
AbSciCon
2019

1
00:00:00,790 --> 00:00:07,320
[Music]

2
00:00:11,699 --> 00:00:09,049
[Applause]

3
00:00:13,830 --> 00:00:11,709
thank you all for for coming and making

4
00:00:16,410 --> 00:00:13,840
it out so I think the two talks before

5
00:00:18,029 --> 00:00:16,420
really set my talk up really well

6
00:00:19,859 --> 00:00:18,039
because we have these universal

7
00:00:22,349 --> 00:00:19,869
principles of life and now we're kind of

8
00:00:24,060 --> 00:00:22,359
constraining the metabolism of single

9
00:00:25,800 --> 00:00:24,070
cell and now I'm going to take you into

10
00:00:29,130 --> 00:00:25,810
the environment where it gets really

11
00:00:31,019 --> 00:00:29,140
messy really fast so I work on

12
00:00:32,519 --> 00:00:31,029
understanding how microbes are

13
00:00:34,860 --> 00:00:32,529

interacting and interfacing with

14
00:00:36,630 --> 00:00:34,870
themselves and their environment and the

15
00:00:38,729 --> 00:00:36,640
model system that I use are

16
00:00:41,729 --> 00:00:38,739
stromatolites here and stromatolites

17
00:00:44,819 --> 00:00:41,739
have popped up quite a few times over

18
00:00:47,459 --> 00:00:44,829
the course of this week and so but I

19
00:00:50,580 --> 00:00:47,469
thought I would define the term because

20
00:00:52,470 --> 00:00:50,590
I think of them as ecosystems but really

21
00:00:54,990 --> 00:00:52,480
stromatolite are structures they're

22
00:00:57,750 --> 00:00:55,000
sedimentary structures that are made by

23
00:01:00,329 --> 00:00:57,760
the activities of microbes and through

24
00:01:02,520 --> 00:01:00,339
their actions of trapping and binding

25
00:01:05,070 --> 00:01:02,530
sediments from their environment they

26
00:01:07,350 --> 00:01:05,080
all and also through precipitation they

27
00:01:10,320 --> 00:01:07,360
have this very iterative growth process

28
00:01:12,270 --> 00:01:10,330
that creates these these laminations or

29
00:01:14,910 --> 00:01:12,280
layers of carbonate structures that we

30
00:01:17,520 --> 00:01:14,920
think of as the stromatolite structure

31
00:01:19,140 --> 00:01:17,530
and we've heard many reasons why

32
00:01:22,289 --> 00:01:19,150
stromatolites are really interesting

33
00:01:24,620 --> 00:01:22,299
studies too to look at they can be

34
00:01:27,359 --> 00:01:24,630
important reservoirs for biosignatures

35
00:01:28,620 --> 00:01:27,369
analogs we for maybe the carbonates on

36
00:01:30,950 --> 00:01:28,630
Mars so these are just some of the

37
00:01:33,630 --> 00:01:30,960
topics but but they're really productive

38
00:01:36,179 --> 00:01:33,640

ecosystems John Speier the other day

39
00:01:38,459 --> 00:01:36,189
called them microbial mats little rain

40
00:01:41,340 --> 00:01:38,469
forests and and you can really apply

41
00:01:42,929 --> 00:01:41,350
some of these ideas about microbes

42
00:01:46,920 --> 00:01:42,939
interfacing with the environment on

43
00:01:49,950 --> 00:01:46,930
these and ecosystems and so I work on a

44
00:01:51,300 --> 00:01:49,960
community of found in I work on there's

45
00:01:53,010 --> 00:01:51,310
several different stromatolites across

46
00:01:54,840 --> 00:01:53,020
the globe but I work on the ones in

47
00:01:57,480 --> 00:01:54,850
Hamlin pool and Shark Bay Western

48
00:02:00,060 --> 00:01:57,490
Australia Shark Bay is a UNESCO World

49
00:02:02,130 --> 00:02:00,070
Heritage Site and Hamlin pool is kind of

50
00:02:04,740 --> 00:02:02,140
cut off from the rest of Shark Bay by

51
00:02:06,690 --> 00:02:04,750
this location it's called a for a sill

52
00:02:08,990 --> 00:02:06,700
that kind of restricts water flow and

53
00:02:12,240 --> 00:02:09,000
creates a hyper saline environment and

54
00:02:13,950 --> 00:02:12,250
these stromatolites were discovered in

55
00:02:16,350 --> 00:02:13,960
the 1950s and they're been these kind of

56
00:02:18,869 --> 00:02:16,360
canonical mat types that have been

57
00:02:19,970 --> 00:02:18,879
described over the last few decades and

58
00:02:23,180 --> 00:02:19,980
some of them

59
00:02:25,490 --> 00:02:23,190
form stromatolites and some do not and

60
00:02:28,699 --> 00:02:25,500
these names have been around for decades

61
00:02:31,970 --> 00:02:28,709
but the location of where they are is it

62
00:02:33,979 --> 00:02:31,980
is a major driver of what type of

63
00:02:36,500 --> 00:02:33,989

microbes and how they're how they're

64
00:02:38,420 --> 00:02:36,510
making stromatolites and so I'm going to

65
00:02:41,930 --> 00:02:38,430
talk about these format types in my

66
00:02:42,680 --> 00:02:41,940
analysis and the pustular strip forming

67
00:02:44,750 --> 00:02:42,690
stromatolites

68
00:02:46,460 --> 00:02:44,760
I did not name that but the pustular

69
00:02:48,050 --> 00:02:46,470
ones are in the intertidal zone where

70
00:02:50,479 --> 00:02:48,060
the smooth and coliform seem to be

71
00:02:52,190 --> 00:02:50,489
always found in the subtitle and then

72
00:02:53,990 --> 00:02:52,200
you have the non lithified mats which

73
00:02:56,690 --> 00:02:54,000
are definitely in the upper intertidal

74
00:02:58,809 --> 00:02:56,700
regions and so the questions that I'm

75
00:03:01,369 --> 00:02:58,819
looking at is is are there really

76
00:03:03,319 --> 00:03:01,379
footprints or by metabolic footprints

77
00:03:04,880 --> 00:03:03,329
for each of these mat types and I'm

78
00:03:07,940 --> 00:03:04,890
pretty much comparing the non let the

79
00:03:10,699 --> 00:03:07,950
fine to the Litha fiying systems and are

80
00:03:12,650 --> 00:03:10,709
they dependent on their geographical

81
00:03:15,309 --> 00:03:12,660
location or other aspects of their

82
00:03:17,630 --> 00:03:15,319
environment and so again I'm looking at

83
00:03:21,020 --> 00:03:17,640
collecting samples from these different

84
00:03:23,150 --> 00:03:21,030
stromatolites and Nan lithium microbial

85
00:03:25,780 --> 00:03:23,160
mats from two different locations within

86
00:03:28,610 --> 00:03:25,790
the pool a more northern site that is a

87
00:03:31,759 --> 00:03:28,620
more less saline and a hypo or hyper

88
00:03:33,710 --> 00:03:31,769

saline at place called go point in the

89
00:03:35,839 --> 00:03:33,720
southern part and we've looked at the

90
00:03:37,490 --> 00:03:35,849
microbial diversity we've looked at the

91
00:03:40,460 --> 00:03:37,500
metagenomics and now I'm going to talk a

92
00:03:44,659 --> 00:03:40,470
little bit about applying a metabolomics

93
00:03:46,370 --> 00:03:44,669
approach to these ecosystems and just

94
00:03:49,009 --> 00:03:46,380
all the data I'm talking about was

95
00:03:51,920 --> 00:03:49,019
collected at noon the peak of

96
00:03:54,559 --> 00:03:51,930
photosynthesis and so most of

97
00:03:57,349 --> 00:03:54,569
unfortunately most of the data that we

98
00:03:58,729 --> 00:03:57,359
get back are unknowns and there's we're

99
00:04:02,050 --> 00:03:58,739
always kind of working on trying to

100
00:04:05,240 --> 00:04:02,060
improve that but the known communities

101
00:04:07,129 --> 00:04:05,250
have made two plots here one with just

102
00:04:09,670 --> 00:04:07,139
the knowns and with the unknown so even

103
00:04:13,640 --> 00:04:09,680
though we don't know what most of these

104
00:04:16,400 --> 00:04:13,650
metabolites are they don't they seem to

105
00:04:18,560 --> 00:04:16,410
be we still see very discrete

106
00:04:20,029 --> 00:04:18,570
populations of communities suggesting

107
00:04:22,520 --> 00:04:20,039
that each of these mat types have a

108
00:04:27,040 --> 00:04:22,530
really distinctive fingerprint of

109
00:04:29,750 --> 00:04:27,050
metabolic or a pattern of metabolic

110
00:04:33,170 --> 00:04:29,760
molecules in their profile and they

111
00:04:36,970 --> 00:04:33,180
follow a very discrete path with

112
00:04:39,710 --> 00:04:36,980
the c-word the most deep-water

113
00:04:41,630 --> 00:04:39,720

microbialites and then there's also the

114
00:04:43,760 --> 00:04:41,640
non with of fiying so let me just add

115
00:04:45,650 --> 00:04:43,770
this on there so whether or not you have

116
00:04:47,990 --> 00:04:45,660
unknown or known you're getting very

117
00:04:49,490 --> 00:04:48,000
discrete populations of the metabolic

118
00:04:52,580 --> 00:04:49,500
profiles that are really clearly

119
00:04:54,950 --> 00:04:52,590
separated by whether the mat type but we

120
00:04:56,750 --> 00:04:54,960
are also seeing a geographic component

121
00:05:00,650 --> 00:04:56,760
so there's two things driving the

122
00:05:03,230 --> 00:05:00,660
differences in these communities and so

123
00:05:04,580 --> 00:05:03,240
we can see really distinct patterns so

124
00:05:06,590 --> 00:05:04,590
these are just the top we're just

125
00:05:08,270 --> 00:05:06,600
dealing with the known metabolites at

126
00:05:11,510 --> 00:05:08,280
this point and we're seeing really

127
00:05:14,570 --> 00:05:11,520
distinctive patterns within these mat

128
00:05:16,520 --> 00:05:14,580
types and some of these are the top 50

129
00:05:18,560 --> 00:05:16,530
metabolites that were recovering from

130
00:05:22,010 --> 00:05:18,570
these mat types and they're divided up

131
00:05:24,860 --> 00:05:22,020
based on on mat type and location but

132
00:05:27,290 --> 00:05:24,870
we're seeing two major trends here some

133
00:05:28,940 --> 00:05:27,300
patterns of molecules really are

134
00:05:31,310 --> 00:05:28,950
affected by water depth and we can

135
00:05:33,830 --> 00:05:31,320
really distinguish and tell you whether

136
00:05:36,890 --> 00:05:33,840
or not that organ that mat type was is

137
00:05:38,570 --> 00:05:36,900
inter title or subtitle and then we're

138
00:05:40,100 --> 00:05:38,580

also seeing pronounced differences of

139
00:05:41,720 --> 00:05:40,110
whether or not they're Litha fiying or

140
00:05:43,940 --> 00:05:41,730
not Litha fiying so it really depends on

141
00:05:46,580 --> 00:05:43,950
on what your question is but we can also

142
00:05:49,160 --> 00:05:46,590
see this group of clusters only seems to

143
00:05:51,200 --> 00:05:49,170
be appearing in lithified stromatolite

144
00:05:53,120 --> 00:05:51,210
forming mats as opposed to the

145
00:05:56,600 --> 00:05:53,130
non-leather fiying so i'm going to give

146
00:05:58,400 --> 00:05:56,610
you one specific example of a comparison

147
00:06:00,680 --> 00:05:58,410
of pairwise comparison between a

148
00:06:02,860 --> 00:06:00,690
stromatolite forming mat and a

149
00:06:06,050 --> 00:06:02,870
non-letter fiying mat to see what we see

150
00:06:08,420 --> 00:06:06,060
and so this is a volcano plot plotting

151
00:06:12,170 --> 00:06:08,430
all of the metabolites that we're

152
00:06:14,570 --> 00:06:12,180
comparing in these two mat types and on

153
00:06:17,600 --> 00:06:14,580
how you read this is everything on this

154
00:06:19,730 --> 00:06:17,610
side is enriched or up in the

155
00:06:23,240 --> 00:06:19,740
stromatolite forming mat and everything

156
00:06:25,910 --> 00:06:23,250
on this side here is up in the nonlethal

157
00:06:28,160 --> 00:06:25,920
and down in the stromatolite mat and

158
00:06:31,180 --> 00:06:28,170
everything in blue and red here are

159
00:06:35,390 --> 00:06:31,190
significant and everything in red is a

160
00:06:36,890 --> 00:06:35,400
two-fold change or higher so what there

161
00:06:39,500 --> 00:06:36,900
are lots of different metabolites I

162
00:06:41,240 --> 00:06:39,510
could talk about but one of the examples

163
00:06:43,010 --> 00:06:41,250

is they seem to have the stromatolite

164
00:06:44,060 --> 00:06:43,020
forming mats and the non let the flying

165
00:06:45,950 --> 00:06:44,070
mat seem to have very different

166
00:06:46,780 --> 00:06:45,960
strategies of how they might deal with

167
00:06:48,160 --> 00:06:46,790
Osmo

168
00:06:50,470 --> 00:06:48,170
pectins for example one of the most

169
00:06:52,690 --> 00:06:50,480
dominant molecules in the stromatolite

170
00:06:54,940 --> 00:06:52,700
forming mats is a molecule called

171
00:06:56,740 --> 00:06:54,950
trigonal een and that is an Osmo

172
00:07:00,010 --> 00:06:56,750
protectant but it's also an important

173
00:07:01,810 --> 00:07:00,020
bacterial regulator the nonlethal mats

174
00:07:03,970 --> 00:07:01,820
do not seem to have this molecule they

175
00:07:06,930 --> 00:07:03,980
seem to be more enriched in other types

176
00:07:10,660 --> 00:07:06,940
of ozma protectants in this case betting

177
00:07:13,090 --> 00:07:10,670
and the carbon carboxylic acid profiles

178
00:07:15,280 --> 00:07:13,100
seem really different between if mats

179
00:07:18,430 --> 00:07:15,290
that make stromatolite and mats that do

180
00:07:21,370 --> 00:07:18,440
not a good example here carboxylic acids

181
00:07:22,900 --> 00:07:21,380
are important in in carbonate morphology

182
00:07:24,850 --> 00:07:22,910
they're not necessarily serving as

183
00:07:27,910 --> 00:07:24,860
nucleation points but they can actually

184
00:07:30,310 --> 00:07:27,920
control the type of morphology that you

185
00:07:32,080 --> 00:07:30,320
see in the case of malic acid which is

186
00:07:35,020 --> 00:07:32,090
strongly enriched in the stromatolite

187
00:07:36,970 --> 00:07:35,030
forming mats they can actually absorb

188
00:07:39,520 --> 00:07:36,980

onto the calcium carbonate structure and

189
00:07:42,850 --> 00:07:39,530
actually malic acid specifically makes

190
00:07:45,610 --> 00:07:42,860
dumbbell shaped carbonate structures so

191
00:07:47,380 --> 00:07:45,620
you can see that was enriched there but

192
00:07:49,810 --> 00:07:47,390
there the nonlethal mats do have

193
00:07:51,490 --> 00:07:49,820
carboxylic acids they need them but they

194
00:07:53,980 --> 00:07:51,500
have very different profiles and in case

195
00:07:56,980 --> 00:07:53,990
gluconic acid is associated often with

196
00:07:59,410 --> 00:07:56,990
carbonate dissolution actually so by

197
00:08:01,570 --> 00:07:59,420
teasing apart we can actually really see

198
00:08:04,170 --> 00:08:01,580
distinct profiles between what makes

199
00:08:07,150 --> 00:08:04,180
instrumentally different from a non

200
00:08:08,470 --> 00:08:07,160
stromatolite forming mats and now what

201
00:08:10,990 --> 00:08:08,480
we're doing is now we're taking that

202
00:08:12,640 --> 00:08:11,000
metabolomic data and overlaying it with

203
00:08:15,850 --> 00:08:12,650
some of the meta genomic data that we've

204
00:08:17,740 --> 00:08:15,860
accumulated and we have about 35

205
00:08:20,160 --> 00:08:17,750
different meta genomes for these

206
00:08:22,240 --> 00:08:20,170
communities and we're trying to know

207
00:08:24,520 --> 00:08:22,250
there's going to be a lot of organisms

208
00:08:26,050 --> 00:08:24,530
that make malic acid and we're trying to

209
00:08:28,870 --> 00:08:26,060
associate with this is a Pearson

210
00:08:31,660 --> 00:08:28,880
correlation of a smooth a stromatolite

211
00:08:34,150 --> 00:08:31,670
forming mat with a pustular and we can

212
00:08:35,530 --> 00:08:34,160
now see taxonomic differences of who

213
00:08:38,860 --> 00:08:35,540

might be making those different

214
00:08:41,890 --> 00:08:38,870
metabolites and we're taking it a step

215
00:08:44,020 --> 00:08:41,900
further and also looking at what

216
00:08:46,270 --> 00:08:44,030
pathways are enriched and not enriched

217
00:08:48,970 --> 00:08:46,280
depending on what what you're looking at

218
00:08:50,140 --> 00:08:48,980
and in the case of the intertidal here's

219
00:08:53,020 --> 00:08:50,150
a case where we're comparing an

220
00:08:55,870 --> 00:08:53,030
intertidal stromatolite forming mat with

221
00:08:57,460 --> 00:08:55,880
a smooth forming mat that's in the

222
00:08:59,880 --> 00:08:57,470
subtitle and we're seeing really

223
00:09:02,940 --> 00:08:59,890
differences in what type of Metabo

224
00:09:05,340 --> 00:09:02,950
are used are enriched in those

225
00:09:07,350 --> 00:09:05,350
communities so in the case here of the

226
00:09:09,269 --> 00:09:07,360
pustular forming Matt we're actually

227
00:09:10,800 --> 00:09:09,279
seeing strong enrichments everything in

228
00:09:13,110 --> 00:09:10,810
green here is a photosynthesis

229
00:09:15,569 --> 00:09:13,120
associated Matt so when you're in the

230
00:09:17,759 --> 00:09:15,579
entire intertidal zone those map

231
00:09:20,940 --> 00:09:17,769
stromatolite forming mats tend to be

232
00:09:23,690 --> 00:09:20,950
more photosynthesis driven whereas in

233
00:09:26,190 --> 00:09:23,700
the in subtitle we're seeing money more

234
00:09:28,290 --> 00:09:26,200
like sulfate reduction more

235
00:09:30,150 --> 00:09:28,300
heterotrophic metabolisms driving that

236
00:09:32,880 --> 00:09:30,160
so we're really seeing we're getting

237
00:09:34,860 --> 00:09:32,890
profiles not only of basically what

238
00:09:36,780 --> 00:09:34,870

metabolisms are there but maybe some of

239
00:09:39,990 --> 00:09:36,790
the major processes that are forming

240
00:09:43,380 --> 00:09:40,000
these ecosystems and now we're layering

241
00:09:45,480 --> 00:09:43,390
in the environment into this we've over

242
00:09:47,730 --> 00:09:45,490
the last six seven years we've had data

243
00:09:50,460 --> 00:09:47,740
loggers all throughout the different

244
00:09:54,090 --> 00:09:50,470
parts of the pool here capturing

245
00:09:55,860 --> 00:09:54,100
temperature salinity and tidal Heights

246
00:09:58,560 --> 00:09:55,870
for all these environments and my

247
00:10:01,920 --> 00:09:58,570
colleagues University Miami have created

248
00:10:04,019 --> 00:10:01,930
a really detailed bathymetry map and

249
00:10:06,360 --> 00:10:04,029
captured some of the more fun more of

250
00:10:08,880 --> 00:10:06,370
the macro features of these

251
00:10:10,829 --> 00:10:08,890
stromatolites and we're starting to

252
00:10:12,900 --> 00:10:10,839
layer in the environmental data

253
00:10:14,610 --> 00:10:12,910
associated with these communities and

254
00:10:18,030 --> 00:10:14,620
one story I'll tell you is about

255
00:10:20,370 --> 00:10:18,040
salinity salinity in a lot of

256
00:10:22,139 --> 00:10:20,380
environments drives certain microbial

257
00:10:24,150 --> 00:10:22,149
populations I've seen it in the mats in

258
00:10:26,850 --> 00:10:24,160
the Bahamas but in this particular

259
00:10:28,500 --> 00:10:26,860
environment salinity accounts from very

260
00:10:30,420 --> 00:10:28,510
little of the diversity that we're

261
00:10:32,430 --> 00:10:30,430
seeing in the communities those treat

262
00:10:35,069 --> 00:10:32,440
those really tight discrete patterns

263
00:10:37,079 --> 00:10:35,079

that we saw in looking at the

264
00:10:39,810 --> 00:10:37,089
metabolomic aynd of gets lost when we

265
00:10:42,689 --> 00:10:39,820
start just focusing on salinity and only

266
00:10:44,790 --> 00:10:42,699
about about less than 10 percent of the

267
00:10:47,250 --> 00:10:44,800
variation could be explained by salinity

268
00:10:49,590 --> 00:10:47,260
so some environmental factors like water

269
00:10:51,990 --> 00:10:49,600
depth seem to be more important than

270
00:10:55,439 --> 00:10:52,000
other factors like salinity and we're

271
00:10:59,910 --> 00:10:55,449
slowly teasing those interactions apart

272
00:11:02,699 --> 00:10:59,920
and just to kind of recap some of these

273
00:11:04,530 --> 00:11:02,709
big ideas are there different distinct

274
00:11:06,930 --> 00:11:04,540
metabolic signatures with each of these

275
00:11:09,389 --> 00:11:06,940
mat types yes there does seem to be

276
00:11:10,470 --> 00:11:09,399
stromatolite specific metabolites that

277
00:11:12,509 --> 00:11:10,480
are found

278
00:11:15,060 --> 00:11:12,519
and yet you can also then use other

279
00:11:17,610 --> 00:11:15,070
patterns within the metabolome profile

280
00:11:19,290 --> 00:11:17,620
to understand where they are or what

281
00:11:21,750 --> 00:11:19,300
signature they have that's dependent on

282
00:11:23,250 --> 00:11:21,760
the environment and one thing I didn't

283
00:11:26,250 --> 00:11:23,260
really talk about are the discreet

284
00:11:28,050 --> 00:11:26,260
really different surface features of

285
00:11:30,960 --> 00:11:28,060
these these morphological features of

286
00:11:33,269 --> 00:11:30,970
the stromatolites and what the big

287
00:11:35,759 --> 00:11:33,279
factor seems to be is where they are in

288
00:11:38,310 --> 00:11:35,769

the water column and that really impacts

289
00:11:40,860 --> 00:11:38,320
the genetic content of these systems and

290
00:11:42,870 --> 00:11:40,870
and now what we're trying to do is

291
00:11:46,560 --> 00:11:42,880
correlate those surface map features

292
00:11:49,199 --> 00:11:46,570
with the subsurface structures to say

293
00:11:53,910 --> 00:11:49,209
what might be the underlying carbonate

294
00:11:56,310 --> 00:11:53,920
structures in those communities and I

295
00:11:57,990 --> 00:11:56,320
just want to say thank you to Joanna

296
00:12:00,600 --> 00:11:58,000
Babilonia she was the graduate student

297
00:12:03,329 --> 00:12:00,610
who did a lot of this work and she's now

298
00:12:06,360 --> 00:12:03,339
a postdoc at the Lawrence Los Alamos

299
00:12:08,850 --> 00:12:06,370
National Lab and Pam Reed who has been a

300
00:12:10,259 --> 00:12:08,860
big help with the geological aspects of

301
00:12:12,389 --> 00:12:10,269
this Tim Garrett who helps with the

302
00:12:13,949 --> 00:12:12,399
metabolomics and Bush heritage and

303
00:12:16,379 --> 00:12:13,959
Western Australia government for

304
00:12:18,150 --> 00:12:16,389
allowing me access to this UNESCO proof

305
00:12:22,050 --> 00:12:18,160
really important unesco world heritage

306
00:12:24,389 --> 00:12:22,060
site and phil Playford who discovered

307
00:12:25,860 --> 00:12:24,399
these in 1952 he passed away about a

308
00:12:27,360 --> 00:12:25,870
little bit more than a year ago so I

309
00:12:29,460 --> 00:12:27,370
really want to say thank you and also

310
00:12:31,620 --> 00:12:29,470
thank you to my funding sources so that

311
00:12:33,389 --> 00:12:31,630
was just a big picture to kind of give

312
00:12:35,519 --> 00:12:33,399
you an idea of how we're applying these

313
00:12:36,480 --> 00:12:35,529

systems biology approaches to modern

314
00:12:42,630 --> 00:12:36,490
living stromatolite

315
00:12:47,830 --> 00:12:45,580
not bad I'm like only 30 seconds over

316
00:12:57,670 --> 00:12:47,840
all right Thank You Jamie one quick

317
00:12:59,290 --> 00:12:57,680
question yes oh yeah yeah actually I've

318
00:13:02,260 --> 00:12:59,300
taken some of these mats into the lab

319
00:13:03,780 --> 00:13:02,270
and built little environmental chambers

320
00:13:06,310 --> 00:13:03,790
where we can manipulate and

321
00:13:08,500 --> 00:13:06,320
interestingly I've manipulated co2

322
00:13:10,930 --> 00:13:08,510
salinity and temperature on these and

323
00:13:13,540 --> 00:13:10,940
it's really hard to break a stromatolite

324
00:13:15,280 --> 00:13:13,550
let's put it that way these systems you

325
00:13:18,280 --> 00:13:15,290
can manipulate and obviously they've

326
00:13:20,980 --> 00:13:18,290
been around for a long with very dynamic

327
00:13:22,570 --> 00:13:20,990
environmental conditions and we have

328
00:13:24,930 --> 00:13:22,580
been able to track and follow how the

329
00:13:26,710 --> 00:13:24,940
community is changing under these

330
00:13:28,900 --> 00:13:26,720
environment if you lay shion's and we

331
00:13:30,910 --> 00:13:28,910
can get these stromatolites to form and