950783

PROGRESS REPORT
Microorganism Study
JPL Contract No. 950783
Systematic Description and Key to
Streptomyces Isolants from Chile, Mexico and
Arizona Desert Soils

Professor W. B. Bollen, Microbiologist and
Sumie Nishikawa, Assistant in Microbiology
Oregon State University, Corvallis, Oregon

August 19, 1968

JET PROPULSION LABORATORY
CALIFORNIA INSTITUTE OF TECHNOLOGY
PASADENA, CALIFORNIA

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This work was performed for the Jet Propulsion Laboratory, California Institute of Technology, sponsored by the National Aeronautics and Space Administration under Contract NAS7-100.

PREFACE

Thirty-six isolants from Chile, Mexico, or Arizona desert soils have been examined. Of these, eighteen have been classified, four are in the process of being identified and will be described in the next report. The remaining fourteen isolants have failed to grow in tryptone-yeast extract broth at 26°, thioglycollate broth at 7, 26, and 37°C, trypticase soy broth at 26°C, upon tryptone-glucose-yeast extract agar at 7, 26, and 37°C, trypticase soy agar at 26°C, soil-extract agar at 7, 26, and 37°C, glucose nutrient agar, malt-extract agar, starch agar, and sodium albuminate agar at 26°C.

The materials and methods used to characterize the isolants listed in this report are identical to that described in the previous report (April 25, 1968). The characteristics used to differentiate the Streptomyces are those described by Hütter, Ralf, "Systematik der Streptomyceten", S. Karger, Basel and New York, 1967, 382 p. and have been listed in the previous report.

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Streptomyces Isolants Identified

Culture No.	JPL No.	Species	Source	Invoice No.	Page
22	245a (#25)	S. netropsis	Chile	D-44829	8
23	245Bb (#24)	S. griseoviridis	Chile	D-44829	13
24	245Bc (#24)	no growth	Chile	D-44829	
25	246a (#25)	no growth	Chile	D-44829	
26	246Ae (#24)	S. lavendulae	Chile	D-44829	18
27	246Af (#24)	S. collinus	Chile	D-44829	23
28	246Bb (#24)	next report	Chile	D-44829	
29	246Bd (#24)	S. caelestis	Chile	D-44829	28
30	247Ad (#24)	no growth	Chile	D-44829	
31	247Bc (#24)	S. tendae	Chile	D-44829	33
32	248Aa (#24)	next report	Chile	D-44829	
33	249Aa (#24)	S. antibioticus	Chile	D-44829	38
34	249Ab (#24)	no growth	Chile	D-44829	
35	250Aa	S. albus (var)	Mexico	D-44829	43
36	276a (#6)	S. albus	Chile	D-44829	48
37	379Ba (Thornton's)	S. antibioticus	Arizona	D-44799	53
38	245TAa	no growth	Chile	D-38463	
39	245TAd	no growth	Chile	D-38463	
40	245TAe	next report	Chile	D-38463	
41	245TAf	S. violaceoruber	Chile	D-38463	58
42	245TBa	S. albogriseolus	Chile	D-38463	63
43	245TBb	no growth	Chile	D-38463	
44	246TAa	S. caelestis	Chile	D-38463	68

45	246TBa	no growth	Chile	D-38463	
46	249TAa	S. longisporuber	Chile	D-38463	73
47	249TBa	S. exfoliatus	Chile	D-38463	78
48	259TBa	no growth	Chile	D-38463	
49	259TBb	S. azureus	Chile	D-38463	83
50	260TAa	no growth	Chile	D-38463	
51	260TBa	no growth	Chile	D-38463	
52	260TBb	no growth	Chile	D-38463	
53	274TAa	no growth	Chile	D-38463	
54	275TAa	S. aureofaciens	Chile	D-38463	88
55	276TBa	S. rimosus	Chile	D-38463	93
56	277TAa	next report	Chile	D-38463	
57	277TBa	no growth	Chile	D-38463	

Key to the Identification of *Streptomyces*

Isolants 22 to 55

I. True mycelium produced, spores formed but not in sporangia.
Substrate mycelium non-septate, not fragmenting into bacillary or coccoid components.....*Streptomycetaceae*

II. Aerial mycelium produced.
Spores formed in chains.....*Streptomyces*

A. Spores with hairy enation.
Aerial mycelium gray to brownish-gray (cinereus)
Sporophores produce spirals.
Melanin-negative.....*S. albogriseolus*
(245TBa) - #42

B. Spores with smooth or warty surface.

1. Aerial mycelium gray to brownish-gray (cinereus)

a. Sporophores straight or wavy (rectus-flexibilis)
Melanin-positive.....*S. antibioticus*
(249Aa) - #33
(379Ba) - #37

b. Sporophores form narrow, intensive screws (spira, type a)
Melanin-negative.....*S. collinus*
(246Af) - #27

c. Sporophores form long, loose screws (spira, type b)

1) Melanin-negative.....*S. violaceoruber*
(245TAf) - #41

2) Melanin-positive.....*S. tendae*
(247Bc) - #31

d. Sporophores form open twists (retinaculum-apertum)
Melanin-negative.....*S. aureofaciens*
(275TAa) - #54

2. Aerial mycelium pale-carmine to cinnamon-brown (cinnamomeus)

a. Sporophores in aerial mycelium form verticils.
Sporophores produce open twists or short, loose screws (verticillus-spira).....*S. netropsis*
(245a) -#22

b. Sporophores in aerial mycelium do not form verticils.

1) Sporophores straight or wavy (rectus-flexibilis) Melanin-negative.....S. exfoliatus (249TBa) - #47

2) Sporophores form open twists (retinaculum-apertum)

a) Melanin-positive.....S. lavendulae (246Ae) - #26

b) Melanin-negative.....S. griseoviridis (245Bb) - #23

3. Aerial mycelium blue to bluish-green (azureus-glaucus)

a. Sporophores form loose, open twists (retinaculum-apertum).....S. caelestis (246Bd) - #29 (246TAa) - #44

b. Sporophores form mostly narrow, closed spirals.....S. azureus (259TBb) - #49

4. Aerial mycelium snow white to chalk white (niveus)

a. Sporophores form narrow, intensive spirals (spira, type a).....S. albus (250Aa) - #35 (276a) - #36

	growth at 55 C	pigment production
Sl. albus (276a)	-	-
S. albus (250Aa)	+	+

b. Sporophores form long, loose screws (spira, type b).....S. rimosus (276TBa) - #55

c. Sporophores form open twists (retinaculum-apertum).....S. longisporuber (249TAa) - #46

#1000 carbon replica grating

28,800 lines/inch

Magnification = 6,825X

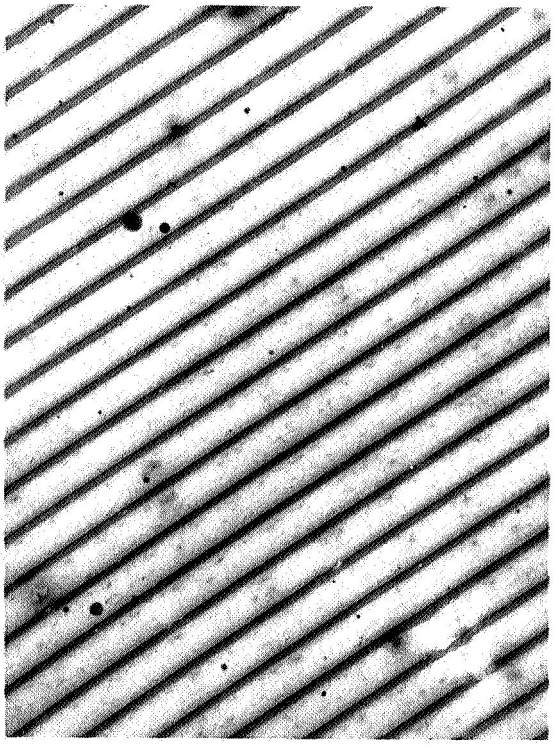
Used in determining dimensions of the following cultures:

#22 - (245a)
#23 - (245Bb)
#26 - (246Ae)
#27 - (246Af)
#31 - (247Bc)
#35 - (250Aa)
#36 - (276a)
#37 - (379Ba)
#42 - (245TBa)
#46 - (249TAa)
#49 - (259TBb)
#54 - (275TAa)

#1000 carbon replica grating

28,800 lines/inch

Magnification = 6,167X



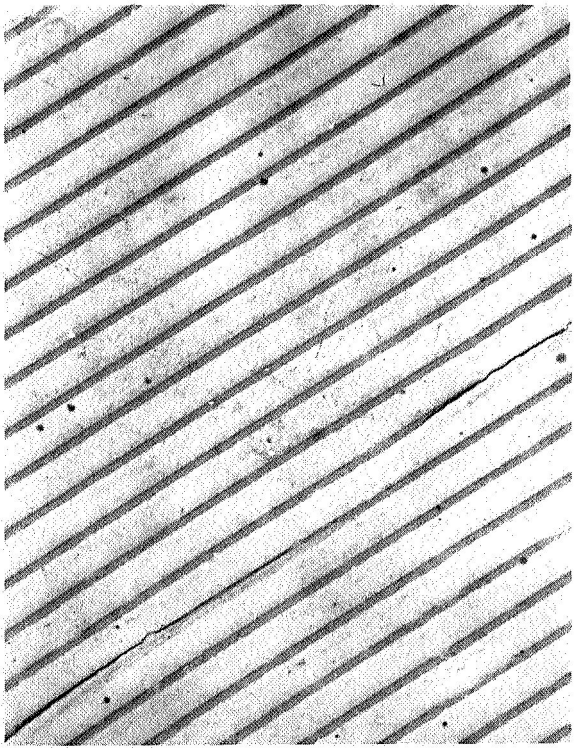
Used in determining dimensions of the following cultures:

#29 - (246Bd)
#33 - (249Aa)
#44 - (246TAa)
#55 - (276TBa)

#1000 carbon replica grating

28,800 lines/inch

Magnification = 6,302X



Used in determining dimensions of the following cultures:

#41 - (245TAf)
#47 - (249TBa)

Culture No. 22 Source Chile

JPL No. 245a Invoice # D-44829

Studied by S. Nishikawa

Species **Streptomyces netropsis**

1. Cultural properties: Temp. 26°C

	Da.	CHM* number and color			
		Medium 2	Medium 3	Medium 4	Medium 5
aerial mycelium	7	5dc = pussywillow gray → a = white	5fe = ashes	5fe = ashes	a = white
	14	d = gray	d = gray	d = gray	a = white
	21	10fe = dusk	10dc = orchid haze	10fe = dusk	10dc = orchid haze
substrate mycelium	7	2ba = pearl shell tint	colorless	2ba = pearl shell tint	2ba = lt. ivory eggshell
	14	2ic = honey gold lt. gold	1ba = yellow tint	2ba = pearl shell tint → b = oyster white	2ca = lt, ivory eggshell
	21	2ic = honey gold lt. gold	2ba = pearl shell tint	2ca = lt, ivory eggshell	2ec = bisquit ecru oatmeal sand
soluble pigment	7	none	none	none	none
	14	none	none	none	none
	21	none	none	none	none

*Color Harmony Manual, Container Corporation of America, Chicago, Illinois, 4th edition, 1958.

Culture No. 22 9

JPL No. 245a

II. Morphological observations

	Da.	Medium 2	Medium 3	Medium 4	Medium 5
Sporophore	7	none	spirals & retinaculum-apertum	spirals and retinaculum apertum	none
	14	retinaculum-apertum spirals	as above	mostly retinaculum-apertum	none
	21	as above	as above	as above	retinaculum-apertum & spirals
Spore No.	7	----	> 10	> 10	none
	14	> 10	> 10	> 10	none
	21	> 10	> 10	> 10	> 10
Verticils	7	----	----	----	----
	14	----	----	----	----
	21	----	----	----	Bivertic[illegible]llus-spira; compound verticils; elements of secondary verticils spiraled

special observations: e.g. globular sporangia; flagellated spores; spores on substrate hyphae; mycelia fragmentation; sclerotia.

none observed

Page 3

Culture No. 22

JPL No. 245a

Species S. netropsis

Photographs: Sporophores

Medium: 5-glycerol-asparagine agar

Age of culture: 21 days

Magnification: 1000X

Medium: 4-starch agar

Age of culture: 7 days

Magnification: 1000X

Culture No. 22

JPL No. 245a

Species S. netropsis

III. Spore morphology and surface:

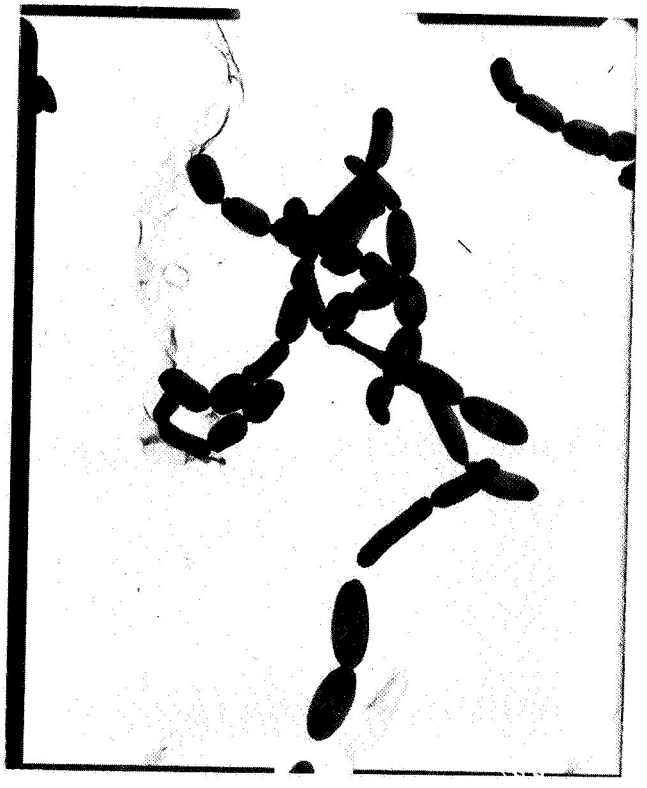
Surface: smooth

Dimensions: 0.88-1.62 x 0.37-0.80

Medium: 4 = starch agar

Age of culture: 8 days

Magnification: 6825X



Culture No. 22

JPL No. 245a

Species S. netropsis

IV. Physiological characteristics

A. Carbohydrate utilization

Carbohydrate	Growth After 10 days	Growth After 16 days
Negative control	-	-
D-glucose	++	++
D-xylose	++	++
L-arabinose	++	++
Sucrose	++	++
D-mannitol	++	++
I-inositol	++	++
D-fructose	++	++
Rhamnose	+	+
Raffinose	++	++
Cellulose	-	-

(++) = Strongly positive utilization. Growth equal to or greater than glucose growth.

(+) = Positive utilization. Growth is significantly better than on basal medium without carbon but less than on glucose.

(±) = Utilization doubtful. Growth slightly better than on basal medium without carbon but significantly less than with glucose.

(-) = Growth similar to or less than growth on basal medium without carbon.

B. Melanin production

Medium 1 - **2 days - negative**
4 days - negative

Medium 6 - **2 days - negative**
4 days - negative

Medium 7 - **2 days - negative**
4 days - negative

C. Starch hydrolysis

positive

Culture No. 23 Source Chile

JPL No. 245Bb Invoice # D-44829

Studied by S. Nishikawa

Species **Streptomyces grisseoviridis**

1. Cultural properties: Temp. 26°C

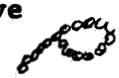
	Da.	CHM* number and color			
		Medium 2	Medium 3	Medium 4	Medium 5
aerial mycelium	7	a = white (sparse)	none	a = white	none
	14	7½1g = rose mauve and specks of white	a = white (sparse)	7fe = ashes and specks of white	a = white
	21	7½1e = rose wine	6ge = {ashes of rose / rose gray} and specks of white	6ec = powder rose	a = white
substrate mycelium	7	2ga = {colonial yellow / maize}	2ba = {pearl / shell tint}	2ia = {squash yellow / maize}	1ca = {lt. ivory / eggshell}
	14	21e = {mustard / old gold}	2ea = {lt. wheat / lt. maize}	3ie = {camel / maple sugar / tan}	1½ea = {lt. yellow / pastel yellow / sunlight yellow}
	21	3pg = golden brown	6ec = powder rose	4ng = {lt. brown / saddle tan / maple}	2ga = {colonial yellow / maize}
soluble pigment	7	none	none	none	none
	14	none	none	none	1½ea = {lt. yellow / pastel yellow / sunlight yellow}
	21	2nc = {brite gold / nugget gold}	none	none	31c = {amber / butterscotch}

*Color Harmony Manual, Container Corporation of America, Chicago, Illinois, 4th edition, 1958.

Culture No. 23 14

JPL No. 245Bb

II. Morphological observations

	Da.	Medium 2	Medium 3	Medium 4	Medium 5
Sporophore	7	none	----	none	----
	14	spirals & retina-culum-apertum	spirals & retina-culum-apertum	spirals & retina-culum-apertum of wide diameter	spirals & retina-culum-apertum
	21	as above	as above	as above 	as above
Spore No.	7	----	----	----	----
	14	> 10	>10	> 10	> 10
	21	> 10	>10	> 10	> 10
Verticils	7	none	none	none	none
	14	none	none	none	none
	21	none	none	none	none

special observations: e.g. globular sporangia; flagellated spores; spores on substrate hyphae; mycelia fragmentation; sclerotia.

none observed

Page 3

Culture No. 23

JPL No. 245Bb

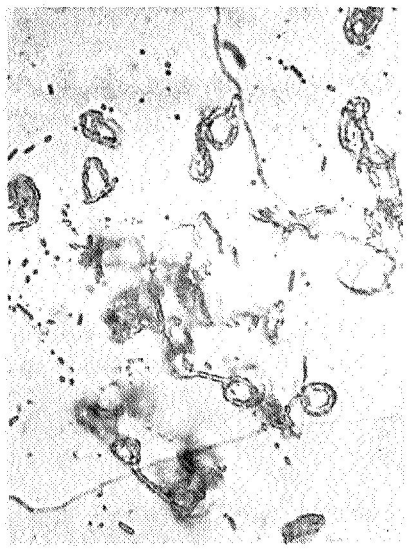
Species S. griseoviridis

Photographs: Sporophores

Medium: 4-starch agar

Age of culture 14 days

Magnification: 1000X



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Culture No. 23

JPL No. 245Bb

Species S. griseoviridis

III. Spore morphology and surface:

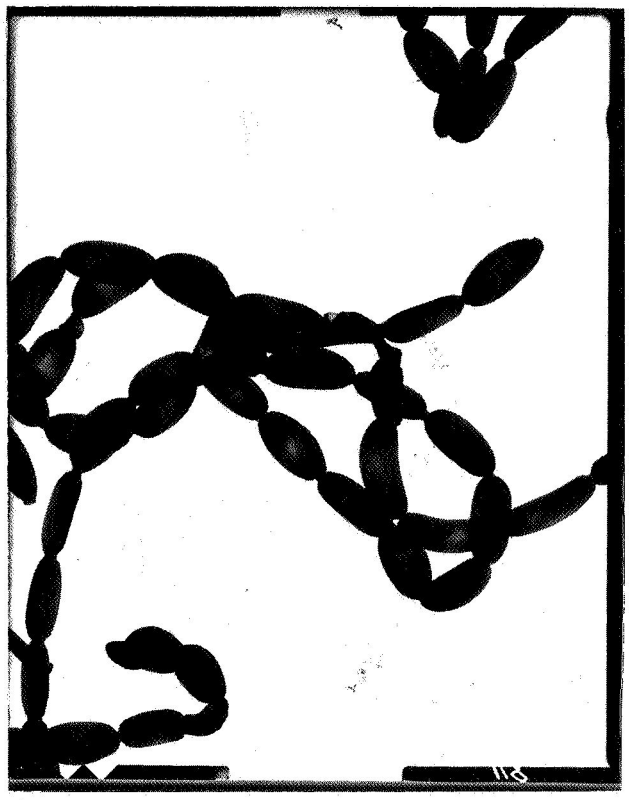
Surface: smooth

Dimensions: 1.17-1.98 x 0.51-0.80

Medium: 2-malt extract agar

Age of culture: 15 days

Magnification: 6825X



Culture No. 23

JPL No. 245Bb

Species S. griseoviridis

IV. Physiological characteristics

A. Carbohydrate utilization

Carbohydrate	Growth After 10 days	Growth After 16 days
Negative control	-	-
D-glucose	++	++
D-xylose	++	++
L-arabinose	++	++
Sucrose	±	±
D-mannitol	-	-
I-inositol	-	-
D-fructose	++	++
Rhamnose	++	++
Raffinose	-	-
Cellulose	-	-

(++) = Strongly positive utilization. Growth equal to or greater than glucose growth.

(+) = Positive utilization. Growth is significantly better than on basal medium without carbon but less than on glucose.

(±) = Utilization doubtful. Growth slightly better than on basal medium without carbon but significantly less than with glucose.

(-) = Growth similar to or less than growth on basal medium without carbon.

B. Melanin production

Medium 1 - **2 days - negative**
4 days - negative

Medium 6 - **2 days - negative**
4 days - negative

Medium 7 - **2 days - negative**
4 days - negative

C. Starch hydrolysis

positive

Culture No. 26 Source Chile

JPL No. 246Ae Invoice # D-44829

Studied by S. Nishikawa

Species Streptomyces lavendulae

1. Cultural properties: Temp. 26°C

	Da.	CHM* number and color			
		Medium 2	Medium 3	Medium 4	Medium 5
aerial mycelium	7	b = oyster white ↓ 13½ca = pale blue	none	none	none
	14	10cb = orchid mist ↓ 10fe = dusk ↓ d = gray	7dc = dawn pink ↓ 7ba = pink tint	10cb = orchid mist ↓ a = white	10cb = orchid mist
	21	8ig = rose mauve	a = white ↓ 10ic = orchid	a = white	10db = orchid mist
substrate mycelium	7	6½pg = barn red	6gc = dusty coral	51c = {copper / persimmon}; 7½ne = lt. wine	51c = {copper / persimmon}
	14	5pl = deep brown	7½ic = rose	8ne = {lt. wine / rose wine}	7½ng = old wine
	21	5pg = henna / lt. copper br. / russet / rust brown	10pe = raspberry	8ne = {lt. wine / rose wine}	8ne = {lt. wine / rose wine}
soluble pigment	7	31e = {cinnamon / yellow maple}	----	----	----
	14	4pg = dk. luggage tan	71c = cherry	7ba = pink tint	none
	21	6pn = {dk. brown / mahogany / dk. brown}	7ec = rose mist	7ec = rose mist	4gc = {nude tan / rose beige}

*Color Harmony Manual, Container Corporation of America, Chicago, Illinois, 4th edition, 1958.

Culture No. 26 19

JPL No. 246Ae

II. Morphological observations

	Da.	Medium 2	Medium 3	Medium 4	Medium 5
Sporophore	7	spirals	----	----	----
	14	loose, open spirals	spirals	none	spirals
	21	as above	as above	as above	as above
Spore No.	7	> 10	----	----	----
	14	> 10	> 10	none	> 10
	21	> 10	> 10	none	> 10
Verticils	7	none	none	none	none
	14	none	none	none	none
	21	none	none	none	none

special observations: e.g. globular sporangia; flagellated spores; spores on substrate hyphae; mycelia fragmentation; sclerotia.

none observed

Culture No. 26

JPL No. 246Aa

Species S. lavendulae

Photographs: Sporophores

Medium: 2-malt extract agar

Age of culture: 14 days

Magnification: 1000X

Culture No. 26

JPL No. 246Aa

Species S. lavendulae

III. Spore morphology and surface

Surface: smooth

Dimensions: 0.88-1.32 x 0.73-0.88

Medium: 2-malt extract agar

Age of culture: 15 days

Magnification: 6825X

Culture No. 26

JPL No. 246Aa

Species S. lavendulae

IV. Physiological characteristics

A. Carbohydrate utilization

Carbohydrate	Growth After 10 days	Growth After 16 days
Negative control	-	-
D-glucose	++	++
D-xylose	++	++
L-arabinose	++	++
Sucrose	++	++
D-mannitol	++	++
I-inositol	++	++
D-fructose	++	++
Rhamnose	++	++
Raffinose	++	++
Cellulose	-	-

(++) = Strongly positive utilization. Growth equal to or greater than glucose growth.

(+) = Positive utilization. Growth is significantly better than on basal medium without carbon but less than on glucose.

(±) = Utilization doubtful. Growth slightly better than on basal medium without carbon but significantly less than with glucose.

(-) = Growth similar to or less than growth on basal medium without carbon.

B. Melanin production

Medium 1 - 2 days - positive
4 days - positive

Medium 6 - 2 days - positive
4 days - positive

Medium 7 - 2 days - positive
4 days - positive

C. Starch hydrolysis

positive

Culture No. 27 Source Chile

JPL No. 246Af Invoice # D-44829

Studied by S. Nishikawa

Species Streptomyces collinus

1. Cultural properties: Temp. 26°C

	Da.	CHM* number and color			
		Medium 2	Medium 3	Medium 4	Medium 5
aerial myeelium	7	a = white	a = white	a = white some parts 3fe = silver gray	none
	14	a = white (cottony texture)	a = white specks of gray	3fe = silver gray	none
	21	a = white ↓ ↓ 5dc = pussywillow gray	a = white ↓ ↓ 5dc = pussywillow gray	a = white ↓ ↓ 5fe = ashes	a = white
substrate mycelium	7	3ec = putty	1ba = yellow tint	1½ca = cream	1½ca = cream
	14	2ic = {honey gold lt. gold	1½ca = cream	1½ca = cream	1½ca = cream
	21	3pg = golden brown	2ea = {lt. wheat lt.mmaize	1½ca = cream	1½ca = cream
soluble pigment	7	3ne = antique gold	none	none	none
	14	2ne = {mustard gold old gold	none	none	none
	21	4pi = {oak brown russet brown	none	none	none

*Color Harmony Manual, Container Corporation of America, Chicago, Illinois, 4th edition, 1958.

Culture No. 27 24

JPL No. 246Af

II. Morphological observations

	Da.	Medium 2	Medium 3	Medium 4	Medium 5
Sporophore	7	none	none	spirals	----
	14	spirals	spirals (corkscrew)	spirals (corkscrew) tight	----
	21	spirals	as above	as above	----
Spore No.	7	----	----	> 10	----
	14	> 10	> 10	> 10	----
	21	> 10	> 10	> 10	----
Verticils	7	none	none	none	none
	14	none	none	none	none
	21	none	none	none	none

special observations: e.g. globular sporangia; flagellated spores; spores on substrate hyphae; mycelia fragmentation; sclerotia.

non observed

Page 3

Culture No. 27

JPL No. 246Af

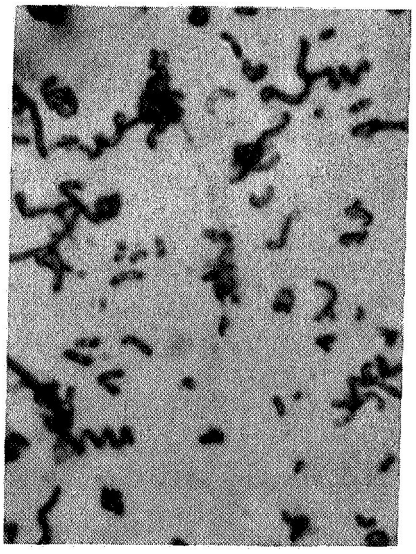
Species S. collinus

Photographs: Sporophore

Medium: 4-starch agar

Age of culture: 14 days

Magnification: 1000X



Page 4

Culture No. 27

JPL No. 246Af

Species S. collinus

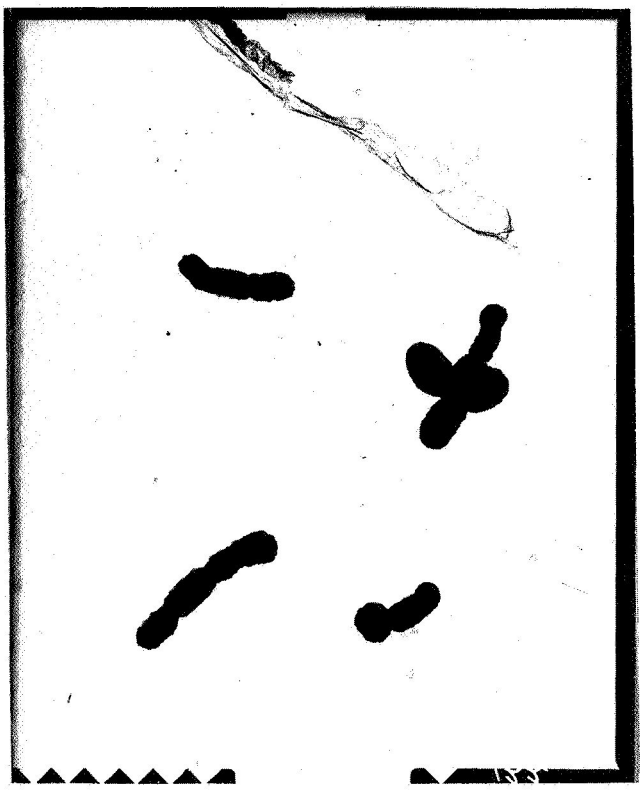
III. Spore morphology and surface:

Surface: warty

Dimensions: 0.66-1.17 x 0.44-0.73

Age of culture: 15 days

Magnification 6825X



Culture No. 27

JPL No. 246Af

Species S. collinus

IV. Physiological characteristics

A. Carbohydrate utilization

Carbohydrate	Growth After 10 days	Growth After 16 days
Negative control	-	-
D-glucose	++	++
D-xylose	++	++
L-arabinose	++	++
Sucrose	+	++
D-mannitol	++	++
I-inositol	++	++
D-fructose	++	++
Rhamnose	++	++
Raffinose	++	++
Cellulose	-	-

(++) = Strongly positive utilization. Growth equal to or greater than glucose growth.

(+) = Positive utilization. Growth is significantly better than on basal medium without carbon but less than on glucose.

(±) = Utilization doubtful. Growth slightly better than on basal medium without carbon but significantly less than with glucose.

(-) = Growth similar to or less than growth on basal medium without carbon.

B. Melanin production

Medium 1 - **2 days - positive**
4 days - positive

Medium 6 - **2 days - positive**
4 days - positive

Medium 7 - **2 days - positive**
4 days - positive

C. Starch hydrolysis

positive

Culture No. 29 Source Chile

JPL No. 246Bd Invoice # D-44829

Studied by S. Nishikawa

Species Streptomyces caelestis

1. Cultural properties: Temp. 26°C

	Da.	CHM* number and color			
		Medium 2	Medium 3	Medium 4	Medium 5
aerial mycelium	7	a = white	a = white (sparse)	none	none
	14	none	a = white (sparse)	a = white	none
	21	2dc = {natural string	a = white → 17ca = {pale aqua blue, pale blue	a = white	none
substrate mycerlium	7	41e = {maple, turf tan	2ca = {lt. ivory, eggshell	2ea = {lt. wheat, lt. maize	2ca = {lt. ivory, eggshell
	14	3pe = {amber, topaz	2ic = {honey gold, lt. gold	2ne = {mustard gold, old gold	2ic = {honey gold, lt. gold
	21	4pi = {oak brown, russet brown	2ic = {honey gold, lt. gold	4pg = mustard gold	4pg = mustard gold
soluble pigment	7	4ng = {maple, lt. brown, saddle tan	3ec = {bisque, beige	none	2ga = {colonial yellow, maize
	14	4pg = dk. luggage tan	2ne = {mustard gold, old gold	2ne = {mustard gold, old gold	2ic = honey gold, lt. gold
	21	4pg = dk. luggage tan	2ge = {bamboo, chamois	2pe = mustard gold	2pe = mustard gold

*Color Harmony Manual, Container Corporation of America, Chicago, Illinois, 4th edition, 1958.

Culture No. 29 29

JPL No. 246Bd

II. Morphological observations

	Da.	Medium 2	Medium 3	Medium 4	Medium 5
Sporophore	7	----	----	----	----
	14	----	none	spirals & retinaculum-apertum	----
	21	spirals	spirals	spirals	----
Spore No.	7	----	----	----	----
	14	----	----	> 10	----
	21	> 10	> 10	> 10	----
Verticils	7	none	none	none	none
	14	none	none	none	none
	21	none	none	none	none

special observations: e.g. globular sporangia; flagellated spores; spores on substrate hyphae; mycelia fragmentation; sclerotia.

none observed

Page 3

Culture No. 29

JPL No. 246Bd

Species S. caelestis

Photographs: Sporophores

Medium: 4-starch agar

Age of culture: 14 days

Magnification: 1000X

Culture No. 29

JPL No. 246Bd

Species S. caelestis

III. Spore morphology and surface:

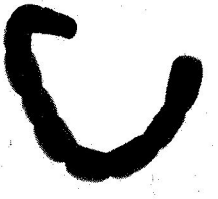
Surface: smooth

Dimensions: 0.65-1.13 x 0.49-0.65 μ

Medium: 4 starch

Age of culture: 16 days

Magnification: 6167X



Culture No. 29

JPL No. 246Bd

Species S. caelestis

IV. Physiological characteristics

A. Carbohydrate utilization

Carbohydrate	Growth After 10 days	Growth After 16 days
Negative control	-	-
D-glucose	++	++
D-xylose	++	++
L-arabinose	++	++
Sucrose	++	++
D-mannitol	++	++
I-inositol	+	+
D-fructose	++	++
Rhamnose	++	++
Raffinose	++	++
Cellulose	-	-

(++) = Strongly positive utilization. Growth equal to or greater than glucose growth.

(+) = Positive utilization. Growth is significantly better than on basal medium without carbon but less than on glucose.

(±) = Utilization doubtful. Growth slightly better than on basal medium without carbon but significantly less than with glucose.

(-) = Growth similar to or less than growth on basal medium without carbon.

B. Melanin production

Medium 1 - **2 days - positive**
4 days - positive

Medium 6 - **2 days - positive**
4 days - positive

Medium 7 - **2 days - positive**
4 days - positive

C. Starch hydrolysis

positive

Culture No. 31 Source Chile

JPL No. 247Bc Invoice # D-44829

Studied by S. Nishikawa

Species Streptomyces tendae

1. Cultural properties: Temp. 26°C

	Da.	CHM* number and color			
		Medium 2	Medium 3	Medium 4	Medium 5
aerial mycelium	7	a = white ↓ ↓ 3fe = silver gray	a = white (sparse)	a = white ↓ ↓ 3fe = silver gray	a = white
	14	f = gray (spots of white)	2fe = covert gray (sparse areas of white)	5ih = {lead gray / shadow gray} Periphery is white	13ba = alabaster tint
	21	10ih = slate	2fe = covert gray ↓ ↓ a = white	13fe = {dusk / pewter}	e = gray
substrate mycelium	7	31g = {adobe brown / cinnamon brown / light brown}	2cb = ivory tint	31i = beaver	1ba = yellow tint
	14	4pn = {choc. brown / dark brown}	2cb = ivory tint	2po = ebony teak	2pg = mustard gold
	21	4pl = {dk. spice bn. / deep brown}	3dc = natural	2pl = nustard bn.	3ng = yellow maple
soluble pigment	7	3ic = lt. amber	none	none	none
	14	31e = {cinnamon / yellow maple}	none	none	none
	21	31e = {cinnamon / yellow maple}	none	none	3gc = lt. tan

*Color Harmony Manual, Container Corporation of America, Chicago, Illinois, 4th edition, 1958.

Culture No. 31 34

JPL No. 247Bc

II. Morphological observations

	Da.	Medium 2	Medium 3	Medium 4	Medium 5
Sporophore	7	retinaculum-apertum	none	retinaculum-apertum & spirals	----
	14	retinaculum-apertum & spirals	retinaculum-apertum & apirals	as above	retinaculum-apertum
	21	as above	as above	as above	as above
Spore No.	7	> 10	----	> 10	----
	14	> 10	> 10	> 10	> 10
	21	> 10	> 10	> 10	> 10
Verticils	7	none	none	none	none
	14	none	none	none	none
	21	none	none	none	none

special observations: e.g. globular sporangia; flagellated spores; spores on substrate hyphae; mycelia fragmentation; schlerotia.

none observed

Page 3

Culture No. 31

JPL No. 247Bc

Species S. tendae

Photographs: Sporophores

Medium: 5-glycerol-asparagine agar

Age of culture: 14 days

Magnification: 1000X

Page 4

Culture No. 31

JPL No. 247Bc

Species S. tendae

III. Spore morphology and surface:

Surface: smooth

Dimensions: 0.88-1.24 x 0.44-0.80 μ

Medium: 5-Glycerol asparagine agar

Age of culture: 15 days

Magnification: 6825X

Culture No. 31

JPL No. 247bC

Species S. tendae

IV. Physiological characteristics

A. Carbohydrate utilization

Carbohydrate	Growth After 10 days	Growth After 16 days
Negative control	-	-
D-glucose	++	++
D-xylose	+	+
L-arabinose	-	-
Sucrose	-	-
D-mannitol	-	-
I-inositol	+	+
D-fructose	-	-
Rhamnose	-	-
Raffinose	-	-
Cellulose	-	-

(++) = Strongly positive utilization. Growth equal to or greater than glucose growth.

(+) = Positive utilization. Growth is significantly better than on basal medium without carbon but less than on glucose.

(±) = Utilization doubtful. Growth slightly better than on basal medium without carbon but significantly less than with glucose.

(-) = Growth similar to or less than growth on basal medium without carbon.

B. Melanin production

Medium 1 - **2 days - positive**
4 days - positive

Medium 6 - **2 days - positive**
4 days - positive

Medium 7 - **2 days - positive**
4 days - positive

C. Starch hydrolysis

positive

Culture No. 33 Source Chile

JPL No. 249 Aa Invoice # D-44829

Studied by S. Nishikawa

Species Streptomyces antibioticus

1. Cultural properties: Temp. 26°C

	Da.	CHM *number and color			
		Medium 2	Medium 3	Medium 4	Medium 5
aerial mycelium	7	a = white (sparse)	a = white (sparse)	a = white (sparse)	none
	14	a = white (sparse)	a = white (sparse)	a= white (moderate)	none
	21	a = white (moderate)	a = white (sparse)	a = white (abundant)	a = white (moderate)
substrate mycelium	7	3 pg = golden brown	1½ ca = cream	2 ba = yellow tint	1½ ca = cream
	14	4 pg = dk. luggage tan	1½ ca = cream	1½ ca = cream	1½ ca = cream
	21	4 ng = lt. brown / saddle tan / maple	1½ ca = cream	2 ea = lt. wheat / lt. maize	1½ ga = butter yellow / jasmine yellow / sunlight yellow
soluble pigment	7	3 ne = topaz / butterscotch	none	none	none
	14	3 ne = topaz / butterscotch	none	none	none
	21	3 pe = amber / topaz	none	none	none

Culture No. 33 39

JPL No. 249 Aa

II. Morphological observations

	Da.	Medium 2	Medium 3	Medium 4	Medium 5
Sporophore	7	none	none	none	----
	14	none	none	none	----
	21	none	none	none	none
	42	----	----	rectus-flexibilis	----
spore No.	7	----	----	----	----
	14	----	----	----	----
	21	----	----	----	----
	42	----	----	> 10	----
Verticils	7	----	----	----	----
	14	----	----	----	----
	21	----	----	----	----
	42	----	----	monoverticillus	----

special observations: e.g. globular sporangia; flagellated spores; spores on substrate hyphae; mycelia fragmentation; sclerotia.

40 day culture (on Starch agar): mycelia appear segmented

Page 3

Culture No. 33
JPL No. 249 Aa
Species S. antibioticus

Photographs: **Sporophores**

Medium: 4-Starch agar
Age of culture: 42 days
Magnification: 1000X

Page 4

Culture No. 33
JPL No. 249 Aa
Species S. antibioticus

III. Spore morphology and surface:

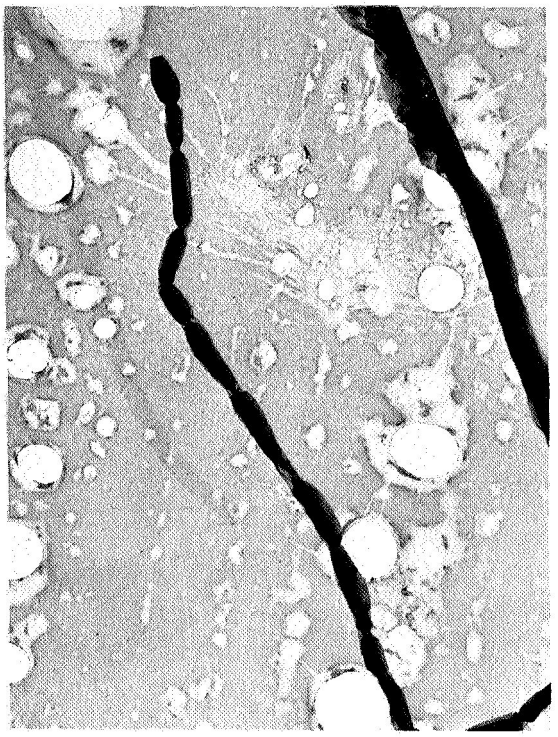
Surface: smooth

Dimensions: 0.86-1.70 x 0.32-0.49 μ

Medium: 4-Starch

Age of culture: 28 days

(Magnification): 6167X



Culture No. 33

JPL No. 249Aa

Species S. antibioticus

IV. Physiological characteristics

A. Carbohydrate utilization

Carbohydrate	Growth after 10 days	Growth after 16 days
Negative control	-	-
D-glucose	++	++
D-xylose	±	±
L-arabinose	-	-
Sucrose	±	+
D-mannitol	-	-
I-inositol	+	++
D-fructose	+	+
Rhamnose	-	-
Raffinose	-	-
Cellulose	-	-

(++) = Strongly positive utilization. Growth equal to or greater than glucose growth.

(+) = Positive utilization. Growth is significantly better than on basal medium without carbon but less than on glucose.

(±) = Utilization doubtful. Growth slightly better than on basal medium without carbon but significantly less than with glucose.

(-) = Growth similar to or less than growth on basal medium without carbon.

B. Malanin production

Medium 1 - 2 days:positive
4 days:positive

Medium 6 - 2 days:positive
4 days:positive

Medium 7 - 2 days:positive
4 days:positive

C. Starch hydrolysis

positive

Culture No. 35 Source Mexico

JPL No. 250 Aa Invoice # D-44829

Studied by S. Nishikawa

Species Streptomyces albus (var)*

1. Cultural properties: Temp. 30°C

	Da.	CHM number and color			
		Medium 2	Medium 3	Medium 4	Medium 5
aerial mycelium	7	a = white (abundant)	a = white (sparse)	a = white (sparse)	a = white (moderate)
	14	a = white (texture of cotton)	3ca = pearl pink shell	3ca = pearl pink shell	a = white (abundant)
	21	a = white	3ca = pearl pink shell	3ca = pearl pink shell	3ca = pearl shell
substrate mycelium	7	21c = gold	colorless	colorless	2ca = lt. ivory eggshell
	14	2ic = honey gold lt. gold	colorless	2ca = lt. ivory eggshell	2ca = lt. ivory eggshell
	21	2ic = honey gold lt. gold	colorless	3gc = lt. tan	3ec = lt. melon yellow
soluble pigment**	7	none	none	none	none
	14	none	none	none	none
	21	2ic = honey gold lt. gold	none	none	none

* characteristics identical to that of S. albus except for differences in the capacity to produce a rose-pink soluble pigment and thermophilic nature.

** pink soluble pigment produced in sodium albuminate, peptone-yeast extract (medium 6) and tyrosine agar (medium 7) media.

Culture No. 35 44

JPL No. 250Aa

II. Morphological observations

	Da.	Medium 2	Medium 3	Medium 4	Medium 5
Sporophore	7	none	----	none	----
	14	none	spirals (type a)	spirals	none
	21	none			none
Spore No.	7	----	----	----	----
	14	----	> 10	> 10	----
	21	----	> 10	> 10	----
Verticils	7	----	----	----	----
	14	----	*monoverticillus-spira	----	----
	21	----	----	----	----

special observations: e.g. globular sporangia; flagellated spores; spores on substrate hyphae; mycelia fragmentation; sclerotia.

none observed

*pseudoverticillar arrangement

Page 3

Culture No. 35

JPL No. 250Aa

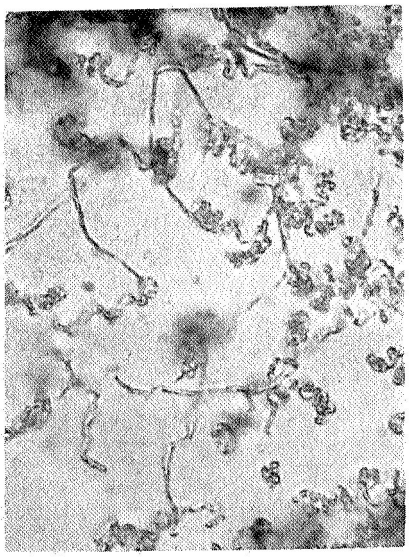
Species S. albus (var)

Photographs: Sporophores

Medium: 3-oatmeal agar

Age of culture: 14 days

Magnification: 1000X



Culture No. 35

JPL No. 250Aa

Species S. albus (var)

III. Spore morphology and surface:

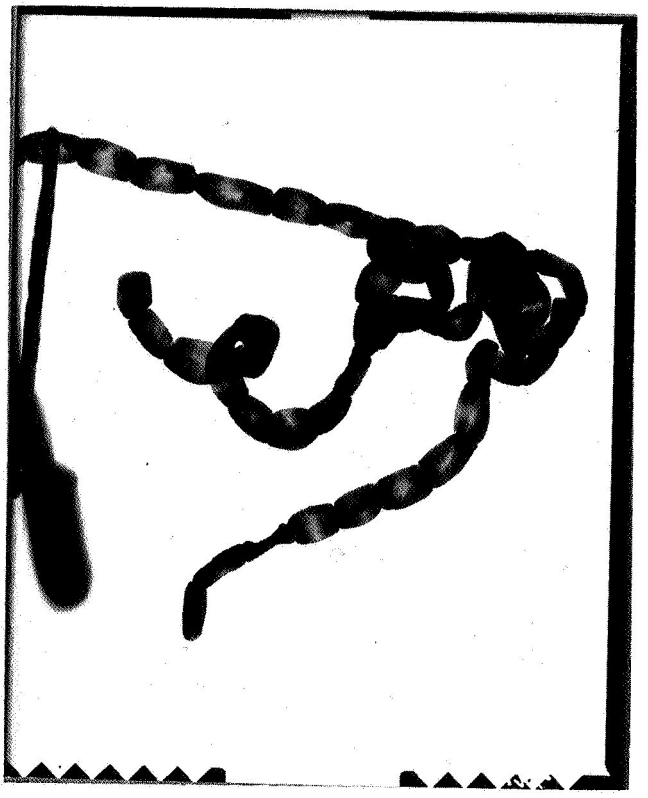
Surface: smooth

Dimensions: 0.88-1.76 x 0.44-0.73 μ

Medium: 3-oatmeal agar

Age of culture: 15 days

Magnification: 6825X



Culture No. 35

JPL No. 250Aa

Species S. albus (var)

IV. Physiological characteristics

A. Carbohydrate utilization

Carbohydrate	Growth After 10 days	Growth After 16 days
Negative control	-	-
D-glucose	++	++
D-xylose	-	±
L-arabinose	±	±
Sucrose	±	+
D-mannitol	-	-
I-inositol	+	++
D-fructose	±	++
Rhamnose	-	-
Raffinose	-	-
Cellulose	-	-

(++) = Strongly positive utilization. Growth equal to or greater than glucose growth.

(+) = Positive utilization. Growth is significantly better than on basal medium without carbon but less than on glucose.

(±) = Utilization doubtful. Growth slightly better than on basal medium without carbon but significantly less than with glucose.

(-) = Growth similar to or less than growth on basal medium without carbon.

B. Melanin production

Medium 1 - **2 days - negative**
4 days - negative

Medium 6 - **2 days - negative**
4 days - negative

Medium 7 - **2 days - negative**
4 days - negative

} . **rose-pink soluble pigment produced**

C. Starch hydrolysis
negative

Culture No. 36 Source Chile

JPL No. 276a Invoice # D-44829

Studied by S. Nishikawa

Species **Streptomyces albus**

1. Cultural properties: Temp. 26°C

	Da.	CHM* number and color			
		Medium 2	Medium 3	Medium 4	Medium 5
aerial mycelium	7	none	a = white	a = white (sparse)	none
	14	a = white (sparse)	a = white (sparse)	a = white	none
	21	a = white	a = white	a = white	none
substrate mycelium	7	1½ca = cream	2ba = yellow tint	2ea = lt. wheat / lt. maize	2ba = yellow tint
	14	2ga = colonial yellow / maize	2ba = yellow tint	2ea = lt. wheat / lt. maize	2ba = yellow tint
	21	2ea = lt. wheat / lt. maize	2ea = lt. wheat / lt. maize	2ea = lt. ivory / eggshell	1½ea = lt. yellow / pastel yellow / sunlight yellow
soluble pigment	7	none	none	none	none
	14	none	none	none	none
	21	none	none	none	none

*Color Harmony Manual, Container Corporation of America, Chicago, Illinois, 4th edition, 1958.

Culture No. 36 49

JPL No. 276a

II. Morphological observations

	Da.	Medium 2	Medium 3	Medium 4	Medium 5
Sporophore	7	----	none	none	----
	14	----	----	spirals (type a)	----
	21	spirals (type a)	----	same as above	----
Spore No.	7	----	----	----	----
	14	----	----	> 10	----
	21	> 10	----	> 10	----
Verticils	7	----	----	----	----
	14	----	----	*biverticillus-spira	----
	21	----	----	biverticillus-spira	----

special observations: e.g. globular sporangia; flagellated spores; spores on substrate hyphae; mycelia fragmentation; sclerotia.

none observed

*pseudoverticillar arrangement

Page 3

Culture No. 36

JPL No. 276a

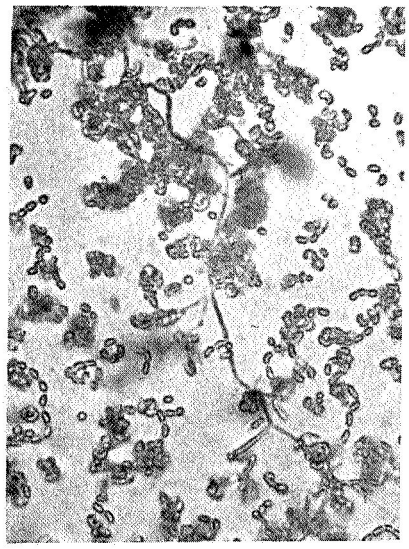
Species S. albus

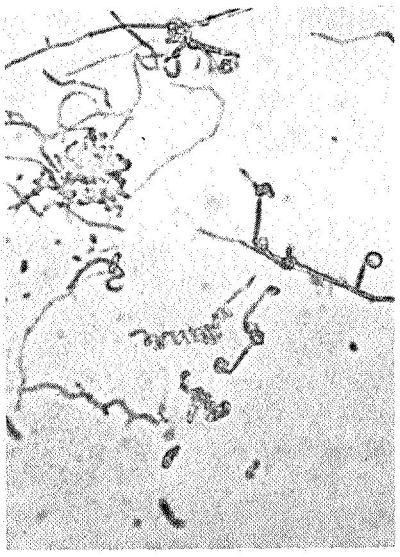
Photographs: Sporophores

Medium: 4-starch agar

Age of culture: 14 days

Magnification: 1000X





Culture No. 36

JPL No. 276a

Species S. albus

III. Spore morphology and surface:

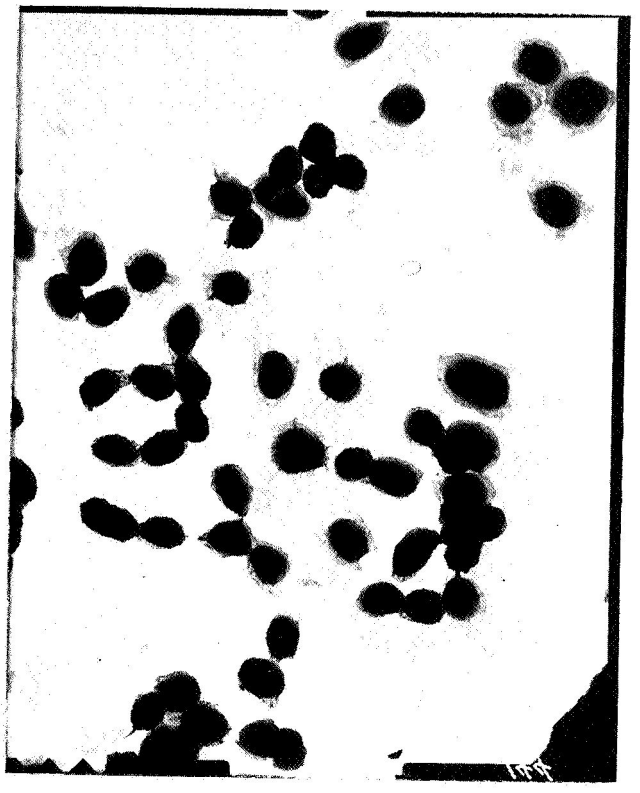
Surface: smooth and warty

Dimensions: 0.80-1.47 x 0.59-0.80 μ

Medium: 4-starch agar

Age of culture: 14 days

Magnification: 6825X



Culture No. 36

JPL No. 276a

Species S. albus

IV. Physiological characteristics

A. Carbohydrate utilization

Carbohydrate	Growth After 10 days	Growth After 16 days
Negative control	-	-
D-glucose	++	++
D-xylose	++	++
L-arabinose	++	++
Sucrose	-	-
D-mannitol	+	++
I-inositol	-	-
D-fructose	++	++
Rhamnose	++	++
Raffinose	-	-
Cellulose	-	-

(++) = Strongly positive utilization. Growth equal to or greater than glucose growth.

(+) = Positive utilization. Growth is significantly better than on basal medium without carbon but less than on glucose.

(±) = Utilization doubtful. Growth slightly better than on basal medium without carbon but significantly less than with glucose.

(-) = Growth similar to or less than growth on basal medium without carbon.

B. Melanin production

Medium 1 - **2 days - negative**
4 days - negative

Medium 6 - **2 days - negative**
4 days - negative

Medium 7 - **2 days - negative**
4 days - negative

C. Starch hydrolysis

positive

Culture No. 37 Source Arizona

JPL No. 379Ba Invoice # D-44 99

Studied by S. Nishikawa

Species **Streptomyces antibioticus**

1. Cultural properties: Temp. 26°C

	Da.	CHM* number and color			
		Medium 2	Medium 3	Medium 4	Medium 5
aerial mycelium	7	a = white	a = white ↓ d = gray (specks)	3cb = sand	none
	14	a = white ↓ 10dc = orchid haze ↓ d = gray	3dc = natural ↓ d = gray	5dc = pussywillow gray	none
	21	10dc = orchid haze	15fe	5dc = pussywillow gray	a = white (sparse)
substrate mycelium	7	5pg = {lt. copper bn, russet, rust brown}	4ca = {flesh pink, pale pink, shell pink, tea rose}	3gc = lt. tan	colorless
	14	5pg = {lt. copper bn. russet, rust brown}	4ec = {bisque, lt. rose beige}	3gc = lt. tan	2ca = {lt. ivory, eggshell}
	21	5pg = {lt. copper bn. russet, rust brown}	41e = {maple, turf tan}	3ie = {camel, maple sugar, tan}	61e = {cedar, redwood}
soluble pigment	7	3ie = {camel, maple sugar, tan}	none	none	none
	14	31e = {cinnamon, yellow maple}	none	none	none
	21	3ne = {topaz, butterscotch}	none	none	noen

*Color Harmony Manual, Container Corporation of America, Chicago, Illinois, 4th edition, 1958.

Culture No. 37

JPL No. 379Ba

II. Morphological observations

	Da.	Medium 2	Medium 3	Medium 4	Medium 5
Sporophore	7	rectus-flexibilis	rectus-flexibilis	rectus-flexibilis	----
	14	rectus-flexibilis	rectus-flexibilis	rectus-flexibilis	----
	21	rectus-flexibilis	rectus-flexibilis	rectus-flexibilis	----
Spore No.	7	> 10	> 10	> 10	----
	14	> 10	> 10	> 10	----
	21	> 10	> 10	> 10	----
Verticils	7	none	none	none	none
	14	none	none	none	none
	21	none	none	none	none

special observations: e.g. globular sporangia; flagellated spores; spores on substrate hyphae; mycelia fragmentation; sclerotia.

none observed

Page 3

Culture No. 37

JPL No. 379Ba

Species S. antibioticus

Photographs: Sporophores

Medium: 2-malt extract agar

Age of culture: 14 days

Magnification: 1000X

Culture No. 37

JPL No. 379Ba

Species S. antibioticus

III. Spore morphology and surface:

Surface: smooth

Dimensions: 1.10-1.62 x 0.44-0.66 μ

Medium: 4-starch agar

Age of culture: 15 days

Magnification: 6825X

Culture No. 37

JPL No. 379Ba

Species S. antibioticus

IV. Physiological characteristics

A. Carbohydrate utilization

Carbohydrate	Growth After 10 days	Growth After 16 days
Negative control	-	-
D-glucose	++	++
D-xylose	++	++
L-arabinose	++	++
Sucrose	++	++
D-mannitol	++	++
I-inositol	++	++
D-fructose	++	++
Rhamnose	++	++
Raffinose	++	++
Cellulose	-	-

(++) = Strongly positive utilization. Growth equal to or greater than glucose growth.

(+) = Positive utilization. Growth is significantly better than on basal medium without carbon but less than on glucose.

(±) = Utilization doubtful. Growth slightly better than on basal medium without carbon but significantly less than with glucose.

(-) = Growth similar to or less than growth on basal medium without carbon.

B. Melanin production

Medium 1 - **2 days - positive**
4 days - positive

Medium 6 - **2 days - positive**
4 days - positive

Medium 7 - **2 days - positive**
4 days - positive

C. Starch hydrolysis

positive

Culture No. 41 Source Chile-Atacama

JPL No. 245 T Af Invoice # D-38463

Studied by S. Nishikawa

Species Streptomyces violaceoruber

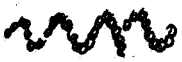
1. Cultural properties: Temp. 26°C

	Da.	CHM* number and color			
		Medium 2	Medium 3	Medium 4	Medium 5
aerial mycelium	7	a = white	a = white	a = white	a = white
	14	a = white ↓ e = gray	c = lt. gray	a = white ↓ d = gray	a = white ↓ 6ec = powder rose ↓ 7 ca = baby pink, pale pink
	21	g = gray	c = lt. gray ↓ g = gray	g = gray	7ec = rose mist
substrate mycelium	7	7ne = lt. wine	5ca = flesh pink, pale peach, shell pink, tea rose	6ca = flesh pink, pale pink, petal pink, shell pink	7lc = cherry
	14	7ng = old wine	4ca = flesh pink, pearl pink, shell pink, tea rose ↓ 7½ne = lt. wine	7ng = old wine	7le = antique rose, rose wine
	21	7½pl = burgundy, cordovan, deep maroon	3ca = pearl pink, shell ↓ 7½ng = old wine	7½ng = old wine	7le = antique rose, rose wine
soluble pigment	7	3pc = amber	none	none	none
	14	3ic = lt. amber	none	4ec = bisque, lt. rose, beige	none
	21	3ic = lt. amber	none	7½ie = ash rose	none

Culture No. 41

JPL No. 245 T Af

II. Morphological observations

	Da.	Medium 2	Medium 3	Medium 4	Medium 5
Sporophore	7	none	none	 spira (Type b)	none
	14	spira 	spira & retinaculum apertum 	spira	spira
	21	spira	spira	spira	spira
Spore Number	7	----	----	> 10	----
	14	> 10	> 10	> 10	> 10
	21	> 10	> 10	> 10	> 10
Verticils	7	----	----	none	----
	14	none	none	none	none
	21	none	none	none	none

special observations: e.g. globular sporangia; flagellated spores; spores on substrate hyphae; mycelia fragmentation; sclerotia.

none observed.

Page 3

Culture No. 41

JPL No. 245 T Af

Species S. violaceoruber

Photographs. Sporophores

Medium: 2-mxa

Age of culture: 14 days

Magnification: 1000X

Page 4

Culture No. 41

JPL No. 245 T Af

Species S. violaceoruber

III. Spore morphology and surface

Surface: smooth

Dimensions: 1.11-1.74 x 0.47-0.79μ

Medium: 4-starch agar

Age of culture: 32 days

Magnification: 6302

Culture No. 41

JPL No. 245 T Af

Species S. violaceoruber

IV. Physiological characteristics

A. Carbohydrate utilization

Carbohydrate	Growth after 10 days	Growth after 16 days
Negative control	-	-
D-glucose	++	++
D-xylose	-	-
L-arabinose	-	-
Sucrose	+	+
D-mannitol	-	-
I-inositol	-	-
D-fructose	-	-
Rhamnose	-	-
Raffinose	-	-
Cellulose	-	-

(++) = Strongly positive utilization. Growth equal to or greater than glucose growth.

(+) = Positive utilization. Growth is significantly better than on basal medium without carbon but less than on glucose.

(±) = Utilization doubtful. Growth slightly better than on basal medium without carbon but significantly less than with glucose.

(-) = Growth similar to or less than growth on basal medium without carbon.

B. Malanin production

Medium 1 - 2 days-negative
4 days-negative

Medium 6 - 2 days-negative
4 days-negative

Medium 7 - 2 days-negative
4 days-negative

C. Starch hydrolysis

positive

Culture No. 42 Source Chile-Atacama

JPL No. 245 T Ba Invoice # D-38463

Studied by S. Nishikawa

Species S. albogriseolus

1. Cultural properties: Temp. 26°C

	Da.	CHM* number and color			
		Medium 2	Medium 3	Medium 4	Medium 5
aerial myeelium	7	a = white (abundant)	a = white	a = white	a = white
	14	a (white) turning to d (gray)	white, turning gray	white, turning gray	a = white
	21	a (white), mostly d (gray)	white, turning gray	h = gray	b = (light gray) ↓ d = (darker gray)
substrate myeelium	7	2ga = {colonial yellow maize	2ba = {pearl shell tint	2ba = {pearl shell tint	2ba = {pearl shell tint
	14	2ic = {honey gold lt. gold	2ca = {lt, ivory eggshell	2ba = {pearl shell tint	2ca = {lt, ivory eggshell
	21	2ne = {mustard gold old gold	2ca = {lt, ivory eggshell	2gc = {bamboo chamois	2gc = {bamboo chamois
soluble pigment	7	none	none	none	none
	14	none	none	none	none
	21	none	none	none	none

Culture No. 42 64

JPL No. 245 T Ba

II. Morphological observations

	Da.	Medium 2	Medium 3	Medium 4	Medium 5
Sporophore	7	none	spirals	spirals	none
	14	spirals	spirals	spirals and short retinaculum-apertum	none
	21	spirals	spirals	some corkscrew spirals spirals	spirals
Spore No.	7	----	> 10	> 10	----
	14	> 10	> 10	> 10	----
	21	> 10	> 10	> 10	> 10
Verticils	7	----	----	----	----
	14	----	----	----	----
	21	----	----	----	----

special observations: e.g. globular sporangia; flagellated spores; spores on substrate hyphae; mycelia fragmentation; sclerotia.

none observed.

Page 3

Culture No. 42

JPL No. 245 T Ba

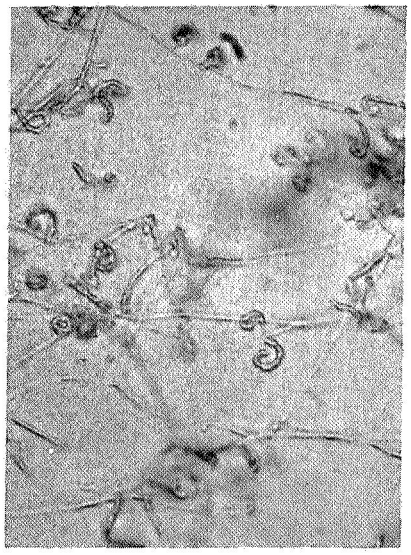
Species S. albogriseolus

Photographs: Sporophores

Medium: 4-Starch agar

Age of culture: 14 days

Magnification: 1000X

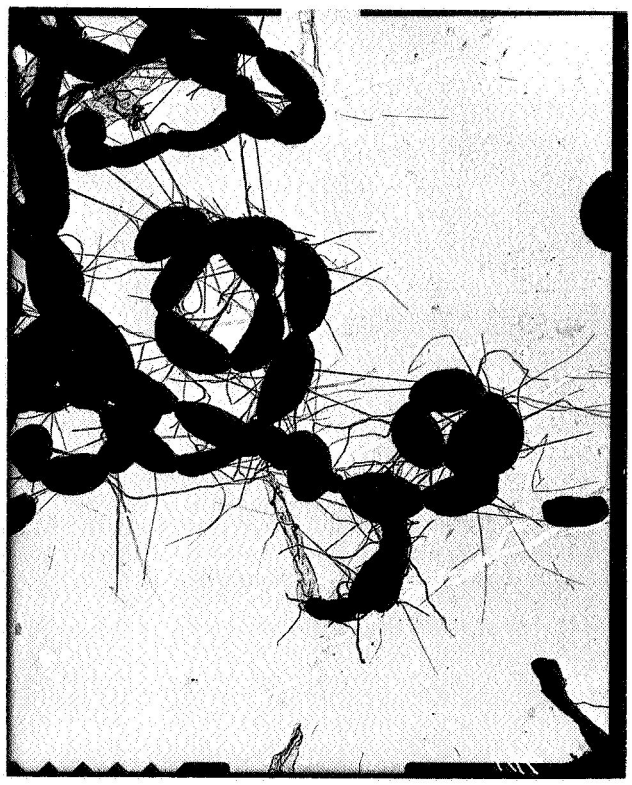


Page 4

Culture No. 42
JPL No. 245 T Ba
Species S. albogriseolus

III. Spore morphology and surface:

Surface: hairy
Dimensions: 0.80-1.91 x 0.37-1.32 μ
Medium: 4-starch agar
Age of culture: 14 days
(Magnification): 6825X



Culture No. 42

JPL No. 245 T Ba

Species S. albogriseolus

IV. Physiological characteristics

A. Carbohydrate utilization

Carbohydrate	Growth after 10 days	Growth after 16 days
Negative control	-	-
D-glucose	++	++
D-xylose	++	++
L-arabinose	++	++
Sucrose	±	+
D-mannitol	++	++
I-inositol	++	++
D-fructose	++	++
Rhamnose	++	++
Raffinose	-	-
Cellulose	-	-

(++) = Strongly positive utilization. Growth equal to or greater than glucose growth.

(+) = Positive utilization. Growth is significantly better than on basal medium without carbon but less than on glucose.

(±) = Utilization doubtful. Growth slightly better than on basal medium without carbon but significantly less than with glucose.

(-) = Growth similar to or less than growth on basal medium without carbon.

B. Malanin production

Medium 1 - 2 days:negative
4 days:negative

Medium 6 - 2 days:negative
4 days:negative

Medium 7 - 2 days:negative
4 days:negative

C. Starch hydrolysis

positive

Culture No. 44

JPL No. 246 T Aa

Source Chile - Atacama

Invoice # D-38463

Studied by S. Nishikawa

Species **Streptomyces caelestis**

1. Cultural properties: Temp. 26°C

	Da.	CHM* number and color			
		Medium 2	Medium 3	Medium 4	Medium 5
aerial mycelium	7	none	a = white (sparse)	none	none
	14	13cb = sand	17ec = lt. aqua blue	17ec = lt. aqua blue	none
	21	17ec = lt. aqua blue	a = white ↓ 17ec = lt. aqua blue	17ec = lt. aqua blue	a = white
substrate mycelium	7	4ng = lt. brown / saddle tan / maple	2ga = colonial yellow / maize	2ga = colonial yellow / maize	2ga = colonial yellow / maize
	14	3pg = golden brown	2ga = colonial yellow / maize	2ne = mustard gold / old gold	2ic = honey gold / lt. gold
	21	3pi = golden brown / tobacco brown	2ia = squash yellow / maize	2pg = mustard gold	2pe = mustard gold
soluble pigment	7	4ng = lt. brown / saddle tan / maple	none	none	3pc = lt. tan
	14	4pg = dk. luggage tan	none	none	2ic = honey gold / lt. gold
	21	3pg = golden brown	none	2ne = mustard gold / old gold	2pc = brite gold

*Color Harmony Manual, Container Corporation of America, Chicago, Illinois, 4th edition, 1958.

Culture No. 44 69

JPL No. 246 T Aa

II. Morphological observations

	Da.	Medium 2	Medium 3	Medium 4	Medium 5
Sporophore	7	----	----	----	----
	14	none	spirals & retinaculum-apertum	retinaculum-apertum	----
	21	spirals & retinaculum-apertum	retinaculum-apertum	retinaculum-apertum	retinaculum-apertum
Spore No.	7	----	----	----	----
	14	----	> 10	> 10	----
	21	> 10	> 10	> 10	> 10
Verticils	7	none	none	none	none
	14	none	none	none	none
	21	none	none	none	none

special observations: e.g. globular sporangia; flagellated spores; spores on substrate hyphae; mycelia fragmentation; sclerotia.

none observed

Page 3

Culture No. 44

JPL No. 246 T Aa

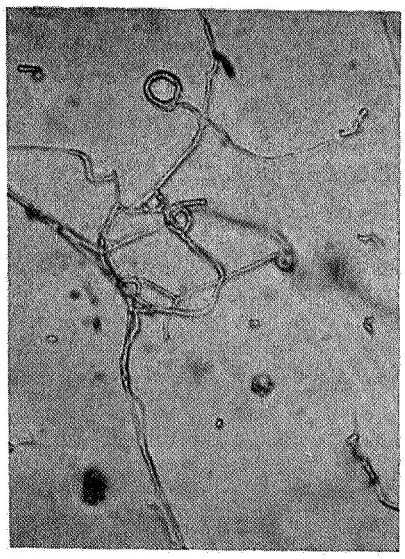
Species S. caelestis

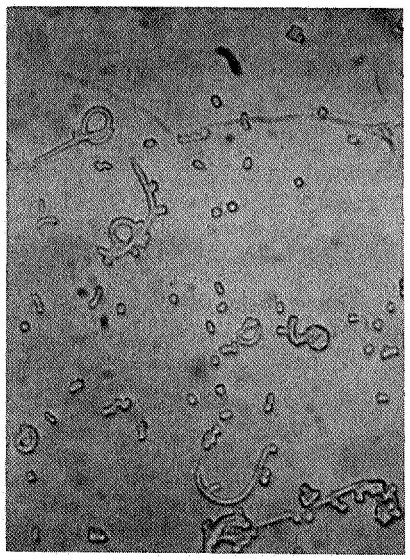
Photographs: Sporophores

Medium: 4-starch agar

Age of culture: 14 days

Magnification: 1000X





Culture No. 44

JPL No. 246 T Aa

Species S. caelestis

III. Spore morphology and surface:

Surface: smooth

Dimensions: 0.97-1.13 x 0.65-0.86 μ

Medium: 3-Oatmeal agar

Age of culture: 16 days

Magnification: 6167X

Culture No. 44

JPL No. 246 T Aa

Species S. caelestis

IV. Physiological characteristics

A. Carbohydrate utilization

Carbohydrate	Growth After 10 days	Growth After 16 days
Negative control	-	-
D-glucose	++	++
D-xylose	++	++
L-arabinose	++	++
Sucrose	++	++
D-mannitol	++	++
I-inositol	++	++
D-fructose	++	++
Rhamnose	++	++
Raffinose	++	++
Cellulose	-	-

(++) = Strongly positive utilization. Growth equal to or greater than glucose growth.

(+) = Positive utilization. Growth is significantly better than on basal medium without carbon but less than on glucose.

(±) = Utilization doubtful. Growth slightly better than on basal medium without carbon but significantly less than with glucose.

(-) = Growth similar to or less than growth on basal medium without carbon.

B. Melanin production

Medium 1 - **2 days - positive**
4 days - positive

Medium 6 - **2 days - positive**
4 days - positive

Medium 7 - **2 days - positive**
4 days - positive

C. Starch hydrolysis

positive

Culture No. 46 Source Chile-Atacama

JPL No. 249 T Aa Invoice # D-38463

Studied by S. Nishikawa

Species Streptomyces longisporuber

1. Cultural properties: Temp. 26°C

	Da.	CHM* number and color			
		Medium 2	Medium 3	Medium 4	Medium 5
aerial mycelium	7	a = white (abundant)	a = white	a = white (abundant)	a = white
	14	a = white	a = white	a = white	a = white
	21	a = white	a = white with tinge of gray	a = white	a = white
substrate mycelium	7	21c = gold	2ba = pearl shell tint	2ca = lt, ivory eggshell	1½ca = cream
	14	3ic = lt. amber	2ba = pearl shell tint	2ea = lt. wheat lt. maize	2ic = honey gold lt. gold
	21	3ne = topaz butterscotch	1½ca = cream	2ea = lt. wheat lt. maize	2ea = lt. wheat lt. maize
soluble pigment	7	21c = gold	none	none	none
	14	3ic = lt. amber	none	none	none
	21	3pe = topaz amber	none	none	none

*Color Harmony Manual, Container Corporation of America, Chicago, Illinois, 4th edition, 1958.

Culture No. 46 74

JPL No. 249 T Aa

II. Morphological observations

	Da.	Medium 2	Medium 3	Medium 4	Medium 5
Sporephore	7	none	none	rectus-flexibilis	none
	14	rectus-flexibilis	rectus-flexibilis	rectus-flexibilis retinaculum-apertum (with large loop)	none
	21	as above	as above		rectus-flexibilis
Spore No.	7	----	----	> 10	----
	14	> 10	> 10	> 10	> 10
	21	> 10	> 10	> 10	> 10
Verticils	7	----	----	----	----
	14	----	----	*verticillus-rectus-flexibilis	----
	21	----	----	----	----

special observations: e.g. globular sporangia; flagellated spores; spores on substrate hyphae; mycelia fragmentation; sclerotia.

non observed

*pseudoverticillar arrangement

Page 3

Culture No. 46

JPL No. 249 T Aa

Species S. longisporuber

Photographs: Sporophores

Medium: 4-starch agar

Age of culture: 14 days

Magnification: 1000X

Culture No. 46

JPL No. 249 T Aa

Species S. longisporuber

III. Spore morphology and surface:

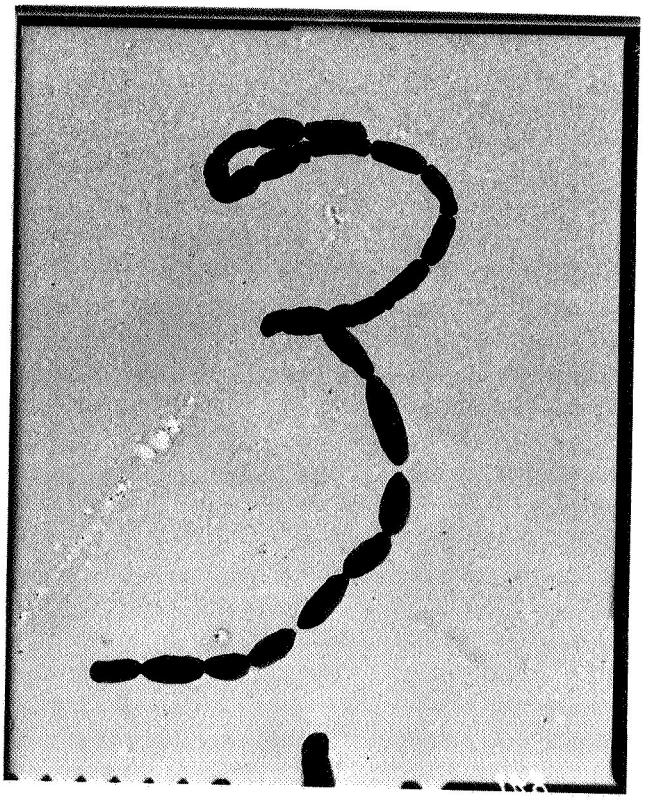
Surface: smooth and warty

Dimensions: 0.88-1.83 x 0.44-0.59 μ

Medium: 4-starch agar

Age of culture: 14 days

Magnification: 6825X



Culture No. 46

JPL No. 249 T Aa

Species S. longisporuber

IV. Physiological characteristics

A. Carbohydrate utilization

Carbohydrate	Growth After 10 days	Growth After 16 days
Negative control	-	-
D-glucose	++	++
D-xylose	++	++
L-arabinose	++	++
Sucrose	-	±
D-mannitol	+	+
I-inositol	++	++
D-fructose	-	±
Rhamnose	-	+
Raffinose	++	++
Cellulose	-	-

(++) = Strongly positive utilization. Growth equal to or greater than glucose growth.

(+) = Positive utilization. Growth is significantly better than on basal medium without carbon but less than on glucose.

(±) = Utilization doubtful. Growth slightly better than on basal medium without carbon but significantly less than with glucose.

(-) = Growth similar to or less than growth on basal medium without carbon.

B. Melanin production

Medium 1 - **2 days - positive**
4 days - positive

Medium 6 - **2 days - positive**
4 days - positive

Medium 7 - **2 days - positive**
4 days - positive

C. Starch hydrolysis

positive

Culture No. 47 Source Chile-Atacama

JPL No. 249 T Ba Invoice # D-38463

Studied by S. Nishikawa

Species **Streptomyces exfoliatus**

1. Cultural properties: Temp. 26°C

	Da.	CHM* number and color			
		Medium 2	Medium 3	Medium 4	Medium 5
aerial mycelium	7	a = white ↓ 6ca = {flesh pink, pale pink, petal pink, shell pink}	a = white ↓ b = oyster white	a = white	a = white
	14	a = white ↓ 7ec = rose mist	b = oyster white ↓ 6ca = {flesh pink, pale pink, petal pink, shell pink}	b = oyster white ↓ 6ca = {flesh pink, pale pink, petal pink, shell pink} ↓ 7ge = {ashes of rose, rose gray}	a = white
	21	7ec = rose mist ↓ 7ge = {ashes of rose, rose gray}	7ec = rose mist	a = white ↓ 7ec = rose mist ↓ 6ge = {ashes of rose, rose gray}	a = white
substrate mycelium	7	2ic = {honey gold, lt. gold}	1ba = yellow tint	2ea = {lt. wheat, lt. maize}	2ca = {lt. ivory, eggshell}
	14	3ic = lt. amber	2ca = {lt. ivory, eggshell}	3ec = {bisque, lt. beige}	2ca = {lt. ivory, eggshell}
	21	3nc = amber	3ca = {pearl pink, shell} ↓ 3gc = lt. tan	3ca = {pearl pink, shell}	2ca = {lt. ivory, eggshell}
soluble pigment	7	none	none	none	none
	14	31c = {amber, butterscotch}	none	3ne = {topaz, butterscotch}	none
	21	31c = {amber, butterscotch}	none	3ne = {topaz, butterscotch}	none

Culture No. 47

JPL No. 249 T Ba

II. Morphological observations

	Da.	Medium 2	Medium 3	Medium 4	Medium 5
Sporophore	7	Rectus-Flexibilis	Rectus-Flexibilis	Rectus-Flexibilis	none*
	14	Rectus-Flexibilis	Rectus-Flexibilis	Rectus-Flexibilis	Rectus-Flexibilis
	21	Rectus-Flexibilis	Rectus-Flexibilis	Rectus-Flexibilis	Rectus-Flexibilis
Spore Number	7	> 10	> 10	> 10	----
	14	> 10	> 10	> 10	> 10
	21	> 10	> 10	> 10	> 10
Verticils	7	----	----	----	----
	14	none	none	none	none
	21	none	none	none	none

special observations: e.g. globular sporangia; flagellated spores; spores on substrate hyphae; mycelia fragmentation; sclerotia.

*m5-7 days culture.

Page 3

Culture No. 47

JPL No. 249 T Ba

Species S. exfoliatus

Photographs. **Sporophores**

Medium: 4-starch agar

Age of culture: 14 days

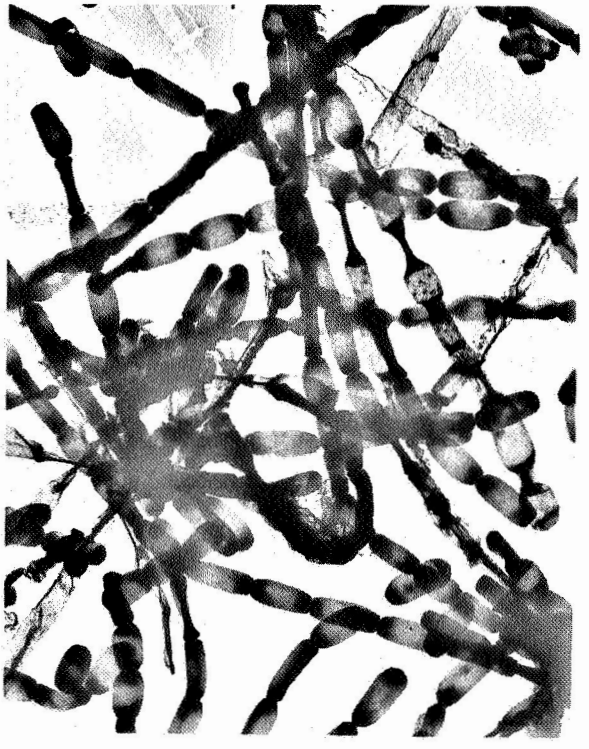
Magnification: 1000X

Page 4

Culture No. 47
JPL No. 249 T Ba
Species S. exfoliatus

III. Spore morphology and surface

Surface: smooth
Dimensions: 1.03-1.58 x 0.39-0.63 μ
Medium: 2-malt extract agar
Age of culture: 32-days
Magnification: 6302



Culture No. 47

JPL No. 249 T Ba

Species S. exfoliatus

IV. Physiological characteristics

A. Carbohydrate utilization

Carbohydrate	Growth after 10 days	Growth after 16 days
Negative control	-	-
D-glucose	++	++*
D-xylose	++*	++*
L-arabinose	++*	++*
Sucrose	+	+*
D-mannitol	+	
I-inositol	++*	++*
D-fructose	+	+*
Rhamnose	++	++
Raffinose	+	++*
Cellulose	-	-

(++) = Strongly positive utilization. Growth equal to or greater than glucose growth.

(+) = Positive utilization. Growth is significantly better than on basal medium without carbon but less than on glucose.

(±) = Utilization doubtful. Growth slightly better than on basal medium without carbon but significantly less than with glucose.

(-) = Growth similar to or less than growth on basal medium without carbon.

B. Malanin production

Medium 1 - 2 days-negative
4 days-negative

Medium 6 - 2 days-negative
4 days-negative

Medium 7 - 2 days-negative
4 days-negative

C. Starch hydrolysis

positive

*rose pink pigment produced. Most prominant in xylose.

Culture No. 49 Source Chile-Atacama

JPL No. 259 T Bb Invoice # D-38463

Studied by S. Nishikawa

Species Streptomyces azureus

1. Cultural properties: Temp. 26°C

	Da.	CHM* number and color			
		Medium 2	Medium 3	Medium 4	Medium 5
aerial mycelium	7	a = white	a = white turning to 17ig	17ie = dusty turquoise blue	none
	14	a (white) with specks of 17ge (dusty aqua blue)	17ig	17ge = dusty aqua blue	none
	21	white with specks of 17ge (dusty aqua blue)	17ig	17ge = dusty aque blue	a = white
substrate mycelium	7	3ne = topaz butterscotch	colorless	3ig = beige brown mist brown	2ba = pearl shell tint
	14	3le = cinnamon yellow maple	colorless	3ig = beige brown mist brown	3ne = topaz butterscotch
	21	3pg = golden brown	1½ca = cream	21g = mustard tan	3pg = golden brown
soluble pigment	7	3ic = lt. amber	none	3ge = beige camel	none
	14	3pe = amber topaz	none	3ig = beige brown mist brown	none
	21	3pg = golden brown	none	3pe = beige camel	none

*Color Harmony Manual, Container Corporation of America, Chicago, Illinois, 4th edition, 1958.

Culture No. 49 84

JPL No. 259 T Bb

II. Morphological observations

	Da.	Medium 2	Medium 3	Medium 4	Medium 5
Sporophore	7	none	spirals (type b)	spirals (type a) 	----
	14	none	spirals (type A and b)	spirals	----
	21	none	spirals (type a &b)	spirals	none
Spore No.	7	----	> 10	> 10	----
	14	----	> 10	> 10	----
	21	----	> 10	> 10	----
Verticils	7	none	none	none	none
	14	none	none	none	none
	21	none	none	none	none

special observations: e.g. globular sporangia; flagellated spores; spores on substrate hyphae; mycelia fragmentation; sclerotia.

none observed

Page 3

Culture No. 49

JPL No. 259 T Bb

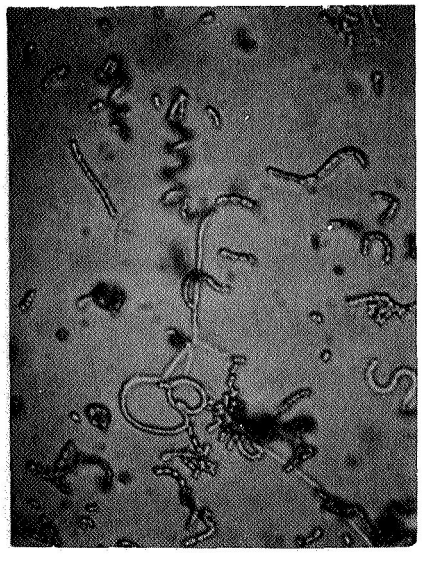
Species S. azureus

Photographs: Sporophores

Medium: 3-oatmeal agar

Age of culture: 7 days

Magnification: 1000X



Page 4

Culture No. 49

JPL No. 259 T Bb

Species S. azureus

III. Spore morphology and surface:

Surface: smooth

Dimensions: 0.88-1.47 x 0.73-0.88 μ

Medium: 3-oatmeal agar

Age of culture: 8 days

Magnification: 6825X

Culture No. 49

JPL No. 259 T Bb

Species S. azureus

IV. Physiological characteristics

A. Carbohydrate utilization

Carbohydrate	Growth After 10 days	Growth After 16 days
Negative control	-	-
D-glucose	++	++
D-xylose	++	++
L-arabinose	+	+
Sucrose	±	±
D-mannitol	+	+
I-inositol	+	+
D-fructose	++	++
Rhamnose	++	++
Raffinose	++	++
Cellulose	-	-

(++) = Strongly positive utilization. Growth equal to or greater than glucose growth.

(+) = Positive utilization. Growth is significantly better than on basal medium without carbon but less than on glucose.

(±) = Utilization doubtful. Growth slightly better than on basal medium without carbon but significantly less than with glucose.

(-) = Growth similar to or less than growth on basal medium without carbon.

B. Melanin production

Medium 1 - **2 days - positive**
4 days - positive

Medium 6 - **2 days - positive**
4 days - positive

Medium 7 - **2 days - negative**
4 days - positive

C. Starch hydrolysis

positive

Culture No. 54 Source Chile-Atacama

JPL No. 275 T Aa Invoice # D-38463

Studied by S. Nishikawa

Species Streptomyces aureofaciens

1. Cultural properties: Temp. 26°C

	Da.	CHM* number and color			
		Medium 2	Medium 3	Medium 4	Medium 5
aerial mycelium	7	c = gray	a = white	e = gray	a = white (sparse)
	14	d = gray	5fe = ashes	5fe = ashes	a = white (sparse)
	21	10dc = or chid haze	5fe = ashes	10fe = dusk	a = white (sparse)
substrate mycelium	7	31e = {cinnamon / yellow maple}	colorless	2fe = covert gray	1½ca = cream
	14	31e = {cinnamon / yellow maple}	2ge = {covert tan / griege}	2ge = {covert tan / griege}	1½ca = cream
	21	3pg = golden brown	3ge = {beige / camel}	3ig = {beige brown / mist brown}	1½ca = cream
soluble pigment	7	none	none	none	none
	14	none	none	none	none
	21	none	none	none	none

*Color Harmony Manual, Container Corporation of America, Chicago, Illinois, 4th edition, 1958.

Culture No. 54 89

JPL No. 275 T Aa

II. Morphological observations

	Da.	Medium 2	Medium 3	Medium 4	Medium 5
Sporophore	7	spirals (type b) & retinaculum-apertum	spirals & retinaculum-apertum	spirals & retinaculum-apertum	none
	14	spirals (type b) & retinaculum-apertum	spirals & retinaculum-apertum	spirals & retinaculum-apertum	none
	21	spirals & retinaculum-apertum	spirals & retinaculum-apertum	spirals & retinaculum-apertum	spirals
Spore No.	7	> 10	> 10	> 10	----
	14	> 10	> 10	> 10	----
	21	> 10	> 10	> 10	> 10
Verticils	7	*verticillus-spira	----	----	----
	14	----	----	----	----
	21	*verticillus-spira	----	----	----

special observations: e.g. globular sporangia; flagellated spores; spores on substrate hyphae; mycelia fragmentation; sclerotia.

none observed

*pseudoverticillar arrangement

Page 3

Culture No. 54

JPL No. 275 T Aa

Species S. aureofaciens

Photographs: Sporophores

Medium: 3-oatmeal agar

Age of culture: 14 days

Magnification: 1000X

Page 4

Culture No. 54

JPL No. 275 T Aa

Species S. aureofaciens

III. Spore morphology and surface:

Surface: warty

Dimensions: 0.80-1.62 x 0.51-0.73 μ

Medium: 4-starch agar

Age of culture: 8 days

Magnification: 6825X

Culture No. 54

JPL No. 275 T Aa

Species S. aureofaciens

IV. Physiological characteristics

A. Carbohydrate utilization

Carbohydrate	Growth After 10 days	Growth After 16 days
Negative control	-	-
D-glucose	++	++
D-xylose	++	++
L-arabinose	++	++
Sucrose	++	++
D-mannitol	++	++
I-inositol	++	++
D-fructose	++	++
Rhamnose	++	++
Raffinose	±	±
Cellulose	-	-

(++) = Strongly positive utilization. Growth equal to or greater than glucose growth.

(+) = Positive utilization. Growth is significantly better than on basal medium without carbon but less than on glucose.

(±) = Utilization doubtful. Growth slightly better than on basal medium without carbon but significantly less than with glucose.

(-) = Growth similar to or less than growth on basal medium without carbon.

B. Melanin production

Medium 1 - **2 days - negative**
4 days - negative

Medium 6 - **2 days - positive**
4 days - positive

Medium 7 - **2 days - negative**
4 days - negative

C. Starch hydrolysis

positive

Culture No. 55 Source Chile-Atacama 93

JPL No. 276 T Ba Invoice # D-38463

Studied by S. Nishikawa

Species **Streptomyces rimosus**

1. Cultural properties: Temp. 26°C

	Da.	CHM* number and color			
		Medium 2	Medium 3	Medium 4	Medium 5
aerial mycelium	7	none	none	24 ig = {reseda green / sage green}	none
	14	none	none	a = white ↓ b = gray	none
	21	a = white	a = white (sparse)	a = white b = gray	
substrate mycelium	7	2 ca = {lt. ivory / eggshell}	2 ea = {lt. wheat / lt. maize}	2 ba = {pearl / shell tint}	2 ca = {lt, ivory / eggshell}
	14	2 ea = {lt. wheat / lt. maize}	2 ca = {lt. ivory / eggshell}	2 ic = {honey gold / lt. gold}	2 ga = {colonial yellow / maize}
	21	2 ic = {honey gold / lt. gold}	2 ca = {lt. ivory / eggshell}	2 ic = {honey gold / lt. gold}	2 lc = gold
soluble pigment	7	none	none	none	none
	14	none	none	none	none
	21	none	none	none	none

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II. Morphological observations

	Da.	Medium 2	Medium 3	Medium 4	Medium 5
Sporophore	7	----	----	----	----
	14	----	----	retinaculum-apertum and spirals	----
	21	spirals and retinaculum-apertum	spirals	spirals	----
Spore No.	7	----	----	----	----
	14	----	----	> 10 < 10	----
	21	> 10	> 10	> 10	----
Verticils	7	none	none	none	none
	14	none	none	none	none
	21	none	none	none	none

special observations: e.g. globular sporangia; flagellated spores; spores on substrate hyphae; mycelia fragmentation; sclerotia.

noneobserved.

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Culture No. 55
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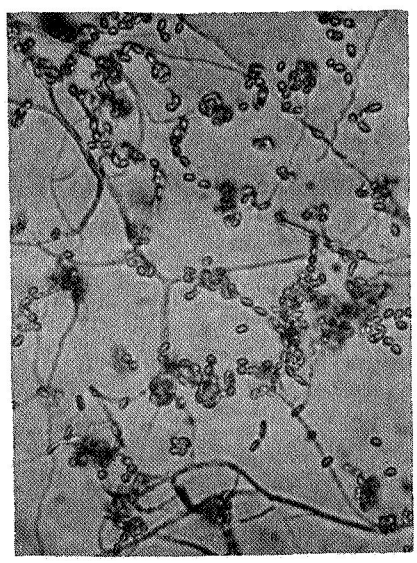
Photographs : Sporophores

Medium: 4-Starch agar
Age of culture: 14 days
Magnification: 1000X



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Species S. rimosus

III. Spore morphology and surface

Surface: warty

Dimensions: 0.81-1.95 x 0.49-0.97 μ

Medium: 4-starch

Age of culture: 15 days

(Magnification): 6167X

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Species S. rimosus

IV. Physiological characteristics

A. Carbohydrate utilization

Carbohydrate	Growth after 10 days	Growth after 16 days
Negative control	-	-
D-glucose	++	++
D-xylose	+	+
L-arabinose	++	++
Sucrose	±	+
D-mannitol	±	±
I-inositol	-	-
D-fructose	±	+
Rhamnose	++	++
Raffinose	±	+
Cellulose	-	-

(++) = Strongly positive utilization. Growth equal to or greater than glucose growth.

(+) = Positive utilization. Growth is significantly better than on basal medium without carbon but less than on glucose.

(±) = Utilization doubtful. Growth slightly better than on basal medium without carbon but significantly less than with glucose.

(-) = Growth similar to or less than growth on basal medium without carbon.

B. Malanin production

Medium 1 - 2 days:negative
4 days:negative

Medium 6 - 2 days:negative
4 days:negative

Medium 7 - 2 days:negative
4 days:negative

C. Starch hydrolysis

positive