Bacillus coahuilensis

- Isolated in the Churince system
- Smallest genome of a Bacillus so far 3.3 Gb
- Sequenced by Sanger and 454
- Implicated as major functional component in marine and desert ecosystems

1
00:00:06,829 --> 00:00:03,409
okay everybody well I think we'll start

2
00:00:08,870 --> 00:00:06,839
with a seminar now welcome to all of

3
00:00:11,780 --> 00:00:08,880
those who are on videocon as well thanks

4
00:00:13,009 --> 00:00:11,790
for joining us so our speaker today and

5
00:00:15,650 --> 00:00:13,019
the University of Washington

6
00:00:18,050 --> 00:00:15,660
astrobiology seminar series is a

7
00:00:21,109 --> 00:00:18,060
professor Janet Seaford she is an

8
00:00:24,349 --> 00:00:21,119
evolutionary molecular biologist to get

9
00:00:26,210 --> 00:00:24,359
that right she got her PhD at the

10
00:00:28,269 --> 00:00:26,220
University of Houston where she worked

11
00:00:30,140 --> 00:00:28,279
with George Fox as her advisor and

12
00:00:33,380 --> 00:00:30,150
Georgia something you know was the

13
00:00:35,330 --> 00:00:33,390

discoverer of the ikea janet is now

14
00:00:37,940 --> 00:00:35,340
currently working as a faculty fellow at

15
00:00:39,650 --> 00:00:37,950
rice university in houston and her

16
00:00:42,020 --> 00:00:39,660
research interests include theoretical

17
00:00:44,900 --> 00:00:42,030
biology horizontal gene transfer and

18
00:00:46,760 --> 00:00:44,910
microbial ecology and today she's going

19
00:00:48,889 --> 00:00:46,770
to be giving us a talk entitled strum

20
00:00:52,430 --> 00:00:48,899
stromatolites what sulfur got to do with

21
00:01:00,260 --> 00:00:52,440
it well I'm glad to be here you're gonna

22
00:01:02,479 --> 00:01:00,270
do the live cam in the dark can't see me

23
00:01:05,479 --> 00:01:02,489
that's good you have to forgive my

24
00:01:07,520 --> 00:01:05,489
southern accent I'm from Arkansas so I

25
00:01:08,690 --> 00:01:07,530
try to hide it a lot but it'll come out

26
00:01:10,160 --> 00:01:08,700
every once them all so you don't

27
00:01:12,590 --> 00:01:10,170
understand something I'm talking about

28
00:01:15,289 --> 00:01:12,600
well just raise your hand and I

29
00:01:18,940 --> 00:01:15,299
certainly don't mind being stalked how

30
00:01:23,300 --> 00:01:18,950
many of you are astronomers in here

31
00:01:25,010 --> 00:01:23,310
biologists cool oh so you tell me a lie

32
00:01:28,340 --> 00:01:25,020
you told me they were going to be done a

33
00:01:30,260 --> 00:01:28,350
bit astronomers in here okay so I'm

34
00:01:31,940 --> 00:01:30,270
going to tell you about actually I'm

35
00:01:34,340 --> 00:01:31,950
going to tell you a little bit about one

36
00:01:35,390 --> 00:01:34,350
of the my favorite places on earth and

37
00:01:37,640 --> 00:01:35,400
I'm going to tell you about some

38
00:01:39,649 --> 00:01:37,650

research that's being done there and the

39
00:01:41,060 --> 00:01:39,659
way i'm going to introduce it is i'm

40
00:01:44,179 --> 00:01:41,070
going to talk about the stromatolites

41
00:01:47,630 --> 00:01:44,189
that are there and the first slide is

42
00:01:49,280 --> 00:01:47,640
just my my side of recognition of

43
00:01:52,010 --> 00:01:49,290
everyone that's working down there this

44
00:01:53,960 --> 00:01:52,020
is quite a group being a part of the

45
00:01:56,240 --> 00:01:53,970
astrobiology you understand that it

46
00:01:57,649 --> 00:01:56,250
takes a huge number of people to

47
00:01:59,899 --> 00:01:57,659
actually tackle some of the problems

48
00:02:01,670 --> 00:01:59,909
that we try to tackle today and that's

49
00:02:04,550 --> 00:02:01,680
reflected in the number of collaborators

50
00:02:06,289 --> 00:02:04,560
that I have here I won't go through a

51
00:02:08,359 --> 00:02:06,299
name each of them but they're across the

52
00:02:10,040 --> 00:02:08,369
border across the Rio Grande all the way

53
00:02:10,770 --> 00:02:10,050
through the southern part of the United

54
00:02:13,800 --> 00:02:10,780
States

55
00:02:17,570 --> 00:02:13,810
and of course very appreciative to to

56
00:02:19,949 --> 00:02:17,580
Vicki all right so let's get started

57
00:02:21,390 --> 00:02:19,959
this is a picture of early Earth I know

58
00:02:23,930 --> 00:02:21,400
you've all seen it's pretty good that we

59
00:02:26,880 --> 00:02:23,940
got this photograph from somebody

60
00:02:29,040 --> 00:02:26,890
there's a very clear feature in this

61
00:02:31,530 --> 00:02:29,050
picture of course this is an artist's

62
00:02:34,290 --> 00:02:31,540
rendition of the early Archaean on the

63
00:02:37,320 --> 00:02:34,300

earth but as you can see there's some

64
00:02:39,780 --> 00:02:37,330
features right here and these look

65
00:02:41,699 --> 00:02:39,790
disturbingly like current features that

66
00:02:44,340 --> 00:02:41,709
you find off the coast in Australia and

67
00:02:46,770 --> 00:02:44,350
sharks bay those are stromatolite so a

68
00:02:56,930 --> 00:02:46,780
stromatolite is actually a fancy a

69
00:03:04,940 --> 00:03:01,810
I thought I have me do disco in a minute

70
00:03:07,760 --> 00:03:04,950
all right so these are stromatolite and

71
00:03:12,350 --> 00:03:07,770
that's a very specific name for a kind

72
00:03:15,020 --> 00:03:12,360
of feature that microbes make and the

73
00:03:18,500 --> 00:03:15,030
general term for that is a microbial

74
00:03:21,560 --> 00:03:18,510
aight so basically I'm going to be using

75
00:03:23,240 --> 00:03:21,570
the word microbial I but most geologists

76
00:03:25,040 --> 00:03:23,250
and most people that are familiar with

77
00:03:27,230 --> 00:03:25,050
these think about stromatolites and the

78
00:03:29,060 --> 00:03:27,240
difference between what the microbial

79
00:03:32,030 --> 00:03:29,070
aight is the general term the

80
00:03:34,310 --> 00:03:32,040
stromatolite is a specific description

81
00:03:38,180 --> 00:03:34,320
of a kind of microbial aight that has

82
00:03:40,310 --> 00:03:38,190
layers to it ok so turns out it's I

83
00:03:43,960 --> 00:03:40,320
don't know why but it affects your to

84
00:03:46,790 --> 00:03:43,970
say stromatolite than microbial aight so

85
00:03:48,860 --> 00:03:46,800
everybody calls them stromatolites but

86
00:03:50,270 --> 00:03:48,870
the general term is microbial aight

87
00:03:53,450 --> 00:03:50,280
that's the one I'm going to be using for

88
00:03:55,130 --> 00:03:53,460

the most of this talk so here that was

89
00:03:57,080 --> 00:03:55,140
what they look like three and a half

90
00:03:59,570 --> 00:03:57,090
billion years ago here's what they look

91
00:04:02,750 --> 00:03:59,580
like today these are in the Bahamas

92
00:04:05,270 --> 00:04:02,760
clearly these are at least if I'm going

93
00:04:09,140 --> 00:04:05,280
to have six foot tall these are at

94
00:04:11,600 --> 00:04:09,150
sharks Bay Australia and almost always

95
00:04:14,510 --> 00:04:11,610
if you find microbial lights or

96
00:04:16,460 --> 00:04:14,520
stromatolites in today's ecosystems it's

97
00:04:18,080 --> 00:04:16,470
because there's something extreme about

98
00:04:25,100 --> 00:04:18,090
that environment that's allowed them to

99
00:04:26,510 --> 00:04:25,110
actually grow alright so what we're

100
00:04:29,420 --> 00:04:26,520
going to talk about is how you actually

101
00:04:33,080 --> 00:04:29,430
form microbial eyes so the recipe for

102
00:04:36,430 --> 00:04:33,090
them is that it's really in essence just

103
00:04:38,630 --> 00:04:36,440
a symbol a simple chemical precipitation

104
00:04:40,030 --> 00:04:38,640
the chemicals in the water the

105
00:04:42,530 --> 00:04:40,040
carbonates in the water actually

106
00:04:46,220 --> 00:04:42,540
precipitating around the microbial

107
00:04:48,350 --> 00:04:46,230
community that's what's happening it's

108
00:04:50,060 --> 00:04:48,360
the same process that happens in Coral

109
00:04:52,760 --> 00:04:50,070
it's just a different organism that's

110
00:04:54,530 --> 00:04:52,770
actually doing it and it's always about

111
00:04:57,650 --> 00:04:54,540
the community there's something about

112
00:05:00,560 --> 00:04:57,660
the microbial community that's making

113
00:05:02,180 --> 00:05:00,570

that precipitation occurred we're going

114
00:05:05,390 --> 00:05:02,190
to talk a little bit about why sometimes

115
00:05:07,430 --> 00:05:05,400
you have microbial mats but sometimes

116
00:05:09,370 --> 00:05:07,440
you have actual microvia lights for some

117
00:05:12,160 --> 00:05:09,380
reason these things

118
00:05:13,390 --> 00:05:12,170
do not cause a precipitation but when

119
00:05:15,870 --> 00:05:13,400
you get a microbial like the

120
00:05:18,460 --> 00:05:15,880
precipitation has actually occurred and

121
00:05:20,170 --> 00:05:18,470
today in today's world just go I said

122
00:05:22,270 --> 00:05:20,180
earlier you must have some sort of

123
00:05:23,770 --> 00:05:22,280
extreme environment to allow that to

124
00:05:26,740 --> 00:05:23,780
happen now let me explain that a little

125
00:05:29,200 --> 00:05:26,750
bit more detail back in the early Earth

126
00:05:31,720 --> 00:05:29,210
when all you had was simple life

127
00:05:33,940 --> 00:05:31,730
microbial life you didn't have the

128
00:05:36,090 --> 00:05:33,950
natural set of predators that might eat

129
00:05:40,330 --> 00:05:36,100
the microbes that would allow them to be

130
00:05:42,010 --> 00:05:40,340
not robust and not allow the reactions

131
00:05:44,320 --> 00:05:42,020
to happen to cause the carbonates to

132
00:05:46,660 --> 00:05:44,330
fall out on top of them today we have

133
00:05:48,520 --> 00:05:46,670
predators that eat the microbes snails

134
00:05:51,010 --> 00:05:48,530
and fish in different things so unless

135
00:05:53,710 --> 00:05:51,020
you have some way of keeping those

136
00:05:55,150 --> 00:05:53,720
predators away from the microbial

137
00:05:57,310 --> 00:05:55,160
community that can make the litho

138
00:06:00,370 --> 00:05:57,320

fighing that you're not going to find

139
00:06:02,430 --> 00:06:00,380
them so anywhere you find microbial

140
00:06:04,960 --> 00:06:02,440
lights are stromatolites in today's

141
00:06:07,600 --> 00:06:04,970
ecosystems it's because you kept the

142
00:06:10,450 --> 00:06:07,610
Predators away somehow in the Sharks Bay

143
00:06:12,040 --> 00:06:10,460
Australia it's too salty for the fish to

144
00:06:16,360 --> 00:06:12,050
come in and actually eat so that's why

145
00:06:19,570 --> 00:06:16,370
you have them there okay Sharon I heard

146
00:06:21,100 --> 00:06:19,580
this before yeah there's grazing today

147
00:06:28,570 --> 00:06:21,110
but I mean there's a lot of grass in the

148
00:06:31,480 --> 00:06:28,580
world today fishin himself he's playing

149
00:06:32,830 --> 00:06:31,490
a lot okay that's already called

150
00:06:35,560 --> 00:06:32,840
agreements astellas you're saying the

151
00:06:38,350 --> 00:06:35,570
equilibrium for some reason is yes you

152
00:06:42,880 --> 00:06:38,360
don't have the extreme conditions right

153
00:06:44,350 --> 00:06:42,890
okay so as usual that is an excellent

154
00:06:46,060 --> 00:06:44,360
question I've never actually thought

155
00:06:47,710 --> 00:06:46,070
about it from that context I mean you

156
00:06:49,510 --> 00:06:47,720
make a good point what I'm fixing to

157
00:06:51,910 --> 00:06:49,520
show you about a place that actually has

158
00:06:54,400 --> 00:06:51,920
these stromatolites there is another

159
00:06:55,870 --> 00:06:54,410
reason why the environment is so extreme

160
00:06:58,030 --> 00:06:55,880
that you don't have the Predators

161
00:07:01,570 --> 00:06:58,040
actually working on it like they would

162
00:07:03,880 --> 00:07:01,580
be now just to compare it with grass I

163
00:07:08,860 --> 00:07:03,890

don't think is a fair is a fair

164
00:07:17,410 --> 00:07:13,540
the the micro the the actual bacteria

165
00:07:19,420 --> 00:07:17,420
that are producing these the the

166
00:07:21,730 --> 00:07:19,430
Predators can actually just keep them

167
00:07:23,440 --> 00:07:21,740
caught down grazed down enough so that

168
00:07:24,910 --> 00:07:23,450
they can't actually produce the

169
00:07:27,400 --> 00:07:24,920
chemistry that needs to cause the

170
00:07:29,170 --> 00:07:27,410
carbonates to pull out whereas you know

171
00:07:31,060 --> 00:07:29,180
if your grazing on grass I mean you can

172
00:07:32,710 --> 00:07:31,070
leave us feels fallow or whatever you

173
00:07:35,530 --> 00:07:32,720
want to let the grass grow up early it's

174
00:07:39,250 --> 00:07:35,540
a little bit different situation but the

175
00:07:42,660 --> 00:07:39,260
bottom line is the natural predators we

176
00:07:47,050 --> 00:07:42,670
had a microbial a dominated community

177
00:07:48,850 --> 00:07:47,060
prior to the rise of oxygen or prior to

178
00:07:51,370 --> 00:07:48,860
2.5 billion years that's in the rock

179
00:07:52,780 --> 00:07:51,380
record we have those and now today we

180
00:07:54,460 --> 00:07:52,790
don't have them except in extreme

181
00:07:57,460 --> 00:07:54,470
environments now I will admit to one

182
00:07:59,500 --> 00:07:57,470
thing I think we're going to find them

183
00:08:01,360 --> 00:07:59,510
in more places than you realize I don't

184
00:08:05,170 --> 00:08:01,370
think they're going to be quite as rare

185
00:08:07,060 --> 00:08:05,180
as we think they are that sort of gets

186
00:08:09,970 --> 00:08:07,070
at your question a little bit but it

187
00:08:11,890 --> 00:08:09,980
still has to say something about the

188
00:08:13,990 --> 00:08:11,900

ecosystem in the community there is

189
00:08:15,310 --> 00:08:14,000
still some reason why they're not just

190
00:08:19,840 --> 00:08:15,320
all over the place like they were

191
00:08:21,900 --> 00:08:19,850
packing what what we think now I don't I

192
00:08:24,750 --> 00:08:21,910
really like it when you ask me questions

193
00:08:27,580 --> 00:08:24,760
that way I know you're not asleep

194
00:08:30,520 --> 00:08:27,590
alright so what I've tried to tell you

195
00:08:32,170 --> 00:08:30,530
is that given this early time at Earth

196
00:08:34,510 --> 00:08:32,180
we don't have all these predators and

197
00:08:37,900 --> 00:08:34,520
you've got microbes dominating why is it

198
00:08:40,030 --> 00:08:37,910
that sometimes you have a mat that

199
00:08:41,800 --> 00:08:40,040
doesn't cause any kind of precipitation

200
00:08:44,110 --> 00:08:41,810
in the chemistry of the water to

201
00:08:46,210 --> 00:08:44,120
precipitate around it and sometimes you

202
00:08:48,820 --> 00:08:46,220
do well there was some great work done

203
00:08:50,440 --> 00:08:48,830
by du pres and Fisher depresses actually

204
00:08:53,200 --> 00:08:50,450
put some excellent papers out on this

205
00:08:54,970 --> 00:08:53,210
and what they did you don't have to

206
00:08:56,590 --> 00:08:54,980
understand too much about this graph I

207
00:08:58,420 --> 00:08:56,600
realized it's pretty busy this table

208
00:09:01,890 --> 00:08:58,430
that came out of their paper basically

209
00:09:04,630 --> 00:09:01,900
what they're showing you is that

210
00:09:07,540 --> 00:09:04,640
sometimes matt solidify these are two

211
00:09:10,440 --> 00:09:07,550
examples that do and sometimes they

212
00:09:13,420 --> 00:09:10,450
don't let the vacation doesn't occur if

213
00:09:15,340 --> 00:09:13,430

lithification occurs you're going to be

214
00:09:18,490 --> 00:09:15,350
able to find that in the rock record at

215
00:09:20,060 --> 00:09:18,500
some time if it doesn't happen you won't

216
00:09:22,850 --> 00:09:20,070
you know there'll be no evidence or just

217
00:09:25,850 --> 00:09:22,860
the soft bodies of the organisms will

218
00:09:28,190 --> 00:09:25,860
not be captured so what causes this to

219
00:09:31,510 --> 00:09:28,200
happen well they discovered that there's

220
00:09:34,310 --> 00:09:31,520
sort of two processes that are at work

221
00:09:38,180 --> 00:09:34,320
sometimes you have a metabolism

222
00:09:40,220 --> 00:09:38,190
controlled environment that's causing

223
00:09:42,260 --> 00:09:40,230
the carbonates in the water to fall out

224
00:09:45,470 --> 00:09:42,270
on it and basically what's happening is

225
00:09:47,600 --> 00:09:45,480
the metabolism around the colony is just

226
00:09:51,170 --> 00:09:47,610
changing the pH enough so that the

227
00:09:53,720 --> 00:09:51,180
carbonates fall out around it or you may

228
00:09:57,610 --> 00:09:53,730
have the situation where the community

229
00:10:00,200 --> 00:09:57,620
is in such an environment that this

230
00:10:01,790 --> 00:10:00,210
you've probably been around bacteria in

231
00:10:04,340 --> 00:10:01,800
ponds or something you've seen it and

232
00:10:06,170 --> 00:10:04,350
it's kind of slimy and gooey well

233
00:10:07,850 --> 00:10:06,180
there's an extra polymeric substance

234
00:10:09,800 --> 00:10:07,860
that some bacteria put out it's kind of

235
00:10:12,920 --> 00:10:09,810
like a net that keeps everything sort of

236
00:10:16,250 --> 00:10:12,930
together and in a mat system that's EPS

237
00:10:18,680 --> 00:10:16,260
so extra polymeric substance if the if

238
00:10:21,740 --> 00:10:18,690

the community is creating that kind of

239
00:10:23,750 --> 00:10:21,750
substance around it and it's in a place

240
00:10:26,720 --> 00:10:23,760
where there's actually kind of a washing

241
00:10:28,820 --> 00:10:26,730
end of detras then that detras can be

242
00:10:30,500 --> 00:10:28,830
trapped in that in the extra polymeric

243
00:10:33,560 --> 00:10:30,510
substance and that can create us from

244
00:10:35,720 --> 00:10:33,570
everyone for a microbial so this paper

245
00:10:37,760 --> 00:10:35,730
is just basically showing you that if

246
00:10:39,830 --> 00:10:37,770
you have either one of these situations

247
00:10:41,900 --> 00:10:39,840
or some combination of these situations

248
00:10:44,420 --> 00:10:41,910
occurring you're likely to get a little

249
00:10:46,790 --> 00:10:44,430
vacation process whereas if you don't

250
00:10:49,220 --> 00:10:46,800
have these two situations happening

251
00:10:53,720 --> 00:10:49,230
you're you won't have Alyssa fication

252
00:10:56,840 --> 00:10:53,730
okay any questions on that all right so

253
00:10:59,590 --> 00:10:56,850
now to some real life microbial lights

254
00:11:04,390 --> 00:10:59,600
in a really interesting and cool place

255
00:11:07,520 --> 00:11:04,400
this is Texas which is where I'm from

256
00:11:08,990 --> 00:11:07,530
this is Mexico and this is the

257
00:11:11,810 --> 00:11:09,000
chihuahuan desert one of the great

258
00:11:13,220 --> 00:11:11,820
southwestern deserts it's right in the

259
00:11:15,380 --> 00:11:13,230
middle of this right in the middle of

260
00:11:18,700 --> 00:11:15,390
the desert is an oasis now let me show

261
00:11:22,190 --> 00:11:18,710
you some pictures Vicki's been down here

262
00:11:24,770 --> 00:11:22,200
this is a valley that's up pretty high

263
00:11:28,700 --> 00:11:24,780

in the mountains completely surrounded

264
00:11:32,060 --> 00:11:28,710
by mountains and there's

265
00:11:34,730 --> 00:11:32,070
pools that are from subterranean vault

266
00:11:36,650 --> 00:11:34,740
system that actually are coming to the

267
00:11:38,810 --> 00:11:36,660
surface there's over about 200 of them

268
00:11:41,210 --> 00:11:38,820
and then you see in this picture the

269
00:11:43,070 --> 00:11:41,220
next picture they actually look like

270
00:11:44,750 --> 00:11:43,080
little pieces of the Caribbean just drop

271
00:11:46,700 --> 00:11:44,760
down into the middle of the desert it's

272
00:11:48,460 --> 00:11:46,710
over 200 of them you can actually see

273
00:11:51,500 --> 00:11:48,470
the fault line running down this one

274
00:11:55,700 --> 00:11:51,510
this one is just about like nice warm

275
00:11:57,470 --> 00:11:55,710
bath water it's that warm this is an

276
00:12:01,100 --> 00:11:57,480
aerial view of some of the ones in the

277
00:12:05,630 --> 00:12:01,110
valley they're called poses and this

278
00:12:12,380 --> 00:12:05,640
right around the rim here is a microbial

279
00:12:14,540 --> 00:12:12,390
on that white room though these mats for

280
00:12:16,010 --> 00:12:14,550
probably thousands of years have

281
00:12:18,800 --> 00:12:16,020
actually been listening in this

282
00:12:21,410 --> 00:12:18,810
particular place now a little bit about

283
00:12:24,320 --> 00:12:21,420
this place it's the area's 1200 square

284
00:12:26,930 --> 00:12:24,330
kilometers the rainfall is less than 150

285
00:12:31,700 --> 00:12:26,940
millimeters per year pretty dry and it's

286
00:12:34,610 --> 00:12:31,710
740 meters above sea level the other

287
00:12:37,280 --> 00:12:34,620
thing that's interesting is there are

288
00:12:39,200 --> 00:12:37,290

dunes there that are that are part of

289
00:12:41,690 --> 00:12:39,210
the part of one of the river systems

290
00:12:44,030 --> 00:12:41,700
that runs along the surface of the

291
00:12:45,950 --> 00:12:44,040
desert floor and I don't know if you

292
00:12:48,140 --> 00:12:45,960
could even hazard a guess what this is

293
00:12:50,960 --> 00:12:48,150
does this look just like sand like sand

294
00:12:53,720 --> 00:12:50,970
dunes to you this is almost ninety seven

295
00:12:56,090 --> 00:12:53,730
percent gypsum actually mind this for

296
00:12:59,360 --> 00:12:56,100
drywall for a long time so this is

297
00:13:01,190 --> 00:12:59,370
carbonates of sulfur carbonates so

298
00:13:02,510 --> 00:13:01,200
there's some special things that are

299
00:13:04,700 --> 00:13:02,520
going on in this valley that I'm trying

300
00:13:06,800 --> 00:13:04,710
to get you to understand one thing is

301
00:13:10,790 --> 00:13:06,810
it's pretty high up so the water sources

302
00:13:12,920 --> 00:13:10,800
are not coming from anywhere up other

303
00:13:15,230 --> 00:13:12,930
than just the subterranean fault system

304
00:13:17,990 --> 00:13:15,240
that you have it's rained completely by

305
00:13:19,880 --> 00:13:18,000
mountains so it's very isolated there's

306
00:13:21,410 --> 00:13:19,890
a sulfur system there's a sulfur cycle

307
00:13:24,590 --> 00:13:21,420
of some kind because you have all of

308
00:13:26,990 --> 00:13:24,600
this gypsum obviously on in the

309
00:13:31,520 --> 00:13:27,000
topography and there's almost no

310
00:13:33,200 --> 00:13:31,530
rainfall ok so the Quattro cienega is

311
00:13:36,500 --> 00:13:33,210
the name of this place it's actually

312
00:13:39,680 --> 00:13:36,510
translates into the for marshes and it's

313
00:13:41,960 --> 00:13:39,690

been proposed as an ancient ocean the

314
00:13:44,270 --> 00:13:41,970
remnant of a nation ocean part of the

315
00:13:47,240 --> 00:13:44,280
protocol 100 million years ago so when

316
00:13:50,120 --> 00:13:47,250
Pangaea was splitting up and the Gulf of

317
00:13:52,160 --> 00:13:50,130
Mexico was being made actually this

318
00:13:54,410 --> 00:13:52,170
particular area right down the gulf of

319
00:13:56,960 --> 00:13:54,420
mex right down the middle of Mexico was

320
00:13:59,060 --> 00:13:56,970
actually part of the proto Gulf and this

321
00:14:01,910 --> 00:13:59,070
was done in a paper with my collaborator

322
00:14:04,760 --> 00:14:01,920
Valerius all set um and it was in pnas

323
00:14:08,240 --> 00:14:04,770
and the thing that's remarkable and

324
00:14:09,730 --> 00:14:08,250
although I have my reservations about it

325
00:14:13,010 --> 00:14:09,740
i'm going to show you some information

326
00:14:15,830 --> 00:14:13,020
that's going to make it appear that not

327
00:14:17,540 --> 00:14:15,840
only can you say this geologically but

328
00:14:21,080 --> 00:14:17,550
it looks like biologically there's

329
00:14:22,640 --> 00:14:21,090
remnants of this marine ecosystem that

330
00:14:24,350 --> 00:14:22,650
have come up in the waters that are

331
00:14:26,360 --> 00:14:24,360
coming down from the ancient from

332
00:14:28,430 --> 00:14:26,370
underneath the other thing that's

333
00:14:31,430 --> 00:14:28,440
extraordinary about this place is it

334
00:14:32,780 --> 00:14:31,440
slow and phosphorus now that's going to

335
00:14:35,120 --> 00:14:32,790
I want you to think about that for a

336
00:14:36,890 --> 00:14:35,130
minute the total phosphorus ranges

337
00:14:39,410 --> 00:14:36,900
between point 05 and point for

338
00:14:42,380 --> 00:14:39,420

micromolar with most of the poses in the

339
00:14:45,950 --> 00:14:42,390
point 1 2.3 micromolar range now what do

340
00:14:48,050 --> 00:14:45,960
you know about phosphorus you ever think

341
00:14:49,670 --> 00:14:48,060
about limiting elements we've talked

342
00:14:52,100 --> 00:14:49,680
about probably you've heard about

343
00:14:53,870 --> 00:14:52,110
nitrogen being limiting I mean you know

344
00:14:56,510 --> 00:14:53,880
you have to have fixed nitrogen the

345
00:14:59,180 --> 00:14:56,520
planet the planets biology has to have

346
00:15:00,590 --> 00:14:59,190
its nitrogen so if you don't have fixed

347
00:15:02,470 --> 00:15:00,600
nitrogen can be limiting that's why you

348
00:15:05,030 --> 00:15:02,480
have to put fertilizer on your gardens

349
00:15:06,830 --> 00:15:05,040
but what about phosphorus what happens

350
00:15:08,590 --> 00:15:06,840
if you're low in phosphorus and this is

351
00:15:12,050 --> 00:15:08,600
actually this is very very low

352
00:15:13,880 --> 00:15:12,060
especially for any other terrains that

353
00:15:16,700 --> 00:15:13,890
are similar to this what do you know

354
00:15:23,120 --> 00:15:16,710
about phosphorus what's phosphorus used

355
00:15:31,850 --> 00:15:28,070
DNA DNA RNA it's also the ATP ATP is the

356
00:15:36,170 --> 00:15:31,860
currency pretty important element as far

357
00:15:38,240 --> 00:15:36,180
as biology is concerned so Arizona State

358
00:15:39,710 --> 00:15:38,250
let me let me tell you this this is one

359
00:15:46,780 --> 00:15:39,720
other thing that's that's especially

360
00:15:53,630 --> 00:15:50,210
Galapagos a have discovered is that the

361
00:15:55,640 --> 00:15:53,640
diversity of endemic species so species

362
00:15:58,340 --> 00:15:55,650
that are not found anywhere else on the

363
00:16:01,760 --> 00:15:58,350

planet just here they've already

364
00:16:03,920 --> 00:16:01,770
described about 70 of them and that's

365
00:16:07,220 --> 00:16:03,930
equal in diversity to the Galapagos

366
00:16:10,130 --> 00:16:07,230
Islands so basically what you have here

367
00:16:12,410 --> 00:16:10,140
is where the Galapagos is actually

368
00:16:15,080 --> 00:16:12,420
isolated because of being surrounded by

369
00:16:16,760 --> 00:16:15,090
water and life has been able to evolve

370
00:16:18,920 --> 00:16:16,770
and adapt their independently of

371
00:16:22,100 --> 00:16:18,930
anything else you have a similar

372
00:16:23,930 --> 00:16:22,110
situation here where the actually the

373
00:16:25,910 --> 00:16:23,940
isolation is because of that big

374
00:16:28,460 --> 00:16:25,920
mountain range that circles the valley

375
00:16:30,950 --> 00:16:28,470
and it's proven in this fact that we

376
00:16:34,400 --> 00:16:30,960
have over 70 speak endemic species there

377
00:16:38,600 --> 00:16:34,410
ranging from reptiles fishes scorpions

378
00:16:44,110 --> 00:16:41,690
so why do you have and the pools at

379
00:16:47,990 --> 00:16:44,120
quadrille cienega stromatolites

380
00:16:50,750 --> 00:16:48,000
dominating this is it again example

381
00:16:52,970 --> 00:16:50,760
again of the the Australian sharks bay

382
00:16:55,250 --> 00:16:52,980
ones this is a little bit what they look

383
00:16:59,240 --> 00:16:55,260
like when you look in the fossil record

384
00:17:02,230 --> 00:16:59,250
in the Pilbara Pilbara she got on too

385
00:17:07,970 --> 00:17:02,240
many other day because I said pale Barra

386
00:17:09,949 --> 00:17:07,980
pilbara region and so this is what some

387
00:17:13,880 --> 00:17:09,959
of the different morphological types

388
00:17:15,890 --> 00:17:13,890

look like at Quattro cienega so this is

389
00:17:18,770 --> 00:17:15,900
the aerial photo that you saw I call

390
00:17:20,569 --> 00:17:18,780
this a shelf stromatolite but I mean you

391
00:17:22,460 --> 00:17:20,579
can tell how I mean it's to me it's

392
00:17:25,549 --> 00:17:22,470
elegant this is made entirely by

393
00:17:27,650 --> 00:17:25,559
microbes basically with a fine pulling

394
00:17:30,710 --> 00:17:27,660
the carbon the carbonates out of the

395
00:17:33,169 --> 00:17:30,720
water and encasing themselves in this is

396
00:17:37,039 --> 00:17:33,179
another type this is just sort of like a

397
00:17:39,650 --> 00:17:37,049
this is a pool that has a spring at the

398
00:17:42,470 --> 00:17:39,660
bottom about 40 foot so it's very quiet

399
00:17:44,299 --> 00:17:42,480
and tranquil not much going on these you

400
00:17:46,909 --> 00:17:44,309
actually find in a river that flows

401
00:17:49,789 --> 00:17:46,919
across in one area of the valley and

402
00:17:52,130 --> 00:17:49,799
these are like being from Texas I call

403
00:17:54,080 --> 00:17:52,140
these kind of like microbial a tumble

404
00:17:56,270 --> 00:17:54,090
weeds because they actually find

405
00:17:59,810 --> 00:17:56,280
something to nuclear nucleate around in

406
00:18:02,030 --> 00:17:59,820
the microbial community nucleates around

407
00:18:03,980 --> 00:18:02,040
that and then just grows yearling and it

408
00:18:07,220 --> 00:18:03,990
can roll around on the bottom of the

409
00:18:08,720 --> 00:18:07,230
river floor this is us actually trying

410
00:18:12,140 --> 00:18:08,730
to take a sample from one of the more

411
00:18:13,310 --> 00:18:12,150
Domo stromatolites and then I just put

412
00:18:14,990 --> 00:18:13,320
this in your you're going to see this

413
00:18:16,520 --> 00:18:15,000

again I just think this is too cool

414
00:18:19,070 --> 00:18:16,530
because I'm going to talk about what

415
00:18:21,289 --> 00:18:19,080
this community is made up of which one

416
00:18:24,049 --> 00:18:21,299
of the things that it's primarily made

417
00:18:25,820 --> 00:18:24,059
up of as cyanobacteria and if you know

418
00:18:27,049 --> 00:18:25,830
anything about cyanobacteria you know

419
00:18:30,590 --> 00:18:27,059
that they're the only things on the

420
00:18:33,110 --> 00:18:30,600
planet that make oxygen the only thing

421
00:18:34,940 --> 00:18:33,120
on the planet that makes oxygen the

422
00:18:38,240 --> 00:18:34,950
reason plants make it is because they

423
00:18:40,909 --> 00:18:38,250
actually co-opted the ability from

424
00:18:42,880 --> 00:18:40,919
cyanobacteria and this is a mat you can

425
00:18:45,560 --> 00:18:42,890
clearly seen the green cyanobacteria

426
00:18:47,990 --> 00:18:45,570
this isn't Quattro cinakisz when we were

427
00:18:49,970 --> 00:18:48,000
swimming underwater and these are oxygen

428
00:18:57,770 --> 00:18:49,980
vocals for the oxygens actually being

429
00:18:59,660 --> 00:18:57,780
produced right sort of crusty if you

430
00:19:05,380 --> 00:18:59,670
feel it and it was the nature okay so

431
00:19:10,400 --> 00:19:08,720
if you took your foot and you punched it

432
00:19:12,290 --> 00:19:10,410
like this it would just fall apart even

433
00:19:14,570 --> 00:19:12,300
disintegrate underneath you if you stuck

434
00:19:15,860 --> 00:19:14,580
this into it you could probably stick it

435
00:19:19,610 --> 00:19:15,870
in and it would kind of crumble around

436
00:19:21,440 --> 00:19:19,620
it but if you touch it it feels hard and

437
00:19:23,150 --> 00:19:21,450
and the thing that's a little bit

438
00:19:24,650 --> 00:19:23,160

confusing to me everybody that I've

439
00:19:26,960 --> 00:19:24,660
talked about that looks at sort of

440
00:19:30,050 --> 00:19:26,970
current stromatolites even the one in

441
00:19:31,910 --> 00:19:30,060
the Bahamas and sharks bay they all kind

442
00:19:33,650 --> 00:19:31,920
of have this structure I don't know if

443
00:19:35,660 --> 00:19:33,660
you can see this this doesn't look like

444
00:19:37,400 --> 00:19:35,670
when you look in the geologic record at

445
00:19:39,560 --> 00:19:37,410
peak pet stromatolites that people calls

446
00:19:42,670 --> 00:19:39,570
from as they're very very distinctive

447
00:19:46,250 --> 00:19:42,680
layers this kind of reminds me of like

448
00:19:49,580 --> 00:19:46,260
tiny broccoli florets that's kind of

449
00:19:52,370 --> 00:19:49,590
what it looks like ever you section it

450
00:19:53,840 --> 00:19:52,380
this is a section this actually looks

451
00:19:56,780 --> 00:19:53,850
like that and if you took a piece of

452
00:19:59,590 --> 00:19:56,790
this it would look similar to though

453
00:20:04,280 --> 00:19:59,600
it's crusty a little harder than Krusty

454
00:20:06,590 --> 00:20:04,290
but definitely pretty fragile and this

455
00:20:08,300 --> 00:20:06,600
is the ones that are alive if they're

456
00:20:09,980 --> 00:20:08,310
alive they're like that there's actually

457
00:20:13,730 --> 00:20:09,990
a pool down there that has some dead

458
00:20:16,700 --> 00:20:13,740
ones and their heart is wrong and I know

459
00:20:19,460 --> 00:20:16,710
they're dead because there's nothing I

460
00:20:23,210 --> 00:20:19,470
mean there's there's you don't see any

461
00:20:25,640 --> 00:20:23,220
kind of if you if you open them and do

462
00:20:27,170 --> 00:20:25,650
any kind of microscope work you don't

463
00:20:29,840 --> 00:20:27,180

see anything in there I mean they're

464
00:20:30,480 --> 00:20:29,850
clearly they turn into rock just so even

465
00:20:35,640 --> 00:20:30,490
close

466
00:20:37,169 --> 00:20:35,650
oh yeah so the story is you get the

467
00:20:40,410 --> 00:20:37,179
strata because you have some sort of

468
00:20:42,240 --> 00:20:40,420
seasonal input right but so far all

469
00:20:43,799 --> 00:20:42,250
there's a little bit of there's a little

470
00:20:45,810 --> 00:20:43,809
bit of strata if you looked real real

471
00:20:48,240 --> 00:20:45,820
close you would see a little bit of

472
00:20:49,860 --> 00:20:48,250
layering up here you would see a little

473
00:20:52,919 --> 00:20:49,870
bit but nothing like what you see in the

474
00:20:54,630 --> 00:20:52,929
geologic record I mean this you have to

475
00:20:57,350 --> 00:20:54,640
I mean you'd really need a rock lands to

476
00:20:59,580 --> 00:20:57,360
look at this close I don't think the

477
00:21:01,320 --> 00:20:59,590
geologic record the stromatolites in the

478
00:21:04,650 --> 00:21:01,330
geologic record there you don't need any

479
00:21:06,330 --> 00:21:04,660
kind of any kind of magnifying aid to

480
00:21:08,970 --> 00:21:06,340
see them so I'm a little confused about

481
00:21:11,070 --> 00:21:08,980
that and I actually talked to Abigail

482
00:21:12,720 --> 00:21:11,080
all wood and she's seen that the

483
00:21:16,470 --> 00:21:12,730
stromatolite sand sharks base she's the

484
00:21:20,640 --> 00:21:16,480
one that did the paper on the Pilbara

485
00:21:22,290 --> 00:21:20,650
region the geologic that the most recent

486
00:21:24,299 --> 00:21:22,300
paper on the stromatolites and

487
00:21:26,910 --> 00:21:24,309
stromatolite in the Pilbara region and

488
00:21:29,910 --> 00:21:26,920

she says that the Sharks palin's are

489
00:21:33,210 --> 00:21:29,920
like this too and there's that's a

490
00:21:35,580 --> 00:21:33,220
completely different ocean dynamics

491
00:21:38,130 --> 00:21:35,590
there than it is here but it's basically

492
00:21:40,680 --> 00:21:38,140
the same I'm confused by that I don't

493
00:21:43,890 --> 00:21:40,690
know what to think about that everybody

494
00:21:46,380 --> 00:21:43,900
have any thoughts are we I said another

495
00:21:50,880 --> 00:21:46,390
question how's your this same thing how

496
00:21:54,630 --> 00:21:50,890
big are they and the microbes just at

497
00:21:57,150 --> 00:21:54,640
the so there it's not it's not like it's

498
00:21:58,980 --> 00:21:57,160
not like just a layer I actually have

499
00:22:02,490 --> 00:21:58,990
one at home in my aquarium it's not just

500
00:22:05,610 --> 00:22:02,500
like a solid layer it's like think about

501
00:22:07,020 --> 00:22:05,620
taking a piece of broccoli and sticking

502
00:22:08,700 --> 00:22:07,030
it out there and put in carbonate all

503
00:22:10,320 --> 00:22:08,710
around it that's kind of what it looks

504
00:22:11,850 --> 00:22:10,330
like to me I mean if you look down deep

505
00:22:15,440 --> 00:22:11,860
into it you can see that there's little

506
00:22:20,190 --> 00:22:15,450
green cyanobacteria down in there too

507
00:22:22,020 --> 00:22:20,200
yeah yeah and there's actually there's

508
00:22:23,700 --> 00:22:22,030
there's little snails all around that

509
00:22:25,980 --> 00:22:23,710
there's there's four or five snails that

510
00:22:27,960 --> 00:22:25,990
are eating on every little on every one

511
00:22:32,530 --> 00:22:27,970
of those like they call those brown ones

512
00:22:34,210 --> 00:22:32,540
on collides call this one alkaloids

513
00:22:35,800 --> 00:22:34,220

and if you look real close you'll see a

514
00:22:36,910 --> 00:22:35,810
little snail here a little snail here

515
00:22:41,830 --> 00:22:36,920
and there's always a worm in there

516
00:22:44,500 --> 00:22:41,840
somewhere too I don't know how well you

517
00:22:45,940 --> 00:22:44,510
can see this but I don't really want you

518
00:22:47,710 --> 00:22:45,950
to take anything home from this this is

519
00:22:49,810 --> 00:22:47,720
Abigail's this is a figure out of

520
00:22:51,640 --> 00:22:49,820
abigails paper and this is where she

521
00:22:53,380 --> 00:22:51,650
basically went to the Pilbara region and

522
00:22:56,590 --> 00:22:53,390
she categorized all the different

523
00:23:00,280 --> 00:22:56,600
morphologies of the stromatolites there

524
00:23:02,020 --> 00:23:00,290
and I remember one time when I was down

525
00:23:03,520 --> 00:23:02,030
at Quattro cienega looking at all the

526
00:23:05,020 --> 00:23:03,530
morphotypes I just showed you in

527
00:23:06,520 --> 00:23:05,030
thinking what would this look like if

528
00:23:09,190 --> 00:23:06,530
you preserve this in the rock record

529
00:23:11,500 --> 00:23:09,200
we'll see she's got she's got basically

530
00:23:13,390 --> 00:23:11,510
sort of very similar morphotypes that

531
00:23:15,880 --> 00:23:13,400
she's cataloged here as we see down

532
00:23:18,250 --> 00:23:15,890
there the Anka lights the big shelf ones

533
00:23:19,900 --> 00:23:18,260
the doma ones I mean even in that small

534
00:23:22,330 --> 00:23:19,910
Valley we've got several different

535
00:23:26,120 --> 00:23:22,340
morphotypes of stromatolites down there

536
00:23:32,880 --> 00:23:31,049
actually these are the three particular

537
00:23:35,250 --> 00:23:32,890
places in the valley i'm going to talk

538
00:23:37,560 --> 00:23:35,260

about this is the valley shaped kind of

539
00:23:40,049 --> 00:23:37,570
like I love my Mexican collaborators

540
00:23:42,090 --> 00:23:40,059
they're very eloquent in their and their

541
00:23:44,610 --> 00:23:42,100
language and they say that the valley is

542
00:23:46,139 --> 00:23:44,620
shaped like a butterfly which it sort of

543
00:23:47,850 --> 00:23:46,149
is and I'm going to talk about three

544
00:23:50,870 --> 00:23:47,860
places I'm going to talk about the

545
00:23:54,060 --> 00:23:50,880
chirren say system which is basically

546
00:23:56,850 --> 00:23:54,070
starts out as a spring manders across

547
00:23:58,799 --> 00:23:56,860
the desert valley empties into a lagoon

548
00:24:01,590 --> 00:23:58,809
and there's an evaporative process that

549
00:24:03,720 --> 00:24:01,600
goes on then meanders across the valley

550
00:24:05,549 --> 00:24:03,730
again it ends up in a big evaporative

551
00:24:07,620 --> 00:24:05,559
looking and that's where those gypsum

552
00:24:10,259 --> 00:24:07,630
dunes are forming I'm going to talk

553
00:24:12,600 --> 00:24:10,269
about the real mosquitoes which is where

554
00:24:14,519 --> 00:24:12,610
it's just an above-ground kind of

555
00:24:17,340 --> 00:24:14,529
fast-moving River and that's where those

556
00:24:19,200 --> 00:24:17,350
round tumbleweed anka lights were and

557
00:24:21,750 --> 00:24:19,210
then I'm going to talk about the poses

558
00:24:28,289 --> 00:24:21,760
azula's which is where those big shelf

559
00:24:30,330 --> 00:24:28,299
storm at once were okay so what what's I

560
00:24:33,409 --> 00:24:30,340
hope you think it's pretty neat place

561
00:24:36,690 --> 00:24:33,419
already but why is it so special well

562
00:24:38,759 --> 00:24:36,700
the theory is that because of that low

563
00:24:40,230 --> 00:24:38,769

phosphorous content remember I told you

564
00:24:43,320 --> 00:24:40,240
there were snails on those stromatolite

565
00:24:45,060 --> 00:24:43,330
those microbial eyes supposedly because

566
00:24:48,960 --> 00:24:45,070
there's low phosphorus there this was a

567
00:24:50,810 --> 00:24:48,970
paper done by Jack farmer and foreign

568
00:24:55,769 --> 00:24:50,820
Garcia pin shell out of Arizona State

569
00:25:00,240 --> 00:24:55,779
they basically measured snail poop and

570
00:25:03,000 --> 00:25:00,250
growth of the stromatolites and measured

571
00:25:05,970 --> 00:25:03,010
the amount of cyanobacteria and they

572
00:25:07,529 --> 00:25:05,980
determined that the the sino bacteria

573
00:25:11,220 --> 00:25:07,539
were growing just a little faster than

574
00:25:13,110 --> 00:25:11,230
the snails could eat and that's why the

575
00:25:15,299 --> 00:25:13,120
paper actually says that that's why

576
00:25:17,879 --> 00:25:15,309
they're stromatolite dominating this

577
00:25:19,379 --> 00:25:17,889
area and that's probably they're sepa

578
00:25:23,240 --> 00:25:19,389
zishan is because of the phosphorus

579
00:25:25,350 --> 00:25:23,250
content so low even though you have

580
00:25:27,509 --> 00:25:25,360
complex organisms they're predators

581
00:25:29,759 --> 00:25:27,519
they're just not robust enough to keep

582
00:25:32,269 --> 00:25:29,769
up with it and so that's a that's always

583
00:25:37,190 --> 00:25:32,279
been considered in astrobiological

584
00:25:40,370 --> 00:25:37,200
context as a proxy of early Earth right

585
00:25:42,680 --> 00:25:40,380
the transition from prokaryotic to when

586
00:25:45,769 --> 00:25:42,690
you begin to have eukaryotes being

587
00:25:50,539 --> 00:25:45,779
dominant over prokaryotes the low p is

588
00:25:52,340 --> 00:25:50,549

the limiting nutrient it's interesting

589
00:25:55,940 --> 00:25:52,350
because I told you about the Marine

590
00:25:57,620 --> 00:25:55,950
origin issue and it has active

591
00:26:02,240 --> 00:25:57,630
liquefying mat so that's the reason why

592
00:26:03,680 --> 00:26:02,250
we study at cuatros okay so now i'm

593
00:26:06,230 --> 00:26:03,690
going to get into a little bit of the

594
00:26:08,870 --> 00:26:06,240
actual work that we're doing down there

595
00:26:12,500 --> 00:26:08,880
and we actually went down there for a

596
00:26:15,039 --> 00:26:12,510
specific reason and the reason was we

597
00:26:18,700 --> 00:26:15,049
wanted to understand how genomes

598
00:26:21,110 --> 00:26:18,710
prokaryotic genomes actually coalesced

599
00:26:22,940 --> 00:26:21,120
because at the heart of understanding

600
00:26:24,980 --> 00:26:22,950
how the origin of life or how life is

601
00:26:26,720 --> 00:26:24,990
adapting its you have to understand how

602
00:26:29,269 --> 00:26:26,730
the genomic comes about or how it

603
00:26:31,549 --> 00:26:29,279
continues to that and the thing that's

604
00:26:34,519 --> 00:26:31,559
interesting about that place being

605
00:26:37,250 --> 00:26:34,529
dominated by prokaryotes basically

606
00:26:39,529 --> 00:26:37,260
prokaryotes don't get to have sex their

607
00:26:40,990 --> 00:26:39,539
way of actually creating diversification

608
00:26:43,970 --> 00:26:41,000
is through horizontal gene transfer

609
00:26:50,029 --> 00:26:43,980
that's their major tool for prokaryotes

610
00:26:52,519 --> 00:26:50,039
for genomic dynamics all right so I'm

611
00:26:53,899 --> 00:26:52,529
not going to go over this too much but I

612
00:26:58,879 --> 00:26:53,909
know you've also how many of you have

613
00:27:00,620 --> 00:26:58,889

never seen this tree clearly what this

614
00:27:04,730 --> 00:27:00,630
is trying to what I'm trying to use but

615
00:27:07,340 --> 00:27:04,740
this is a visual a4 is there was a time

616
00:27:09,289 --> 00:27:07,350
when I first started working Vicki

617
00:27:10,909 --> 00:27:09,299
mentioned that I worked with I got my

618
00:27:13,820 --> 00:27:10,919
degree with George Fox who was one of

619
00:27:15,049 --> 00:27:13,830
the co-discoverer of archaea they did it

620
00:27:17,090 --> 00:27:15,059
because they didn't believe there was

621
00:27:18,919 --> 00:27:17,100
any gene transfer going on that you

622
00:27:21,740 --> 00:27:18,929
could actually take a molecule from

623
00:27:23,539 --> 00:27:21,750
today's life and you could trace it back

624
00:27:27,200 --> 00:27:23,549
and figure out what the relationship

625
00:27:29,000 --> 00:27:27,210
wasn't he was here so about 15 years ago

626
00:27:30,590 --> 00:27:29,010
when there was so much sequencing going

627
00:27:32,810 --> 00:27:30,600
on people began to realize that there

628
00:27:35,659 --> 00:27:32,820
was a lot of Rosie horizontal gene

629
00:27:37,039 --> 00:27:35,669
transfer form and scared everybody well

630
00:27:39,470 --> 00:27:37,049
you know if there's this much going on

631
00:27:41,240 --> 00:27:39,480
how could we ever understand anything

632
00:27:44,029 --> 00:27:41,250
about how things are related in the

633
00:27:46,759 --> 00:27:44,039
prokaryotic world and this is for

634
00:27:50,090 --> 00:27:46,769
Doolittle's sort of example of just how

635
00:27:52,340 --> 00:27:50,100
complex all that horizontal

636
00:27:54,830 --> 00:27:52,350
for may have made us understanding how

637
00:27:58,010 --> 00:27:54,840
life is how life is related to each

638
00:27:59,750 --> 00:27:58,020

other this is an old slide and you don't

639
00:28:02,630 --> 00:27:59,760
need to know anything about it except

640
00:28:08,299 --> 00:28:02,640
you need to recognize that this is 15 or

641
00:28:13,220 --> 00:28:08,309
20 bacterium this is the length of their

642
00:28:15,049 --> 00:28:13,230
genomes and the blue is their own DNA

643
00:28:18,289 --> 00:28:15,059
whereas the yellow and the peak

644
00:28:20,299 --> 00:28:18,299
represent different amounts for each one

645
00:28:23,330 --> 00:28:20,309
of those bacteria of alien genes that

646
00:28:25,010 --> 00:28:23,340
were located in their genomic so what

647
00:28:27,470 --> 00:28:25,020
you need to get from this is just one

648
00:28:29,799 --> 00:28:27,480
thing it really doesn't matter how long

649
00:28:32,840 --> 00:28:29,809
your janome is or how big your genome is

650
00:28:34,580 --> 00:28:32,850
different bacteria will accept different

651
00:28:41,720 --> 00:28:34,590
amounts of horizontally transferred

652
00:28:43,669 --> 00:28:41,730
material okay so I need you to think for

653
00:28:46,640 --> 00:28:43,679
a second so I've told you this place is

654
00:28:48,320 --> 00:28:46,650
low in phosphorus so when I heard that

655
00:28:49,760 --> 00:28:48,330
it was low in phosphorus and I was

656
00:28:52,070 --> 00:28:49,770
thinking about horizontal gene transfer

657
00:28:53,960 --> 00:28:52,080
a couple of my friends and I we got

658
00:28:56,090 --> 00:28:53,970
together we said well if you have a

659
00:28:59,049 --> 00:28:56,100
place that slow and phosphorus is that

660
00:29:01,789 --> 00:28:59,059
going to affect horizontal gene transfer

661
00:29:03,799 --> 00:29:01,799
well you need to know a little bit about

662
00:29:07,010 --> 00:29:03,809
how horizontal gene transfer actually

663
00:29:08,450 --> 00:29:07,020

happens it can happen three ways and you

664
00:29:09,560 --> 00:29:08,460
should be familiar with these if you've

665
00:29:11,649 --> 00:29:09,570
done anything in molecular biology

666
00:29:16,669 --> 00:29:11,659
because we use these all the time

667
00:29:20,360 --> 00:29:16,679
transduction which is viruses so a virus

668
00:29:22,100 --> 00:29:20,370
infects the host bacterium and when it

669
00:29:25,070 --> 00:29:22,110
does it brings a little bit of DNA from

670
00:29:27,020 --> 00:29:25,080
its previous victim in that's

671
00:29:28,909 --> 00:29:27,030
transduction it could be conjugation

672
00:29:31,610 --> 00:29:28,919
this is the only thing that bacteria get

673
00:29:33,680 --> 00:29:31,620
to do that sort of resembles sex they

674
00:29:36,200 --> 00:29:33,690
get to get next to each other and they

675
00:29:38,360 --> 00:29:36,210
need to exchange plasmids or different

676
00:29:41,029 --> 00:29:38,370
kinds of alien other DNA that's within

677
00:29:44,720 --> 00:29:41,039
them or transformation which means that

678
00:29:46,669 --> 00:29:44,730
a cell just breaks open and the DNA is

679
00:29:49,490 --> 00:29:46,679
just lying around in the environment and

680
00:29:51,710 --> 00:29:49,500
for some reason this host bacterium has

681
00:29:55,340 --> 00:29:51,720
the ability to actually suck it up into

682
00:29:57,860 --> 00:29:55,350
it okay I'm going to see if you can

683
00:29:59,810 --> 00:29:57,870
figure out what we figured out if you

684
00:30:01,669 --> 00:29:59,820
know that place is low in phosphorus and

685
00:30:03,250 --> 00:30:01,679
you're trying to understand how

686
00:30:06,370 --> 00:30:03,260
horizontal gene transfer have

687
00:30:08,260 --> 00:30:06,380
do you think an environment low in

688
00:30:12,340 --> 00:30:08,270

phosphorus would favor one of these

689
00:30:16,840 --> 00:30:12,350
vectors over another just think about it

690
00:30:19,210 --> 00:30:16,850
what would you think this one but this

691
00:30:23,500 --> 00:30:19,220
takes a lot of phosphorus or not much

692
00:30:26,830 --> 00:30:23,510
phosphorus got to make a lot of viral

693
00:30:29,830 --> 00:30:26,840
particles they're all RNA or DNA so

694
00:30:32,050 --> 00:30:29,840
what's this going to do this one would

695
00:30:34,270 --> 00:30:32,060
probably take a lot right this would

696
00:30:35,620 --> 00:30:34,280
probably take a lot of phosphorus this

697
00:30:36,880 --> 00:30:35,630
one we just gonna let them enjoy

698
00:30:39,430 --> 00:30:36,890
themselves we're not going to talk about

699
00:30:42,520 --> 00:30:39,440
it they have sex their transformation

700
00:30:44,950 --> 00:30:42,530
we're talking about this is just DNA out

701
00:30:46,780 --> 00:30:44,960
of the environment if you don't have

702
00:30:49,380 --> 00:30:46,790
much phosphorus wouldn't you find ways

703
00:30:53,080 --> 00:30:49,390
to scavenge this up and pick it up I

704
00:30:55,660 --> 00:30:53,090
mean if the if the environment slow and

705
00:30:57,130 --> 00:30:55,670
phosphorus if you if you could adapt to

706
00:30:58,510 --> 00:30:57,140
pick this stuff out of the environment

707
00:30:59,650 --> 00:30:58,520
whenever something is broken open that

708
00:31:01,990 --> 00:30:59,660
seems like that would be the best

709
00:31:06,880 --> 00:31:02,000
strategy how many of you think that

710
00:31:10,990 --> 00:31:06,890
sounds reasonable okay I did too but

711
00:31:14,520 --> 00:31:11,000
it's not right turns out this is what we

712
00:31:17,250 --> 00:31:14,530
thought mechanisms of gene exchange

713
00:31:19,510 --> 00:31:17,260

transformation if you have low p

714
00:31:20,980 --> 00:31:19,520
transformations probably going to be the

715
00:31:23,050 --> 00:31:20,990
best thing that you're going to do

716
00:31:26,460 --> 00:31:23,060
transduction the viruses will probably

717
00:31:29,560 --> 00:31:26,470
be the worst thing that you could do

718
00:31:33,100 --> 00:31:29,570
what's our education should be good in

719
00:31:35,250 --> 00:31:33,110
the sense that its most efficient you're

720
00:31:37,420 --> 00:31:35,260
not spraying your bosphorus around

721
00:31:39,670 --> 00:31:37,430
that's actually good there's a problem

722
00:31:41,620 --> 00:31:39,680
with conjugation each one thing I didn't

723
00:31:45,780 --> 00:31:41,630
go over with those three things each one

724
00:31:48,520 --> 00:31:45,790
of them can carry different amounts of

725
00:31:50,170 --> 00:31:48,530
alien DNA and they can carry they have

726
00:31:52,360 --> 00:31:50,180
to carry things that are more related so

727
00:31:54,190 --> 00:31:52,370
if you're actually conjugating you're

728
00:31:57,970 --> 00:31:54,200
actually probably more related so that's

729
00:31:59,620 --> 00:31:57,980
more enter specific type not likely to

730
00:32:01,780 --> 00:31:59,630
bring in something that you know is just

731
00:32:03,930 --> 00:32:01,790
completely foreign which you know I'm a

732
00:32:07,480 --> 00:32:03,940
biologist I like the really odd things

733
00:32:09,400 --> 00:32:07,490
okay so it was about this time when

734
00:32:10,930 --> 00:32:09,410
somebody tell me about quattro cienega

735
00:32:11,480 --> 00:32:10,940
sand i was thinking about phosphorus and

736
00:32:14,450 --> 00:32:11,490
i was thinking

737
00:32:16,580 --> 00:32:14,460
okay should I shift focus from micro

738
00:32:19,549 --> 00:32:16,590

built I could be a microbial ecologist

739
00:32:21,169 --> 00:32:19,559
and I have to admit we sip a little

740
00:32:23,270 --> 00:32:21,179
tequila in the desert when we go down

741
00:32:25,730 --> 00:32:23,280
there or sit at a computer in Houston

742
00:32:28,430 --> 00:32:25,740
and analyze those AC GS and T's so I

743
00:32:31,330 --> 00:32:28,440
tried to become a microbial ecologist

744
00:32:34,940 --> 00:32:31,340
which turns out to be very complicated

745
00:32:37,220 --> 00:32:34,950
so we began this suite of projects at

746
00:32:39,130 --> 00:32:37,230
cuatros images to try to get at what was

747
00:32:42,049 --> 00:32:39,140
actually happening in those in those

748
00:32:44,299 --> 00:32:42,059
microbial lights and in the water and in

749
00:32:45,950 --> 00:32:44,309
the poses so this is just sort of i

750
00:32:47,180 --> 00:32:45,960
showed you all those people before these

751
00:32:50,480 --> 00:32:47,190
were some of the things that we actually

752
00:32:52,150 --> 00:32:50,490
began to do so this one I'm going to

753
00:32:55,100 --> 00:32:52,160
talk about bacterial and viral

754
00:32:57,080 --> 00:32:55,110
metagenomics of the microbial eyes so

755
00:32:59,210 --> 00:32:57,090
all we did was we went down and took

756
00:33:00,590 --> 00:32:59,220
samples and I was telling some of the

757
00:33:02,390 --> 00:33:00,600
students at lunch about one of the

758
00:33:05,000 --> 00:33:02,400
horrendous things that happened took a

759
00:33:07,790 --> 00:33:05,010
sample took a sample we take it back to

760
00:33:09,710 --> 00:33:07,800
the lab and we don't care we don't try

761
00:33:11,870 --> 00:33:09,720
to culture anything we don't try to

762
00:33:15,590 --> 00:33:11,880
separate anything we just take the whole

763
00:33:17,299 --> 00:33:15,600

sample bag extract all the available DNA

764
00:33:21,110 --> 00:33:17,309
in it and then sequence it in little

765
00:33:22,580 --> 00:33:21,120
bits on 454 sequencing machine so rather

766
00:33:25,520 --> 00:33:22,590
than think about you know like an

767
00:33:27,710 --> 00:33:25,530
individual microbe we actually took that

768
00:33:29,600 --> 00:33:27,720
whole stromatolite took it back to the

769
00:33:32,090 --> 00:33:29,610
lab and sequence every people in a unit

770
00:33:34,669 --> 00:33:32,100
to try to figure out something about the

771
00:33:37,760 --> 00:33:34,679
community rather than the individual and

772
00:33:40,220 --> 00:33:37,770
the community okay the other thing that

773
00:33:42,260 --> 00:33:40,230
we did was we did an isotope analysis of

774
00:33:44,660 --> 00:33:42,270
cores and sediments and the microvia

775
00:33:48,620 --> 00:33:44,670
lights there was a bacterial census done

776
00:33:51,860 --> 00:33:48,630
over the whole valley genome sequencing

777
00:33:54,080 --> 00:33:51,870
of a specific bacterium we did ecosystem

778
00:33:58,010 --> 00:33:54,090
nutrient perturbations and analysis so

779
00:33:59,930 --> 00:33:58,020
in other words streamside buckets filled

780
00:34:01,190 --> 00:33:59,940
with those little anka lights and dumped

781
00:34:04,010 --> 00:34:01,200
phosphorus in it to see what would

782
00:34:06,620 --> 00:34:04,020
happen and then ran analysis experiments

783
00:34:09,109 --> 00:34:06,630
to determine how fast that those micro

784
00:34:11,389 --> 00:34:09,119
bio lights were forming continuing to

785
00:34:13,250 --> 00:34:11,399
isolate new species and then comparative

786
00:34:14,780 --> 00:34:13,260
census of microbial communities so I'm

787
00:34:17,450 --> 00:34:14,790
going to talk about three of these right

788
00:34:21,680 --> 00:34:17,460

now I do want to tell you one thing

789
00:34:23,330 --> 00:34:21,690
before I continue we are very privileged

790
00:34:26,120 --> 00:34:23,340
to actually be working at this

791
00:34:28,850 --> 00:34:26,130
it's now under the Quattro cienega

792
00:34:31,220 --> 00:34:28,860
Valley is actually a world heritage site

793
00:34:33,320 --> 00:34:31,230
now and is protected by the Mexican

794
00:34:35,060 --> 00:34:33,330
government and as I told you a minute

795
00:34:36,740 --> 00:34:35,070
ago how fragile those things where you

796
00:34:38,180 --> 00:34:36,750
can imagine those beautiful shelf ones

797
00:34:40,580 --> 00:34:38,190
if there were very many people swimming

798
00:34:43,900 --> 00:34:40,590
around which this is a place to go at

799
00:34:46,760 --> 00:34:43,910
Eastern for a lot of northern Mexican

800
00:34:49,910 --> 00:34:46,770
people we can imagine how fast that

801
00:34:52,880 --> 00:34:49,920
would be decimated so one of the ways

802
00:34:56,120 --> 00:34:52,890
that we pay we try to show our respect

803
00:34:58,580 --> 00:34:56,130
and our appreciation is we actually take

804
00:35:00,950 --> 00:34:58,590
a planetarium a portable planetarium

805
00:35:03,050 --> 00:35:00,960
down these communities don't have any

806
00:35:06,710 --> 00:35:03,060
movie theaters most of them don't even

807
00:35:08,480 --> 00:35:06,720
have television and so we have three

808
00:35:09,980 --> 00:35:08,490
planetarium shows that were translated

809
00:35:14,000 --> 00:35:09,990
in Spanish so we take these down about

810
00:35:16,850 --> 00:35:14,010
three times a year to help educate the

811
00:35:19,340 --> 00:35:16,860
community so the one thing I want to

812
00:35:21,440 --> 00:35:19,350
talk about is the bacterial census that

813
00:35:23,510 --> 00:35:21,450

we did of the valley ok so I told you

814
00:35:25,070 --> 00:35:23,520
about the intimate the in the mizzen of

815
00:35:27,740 --> 00:35:25,080
the Mac Ramona I told you there were

816
00:35:30,200 --> 00:35:27,750
over 70 endemic species well we wondered

817
00:35:34,070 --> 00:35:30,210
is it possible that you might have

818
00:35:35,810 --> 00:35:34,080
endemic microbes here as well and that's

819
00:35:37,610 --> 00:35:35,820
a problem if you're a biologist you

820
00:35:40,060 --> 00:35:37,620
already know what the problem is we

821
00:35:42,680 --> 00:35:40,070
don't really know what a species is it

822
00:35:44,720 --> 00:35:42,690
we don't know what to call a species and

823
00:35:47,120 --> 00:35:44,730
microbes there again it's that problem

824
00:35:48,560 --> 00:35:47,130
of not having sex they're clones so

825
00:35:51,590 --> 00:35:48,570
we're not real sure how you say a

826
00:35:55,220 --> 00:35:51,600
species but let's say we can find an

827
00:35:57,320 --> 00:35:55,230
example of such an extreme case that we

828
00:35:58,760 --> 00:35:57,330
had to say the microbes were endemic to

829
00:36:01,370 --> 00:35:58,770
that region we began to think about

830
00:36:03,800 --> 00:36:01,380
looking for that we also wanted to see

831
00:36:05,780 --> 00:36:03,810
well just what what are the microbes

832
00:36:08,300 --> 00:36:05,790
like this is in general in the water

833
00:36:10,940 --> 00:36:08,310
systems down there and this was a census

834
00:36:12,620 --> 00:36:10,950
that was done and all you need to see

835
00:36:16,720 --> 00:36:12,630
from this is that no matter where we

836
00:36:22,610 --> 00:36:20,240
those sequences for the microbes that we

837
00:36:25,280 --> 00:36:22,620
took down here we're all more closely

838
00:36:26,850 --> 00:36:25,290

related to marine sequences in the

839
00:36:28,140 --> 00:36:26,860
databases that are

840
00:36:31,680 --> 00:36:28,150
all over the world and they are to

841
00:36:33,450 --> 00:36:31,690
anything else now when my collaborator

842
00:36:36,120 --> 00:36:33,460
Valyria told me that I thought it cannot

843
00:36:38,850 --> 00:36:36,130
be possible that a hundred million years

844
00:36:41,460 --> 00:36:38,860
we still have some sort of marine

845
00:36:44,640 --> 00:36:41,470
signature in the bacteria because it was

846
00:36:47,870 --> 00:36:44,650
left over from the protocol well but

847
00:36:50,370 --> 00:36:47,880
they did several sort of statistical

848
00:36:54,810 --> 00:36:50,380
analysis make sure that this wasn't some

849
00:36:56,790 --> 00:36:54,820
sort of misleading result and it turns

850
00:37:00,330 --> 00:36:56,800
out that it looks true it looks like the

851
00:37:02,250 --> 00:37:00,340
majority of the residents there are more

852
00:37:06,660 --> 00:37:02,260
closely to other marine organisms than

853
00:37:08,660 --> 00:37:06,670
they are to anything else so this is

854
00:37:11,220 --> 00:37:08,670
what I was talking about we thought well

855
00:37:13,020 --> 00:37:11,230
so they're more related to marine

856
00:37:16,050 --> 00:37:13,030
organisms but are they endemic to that

857
00:37:18,840 --> 00:37:16,060
region so I want to talk a little bit

858
00:37:21,500 --> 00:37:18,850
about that Trent's a system remember I

859
00:37:23,820 --> 00:37:21,510
told you that it started at a spring

860
00:37:25,410 --> 00:37:23,830
meanders across the desert floor and

861
00:37:27,150 --> 00:37:25,420
goes into a lagoon and there's some

862
00:37:29,520 --> 00:37:27,160
evaporative process and then this is the

863
00:37:32,100 --> 00:37:29,530

big evaporative and here's the big

864
00:37:35,850 --> 00:37:32,110
evaporative pond there and you can see

865
00:37:38,190 --> 00:37:35,860
there's a variation in a magnesium and

866
00:37:44,040 --> 00:37:38,200
sodium and calcium going from one end to

867
00:37:45,480 --> 00:37:44,050
the other so it turns out that when you

868
00:37:47,190 --> 00:37:45,490
look at this when you look at that

869
00:37:50,760 --> 00:37:47,200
particular region you find a high

870
00:37:55,140 --> 00:37:50,770
percentage of bacillus strains there not

871
00:37:56,940 --> 00:37:55,150
only that we found one in particular let

872
00:37:59,490 --> 00:37:56,950
me talk a little bit about bacillus it

873
00:38:00,840 --> 00:37:59,500
turns out that we were focusing when we

874
00:38:03,570 --> 00:38:00,850
first went down there because it's from

875
00:38:05,910 --> 00:38:03,580
analytes were so intriguing everybody

876
00:38:08,520 --> 00:38:05,920
talks about stromatolites being produced

877
00:38:10,590 --> 00:38:08,530
by cyanobacteria and they do have a role

878
00:38:13,680 --> 00:38:10,600
in them because they are a primary

879
00:38:16,620 --> 00:38:13,690
producer but it turns out that

880
00:38:19,230 --> 00:38:16,630
cyanobacteria don't like to be isolated

881
00:38:21,210 --> 00:38:19,240
they don't like to be in pure culture

882
00:38:23,400 --> 00:38:21,220
and they are terrifically difficult to

883
00:38:25,500 --> 00:38:23,410
get into pure culture so we began to

884
00:38:27,810 --> 00:38:25,510
look for other organisms there that were

885
00:38:29,310 --> 00:38:27,820
indicative of the region that might be

886
00:38:32,100 --> 00:38:29,320
easier to cultivate it turns out

887
00:38:34,860 --> 00:38:32,110
bacillus are so they were widespread

888
00:38:36,540 --> 00:38:34,870

throughout the valley they're in

889
00:38:37,420 --> 00:38:36,550
different environments we found at least

890
00:38:39,339 --> 00:38:37,430
17

891
00:38:40,809 --> 00:38:39,349
in that little Trent's a system that I

892
00:38:43,480 --> 00:38:40,819
showed you there fast and easy to

893
00:38:45,490 --> 00:38:43,490
culture and for another project they're

894
00:38:47,620 --> 00:38:45,500
actually important in nitrogen cycle and

895
00:38:51,370 --> 00:38:47,630
I'm not going to talk about them but so

896
00:38:55,720 --> 00:38:51,380
lo and behold we found bacillus cual

897
00:38:58,359 --> 00:38:55,730
winces and we sequence the genome turns

898
00:39:03,000 --> 00:38:58,369
out that it's the smallest vasilis

899
00:39:05,799 --> 00:39:03,010
genome known only 3.3 Giga bases now

900
00:39:08,349 --> 00:39:05,809
vasilis are usually sort of in the world

901
00:39:11,230 --> 00:39:08,359
of bacteria they're kind of complicated

902
00:39:12,819 --> 00:39:11,240
because they actually produce spores so

903
00:39:14,770 --> 00:39:12,829
they usually have big genome so it's

904
00:39:17,640 --> 00:39:14,780
kind of it was very unusual to recognize

905
00:39:22,210 --> 00:39:17,650
that this one had a very small one in

906
00:39:24,940 --> 00:39:22,220
this particular group you find relatives

907
00:39:27,010 --> 00:39:24,950
of this not this one but relatives of

908
00:39:30,010 --> 00:39:27,020
this all over the world in marine and

909
00:39:34,210 --> 00:39:30,020
saline environments so in the sequencing

910
00:39:35,470 --> 00:39:34,220
of it this is just your standard this

911
00:39:37,089 --> 00:39:35,480
doesn't mean anything I don't care that

912
00:39:39,069 --> 00:39:37,099
you even look at this this just pretty

913
00:39:42,549 --> 00:39:39,079

we actually sequence the genome this is

914
00:39:45,220 --> 00:39:42,559
though huh this is important here so it

915
00:39:49,000 --> 00:39:45,230
turns out to this little vasilis that's

916
00:39:51,099 --> 00:39:49,010
down there in Quattro Santa ghus because

917
00:39:56,039 --> 00:39:51,109
actually has the smallest genome has

918
00:39:59,950 --> 00:39:56,049
actually co-opted a myriad group of

919
00:40:01,630 --> 00:39:59,960
biological mechanisms into its genomic

920
00:40:03,640 --> 00:40:01,640
while it's been reducing it it's

921
00:40:05,230 --> 00:40:03,650
actually co-opted through horizontal

922
00:40:07,900 --> 00:40:05,240
gene transfer some very interesting

923
00:40:09,940 --> 00:40:07,910
attributes one of them from the

924
00:40:12,640 --> 00:40:09,950
cyanobacteria around there it's taken

925
00:40:16,299 --> 00:40:12,650
sulfa lipids now let me explain that to

926
00:40:20,380 --> 00:40:16,309
you how many of you know what a membrane

927
00:40:22,620 --> 00:40:20,390
cell membrane is made of her has

928
00:40:26,559 --> 00:40:22,630
something in it we've been talking about

929
00:40:28,359 --> 00:40:26,569
phosphorous phospholipids right what do

930
00:40:29,950 --> 00:40:28,369
I told you about this place it's low in

931
00:40:32,890 --> 00:40:29,960
phosphorus so guess what this thing's

932
00:40:34,539 --> 00:40:32,900
figured out how to do you sell fur it

933
00:40:36,760 --> 00:40:34,549
doesn't even make phospholipids in New

934
00:40:39,309 --> 00:40:36,770
York it makes sulfur lipids and it's in

935
00:40:40,980 --> 00:40:39,319
its membranes and it co-opted that from

936
00:40:44,200 --> 00:40:40,990
cyanobacteria

937
00:40:46,300 --> 00:40:44,210
so a horizontal gene transfer event that

938
00:40:48,760 --> 00:40:46,310

we actually know occurred because of it

939
00:40:50,530 --> 00:40:48,770
being in this place now won't go over

940
00:40:52,420 --> 00:40:50,540
too many of these because they're not as

941
00:40:55,510 --> 00:40:52,430
important as that is right now but what

942
00:40:58,710 --> 00:40:55,520
I'm trying to tell you this is likely

943
00:41:02,830 --> 00:40:58,720
this particular bacillus that can do

944
00:41:04,120 --> 00:41:02,840
soulful lipid metabolism is probably not

945
00:41:06,310 --> 00:41:04,130
present anywhere else in the world

946
00:41:11,320 --> 00:41:06,320
because this unique environment so this

947
00:41:14,040 --> 00:41:11,330
is probably an endemic bacterium from

948
00:41:19,240 --> 00:41:14,050
this region I don't know what that was

949
00:41:20,920 --> 00:41:19,250
only it's time is done okay so it's the

950
00:41:24,790 --> 00:41:20,930
first described heterotroph to produce

951
00:41:26,380 --> 00:41:24,800
cellphone lipids even though relatives

952
00:41:29,110 --> 00:41:26,390
of it are common throughout the world in

953
00:41:30,880 --> 00:41:29,120
saline and marine environment it's a

954
00:41:32,440 --> 00:41:30,890
perfect candidate for analysis of those

955
00:41:34,990 --> 00:41:32,450
globally distributed relatives to

956
00:41:37,150 --> 00:41:35,000
understand what endemism might mean in

957
00:41:42,310 --> 00:41:37,160
the bacterial world and this has

958
00:41:44,170 --> 00:41:42,320
actually been accepted by pnas so okay

959
00:41:46,330 --> 00:41:44,180
the next two slides they don't want you

960
00:41:48,220 --> 00:41:46,340
to get the next one's going to be very

961
00:41:49,570 --> 00:41:48,230
complicated and it's just to show you

962
00:41:51,490 --> 00:41:49,580
something you know I try to get you to

963
00:41:53,220 --> 00:41:51,500

think through the process about what we

964
00:41:55,480 --> 00:41:53,230
thought about horizontal gene transfer

965
00:41:57,490 --> 00:41:55,490
happening in a low phosphorus

966
00:41:59,200 --> 00:41:57,500
environment and about a third of you

967
00:42:04,030 --> 00:41:59,210
agreed with me that this probably seemed

968
00:42:09,490 --> 00:42:04,040
reasonable so this is actually what we

969
00:42:11,680 --> 00:42:09,500
ended up with just like all in biology

970
00:42:13,930 --> 00:42:11,690
it's always way more complicated than

971
00:42:16,600 --> 00:42:13,940
you ever thought it would be it turns

972
00:42:19,330 --> 00:42:16,610
out that we've knew that we had low p

973
00:42:22,180 --> 00:42:19,340
and we know we have high diversification

974
00:42:23,770 --> 00:42:22,190
I told you this is like Galapagos even

975
00:42:26,470 --> 00:42:23,780
in the microbial world there's a lot of

976
00:42:31,240 --> 00:42:26,480
diversification and it turns out that

977
00:42:32,830 --> 00:42:31,250
that low p affects everything it doesn't

978
00:42:34,240 --> 00:42:32,840
just affect one it affects everything

979
00:42:36,330 --> 00:42:34,250
there's low transformation low

980
00:42:39,370 --> 00:42:36,340
conjugation low transduction and

981
00:42:41,580 --> 00:42:39,380
actually interestingly enough we believe

982
00:42:45,340 --> 00:42:41,590
that that leads to kind of a high

983
00:42:47,200 --> 00:42:45,350
diversification that happens in the

984
00:42:50,520 --> 00:42:47,210
independent little lineages all

985
00:42:56,859 --> 00:42:53,890
now the selection 4p actually does have

986
00:43:00,760 --> 00:42:56,869
some consequences on a genome it

987
00:43:02,890 --> 00:43:00,770
actually probably forces any genomes

988
00:43:04,990 --> 00:43:02,900

down there to purge themselves of any

989
00:43:07,120 --> 00:43:05,000
genes they don't need remember I told

990
00:43:09,730 --> 00:43:07,130
you this have the smallest genome of any

991
00:43:12,250 --> 00:43:09,740
bacillus and that so there's probably

992
00:43:15,120 --> 00:43:12,260
two things that happen in a low

993
00:43:16,990 --> 00:43:15,130
phosphorus environment you have extreme

994
00:43:18,700 --> 00:43:17,000
diversification because of a local

995
00:43:21,970 --> 00:43:18,710
adaptation and you actually try to get

996
00:43:24,280 --> 00:43:21,980
smaller and smaller general okay so

997
00:43:26,980 --> 00:43:24,290
putting it all together as far as

998
00:43:29,710 --> 00:43:26,990
endemism and horizontal gene transfer at

999
00:43:31,870 --> 00:43:29,720
cuatro cinakisz the dogma has always

1000
00:43:34,750 --> 00:43:31,880
been that with respect to bacteria

1001
00:43:38,020 --> 00:43:34,760
everything is everywhere no matter where

1002
00:43:39,490 --> 00:43:38,030
you went on the planet every species of

1003
00:43:42,930 --> 00:43:39,500
bacteria is there it's just not

1004
00:43:45,430 --> 00:43:42,940
prominent but at Quattro cinakisz

1005
00:43:47,589 --> 00:43:45,440
everything is not everywhere and maybe

1006
00:43:49,150 --> 00:43:47,599
in some places everything is special so

1007
00:43:51,670 --> 00:43:49,160
we actually think Watrous you

1008
00:43:54,940 --> 00:43:51,680
because if the local adaptation in its

1009
00:43:57,790 --> 00:43:54,950
Galapagos like environment has actually

1010
00:44:00,070 --> 00:43:57,800
not only does it have macro faunal in

1011
00:44:02,020 --> 00:44:00,080
dominica species but it's also bacterial

1012
00:44:07,400 --> 00:44:02,030
and this is actually a nature reviews

1013
00:44:15,060 --> 00:44:12,630

well no other bacillus in the world of

1014
00:44:17,370 --> 00:44:15,070
all the the 50 or 60 that have been

1015
00:44:20,760 --> 00:44:17,380
sequenced none of them produce cell

1016
00:44:23,370 --> 00:44:20,770
phone rings now you actually make a good

1017
00:44:25,470 --> 00:44:23,380
point I mean it's a bacillus right i

1018
00:44:27,810 --> 00:44:25,480
mean it's it's a facility that's related

1019
00:44:30,120 --> 00:44:27,820
it has other organisms thats related to

1020
00:44:31,770 --> 00:44:30,130
so you have to define in your own mind

1021
00:44:36,480 --> 00:44:31,780
whether or not you want to count a

1022
00:44:39,780 --> 00:44:36,490
microbe as being the same if it has the

1023
00:44:43,440 --> 00:44:39,790
same ribosomal RNA or whether or not it

1024
00:44:45,450 --> 00:44:43,450
can do unusual things so it's a it's a

1025
00:44:47,790 --> 00:44:45,460
matter of definition but I think if you

1026
00:44:49,410 --> 00:44:47,800
want to count something as endemic this

1027
00:44:50,730 --> 00:44:49,420
is about the strongest argument you

1028
00:44:52,710 --> 00:44:50,740
could have if you're talking about

1029
00:44:54,180 --> 00:44:52,720
microbes I'm okay if you want to

1030
00:44:58,349 --> 00:44:54,190
disagree with it because I can

1031
00:45:00,720 --> 00:44:58,359
understand it but nowhere else it's

1032
00:45:02,730 --> 00:45:00,730
never been reported that any other

1033
00:45:05,510 --> 00:45:02,740
vasilis not only any other bacillus but

1034
00:45:07,980 --> 00:45:05,520
no other heterotroph make soulful lipids

1035
00:45:09,780 --> 00:45:07,990
soulful lipids are made in the ocean all

1036
00:45:18,089 --> 00:45:09,790
the time by all kinds of cyanobacteria

1037
00:45:20,099 --> 00:45:18,099
that's well known okay so now i'm going

1038
00:45:24,420 --> 00:45:20,109

to talk just for a few seconds about the

1039
00:45:26,700 --> 00:45:24,430
metagenomes we actually took one of the

1040
00:45:29,010 --> 00:45:26,710
Anka lights and a piece of the

1041
00:45:30,450 --> 00:45:29,020
stromatolite and we did the meta-genome

1042
00:45:37,800 --> 00:45:30,460
step remember that's just the whole

1043
00:45:39,540 --> 00:45:37,810
community RNA and we looked at the viral

1044
00:45:42,150 --> 00:45:39,550
component of it and the bacterial

1045
00:45:44,430 --> 00:45:42,160
component and we also evaluated the

1046
00:45:46,560 --> 00:45:44,440
isotopes of the water in the microbial

1047
00:45:48,210 --> 00:45:46,570
lights now this was quite a project

1048
00:45:50,430 --> 00:45:48,220
those two sentences make it seem real

1049
00:45:52,910 --> 00:45:50,440
simple I'm going to go over the viral

1050
00:45:57,089 --> 00:45:52,920
community I only have this one slide

1051
00:46:01,710 --> 00:45:57,099
this was a paper that came out in nature

1052
00:46:03,570 --> 00:46:01,720
about two weeks ago and basically this

1053
00:46:06,570 --> 00:46:03,580
was kind of scary to me the results of

1054
00:46:09,630 --> 00:46:06,580
this because what it actually shows is

1055
00:46:12,480 --> 00:46:09,640
real mosquitoes is to uncle aight this

1056
00:46:17,640 --> 00:46:12,490
is the shelf stromatolite and these are

1057
00:46:18,279 --> 00:46:17,650
each different marine samples of virus

1058
00:46:20,289 --> 00:46:18,289
particles

1059
00:46:22,209 --> 00:46:20,299
right so these are viruses from this

1060
00:46:25,390 --> 00:46:22,219
from this and then these were all marine

1061
00:46:29,439 --> 00:46:25,400
and all you have to know is that if you

1062
00:46:35,890 --> 00:46:29,449
have anything that's greater than point

1063
00:46:40,179 --> 00:46:35,900

25 over here that means that whatever is

1064
00:46:42,370 --> 00:46:40,189
greater than point 0 to 5 has a greater

1065
00:46:45,999 --> 00:46:42,380
different has point let me get this

1066
00:46:47,859 --> 00:46:46,009
right samples yeah okay this is the

1067
00:46:52,929 --> 00:46:47,869
combined this is comparing to the

1068
00:46:56,650 --> 00:46:52,939
combined marine sample and if there's no

1069
00:46:59,109 --> 00:46:56,660
difference if it's less than 0 point 0 5

1070
00:47:01,749 --> 00:46:59,119
then it's exactly like it has a

1071
00:47:03,759 --> 00:47:01,759
relationship to the marine sample so it

1072
00:47:06,279 --> 00:47:03,769
turns out these are all marine samples

1073
00:47:10,349 --> 00:47:06,289
and if you compare the Gulf of Mexico

1074
00:47:12,880 --> 00:47:10,359
viral viruses with the combined marine

1075
00:47:17,079 --> 00:47:12,890
viruses there's no difference right

1076
00:47:19,689 --> 00:47:17,089
following me pose us as Sulis that shelf

1077
00:47:24,189 --> 00:47:19,699
stromatolite looks exactly like a marine

1078
00:47:25,899 --> 00:47:24,199
single so in the paper this actually

1079
00:47:28,630 --> 00:47:25,909
corroborates that idea that not only

1080
00:47:30,489 --> 00:47:28,640
does the bacteria look like it has a

1081
00:47:32,140 --> 00:47:30,499
marine signature but the viral

1082
00:47:35,019 --> 00:47:32,150
components look like they have a marine

1083
00:47:37,329 --> 00:47:35,029
signature as well building on the

1084
00:47:40,539 --> 00:47:37,339
argument that this is a relic of the

1085
00:47:42,429 --> 00:47:40,549
ancient ocean now love this picture just

1086
00:47:44,529 --> 00:47:42,439
because this shows how dirty this work

1087
00:47:46,329 --> 00:47:44,539
was when we were doing isotope analysis

1088
00:47:48,429 --> 00:47:46,339

when we went down to the to get the

1089
00:47:50,649 --> 00:47:48,439
samples to do the isotopes this is David

1090
00:47:53,199 --> 00:47:50,659
hollander and he actually looks like

1091
00:47:55,509 --> 00:47:53,209
that most of the time and this is as

1092
00:47:59,169 --> 00:47:55,519
taking a core this is Maya Breitbart in

1093
00:48:00,640 --> 00:47:59,179
David and this is the core and so David

1094
00:48:04,929 --> 00:48:00,650
is the one that does all the isotope

1095
00:48:08,199 --> 00:48:04,939
analysis this is the bacterial component

1096
00:48:12,969 --> 00:48:08,209
of the stromatolites and this is just to

1097
00:48:16,599 --> 00:48:12,979
show you that the light bar is the Shelf

1098
00:48:19,209 --> 00:48:16,609
stromatolite and the dark bar is the

1099
00:48:22,120 --> 00:48:19,219
real mosquitoes so looking at the

1100
00:48:24,519 --> 00:48:22,130
bacterial fractions we tried to figure

1101
00:48:26,360 --> 00:48:24,529
out what were the components what were

1102
00:48:28,310 --> 00:48:26,370
the microbial identities and

1103
00:48:30,890 --> 00:48:28,320
one of them and you can see one thing

1104
00:48:32,240 --> 00:48:30,900
very clearly they look like there's two

1105
00:48:34,940 --> 00:48:32,250
different communities there right

1106
00:48:39,730 --> 00:48:34,950
they're not the same that seem

1107
00:48:42,890 --> 00:48:39,740
reasonable to you they're different okay

1108
00:48:47,270 --> 00:48:42,900
so the only thing you need to recognize

1109
00:48:50,240 --> 00:48:47,280
about this is that if you compare the

1110
00:48:52,610 --> 00:48:50,250
micro this is a slide of the functions

1111
00:48:56,390 --> 00:48:52,620
of the genes that we found in the metaji

1112
00:48:59,870 --> 00:48:56,400
notes so these are all the different

1113
00:49:03,500 --> 00:48:59,880

categories and the comparison is the

1114
00:49:05,990 --> 00:49:03,510
microbial lights compared to marine ones

1115
00:49:08,540 --> 00:49:06,000
to marine functions and compared to

1116
00:49:09,890 --> 00:49:08,550
fresh water and the only thing you need

1117
00:49:11,810 --> 00:49:09,900
to notice the only thing I want you to

1118
00:49:16,070 --> 00:49:11,820
notice on this is that this little red

1119
00:49:17,780 --> 00:49:16,080
bar here is sulfur metabolism and it

1120
00:49:20,300 --> 00:49:17,790
actually shows that no matter whether

1121
00:49:23,510 --> 00:49:20,310
you compare it with marine bacteria or

1122
00:49:28,180 --> 00:49:23,520
freshwater bacteria the bacteria in

1123
00:49:30,740 --> 00:49:28,190
these microbial lights are actually have

1124
00:49:33,800 --> 00:49:30,750
something's going on with a sulfur cycle

1125
00:49:37,280 --> 00:49:33,810
that's not normal for most of freshwater

1126
00:49:38,870 --> 00:49:37,290
or marine biology microbiology so

1127
00:49:42,260 --> 00:49:38,880
there's something about the sulfur

1128
00:49:43,940 --> 00:49:42,270
that's causing both communities no

1129
00:49:46,070 --> 00:49:43,950
matter what organisms that are in them

1130
00:49:48,140 --> 00:49:46,080
both communities have a high sulfur

1131
00:49:52,850 --> 00:49:48,150
cycle there's something going on about

1132
00:49:54,650 --> 00:49:52,860
the sulfur cycle this is just another

1133
00:49:55,940 --> 00:49:54,660
graph to show you a little bit about

1134
00:49:57,470 --> 00:49:55,950
remember I told you you're going to have

1135
00:49:59,180 --> 00:49:57,480
liftoff eyeing Matt's either because

1136
00:50:03,410 --> 00:49:59,190
you've changed the metabolism or you've

1137
00:50:05,630 --> 00:50:03,420
done something about making it extra

1138
00:50:07,850 --> 00:50:05,640

polymeric substance and this is showing

1139
00:50:10,580 --> 00:50:07,860
you that both in the the round

1140
00:50:12,800 --> 00:50:10,590
stromatolite the microbial light and the

1141
00:50:14,960 --> 00:50:12,810
shelf stromatolite there's actually a

1142
00:50:17,780 --> 00:50:14,970
lot of eps production and a lot of

1143
00:50:20,360 --> 00:50:17,790
degradation so extra polymeric

1144
00:50:22,610 --> 00:50:20,370
substances are also active in this so

1145
00:50:26,890 --> 00:50:22,620
these microbial lights are probably

1146
00:50:30,230 --> 00:50:26,900
using sulfur metabolism as well as

1147
00:50:33,560 --> 00:50:30,240
creating EPS to actually cause that

1148
00:50:35,660 --> 00:50:33,570
precipitation to occur so basically what

1149
00:50:38,340 --> 00:50:35,670
this what these slides are showing you

1150
00:50:41,670 --> 00:50:38,350
is that that model that depress and

1151
00:50:43,500 --> 00:50:41,680
had actually put forth is actually

1152
00:50:46,800 --> 00:50:43,510
corroborated by this evidence there's

1153
00:50:49,230 --> 00:50:46,810
two there's there's at least two the EPS

1154
00:50:51,000 --> 00:50:49,240
and the metabolisms are actually

1155
00:50:53,400 --> 00:50:51,010
affecting the fact that carbonate is

1156
00:50:55,650 --> 00:50:53,410
actually precipitating on these

1157
00:50:59,310 --> 00:50:55,660
communities differently than what it

1158
00:51:02,040 --> 00:50:59,320
would in other places okay so basically

1159
00:51:05,310 --> 00:51:02,050
strahm's are complex redox dependent

1160
00:51:07,410 --> 00:51:05,320
highly dependent communities they're

1161
00:51:09,510 --> 00:51:07,420
highly integrated their metabolic

1162
00:51:11,220 --> 00:51:09,520
composition is distinct from other

1163
00:51:13,830 --> 00:51:11,230

marine and freshwater microbial

1164
00:51:16,650 --> 00:51:13,840
communities even though the taxonomy of

1165
00:51:19,020 --> 00:51:16,660
the two strands are very different their

1166
00:51:22,260 --> 00:51:19,030
metabolites their metabolic potential is

1167
00:51:25,040 --> 00:51:22,270
the same and that particular potential

1168
00:51:27,450 --> 00:51:25,050
is important for carbonate precipitation

1169
00:51:29,280 --> 00:51:27,460
the isotopes i didn't i'm not going to

1170
00:51:32,610 --> 00:51:29,290
go over that but the isotopes indicate

1171
00:51:35,010 --> 00:51:32,620
that heterotrophic respiration occurs of

1172
00:51:37,380 --> 00:51:35,020
the photosynthetic biomass even though

1173
00:51:41,600 --> 00:51:37,390
the cyanobacteria are there and they're

1174
00:51:43,680 --> 00:51:41,610
actually the primary producers their

1175
00:51:45,780 --> 00:51:43,690
metabolism is not the one that's

1176
00:51:47,520 --> 00:51:45,790
actually causing the precipitation it's

1177
00:51:50,550 --> 00:51:47,530
the sulfur and the heterotrophs that are

1178
00:51:52,170 --> 00:51:50,560
actually causing the precipitation the

1179
00:51:54,030 --> 00:51:52,180
sulfate reducing bacteria are key

1180
00:51:59,240 --> 00:51:54,040
components to the community now what

1181
00:52:05,520 --> 00:52:03,030
that has to do with biology astrobiology

1182
00:52:08,840 --> 00:52:05,530
because we are beginning to understand

1183
00:52:11,130 --> 00:52:08,850
what the constraints are that allow

1184
00:52:14,070 --> 00:52:11,140
precipitation to happen and for you to

1185
00:52:16,020 --> 00:52:14,080
get a lithified mapped and if we can

1186
00:52:17,400 --> 00:52:16,030
understand the constraints of what has

1187
00:52:20,090 --> 00:52:17,410
to happen in order for you to get

1188
00:52:22,980 --> 00:52:20,100

lithification we can understand how

1189
00:52:24,930 --> 00:52:22,990
through the rock record what the ocean

1190
00:52:26,730 --> 00:52:24,940
chemistry had to be like or what the

1191
00:52:29,100 --> 00:52:26,740
microbial community had to be like in

1192
00:52:30,720 --> 00:52:29,110
order to get multiplication and if we

1193
00:52:33,090 --> 00:52:30,730
can understand that we might be able to

1194
00:52:34,140 --> 00:52:33,100
actually extrapolate that for it if you

1195
00:52:35,850 --> 00:52:34,150
were going to look for life

1196
00:52:37,920 --> 00:52:35,860
stromatolites if you could actually

1197
00:52:39,720 --> 00:52:37,930
visually ever look at something else to

1198
00:52:41,550 --> 00:52:39,730
see what evidence of stromatolites might

1199
00:52:43,740 --> 00:52:41,560
be on other planets or microbial lights

1200
00:52:46,170 --> 00:52:43,750
you would know what the conditions had

1201
00:52:47,940 --> 00:52:46,180
to be and that's actually getting us

1202
00:52:49,920 --> 00:52:47,950
that that's actually a step forward

1203
00:52:51,390 --> 00:52:49,930
we're going to actually be able to

1204
00:52:54,870 --> 00:52:51,400
measure horizontal

1205
00:52:56,880 --> 00:52:54,880
transfer using the cut rosina gets

1206
00:52:58,920 --> 00:52:56,890
isolates will understand a little bit

1207
00:53:00,870 --> 00:52:58,930
more about genomic coalescence I

1208
00:53:03,510 --> 00:53:00,880
mentioned the list the vacation of the

1209
00:53:05,400 --> 00:53:03,520
ecosystem and then this is important

1210
00:53:08,220 --> 00:53:05,410
will understand and be able to evaluate

1211
00:53:10,289 --> 00:53:08,230
P as a limiting nutrients and its effect

1212
00:53:12,750 --> 00:53:10,299
which can provide better early Earth

1213
00:53:16,349 --> 00:53:12,760

model constraints and this is something

1214
00:53:20,099 --> 00:53:16,359
I talked about at lunch this may seem

1215
00:53:21,660 --> 00:53:20,109
kind of you know it's just advanced life

1216
00:53:24,210 --> 00:53:21,670
on Earth that we're actually talking

1217
00:53:25,710 --> 00:53:24,220
about the fact of the matter is no

1218
00:53:28,730 --> 00:53:25,720
matter where you are in the universe you

1219
00:53:32,160 --> 00:53:28,740
still have the same periodic table so

1220
00:53:34,109 --> 00:53:32,170
the same element building blocks have to

1221
00:53:37,470 --> 00:53:34,119
be used no matter where you are so the

1222
00:53:40,710 --> 00:53:37,480
fact that you're precipitating just a

1223
00:53:43,769 --> 00:53:40,720
chemical process carbonates out of water

1224
00:53:45,690 --> 00:53:43,779
by my biological intervention could

1225
00:53:47,099 --> 00:53:45,700
happen anywhere first we wouldn't have

1226
00:53:52,980 --> 00:53:47,109
to actually understand what the life was

1227
00:53:55,680 --> 00:53:52,990
like so this is just two more shots of

1228
00:53:57,089 --> 00:53:55,690
quattro Senecas to show you just a

1229
00:53:59,370 --> 00:53:57,099
little bit more about how beautiful it

1230
00:54:01,140 --> 00:53:59,380
actually is and this is this is just how

1231
00:54:03,870 --> 00:54:01,150
majestic the mountains are that's

1232
00:54:31,269 --> 00:54:03,880
surrounded and I'll give my thanks to

1233
00:54:40,569 --> 00:54:35,420
um I mean you could you could say that I

1234
00:54:45,920 --> 00:54:44,059
think that's too I think that's putting

1235
00:54:50,200 --> 00:54:45,930
too much and what we have at this

1236
00:54:52,430 --> 00:54:50,210
specific place I don't know how much

1237
00:54:54,140 --> 00:54:52,440
what I showed you actually I mean you

1238
00:54:56,509 --> 00:54:54,150

have to appreciate that microbial

1239
00:54:58,789 --> 00:54:56,519
ecology very seldom do you have a place

1240
00:55:00,920 --> 00:54:58,799
that's isolated like this is dominated

1241
00:55:03,950 --> 00:55:00,930
by microbes so this is a really unique

1242
00:55:06,200 --> 00:55:03,960
situation and I don't know even though I

1243
00:55:08,299 --> 00:55:06,210
think it has some relevance for general

1244
00:55:10,849 --> 00:55:08,309
principles I'm not sure what I mean it's

1245
00:55:13,339 --> 00:55:10,859
too it's too early for me to even begin

1246
00:55:18,260 --> 00:55:13,349
to think there what I mean we can have

1247
00:55:24,230 --> 00:55:21,320
I didn't rather expected that the

1248
00:55:26,840 --> 00:55:24,240
precipitation of carbonate would be if

1249
00:55:30,650 --> 00:55:26,850
bicarbonate was being used as the carbon

1250
00:55:32,840 --> 00:55:30,660
source pull out one co2 your life with

1251
00:55:36,320 --> 00:55:32,850
carbonate and I can imagine that if it's

1252
00:55:37,970 --> 00:55:36,330
a single individual cell carbonate might

1253
00:55:40,850 --> 00:55:37,980
precipitate away from it but if you've

1254
00:55:43,460 --> 00:55:40,860
had on that of blue parades that they

1255
00:55:45,200 --> 00:55:43,470
made the calcium carbonate kind of sit

1256
00:55:49,340 --> 00:55:45,210
on top of it he didn't refer

1257
00:55:51,620 --> 00:55:49,350
specifically to that reaction that that

1258
00:55:54,860 --> 00:55:51,630
reaction does happen when they create

1259
00:55:57,740 --> 00:55:54,870
the the EPS it actually does sometimes

1260
00:56:00,530 --> 00:55:57,750
cause the bicarbonate to split in that

1261
00:56:02,750 --> 00:56:00,540
actual reaction to occur I don't know

1262
00:56:05,090 --> 00:56:02,760
specifically if that's happening here I

1263
00:56:06,860 --> 00:56:05,100

don't know that but that does I just

1264
00:56:08,810 --> 00:56:06,870
didn't go into that much detail about it

1265
00:56:11,540 --> 00:56:08,820
but I mean it that certainly can't

1266
00:56:14,030 --> 00:56:11,550
happen I mean the basic the basic thing

1267
00:56:17,630 --> 00:56:14,040
that you can take home is something has

1268
00:56:19,820 --> 00:56:17,640
to happen locally for that precipitation

1269
00:56:21,350 --> 00:56:19,830
to occur and as much as we can

1270
00:56:23,570 --> 00:56:21,360
understand about what's causing that

1271
00:56:26,380 --> 00:56:23,580
local precipitation occur whether its pH

1272
00:56:29,090 --> 00:56:26,390
change or bicarbonate ions you know

1273
00:56:30,740 --> 00:56:29,100
breaking them breaking bicarbonate up or

1274
00:56:33,980 --> 00:56:30,750
whatever I mean that adds to us

1275
00:56:39,170 --> 00:56:33,990
understanding housing because you can go

1276
00:56:41,190 --> 00:56:39,180
to places that it doesn't happen do a

1277
00:56:44,420 --> 00:56:41,200
sense from originally

1278
00:56:52,730 --> 00:56:48,860
no yes okay the question was how many

1279
00:56:55,040 --> 00:56:52,740
other organisms at Quattro Senecas might

1280
00:56:57,380 --> 00:56:55,050
be used utilizing soulful lipids and

1281
00:57:00,680 --> 00:56:57,390
their membranes as the pasilla sister

1282
00:57:04,070 --> 00:57:00,690
that is an excellent excellent question

1283
00:57:06,220 --> 00:57:04,080
and if you were if I could ask for a

1284
00:57:08,990 --> 00:57:06,230
reviewer for a grant I put your name

1285
00:57:13,130 --> 00:57:09,000
because that's a grant we currently have

1286
00:57:15,080 --> 00:57:13,140
helped for exactly that thing I mean you

1287
00:57:16,970 --> 00:57:15,090
would think that probably there'd be

1288
00:57:19,790 --> 00:57:16,980

lots of stuff down there that's resorted

1289
00:57:21,440 --> 00:57:19,800
to that strategy I mean why other thing

1290
00:57:28,210 --> 00:57:21,450
you know other things too that's an

1291
00:57:28,220 --> 00:57:45,660
No

1292
00:57:45,670 --> 00:57:51,120
right

1293
00:57:55,550 --> 00:57:53,250
okay I'll just I'm going to have to

1294
00:57:57,810 --> 00:57:55,560
admit i am not a geologist and I know

1295
00:57:59,580 --> 00:57:57,820
extreme I mean I just there's no way I

1296
00:58:01,230 --> 00:57:59,590
could answer that maybe somebody in the

1297
00:58:03,000 --> 00:58:01,240
room here understands a little bit more

1298
00:58:06,060 --> 00:58:03,010
about phosphorus availability and what

1299
00:58:07,970 --> 00:58:06,070
happens you know when when you're when

1300
00:58:10,470 --> 00:58:07,980
you're looking at an environment and

1301
00:58:11,640 --> 00:58:10,480
there's a lot of evaporative process is

1302
00:58:15,540 --> 00:58:11,650
going on I don't know what would make

1303
00:58:17,100 --> 00:58:15,550
phosphorus low there I have no clue let

1304
00:58:19,380 --> 00:58:17,110
me ask you a question how many of you in

1305
00:58:23,310 --> 00:58:19,390
here believe that that's the sort of a

1306
00:58:25,980 --> 00:58:23,320
relic relic of ancient oceans you think

1307
00:58:30,590 --> 00:58:25,990
that's reasonable to think that you're

1308
00:58:35,400 --> 00:58:30,600
okay with them usually I get some very

1309
00:58:37,440 --> 00:58:35,410
pointed arguments I don't understand how

1310
00:58:40,800 --> 00:58:37,450
you could do that I understand how it

1311
00:58:44,370 --> 00:58:40,810
could be the biology could be you know

1312
00:58:46,860 --> 00:58:44,380
ancient relics for that the problem is

1313
00:58:48,270 --> 00:58:46,870

it just we keep having data that shows

1314
00:58:49,980 --> 00:58:48,280
that I mean I didn't tell you that

1315
00:58:52,500 --> 00:58:49,990
there's diatoms down there that look

1316
00:58:54,450 --> 00:58:52,510
like they're boring I mean with bacteria

1317
00:58:56,490 --> 00:58:54,460
i mighta could have said well maybe it's

1318
00:58:58,850 --> 00:58:56,500
sort of convergent evolution because

1319
00:59:00,780 --> 00:58:58,860
it's you know it's incident you know

1320
00:59:03,810 --> 00:59:00,790
salty environment although it's not

1321
00:59:06,560 --> 00:59:03,820
sodium chloride but it's a marine

1322
00:59:09,540 --> 00:59:06,570
signature it's not a it's not a salt

1323
00:59:11,520 --> 00:59:09,550
signature that showing up so y'all are

1324
00:59:13,580 --> 00:59:11,530
much more maybe that's people that live

1325
00:59:18,060 --> 00:59:13,590
in Seattle are much more willing to

1326
00:59:21,930 --> 00:59:18,070
thank you outside the box very different

1327
00:59:23,370 --> 00:59:21,940
compositions as well get it well they so

1328
00:59:26,100 --> 00:59:23,380
it's kind of its kind of some of them

1329
00:59:28,290 --> 00:59:26,110
you can have one that's you know like

1330
00:59:29,550 --> 00:59:28,300
real big and it's about this much space

1331
00:59:31,680 --> 00:59:29,560
between the next one and this one will

1332
00:59:34,110 --> 00:59:31,690
be dark brown and that one will be blue

1333
00:59:36,480 --> 00:59:34,120
green and there's about this much space

1334
00:59:38,400 --> 00:59:36,490
between two but I don't know what that

1335
00:59:42,840 --> 00:59:38,410
translates into there's there's some

1336
00:59:51,210 --> 00:59:42,850
chemistry differences but I don't we

1337
00:59:58,950 --> 00:59:56,280
there's a lot of project all right I'm

1338
01:00:01,109 --> 00:59:58,960

sure Janet wouldn't mind so in rotation

1339
01:00:02,490 --> 01:00:01,119
oh yes we always have we love to have a

1340
01:00:05,700 --> 01:00:02,500
good light to go on a field trip with

1341
01:00:09,510 --> 01:00:05,710
Janet I'm thinking about asking micro to

1342
01:00:14,910 --> 01:00:09,520
come down do you know micro y'all don't

1343
01:00:16,980 --> 01:00:14,920
watch dirty jobs oh my gosh we have to

1344
01:00:21,330 --> 01:00:16,990
dig around in the sulfur smelling you

1345
01:00:22,890 --> 01:00:21,340
know yeah it's pretty dirty dusty and

1346
01:00:25,380 --> 01:00:22,900
you need a crash helmet for the right

1347
01:00:28,109 --> 01:00:25,390
across the desert because we've just get

1348
01:00:30,089 --> 01:00:28,119
to be part of the country anyway do we

1349
01:00:32,339 --> 01:00:30,099
have any questions on videocon no no

1350
01:00:35,310 --> 01:00:32,349
okay then all right you ready more

1351
01:00:37,310 --> 01:00:35,320
questions for Janet yes yeah that's what

1352
01:00:40,260 --> 01:00:37,320
so what's this what kind of

1353
01:00:43,200 --> 01:00:40,270
cyanobacteria so there's Cal thanks

1354
01:00:45,599 --> 01:00:43,210
maybe the other question is how closely

1355
01:00:47,390 --> 01:00:45,609
related are sheep cheese for self

1356
01:00:53,370 --> 01:00:47,400
Olympics and no sign of activity

1357
01:00:56,930 --> 01:00:53,380
facility sleep-related are the ones the

1358
01:00:59,550 --> 01:00:56,940
ones locally yeah that's a problem

1359
01:01:03,089 --> 01:00:59,560
callithrix is there's a there's a

1360
01:01:05,160 --> 01:01:03,099
succession of you know I guess it's just

1361
01:01:07,770 --> 01:01:05,170
like anything in biology something moves

1362
01:01:10,260 --> 01:01:07,780
in and then other things move in so

1363
01:01:13,800 --> 01:01:10,270

clearly callithrix which is a

1364
01:01:16,260 --> 01:01:13,810
cyanobacteria that has this real heavy

1365
01:01:19,140 --> 01:01:16,270
brown you can almost see it with I

1366
01:01:21,540 --> 01:01:19,150
sheath around it clearly sort of the

1367
01:01:25,440 --> 01:01:21,550
thing that's on top of all the surfaces

1368
01:01:28,740 --> 01:01:25,450
of the microbial arts and we have been

1369
01:01:31,290 --> 01:01:28,750
it's been impossible for us or the

1370
01:01:34,230 --> 01:01:31,300
Arizona State people to isolate them so

1371
01:01:37,230 --> 01:01:34,240
we have no clue how similar those

1372
01:01:39,349 --> 01:01:37,240
soulful lipids are to the ones that

1373
01:01:42,030 --> 01:01:39,359
might be resident there now actually I

1374
01:01:43,410 --> 01:01:42,040
should ask actually I should looking

1375
01:01:45,480 --> 01:01:43,420
because we should have some information

1376
01:01:47,490 --> 01:01:45,490
on that with the meta-genome we should

1377
01:01:48,720 --> 01:01:47,500
be able to tell that i don't remember

1378
01:01:50,430 --> 01:01:48,730
that we ever looked at that that's

1379
01:01:52,920 --> 01:01:50,440
actually a good point so i will look at

1380
01:01:53,940 --> 01:01:52,930
that and see but we would not be able to

1381
01:01:57,329 --> 01:01:53,950
even at that

1382
01:01:59,280 --> 01:01:57,339
would not be able to identify it with a

1383
01:02:02,069 --> 01:01:59,290
particular species I don't think is we

1384
01:02:05,000 --> 01:02:02,079
don't know how many we don't know which

1385
01:02:10,440 --> 01:02:05,010
gene might be with which species here

1386
01:02:12,060 --> 01:02:10,450
that makes sense yeah I thought with the

1387
01:02:13,500 --> 01:02:12,070
meta-genome we should have been able to

1388
01:02:15,060 --> 01:02:13,510

figure we should have been able to see

1389
01:02:18,180 --> 01:02:15,070
that I'll have to ask I'll have to go

1390
01:02:22,010 --> 01:02:18,190
back and ask that same question is what

1391
01:02:25,250 --> 01:02:22,020
did overall diversity of the gene tribal

1392
01:02:29,790 --> 01:02:25,260
religions are they extend the arm about

1393
01:02:31,589 --> 01:02:29,800
right well I mean there are no self a

1394
01:02:33,270 --> 01:02:31,599
lipid zinda sillas so there's no way to

1395
01:02:35,240 --> 01:02:33,280
compare the other Priscilla maybe it

1396
01:02:42,930 --> 01:02:35,250
would didn't with innocent world yeah

1397
01:02:44,700 --> 01:02:42,940
diversity well definitely i'll have to

1398
01:02:47,010 --> 01:02:44,710
go back and look at that i don't know i

1399
01:02:49,109 --> 01:02:47,020
actually don't know and the so I of

1400
01:02:53,390 --> 01:02:49,119
course are the original one of the

1401
01:02:58,530 --> 01:02:56,069
they are also fairly closely related to

1402
01:03:03,210 --> 01:02:58,540
cyanobacteria biogenetic tweets and

1403
01:03:06,210 --> 01:03:03,220
should potentially beaten path well you

1404
01:03:12,950 --> 01:03:06,220
know the first time that the sofa lipids

1405
01:03:19,920 --> 01:03:18,059
anyway they described them in the Senate

1406
01:03:22,260 --> 01:03:19,930
caucus and prochlorococcus that are all

1407
01:03:24,240 --> 01:03:22,270
in the temperate oceans and they've

1408
01:03:26,490 --> 01:03:24,250
actually done many genomes of the ocean

1409
01:03:30,240 --> 01:03:26,500
and they have found what they think is a

1410
01:03:31,680 --> 01:03:30,250
heterotrophic soulful lipid component

1411
01:03:33,620 --> 01:03:31,690
but they can't figure out where it's at

1412
01:03:35,760 --> 01:03:33,630
I actually read that the other day so

1413
01:03:37,410 --> 01:03:35,770

you know I don't know what that means

1414
01:03:39,030 --> 01:03:37,420
they're not saying they're vasilis I

1415
01:03:41,580 --> 01:03:39,040
mean I don't know facilities are in open

1416
01:03:45,760 --> 01:03:41,590
ocean too much

1417
01:03:47,290 --> 01:03:45,770
you know the course the oceans the open

1418
01:03:50,860 --> 01:03:47,300
oceans are low in phosphorus right

1419
01:03:52,840 --> 01:03:50,870
that's why that's why the Senate caucus

1420
01:03:54,970 --> 01:03:52,850
and the prochlorococcus have had

1421
01:03:57,640 --> 01:03:54,980
co-opted that ability they sometimes

1422
01:04:00,430 --> 01:03:57,650
when the phosphorus is the phosphorus is

1423
01:04:02,140 --> 01:04:00,440
plentiful they make possible routes but

1424
01:04:03,970 --> 01:04:02,150
when it's not then they revert to sulfur

1425
01:04:08,680 --> 01:04:03,980
lipids this thing doesn't do anything

1426
01:04:10,780 --> 01:04:08,690
but soulful I can't make possible all