
AbSciCon
2017
MESA, ARIZONA

1
00:00:12,250 --> 00:00:06,150
you

2
00:00:15,670 --> 00:00:14,250
[Music]

3
00:00:17,590 --> 00:00:15,680
thank you

4
00:00:20,440 --> 00:00:17,600
I actually I would like to thank the

5
00:00:22,810 --> 00:00:20,450
four new lab members also for doing a

6
00:00:24,249 --> 00:00:22,820
very good job in opening how we opening

7
00:00:26,260 --> 00:00:24,259
the argument on how we can use

8
00:00:28,720 --> 00:00:26,270
phylogenetic reconstruction to travel

9
00:00:31,180 --> 00:00:28,730
back in time and understand the early

10
00:00:34,510 --> 00:00:31,190
events that are related to perhaps in

11
00:00:36,340 --> 00:00:34,520
shape to earth life coevolution this is

12
00:00:39,009 --> 00:00:36,350
the first time I'm presenting the

13
00:00:42,220 --> 00:00:39,019

results of this work and and I termed

14
00:00:45,160 --> 00:00:42,230
this work as is the term I use is the

15
00:00:47,110 --> 00:00:45,170
paleo phenotype reconstruction I'm a

16
00:00:50,770 --> 00:00:47,120
cell biologist and an evolutionary

17
00:00:52,600 --> 00:00:50,780
biologist and I do reconstruct genes and

18
00:00:57,190 --> 00:00:52,610
then study the behavior of these

19
00:01:00,490 --> 00:00:57,200
proteins in using modern using modern

20
00:01:04,329 --> 00:01:00,500
cells and then link the behavior that I

21
00:01:06,430 --> 00:01:04,339
measure to two questions related to deep

22
00:01:12,460 --> 00:01:06,440
life you guys hear me now in my mind

23
00:01:15,070 --> 00:01:12,470
okay good all right so let's go the

24
00:01:18,210 --> 00:01:15,080
first work that we did focused on the

25
00:01:20,950 --> 00:01:18,220
carbon isotope fractionation values so

26
00:01:22,359 --> 00:01:20,960
there are various bio signatures and

27
00:01:24,280 --> 00:01:22,369
carbon isotopes are that they were

28
00:01:26,440 --> 00:01:24,290
interesting to us because they they can

29
00:01:28,179 --> 00:01:26,450
relate all the way back to the origins

30
00:01:30,760 --> 00:01:28,189
of life and there was the most pervasive

31
00:01:33,280 --> 00:01:30,770
one and what is really interesting here

32
00:01:35,289 --> 00:01:33,290
is that just just a belief or review is

33
00:01:37,300 --> 00:01:35,299
that what we have here is a biochemical

34
00:01:39,730 --> 00:01:37,310
process if if this carbon fractionation

35
00:01:41,830 --> 00:01:39,740
is linked to a biological behavior a

36
00:01:44,530 --> 00:01:41,840
biochemical process that can cause a

37
00:01:46,870 --> 00:01:44,540
fluctuation in the amounts of isotopes

38
00:01:49,210 --> 00:01:46,880

of carbon ratios that are incorporated

39
00:01:52,030 --> 00:01:49,220
into the cell and there are different

40
00:01:53,460 --> 00:01:52,040
carbon isotopes that are available and

41
00:01:55,990 --> 00:01:53,470
then there are carbon isotopes that are

42
00:01:58,240 --> 00:01:56,000
present in the cell and the ask okay

43
00:02:00,940 --> 00:01:58,250
what are the biological components that

44
00:02:03,160 --> 00:02:00,950
are responsible inside the cell that

45
00:02:05,050 --> 00:02:03,170
caused this biochemical dependent

46
00:02:09,999 --> 00:02:05,060
fractionation that we observe in the

47
00:02:11,319 --> 00:02:10,009
rock record and the environment at least

48
00:02:14,020 --> 00:02:11,329
in the case of carbon isotope

49
00:02:15,520 --> 00:02:14,030
fractionation what was called Rubisco so

50
00:02:17,710 --> 00:02:15,530
the answer was its straightforward in

51
00:02:20,199 --> 00:02:17,720
this case because the behavior of this

52
00:02:22,660 --> 00:02:20,209
enzyme rubisco is directly associated

53
00:02:25,589 --> 00:02:22,670
with the carbon isotope records that we

54
00:02:28,830 --> 00:02:25,599
measure in the rock record in the car

55
00:02:31,050 --> 00:02:28,840
isotope data attributes to to live

56
00:02:33,390 --> 00:02:31,060
organism or organism that survive in the

57
00:02:36,059 --> 00:02:33,400
past the dubis Co converts oxidized

58
00:02:38,729 --> 00:02:36,069
carbon dioxide to reduce organic carbon

59
00:02:41,369 --> 00:02:38,739
and it's going to prevent add the

60
00:02:43,770 --> 00:02:41,379
carbon-12 isotope over carbon 13 given

61
00:02:48,259 --> 00:02:43,780
that carbon-12 which hits the enzyme

62
00:02:52,679 --> 00:02:50,699
it's a pretty interesting enzyme and

63
00:02:54,390 --> 00:02:52,689

also has been a focus of various studies

64
00:02:56,940 --> 00:02:54,400
that won't improve the photosynthetic

65
00:02:59,879 --> 00:02:56,950
ability or carbon fixation ability of

66
00:03:02,640 --> 00:02:59,889
car of cyanobacteria but our interest

67
00:03:04,530 --> 00:03:02,650
was in related to questions that are

68
00:03:05,429 --> 00:03:04,540
interesting to us the origins of life in

69
00:03:07,259 --> 00:03:05,439
astrobiology

70
00:03:09,899 --> 00:03:07,269
it's the Rubisco is the most abundant

71
00:03:12,270 --> 00:03:09,909
protein on earth it is it is rather slow

72
00:03:14,759 --> 00:03:12,280
and confused it cannot readily

73
00:03:18,089 --> 00:03:14,769
differentiate carbon dioxide with from

74
00:03:20,159 --> 00:03:18,099
oxygen which leads to a lot of big most

75
00:03:21,509 --> 00:03:20,169
of energy in the cell because the cell

76
00:03:23,520 --> 00:03:21,519
does not end up preceding the

77
00:03:25,920 --> 00:03:23,530
carboxylation reaction but then precedes

78
00:03:28,259 --> 00:03:25,930
it oxygenation reaction and thus cannot

79
00:03:30,149 --> 00:03:28,269
proceed and complete the photosynthesis

80
00:03:33,659 --> 00:03:30,159
as efficiently as it would otherwise do

81
00:03:35,849 --> 00:03:33,669
with the carbon dioxide so we simply

82
00:03:37,559 --> 00:03:35,859
asked can we resurrect

83
00:03:39,300 --> 00:03:37,569
early life bio signatures at least in

84
00:03:42,569 --> 00:03:39,310
the case for in this case four carbon

85
00:03:45,390 --> 00:03:42,579
isotope discrimination related proteins

86
00:03:47,429 --> 00:03:45,400
using Rubisco and our test was to go

87
00:03:50,189 --> 00:03:47,439
back in time by using phylogenetic some

88
00:03:52,259 --> 00:03:50,199

molecular evolution and resurrect the

89
00:03:54,599 --> 00:03:52,269
key notes using the phylogenetic tree

90
00:03:56,580 --> 00:03:54,609
and study the behavior of this ancient

91
00:04:01,409 --> 00:03:56,590
environment in this case is going to the

92
00:04:04,259 --> 00:04:01,419
ancient ruby screen van so let's come

93
00:04:05,789 --> 00:04:04,269
back to the future today we have four

94
00:04:07,979 --> 00:04:05,799
different types of Rubisco that is

95
00:04:10,439 --> 00:04:07,989
present inside the cell for our

96
00:04:13,289 --> 00:04:10,449
convenience these are named at group 1 2

97
00:04:15,270 --> 00:04:13,299
3 & 4 viscose and they at a glance at

98
00:04:17,159 --> 00:04:15,280
the monomer level they are similar but

99
00:04:19,349 --> 00:04:17,169
at the older grammar level it's the

100
00:04:21,479 --> 00:04:19,359
multiple protein domain level they may

101
00:04:23,459 --> 00:04:21,489
have some differences but at large they

102
00:04:26,580 --> 00:04:23,469
are thought to be pretty identical at

103
00:04:29,339 --> 00:04:26,590
least it's a structural level and group

104
00:04:30,959 --> 00:04:29,349
1 is the most abundant protein that we

105
00:04:36,149 --> 00:04:30,969
have right now and it's also the one

106
00:04:37,830 --> 00:04:36,159
that is used by cyanobacteria and in

107
00:04:38,999 --> 00:04:37,840
following up on the previous circuit we

108
00:04:41,010 --> 00:04:39,009
also you

109
00:04:42,839 --> 00:04:41,020
phylogenetically construction in our

110
00:04:45,779 --> 00:04:42,849
case we use different alignment tools

111
00:04:47,730 --> 00:04:45,789
and different inference tools in order

112
00:04:50,010 --> 00:04:47,740
to generate multiple trees and then

113
00:04:51,600 --> 00:04:50,020

among these trees that we created we

114
00:04:54,089 --> 00:04:51,610
picked the one that support that has

115
00:04:58,909 --> 00:04:54,099
high branch support value and that also

116
00:05:01,019 --> 00:04:58,919
led to a multiple actually a sequence of

117
00:05:02,969 --> 00:05:01,029
representation to risk operating so just

118
00:05:04,589 --> 00:05:02,979
to run you through we start with the

119
00:05:06,899 --> 00:05:04,599
currently available sequences for the

120
00:05:09,659 --> 00:05:06,909
case of Rubisco we scanned all of these

121
00:05:11,489 --> 00:05:09,669
group one two for a group one two for

122
00:05:14,129 --> 00:05:11,499
Rubisco and then performs multiple

123
00:05:16,589 --> 00:05:14,139
alignments and then from there use

124
00:05:19,019 --> 00:05:16,599
maximum likelihood phylogeny algorithm

125
00:05:21,299 --> 00:05:19,029
and then we constructed ancestors and we

126
00:05:23,519 --> 00:05:21,309
use this currently available online tool

127
00:05:25,379 --> 00:05:23,529
called final but it's a friendly robot

128
00:05:27,659 --> 00:05:25,389
that automates your phylogenetically

129
00:05:30,059 --> 00:05:27,669
constructions for you I'm not paid to

130
00:05:31,860 --> 00:05:30,069
say that with free fuels and and if you

131
00:05:33,779 --> 00:05:31,870
have a favorite gene that you want to

132
00:05:38,730 --> 00:05:33,789
reconstruct you can also use this tool

133
00:05:39,989 --> 00:05:38,740
it's called Philo bot comm so here

134
00:05:42,119 --> 00:05:39,999
you're looking at the evolutionary

135
00:05:44,129 --> 00:05:42,129
history of Rubisco protein we are

136
00:05:46,290 --> 00:05:44,139
starting with our interest with soil

137
00:05:48,449 --> 00:05:46,300
bacteria because cyanobacteria is a

138
00:05:50,820 --> 00:05:48,459

first of all as I said it has the

139
00:05:53,309 --> 00:05:50,830
highest abundant of Rubisco protein

140
00:05:55,019 --> 00:05:53,319
today and also we can culture

141
00:05:57,029 --> 00:05:55,029
cyanobacteria in the lab and even

142
00:05:59,100 --> 00:05:57,039
engineer its genome and that is of

143
00:06:01,079 --> 00:05:59,110
interest to us because we are interested

144
00:06:03,570 --> 00:06:01,089
in alternately understanding what these

145
00:06:05,399 --> 00:06:03,580
ancient sequences will do inside the

146
00:06:07,230 --> 00:06:05,409
cell and hopefully measure the isotopic

147
00:06:09,239 --> 00:06:07,240
fractionation values that will be

148
00:06:11,459 --> 00:06:09,249
generated by these ancient proteins and

149
00:06:14,159 --> 00:06:11,469
then see if we can match the isotope

150
00:06:17,399 --> 00:06:14,169
fractionation values that we generate to

151
00:06:19,199 --> 00:06:17,409
the rock record so just to walk you

152
00:06:22,409 --> 00:06:19,209
through here your starting oh my

153
00:06:25,049 --> 00:06:22,419
goodness alright well designers we have

154
00:06:27,629 --> 00:06:25,059
the 1b cyanobacteria and you're the

155
00:06:30,149 --> 00:06:27,639
ancestor of 1a and 1b one in one being

156
00:06:31,980 --> 00:06:30,159
very walking backwards in time and going

157
00:06:33,839 --> 00:06:31,990
back to the ancestor one two three this

158
00:06:36,329 --> 00:06:33,849
is the whole ancestor of all the groups

159
00:06:39,239 --> 00:06:36,339
so we can walk back in the branches of

160
00:06:41,100 --> 00:06:39,249
trees and and then reach to a time in

161
00:06:46,679 --> 00:06:41,110
the past and then reconstruct the

162
00:06:48,389 --> 00:06:46,689
sequences of these enzymes and all these

163
00:06:51,269 --> 00:06:48,399

sequences for the first time are

164
00:06:53,100 --> 00:06:51,279
available for the use of any community

165
00:06:54,960 --> 00:06:53,110
really and hopefully the geobiology

166
00:06:57,300 --> 00:06:54,970
musi so by going into this address you

167
00:06:59,310 --> 00:06:57,310
can download this tree and also click in

168
00:07:01,020 --> 00:06:59,320
h and every note and not only see the

169
00:07:03,060 --> 00:07:01,030
most likely sequence but all the

170
00:07:06,750 --> 00:07:03,070
possible ancestors so if you have a ruby

171
00:07:08,790 --> 00:07:06,760
story an organism that you I don't you

172
00:07:10,470 --> 00:07:08,800
extracted in the field and you think

173
00:07:12,060 --> 00:07:10,480
that there is an interesting Rubisco

174
00:07:14,100 --> 00:07:12,070
sequence there please go ahead and use

175
00:07:15,720 --> 00:07:14,110
our tree to compare these sequences and

176
00:07:17,430 --> 00:07:15,730
see if you can find some interesting

177
00:07:19,260 --> 00:07:17,440
stories and we have some members in our

178
00:07:21,450 --> 00:07:19,270
community they are using art that are

179
00:07:23,670 --> 00:07:21,460
using our Trina for group to riscos and

180
00:07:24,750 --> 00:07:23,680
which is great so here is the

181
00:07:26,970 --> 00:07:24,760
evolutionary history of Rubisco

182
00:07:29,400 --> 00:07:26,980
operating in a more simplified way the

183
00:07:33,230 --> 00:07:29,410
in blue is the cyanobacteria the current

184
00:07:35,790 --> 00:07:33,240
cyanobacterial group and all these um I

185
00:07:37,980 --> 00:07:35,800
will come to what all these aesthetics

186
00:07:39,810 --> 00:07:37,990
is mean in a minute but we basically ask

187
00:07:41,550 --> 00:07:39,820
what is the sequence what is the

188
00:07:43,230 --> 00:07:41,560

structure and what is the functional

189
00:07:46,320 --> 00:07:43,240
suite ancient Ruby stores and can we

190
00:07:48,990 --> 00:07:46,330
infer any information about to pass by

191
00:07:53,160 --> 00:07:49,000
using these sequences structures and

192
00:07:54,690 --> 00:07:53,170
ultimately function so let's start with

193
00:07:56,730 --> 00:07:54,700
the group one ancestor here you're

194
00:07:58,860 --> 00:07:56,740
looking at the knot sequence by the

195
00:08:01,410 --> 00:07:58,870
inferred structure of the disk operating

196
00:08:02,940 --> 00:08:01,420
this is the ancestor of Group one that

197
00:08:06,330 --> 00:08:02,950
is also you're looking at the

198
00:08:08,760 --> 00:08:06,340
cyanobacteria ancestor of Rubisco that

199
00:08:12,960 --> 00:08:08,770
may be live as old as the cyanobacteria

200
00:08:16,440 --> 00:08:12,970
ancestor did and and here is the group 1

201
00:08:18,180 --> 00:08:16,450
3 ancestor and group 1 2 3 ancestor so

202
00:08:19,710 --> 00:08:18,190
as you can see there is no drastic

203
00:08:21,570 --> 00:08:19,720
change in the structure of this protein

204
00:08:25,490 --> 00:08:21,580
that the structure of the rubik's code

205
00:08:28,350 --> 00:08:25,500
seems to be conserved across time so

206
00:08:31,530 --> 00:08:28,360
okay how about variation at the sequence

207
00:08:33,360 --> 00:08:31,540
level apple can look apple in variety of

208
00:08:37,400 --> 00:08:33,370
ways but even for apple we have

209
00:08:41,010 --> 00:08:37,410
different DNA sequences and that's what

210
00:08:43,320 --> 00:08:41,020
we've looked at we basically ask that

211
00:08:45,920 --> 00:08:43,330
the structure identity mean functional

212
00:08:48,210 --> 00:08:45,930
identity and is just that general

213
00:08:50,880 --> 00:08:48,220

phenomenon in biochemistry that that's

214
00:08:52,800 --> 00:08:50,890
not necessarily true DNA sequence can be

215
00:08:54,570 --> 00:08:52,810
pretty identical for between two

216
00:08:56,460 --> 00:08:54,580
different proteins but their function

217
00:08:58,020 --> 00:08:56,470
could be drastically different depending

218
00:08:59,820 --> 00:08:58,030
on where these mutations where these

219
00:09:02,370 --> 00:08:59,830
differences between these two sequences

220
00:09:03,960 --> 00:09:02,380
may be located and that's a property

221
00:09:04,939 --> 00:09:03,970
that we see even at the currently

222
00:09:07,009 --> 00:09:04,949
existing ruby

223
00:09:09,439 --> 00:09:07,019
even though they look pretty similar the

224
00:09:11,689 --> 00:09:09,449
our carbon fractionation values that

225
00:09:15,789 --> 00:09:11,699
they exhibit and their carbon dioxide

226
00:09:20,119 --> 00:09:15,799
oxygen specificity even can be different

227
00:09:21,769 --> 00:09:20,129
and be focused on multiple locations in

228
00:09:23,679 --> 00:09:21,779
this protein that are thought to be

229
00:09:27,109 --> 00:09:23,689
associated with the carbon fixation

230
00:09:28,879 --> 00:09:27,119
ability of this protein itself and these

231
00:09:31,159 --> 00:09:28,889
are the n-terminal domains and alpha

232
00:09:32,900 --> 00:09:31,169
beta barrels and large small and large

233
00:09:34,669 --> 00:09:32,910
large subunit interfaces and these were

234
00:09:36,650 --> 00:09:34,679
all based on previously published

235
00:09:38,780 --> 00:09:36,660
literature data in the literature that

236
00:09:41,119 --> 00:09:38,790
showed that changes in this area could

237
00:09:44,119 --> 00:09:41,129
impact the property to be function of

238
00:09:46,939 --> 00:09:44,129

the enzyme that are referred as hot

239
00:09:52,819 --> 00:09:46,949
spots because biochemists like the drama

240
00:09:56,030 --> 00:09:52,829
well yo wait okay here we go so so here

241
00:09:58,009 --> 00:09:56,040
I bitmap the the Rubisco proteins that

242
00:09:59,720 --> 00:09:58,019
we see through time you're going

243
00:10:01,669 --> 00:09:59,730
backwards in millions of years so the

244
00:10:03,349 --> 00:10:01,679
structure is conserved but let's forget

245
00:10:05,479 --> 00:10:03,359
the sequence and for this lead with some

246
00:10:07,609 --> 00:10:05,489
evolutionary change evolutionary tests

247
00:10:09,559 --> 00:10:07,619
using the DNA and protein sequence data

248
00:10:11,179 --> 00:10:09,569
to understand the substitution among

249
00:10:13,970 --> 00:10:11,189
these proteins and deceased these

250
00:10:16,999 --> 00:10:13,980
substitutions can be adaptive so what we

251
00:10:20,720 --> 00:10:17,009
see is that the main changes happen

252
00:10:23,150 --> 00:10:20,730
between group 1 3 and group 1 and these

253
00:10:25,280 --> 00:10:23,160
are in the internal location of Group 1

254
00:10:27,650 --> 00:10:25,290
tree and group 1 seems to be

255
00:10:29,929 --> 00:10:27,660
experiencing mutation all over the place

256
00:10:31,609 --> 00:10:29,939
so the enzyme is evolving very rapidly

257
00:10:36,799 --> 00:10:31,619
when it comes to the ancestor of

258
00:10:38,749 --> 00:10:36,809
cyanobacteria and the group 1 ancestors

259
00:10:41,419 --> 00:10:38,759
sequence overall seem to resemble the

260
00:10:45,019 --> 00:10:41,429
modern cyanobacteria Rubisco which

261
00:10:47,359 --> 00:10:45,029
belongs to oxalate whereas the oldest

262
00:10:49,970 --> 00:10:47,369
ancestors resembled an anoxic rate

263
00:10:52,340 --> 00:10:49,980

sequence when we did multiple alignments

264
00:10:55,489 --> 00:10:52,350
and test using the currently existing

265
00:10:57,619 --> 00:10:55,499
sequence information so with that with

266
00:10:59,179 --> 00:10:57,629
that we thought perhaps the transition

267
00:11:01,309 --> 00:10:59,189
between the group one tree and group mom

268
00:11:03,699 --> 00:11:01,319
vacations that are the functionally

269
00:11:05,989 --> 00:11:03,709
important regions could maybe a

270
00:11:07,340 --> 00:11:05,999
correlate so again I have to show the

271
00:11:10,609 --> 00:11:07,350
slightest like everyone else in this

272
00:11:12,859 --> 00:11:10,619
session that revisiting the Earth's life

273
00:11:15,409 --> 00:11:12,869
history and the change in the atmosphere

274
00:11:17,570 --> 00:11:15,419
perhaps the these changes could be

275
00:11:20,630 --> 00:11:17,580
correlated with the changes in the

276
00:11:22,400 --> 00:11:20,640
most feared conditions and very wild

277
00:11:24,590 --> 00:11:22,410
when we don't see much significant

278
00:11:27,380 --> 00:11:24,600
change after the rise of the oxygen but

279
00:11:29,210 --> 00:11:27,390
what previous and even the previous

280
00:11:32,630 --> 00:11:29,220
presenters showed some cases of this

281
00:11:34,490 --> 00:11:32,640
early victim change in atmosphere so in

282
00:11:36,520 --> 00:11:34,500
fact our data seems to be suggesting

283
00:11:39,260 --> 00:11:36,530
these changes because we do see

284
00:11:41,960 --> 00:11:39,270
mutations in the protein that is even

285
00:11:45,140 --> 00:11:41,970
prior to the rise of cyanobacteria and

286
00:11:47,690 --> 00:11:45,150
our early example early data in the

287
00:11:49,760 --> 00:11:47,700
biochemical biochemical if you look at

288
00:11:51,290 --> 00:11:49,770

these enzymes we show that the early

289
00:11:54,140 --> 00:11:51,300
mutations that we seem to be changing

290
00:11:56,690 --> 00:11:54,150
the activity of the protein as much a

291
00:11:58,550 --> 00:11:56,700
little bit but the group one does seem

292
00:11:59,930 --> 00:11:58,560
to be changing the proteins activities

293
00:12:02,390 --> 00:11:59,940
which is pretty interesting that we

294
00:12:04,330 --> 00:12:02,400
think perhaps the ancient cell harboring

295
00:12:07,040 --> 00:12:04,340
the group one tree and sister may be

296
00:12:08,990 --> 00:12:07,050
preconditioning in if the atmosphere

297
00:12:10,760 --> 00:12:09,000
that this organism was living it has a

298
00:12:17,240 --> 00:12:10,770
little bit of oxygen increase or vice

299
00:12:20,390 --> 00:12:17,250
versa and our current direction is now

300
00:12:21,590 --> 00:12:20,400
to reconstruct the cellular partners

301
00:12:23,990 --> 00:12:21,600
that will be scar is interacting with

302
00:12:25,640 --> 00:12:24,000
and resurrected phenotype by measuring

303
00:12:28,820 --> 00:12:25,650
the carbon isotope fractionation of

304
00:12:30,740 --> 00:12:28,830
these genes that are present in

305
00:12:32,420 --> 00:12:30,750
cyanobacteria and for that we are

306
00:12:34,820 --> 00:12:32,430
focusing on the car boxes on this is

307
00:12:37,250 --> 00:12:34,830
also in cyanobacteria we have Rubisco

308
00:12:39,500 --> 00:12:37,260
Rubisco as many proteins in the cell is

309
00:12:41,930 --> 00:12:39,510
not functioning by itself it does rely

310
00:12:44,630 --> 00:12:41,940
on another protein I always call them as

311
00:12:45,890 --> 00:12:44,640
Batman and Robin the Batman gets all the

312
00:12:48,020 --> 00:12:45,900
credit but Robin is doing all the work

313
00:12:51,640 --> 00:12:48,030

carbonic anhydrase is actually helping

314
00:12:54,080 --> 00:12:51,650
the the car boxes on to concentrate the

315
00:12:56,480 --> 00:12:54,090
carbon dioxide inside the car box is

316
00:12:58,760 --> 00:12:56,490
also very constructed the the ancient

317
00:13:00,590 --> 00:12:58,770
sequences of carbonic anhydrase and this

318
00:13:02,450 --> 00:13:00,600
tree also will be available for you to

319
00:13:04,520 --> 00:13:02,460
use so we are currently engineering the

320
00:13:06,350 --> 00:13:04,530
cyanobacteria to not only contain

321
00:13:09,170 --> 00:13:06,360
ancient Rubisco but it is ancient

322
00:13:11,960 --> 00:13:09,180
partners to see if we can recreate an

323
00:13:14,000 --> 00:13:11,970
ancient carbon fixation system inside a

324
00:13:16,340 --> 00:13:14,010
modern organism for the first time and

325
00:13:19,400 --> 00:13:16,350
study the isotope behavior of this

326
00:13:23,300 --> 00:13:19,410
engineered organism which is exactly

327
00:13:25,790 --> 00:13:23,310
what I said here and with that

328
00:13:29,569 --> 00:13:25,800
I would like to thank our funders and

329
00:13:31,189 --> 00:13:29,579
for thinking that this project could fit

330
00:13:41,389 --> 00:13:31,199
here thank you very much Tim and thank

331
00:13:51,160 --> 00:13:41,399
you for listening thanks very much

332
00:13:55,999 --> 00:13:54,350
very nice talk for that last part and

333
00:13:57,860 --> 00:13:56,009
trying to reconstruct this in

334
00:13:59,660 --> 00:13:57,870
cyanobacteria what organism are you

335
00:14:07,220 --> 00:13:59,670
thinking of using your using snicker

336
00:14:09,619 --> 00:14:07,230
caucus oh go ahead

337
00:14:11,509 --> 00:14:09,629
super quick comment and this is also

338
00:14:13,579 --> 00:14:11,519

relevant to the previous talk to and as

339
00:14:15,319 --> 00:14:13,589
microbial ecologists I spent a lot of

340
00:14:16,850 --> 00:14:15,329
time measuring oxygen and mass and you

341
00:14:19,879 --> 00:14:16,860
saw in earlier plots that there's a lot

342
00:14:21,590 --> 00:14:19,889
of local buildup of oxygen and so you

343
00:14:23,239 --> 00:14:21,600
know it took a very long time for that

344
00:14:24,739 --> 00:14:23,249
to saturate different sinks and then

345
00:14:26,540 --> 00:14:24,749
build up in the atmosphere so as you're

346
00:14:29,150 --> 00:14:26,550
thinking about evolution is different

347
00:14:30,559 --> 00:14:29,160
either oxygen requiring enzymes or

348
00:14:32,569 --> 00:14:30,569
things that protect yourself from oxygen

349
00:14:34,519 --> 00:14:32,579
or things that are tolerant to an toxic

350
00:14:35,840 --> 00:14:34,529
toxic environment to keep in mind the

351
00:14:38,360 --> 00:14:35,850
local environment and the selection

352
00:14:40,490 --> 00:14:38,370
pressure pressure that could be provided

353
00:14:43,160 --> 00:14:40,500
there the timing of that may be very

354
00:14:44,509 --> 00:14:43,170
different from widespread oxygenation in

355
00:14:46,490 --> 00:14:44,519
that yeah exactly

356
00:14:49,460 --> 00:14:46,500
which is also why we're using libraries

357
00:14:51,939 --> 00:14:49,470
and not just one Rubisco of ancient

358
00:14:54,619 --> 00:14:51,949
Rubisco and tying that is the single

359
00:14:57,439 --> 00:14:54,629
parameter but we are using the whole

360
00:14:59,150 --> 00:14:57,449
library to see if we can look at the

361
00:15:01,819 --> 00:14:59,160
variation across different sequences

362
00:15:04,939 --> 00:15:01,829
that may represent different localities

363
00:15:05,990 --> 00:15:04,949

as well thank you yeah we'd add to that

364
00:15:07,669 --> 00:15:06,000
there's different scales of

365
00:15:09,799 --> 00:15:07,679
heterogeneity within math but also

366
00:15:12,079 --> 00:15:09,809
within certain portions of the ocean

367
00:15:14,329 --> 00:15:12,089
productive regions so it's a really good

368
00:15:16,720 --> 00:15:14,339
point we should move on but thanks you