments on the manuscript.

This work was supported by grants of the program MCB of the Russian Academy of Science and the Ministry of Education and Science of the Russian Federation (N. 16.518.11.7035).

References

1. OECD best practice guidelines for biological resource centers. OECD; 2007. 115p.
2. Glyn NS, Day JGD (2007) Long-term *ex situ* conservation of biological resources and the role of biological resource centers. In: Day JG (ed) Methods in molecular biology, vol 368. Humana Press, Totowa, pp 1–14
3. Smith D (1998) Culture and preservation. In: Hawksworth DL, Kirsop BE (eds) Living resources for biotechnology. Filamentous fungi. Cambridge Univ. Press, UK, pp 75–99
4. Guidelines for the establishment and operation of collections of cultures of microorganisms. 3rd ed. WFCC; 2010. 19p. http://www.wfcc.info/pdf/Guidelines_e.pdf.
5. Smith D, Onions AHS (1994) The preservation and maintenance of living fungi, 2nd edn. AB International, Wallingford, UK, p 132
6. Nakasone KK, Peterson SW, Jong S-C (2004) Preservation and distribution of fungal cultures. In: Mueller GM et al (eds) Biodiversity of fungi. Inventory and monitoring methods. Elsevier/Academic Press, Amsterdam, pp 37–47
7. Ryan MJ, Smith D (2007) Cryopreservation and freeze-drying of fungi employing centrifugal and shelf freeze-drying. In: Day JG (ed) Methods in molecular biology, vol 368. Humana Press, Totowa, pp 127–140
8. Smith D, Thomas VE (1998) Cryogenic light microscopy and the development of cooling protocols for the cryopreservation of filamentous fungi. World J Microb Biotech 14:49–57
9. Sidyakina TM (1988) Methods of preservation of microorganisms. In: Veprintzev BN (ed) Konservatziya geneticheskikh resursov. ONTI NTzBI AN USSR, Pushchino, p 59 (In Russian)
10. Ivanushkina NE, Kochkina GA, Eremina SS, Ozerskaya SM (2010) Experience in using modern methods of long-term preservation of VKM fungi. Mikol Phytopathol 44:19–30 (In Russian)
11. Ryan MJ, Smith D, Jeffries P (2000) A decision-based key to determine the most appropriate protocol for the preservation of fungi. World J Microb Biotech 16:183–186
12. Milosevic MB, Medic-Pap SS, Ignatov MV, Petrovic DN (2007) Lyophilization as a method for pathogens long term preservation. Proc Nat Sci Matica Srska Novi Sad 113:203–210
13. Sundari SK, Adholeya A (1999) Freeze-drying vegetative mycelium of *Laccaria fraterna* and its subsequent regeneration. Biotechnol Tech 13:491–495

14. Raper KB, Fennell DI (1965) The genus *Aspergillus*. The Williams and Wilkins Company, Baltimore, p 686
15. Suprun TP (1965) Preservation of microscopic fungi in sterile soil. Mikrobiologiya 34:539–545 (In Russian)
16. Belyakova LA, Lavrova LN, Kudryavtzev VI (1967) Preservation of fungal cultures. Metody khranenija kollekcionnykh kul'tur mikroorganizmov. M.: Nauka, p 7–55 (In Russian)
17. Atkinson RG (1953) Survival and pathogenicity of *Alternaria raphani* after five years in dried soil cultures. Can J Bot 31:542–546
18. Hine RB (1962) Saprophytic growth of *Fusarium oxysporum* f. *niveum* in soil. Phytopathology 52:840–845
19. Shearer BL, Zeyen RJ, Ooka JJ (1974) Storage and behavior in soil of *Septoria* species isolated from cereals. Phytopathology 64:163–167