FINAL TECHNICAL REPORT

Microorganism Study, Desert Fungi

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Identification of Fungi from Desert Soils

This investigation is one portion of a broader and larger scope of work. Validation of microbial types are being conducted in segments by various groups. This entire procedure is being directed through the Jet Propulsion Laboratory, Pasadena, California. Dr. Roy E. Cameron, Senior Biologist is directing the overall activity.

Several techniques can be employed to study the presence of fungal flora, and each has its own advantages and disadvantages. No single technique can be used to adequately describe the entire fungal generic composition associated with a soil or soils. The procedure most frequently employed for fungal enumeration has been the plate count method, whereby the soil specimen is diluted in sterile water and plated on a suitable agar medium. Because other microbes may be more numerous or possess a more rapid rate of metabolism than fungi, the development of the former organisms are suppressed by adding rose bengal, a bacterial antibiotic, or both to the agar medium. The former was used in this work and the rose bengal tubes containing the fungal isolates were received in the New Mexico State University Microbiological Laboratory.

Fungal isolates were extracted from soils removed under desert conditions in Chile, Egypt, Oregon, Wyoming, Hawaii and White Mountain of California. These organisms were transferred to Czapek's and carrot decoction agars to facilitate identification.

The following organisms were found in the tubes receiving isolates from Chile soils:

Isolate	Identity
290 Ba	Tetracoccosporium paxianum
290 Bb	Mycelia Sterilia
291 Ba	Cladosporium hordei
292 Bb	Aspergillus humicola

Most of these organisms possess a dark pigment and other authors have made reference to the radiation protective capacity of this type of pigmentation.

Organisms that were removed from United Arab Republic (Egypt) soils included:

Isolate	Identity
293 Ab	Penicillium citrinum
293 Ba	No growth
295 Bb	Nigrospora sphaerica (?)
295 Bc	Fusarium oxysporum
296 Aa	Mycelia sterilia (at present)
296 Bb	Penicillium sp.
297 Ba	No growth
298 Ac	Stachybotrys atra (cylindrosporum)
298 Bb	Chaetomium spirale

Complete fungal description charts have been submitted on the above isolates including order, family, genus, species, colony character-

istics, and sexual or asexual reproductive aspects.

Fungi isolated from Oregon soils included:

Isolate	Identity
148 Aa	*Penicillium* sp.
148 Bb	*Penicillium* sp.
150 Aa	*Fusarium* sp.
151 Ab	*Penicillium* sp.
151 Ac	*Penicillium* sp.

Fungal isolations from Wyoming soils included:

Isolate	Identity
306 Aa	*Alternaria tenuis*
306 Bb	*Aspergillus* sp.
307 Aa	*Aspergillus* sp.
307 Ab	*Phoma glomerata*
308 Ba	*Penicillium* sp.
309 Aa	*Penicillium* sp.
310 Aa	*Penicillium* sp.
310 Ac	*Penicillium* sp.
310 Ad	*Penicillium aculeatum* (?)
310 Bb	*Alternaria tenuis*
311 Ab	No growth
311 Ba	*Aspergillus*
312 Ac	*Chaetomium globosum*
312 Ba	*Penicillium* sp.

313 Ab	Penicillium sp.
313 Ba	Penicillium sp.
314 Ba	Penicillium simplicissimum (?)
315 Ab	Penicillium sp.
315 Ba	Penicillium sp.
316 Ab	Alternaria tenuis
316 Ac	No growth
316 Ba	Penicillium sp.
317 Aa	Penicillium sp.
317 Ab	Stachybotrys atra
318 Bb	Penicillium sp.
319 Ab	Penicillium sp.
319 Ac	Tetracoccosporium paxianum
319 Ba	Phoma hibernica
319 Bd	Mycelia sterilia
320 Bc	Penicillium sp.
321 Ac	Penicillium sp.
322 Bc	Tetracoccosporium paxianum
324 Aa	Fusarium sp.
324 Ab	Penicillium sp.
324 Bd	Penicillium sp.
324 Be	Penicillium sp.
325 Ab	Penicillium sp.
326 Ba	Penicillium sp.
327	Penicillium

Isolates removed from Hawaii soils included the following forms:

Isolate	Identity
29 Aa	*Penicillium* sp.
29 Ab	*Penicillium* sp.
29 Bc	*Penicillium* sp. and *Aspergillus nidulans*
29 Bd	*Penicillium* sp.
31 Ba	*Circinella rigida*
31 Bb	*Penicillium* sp.
32 Aa	*Hyalopus ater*
32 Bb	Mycelia sterilia
32 Bd	Mycelia sterilia
32 Bc	Mycelia sterilia
34 Aa	*Aspergillus* sp.
34 Ab	*Oospora variabilis*
34 Bc	No growth
34 Bd	*Aspergillus* sp.
34 Be	No growth
35 Aa	*Penicillium* sp.
35 Ab	*Aspergillus* sp.
35 Ac	*Penicillium* sp.
35 Bd	Mycelia sterilia
37 Ba	*Penicillium* sp.
37 Bb	*Myrothecium verrucaria*

38 Aa	Mycelia sterilia
38 Bb	Myrothecium verrucaria
38 Bc	Penicillium fellutanum (?)
38 Bd	Mycelia sterilia
39 Aa	No growth
39 Ac	Penicillium

Isolations obtained from the White Mountain soil samples included the following:

Isolate	Identity
9-2A	Stemphylium botryosum
9-2B	Penicillium
9-2C	Phoma sphaerica
9-2D	Verticillium sulfurellum
10-2D	Penicillium sp.
14-2E	Penicillium sp.
14-2F	Phoma sphaerica
14-2G	Penicillium sp.
15-2E	Penicillium sp.
17-2F	Penicillium sp.
17-2G	Penicillium sp.
17-2H	Fusarium roseum
17-2I	Penicillium sp.
17-2J	Curvularia sp.
17-2L	Mycelia sterilia

18-2D	Penicillium sp.
18-2E	Myrothecium verrucaria
18-2F	Penicillium sp.

Many of the above species have been tentatively identified and have been submitted to experts for verification. Word has not been received on the species verifications and if it is not received within the next three weeks, the determinations made in this laboratory will be submitted.

Representative of the genus Penicillium were the most numerous organisms isolated and submitted for identification (Table I). Species of this genus were isolated from every soil except Chile. Since only four isolates were obtained from Chile soils, the number of isolates was insufficient to make any generalization. It was expected that at least one isolate would be received since forms of the genus Penicillium constituted at least one half of the total isolates obtained. Species of Penicillium were more prevalent from United States soils than other desert soils. The remaining 17 genera or groups of organisms were not found in sufficient numbers to allow determinations of the cosmopolitan or restricted distribution of these forms within desert soils.

Bimonthly progress reports were submitted beginning November 1966 and were continued through a 12-month period. An extension was requested due to hospitalization of the principal investigator. Three larger reports were submitted and were entitled:

1. "Occurrence of Microorganisms in Hilgard Soil Samples", 30 January 1968.

TABLE I GENERA OF FUNGI ISOLATED FROM SIX DESERT SOILS

	Fungi were isolated from soils obtained in						
GENERA	Chile	Egypt	Oregon	Wyoming	Hawaii	White Mt.	Total
Penicillium spp.	-	2	4	23	10	11	50
Aspergillus spp.	1	-	-	3	3	-	7
Fusarium spp.	-	1	1	1	-	1	4
Phoma spp.	-	-	-	2	-	2	4
Myrothecium sp.	-	-	-	-	2	1	3
Alternaria sp.	-	-	-	3	-	-	3
Tetracoccosporium sp.	1	-	-	2	-	-	3
Stachybotrys sp.	-	1	-	1	-	-	2
Chaetomium spp.	-	1	-	1	-	-	2
Hyalopus sp.	-	-	-	-	1	-	1
Circinella sp.	-	-	-	-	1	-	1
Verticillium sp.	-	-	-	-	-	1	1
Oospora sp.	-	-	-	-	1	-	1
Stemphylium sp.	-	-	-	-	-	1	1
Cladosporium sp.	1	-	-	-	-	-	1
Curvularia sp.	-	-	-	-	-	1	1
Nigrospora sp.	-	1	-	-	-	-	1
Mycelia sterilia	1	1	-	1	6	1	10
No growth	-	2	-	2	3	-	7
Total	4	9	5	39	27	18	

2. "Microorganisms Colonizing Straws Buried in Chile Desert Soil Samples", 25 September 1967.

3. "Comparison of Microorganisms Inhabiting Three Desert Soils in the Western Hemisphere", 7 February 1968.

Fungi that have been received and subjected identity determinations did not follow previously reported concepts. Russian investigators reported that Penicillium species were the most prevalent fungi in the northern latitudes and were progressively replaced by Aspergillus spp. as one moves toward the equator. This trend was not apparent from the isolations during this investigation. Other experimentors have reported a predominance of pigmented forms as characterized by fungi constituting the form-family Dematiaceae. These fungi were represented by seven (Alternaria, Tetracoccosporium, Stachybotrys, Stemphylium, Cladosporium, Curvularia, and Nigrospora) out of 17 genera and included 12 of 102 isolates examined. Representatives of the most prevalent genus, Penicillium, were not found to be the most common species previously encountered. We have 30 species of Penicillium in our microbial bank, but very few of the isolates received from the Jet Propulsion Laboratory were determined to be the same as the identified forms on hand in the New Mexico State University microbial bank. Therefore, few comparisons could be conducted with previously identified cultures. These isolates have been tentatively identified and submitted for verification. If these verifications are not received within the next 3-4 weeks the identifications made in this laboratory will be submitted.

The fungi associated with the decomposition of buried, sterile, organic substrates appeared to be quantitively and qualitatively different than those isolated during the dilution plate studies. It is suggested that the two techniques be conducted concurrently to allow adequate comparisons of these techniques. Also additional isolates from Chile, Egypt and Oregon soils should be obtained to develop a more complete involvement of the fungi present in these soils.

The principal investigator would like to continue the work with fungi associated with desert soils in cooperation with Dr. Cameron. Additional work is required to substantiate and expand the information submitted in the three larger reports mentioned earlier. The extended investigations would allow this study to be summarized in a more scientific manner and be published. Permission is requested to enable Dr. Roy E. Cameron to co-author this activity. The above cooperative effort is requested with the assurance that monetary support is not a part of the effort.