227: Understanding Adaptation & Evolution of Earth Organisms to Extraterrestrial Environments I

1
00:00:06,389 --> 00:00:03,189
so welcome everyone um online and on

2
00:00:08,950 --> 00:00:06,399
site this is a hybrid session um

3
00:00:11,509 --> 00:00:08,960
uh titled understanding adaptation and

4
00:00:13,830 --> 00:00:11,519
evolution of earth organisms uh to

5
00:00:15,990 --> 00:00:13,840
extraterrestrial environment um i am

6
00:00:18,310 --> 00:00:16,000
your virtual chair marina walther

7
00:00:20,790 --> 00:00:18,320
antonio from mayo clinic um i have a

8
00:00:22,790 --> 00:00:20,800
co-chair dirk schulze machook from

9
00:00:24,710 --> 00:00:22,800
the technical university of berlin but

10
00:00:25,990 --> 00:00:24,720
due to family matters you won't be able

11
00:00:27,589 --> 00:00:26,000
to attend

12
00:00:30,310 --> 00:00:27,599
but we do have

13
00:00:32,150 --> 00:00:30,320

frank rosenzweig from the georgia

14
00:00:33,990 --> 00:00:32,160
institute of technology just right there

15
00:00:35,750 --> 00:00:34,000
and flesh and bone to help

16
00:00:38,150 --> 00:00:35,760
with the session for for those who are

17
00:00:41,270 --> 00:00:38,160
more physically there

18
00:00:42,389 --> 00:00:41,280
we have a tight session uh six speakers

19
00:00:43,430 --> 00:00:42,399
so

20
00:00:45,190 --> 00:00:43,440
you know with 10 minutes for

21
00:00:49,350 --> 00:00:45,200
presentation time and then five minutes

22
00:00:51,590 --> 00:00:49,360
for q a um so i'll uh go ahead and and

23
00:00:53,910 --> 00:00:51,600
uh the first speaker can um can can

24
00:00:58,069 --> 00:00:53,920
start the presentation a virtual speaker

25
00:00:59,670 --> 00:00:58,079
uh you won't leo from um the mayo clinic

26
00:01:12,070 --> 00:00:59,680
go ahead do you want

27
00:01:17,590 --> 00:01:15,429
good afternoon everyone my name is

28
00:01:20,070 --> 00:01:17,600
and today i'm presenting on behalf of

29
00:01:23,350 --> 00:01:20,080
our contributing authors in our recent

30
00:01:26,789 --> 00:01:23,360
work on non-random genetic alterations

31
00:01:27,670 --> 00:01:26,799
in cyanobacteria nonstop species exposed

32
00:01:30,950 --> 00:01:27,680
to

33
00:01:34,469 --> 00:01:31,990
so the

34
00:01:37,270 --> 00:01:34,479
overall motivation is to

35
00:01:39,830 --> 00:01:37,280
try to find out a bigger question about

36
00:01:42,310 --> 00:01:39,840
what genetic communications can occur in

37
00:01:44,789 --> 00:01:42,320
microbes after their exposure to space

38
00:01:46,870 --> 00:01:44,799

and simulated mars conditions and this

39
00:01:49,749 --> 00:01:46,880
experiment is part of a larger effort

40
00:01:52,310 --> 00:01:49,759
called biomass project that is a biology

41
00:01:54,870 --> 00:01:52,320
and mars experiments and it goes to

42
00:01:57,670 --> 00:01:54,880
identify the genomic variation of nasdaq

43
00:02:00,630 --> 00:01:57,680
species exposed to mars and

44
00:02:03,030 --> 00:02:00,640
space conditions so uh the the the

45
00:02:05,429 --> 00:02:03,040
sample were first cultured in a natural

46
00:02:07,670 --> 00:02:05,439
condition uh on earth and part of them

47
00:02:09,510 --> 00:02:07,680
were sent to the international state

48
00:02:11,750 --> 00:02:09,520
space station and in flight for 15

49
00:02:13,990 --> 00:02:11,760
months and part of them remain in the

50
00:02:16,869 --> 00:02:14,000
experimental simulation chamber on the

51
00:02:19,110 --> 00:02:16,879
earth and after the iss returned the

52
00:02:20,229 --> 00:02:19,120
sample to the ground and

53
00:02:22,949 --> 00:02:20,239
they were

54
00:02:25,589 --> 00:02:22,959
processed and sent to us at mayo clinic

55
00:02:27,350 --> 00:02:25,599
and we have the microfluidic and uh

56
00:02:28,790 --> 00:02:27,360
optical treatment system that will be

57
00:02:30,710 --> 00:02:28,800
able to

58
00:02:33,350 --> 00:02:30,720
handle in single cells and what we did

59
00:02:36,070 --> 00:02:33,360
is to rehydrate the cells and fed them

60
00:02:36,949 --> 00:02:36,080
into microfluidic device and use our

61
00:02:39,430 --> 00:02:36,959
single

62
00:02:41,350 --> 00:02:39,440
optical tweezer to select and manipulate

63
00:02:44,229 --> 00:02:41,360

single cells into the individual

64
00:02:46,070 --> 00:02:44,239
chambers in the device and perform

65
00:02:47,910 --> 00:02:46,080
cell lysis and the whole genome

66
00:02:51,190 --> 00:02:47,920
amplification and then we collect the

67
00:02:52,949 --> 00:02:51,200
sample for downstream sequencing and the

68
00:02:54,869 --> 00:02:52,959
data analysis

69
00:02:57,750 --> 00:02:54,879
so from this work we were able to

70
00:03:00,630 --> 00:02:57,760
recover uh almost complete genome for

71
00:03:02,390 --> 00:03:00,640
the non-stop species from the single

72
00:03:04,229 --> 00:03:02,400
cells and we can see some light

73
00:03:07,030 --> 00:03:04,239
contaminants but they were easily

74
00:03:08,630 --> 00:03:07,040
removed prior to the data analysis and

75
00:03:10,710 --> 00:03:08,640
we have a more

76
00:03:12,470 --> 00:03:10,720
comprehensive analysis on the quality of

77
00:03:14,309 --> 00:03:12,480
the single cell data

78
00:03:16,550 --> 00:03:14,319
using the single cell technology in the

79
00:03:19,190 --> 00:03:16,560
microfluidic device which is uh

80
00:03:21,830 --> 00:03:19,200
published in eye science

81
00:03:23,670 --> 00:03:21,840
very recently

82
00:03:26,229 --> 00:03:23,680
the first thing that we looked at the

83
00:03:28,630 --> 00:03:26,239
data set is nonstop species sample

84
00:03:31,509 --> 00:03:28,640
purity and genome coverage

85
00:03:34,470 --> 00:03:31,519
in general we have a cert we have a

86
00:03:37,110 --> 00:03:34,480
observed that the samples on iss display

87
00:03:40,229 --> 00:03:37,120
higher purity than grout samples and

88
00:03:42,789 --> 00:03:40,239

especially it's interesting to see that

89
00:03:44,710 --> 00:03:42,799
the on the iss even the samples that are

90
00:03:46,869 --> 00:03:44,720
exposed to uv

91
00:03:48,630 --> 00:03:46,879
they were they showed us three times

92
00:03:50,949 --> 00:03:48,640
purities and the ground samples that are

93
00:03:53,589 --> 00:03:50,959
exposed to uv although the uv

94
00:03:55,270 --> 00:03:53,599
underground is almost twice as high as

95
00:03:57,910 --> 00:03:55,280
uh on the iss

96
00:04:00,550 --> 00:03:57,920
so this can indicate that there is some

97
00:04:02,710 --> 00:04:00,560
complex cosmic radiation effect in the

98
00:04:05,429 --> 00:04:02,720
near-earth environment that can be

99
00:04:09,270 --> 00:04:05,439
detrimental and challenge the survival

100
00:04:11,750 --> 00:04:09,280
of the companion microbial species

101
00:04:13,910 --> 00:04:11,760
within the sample but only those uh

102
00:04:16,150 --> 00:04:13,920
nasdaq species that are very resilient

103
00:04:19,509 --> 00:04:16,160
and have very thick cellular structures

104
00:04:21,590 --> 00:04:19,519
can survive those extreme conditions

105
00:04:24,629 --> 00:04:21,600
we also have observed that the samples

106
00:04:28,469 --> 00:04:24,639
in lunar and martian medium displayed

107
00:04:31,110 --> 00:04:28,479
relatively poor coverage compare and and

108
00:04:34,150 --> 00:04:31,120
the best sample purity were achieved in

109
00:04:36,070 --> 00:04:34,160
uh bj11 media which is a natural media

110
00:04:38,870 --> 00:04:36,080
and tailored to the maximum survival of

111
00:04:42,230 --> 00:04:38,880
a non-stop species and this happens both

112
00:04:44,950 --> 00:04:42,240
on the iss and on the ground and this is

113
00:04:48,310 --> 00:04:44,960

indicating that nostalgia can better

114
00:04:51,270 --> 00:04:48,320
adapt to uv radiation if it's it's a

115
00:04:54,310 --> 00:04:51,280
natural habitat

116
00:04:56,150 --> 00:04:54,320
so the next we looked at the

117
00:04:58,310 --> 00:04:56,160
the whole genome and see if there are

118
00:05:00,629 --> 00:04:58,320
some variants

119
00:05:02,070 --> 00:05:00,639
across the genome the first set of

120
00:05:04,870 --> 00:05:02,080
variants we have

121
00:05:07,510 --> 00:05:04,880
noticed is that the biofilm associated

122
00:05:10,550 --> 00:05:07,520
hemagglutinin gene and

123
00:05:13,189 --> 00:05:10,560
we call it a variant if they appear in

124
00:05:14,629 --> 00:05:13,199
at least two single cells

125
00:05:17,749 --> 00:05:14,639
so uh this

126
00:05:19,430 --> 00:05:17,759
hemagglutinin related gene

127
00:05:22,150 --> 00:05:19,440
are responsible for

128
00:05:24,390 --> 00:05:22,160
mediating contacts between cells and

129
00:05:27,590 --> 00:05:24,400
also colony formation and biofilm

130
00:05:30,230 --> 00:05:27,600
maturation and also plays a hero and

131
00:05:32,070 --> 00:05:30,240
protect the colonies from desiccation so

132
00:05:34,629 --> 00:05:32,080
this is the first of a set of gene that

133
00:05:37,110 --> 00:05:34,639
we have observed there are variants both

134
00:05:39,189 --> 00:05:37,120
synonymous and non-synonymous

135
00:05:41,189 --> 00:05:39,199
and the second the

136
00:05:43,909 --> 00:05:41,199
area that i would that receive lots of

137
00:05:46,790 --> 00:05:43,919
variances are photosynthesis associated

138
00:05:50,550 --> 00:05:46,800

genes especially photosystem protein a

139
00:05:53,430 --> 00:05:50,560
psba gene and you can see a lot of

140
00:05:55,350 --> 00:05:53,440
variants here this gene is

141
00:05:58,070 --> 00:05:55,360
considered the

142
00:06:01,990 --> 00:05:58,080
photosystem reaction center and is found

143
00:06:04,070 --> 00:06:02,000
in all photosynthetic organisms and

144
00:06:08,390 --> 00:06:04,080
it plays a protective role in

145
00:06:10,150 --> 00:06:08,400
cyanobacteria from radiation damage

146
00:06:11,430 --> 00:06:10,160
so uh the next thing we would like to

147
00:06:13,990 --> 00:06:11,440
find out is

148
00:06:16,629 --> 00:06:14,000
is to see if these uh the the

149
00:06:20,150 --> 00:06:16,639
the variance pattern are random or they

150
00:06:21,830 --> 00:06:20,160
have a certain trend so we look we

151
00:06:22,790 --> 00:06:21,840
looked at the the

152
00:06:25,350 --> 00:06:22,800
some uh

153
00:06:26,550 --> 00:06:25,360
tsunamis and non-synonymous variants and

154
00:06:28,870 --> 00:06:26,560
we see that

155
00:06:31,590 --> 00:06:28,880
there there happen to have some high

156
00:06:33,430 --> 00:06:31,600
similarity in variant profile

157
00:06:35,430 --> 00:06:33,440
in the same gene across different

158
00:06:37,749 --> 00:06:35,440
conditions for example you can see here

159
00:06:40,070 --> 00:06:37,759
here and here

160
00:06:41,029 --> 00:06:40,080
here they look very similar

161
00:06:43,830 --> 00:06:41,039
so

162
00:06:46,070 --> 00:06:43,840
we did a jing bai jing and geno-white

163
00:06:48,790 --> 00:06:46,080

analysis to see what's the probability

164
00:06:50,950 --> 00:06:48,800
of these variants being random across

165
00:06:52,150 --> 00:06:50,960
different conditions from the gene by g

166
00:06:54,070 --> 00:06:52,160
analysis

167
00:06:56,309 --> 00:06:54,080
the result showed that

168
00:06:58,950 --> 00:06:56,319
the variance being random is only less

169
00:07:03,110 --> 00:06:58,960
than 0.1 percent and from a genome-wide

170
00:07:08,070 --> 00:07:03,120
analysis the probability is less than 10

171
00:07:13,029 --> 00:07:10,710
so the next thing we looked at is the

172
00:07:15,990 --> 00:07:13,039
synonymous versus non-synonymous

173
00:07:17,909 --> 00:07:16,000
variance because the anonymous variance

174
00:07:20,309 --> 00:07:17,919
do not change the encoded protein and

175
00:07:23,029 --> 00:07:20,319
they are usually regarded as silence

176
00:07:25,029 --> 00:07:23,039
while non-synonymous variants have a

177
00:07:28,550 --> 00:07:25,039
translational impact on the encoded

178
00:07:30,550 --> 00:07:28,560
protein so we counted those numbers

179
00:07:32,710 --> 00:07:30,560
and then the genome-wide and gene by g

180
00:07:35,270 --> 00:07:32,720
analysis of the ratio between uh

181
00:07:37,430 --> 00:07:35,280
non-synonymous and synonymous variants

182
00:07:40,150 --> 00:07:37,440
and we see that

183
00:07:42,830 --> 00:07:40,160
many of them are less than one which

184
00:07:45,189 --> 00:07:42,840
means that all conditions exhibited

185
00:07:49,270 --> 00:07:45,199
uh preferentially

186
00:07:53,749 --> 00:07:51,430
uh indeed there are some of the uh

187
00:07:55,909 --> 00:07:53,759
the variants are not synonymous so in

188
00:07:58,950 --> 00:07:55,919

order to find out whether there is a

189
00:08:01,909 --> 00:07:58,960
impact on the protein structure we did a

190
00:08:04,469 --> 00:08:01,919
protein structure prediction to

191
00:08:07,749 --> 00:08:04,479
to for this investigation and we focused

192
00:08:08,629 --> 00:08:07,759
primarily on a pspa protein encoding

193
00:08:10,869 --> 00:08:08,639
gene

194
00:08:13,350 --> 00:08:10,879
because this is the area that most of

195
00:08:14,230 --> 00:08:13,360
the variants cluster but we have found

196
00:08:16,150 --> 00:08:14,240
uh

197
00:08:16,950 --> 00:08:16,160
there are two things one is um shown on

198
00:08:21,830 --> 00:08:16,960
the

199
00:08:24,710 --> 00:08:21,840
announced numbers variants that are

200
00:08:27,189 --> 00:08:24,720
showing up in iss sample that are in the

201
00:08:29,510 --> 00:08:27,199
dark but not showing up in iss sample

202
00:08:31,990 --> 00:08:29,520
that are exposed to uv conditions

203
00:08:35,829 --> 00:08:32,000
and this can indicate that the combined

204
00:08:38,310 --> 00:08:35,839
effects of ionizing cosmic rays and also

205
00:08:41,029 --> 00:08:38,320
uv radiation they may not have the same

206
00:08:43,110 --> 00:08:41,039
effects if each type of radiation stand

207
00:08:45,110 --> 00:08:43,120
alone and the other

208
00:08:47,430 --> 00:08:45,120
thing we have observed is that now

209
00:08:48,230 --> 00:08:47,440
synonymous variants a uv

210
00:08:50,070 --> 00:08:48,240
in a

211
00:08:52,230 --> 00:08:50,080
exposure in the ground

212
00:08:53,430 --> 00:08:52,240
but they are not showing up in uv

213
00:08:56,230 --> 00:08:53,440

exposure

214
00:08:58,710 --> 00:08:56,240
on the iss and this can do

215
00:09:01,110 --> 00:08:58,720
because of some of the unique aspects of

216
00:09:02,230 --> 00:09:01,120
the ground uv such as higher uv

217
00:09:06,070 --> 00:09:02,240
radiation

218
00:09:08,790 --> 00:09:06,080
versus the the intensity on the iss

219
00:09:10,470 --> 00:09:08,800
so the conclusion is that the uh

220
00:09:12,870 --> 00:09:10,480
the pattern of the

221
00:09:15,030 --> 00:09:12,880
uh variants we have seen is not random

222
00:09:16,870 --> 00:09:15,040
because if the genetic variants just

223
00:09:18,710 --> 00:09:16,880
occur randomly they would be scattered

224
00:09:20,790 --> 00:09:18,720
all over the genome but they seem to

225
00:09:23,910 --> 00:09:20,800
concentrate only on the

226
00:09:25,750 --> 00:09:23,920
biofilm and photosynthetic loci and the

227
00:09:28,389 --> 00:09:25,760
uh the second thing is that the flight

228
00:09:30,150 --> 00:09:28,399
sample showed higher number of biofilm

229
00:09:31,590 --> 00:09:30,160
uh including variants where the ground

230
00:09:33,590 --> 00:09:31,600
sample showed a higher number of

231
00:09:36,230 --> 00:09:33,600
photosynthetic variants

232
00:09:39,110 --> 00:09:36,240
and the photo system is also changing in

233
00:09:39,910 --> 00:09:39,120
the space but just not as fast as ground

234
00:09:42,310 --> 00:09:39,920
but

235
00:09:44,870 --> 00:09:42,320
in the in the flight condition the

236
00:09:47,430 --> 00:09:44,880
biofilms low size seems to be a hot spot

237
00:09:49,269 --> 00:09:47,440
and which can uh be accelerated

238
00:09:51,350 --> 00:09:49,279

in its evolution

239
00:09:53,509 --> 00:09:51,360
so the the next step

240
00:09:55,590 --> 00:09:53,519
it will be interesting to investigate

241
00:09:57,590 --> 00:09:55,600
different substrates and different

242
00:10:00,710 --> 00:09:57,600
species and to see if there is a genetic

243
00:10:03,269 --> 00:10:00,720
variation uh pattern

244
00:10:04,710 --> 00:10:03,279
if it's species dependence and it would

245
00:10:06,790 --> 00:10:04,720
be also

246
00:10:09,750 --> 00:10:06,800
interesting to perform microbial single

247
00:10:11,670 --> 00:10:09,760
cell transcriptone and proteome analysis

248
00:10:14,150 --> 00:10:11,680
to investigate functionality of these

249
00:10:16,870 --> 00:10:14,160
variants in our lab we developed

250
00:10:19,030 --> 00:10:16,880
microfluidic tools to for bacterial

251
00:10:21,190 --> 00:10:19,040
single cell studies for example the

252
00:10:23,670 --> 00:10:21,200
lysis are very difficult to lyse

253
00:10:26,470 --> 00:10:23,680
bacteria and also

254
00:10:28,870 --> 00:10:26,480
single cell rna-seq as well as the tools

255
00:10:31,350 --> 00:10:28,880
that can rapidly detect phenograms of

256
00:10:32,389 --> 00:10:31,360
bacterial dna very quickly so we

257
00:10:35,590 --> 00:10:32,399
acknowledge

258
00:10:37,829 --> 00:10:35,600
our collaborators and their um

259
00:10:40,550 --> 00:10:37,839
and all our funders and both individual

260
00:10:47,030 --> 00:10:40,560
and as a funding agency and thank you

261
00:10:51,910 --> 00:10:49,590
thank you um

262
00:10:59,430 --> 00:10:51,920
are there any questions either on site

263
00:11:04,069 --> 00:11:02,150

and while we wait uh just just for

264
00:11:05,990 --> 00:11:04,079
require there's one all right yeah i

265
00:11:07,030 --> 00:11:06,000
have a question is this one

266
00:11:08,790 --> 00:11:07,040
um

267
00:11:10,710 --> 00:11:08,800
i'm penny khan from university of

268
00:11:14,790 --> 00:11:10,720
british columbia i'm just wondering if

269
00:11:17,509 --> 00:11:14,800
you have an idea as to why a biofilm

270
00:11:20,389 --> 00:11:17,519
phenotype would be adaptive in a space

271
00:11:27,430 --> 00:11:22,069
so

272
00:11:31,030 --> 00:11:27,440
assumption is that when when under the

273
00:11:33,430 --> 00:11:31,040
stress or uv the cyanobacteria was uh

274
00:11:35,910 --> 00:11:33,440
was shown that they can release certain

275
00:11:38,069 --> 00:11:35,920
uh substances to protect themselves from

276
00:11:39,910 --> 00:11:38,079
the uv so uh but so we

277
00:11:42,550 --> 00:11:39,920
we have observed uh we have tried to

278
00:11:44,790 --> 00:11:42,560
observe the phenotype change

279
00:11:47,030 --> 00:11:44,800
after they are returned to the uh from

280
00:11:49,509 --> 00:11:47,040
the space we didn't see any uh

281
00:11:51,590 --> 00:11:49,519
phenotypic change under the microscope

282
00:11:53,509 --> 00:11:51,600
but just showing up in the energy but

283
00:11:56,389 --> 00:11:53,519
this is something interesting that was

284
00:12:00,629 --> 00:11:56,399
further investigation

285
00:12:05,350 --> 00:12:03,509
are there other questions

286
00:12:06,150 --> 00:12:05,360
this is frank rosen so i get georgia

287
00:12:08,389 --> 00:12:06,160
tech

288
00:12:10,470 --> 00:12:08,399

thank you for a lovely talk i have a

289
00:12:14,389 --> 00:12:10,480
couple of questions about your about the

290
00:12:19,350 --> 00:12:16,550
how many generations

291
00:12:21,110 --> 00:12:19,360
were these experiments

292
00:12:22,470 --> 00:12:21,120
and given what you know

293
00:12:24,870 --> 00:12:22,480
about the

294
00:12:26,949 --> 00:12:24,880
mutation rate in the organism and the

295
00:12:28,710 --> 00:12:26,959
number of generations in the population

296
00:12:31,509 --> 00:12:28,720
size are the

297
00:12:35,509 --> 00:12:31,519
the numbers of mutations that you're re

298
00:12:37,829 --> 00:12:35,519
recovering uh you know consistent with

299
00:12:39,990 --> 00:12:37,839
you know the the arithmetic there so

300
00:12:42,069 --> 00:12:40,000
that's kind of one question

301
00:12:43,269 --> 00:12:42,079
and the other question is

302
00:12:44,629 --> 00:12:43,279
uh

303
00:12:47,269 --> 00:12:44,639
did you

304
00:12:48,629 --> 00:12:47,279
check you know the fitness of these

305
00:12:51,190 --> 00:12:48,639
phenotypes

306
00:12:54,710 --> 00:12:51,200
with respect to the

307
00:12:58,389 --> 00:12:54,720
ancestral strain that was used to uh

308
00:12:59,750 --> 00:12:58,399
found the these evolution experiments

309
00:13:04,069 --> 00:12:59,760
uh

310
00:13:06,069 --> 00:13:04,079
are

311
00:13:08,550 --> 00:13:06,079
we have

312
00:13:12,069 --> 00:13:08,560
we use the the sample directly returned

313
00:13:14,150 --> 00:13:12,079

from from iss and

314
00:13:16,550 --> 00:13:14,160
fed into our microfluidic device to

315
00:13:19,670 --> 00:13:16,560
perform a direct sequencing so what we

316
00:13:22,150 --> 00:13:19,680
have seen here is possibly uh

317
00:13:23,269 --> 00:13:22,160
the damage occurred during the process

318
00:13:30,870 --> 00:13:23,279
we didn't

319
00:13:34,470 --> 00:13:32,310
so these cells

320
00:13:36,150 --> 00:13:34,480
were or were not replicating when they

321
00:13:38,949 --> 00:13:36,160
were um

322
00:13:40,470 --> 00:13:38,959
when they were on the iss

323
00:13:43,110 --> 00:13:40,480
they're in a uh

324
00:13:45,990 --> 00:13:43,120
alkalized condition so um there are

325
00:13:49,590 --> 00:13:46,000
minimal biological activity over there

326
00:13:52,389 --> 00:13:49,600
okay all right got it thank you so much

327
00:13:56,150 --> 00:13:52,399
and and how about checking the fitness

328
00:13:57,110 --> 00:13:56,160
of these phenotypes that developed um

329
00:14:00,150 --> 00:13:57,120
um

330
00:14:02,310 --> 00:14:00,160
right now we uh use this technology to

331
00:14:04,870 --> 00:14:02,320
kind of give a proof of concept that

332
00:14:07,030 --> 00:14:04,880
this is something we can do we didn't go

333
00:14:10,470 --> 00:14:07,040
deeper into that

334
00:14:12,949 --> 00:14:10,480
discussion in this work

335
00:14:14,790 --> 00:14:13,910
thank you

336
00:14:17,750 --> 00:14:14,800
um

337
00:14:20,069 --> 00:14:17,760
so an interest of time let's move on to

338
00:14:21,350 --> 00:14:20,079

the next speaker which i believe is on

339
00:14:22,550 --> 00:14:21,360
site

340
00:14:24,710 --> 00:14:22,560
um

341
00:14:27,670 --> 00:14:24,720
diction geltem from northern illinois

342
00:14:42,389 --> 00:14:29,670
there we go

343
00:14:42,399 --> 00:14:51,829
well that's it

344
00:14:59,110 --> 00:14:54,790
all right

345
00:15:00,949 --> 00:14:59,120
okay my name is desant i'm from northern

346
00:15:02,389 --> 00:15:00,959
indonesia university i'm doing my phd

347
00:15:04,629 --> 00:15:02,399
there

348
00:15:06,310 --> 00:15:04,639
uh for the past few years a major part

349
00:15:08,069 --> 00:15:06,320
of my research has been looking at this

350
00:15:09,670 --> 00:15:08,079
uh pigment that is responsible for

351
00:15:12,629 --> 00:15:09,680
giving the green characteristic green

352
00:15:14,470 --> 00:15:12,639
color to our planet earth

353
00:15:17,030 --> 00:15:14,480
as a astrobiologist we know the

354
00:15:18,870 --> 00:15:17,040
importance of chlorophyll for uh

355
00:15:20,310 --> 00:15:18,880
for the biosignatures

356
00:15:23,030 --> 00:15:20,320
and most of the chlorophyll that we see

357
00:15:24,949 --> 00:15:23,040
floating around is mostly chlorophyll a

358
00:15:26,870 --> 00:15:24,959
there are other rare chlorophyll like

359
00:15:30,069 --> 00:15:26,880
chlorophyll t which is found in a

360
00:15:32,150 --> 00:15:30,079
keratorius marina on the cyanobacteria

361
00:15:34,550 --> 00:15:32,160
and we don't know we haven't

362
00:15:37,110 --> 00:15:34,560
characterized the gene for it

363
00:15:38,870 --> 00:15:37,120

uh that chlorophyll d is very important

364
00:15:41,910 --> 00:15:38,880
for us because

365
00:15:43,670 --> 00:15:41,920
it absorbs light around the uh

366
00:15:45,189 --> 00:15:43,680
like the near infrared region of the

367
00:15:47,350 --> 00:15:45,199
visible spectrum

368
00:15:49,990 --> 00:15:47,360
and it is important because most of the

369
00:15:51,350 --> 00:15:50,000
cooler star emits light around this uh

370
00:15:54,550 --> 00:15:51,360
wavelength

371
00:15:56,550 --> 00:15:54,560
it is important up there for uh

372
00:15:57,509 --> 00:15:56,560
the eggs like up there in the space for

373
00:15:59,509 --> 00:15:57,519
uh

374
00:16:01,590 --> 00:15:59,519
exoplanets habitability and it is

375
00:16:02,550 --> 00:16:01,600
equally equally important down here in

376
00:16:05,030 --> 00:16:02,560
the earth

377
00:16:07,189 --> 00:16:05,040
uh for if you want to grow crops that

378
00:16:09,269 --> 00:16:07,199
can uh grow in a

379
00:16:11,269 --> 00:16:09,279
area where there is lower amount of

380
00:16:12,949 --> 00:16:11,279
sunlight then if we can characterize

381
00:16:15,110 --> 00:16:12,959
this gene and transfer them to the

382
00:16:17,030 --> 00:16:15,120
plants then there is a good

383
00:16:18,310 --> 00:16:17,040
possibility for increasing the

384
00:16:19,990 --> 00:16:18,320
agriculture

385
00:16:21,110 --> 00:16:20,000
production

386
00:16:23,030 --> 00:16:21,120
the thing is

387
00:16:25,189 --> 00:16:23,040
we know all about chlorophyll a the gene

388
00:16:27,110 --> 00:16:25,199

that synthesizes it chlorophyll b for

389
00:16:28,550 --> 00:16:27,120
chlorophyll f which was discovered later

390
00:16:30,710 --> 00:16:28,560
than chlorophyll d we know the gene that

391
00:16:32,710 --> 00:16:30,720
synthesizes it but we don't know the

392
00:16:34,550 --> 00:16:32,720
gene and that synthesizer chlorophyll d

393
00:16:37,030 --> 00:16:34,560
my advisor had

394
00:16:38,389 --> 00:16:37,040
tried to to synthesize it uh try to

395
00:16:40,550 --> 00:16:38,399
characterize the gene for it during his

396
00:16:43,189 --> 00:16:40,560
thesis i've been trying to do it so it's

397
00:16:45,189 --> 00:16:43,199
a long problem

398
00:16:46,790 --> 00:16:45,199
um so when we try to characterize or

399
00:16:48,389 --> 00:16:46,800
when we try to find the chlorophyll

400
00:16:50,949 --> 00:16:48,399
genes we

401
00:16:52,310 --> 00:16:50,959
go the straightforward approach and try

402
00:16:53,749 --> 00:16:52,320
to look for the chlorophyll binding

403
00:16:55,990 --> 00:16:53,759
domains

404
00:16:57,829 --> 00:16:56,000
and the way we do it is normally is that

405
00:17:00,150 --> 00:16:57,839
we use the sequence to determine the

406
00:17:01,829 --> 00:17:00,160
profile structures and

407
00:17:03,829 --> 00:17:01,839
we use tools like annotation tool that

408
00:17:06,549 --> 00:17:03,839
can easily find the structures using

409
00:17:09,510 --> 00:17:06,559
models like hidden markup models

410
00:17:10,789 --> 00:17:09,520
but is does this work always most of the

411
00:17:12,789 --> 00:17:10,799
time it does

412
00:17:14,230 --> 00:17:12,799
but there are in every genome annotation

413
00:17:16,789 --> 00:17:14,240

you always find proteins that are

414
00:17:19,350 --> 00:17:16,799
labeled as hypothetical proteins right

415
00:17:20,549 --> 00:17:19,360
so what if chlorophyll d gene is one of

416
00:17:22,390 --> 00:17:20,559
the hypothetic it's labeled as

417
00:17:23,990 --> 00:17:22,400
hypothetical protein so we are not

418
00:17:26,390 --> 00:17:24,000
finding it

419
00:17:28,150 --> 00:17:26,400
the way hmm profiling normally works is

420
00:17:30,710 --> 00:17:28,160
that if you look at the lower figure we

421
00:17:32,549 --> 00:17:30,720
see the matches m1 m2 m3 so those

422
00:17:35,029 --> 00:17:32,559
matches are

423
00:17:38,230 --> 00:17:35,039
uh calculated based on the consistent

424
00:17:40,070 --> 00:17:38,240
sequence that hmm uh finds out between

425
00:17:42,470 --> 00:17:40,080
the similar proteins along with the

426
00:17:45,110 --> 00:17:42,480
matches it also can find it also takes

427
00:17:46,390 --> 00:17:45,120
in account the insertions and deletions

428
00:17:48,710 --> 00:17:46,400
of the bases

429
00:17:50,150 --> 00:17:48,720
so taking the analogy of the dock if you

430
00:17:51,990 --> 00:17:50,160
are trying to

431
00:17:54,390 --> 00:17:52,000
find the similarity between the docks it

432
00:17:55,909 --> 00:17:54,400
looks for the peaks and the lakes which

433
00:17:56,710 --> 00:17:55,919
are similar

434
00:18:06,230 --> 00:17:56,720
the

435
00:18:08,310 --> 00:18:06,240
trains itself with such features

436
00:18:09,669 --> 00:18:08,320
and that way it can predict other uh

437
00:18:11,590 --> 00:18:09,679
docks right

438
00:18:14,950 --> 00:18:11,600

but what if there are some weird type of

439
00:18:16,789 --> 00:18:14,960
talk hmm is might is failing in uh

440
00:18:17,750 --> 00:18:16,799
characterizing such uh

441
00:18:18,630 --> 00:18:17,760
talks

442
00:18:20,870 --> 00:18:18,640
so

443
00:18:22,950 --> 00:18:20,880
what we thought of it was like okay now

444
00:18:24,549 --> 00:18:22,960
let's focus on more subtle features than

445
00:18:26,630 --> 00:18:24,559
these general features

446
00:18:28,789 --> 00:18:26,640
uh with html model focuses so let's go

447
00:18:30,310 --> 00:18:28,799
even software and deeper and look at the

448
00:18:32,710 --> 00:18:30,320
rgb values

449
00:18:35,350 --> 00:18:32,720
uh using the machine learning models

450
00:18:37,430 --> 00:18:35,360
if we do that we think we can we can

451
00:18:39,029 --> 00:18:37,440
find even better relationship between

452
00:18:40,870 --> 00:18:39,039
those proteins

453
00:18:43,350 --> 00:18:40,880
so and one thing that machine learning

454
00:18:45,510 --> 00:18:43,360
model has is or we believe it gives a is

455
00:18:47,510 --> 00:18:45,520
over xml model is that along with the

456
00:18:49,110 --> 00:18:47,520
positive data set like similar ducks it

457
00:18:52,070 --> 00:18:49,120
also looks at the negative data sets a

458
00:18:54,710 --> 00:18:52,080
feature that other species like rats and

459
00:18:56,549 --> 00:18:54,720
falcon might not have with the dark set

460
00:18:58,470 --> 00:18:56,559
so that might give it a is over

461
00:19:00,390 --> 00:18:58,480
uh that's a memorable

462
00:19:02,070 --> 00:19:00,400
so we use the random forest for our

463
00:19:04,070 --> 00:19:02,080

machine learning model

464
00:19:05,669 --> 00:19:04,080
and random forest is a collection of

465
00:19:07,110 --> 00:19:05,679
decision trees

466
00:19:10,310 --> 00:19:07,120
which can identify

467
00:19:12,630 --> 00:19:10,320
classify one category over other and

468
00:19:14,630 --> 00:19:12,640
switching from the example of dock we

469
00:19:16,230 --> 00:19:14,640
uh let's go to a jar with a collection

470
00:19:17,669 --> 00:19:16,240
of leaves and

471
00:19:19,430 --> 00:19:17,679
a bigfoot

472
00:19:20,870 --> 00:19:19,440
and when we have already trained our

473
00:19:23,510 --> 00:19:20,880
model with positive

474
00:19:24,870 --> 00:19:23,520
negative training dataset when we take

475
00:19:26,470 --> 00:19:24,880
out one of the

476
00:19:28,630 --> 00:19:26,480
objects from the tsar

477
00:19:31,110 --> 00:19:28,640
and feed it to the model the way the

478
00:19:33,909 --> 00:19:31,120
model works is that each decision tree

479
00:19:37,110 --> 00:19:33,919
is going to decide whether that

480
00:19:40,230 --> 00:19:37,120
object is a leaf or a bigfoot

481
00:19:42,230 --> 00:19:40,240
and they might have different decision

482
00:19:43,669 --> 00:19:42,240
but in the end the majority what the

483
00:19:45,270 --> 00:19:43,679
majority of tree decides that's going to

484
00:19:48,070 --> 00:19:45,280
be our final object

485
00:19:50,070 --> 00:19:48,080
in this case it's the leaf

486
00:19:51,750 --> 00:19:50,080
another thing is the feature selection

487
00:19:54,870 --> 00:19:51,760
like in the case of talk we were looking

488
00:19:56,549 --> 00:19:54,880

at their bills and legs here for protein

489
00:19:58,710 --> 00:19:56,559
sequences uh

490
00:20:00,310 --> 00:19:58,720
we are looking at is amino acids

491
00:20:02,950 --> 00:20:00,320
however the modal machine learning model

492
00:20:04,950 --> 00:20:02,960
it requires uh it requires uh features

493
00:20:07,430 --> 00:20:04,960
in the terms of numbers so we use

494
00:20:09,590 --> 00:20:07,440
conjoined triads to uh extract features

495
00:20:11,990 --> 00:20:09,600
from our amino acid the way it works is

496
00:20:14,310 --> 00:20:12,000
that it it divides our amino acids into

497
00:20:16,870 --> 00:20:14,320
seven classes and it takes a group of

498
00:20:17,669 --> 00:20:16,880
three so every time it's taking group of

499
00:20:28,070 --> 00:20:17,679
three

500
00:20:30,149 --> 00:20:28,080
uh looking at the frequency of those 343

501
00:20:30,950 --> 00:20:30,159
each of the 340 columns in the sequences

502
00:20:32,710 --> 00:20:30,960
right

503
00:20:34,390 --> 00:20:32,720
and how we are working on it is that it

504
00:20:36,950 --> 00:20:34,400
starts with the first sequences uh

505
00:20:39,430 --> 00:20:36,960
that's one in the figure and

506
00:20:41,590 --> 00:20:39,440
it's going to classify them like the lcs

507
00:20:42,549 --> 00:20:41,600
is being classified into g2 g7 and z3

508
00:20:44,310 --> 00:20:42,559
class

509
00:20:46,630 --> 00:20:44,320
then it uh

510
00:20:50,950 --> 00:20:46,640
counts its frequency then it is going to

511
00:20:53,029 --> 00:20:50,960
roll over from to css and so on

512
00:20:55,510 --> 00:20:53,039
so in this way we classify the

513
00:20:57,669 --> 00:20:55,520

frequency of our amino acids and for

514
00:20:59,270 --> 00:20:57,679
training our model we use

515
00:21:02,470 --> 00:20:59,280
chlorophyll binding proteins from

516
00:21:04,630 --> 00:21:02,480
uniprot datasets as a positive training

517
00:21:06,870 --> 00:21:04,640
and e coli proteins for our negative

518
00:21:10,230 --> 00:21:06,880
training data

519
00:21:13,029 --> 00:21:10,240
what we found from our model uh

520
00:21:14,390 --> 00:21:13,039
was that we identified around 64 genes

521
00:21:16,230 --> 00:21:14,400
from the model

522
00:21:18,870 --> 00:21:16,240
many of um some of them were the photo

523
00:21:21,029 --> 00:21:18,880
system genes but we the model didn't

524
00:21:22,630 --> 00:21:21,039
predict any biosynthetic thing

525
00:21:25,510 --> 00:21:22,640
we tried to validate the genes to the

526
00:21:27,669 --> 00:21:25,520
amor in our core

527
00:21:30,549 --> 00:21:27,679
and noted that these genes are not

528
00:21:32,149 --> 00:21:30,559
exclusive to the a marina cyanobacteria

529
00:21:33,830 --> 00:21:32,159
these are also present in other

530
00:21:34,789 --> 00:21:33,840
cyanobacteria

531
00:21:36,310 --> 00:21:34,799
so

532
00:21:38,070 --> 00:21:36,320
what does this mean

533
00:21:41,669 --> 00:21:38,080
one thing it might mean is that our

534
00:21:43,830 --> 00:21:41,679
modal needs might need some tuning and

535
00:21:45,750 --> 00:21:43,840
we might have to use other negative

536
00:21:48,230 --> 00:21:45,760
training data set even a closer one the

537
00:21:49,669 --> 00:21:48,240
closer sign of bacteria or it also could

538
00:21:51,750 --> 00:21:49,679

mean that

539
00:21:53,990 --> 00:21:51,760
the gene is present in both all the

540
00:21:56,710 --> 00:21:54,000
cyanobacteria the only thing difference

541
00:21:58,710 --> 00:21:56,720
is that in some the footage on the gas

542
00:22:00,549 --> 00:21:58,720
foot is off the gas pedal and in our a

543
00:22:02,630 --> 00:22:00,559
marina the foot is on the gas pedal so

544
00:22:05,430 --> 00:22:02,640
it's being uh

545
00:22:07,750 --> 00:22:05,440
the transcription is there

546
00:22:09,590 --> 00:22:07,760
so for looking at those the expression

547
00:22:11,990 --> 00:22:09,600
of those whether it's the expression

548
00:22:15,590 --> 00:22:12,000
that's that really the difference what i

549
00:22:17,430 --> 00:22:15,600
did was i looked at the uh i i took out

550
00:22:19,990 --> 00:22:17,440
the samples from ncbi

551
00:22:21,830 --> 00:22:20,000
that uh had done that uh that like

552
00:22:23,990 --> 00:22:21,840
different projects have been uh

553
00:22:26,230 --> 00:22:24,000
done under for a marina looking at the

554
00:22:27,909 --> 00:22:26,240
different conditions some were done for

555
00:22:29,270 --> 00:22:27,919
with for the oxygen so we're done with

556
00:22:30,789 --> 00:22:29,280
the iron

557
00:22:32,390 --> 00:22:30,799
and what i did was i merged them all

558
00:22:35,510 --> 00:22:32,400
into a single uh

559
00:22:38,070 --> 00:22:35,520
uh like into a single training data and

560
00:22:40,390 --> 00:22:38,080
testing data i combined all the features

561
00:22:41,830 --> 00:22:40,400
and i supplied it to the model

562
00:22:43,669 --> 00:22:41,840
thinking that the

563
00:22:45,590 --> 00:22:43,679

graphing binding genes will cluster into

564
00:22:47,110 --> 00:22:45,600
a together and the rest of the genes

565
00:22:49,110 --> 00:22:47,120
will be clustered far

566
00:22:51,110 --> 00:22:49,120
but what i found was that they didn't

567
00:22:53,110 --> 00:22:51,120
cluster together the blue or the

568
00:22:54,789 --> 00:22:53,120
chlorophyll um genes involving graphic

569
00:22:55,909 --> 00:22:54,799
biosynthesis and the yellow are the rest

570
00:22:57,830 --> 00:22:55,919
of the genes

571
00:22:58,630 --> 00:22:57,840
so one thing that might have gone wrong

572
00:23:00,390 --> 00:22:58,640
or

573
00:23:02,470 --> 00:23:00,400
is that there are lots of noises there

574
00:23:04,390 --> 00:23:02,480
are noises here when i played around

575
00:23:06,310 --> 00:23:04,400
with features i found the clustering was

576
00:23:09,110 --> 00:23:06,320
a little bit improved but

577
00:23:11,669 --> 00:23:09,120
it didn't so the clustering here is done

578
00:23:14,310 --> 00:23:11,679
using a tsne plot so it's it's a

579
00:23:16,390 --> 00:23:14,320
dimensional reduction plot just like pca

580
00:23:18,630 --> 00:23:16,400
and it it also does the unsupervised

581
00:23:20,230 --> 00:23:18,640
learning right so when i use this uh for

582
00:23:21,750 --> 00:23:20,240
clustering i found

583
00:23:23,430 --> 00:23:21,760
well it wasn't crosstalking wheel and

584
00:23:25,510 --> 00:23:23,440
when i tried to play around with some of

585
00:23:27,669 --> 00:23:25,520
the features i found that well there are

586
00:23:28,789 --> 00:23:27,679
noises there and if i could reduce the

587
00:23:32,549 --> 00:23:28,799
noise then

588
00:23:35,029 --> 00:23:32,559

this um genes will cluster together well

589
00:23:37,590 --> 00:23:35,039
so this brings us to our future work

590
00:23:39,750 --> 00:23:37,600
which is that

591
00:23:41,510 --> 00:23:39,760
we need more transcriptomic experiments

592
00:23:44,549 --> 00:23:41,520
done so if you can add more features

593
00:23:46,630 --> 00:23:44,559
into the uh in my training data then we

594
00:23:48,789 --> 00:23:46,640
our model will be better at

595
00:23:50,789 --> 00:23:48,799
clustering all those genes responsible

596
00:23:52,149 --> 00:23:50,799
for chlorophyll biosynthesis

597
00:23:54,149 --> 00:23:52,159
we need more genome sequencing of the

598
00:23:56,549 --> 00:23:54,159
non-chlorophyll d groups and using the

599
00:23:58,710 --> 00:23:56,559
computation analysis we can

600
00:24:01,350 --> 00:23:58,720
reduce the number of uh core genes to a

601
00:24:02,950 --> 00:24:01,360
marina and lastly uh we're also planning

602
00:24:04,549 --> 00:24:02,960
to use deep neural network because we

603
00:24:06,789 --> 00:24:04,559
have seen in many instances that deep

604
00:24:09,269 --> 00:24:06,799
neural neural network is works better in

605
00:24:10,549 --> 00:24:09,279
identifying certain patterns um

606
00:24:12,310 --> 00:24:10,559
like like in the case in some

607
00:24:13,990 --> 00:24:12,320
experiments they have been they have

608
00:24:15,909 --> 00:24:14,000
used it to classify biflim proteins

609
00:24:18,549 --> 00:24:15,919
which were previously thought to be

610
00:24:21,269 --> 00:24:18,559
hypothetical has been classified as

611
00:24:23,110 --> 00:24:21,279
bioframe so and one reason we wanted to

612
00:24:25,750 --> 00:24:23,120
use it for rns value is that because

613
00:24:28,310 --> 00:24:25,760

when we reach to the our level of rnc

614
00:24:29,990 --> 00:24:28,320
expression we are losing um

615
00:24:31,990 --> 00:24:30,000
we have already processing the data

616
00:24:34,470 --> 00:24:32,000
using different sort of normalization so

617
00:24:36,230 --> 00:24:34,480
what if if we just feed in the raw data

618
00:24:38,710 --> 00:24:36,240
to the model maybe it can find the

619
00:24:40,070 --> 00:24:38,720
machine can find some patterns that

620
00:24:42,470 --> 00:24:40,080
might have been lost during this

621
00:24:44,230 --> 00:24:42,480
processing so these are all our feature

622
00:24:45,430 --> 00:24:44,240
work that we are currently doing

623
00:24:47,269 --> 00:24:45,440
so in this way i'm going to acknowledge

624
00:24:48,630 --> 00:24:47,279
acknowledge the nasa's exobiology

625
00:24:50,149 --> 00:24:48,640
program for the funding chariot for

626
00:24:51,590 --> 00:24:50,159
sequencing nna for giving me the

627
00:24:56,149 --> 00:24:51,600
opportunity to come here and present

628
00:25:00,950 --> 00:24:57,430
thank you

629
00:25:06,710 --> 00:25:00,960
um any questions

630
00:25:11,110 --> 00:25:08,789
i i just have a question while we wait

631
00:25:12,710 --> 00:25:11,120
still um so he said that the model

632
00:25:14,950 --> 00:25:12,720
predicted

633
00:25:16,789 --> 00:25:14,960
for the system genes um

634
00:25:17,909 --> 00:25:16,799
well but really uh

635
00:25:19,590 --> 00:25:17,919
wasn't very good at predicting

636
00:25:21,430 --> 00:25:19,600
biosynthesis genes is this like a

637
00:25:22,310 --> 00:25:21,440
database issue or what what do you think

638
00:25:24,950 --> 00:25:22,320

is the

639
00:25:26,230 --> 00:25:24,960
the reason for that particular

640
00:25:27,190 --> 00:25:26,240
observation

641
00:25:30,870 --> 00:25:27,200
i think

642
00:25:31,909 --> 00:25:30,880
the

643
00:25:33,909 --> 00:25:31,919
model

644
00:25:35,590 --> 00:25:33,919
must look uh didn't get the features

645
00:25:37,909 --> 00:25:35,600
that are very uh

646
00:25:39,830 --> 00:25:37,919
like you know exclusive to cyanobacteria

647
00:25:40,710 --> 00:25:39,840
right now i've modeled it with e coli so

648
00:25:41,990 --> 00:25:40,720
maybe

649
00:25:44,230 --> 00:25:42,000
it was able to differentiate between e

650
00:25:45,830 --> 00:25:44,240
coli and cyanobacteria but uh

651
00:25:47,669 --> 00:25:45,840
you know it didn't find a model that is

652
00:25:49,669 --> 00:25:47,679
very exclusive to our feces that is very

653
00:25:51,269 --> 00:25:49,679
exclusive to cyanobacteria so i think it

654
00:25:53,909 --> 00:25:51,279
will work better if i

655
00:25:56,230 --> 00:25:53,919
add in some cyanobacteria also for the

656
00:25:57,830 --> 00:25:56,240
negative training data sets and train it

657
00:25:59,909 --> 00:25:57,840
so that it can easily recognize the

658
00:26:01,669 --> 00:25:59,919
features of cyanobacteria so that i

659
00:26:04,630 --> 00:26:01,679
think i believe it's going to work well

660
00:26:08,830 --> 00:26:06,149
yeah looks like you can uh reach out to

661
00:26:12,149 --> 00:26:08,840
u1 as the hold on no stock and

662
00:26:13,510 --> 00:26:12,159
cyanobacteria might be a way to

663
00:26:14,630 --> 00:26:13,520

collaborate

664
00:26:17,510 --> 00:26:14,640
um

665
00:26:20,630 --> 00:26:17,520
very good any any other questions uh

666
00:26:22,230 --> 00:26:20,640
from anyone we have one in the chat

667
00:26:25,269 --> 00:26:22,240
yeah please go ahead

668
00:26:26,950 --> 00:26:25,279
from diana gentry at nasa ames um

669
00:26:29,750 --> 00:26:26,960
did you have a toolkit in mind for your

670
00:26:31,830 --> 00:26:29,760
deep neural network future work

671
00:26:33,510 --> 00:26:31,840
sorry i didn't hear it well something on

672
00:26:35,110 --> 00:26:33,520
neural network uh what was that the

673
00:26:37,590 --> 00:26:35,120
question is did you have a toolkit in

674
00:26:38,870 --> 00:26:37,600
mind for your deep neural network future

675
00:26:41,909 --> 00:26:38,880
work

676
00:26:44,070 --> 00:26:41,919
uh a toolkit

677
00:26:45,190 --> 00:26:44,080
did you say toolkit sorry

678
00:26:47,269 --> 00:26:45,200
um

679
00:26:48,630 --> 00:26:47,279
i'm still planning i don't know

680
00:26:50,230 --> 00:26:48,640
there are different like convolution

681
00:26:51,590 --> 00:26:50,240
neural network and other things that

682
00:26:53,590 --> 00:26:51,600
people have been using so i need to

683
00:27:01,510 --> 00:26:53,600
explore more on that

684
00:27:01,520 --> 00:27:08,070
i'm sorry does that answer your question

685
00:27:16,149 --> 00:27:09,750
probably

686
00:27:19,190 --> 00:27:17,269
so you're gonna explore the

687
00:27:21,750 --> 00:27:19,200
transcriptome you said um

688
00:27:23,590 --> 00:27:21,760

any uh are you also going to exploit

689
00:27:25,430 --> 00:27:23,600
exploring or the proteome uh

690
00:27:27,590 --> 00:27:25,440
functionality of

691
00:27:29,510 --> 00:27:27,600
prediction models or just more genome

692
00:27:32,149 --> 00:27:29,520
interest crypto

693
00:27:34,470 --> 00:27:32,159
oh further

694
00:27:36,070 --> 00:27:34,480
for the raw sequences it's it's gonna be

695
00:27:37,669 --> 00:27:36,080
it's it's also gonna be the prediction

696
00:27:39,029 --> 00:27:37,679
model it's gonna predict the zero and

697
00:27:41,590 --> 00:27:39,039
one like whether it's chlorophyll

698
00:27:43,350 --> 00:27:41,600
binding and non-binding but yeah the

699
00:27:45,029 --> 00:27:43,360
features features that i'm going to

700
00:27:49,029 --> 00:27:45,039
supply might be different like i might

701
00:27:52,310 --> 00:27:49,990
pretty good

702
00:27:54,470 --> 00:27:52,320
yeah i think you and you wanted to talk

703
00:27:56,070 --> 00:27:54,480
because you can help with functionality

704
00:27:57,590 --> 00:27:56,080
for her data set and she can help you

705
00:28:00,630 --> 00:27:57,600
with the database

706
00:28:01,510 --> 00:28:00,640
for the cyanobacteria so this is great

707
00:28:03,909 --> 00:28:01,520
um

708
00:28:11,110 --> 00:28:03,919
any other com comments or questions

709
00:28:15,269 --> 00:28:13,590
otherwise i think um we're about on time

710
00:28:17,110 --> 00:28:15,279
so thank you uh the sean great

711
00:28:17,909 --> 00:28:17,120
representation

712
00:28:21,590 --> 00:28:17,919
um

713
00:28:23,990 --> 00:28:21,600

and we can move on to uh virtual uh

714
00:28:25,029 --> 00:28:24,000
speaker joseph stone

715
00:28:27,990 --> 00:28:25,039
um

716
00:28:30,470 --> 00:28:29,430
awesome

717
00:28:32,710 --> 00:28:30,480
i am

718
00:28:35,590 --> 00:28:32,720
uh joseph stone from uh rayquam young

719
00:28:37,909 --> 00:28:35,600
university so please go ahead

720
00:28:39,990 --> 00:28:37,919
all right so today i'll be presenting on

721
00:28:42,789 --> 00:28:40,000
the microbial metabolism measurement

722
00:28:45,269 --> 00:28:42,799
system which is a device to simulate the

723
00:28:47,190 --> 00:28:45,279
impact of habitability stressors on

724
00:28:51,110 --> 00:28:47,200
microbial cultures and i'm presenting on

725
00:28:52,950 --> 00:28:51,120
behalf of the nasa ames research center

726
00:28:54,710 --> 00:28:52,960
so

727
00:28:57,669 --> 00:28:54,720
the system i'll just call the system for

728
00:28:59,190 --> 00:28:57,679
brevity in this presentation

729
00:29:02,149 --> 00:28:59,200
there's potential extraterrestrial

730
00:29:03,909 --> 00:29:02,159
habitats that can be limited by a number

731
00:29:06,789 --> 00:29:03,919
of different stressors including

732
00:29:08,710 --> 00:29:06,799
ultraviolet radiation ionizing radiation

733
00:29:10,389 --> 00:29:08,720
uh high and low temperature

734
00:29:12,470 --> 00:29:10,399
lack of water and other nutrients as

735
00:29:13,909 --> 00:29:12,480
well as high mlph

736
00:29:15,029 --> 00:29:13,919
each of these stressors will

737
00:29:17,990 --> 00:29:15,039
individually

738
00:29:19,830 --> 00:29:18,000

limit microbial growth and survival

739
00:29:21,909 --> 00:29:19,840
but when they are combined

740
00:29:24,149 --> 00:29:21,919
they have additional effects

741
00:29:25,750 --> 00:29:24,159
and so these combined stressors are key

742
00:29:27,510 --> 00:29:25,760
to our understanding of how earth-like

743
00:29:29,110 --> 00:29:27,520
organisms can adapt to harsh

744
00:29:29,830 --> 00:29:29,120
environments that are found outside of

745
00:29:31,990 --> 00:29:29,840
earth

746
00:29:33,830 --> 00:29:32,000
and our system is

747
00:29:35,909 --> 00:29:33,840
its purpose is to measure the effect of

748
00:29:38,830 --> 00:29:35,919
combined stressors in real time

749
00:29:42,470 --> 00:29:40,470
so uh

750
00:29:44,389 --> 00:29:42,480
the system is an automated liquid

751
00:29:46,549 --> 00:29:44,399
culture system equipped with

752
00:29:48,149 --> 00:29:46,559
environmental control and multiple

753
00:29:50,950 --> 00:29:48,159
embedded sensors

754
00:29:52,470 --> 00:29:50,960
um you can see in the images below on

755
00:29:55,990 --> 00:29:52,480
the left is the vessel which controls

756
00:29:57,590 --> 00:29:56,000
the or which holds the cold spring

757
00:30:00,230 --> 00:29:57,600
as well as

758
00:30:02,230 --> 00:30:00,240
the sensors

759
00:30:04,630 --> 00:30:02,240
and then there's also a

760
00:30:07,269 --> 00:30:04,640
an additional sensor that has recently

761
00:30:09,190 --> 00:30:07,279
been added the optical density sensor

762
00:30:10,310 --> 00:30:09,200
communication circuit which controls the

763
00:30:12,710 --> 00:30:10,320

sensors

764
00:30:16,789 --> 00:30:12,720
and then the environmental control

765
00:30:19,110 --> 00:30:16,799
on the right is a uv led housing

766
00:30:20,710 --> 00:30:19,120
and then to go into more detail on on

767
00:30:23,590 --> 00:30:20,720
the sensors

768
00:30:26,470 --> 00:30:23,600
the oxidation reduction potential

769
00:30:29,190 --> 00:30:26,480
is able to measure consumed or available

770
00:30:31,590 --> 00:30:29,200
metabolic energy

771
00:30:33,269 --> 00:30:31,600
the electro conductivity and potential

772
00:30:35,830 --> 00:30:33,279
of hydrogen sensors

773
00:30:37,350 --> 00:30:35,840
can measure osmotic stress or metabolite

774
00:30:39,750 --> 00:30:37,360
production

775
00:30:42,870 --> 00:30:39,760
the dissolved oxygen measures anaerobic

776
00:30:45,430 --> 00:30:42,880
environment or oxygen consumption

777
00:30:47,909 --> 00:30:45,440
and the optical density sensor can

778
00:30:49,669 --> 00:30:47,919
measure the population density

779
00:30:51,909 --> 00:30:49,679
as well as some temperature

780
00:30:53,830 --> 00:30:51,919
sensors to monitor the conditions and

781
00:30:55,750 --> 00:30:53,840
cannula that can inject into the medium

782
00:30:56,870 --> 00:30:55,760
head space each of these sensors can be

783
00:30:59,509 --> 00:30:56,880
used

784
00:31:01,509 --> 00:30:59,519
with the environmental control to

785
00:31:05,350 --> 00:31:01,519
control the environment or

786
00:31:06,549 --> 00:31:05,360
just to see how the the culture is doing

787
00:31:08,549 --> 00:31:06,559
and the

788
00:31:11,750 --> 00:31:08,559

response it has

789
00:31:15,110 --> 00:31:11,760
so one example application of our system

790
00:31:15,909 --> 00:31:15,120
uh biosentinel is a cube satellite which

791
00:31:18,070 --> 00:31:15,919
is

792
00:31:20,789 --> 00:31:18,080
the first to go beyond low earth orbit

793
00:31:24,310 --> 00:31:20,799
with a biological cubesat

794
00:31:26,070 --> 00:31:24,320
they have yeast and they're going to be

795
00:31:27,990 --> 00:31:26,080
determining the effects of space

796
00:31:29,269 --> 00:31:28,000
radiation on this yeast as a model

797
00:31:31,269 --> 00:31:29,279
organism for

798
00:31:32,710 --> 00:31:31,279
future space missions outside of low

799
00:31:35,269 --> 00:31:32,720
earth orbit

800
00:31:37,509 --> 00:31:35,279
and so what our system is doing is it's

801
00:31:39,830 --> 00:31:37,519
on the ground as a part of some ground

802
00:31:41,350 --> 00:31:39,840
experiments what it does is it's able to

803
00:31:44,389 --> 00:31:41,360
take more detailed measurements of the

804
00:31:45,830 --> 00:31:44,399
same assay than biosentinel

805
00:31:47,350 --> 00:31:45,840
which will allow the researchers to

806
00:31:48,230 --> 00:31:47,360
interpret the data

807
00:31:51,669 --> 00:31:48,240
and

808
00:31:53,190 --> 00:31:51,679
what is going on with the

809
00:31:53,990 --> 00:31:53,200
the cells

810
00:31:56,870 --> 00:31:54,000
um

811
00:31:58,389 --> 00:31:56,880
it's also has a history of of

812
00:32:01,110 --> 00:31:58,399
past biopolytic satellites that have

813
00:32:02,870 --> 00:32:01,120

used a similar assay

814
00:32:05,430 --> 00:32:02,880
and it will be useful for future

815
00:32:09,430 --> 00:32:07,830
so recently

816
00:32:11,029 --> 00:32:09,440
some changes

817
00:32:12,549 --> 00:32:11,039
were made to this system

818
00:32:14,950 --> 00:32:12,559
there are some problems with it being

819
00:32:16,710 --> 00:32:14,960
partially reusable not airtight not as

820
00:32:18,549 --> 00:32:16,720
robust as well as

821
00:32:20,549 --> 00:32:18,559
too much headspace

822
00:32:22,310 --> 00:32:20,559
and so some

823
00:32:24,389 --> 00:32:22,320
improvements were made you can see a

824
00:32:27,830 --> 00:32:24,399
reduction in the headspace as well as

825
00:32:30,149 --> 00:32:27,840
air tightness was achieved with a

826
00:32:32,549 --> 00:32:30,159
threaded adapters for canyonland probes

827
00:32:34,389 --> 00:32:32,559
as well as clamps

828
00:32:36,470 --> 00:32:34,399
and the plastic threads are replaced

829
00:32:39,590 --> 00:32:36,480
with metal and rubber parts with

830
00:32:41,509 --> 00:32:39,600
autoclavable material

831
00:32:43,430 --> 00:32:41,519
another part of the system there was a

832
00:32:46,310 --> 00:32:43,440
previous version of the optical density

833
00:32:47,750 --> 00:32:46,320
sensor which used pneumatic force from

834
00:32:49,269 --> 00:32:47,760
an air cylinder

835
00:32:51,029 --> 00:32:49,279
to

836
00:32:52,630 --> 00:32:51,039
drop the media

837
00:32:55,269 --> 00:32:52,640
and then

838
00:32:56,950 --> 00:32:55,279

determine the population with

839
00:32:58,310 --> 00:32:56,960
leds

840
00:32:59,509 --> 00:32:58,320
shining through it

841
00:33:01,830 --> 00:32:59,519
the problem here was there's a

842
00:33:02,870 --> 00:33:01,840
deformation of the the silicone on the

843
00:33:04,549 --> 00:33:02,880
plunger

844
00:33:06,870 --> 00:33:04,559
and it wasn't able to drive

845
00:33:08,630 --> 00:33:06,880
as well as you can see it's it's in

846
00:33:11,110 --> 00:33:08,640
not a temporary form

847
00:33:12,230 --> 00:33:11,120
and so some improvements were made uh to

848
00:33:14,630 --> 00:33:12,240
the system

849
00:33:16,630 --> 00:33:14,640
a printed circuit board was designed as

850
00:33:17,990 --> 00:33:16,640
well as the the actuator is replaced

851
00:33:19,430 --> 00:33:18,000
with one

852
00:33:22,310 --> 00:33:19,440
connected directly to the plunger in

853
00:33:23,190 --> 00:33:22,320
order to reliably drop the media

854
00:33:26,710 --> 00:33:23,200
and

855
00:33:29,029 --> 00:33:26,720
signal integrity

856
00:33:31,110 --> 00:33:29,039
here's a video showing uh the prototype

857
00:33:34,070 --> 00:33:31,120
for the new sensor

858
00:33:36,389 --> 00:33:34,080
it draws up the media

859
00:33:37,430 --> 00:33:36,399
and then the leds shine through to

860
00:33:39,269 --> 00:33:37,440
determine

861
00:33:41,750 --> 00:33:39,279
the density and all this is being

862
00:33:43,029 --> 00:33:41,760
controlled by a raspberry pi computer

863
00:33:45,190 --> 00:33:43,039

which is more

864
00:33:50,389 --> 00:33:45,200
integrable into the

865
00:33:53,990 --> 00:33:52,310
now the last part of the system the the

866
00:33:56,870 --> 00:33:54,000
communication

867
00:33:58,389 --> 00:33:56,880
uh circuit which controlled the sensors

868
00:34:00,389 --> 00:33:58,399
um and

869
00:34:01,590 --> 00:34:00,399
fed the information to the the raspberry

870
00:34:04,070 --> 00:34:01,600
pi computer

871
00:34:06,630 --> 00:34:04,080
uh again it was in a breadboard format

872
00:34:08,310 --> 00:34:06,640
and so it was prone to disconnect um

873
00:34:10,069 --> 00:34:08,320
occupies a lot of space and susceptible

874
00:34:11,190 --> 00:34:10,079
to water damage

875
00:34:12,230 --> 00:34:11,200
and so

876
00:34:15,270 --> 00:34:12,240
uh

877
00:34:17,589 --> 00:34:15,280
again improvements were made to

878
00:34:20,710 --> 00:34:17,599
by designing a printed circuit board

879
00:34:23,109 --> 00:34:20,720
which made it more immune to movement

880
00:34:24,550 --> 00:34:23,119
having soldered parts the copper tracks

881
00:34:25,669 --> 00:34:24,560
in the circuit board allow for tighter

882
00:34:28,629 --> 00:34:25,679
connections

883
00:34:30,790 --> 00:34:28,639
uh reduced the size and made it able to

884
00:34:33,109 --> 00:34:30,800
be mass produced

885
00:34:34,550 --> 00:34:33,119
as well as inherent to a printed circuit

886
00:34:38,149 --> 00:34:34,560
board improves the signal and power

887
00:34:40,550 --> 00:34:38,159
integrity as well as water resistance

888
00:34:44,310 --> 00:34:43,030

why why is this system important

889
00:34:45,589 --> 00:34:44,320
you can see that

890
00:34:46,389 --> 00:34:45,599
on the left here

891
00:34:48,790 --> 00:34:46,399
there's a number of different

892
00:34:50,069 --> 00:34:48,800
applications this system can be in for

893
00:34:54,710 --> 00:34:50,079
different

894
00:34:56,069 --> 00:34:54,720
forms of experiments

895
00:34:57,910 --> 00:34:56,079
on the left here

896
00:35:00,470 --> 00:34:57,920
are just some charts showing

897
00:35:01,589 --> 00:35:00,480
another example of e coli being exposed

898
00:35:03,349 --> 00:35:01,599
to

899
00:35:05,430 --> 00:35:03,359
ultraviolet radiation

900
00:35:06,310 --> 00:35:05,440
across a number of iterations

901
00:35:08,310 --> 00:35:06,320
and

902
00:35:10,470 --> 00:35:08,320
in the bottom you can see

903
00:35:12,550 --> 00:35:10,480
all of the sensors inside the system

904
00:35:13,829 --> 00:35:12,560
showing the response that it has over

905
00:35:16,390 --> 00:35:13,839
time

906
00:35:18,550 --> 00:35:16,400
on the right is another example

907
00:35:20,310 --> 00:35:18,560
application of a slightly different

908
00:35:22,550 --> 00:35:20,320
form of the system

909
00:35:25,990 --> 00:35:22,560
which is being used to

910
00:35:27,030 --> 00:35:26,000
as an analog for europa waters

911
00:35:28,550 --> 00:35:27,040
and you can see in the bottom the

912
00:35:29,510 --> 00:35:28,560
different sensors connections there as

913
00:35:30,950 --> 00:35:29,520

well as

914
00:35:35,430 --> 00:35:30,960
ports for the

915
00:35:39,910 --> 00:35:38,390
here i said previously i talked about

916
00:35:42,390 --> 00:35:39,920
how it's able to

917
00:35:44,390 --> 00:35:42,400
have real-time autonomous data here's a

918
00:35:47,510 --> 00:35:44,400
video showing um

919
00:35:49,670 --> 00:35:47,520
collection of data on the left is the

920
00:35:51,190 --> 00:35:49,680
left beaker is a system or a culture

921
00:35:52,950 --> 00:35:51,200
that just has

922
00:35:55,190 --> 00:35:52,960
that doesn't have a metabolic indicator

923
00:35:56,630 --> 00:35:55,200
die and on the right it does

924
00:35:58,390 --> 00:35:56,640
and you can see

925
00:36:00,150 --> 00:35:58,400
that on the right the the graph is

926
00:36:00,950 --> 00:36:00,160
slightly different showing that

927
00:36:02,790 --> 00:36:00,960
um

928
00:36:07,030 --> 00:36:02,800
there are different growth parameters

929
00:36:13,589 --> 00:36:11,430
with the metabolic indicator die and so

930
00:36:15,990 --> 00:36:13,599
again this system because of its ability

931
00:36:18,390 --> 00:36:16,000
to to integrate multiple sensors into

932
00:36:20,630 --> 00:36:18,400
one form um

933
00:36:23,430 --> 00:36:20,640
and control it uh

934
00:36:25,349 --> 00:36:23,440
with software it's able to

935
00:36:27,829 --> 00:36:25,359
enable researchers to

936
00:36:29,349 --> 00:36:27,839
have a system that's able to

937
00:36:31,670 --> 00:36:29,359
to measure this in real time as well as

938
00:36:32,870 --> 00:36:31,680

multiple parameters

939
00:36:37,589 --> 00:36:32,880
which makes

940
00:36:40,950 --> 00:36:38,470
and

941
00:36:42,630 --> 00:36:40,960
i just like to acknowledge um tao shang

942
00:36:43,829 --> 00:36:42,640
a fellow intern for his feedback on the

943
00:36:45,829 --> 00:36:43,839
presentation

944
00:36:48,390 --> 00:36:45,839
as well as chimay kavanaugh raj and

945
00:36:50,470 --> 00:36:48,400
chloe makates for the europa application

946
00:36:52,829 --> 00:36:50,480
information as well as my internship

947
00:36:54,550 --> 00:36:52,839
coordinators porsche parker and haley

948
00:36:57,109 --> 00:36:54,560
feck

949
00:37:00,710 --> 00:36:57,119
and thank you i'll turn the time now to

950
00:37:03,750 --> 00:37:02,790
thank you thank you joseph

951
00:37:05,750 --> 00:37:03,760
um

952
00:37:08,870 --> 00:37:05,760
great to work on time

953
00:37:12,710 --> 00:37:08,880
uh any any questions from anybody

954
00:37:18,150 --> 00:37:14,790
we do have a question i'll ask one

955
00:37:20,870 --> 00:37:18,160
marina and that is um

956
00:37:23,270 --> 00:37:20,880
can this be adapted for uh continuous

957
00:37:25,270 --> 00:37:23,280
culture uh

958
00:37:27,750 --> 00:37:25,280
that is to say to do evolution

959
00:37:31,030 --> 00:37:27,760
experiments or is this

960
00:37:33,349 --> 00:37:31,040
for relatively short term physiological

961
00:37:35,670 --> 00:37:33,359
experiments what what are you

962
00:37:39,349 --> 00:37:35,680
what do you guys think yes

963
00:37:41,510 --> 00:37:39,359

yeah it can be adapted to that form uh a

964
00:37:42,550 --> 00:37:41,520
previous form or another form is

965
00:37:43,910 --> 00:37:42,560
actually

966
00:37:51,190 --> 00:37:43,920
um

967
00:37:52,630 --> 00:37:51,200
just with the fluid flow i showed on

968
00:37:54,470 --> 00:37:52,640
this slide

969
00:37:57,109 --> 00:37:54,480
um this was

970
00:37:59,109 --> 00:37:57,119
exposing the the e-coil to multiple

971
00:38:01,589 --> 00:37:59,119
different iterations so

972
00:38:03,109 --> 00:38:01,599
um yeah it has been used before

973
00:38:05,109 --> 00:38:03,119
a different form of this system has been

974
00:38:06,950 --> 00:38:05,119
used for

975
00:38:09,270 --> 00:38:06,960
experimental evolution

976
00:38:12,790 --> 00:38:09,280
and so yes it can easily easily be

977
00:38:12,800 --> 00:38:16,390
great thank you

978
00:38:20,150 --> 00:38:17,670
well i think i heard that there was some

979
00:38:23,030 --> 00:38:20,160
other question maybe online was it

980
00:38:25,190 --> 00:38:23,040
yeah we have a question from laura

981
00:38:27,109 --> 00:38:25,200
it says hi joseph very cool have you

982
00:38:28,630 --> 00:38:27,119
considered accounting for the impact of

983
00:38:30,790 --> 00:38:28,640
microgravity

984
00:38:35,670 --> 00:38:30,800
for example by integrating your setup

985
00:38:35,680 --> 00:38:38,870
um

986
00:38:43,430 --> 00:38:41,020
i i have not considered that

987
00:38:45,430 --> 00:38:43,440
[Music]

988
00:38:48,470 --> 00:38:45,440

but that's definitely something that

989
00:38:50,390 --> 00:38:48,480
that we can look at um

990
00:38:52,550 --> 00:38:50,400
this yeah this

991
00:38:54,870 --> 00:38:52,560
right now this is mainly used for for

992
00:38:57,270 --> 00:38:54,880
ground experiments um and so we haven't

993
00:38:57,990 --> 00:38:57,280
really thought of um

994
00:39:02,230 --> 00:38:58,000
other

995
00:39:07,510 --> 00:39:02,240
applications but um

996
00:39:07,520 --> 00:39:12,069
other questions

997
00:39:15,750 --> 00:39:13,670
so i was i was thinking as i was

998
00:39:17,190 --> 00:39:15,760
watching you you had the two um chambers

999
00:39:19,430 --> 00:39:17,200
for example you were comparing with a

1000
00:39:21,270 --> 00:39:19,440
different sensor um and i was thinking

1001
00:39:22,710 --> 00:39:21,280
could you utilize this

1002
00:39:25,190 --> 00:39:22,720
say for

1003
00:39:27,589 --> 00:39:25,200
more of a life detection mission sort of

1004
00:39:29,510 --> 00:39:27,599
thing to determine if a sample is

1005
00:39:31,190 --> 00:39:29,520
you know has some kind of biology in

1006
00:39:33,430 --> 00:39:31,200
their biological

1007
00:39:35,750 --> 00:39:33,440
agent um by just having basically

1008
00:39:37,510 --> 00:39:35,760
replicates of of the sample one

1009
00:39:38,630 --> 00:39:37,520
sterilized and whatnot and see whether

1010
00:39:39,430 --> 00:39:38,640
that changes

1011
00:39:41,030 --> 00:39:39,440
um

1012
00:39:42,710 --> 00:39:41,040
those markers they're measuring and in

1013
00:39:44,150 --> 00:39:42,720

this case temperature ph and other

1014
00:39:46,390 --> 00:39:44,160
things we could measure

1015
00:39:47,670 --> 00:39:46,400
um whatever you like and just to see is

1016
00:39:49,510 --> 00:39:47,680
the difference could you utilize it for

1017
00:39:52,390 --> 00:39:49,520
that sort of thing

1018
00:39:53,190 --> 00:39:52,400
uh yes i think you could um

1019
00:39:54,790 --> 00:39:53,200
yeah

1020
00:39:56,790 --> 00:39:54,800
you'd probably have you'd have to adjust

1021
00:39:58,230 --> 00:39:56,800
the form of the the vessel culture

1022
00:39:59,990 --> 00:39:58,240
obviously but um

1023
00:40:01,109 --> 00:40:00,000
these kinds of sensors i think would be

1024
00:40:03,430 --> 00:40:01,119
able to

1025
00:40:05,589 --> 00:40:03,440
uh detect that and

1026
00:40:06,550 --> 00:40:05,599
um with the with the biosentinel

1027
00:40:07,750 --> 00:40:06,560
emission

1028
00:40:10,470 --> 00:40:07,760
um

1029
00:40:12,309 --> 00:40:10,480
for example using a metabolic indicator

1030
00:40:13,510 --> 00:40:12,319
die

1031
00:40:14,870 --> 00:40:13,520
it's

1032
00:40:16,550 --> 00:40:14,880
actually improving

1033
00:40:19,030 --> 00:40:16,560
that assay

1034
00:40:21,829 --> 00:40:19,040
by giving more in depth a look at how

1035
00:40:24,150 --> 00:40:21,839
that the indicator die

1036
00:40:25,349 --> 00:40:24,160
is parameterized by all these different

1037
00:40:27,589 --> 00:40:25,359
you know the ph the electrical

1038
00:40:29,670 --> 00:40:27,599

conductivity and so it gives a wider

1039
00:40:31,109 --> 00:40:29,680
picture so yeah i think that with these

1040
00:40:33,670 --> 00:40:31,119
with these parameters you can adapt it

1041
00:40:34,950 --> 00:40:33,680
to that kind of system

1042
00:40:36,630 --> 00:40:34,960
and even through time right you could

1043
00:40:39,030 --> 00:40:36,640
you could track whether whatever is

1044
00:40:41,109 --> 00:40:39,040
there is growing and reaches and

1045
00:40:43,030 --> 00:40:41,119
sorts right it's pretty

1046
00:40:45,030 --> 00:40:43,040
very very interesting actually

1047
00:40:46,790 --> 00:40:45,040
um

1048
00:40:50,790 --> 00:40:46,800
yeah there's a lot of applications for

1049
00:40:52,150 --> 00:40:50,800
this system yeah yeah there are um

1050
00:40:54,150 --> 00:40:52,160
i'd be interesting

1051
00:40:56,470 --> 00:40:54,160
that's a system like this for

1052
00:40:57,349 --> 00:40:56,480
purposes too this is very neat

1053
00:40:59,109 --> 00:40:57,359
um

1054
00:41:00,309 --> 00:40:59,119
are there other questions from anybody

1055
00:41:02,309 --> 00:41:00,319
else

1056
00:41:04,870 --> 00:41:02,319
uh yes can you hear me

1057
00:41:07,349 --> 00:41:04,880
yes hi rosa santo martino from the

1058
00:41:09,670 --> 00:41:07,359
university of edinburgh thanks for this

1059
00:41:11,270 --> 00:41:09,680
work which was very great and i was

1060
00:41:14,470 --> 00:41:11,280
wondering do you think it would be

1061
00:41:15,829 --> 00:41:14,480
possible to add substrates like regolith

1062
00:41:18,630 --> 00:41:15,839
for instance

1063
00:41:21,109 --> 00:41:18,640

or is it going to damage

1064
00:41:22,870 --> 00:41:21,119
the sensors

1065
00:41:24,630 --> 00:41:22,880
edwards sorry

1066
00:41:28,309 --> 00:41:24,640
regularly if you can add regulators or

1067
00:41:31,349 --> 00:41:29,910
um

1068
00:41:32,829 --> 00:41:31,359
i'm not sure

1069
00:41:36,630 --> 00:41:32,839
uh

1070
00:41:38,470 --> 00:41:36,640
what kind of damage would you would you

1071
00:41:40,950 --> 00:41:38,480
be worried about was that

1072
00:41:42,950 --> 00:41:40,960
like for instance you could study well i

1073
00:41:44,230 --> 00:41:42,960
work on biomining so i'm always thinking

1074
00:41:46,150 --> 00:41:44,240
about that

1075
00:41:48,390 --> 00:41:46,160
like interaction of the microbes with

1076
00:41:50,630 --> 00:41:48,400
the the regolith

1077
00:41:53,270 --> 00:41:50,640
maybe some martian analogs or lunar

1078
00:41:54,870 --> 00:41:53,280
analogs or even just terrestrial rocks

1079
00:41:57,030 --> 00:41:54,880
something like that

1080
00:42:00,870 --> 00:41:57,040
i don't know if it's going to damage the

1081
00:42:03,349 --> 00:42:00,880
the sensor that's why i'm asking

1082
00:42:05,829 --> 00:42:03,359
um yeah so

1083
00:42:08,950 --> 00:42:05,839
i'm not sure uh

1084
00:42:11,670 --> 00:42:08,960
on that i could get you in contact um

1085
00:42:13,829 --> 00:42:11,680
with my mentor diana gentry who has a

1086
00:42:15,510 --> 00:42:13,839
little bit more understanding of the

1087
00:42:17,670 --> 00:42:15,520
mechanical

1088
00:42:18,950 --> 00:42:17,680

impacts on the sensor and

1089
00:42:20,870 --> 00:42:18,960
um

1090
00:42:22,069 --> 00:42:20,880
but i'm not sure if i don't believe

1091
00:42:24,790 --> 00:42:22,079
there would be

1092
00:42:26,309 --> 00:42:24,800
damages to it

1093
00:42:28,390 --> 00:42:26,319
okay

1094
00:42:29,270 --> 00:42:28,400
i think what rosa is asking is in terms

1095
00:42:31,270 --> 00:42:29,280
of

1096
00:42:32,550 --> 00:42:31,280
you know even physical you know because

1097
00:42:33,990 --> 00:42:32,560
there's movement right in your system

1098
00:42:36,790 --> 00:42:34,000
there's some motion that kind of make

1099
00:42:38,069 --> 00:42:36,800
keeps in mixing right so if you have um

1100
00:42:40,150 --> 00:42:38,079
kind of uh

1101
00:42:42,390 --> 00:42:40,160
you know abrasive um substrates that

1102
00:42:45,430 --> 00:42:42,400
could cause physical damage to it or

1103
00:42:46,950 --> 00:42:45,440
corrosion as well right um it could also

1104
00:42:48,150 --> 00:42:46,960
damage some of the components i think

1105
00:42:49,990 --> 00:42:48,160
that's that's kind of where the question

1106
00:42:51,589 --> 00:42:50,000
is yes and it could also cover some

1107
00:42:53,829 --> 00:42:51,599
sensors i guess

1108
00:42:54,950 --> 00:42:53,839
or stick to it right lots of things

1109
00:42:56,790 --> 00:42:54,960
right

1110
00:42:59,990 --> 00:42:56,800
yeah the system

1111
00:43:03,109 --> 00:43:00,000
right now is pretty robust to

1112
00:43:05,030 --> 00:43:03,119
any corrosion

1113
00:43:06,630 --> 00:43:05,040

but i'm not sure for all different kinds

1114
00:43:09,750 --> 00:43:06,640
of substances

1115
00:43:10,630 --> 00:43:09,760
what the impact could be

1116
00:43:12,870 --> 00:43:10,640
okay

1117
00:43:16,630 --> 00:43:12,880
thank you very much thank you for your

1118
00:43:16,640 --> 00:43:22,150
uh any other questions

1119
00:43:26,870 --> 00:43:24,230
otherwise i think we're we're good on

1120
00:43:28,550 --> 00:43:26,880
time so thank you joseph much appreciate

1121
00:43:32,069 --> 00:43:28,560
it

1122
00:43:33,270 --> 00:43:32,079
and we can move on to eric weingarten i

1123
00:43:35,750 --> 00:43:33,280
believe

1124
00:43:36,630 --> 00:43:35,760
he is on site

1125
00:43:39,109 --> 00:43:36,640
uh

1126
00:43:41,750 --> 00:43:39,119
from the u.s army engineer research and

1127
00:43:44,950 --> 00:43:41,760
development center

1128
00:43:48,390 --> 00:43:46,150
okay

1129
00:43:49,670 --> 00:43:48,400
all right all right well i'm already

1130
00:43:50,710 --> 00:43:49,680
messing it up

1131
00:43:52,470 --> 00:43:50,720
nope

1132
00:43:55,270 --> 00:43:52,480
okay so

1133
00:43:57,109 --> 00:43:55,280
this is me

1134
00:43:59,270 --> 00:43:57,119
give a computational biologist the

1135
00:44:01,910 --> 00:43:59,280
computer and

1136
00:44:04,470 --> 00:44:01,920
all right we got it figured out okay so

1137
00:44:06,710 --> 00:44:04,480
uh yes i'm eric weingarten

1138
00:44:08,230 --> 00:44:06,720

um glad we've got enough room here

1139
00:44:09,430 --> 00:44:08,240
everybody

1140
00:44:11,109 --> 00:44:09,440
so i'm going to be talking about

1141
00:44:13,349 --> 00:44:11,119
microbial communities

1142
00:44:15,030 --> 00:44:13,359
and salt pan sediments and

1143
00:44:18,309 --> 00:44:15,040
their results

1144
00:44:20,950 --> 00:44:18,319
in response to a simulated martian

1145
00:44:23,430 --> 00:44:20,960
environment microcosm

1146
00:44:26,230 --> 00:44:23,440
and these are sort of sourced from an

1147
00:44:27,829 --> 00:44:26,240
unusual terrestrial analog

1148
00:44:29,589 --> 00:44:27,839
um and i'm gonna

1149
00:44:32,710 --> 00:44:29,599
go through sort of some of the benefits

1150
00:44:36,550 --> 00:44:32,720
of using this type of system

1151
00:44:39,910 --> 00:44:36,560
uh so salt pans also referred to as salt

1152
00:44:41,910 --> 00:44:39,920
flats are coastal ecosystems

1153
00:44:43,750 --> 00:44:41,920
so you you hear a lot

1154
00:44:45,750 --> 00:44:43,760
in terms of

1155
00:44:48,790 --> 00:44:45,760
analog environments you know people go

1156
00:44:51,910 --> 00:44:48,800
to lots of very far-flung places

1157
00:44:54,550 --> 00:44:51,920
antarctica the far arctic the atacama

1158
00:44:56,950 --> 00:44:54,560
these are all very exciting places

1159
00:44:58,630 --> 00:44:56,960
i went to the coast of mississippi i'd

1160
00:45:00,150 --> 00:44:58,640
like to think that it's exciting in its

1161
00:45:01,510 --> 00:45:00,160
own ways

1162
00:45:04,630 --> 00:45:01,520
but this

1163
00:45:07,109 --> 00:45:04,640

system has an interesting hydrology

1164
00:45:08,390 --> 00:45:07,119
in addition to being hyper saline

1165
00:45:10,390 --> 00:45:08,400
so some

1166
00:45:12,790 --> 00:45:10,400
of these salt pan ecosystem salt flats

1167
00:45:15,910 --> 00:45:12,800
especially ones that exist in china

1168
00:45:17,589 --> 00:45:15,920
can be up to 20 sodium chloride so 200

1169
00:45:20,069 --> 00:45:17,599
parts per thousand the ones that we are

1170
00:45:22,630 --> 00:45:20,079
working in are slightly less saline but

1171
00:45:25,270 --> 00:45:22,640
still certainly hyper saline

1172
00:45:27,030 --> 00:45:25,280
and they go through these phases of

1173
00:45:29,670 --> 00:45:27,040
matrix osmotic stress where they go

1174
00:45:33,430 --> 00:45:29,680
through long periods of desiccation and

1175
00:45:36,470 --> 00:45:33,440
very short periods of hydration and so

1176
00:45:40,069 --> 00:45:36,480
they serve as a very good analog for

1177
00:45:42,710 --> 00:45:40,079
just two parameters that we suspect

1178
00:45:45,430 --> 00:45:42,720
will come into play in

1179
00:45:46,390 --> 00:45:45,440
martian rsl or potentially subsurface

1180
00:45:48,150 --> 00:45:46,400
brines

1181
00:45:51,589 --> 00:45:48,160
where we're looking at hyper salinity

1182
00:45:55,270 --> 00:45:51,599
and matrix osmotic stress

1183
00:45:57,990 --> 00:45:55,280
and so the way that these salt pans form

1184
00:45:59,910 --> 00:45:58,000
is that they are sort of inland coastal

1185
00:46:01,430 --> 00:45:59,920
systems so normally they receive no

1186
00:46:03,670 --> 00:46:01,440
hydration

1187
00:46:06,710 --> 00:46:03,680
but they become hydrated during storm

1188
00:46:08,550 --> 00:46:06,720

tide so during hurricanes and so you can

1189
00:46:10,390 --> 00:46:08,560
see in the diagram here normally these

1190
00:46:12,150 --> 00:46:10,400
are completely unhydrated

1191
00:46:13,430 --> 00:46:12,160
when storm systems come through the

1192
00:46:16,230 --> 00:46:13,440
particular system that we were looking

1193
00:46:19,030 --> 00:46:16,240
at was before and after a tropical storm

1194
00:46:20,950 --> 00:46:19,040
um water pushes in and because these are

1195
00:46:23,190 --> 00:46:20,960
inland systems the water just cannot

1196
00:46:26,069 --> 00:46:23,200
retreat back out with the tide and so

1197
00:46:28,870 --> 00:46:26,079
you sort of get these small tide pools

1198
00:46:31,190 --> 00:46:28,880
uh that exist inland um but then what

1199
00:46:33,349 --> 00:46:31,200
happens is this water evaporates away

1200
00:46:36,870 --> 00:46:33,359
and all of the solutes in that water

1201
00:46:39,510 --> 00:46:36,880
precipitate out and as this happens

1202
00:46:43,190 --> 00:46:39,520
over you know geologic time scales you

1203
00:46:45,109 --> 00:46:43,200
build these deep salt crusts and you can

1204
00:46:46,710 --> 00:46:45,119
you can see the little diagram here you

1205
00:46:48,710 --> 00:46:46,720
sort of have

1206
00:46:50,470 --> 00:46:48,720
these sand flats that exist on the

1207
00:46:53,349 --> 00:46:50,480
perimeter and then you get these small

1208
00:46:55,030 --> 00:46:53,359
brine ecosystems that exist for long

1209
00:46:58,950 --> 00:46:55,040
periods of time with very high salt

1210
00:47:04,870 --> 00:47:02,230
and why these are potentially good

1211
00:47:06,950 --> 00:47:04,880
models for martian soil

1212
00:47:08,230 --> 00:47:06,960
is that they have high salinity so like

1213
00:47:09,829 --> 00:47:08,240

i said

1214
00:47:11,589 --> 00:47:09,839
the the sites that we are looking at

1215
00:47:14,550 --> 00:47:11,599
only gets up to about 50 parts per

1216
00:47:16,710 --> 00:47:14,560
thousand other salt pan ecosystems can

1217
00:47:18,470 --> 00:47:16,720
spike up to 200

1218
00:47:20,470 --> 00:47:18,480
but they also experience high uv so

1219
00:47:24,309 --> 00:47:20,480
these are unvegetated systems this is

1220
00:47:26,309 --> 00:47:24,319
this is our site um in the um desiccated

1221
00:47:27,349 --> 00:47:26,319
at the top and hydrated at the bottom

1222
00:47:28,470 --> 00:47:27,359
states

1223
00:47:29,829 --> 00:47:28,480
and so you can see that at these

1224
00:47:33,109 --> 00:47:29,839
salinities you're not going to get any

1225
00:47:34,549 --> 00:47:33,119
coastal vegetation that's going to form

1226
00:47:38,390 --> 00:47:34,559
and because they're unvegetated they

1227
00:47:39,829 --> 00:47:38,400
also experience locally very high uv

1228
00:47:41,990 --> 00:47:39,839
and they're also going to be dealing

1229
00:47:43,430 --> 00:47:42,000
with this hydrologic condition where

1230
00:47:45,349 --> 00:47:43,440
you're going to have periods of

1231
00:47:47,589 --> 00:47:45,359
prolonged desiccation and low water

1232
00:47:50,150 --> 00:47:47,599
availability and so we're talking about

1233
00:47:51,430 --> 00:47:50,160
martian rsls

1234
00:47:53,430 --> 00:47:51,440
from the

1235
00:47:54,470 --> 00:47:53,440
microbes perspective you sort of got to

1236
00:47:57,829 --> 00:47:54,480
balance

1237
00:47:59,510 --> 00:47:57,839
the um potential damage from either

1238
00:48:02,309 --> 00:47:59,520

osmotic stress from things like sodium

1239
00:48:03,829 --> 00:48:02,319
chloride or particularly in martian

1240
00:48:05,349 --> 00:48:03,839
brines we're looking at perchlorates

1241
00:48:07,430 --> 00:48:05,359
which are going to have kaotropic and

1242
00:48:08,950 --> 00:48:07,440
other toxic effects and so you sort of

1243
00:48:11,270 --> 00:48:08,960
have to balance

1244
00:48:13,910 --> 00:48:11,280
how beneficial is

1245
00:48:17,270 --> 00:48:13,920
the salt presence for retention of

1246
00:48:19,670 --> 00:48:17,280
liquid water versus the pressure that's

1247
00:48:21,589 --> 00:48:19,680
put in by hyper salinity

1248
00:48:24,549 --> 00:48:21,599
and so

1249
00:48:26,790 --> 00:48:24,559
the essentially in the desiccated state

1250
00:48:29,589 --> 00:48:26,800
we're thinking about the

1251
00:48:31,349 --> 00:48:29,599
martian equator in the desiccated state

1252
00:48:33,430 --> 00:48:31,359
and then in the hydrated state we're

1253
00:48:35,349 --> 00:48:33,440
thinking about these rsls when they are

1254
00:48:37,910 --> 00:48:35,359
potentially flowing i know the origin of

1255
00:48:39,990 --> 00:48:37,920
rsls is contentious but this is assuming

1256
00:48:42,950 --> 00:48:40,000
a hydrologic

1257
00:48:45,589 --> 00:48:42,960
source for rsls

1258
00:48:46,950 --> 00:48:45,599
and so just some some quick assumption

1259
00:48:48,470 --> 00:48:46,960
testing

1260
00:48:50,230 --> 00:48:48,480
so this was and

1261
00:48:52,630 --> 00:48:50,240
my a lot of the research that this

1262
00:48:54,309 --> 00:48:52,640
stemmed off of is actually global change

1263
00:48:55,829 --> 00:48:54,319

biology research

1264
00:48:57,910 --> 00:48:55,839
so this is in association with other

1265
00:49:00,630 --> 00:48:57,920
coastal research studies but

1266
00:49:02,870 --> 00:49:00,640
right off the bat these are three

1267
00:49:04,230 --> 00:49:02,880
wetland types fresh marsh brackish marsh

1268
00:49:05,270 --> 00:49:04,240
and salt pan and so you can see right

1269
00:49:07,670 --> 00:49:05,280
off the bat

1270
00:49:09,829 --> 00:49:07,680
on the left is the bacterial community

1271
00:49:11,270 --> 00:49:09,839
on the right is the archaeal community

1272
00:49:13,430 --> 00:49:11,280
and so you can see they are distinct

1273
00:49:17,109 --> 00:49:13,440
which is a good a good thing

1274
00:49:18,630 --> 00:49:17,119
and then separating the surface samples

1275
00:49:19,829 --> 00:49:18,640
from the subsurface samples which we

1276
00:49:21,670 --> 00:49:19,839
would assume

1277
00:49:23,510 --> 00:49:21,680
just based on oxygen availability that

1278
00:49:25,510 --> 00:49:23,520
there's going to be strong differences

1279
00:49:27,589 --> 00:49:25,520
in these compacted crusts

1280
00:49:29,349 --> 00:49:27,599
between the surface and the subsurface

1281
00:49:32,069 --> 00:49:29,359
and basically this indicator species

1282
00:49:35,349 --> 00:49:32,079
analysis is showing that the

1283
00:49:41,109 --> 00:49:35,359
surface community is dominated by a rich

1284
00:49:46,950 --> 00:49:43,670
magnesium perchlorate sodium perchlorate

1285
00:49:49,349 --> 00:49:46,960
or all salts combined

1286
00:49:50,549 --> 00:49:49,359
so for a total of 24 different treatment

1287
00:49:52,069 --> 00:49:50,559
levels

1288
00:49:55,030 --> 00:49:52,079

and then they were incubated in

1289
00:49:58,069 --> 00:49:55,040
anaerobic jars that were

1290
00:49:59,910 --> 00:49:58,079
the oxygen was removed a co2 atmosphere

1291
00:50:02,470 --> 00:49:59,920
was generated

1292
00:50:06,710 --> 00:50:02,480
and they were incubated for 21 days each

1293
00:50:08,230 --> 00:50:06,720
at -20 plus 27 and minus 80 degrees in

1294
00:50:11,349 --> 00:50:08,240
series

1295
00:50:13,510 --> 00:50:11,359
which is a relatively good approximation

1296
00:50:15,829 --> 00:50:13,520
of martian equatorial

1297
00:50:17,829 --> 00:50:15,839
average high and low temperatures based

1298
00:50:20,230 --> 00:50:17,839
on rover readings with a little bit of

1299
00:50:21,829 --> 00:50:20,240
artistic license because any laboratory

1300
00:50:25,190 --> 00:50:21,839
biologists know that those are pretty

1301
00:50:28,549 --> 00:50:25,200
easy numbers to model in the laboratory

1302
00:50:30,829 --> 00:50:28,559
um and then 16s ribosomal rna for

1303
00:50:32,710 --> 00:50:30,839
tracking compositional change uh

1304
00:50:37,349 --> 00:50:32,720
metatranscriptomics as well as culturing

1305
00:50:42,630 --> 00:50:39,750
and so what we see this is our

1306
00:50:45,510 --> 00:50:42,640
survivorship table so colony forming

1307
00:50:47,750 --> 00:50:45,520
units on the y-axis experimental days on

1308
00:50:49,430 --> 00:50:47,760
the x and so you can see

1309
00:50:51,349 --> 00:50:49,440
that each perchlorate treatment had

1310
00:50:53,510 --> 00:50:51,359
relatively similar survivorship no

1311
00:50:55,349 --> 00:50:53,520
significant differences so each of the

1312
00:50:57,270 --> 00:50:55,359
three perchlorates that we tested had

1313
00:50:59,430 --> 00:50:57,280

similar results

1314
00:51:01,109 --> 00:50:59,440
and they were all significantly lower

1315
00:51:03,510 --> 00:51:01,119
than the no salt group so the one that

1316
00:51:05,430 --> 00:51:03,520
we did not amend with either

1317
00:51:07,349 --> 00:51:05,440
chloride or perchlorate

1318
00:51:08,630 --> 00:51:07,359
actually survived these conditions

1319
00:51:10,710 --> 00:51:08,640
better

1320
00:51:12,710 --> 00:51:10,720
overall survivorship diminished over

1321
00:51:14,790 --> 00:51:12,720
over time significantly but there was no

1322
00:51:16,710 --> 00:51:14,800
significant change within any single

1323
00:51:19,589 --> 00:51:16,720
treatment so overall we're seeing that

1324
00:51:22,950 --> 00:51:19,599
these communities were able to survive

1325
00:51:25,190 --> 00:51:22,960
this analog experiment but

1326
00:51:26,790 --> 00:51:25,200
the perchlorate treatment groups had a

1327
00:51:29,109 --> 00:51:26,800
lower survivorship than the ones that we

1328
00:51:30,870 --> 00:51:29,119
did not amend with any salinity and i'll

1329
00:51:33,030 --> 00:51:30,880
get to potential implications of that in

1330
00:51:34,790 --> 00:51:33,040
a second

1331
00:51:37,109 --> 00:51:34,800
another interesting finding was that the

1332
00:51:39,270 --> 00:51:37,119
fate of the microcosm communities was

1333
00:51:41,829 --> 00:51:39,280
strongly tied to the source sediment

1334
00:51:43,910 --> 00:51:41,839
used whether that was the dry surface

1335
00:51:45,349 --> 00:51:43,920
wet surface dry subsurface or wet

1336
00:51:48,470 --> 00:51:45,359
subsurface

1337
00:51:50,309 --> 00:51:48,480
the two ordinations on the left so bray

1338
00:51:52,549 --> 00:51:50,319

curtis and jacquard that's looking at

1339
00:51:54,549 --> 00:51:52,559
changes in community abundance and

1340
00:51:56,470 --> 00:51:54,559
community occurrence and you can see

1341
00:51:58,390 --> 00:51:56,480
that they're sort of the the big squares

1342
00:52:00,309 --> 00:51:58,400
are starting conditions and you can see

1343
00:52:03,270 --> 00:52:00,319
that we sort of shotgun out into

1344
00:52:06,309 --> 00:52:03,280
separate corners and so in terms of the

1345
00:52:07,750 --> 00:52:06,319
bacteria and archaea that are present

1346
00:52:09,589 --> 00:52:07,760
in terms of their relative numbers we

1347
00:52:11,589 --> 00:52:09,599
have different responses

1348
00:52:14,470 --> 00:52:11,599
from these different environments but

1349
00:52:16,470 --> 00:52:14,480
unifrac is an ordination mesh method

1350
00:52:18,069 --> 00:52:16,480
that is looking at taxonomy and you can

1351
00:52:20,790 --> 00:52:18,079
see that we get a shift to left to the

1352
00:52:22,790 --> 00:52:20,800
left across all treatments and what we

1353
00:52:24,549 --> 00:52:22,800
hypothesize is that that is essentially

1354
00:52:26,790 --> 00:52:24,559
we are selecting for nothing but

1355
00:52:29,190 --> 00:52:26,800
extremophiles and so

1356
00:52:31,109 --> 00:52:29,200
different environments were better or

1357
00:52:32,790 --> 00:52:31,119
less adapted to the environment but the

1358
00:52:36,390 --> 00:52:32,800
things that survived across the board

1359
00:52:40,150 --> 00:52:37,910
and then there's there's a lot of

1360
00:52:42,309 --> 00:52:40,160
ordinations here but essentially the the

1361
00:52:44,309 --> 00:52:42,319
two left columns versus the two right

1362
00:52:47,109 --> 00:52:44,319
columns we see that the surface

1363
00:52:49,190 --> 00:52:47,119

community had a relatively consistent

1364
00:52:50,790 --> 00:52:49,200
response whereas the subsurface

1365
00:52:52,549 --> 00:52:50,800
community had a shotgun response so

1366
00:52:54,950 --> 00:52:52,559
there was no consistent response in the

1367
00:52:57,190 --> 00:52:54,960
subsurface in the surface we had a

1368
00:52:59,030 --> 00:52:57,200
similar response across the board across

1369
00:53:00,549 --> 00:52:59,040
all metrics and we hypothesized that

1370
00:53:02,790 --> 00:53:00,559
that's because at this surface where we

1371
00:53:05,030 --> 00:53:02,800
have higher salinity higher uv and

1372
00:53:07,190 --> 00:53:05,040
higher hydration variability you're

1373
00:53:08,710 --> 00:53:07,200
getting a similar selection for nothing

1374
00:53:11,190 --> 00:53:08,720
but extremophiles and so they were

1375
00:53:13,589 --> 00:53:11,200
better adapted to this

1376
00:53:15,589 --> 00:53:13,599
environment that we're modeling

1377
00:53:17,670 --> 00:53:15,599
and then finally

1378
00:53:20,870 --> 00:53:17,680
looking at the response here

1379
00:53:22,870 --> 00:53:20,880
a great big heat map but in summary we

1380
00:53:25,589 --> 00:53:22,880
uh the the domina the dominating

1381
00:53:27,510 --> 00:53:25,599
survival surviving lineages were

1382
00:53:28,470 --> 00:53:27,520
dominated by halophiles which i've

1383
00:53:31,670 --> 00:53:28,480
highlighted

1384
00:53:33,030 --> 00:53:31,680
thermophiles psychophiles and radiation

1385
00:53:35,910 --> 00:53:33,040
tolerant organisms so you can see

1386
00:53:37,750 --> 00:53:35,920
roughly half here are known lineages

1387
00:53:38,950 --> 00:53:37,760
that are extremophilic and extremophilic

1388
00:53:41,589 --> 00:53:38,960

for the

1389
00:53:43,510 --> 00:53:41,599
conditions that we were testing for

1390
00:53:45,589 --> 00:53:43,520
so in conclusion

1391
00:53:48,069 --> 00:53:45,599
we demonstrated the good news we

1392
00:53:50,630 --> 00:53:48,079
demonstrated sustained viability of a

1393
00:53:52,390 --> 00:53:50,640
mixed natural archaeal and

1394
00:53:55,589 --> 00:53:52,400
bacterial community to mars analog

1395
00:53:58,230 --> 00:53:55,599
conditions for 63 days

1396
00:54:01,190 --> 00:53:58,240
and we observed a shift in taxonomy

1397
00:54:02,069 --> 00:54:01,200
towards known extremophiles that would

1398
00:54:03,990 --> 00:54:02,079
be

1399
00:54:06,230 --> 00:54:04,000
at least hypothetically well adapted to

1400
00:54:08,549 --> 00:54:06,240
martian conditions so the the key

1401
00:54:10,470 --> 00:54:08,559
methodological finding is that you know

1402
00:54:12,230 --> 00:54:10,480
there is some benefit to doing things

1403
00:54:14,790 --> 00:54:12,240
through a whole microbiome approach

1404
00:54:16,470 --> 00:54:14,800
rather than a stock culture approach

1405
00:54:18,549 --> 00:54:16,480
the bad news was that growth and

1406
00:54:21,109 --> 00:54:18,559
sequence counts declined significantly

1407
00:54:23,670 --> 00:54:21,119
when exposed to chloride and perchlorate

1408
00:54:25,430 --> 00:54:23,680
so in terms of thinking about chlorides

1409
00:54:27,109 --> 00:54:25,440
and perchlorates in terms of their

1410
00:54:29,190 --> 00:54:27,119
eutectic

1411
00:54:36,470 --> 00:54:29,200
or

1412
00:54:38,390 --> 00:54:36,480
in terms of those benefits that provided

1413
00:54:40,710 --> 00:54:38,400

relatively little benefit

1414
00:54:42,789 --> 00:54:40,720
relative to the added osmotic and

1415
00:54:44,230 --> 00:54:42,799
chaotropic toxicity

1416
00:54:45,670 --> 00:54:44,240
so this is where i'm talking about when

1417
00:54:47,270 --> 00:54:45,680
we're starting to think about these

1418
00:54:49,430 --> 00:54:47,280
martian brine ecosystems and their

1419
00:54:51,829 --> 00:54:49,440
habitability it shouldn't be taken for

1420
00:54:53,109 --> 00:54:51,839
granted that hypersalinity is a good

1421
00:54:54,950 --> 00:54:53,119
thing because it's going to provide

1422
00:54:57,829 --> 00:54:54,960
liquid water the conditions have to be

1423
00:55:00,470 --> 00:54:57,839
right that the temperature and

1424
00:55:03,910 --> 00:55:00,480
liquid availability needs to be right in

1425
00:55:06,630 --> 00:55:03,920
that goldilocks zone for the

1426
00:55:08,630 --> 00:55:06,640
trade-offs in terms of toxicity to be a

1427
00:55:10,710 --> 00:55:08,640
benefit

1428
00:55:12,630 --> 00:55:10,720
and so we show that mixed analog soil

1429
00:55:14,950 --> 00:55:12,640
communities can serve as

1430
00:55:16,789 --> 00:55:14,960
agnostic predictors for adaptation to

1431
00:55:17,910 --> 00:55:16,799
extraterrestrial environments so i would

1432
00:55:21,430 --> 00:55:17,920
encourage

1433
00:55:23,990 --> 00:55:21,440
others to explore that approach as well

1434
00:55:26,069 --> 00:55:24,000
thank you to my co-authors especially

1435
00:55:28,150 --> 00:55:26,079
the field personnel who helped identify

1436
00:55:29,829 --> 00:55:28,160
and collect these samples

1437
00:55:32,710 --> 00:55:29,839
the results are going to be in

1438
00:55:34,470 --> 00:55:32,720

astrobiology in the july edition i think

1439
00:55:39,349 --> 00:55:34,480
and nasa for funding and i'll take any

1440
00:55:42,630 --> 00:55:40,789
thank you eric

1441
00:55:47,990 --> 00:55:42,640
any questions

1442
00:55:53,910 --> 00:55:51,349
and i'll go ahead with one uh so

1443
00:55:56,309 --> 00:55:53,920
so you picked up those samples and

1444
00:55:58,710 --> 00:55:56,319
um put them in you know minus 20 or

1445
00:56:00,710 --> 00:55:58,720
minus 80 in different conditions

1446
00:56:02,390 --> 00:56:00,720
chloride and perchloride is there

1447
00:56:04,710 --> 00:56:02,400
interest um in

1448
00:56:05,750 --> 00:56:04,720
trying to do that in a in a step-by-step

1449
00:56:08,309 --> 00:56:05,760
uh

1450
00:56:10,549 --> 00:56:08,319
manner so kind of allowing acclimation

1451
00:56:12,789 --> 00:56:10,559
of the samples through time to kind of

1452
00:56:15,510 --> 00:56:12,799
adapt to it slowly rather than a kind of

1453
00:56:16,549 --> 00:56:15,520
abrupt change um that could improve a

1454
00:56:17,750 --> 00:56:16,559
lot of the

1455
00:56:19,030 --> 00:56:17,760
uh you know

1456
00:56:20,549 --> 00:56:19,040
growth rates and all that is that

1457
00:56:23,510 --> 00:56:20,559
interested in pursuing something like

1458
00:56:25,270 --> 00:56:23,520
that uh yeah i would ask can i put that

1459
00:56:29,349 --> 00:56:25,280
question in writing on my current grant

1460
00:56:31,910 --> 00:56:29,359
proposal um because i i work you know

1461
00:56:34,150 --> 00:56:31,920
interesting employer for this meeting i

1462
00:56:36,549 --> 00:56:34,160
work for the u.s army

1463
00:56:38,390 --> 00:56:36,559

i'm currently applying for darpa funding

1464
00:56:39,109 --> 00:56:38,400
because there's lots of darpa interest

1465
00:56:40,150 --> 00:56:39,119
in

1466
00:56:41,829 --> 00:56:40,160
basically

1467
00:56:45,109 --> 00:56:41,839
building synthetic biological

1468
00:56:47,190 --> 00:56:45,119
communities off of various exotic soils

1469
00:56:49,190 --> 00:56:47,200
and so what what we're planning to do is

1470
00:56:52,069 --> 00:56:49,200
sort of take this this was sort of a

1471
00:56:53,349 --> 00:56:52,079
ham-fisted example of directed evolution

1472
00:56:54,950 --> 00:56:53,359
we would like to be a little bit more

1473
00:56:57,430 --> 00:56:54,960
systematic with it

1474
00:57:00,309 --> 00:56:57,440
and basically piecemeal out

1475
00:57:02,789 --> 00:57:00,319
different levels of these solutes into

1476
00:57:04,950 --> 00:57:02,799
different soils and grow them over a

1477
00:57:07,190 --> 00:57:04,960
series of generations and really what

1478
00:57:09,750 --> 00:57:07,200
we're planning is in addition to sort of

1479
00:57:12,390 --> 00:57:09,760
that forward directed evolution over

1480
00:57:13,990 --> 00:57:12,400
time we also want to take out subsamples

1481
00:57:15,990 --> 00:57:14,000
of both the soil media that we're

1482
00:57:18,069 --> 00:57:16,000
generating and the communities that grow

1483
00:57:19,750 --> 00:57:18,079
off of them and then we can backwards

1484
00:57:22,470 --> 00:57:19,760
challenge and basically you know

1485
00:57:25,430 --> 00:57:22,480
generation 10 can we put generation 10

1486
00:57:26,950 --> 00:57:25,440
back into a generation 2 soil and are

1487
00:57:29,829 --> 00:57:26,960
they now better adapted to those

1488
00:57:31,109 --> 00:57:29,839

conditions so that's what we're planning

1489
00:57:33,910 --> 00:57:31,119
that's great and i think you can even

1490
00:57:36,549 --> 00:57:33,920
use joseph's uh system yes yeah i was

1491
00:57:42,230 --> 00:57:36,559
thinking that too

1492
00:57:46,549 --> 00:57:44,309
all right otherwise we're up on time

1493
00:57:48,230 --> 00:57:46,559
thank you so much uh really really very

1494
00:57:50,069 --> 00:57:48,240
very interesting uh presentation and i

1495
00:57:51,670 --> 00:57:50,079
want to see that follow-up work uh

1496
00:57:53,510 --> 00:57:51,680
really very interesting

1497
00:57:56,710 --> 00:57:53,520
um all right we can move on to the next

1498
00:57:58,870 --> 00:57:56,720
speaker uh rosa santo martino from the

1499
00:58:05,589 --> 00:57:58,880
university of edinburgh um

1500
00:58:05,599 --> 00:58:14,470
next presentation i guess

1501
00:58:19,349 --> 00:58:17,030
all right so thanks for being here

1502
00:58:20,870 --> 00:58:19,359
today i'm going to talk about what we

1503
00:58:23,510 --> 00:58:20,880
learned from two space microbiology

1504
00:58:28,150 --> 00:58:23,520
experiments that we performed in 2019

1505
00:58:29,829 --> 00:58:28,160
and 2020 20 20 2020 2021 by a rock and

1506
00:58:31,829 --> 00:58:29,839
bio-asteroid

1507
00:58:33,589 --> 00:58:31,839
and what we learned from that from the

1508
00:58:35,430 --> 00:58:33,599
perspective of microbial interaction

1509
00:58:37,430 --> 00:58:35,440
with terrestrial and extraterrestrial

1510
00:58:39,750 --> 00:58:37,440
rocks

1511
00:58:42,870 --> 00:58:39,760
so microorganisms perform a variety of

1512
00:58:44,390 --> 00:58:42,880
different tasks and for us on earth i'm

1513
00:58:45,829 --> 00:58:44,400

sure i don't have to convince you about

1514
00:58:47,589 --> 00:58:45,839
that

1515
00:58:49,190 --> 00:58:47,599
but today i want to focus on one in

1516
00:58:50,549 --> 00:58:49,200
particular which is the process of

1517
00:58:52,870 --> 00:58:50,559
biomining

1518
00:58:54,950 --> 00:58:52,880
so what is that is the process of using

1519
00:58:56,789 --> 00:58:54,960
microorganisms to extract metal of

1520
00:59:00,950 --> 00:58:56,799
economic interest from rock ores and

1521
00:59:02,710 --> 00:59:00,960
mine waste it is also used in other um

1522
00:59:03,990 --> 00:59:02,720
similar chemical reactions are also used

1523
00:59:05,990 --> 00:59:04,000
in some other processes like

1524
00:59:08,150 --> 00:59:06,000
bioremediation for instance

1525
00:59:10,069 --> 00:59:08,160
both chemolithotrophic and organotrophic

1526
00:59:11,270 --> 00:59:10,079
microbes can be used for this

1527
00:59:13,510 --> 00:59:11,280
and

1528
00:59:15,349 --> 00:59:13,520
on earth it is currently used to extract

1529
00:59:17,750 --> 00:59:15,359
a variety of different metals like

1530
00:59:20,230 --> 00:59:17,760
copper gold and others there are in

1531
00:59:21,990 --> 00:59:20,240
general some advantages of using

1532
00:59:23,349 --> 00:59:22,000
biomining in respect to traditional

1533
00:59:25,990 --> 00:59:23,359
mining because it is generally

1534
00:59:29,910 --> 00:59:26,000
considered complementary as well as more

1535
00:59:30,710 --> 00:59:29,920
economic and environmentally friendly

1536
00:59:33,030 --> 00:59:30,720
now

1537
00:59:36,789 --> 00:59:33,040
because of how many tasks microorganisms

1538
00:59:39,349 --> 00:59:36,799

perform on earth um imagine how many of

1539
00:59:40,390 --> 00:59:39,359
them could be actually translated beyond

1540
00:59:42,710 --> 00:59:40,400
earth for instance on an

1541
00:59:45,270 --> 00:59:42,720
extraterrestrial settlement and some of

1542
00:59:46,470 --> 00:59:45,280
them include the generation of food and

1543
00:59:48,630 --> 00:59:46,480
oxygen

1544
00:59:51,270 --> 00:59:48,640
the recycling of waste the production of

1545
00:59:53,030 --> 00:59:51,280
fertile soil out of excess restaurant

1546
00:59:54,549 --> 00:59:53,040
regolith and also in some space

1547
00:59:56,710 --> 00:59:54,559
bioindustries

1548
00:59:58,230 --> 00:59:56,720
now you may notice that all these

1549
01:00:00,710 --> 00:59:58,240
possible

1550
01:00:03,190 --> 01:00:00,720
roles for micros beyond earth

1551
01:00:05,030 --> 01:00:03,200
and all the final aim to sustain life

1552
01:00:06,870 --> 01:00:05,040
support systems

1553
01:00:08,549 --> 01:00:06,880
and this is also related to the concept

1554
01:00:11,030 --> 01:00:08,559
of incident resource utilization which

1555
01:00:12,710 --> 01:00:11,040
is just the concept of utilizing the

1556
01:00:14,630 --> 01:00:12,720
resources in the place in which we are

1557
01:00:16,549 --> 01:00:14,640
going to settle rather than relying on a

1558
01:00:18,470 --> 01:00:16,559
constant resupply or resources from

1559
01:00:20,549 --> 01:00:18,480
earth which the farther we will go from

1560
01:00:21,510 --> 01:00:20,559
earth the less become sustainable of

1561
01:00:23,190 --> 01:00:21,520
course

1562
01:00:25,349 --> 01:00:23,200
and from this perspective the

1563
01:00:27,670 --> 01:00:25,359

possibility of performing biomining in

1564
01:00:30,470 --> 01:00:27,680
space is rising and increasing interest

1565
01:00:33,109 --> 01:00:30,480
and maybe it's easy to understand why of

1566
01:00:36,230 --> 01:00:33,119
course the uh the possibility of using

1567
01:00:38,309 --> 01:00:36,240
microbes to extract elements useful um

1568
01:00:39,910 --> 01:00:38,319
components materials in the place in

1569
01:00:41,349 --> 01:00:39,920
which we are going to settle is quite

1570
01:00:43,109 --> 01:00:41,359
intriguing

1571
01:00:45,510 --> 01:00:43,119
from this perspective the planetary

1572
01:00:46,870 --> 01:00:45,520
bodies of interest are moon mars and

1573
01:00:48,710 --> 01:00:46,880
asteroids

1574
01:00:50,309 --> 01:00:48,720
moon and mars because of because they

1575
01:00:52,230 --> 01:00:50,319
are the the

1576
01:00:53,750 --> 01:00:52,240
for regarding like space agencies think

1577
01:00:55,510 --> 01:00:53,760
that these are the future of human space

1578
01:00:57,109 --> 01:00:55,520
exploration and asteroids because they

1579
01:00:59,510 --> 01:00:57,119
contain some

1580
01:01:01,190 --> 01:00:59,520
key and precious elements

1581
01:01:02,710 --> 01:01:01,200
however

1582
01:01:04,549 --> 01:01:02,720
the conditions that are present in these

1583
01:01:06,630 --> 01:01:04,559
planetary bodies are of course different

1584
01:01:08,950 --> 01:01:06,640
than those on earth and just to mention

1585
01:01:10,950 --> 01:01:08,960
one gravity is different it is lower in

1586
01:01:13,190 --> 01:01:10,960
respect to earth

1587
01:01:15,510 --> 01:01:13,200
in general so if we want to understand

1588
01:01:17,270 --> 01:01:15,520

if we can perform biomining in space we

1589
01:01:19,990 --> 01:01:17,280
first need to understand

1590
01:01:21,270 --> 01:01:20,000
uh how gravity uh

1591
01:01:23,190 --> 01:01:21,280
conditions that are present in these

1592
01:01:25,030 --> 01:01:23,200
planetary bodies for instance gravity

1593
01:01:27,270 --> 01:01:25,040
influence the way in which

1594
01:01:29,190 --> 01:01:27,280
minerals and microbes interact with each

1595
01:01:32,950 --> 01:01:29,200
other we cannot assume that what happens

1596
01:01:34,789 --> 01:01:32,960
on earth is going to work even in space

1597
01:01:36,549 --> 01:01:34,799
so with this question in mind we

1598
01:01:38,150 --> 01:01:36,559
performed the first two biomining

1599
01:01:41,349 --> 01:01:38,160
experiments on board the international

1600
01:01:44,309 --> 01:01:41,359
space station by rock in 2019 and by

1601
01:01:47,510 --> 01:01:44,319
asteroid in 2020 2021

1602
01:01:50,470 --> 01:01:47,520
so let's go for bio rock first

1603
01:01:52,309 --> 01:01:50,480
um byrock as i said was launched in 2019

1604
01:01:54,069 --> 01:01:52,319
but it was first proposed by professor

1605
01:01:57,349 --> 01:01:54,079
kokel from the university of edinburgh

1606
01:01:59,430 --> 01:01:57,359
in 2008 and as you can see here a

1607
01:02:02,230 --> 01:01:59,440
variety of different groups

1608
01:02:03,910 --> 01:02:02,240
made it possible

1609
01:02:05,029 --> 01:02:03,920
the first thing that we need to do was

1610
01:02:08,789 --> 01:02:05,039
to

1611
01:02:11,029 --> 01:02:08,799
right microorganisms we needed which

1612
01:02:13,589 --> 01:02:11,039
needed to have some characteristics in

1613
01:02:15,910 --> 01:02:13,599

common among them eventually we decided

1614
01:02:17,910 --> 01:02:15,920
to go for these three microorganisms

1615
01:02:19,750 --> 01:02:17,920
here they are all bacterial species

1616
01:02:21,829 --> 01:02:19,760
swinging on this is the bacillus

1617
01:02:24,549 --> 01:02:21,839
subtilis and cubryados metallidurans

1618
01:02:25,670 --> 01:02:24,559
each one provided by a different group

1619
01:02:28,549 --> 01:02:25,680
um

1620
01:02:30,470 --> 01:02:28,559
but we also needed to select the right

1621
01:02:33,349 --> 01:02:30,480
terrestrial rock substrate and we

1622
01:02:35,589 --> 01:02:33,359
selected basalt mainly for two reasons

1623
01:02:38,230 --> 01:02:35,599
the first is that basalt is quite poor

1624
01:02:40,230 --> 01:02:38,240
so it provided a good support for

1625
01:02:42,950 --> 01:02:40,240
bacterial colonization and the second is

1626
01:02:45,109 --> 01:02:42,960
that it is widely present on both moon

1627
01:02:46,309 --> 01:02:45,119
and mars so it provided basically a good

1628
01:02:48,789 --> 01:02:46,319
analogue

1629
01:02:51,029 --> 01:02:48,799
so we've selected one uh specimen from

1630
01:02:52,950 --> 01:02:51,039
iceland we cut it into buzzer's light

1631
01:02:56,230 --> 01:02:52,960
you can see here on the right maybe i

1632
01:02:58,470 --> 01:02:56,240
have the arrow yes you can see here

1633
01:03:01,430 --> 01:02:58,480
um a buzzer's light an example of that

1634
01:03:03,190 --> 01:03:01,440
which was a rough roughly 15 millimeter

1635
01:03:06,150 --> 01:03:03,200
wide

1636
01:03:08,069 --> 01:03:06,160
by side and two three millimeters

1637
01:03:10,710 --> 01:03:08,079
thick

1638
01:03:12,710 --> 01:03:10,720

then we inoculated every bacterial uh

1639
01:03:15,190 --> 01:03:12,720
every basal slide with a single

1640
01:03:17,270 --> 01:03:15,200
bacterial culture but we also had some

1641
01:03:19,750 --> 01:03:17,280
non-biological control which was just

1642
01:03:22,630 --> 01:03:19,760
some sterile basal slide

1643
01:03:25,029 --> 01:03:22,640
and we have put them into the biominine

1644
01:03:26,390 --> 01:03:25,039
reactor which was an artwork that was

1645
01:03:28,829 --> 01:03:26,400
specifically designed for this

1646
01:03:31,750 --> 01:03:28,839
experiment by our group and the kaiser

1647
01:03:34,710 --> 01:03:31,760
italian and then it was launched on the

1648
01:03:36,870 --> 01:03:34,720
international space station in july 2019

1649
01:03:39,910 --> 01:03:36,880
on spacex commercially supply service

1650
01:03:42,150 --> 01:03:39,920
18. here you can see well here the this

1651
01:03:44,150 --> 01:03:42,160
is me very happy on the launch site and

1652
01:03:45,750 --> 01:03:44,160
this is the astronaut look at parmitano

1653
01:03:49,750 --> 01:03:45,760
installing the samples on board the

1654
01:03:53,029 --> 01:03:51,430
when in space

1655
01:03:55,270 --> 01:03:53,039
samples were subjected to either

1656
01:03:57,430 --> 01:03:55,280
microgravity simulated martian gravity

1657
01:03:59,829 --> 01:03:57,440
or simulated terrestrial gravity but we

1658
01:04:02,309 --> 01:03:59,839
also had another set of sample identical

1659
01:04:04,150 --> 01:04:02,319
to the others which was we call it

1660
01:04:06,150 --> 01:04:04,160
ground control it stayed on the ground

1661
01:04:08,789 --> 01:04:06,160
so on earth and it was subjected of

1662
01:04:10,549 --> 01:04:08,799
course just to true terrestrial gravity

1663
01:04:12,789 --> 01:04:10,559

samples grow in liquid culture in the

1664
01:04:15,910 --> 01:04:12,799
presence of the buzzer's light for 21

1665
01:04:18,630 --> 01:04:15,920
days at 20 degrees and after this period

1666
01:04:19,510 --> 01:04:18,640
they come back on earth and we analyze

1667
01:04:21,510 --> 01:04:19,520
them

1668
01:04:23,910 --> 01:04:21,520
so let's go to the results what did we

1669
01:04:25,670 --> 01:04:23,920
discover out of this experiment the

1670
01:04:27,910 --> 01:04:25,680
first thing that we tested was the final

1671
01:04:30,309 --> 01:04:27,920
cell concentration and we analyzed that

1672
01:04:31,430 --> 01:04:30,319
by both direct cell counting and optical

1673
01:04:33,589 --> 01:04:31,440
density

1674
01:04:35,270 --> 01:04:33,599
what you can notice from these results

1675
01:04:37,190 --> 01:04:35,280
here is that you can find some

1676
01:04:39,190 --> 01:04:37,200
differences between some of the ground

1677
01:04:41,829 --> 01:04:39,200
controls some of the space samples which

1678
01:04:44,230 --> 01:04:41,839
are indicated here by the asterisks but

1679
01:04:46,309 --> 01:04:44,240
in general the main result here is that

1680
01:04:48,150 --> 01:04:46,319
when we compare the space samples so all

1681
01:04:50,069 --> 01:04:48,160
the samples that were present in space

1682
01:04:51,910 --> 01:04:50,079
we found no significant

1683
01:04:54,549 --> 01:04:51,920
difference

1684
01:04:56,710 --> 01:04:54,559
in final cell concentration what does it

1685
01:04:58,309 --> 01:04:56,720
mean from a biological perspective or if

1686
01:05:00,470 --> 01:04:58,319
you want a space biotechnological

1687
01:05:02,870 --> 01:05:00,480
perspective this

1688
01:05:05,510 --> 01:05:02,880

means that

1689
01:05:07,589 --> 01:05:05,520
after 21 days the bacterial cell culture

1690
01:05:09,670 --> 01:05:07,599
all reach the same final concentration

1691
01:05:11,190 --> 01:05:09,680
regardless of the gravity condition and

1692
01:05:13,349 --> 01:05:11,200
this may be a good indication that

1693
01:05:14,390 --> 01:05:13,359
biotechnological application happening

1694
01:05:16,309 --> 01:05:14,400
in uh

1695
01:05:17,910 --> 01:05:16,319
lower gravities in respect to earth are

1696
01:05:19,990 --> 01:05:17,920
not going to be negatively affected by

1697
01:05:22,710 --> 01:05:20,000
gravity so they may be

1698
01:05:24,390 --> 01:05:22,720
possible

1699
01:05:27,430 --> 01:05:24,400
the other thing that we focused on is

1700
01:05:30,230 --> 01:05:27,440
biomining of course so we

1701
01:05:32,950 --> 01:05:30,240
focus on two main type of elements rare

1702
01:05:35,670 --> 01:05:32,960
earth elements and vanadium both have

1703
01:05:37,750 --> 01:05:35,680
high industrial interests and we believe

1704
01:05:40,230 --> 01:05:37,760
that they may be important in a future

1705
01:05:42,549 --> 01:05:40,240
space application

1706
01:05:45,670 --> 01:05:42,559
and what we found is that at least one

1707
01:05:48,549 --> 01:05:45,680
out of the three microbes um one here

1708
01:05:51,190 --> 01:05:48,559
and two in the case of vanadium was were

1709
01:05:52,870 --> 01:05:51,200
actually able to extract these elements

1710
01:05:55,430 --> 01:05:52,880
on in all the gravity conditions that we

1711
01:05:56,870 --> 01:05:55,440
tested so basically the results that i

1712
01:05:59,349 --> 01:05:56,880
show you here

1713
01:06:01,109 --> 01:05:59,359

um the two micro organisms that were

1714
01:06:04,549 --> 01:06:01,119
able to do that were sphingomonas disa

1715
01:06:06,710 --> 01:06:04,559
cables and bacillus subtilis and these

1716
01:06:09,270 --> 01:06:06,720
results indicate that space biomania is

1717
01:06:11,589 --> 01:06:09,280
in principle achievable under a range of

1718
01:06:13,510 --> 01:06:11,599
gravity conditions

1719
01:06:16,230 --> 01:06:13,520
we also tested bioform biofuel

1720
01:06:18,710 --> 01:06:16,240
information on the basal surface and as

1721
01:06:21,190 --> 01:06:18,720
you can appreciate from this picture

1722
01:06:24,630 --> 01:06:21,200
while bacillus subtilis didn't form much

1723
01:06:26,069 --> 01:06:24,640
biofilm on the rock surface uh both

1724
01:06:28,069 --> 01:06:26,079
sphingomonas cystic capillaries and

1725
01:06:29,430 --> 01:06:28,079
cubriavidus metallidurans

1726
01:06:31,510 --> 01:06:29,440
have a positive trend of biofuel

1727
01:06:33,109 --> 01:06:31,520
information on increasing gravity

1728
01:06:34,950 --> 01:06:33,119
regiments and i hope you can appreciate

1729
01:06:37,349 --> 01:06:34,960
it from both the

1730
01:06:41,510 --> 01:06:37,359
the the pictures and the

1731
01:06:45,589 --> 01:06:43,670
now after biorock we decided to go for a

1732
01:06:47,670 --> 01:06:45,599
second space biomining experiment called

1733
01:06:50,470 --> 01:06:47,680
bioasteroid which is a little more

1734
01:06:54,230 --> 01:06:50,480
recent it was launched in december 2020

1735
01:06:56,150 --> 01:06:54,240
and our samples came back in 2021

1736
01:06:58,549 --> 01:06:56,160
it is quite similar to biorock but there

1737
01:07:00,870 --> 01:06:58,559
are some key differences for instance in

1738
01:07:03,589 --> 01:07:00,880

the microorganisms that we used this

1739
01:07:04,950 --> 01:07:03,599
time we use uh the same bacterium one of

1740
01:07:07,029 --> 01:07:04,960
the three bacteria that we use for

1741
01:07:08,950 --> 01:07:07,039
biorock which is a sphingomonas cystic

1742
01:07:11,190 --> 01:07:08,960
cables because he behaved quite well in

1743
01:07:13,670 --> 01:07:11,200
biorock but we also decided to expand

1744
01:07:16,069 --> 01:07:13,680
our knowledge on microbial

1745
01:07:18,309 --> 01:07:16,079
behavior basically in these conditions

1746
01:07:20,789 --> 01:07:18,319
by adding a fungus a penis called

1747
01:07:22,470 --> 01:07:20,799
penicillium simply systemum and we also

1748
01:07:24,150 --> 01:07:22,480
selected a mix

1749
01:07:27,190 --> 01:07:24,160
we didn't know we didn't select we

1750
01:07:30,230 --> 01:07:27,200
decided to go on for a mix of the two

1751
01:07:31,109 --> 01:07:30,240
we also changed the rock substrate in

1752
01:07:32,950 --> 01:07:31,119
fact

1753
01:07:35,270 --> 01:07:32,960
instead of using terrestrial rock as we

1754
01:07:37,910 --> 01:07:35,280
did in byrock this time we decided to go

1755
01:07:39,750 --> 01:07:37,920
for real extraterrestrial rock

1756
01:07:43,029 --> 01:07:39,760
uh to build more specific crushed

1757
01:07:46,549 --> 01:07:44,870
the experiment again is quite similar

1758
01:07:48,789 --> 01:07:46,559
but it's little

1759
01:07:50,870 --> 01:07:48,799
smaller in respect to biorock in fact we

1760
01:07:52,470 --> 01:07:50,880
only had some samples launched on board

1761
01:07:55,109 --> 01:07:52,480
the international space station which

1762
01:07:57,589 --> 01:07:55,119
were subjected to microgravity and

1763
01:07:59,910 --> 01:07:57,599

another set of samples that were remain

1764
01:08:02,150 --> 01:07:59,920
on earth and it was ground control apart

1765
01:08:04,630 --> 01:08:02,160
from that everything was quite similar

1766
01:08:07,190 --> 01:08:04,640
but um apart from the fact that instead

1767
01:08:09,750 --> 01:08:07,200
of having 21 days of growth we had none

1768
01:08:11,589 --> 01:08:09,760
19 days

1769
01:08:13,910 --> 01:08:11,599
so do we have any results because the

1770
01:08:16,709 --> 01:08:13,920
samples the the experiment was more

1771
01:08:19,030 --> 01:08:16,719
recent the results are still uh under

1772
01:08:21,990 --> 01:08:19,040
analysis but i can show you something

1773
01:08:24,630 --> 01:08:22,000
for instance when we analyze the pieces

1774
01:08:26,309 --> 01:08:24,640
of meteorite that came back so after the

1775
01:08:28,149 --> 01:08:26,319
space flight

1776
01:08:31,349 --> 01:08:28,159
under scanning electron microscopy we

1777
01:08:33,510 --> 01:08:31,359
could um we saw that the bacterial

1778
01:08:36,309 --> 01:08:33,520
species the samples that were in contact

1779
01:08:38,070 --> 01:08:36,319
with the bacterial culture did have some

1780
01:08:39,430 --> 01:08:38,080
feature indicating that bifur

1781
01:08:42,229 --> 01:08:39,440
information

1782
01:08:43,829 --> 01:08:42,239
actually formed on

1783
01:08:46,550 --> 01:08:43,839
on the meteorite rocks and you can see

1784
01:08:48,149 --> 01:08:46,560
that with the red arrows but maybe more

1785
01:08:50,229 --> 01:08:48,159
interestingly when we checked the

1786
01:08:51,349 --> 01:08:50,239
samples that

1787
01:08:53,349 --> 01:08:51,359
that were

1788
01:08:56,229 --> 01:08:53,359

contained the fungus both the mixed and

1789
01:09:01,110 --> 01:08:56,239
the single culture one we saw mycelium

1790
01:09:03,110 --> 01:09:01,120
formation on the top of the rock pieces

1791
01:09:05,030 --> 01:09:03,120
from the perspective of biomining this

1792
01:09:06,550 --> 01:09:05,040
time we focused on another group of

1793
01:09:09,749 --> 01:09:06,560
elements called the platinum group

1794
01:09:11,110 --> 01:09:09,759
elements which are quite precious

1795
01:09:13,030 --> 01:09:11,120
type of

1796
01:09:15,990 --> 01:09:13,040
metals and

1797
01:09:18,070 --> 01:09:16,000
as you can see here

1798
01:09:20,149 --> 01:09:18,080
these images here show that we found

1799
01:09:23,110 --> 01:09:20,159
evidence of a fungal extraction of

1800
01:09:27,430 --> 01:09:23,120
palladium here which is one of pges

1801
01:09:32,229 --> 01:09:30,070
so to summarize and conclude uh with

1802
01:09:33,910 --> 01:09:32,239
these two experiments we demonstrated

1803
01:09:36,309 --> 01:09:33,920
for the first time biomining on a space

1804
01:09:38,070 --> 01:09:36,319
station particularly of some precious

1805
01:09:40,309 --> 01:09:38,080
elements like rare earth elements and

1806
01:09:43,110 --> 01:09:40,319
pges from both the restaurant and

1807
01:09:45,110 --> 01:09:43,120
extraterrestrial rocks and using both

1808
01:09:47,510 --> 01:09:45,120
organo sorry using organotrophic

1809
01:09:49,430 --> 01:09:47,520
microorganisms we demonstrated that

1810
01:09:51,910 --> 01:09:49,440
biomining is in principle achievable

1811
01:09:53,669 --> 01:09:51,920
under range of gravity regiments and

1812
01:09:55,270 --> 01:09:53,679
also that the financial numbers were not

1813
01:09:57,110 --> 01:09:55,280

affected after

1814
01:09:59,669 --> 01:09:57,120
by the gravity condition after 21 days

1815
01:10:01,990 --> 01:09:59,679
which is a good indication of

1816
01:10:03,270 --> 01:10:02,000
space by industrial applications we

1817
01:10:05,750 --> 01:10:03,280
discovered the novel biomini

1818
01:10:07,189 --> 01:10:05,760
microorganism which is fingomonas and we

1819
01:10:08,630 --> 01:10:07,199
also demonstrated for the first time

1820
01:10:10,070 --> 01:10:08,640
microbial interaction with meteorite

1821
01:10:13,189 --> 01:10:10,080
material on a space station in

1822
01:10:14,870 --> 01:10:13,199
microgravity at least to my knowledge

1823
01:10:17,189 --> 01:10:14,880
but there is a light that we still need

1824
01:10:18,870 --> 01:10:17,199
to understand for instance we need to

1825
01:10:21,510 --> 01:10:18,880
have more insights of the effect of

1826
01:10:23,990 --> 01:10:21,520
gravity and other space flight

1827
01:10:25,910 --> 01:10:24,000
conditions on the microbial processes we

1828
01:10:27,830 --> 01:10:25,920
need to select the best microorganisms

1829
01:10:29,189 --> 01:10:27,840
for any given application that you want

1830
01:10:30,870 --> 01:10:29,199
to do in space

1831
01:10:33,910 --> 01:10:30,880
we need to scale up the system and

1832
01:10:37,189 --> 01:10:33,920
develop technologies of that because our

1833
01:10:39,189 --> 01:10:37,199
reactor was 5 ml

1834
01:10:41,510 --> 01:10:39,199
of volume so it's quite a small

1835
01:10:43,350 --> 01:10:41,520
volume if you scale up the system is are

1836
01:10:44,790 --> 01:10:43,360
you still going to have the same results

1837
01:10:47,430 --> 01:10:44,800
we don't know so it's something that

1838
01:10:50,149 --> 01:10:47,440

need to be tested and then uh last thing

1839
01:10:51,990 --> 01:10:50,159
that i want to point here is how can we

1840
01:10:53,910 --> 01:10:52,000
use microbial biotechnology to support

1841
01:10:56,470 --> 01:10:53,920
sustainable space exploration and this

1842
01:10:58,950 --> 01:10:56,480
is a project that i am starting now uh

1843
01:11:01,110 --> 01:10:58,960
it's funded by the lavrom trust and i'm

1844
01:11:02,950 --> 01:11:01,120
going to focus particularly on plastic

1845
01:11:05,910 --> 01:11:02,960
biodegrading microorganisms so if you

1846
01:11:07,510 --> 01:11:05,920
want to know more just contact me or

1847
01:11:09,430 --> 01:11:07,520
come to me later

1848
01:11:12,229 --> 01:11:09,440
and with that i would like to thank both

1849
01:11:14,950 --> 01:11:12,239
the bioroc and the bioasteroid teams and

1850
01:11:20,470 --> 01:11:14,960
you all for your attention and i will be

1851
01:11:28,470 --> 01:11:21,990
thank you rosa

1852
01:11:34,070 --> 01:11:32,070
and i i have one oh yeah go ahead 301 hi

1853
01:11:37,030 --> 01:11:34,080
um adam ellington from uh university of

1854
01:11:39,990 --> 01:11:37,040
florida um first of all amazing i love

1855
01:11:42,310 --> 01:11:40,000
this is very exciting thank you um do

1856
01:11:44,070 --> 01:11:42,320
you so the organisms that you used were

1857
01:11:45,189 --> 01:11:44,080
not genetically modified in any way

1858
01:11:46,470 --> 01:11:45,199
right they're just the wild type

1859
01:11:48,630 --> 01:11:46,480
organisms

1860
01:11:50,070 --> 01:11:48,640
and do you have any plans to try to

1861
01:11:51,750 --> 01:11:50,080
optimize

1862
01:11:53,430 --> 01:11:51,760
the efficiency of the extraction process

1863
01:11:55,350 --> 01:11:53,440

or any of that through any genetic

1864
01:11:57,350 --> 01:11:55,360
modifications

1865
01:11:59,270 --> 01:11:57,360
yeah thanks for the question so

1866
01:12:01,990 --> 01:11:59,280
we after

1867
01:12:03,750 --> 01:12:02,000
biorock basically um one of the

1868
01:12:05,510 --> 01:12:03,760
microorganisms that behaved better is

1869
01:12:07,510 --> 01:12:05,520
finger monasticicalis

1870
01:12:09,910 --> 01:12:07,520
and

1871
01:12:10,870 --> 01:12:09,920
one phd student is now studying this so

1872
01:12:12,870 --> 01:12:10,880
he's studying first of all the

1873
01:12:15,030 --> 01:12:12,880
mechanisms because we don't know how it

1874
01:12:17,189 --> 01:12:15,040
works actually we didn't even know that

1875
01:12:18,950 --> 01:12:17,199
he would be able to to buy online

1876
01:12:21,590 --> 01:12:18,960
because we had indication that he could

1877
01:12:22,390 --> 01:12:21,600
do that but we weren't sure about that

1878
01:12:23,830 --> 01:12:22,400
and

1879
01:12:25,830 --> 01:12:23,840
he is analyzing first of all the

1880
01:12:27,910 --> 01:12:25,840
mechanisms being an etherotrophy

1881
01:12:30,310 --> 01:12:27,920
microorganisms is must be something

1882
01:12:32,149 --> 01:12:30,320
related to um

1883
01:12:33,830 --> 01:12:32,159
organic

1884
01:12:36,470 --> 01:12:33,840
acids basically

1885
01:12:39,270 --> 01:12:36,480
and then the the idea is to understand

1886
01:12:41,750 --> 01:12:39,280
once once we understood which are the

1887
01:12:45,510 --> 01:12:41,760
key genes to try and modify it to see if

1888
01:12:48,550 --> 01:12:46,950

very good and i think you know in the

1889
01:12:50,709 --> 01:12:48,560
interest of time we'll have to move on

1890
01:12:52,070 --> 01:12:50,719
um but i just want to say that maybe

1891
01:12:53,669 --> 01:12:52,080
yeah speaking with you one might be

1892
01:12:56,070 --> 01:12:53,679
interesting because she had the findings

1893
01:12:57,750 --> 01:12:56,080
about the biofilm um preferential

1894
01:12:59,030 --> 01:12:57,760
mutation and

1895
01:13:00,310 --> 01:12:59,040
you know i don't think you have genomic

1896
01:13:02,550 --> 01:13:00,320
data and she doesn't have functional

1897
01:13:04,310 --> 01:13:02,560
data but it seems like there's something

1898
01:13:05,350 --> 01:13:04,320
interesting there to to talk about in

1899
01:13:07,830 --> 01:13:05,360
terms of

1900
01:13:10,229 --> 01:13:07,840
potentially gravity um or lack of

1901
01:13:12,790 --> 01:13:10,239
gravity interfering with um biofilm

1902
01:13:13,750 --> 01:13:12,800
formation um sure drop me an email of

1903
01:13:15,510 --> 01:13:13,760
course

1904
01:13:18,790 --> 01:13:15,520
thank you very much that was great thank

1905
01:13:20,229 --> 01:13:18,800
you um all right so christian lawrence

1906
01:13:23,430 --> 01:13:20,239
will be

1907
01:13:25,910 --> 01:13:23,440
our last speaker and he's um virtually

1908
01:13:27,830 --> 01:13:25,920
here with us and um he's in the

1909
01:13:29,830 --> 01:13:27,840
university of florence so christian

1910
01:13:33,910 --> 01:13:29,840
please go ahead

1911
01:13:36,310 --> 01:13:33,920
yeah can you see my screen

1912
01:13:38,470 --> 01:13:36,320
yeah uh yeah yep i see it very well

1913
01:13:41,030 --> 01:13:38,480

thank you okay okay

1914
01:13:42,790 --> 01:13:41,040
thanks uh i'm christian lawrence a

1915
01:13:45,669 --> 01:13:42,800
master student from university of

1916
01:13:48,310 --> 01:13:45,679
florence italy and today i'm going to

1917
01:13:50,709 --> 01:13:48,320
talk about the survival of the lichen

1918
01:13:52,470 --> 01:13:50,719
species santori paratina in simulated

1919
01:13:55,510 --> 01:13:52,480
space condition

1920
01:13:58,310 --> 01:13:55,520
and let's start with an introduction on

1921
01:14:01,270 --> 01:13:58,320
why we choose as biological sample this

1922
01:14:02,310 --> 01:14:01,280
particular lichen and why this lichen

1923
01:14:05,030 --> 01:14:02,320
species

1924
01:14:07,510 --> 01:14:05,040
so lichens are considered a

1925
01:14:09,669 --> 01:14:07,520
poikilohedric organism that means that

1926
01:14:12,630 --> 01:14:09,679
they are considered photosynthetically

1927
01:14:14,390 --> 01:14:12,640
active when there is water available

1928
01:14:15,590 --> 01:14:14,400
availability in the environment

1929
01:14:18,390 --> 01:14:15,600
around them

1930
01:14:20,470 --> 01:14:18,400
and they are considered deactivated but

1931
01:14:23,750 --> 01:14:20,480
not that when there is no water

1932
01:14:26,070 --> 01:14:23,760
surrounding them so uh this feature

1933
01:14:28,550 --> 01:14:26,080
allowed them to colonize a lot of

1934
01:14:31,590 --> 01:14:28,560
different environments on earth and in

1935
01:14:36,149 --> 01:14:31,600
particular the most history extreme ones

1936
01:14:37,910 --> 01:14:36,159
and the reasons why santori paratina

1937
01:14:40,870 --> 01:14:37,920
refers to

1938
01:14:43,750 --> 01:14:40,880

the physiology of his lichen because

1939
01:14:46,149 --> 01:14:43,760
it's able to produce the ant requirement

1940
01:14:48,870 --> 01:14:46,159
parietin that has uv shielding

1941
01:14:50,790 --> 01:14:48,880
properties and the second reason is

1942
01:14:52,310 --> 01:14:50,800
referred to

1943
01:14:55,030 --> 01:14:52,320
the background the asteroid

1944
01:14:57,590 --> 01:14:55,040
astrobiological background indeed

1945
01:15:00,070 --> 01:14:57,600
santoria elegance that is a

1946
01:15:02,709 --> 01:15:00,080
really close phylum genetically speaking

1947
01:15:05,189 --> 01:15:02,719
species to santori paratina show with

1948
01:15:06,630 --> 01:15:05,199
some of the best recovery values after

1949
01:15:09,270 --> 01:15:06,640
treatment in

1950
01:15:10,390 --> 01:15:09,280
ground-based experiments but also in

1951
01:15:13,189 --> 01:15:10,400
real

1952
01:15:15,910 --> 01:15:13,199
pace experiment like on the xposed

1953
01:15:19,430 --> 01:15:15,920
module on the iss or

1954
01:15:22,470 --> 01:15:19,440
the photon m series of satellites so

1955
01:15:24,950 --> 01:15:22,480
the aims of this project were to obtain

1956
01:15:27,030 --> 01:15:24,960
for the first time the santori paratina

1957
01:15:29,910 --> 01:15:27,040
ftier reflectance spectrum in not

1958
01:15:32,310 --> 01:15:29,920
irradiated conditions and to monitor it

1959
01:15:35,669 --> 01:15:32,320
in situ during treatments to evaluate

1960
01:15:37,669 --> 01:15:35,679
event wall spectral bands changes and in

1961
01:15:41,189 --> 01:15:37,679
the end to verify centauri paratina

1962
01:15:43,189 --> 01:15:41,199
recovery capacity after treatments

1963
01:15:45,510 --> 01:15:43,199

so here you can appreciate the simulated

1964
01:15:47,910 --> 01:15:45,520
condition we applied with a uv lamp with

1965
01:15:50,470 --> 01:15:47,920
a sunlight emission spectrum and we

1966
01:15:52,870 --> 01:15:50,480
radiated the samples in two different

1967
01:15:56,390 --> 01:15:52,880
atmospheric conditions that were

1968
01:15:59,669 --> 01:15:56,400
uvm2 so uv radiation under nitrogen flux

1969
01:16:00,950 --> 01:15:59,679
and uv back uv radiation in high vacuum

1970
01:16:04,709 --> 01:16:00,960
conditions

1971
01:16:07,270 --> 01:16:04,719
and here you can see our experimental

1972
01:16:09,830 --> 01:16:07,280
design from the simple collection and

1973
01:16:13,030 --> 01:16:09,840
simple preparation and most important

1974
01:16:15,430 --> 01:16:13,040
the pre-exposure measures of the photo

1975
01:16:18,709 --> 01:16:15,440
efficiency parameters that we use to

1976
01:16:20,470 --> 01:16:18,719
assess like in vitality that were ndi

1977
01:16:22,950 --> 01:16:20,480
and fluorescence variation

1978
01:16:25,750 --> 01:16:22,960
and then the exposure phase with six

1979
01:16:28,709 --> 01:16:25,760
replicas for each treatment that were

1980
01:16:30,390 --> 01:16:28,719
controlled uvn-2 and uv back and finally

1981
01:16:32,390 --> 01:16:30,400
the post-exposure phase with

1982
01:16:34,470 --> 01:16:32,400
post-exposure measures of the

1983
01:16:39,189 --> 01:16:34,480
photoefficiency parameter

1984
01:16:40,310 --> 01:16:39,199
every 24 hours within the 72 hours from

1985
01:16:42,229 --> 01:16:40,320
the

1986
01:16:45,030 --> 01:16:42,239
exposure phase

1987
01:16:48,470 --> 01:16:45,040
so let's start with the results from the

1988
01:16:49,990 --> 01:16:48,480

spectroscopic analysis and here you are

1989
01:16:53,270 --> 01:16:50,000
seeing to the

1990
01:16:55,510 --> 01:16:53,280
not irradiated spectrum of a lichen and

1991
01:16:57,669 --> 01:16:55,520
in the overtone region maybe you can

1992
01:16:59,990 --> 01:16:57,679
recognize some of

1993
01:17:03,669 --> 01:17:00,000
very common bands that you can see also

1994
01:17:06,070 --> 01:17:03,679
in other biological samples but the most

1995
01:17:09,189 --> 01:17:06,080
relevant part is for sure the

1996
01:17:11,310 --> 01:17:09,199
fingerprint part region that

1997
01:17:13,590 --> 01:17:11,320
was very important for

1998
01:17:16,310 --> 01:17:13,600
characterizing functional group that we

1999
01:17:19,030 --> 01:17:16,320
can find in a imperative in the

2000
01:17:20,470 --> 01:17:19,040
substance with uv shielding properties

2001
01:17:22,229 --> 01:17:20,480
as we

2002
01:17:23,510 --> 01:17:22,239
find in

2003
01:17:27,590 --> 01:17:23,520
some work

2004
01:17:30,470 --> 01:17:27,600
like the edwards at all from 2003 work

2005
01:17:32,310 --> 01:17:30,480
and then starting with the treatments

2006
01:17:34,870 --> 01:17:32,320
with uvn2

2007
01:17:37,590 --> 01:17:34,880
in this slide you can see two lines two

2008
01:17:40,790 --> 01:17:37,600
colors so the first line the black and

2009
01:17:44,149 --> 01:17:40,800
thinner one is the first retrieved

2010
01:17:47,270 --> 01:17:44,159
spectrum and the thicker and magenta one

2011
01:17:50,470 --> 01:17:47,280
is the last one retrieved and as you can

2012
01:17:53,030 --> 01:17:50,480
notice here in the overtone region there

2013
01:17:55,510 --> 01:17:53,040

is the complete disappearance of a water

2014
01:17:58,470 --> 01:17:55,520
band due to the extremely dehydrating

2015
01:18:01,110 --> 01:17:58,480
condition offered by the nitrogen flux

2016
01:18:03,270 --> 01:18:01,120
and a general up shifting of a continuum

2017
01:18:05,750 --> 01:18:03,280
of a spectrum that can

2018
01:18:09,189 --> 01:18:05,760
be noticed here in the overton region

2019
01:18:12,070 --> 01:18:09,199
but also in the fingerprint part region

2020
01:18:14,070 --> 01:18:12,080
and here in detail there is a zoom on

2021
01:18:15,510 --> 01:18:14,080
the water band

2022
01:18:17,590 --> 01:18:15,520
analyzed

2023
01:18:18,870 --> 01:18:17,600
through time incident during the

2024
01:18:21,430 --> 01:18:18,880
treatment and

2025
01:18:22,950 --> 01:18:21,440
the complete disappearance at the end of

2026
01:18:25,350 --> 01:18:22,960
a simulation

2027
01:18:27,110 --> 01:18:25,360
moving to the other treatment that was

2028
01:18:29,270 --> 01:18:27,120
uv back

2029
01:18:31,830 --> 01:18:29,280
also here there is the disappearance of

2030
01:18:34,470 --> 01:18:31,840
water band but it's quicker than

2031
01:18:37,910 --> 01:18:34,480
the previous treatment and also you can

2032
01:18:40,709 --> 01:18:37,920
notice a more relevant and important

2033
01:18:42,709 --> 01:18:40,719
upshifting of a continuum of a spectrum

2034
01:18:45,590 --> 01:18:42,719
that characterized almost all the

2035
01:18:48,310 --> 01:18:45,600
spectrum but there is something strange

2036
01:18:51,830 --> 01:18:48,320
it seems strange here in the fingerprint

2037
01:18:54,229 --> 01:18:51,840
part region where the peak intensities

2038
01:18:57,030 --> 01:18:54,239

of bands seems to increase so let's

2039
01:19:00,070 --> 01:18:57,040
focus on this part taking

2040
01:19:02,229 --> 01:19:00,080
for instance these two bands that are in

2041
01:19:05,189 --> 01:19:02,239
that part highlighted

2042
01:19:07,990 --> 01:19:05,199
and here you can see clearly how

2043
01:19:10,070 --> 01:19:08,000
the peak intensities of these two bands

2044
01:19:13,270 --> 01:19:10,080
seems to increase but we need to

2045
01:19:14,870 --> 01:19:13,280
consider the big picture usually in ir

2046
01:19:17,510 --> 01:19:14,880
spectroscopy

2047
01:19:20,149 --> 01:19:17,520
the increasing of peak intensities is

2048
01:19:23,189 --> 01:19:20,159
related to the increase of a functional

2049
01:19:26,229 --> 01:19:23,199
group abundance but we need to consider

2050
01:19:27,189 --> 01:19:26,239
a better proxy to evaluate to evaluate

2051
01:19:34,229 --> 01:19:27,199
this

2052
01:19:37,350 --> 01:19:34,239
fact if you notice here here in these

2053
01:19:39,990 --> 01:19:37,360
two bands there is a complete flattening

2054
01:19:41,910 --> 01:19:40,000
of the two bands that is related to the

2055
01:19:45,189 --> 01:19:41,920
higher and stronger effect of photo

2056
01:19:48,470 --> 01:19:45,199
degradation offered by uv in vacuum

2057
01:19:51,510 --> 01:19:48,480
condition so just moving in other part

2058
01:19:53,189 --> 01:19:51,520
of the spectrum we can notice the usual

2059
01:19:55,750 --> 01:19:53,199
pattern of

2060
01:19:58,950 --> 01:19:55,760
uprising upshifting of a continuum of

2061
01:20:01,590 --> 01:19:58,960
spectrum and decreasing of benz area

2062
01:20:04,470 --> 01:20:01,600
moving to the ecophysiological analysis

2063
01:20:06,149 --> 01:20:04,480

so with the recovery analysis

2064
01:20:08,950 --> 01:20:06,159
starting with the

2065
01:20:11,270 --> 01:20:08,960
fluorescence variation of chlorophyll a

2066
01:20:14,070 --> 01:20:11,280
to assess the photosynthetic efficiency

2067
01:20:16,709 --> 01:20:14,080
of a photosystem 2 of the algae layer

2068
01:20:19,110 --> 01:20:16,719
inside the lichen as you can see there

2069
01:20:21,590 --> 01:20:19,120
is a significant difference between the

2070
01:20:24,310 --> 01:20:21,600
samples of the two treatments uv and two

2071
01:20:26,629 --> 01:20:24,320
and uv back even if there is a similar

2072
01:20:29,110 --> 01:20:26,639
pattern in the drop down fall after we

2073
01:20:33,110 --> 01:20:29,120
posted after the exposure

2074
01:20:35,510 --> 01:20:33,120
and anyway uv two samples seems to

2075
01:20:38,950 --> 01:20:35,520
recover around the 90 percent of a

2076
01:20:42,629 --> 01:20:38,960
beginning value in 24 hours instead the

2077
01:20:44,229 --> 01:20:42,639
uv vac samples seems to recover less

2078
01:20:45,189 --> 01:20:44,239
than the 50

2079
01:20:49,030 --> 01:20:45,199
after

2080
01:20:50,950 --> 01:20:49,040
72 hours so this kind of results seems

2081
01:20:53,270 --> 01:20:50,960
to be okay with the

2082
01:20:55,750 --> 01:20:53,280
with the spectroscopic analysis results

2083
01:20:58,070 --> 01:20:55,760
that assess that there is a higher and

2084
01:21:01,270 --> 01:20:58,080
stronger effect of photo degradation in

2085
01:21:04,470 --> 01:21:01,280
a uv back condition but the other model

2086
01:21:07,270 --> 01:21:04,480
that is the ndi model that measure the

2087
01:21:09,910 --> 01:21:07,280
chlorophyll a reflectance to assess the

2088
01:21:12,149 --> 01:21:09,920

photosystem to structural integrity

2089
01:21:15,430 --> 01:21:12,159
showed something interesting even if

2090
01:21:18,950 --> 01:21:15,440
there is a similar kind of pattern in

2091
01:21:21,750 --> 01:21:18,960
the recovery between the two treatments

2092
01:21:23,030 --> 01:21:21,760
uvn-2 and uv back

2093
01:21:26,470 --> 01:21:23,040
we need to

2094
01:21:29,990 --> 01:21:26,480
focus on the uv back

2095
01:21:32,870 --> 01:21:30,000
samples in fact uh comparing this model

2096
01:21:36,390 --> 01:21:32,880
the ndi model with the previous one

2097
01:21:39,430 --> 01:21:36,400
uh we can suppose that actually uvax

2098
01:21:42,070 --> 01:21:39,440
samples did not suffered a real

2099
01:21:45,430 --> 01:21:42,080
damage from photo degradation of uv

2100
01:21:47,830 --> 01:21:45,440
radiation because they were able to

2101
01:21:49,830 --> 01:21:47,840
preserve or better to recover the

2102
01:21:54,070 --> 01:21:49,840
structural integrity of a photo system

2103
01:21:56,870 --> 01:21:54,080
too but they showed a lag or a yeah a

2104
01:21:59,830 --> 01:21:56,880
time lag recovery or a delayed in the

2105
01:22:02,550 --> 01:21:59,840
recovery of a photosynthetic activity

2106
01:22:05,110 --> 01:22:02,560
so in conclusion we can say to have

2107
01:22:07,669 --> 01:22:05,120
obtained for the first time the santori

2108
01:22:11,270 --> 01:22:07,679
paratina ftir reflectance spectrum and

2109
01:22:14,070 --> 01:22:11,280
to have monitor it is in it in sidu uh

2110
01:22:17,510 --> 01:22:14,080
analyzing and identifying the

2111
01:22:19,669 --> 01:22:17,520
identifying evidence changes in some

2112
01:22:22,310 --> 01:22:19,679
bands like the water band and the

2113
01:22:24,470 --> 01:22:22,320

fingerprint part region and recovery

2114
01:22:26,550 --> 01:22:24,480
analysis have highlighted that different

2115
01:22:29,990 --> 01:22:26,560
treatments are decisive for recovery

2116
01:22:32,709 --> 01:22:30,000
trends in particular with nvi analysis

2117
01:22:35,669 --> 01:22:32,719
we showed a completely recovered in 72

2118
01:22:36,830 --> 01:22:35,679
hours for both the treatments but from

2119
01:22:40,229 --> 01:22:36,840
fluorescence

2120
01:22:42,629 --> 01:22:40,239
analysis it came out that uv radiation

2121
01:22:44,229 --> 01:22:42,639
in vacuum may cause higher damages

2122
01:22:46,790 --> 01:22:44,239
effect

2123
01:22:49,350 --> 01:22:46,800
and in particular uv bug samples show

2124
01:22:52,310 --> 01:22:49,360
that a delayed or time lag recovery in

2125
01:22:53,030 --> 01:22:52,320
photosynthetic efficiency that is okay

2126
01:22:55,750 --> 01:22:53,040
with

2127
01:22:57,030 --> 01:22:55,760
our results from the spectroscopic

2128
01:23:03,750 --> 01:22:57,040
analysis

2129
01:23:04,870 --> 01:23:03,760
elaborating data from another experiment

2130
01:23:06,390 --> 01:23:04,880
we

2131
01:23:08,550 --> 01:23:06,400
irradiated the

2132
01:23:10,709 --> 01:23:08,560
santori paratina species in mars

2133
01:23:12,229 --> 01:23:10,719
simulated conditions

2134
01:23:15,669 --> 01:23:12,239
and

2135
01:23:19,189 --> 01:23:15,679
our next step is to focus more on the

2136
01:23:21,510 --> 01:23:19,199
substance so parietin in particular

2137
01:23:24,310 --> 01:23:21,520
analyzing parity in photo degradation

2138
01:23:26,629 --> 01:23:24,320

under space and mars simulated condition

2139
01:23:31,030 --> 01:23:26,639
with the ir spectroscopy

2140
01:23:35,910 --> 01:23:32,149
thank you

2141
01:23:36,709 --> 01:23:35,920
all right

2142
01:23:38,070 --> 01:23:36,719
uh

2143
01:23:39,030 --> 01:23:38,080
questions

2144
01:23:41,430 --> 01:23:39,040
um

2145
01:23:50,870 --> 01:23:41,440
online or in person

2146
01:23:57,270 --> 01:23:54,149
um so you you've identified that there's

2147
01:23:59,990 --> 01:23:57,280
you know there's a higher level of

2148
01:24:02,790 --> 01:24:00,000
damage i guess introduced by uv

2149
01:24:04,149 --> 01:24:02,800
radiation vacuum conditions that may not

2150
01:24:05,990 --> 01:24:04,159
destroy for the system but at least

2151
01:24:07,110 --> 01:24:06,000
delays its recovery right

2152
01:24:09,510 --> 01:24:07,120
um

2153
01:24:12,229 --> 01:24:09,520
is there is there an interpretation of

2154
01:24:13,189 --> 01:24:12,239
why or what's the mechanism behind that

2155
01:24:14,550 --> 01:24:13,199
um

2156
01:24:16,550 --> 01:24:14,560
that process

2157
01:24:19,590 --> 01:24:16,560
you mean the photo degradation in

2158
01:24:23,030 --> 01:24:19,600
spectroscopic analysis because here i

2159
01:24:26,709 --> 01:24:23,040
think uh we need to consider just the

2160
01:24:27,910 --> 01:24:26,719
surface of a of a sample of the icon

2161
01:24:30,390 --> 01:24:27,920
because

2162
01:24:32,070 --> 01:24:30,400
lichen structure is really it's really

2163
01:24:34,390 --> 01:24:32,080

simple but

2164
01:24:35,830 --> 01:24:34,400
it's important to

2165
01:24:38,790 --> 01:24:35,840
understand his

2166
01:24:39,669 --> 01:24:38,800
the capacity of liking to survive in

2167
01:24:41,830 --> 01:24:39,679
many

2168
01:24:45,110 --> 01:24:41,840
different environments in particular

2169
01:24:48,229 --> 01:24:45,120
extreme environments like the deserts

2170
01:24:52,390 --> 01:24:48,239
where there is a high level of

2171
01:24:55,750 --> 01:24:52,400
life fluxes and so here i think that is

2172
01:24:59,590 --> 01:24:55,760
just a surface for the degradation of

2173
01:25:01,750 --> 01:24:59,600
substances maybe parietin2 and other

2174
01:25:04,629 --> 01:25:01,760
substances of the lichen

2175
01:25:06,470 --> 01:25:04,639
and for this reason

2176
01:25:09,350 --> 01:25:06,480
we assess the

2177
01:25:11,990 --> 01:25:09,360
delay of a photosynthetic

2178
01:25:13,430 --> 01:25:12,000
activity restart after after the

2179
01:25:15,270 --> 01:25:13,440
exposure

2180
01:25:18,550 --> 01:25:15,280
and

2181
01:25:19,669 --> 01:25:18,560
anyway from the nbi model we didn't we

2182
01:25:23,110 --> 01:25:19,679
didn't

2183
01:25:25,590 --> 01:25:23,120
see something really important as damage

2184
01:25:26,870 --> 01:25:25,600
from from this model that you can see

2185
01:25:29,750 --> 01:25:26,880
also here

2186
01:25:31,990 --> 01:25:29,760
so i don't know if i answered your

2187
01:25:33,910 --> 01:25:32,000
question uh

2188
01:25:36,470 --> 01:25:33,920

yeah it was more trying to understand

2189
01:25:38,310 --> 01:25:36,480
why why is it that

2190
01:25:40,229 --> 01:25:38,320
under vacuum conditions that

2191
01:25:41,270 --> 01:25:40,239
why that happens i guess it might be

2192
01:25:43,430 --> 01:25:41,280
just a

2193
01:25:44,870 --> 01:25:43,440
the desiccation or right

2194
01:25:49,270 --> 01:25:44,880
yeah

2195
01:25:52,550 --> 01:25:49,280
than the

2196
01:25:55,990 --> 01:25:52,560
nitrogen atmosphere and maybe for this

2197
01:25:59,910 --> 01:25:56,000
reason the uv radiation is more intense

2198
01:26:01,669 --> 01:25:59,920
on the on the on the samples

2199
01:26:04,550 --> 01:26:01,679
right and you didn't do any

2200
01:26:06,229 --> 01:26:04,560
uh for how long was the exposure

2201
01:26:10,950 --> 01:26:06,239
it was ex

2202
01:26:13,229 --> 01:26:10,960
exposed for 36 mins with a

2203
01:26:18,870 --> 01:26:13,239
um

2204
01:26:23,830 --> 01:26:18,880
1.34 mega jaw on a square meter as total

2205
01:26:25,510 --> 01:26:23,840
absorb those so it was like 25 hours on

2206
01:26:28,950 --> 01:26:25,520
the iss

2207
01:26:32,870 --> 01:26:28,960
compressed in 36 mins

2208
01:26:37,030 --> 01:26:34,790
uh any other questions

2209
01:26:42,070 --> 01:26:37,040
from anyone

2210
01:26:46,229 --> 01:26:44,149
yeah i wonder if you were to even extend

2211
01:26:47,750 --> 01:26:46,239
that uh period of time if that would

2212
01:26:50,550 --> 01:26:47,760
actually

2213
01:26:51,830 --> 01:26:50,560

make it unrecoverable right probably

2214
01:26:54,629 --> 01:26:51,840
becomes

2215
01:26:58,709 --> 01:26:54,639
actually we did it as

2216
01:27:00,310 --> 01:26:58,719
like some kind of test experiment

2217
01:27:02,390 --> 01:27:00,320
and

2218
01:27:04,629 --> 01:27:02,400
we proceed

2219
01:27:06,629 --> 01:27:04,639
with the irradiation over and over and

2220
01:27:10,229 --> 01:27:06,639
over till the

2221
01:27:10,760 --> 01:27:10,239
the sample was completely burnt

2222
01:27:12,470 --> 01:27:10,770
and

2223
01:27:16,870 --> 01:27:12,480
[Music]

2224
01:27:19,270 --> 01:27:16,880
after like uh three four hours uh with

2225
01:27:24,709 --> 01:27:19,280
with these conditions it was yeah a

2226
01:27:27,669 --> 01:27:26,709
yeah very cool well i was i was

2227
01:27:30,149 --> 01:27:27,679
wondering about that but i guess you

2228
01:27:33,030 --> 01:27:30,159
guys already did it

2229
01:27:34,790 --> 01:27:33,040
very neat um all right so i i want to i

2230
01:27:36,950 --> 01:27:34,800
want to thank every you know every

2231
01:27:38,709 --> 01:27:36,960
speaker for keeping us on time and and

2232
01:27:40,310 --> 01:27:38,719
really a great a great uh a great

2233
01:27:42,070 --> 01:27:40,320
session and um

2234
01:27:43,830 --> 01:27:42,080
uh very much synergistic i i do

2235
01:27:45,189 --> 01:27:43,840
encourage all the speakers really to get

2236
01:27:46,470 --> 01:27:45,199
in touch with each other because i see a

2237
01:27:48,950 --> 01:27:46,480
lot of

2238
01:27:51,510 --> 01:27:48,960

potential collaborations here that that

2239
01:27:53,750 --> 01:27:51,520
you can establish um so anyways thank

2240
01:27:56,390 --> 01:27:53,760
you very much and i'll see you later um