Panelists

Attendees (28)

- Hosts (1)
  - Mike Toillion
- Presenters (6)
  - Andy Burnett
  - frank Rosenzweig
  - Matthew Powell
  - Michael New (NAS...
  - Shawn Domagal-G...
  - tim morley
- Participants (21)
  - Aaron Goldman
  - Aaron Gronstal
  - Amy Williams
  - Betul Kacar
  - Burckhard Seelig
  - CIW
  - Cole Miller
  - Damien Woods
  - Eric Smith
  - G. Cody
  - John Cave
  - John Cave 2

Open Chat (Everyone)

fracturing for vents to occur. Do the panellists think this area may be a good place to start looking for complex based life forms to occur?

---------- (05/13/2013 12:17) ----------

Yuri Gorby: Hello All. Having sound problems, but glad to be here. Yuri

---------- (05/13/2013 12:20) ----------

Mike Toillion: For people with sound issues, all you have to do is dial the telecon listed below. For to help with background noise/echo, please mute your phone's mic by pushing *6 upon entering the meeting. When we get to Q&A, you can push *6 again to unmute if you would like to speak.

Eric Smith: The really major transitions as defined are connected to the rise of atmospheric oxygen. If a planet lacks sufficient oxygen, what other transitions would be defined.

---------- (05/13/2013 12:22) ----------

Michael New (NASA HQ): Good point, Eric. Raise your hand and ask the panel!!

Shawn Domagal-Goldman is typing...

Teleconference Instructions (Partic...

Teleconference Line: (866) 692-4538
Passcode: 7496560#
More info:

Live Notes

What are the panels thoughts on complex life forms appearing around hydro-thermal vents on Europa was. Structural flexing of the Europan surface should provide enough surface fracturing for vents to occur. Do the panellists think this area may be a good place to start looking for complex based life forms to occur?

The really major transitions as defined are connected to the rise of atmospheric oxygen. If a planet lacks sufficient oxygen, what other transitions would be defined.

Advanced Life.pptx

Full Screen

Opening Panel Questions

- What are the major Evolutionary Transitions in the history of life from less complex to more complex forms?
- What comparative methods can be used to draw strong inferences about mechanisms driving evolutionary transitions (B) What experimental methods?
- What is the single most important research problem in trying to ascertain major transitions from simple to complex life forms?
- How do the units of selection change as major evolutionary transitions occur? and (B) Can we ever consider metabolically interconnected communities (of microorganisms or multicellular organisms) an "organisms" or "superorganism" sensu Clements and Wilson?

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1
00:00:15,880 --> 00:00:12,169
right good afternoon everyone I see some

2
00:00:20,900 --> 00:00:15,890
of you were here from earlier shows so

3
00:00:24,560 --> 00:00:20,910
the issues earlier webinars so let me

4
00:00:26,779 --> 00:00:24,570
just briefly do an overview for for

5
00:00:29,570 --> 00:00:26,789
people who may be new here first thing I

6
00:00:32,150 --> 00:00:29,580
wanted to say is this event is being

7
00:00:34,639 --> 00:00:32,160
recorded it will be on YouTube and

8
00:00:37,100 --> 00:00:34,649
everything that you see on the screen is

9
00:00:42,139 --> 00:00:37,110
recorded including the chat window just

10
00:00:45,770 --> 00:00:42,149
so we're all clear on that we are going

11
00:00:49,209 --> 00:00:45,780
to be running for an hour again we have

12
00:00:53,000 --> 00:00:49,219
two presenters a series of questions

13
00:00:56,479 --> 00:00:53,010

Michael new is going to set context

14
00:00:59,360 --> 00:00:56,489
again for us and then in the same way

15
00:01:02,720 --> 00:00:59,370
that we have done for previous webinars

16
00:01:05,329 --> 00:01:02,730
we encourage all of the attendees to ask

17
00:01:08,149 --> 00:01:05,339
questions make points and that sort of

18
00:01:12,050 --> 00:01:08,159
thing as we go along and I will try to

19
00:01:14,780 --> 00:01:12,060
pick them up and certainly after of now

20
00:01:17,090 --> 00:01:14,790
40 minutes depending on how we go we

21
00:01:20,270 --> 00:01:17,100
will throw it open for people to ask

22
00:01:22,010 --> 00:01:20,280
questions and if anyone has any

23
00:01:23,960 --> 00:01:22,020
technical issues as they're going along

24
00:01:27,350 --> 00:01:23,970
just pop it into the chat window we will

25
00:01:30,980 --> 00:01:27,360
try and deal with those as well so

26
00:01:35,480 --> 00:01:30,990
having said that um Michael advanced

27
00:01:37,880 --> 00:01:35,490
life the sicker context sure thank you

28
00:01:39,530 --> 00:01:37,890
Andy so I'm Michael new I'm the

29
00:01:42,230 --> 00:01:39,540
astrobiology discipline scientist NASA

30
00:01:47,030 --> 00:01:42,240
headquarters um many of you know me some

31
00:01:48,830 --> 00:01:47,040
of you don't hello um what we're trying

32
00:01:50,450 --> 00:01:48,840
to do here is start a conversation

33
00:01:52,010 --> 00:01:50,460
within our community and hopefully

34
00:01:57,069 --> 00:01:52,020
beyond the standard community of

35
00:02:01,880 --> 00:02:00,170
somebody gain echo I don't know how to

36
00:02:06,170 --> 00:02:01,890
fix that I only have one mic and that's

37
00:02:09,740 --> 00:02:06,180
on my ear right now we we're not hearing

38
00:02:10,880 --> 00:02:09,750

it so well I'm sorry just carry on okay

39
00:02:14,720 --> 00:02:10,890
I'm sorry

40
00:02:16,309 --> 00:02:14,730
um so the astrobiology roadmap is a

41
00:02:19,280 --> 00:02:16,319
document that we that the community

42
00:02:21,890 --> 00:02:19,290
produces every decade or so and it

43
00:02:24,610 --> 00:02:21,900
informs NASA about what are the open

44
00:02:27,770 --> 00:02:24,620
compelling questions in astrobiology and

45
00:02:30,500 --> 00:02:27,780
what and therefore informs what NASA

46
00:02:32,330 --> 00:02:30,510
will invest in it also informs hopefully

47
00:02:33,650 --> 00:02:32,340
the community about what the research

48
00:02:38,540 --> 00:02:33,660
they want to do and what they want to

49
00:02:41,600 --> 00:02:38,550
apply to NASA to fund so that's kind of

50
00:02:43,400 --> 00:02:41,610
where we're at for that on the every

51
00:02:44,990 --> 00:02:43,410
five years or so we take a look at the

52
00:02:48,020 --> 00:02:45,000
roadmap and make little tweaks and

53
00:02:49,520 --> 00:02:48,030
adjustments but the big structure of the

54
00:02:51,949 --> 00:02:49,530
roadmap the overarching goals and

55
00:02:54,350 --> 00:02:51,959
objectives they don't change shouldn't

56
00:02:56,630 --> 00:02:54,360
change except every 10 years or so um

57
00:03:00,890 --> 00:02:56,640
this roadmap NASA's looking for

58
00:03:02,330 --> 00:03:00,900
something that is fairly aspirational

59
00:03:04,670 --> 00:03:02,340
and inspirational we're looking for

60
00:03:06,770 --> 00:03:04,680
something that really throws a lawn dart

61
00:03:09,680 --> 00:03:06,780
way out there in the future and let's

62
00:03:11,860 --> 00:03:09,690
give us something to work for um so a

63
00:03:14,780 --> 00:03:11,870

document that lays out objectives that

64
00:03:16,610 --> 00:03:14,790
can be accomplished in what would take

65
00:03:19,100 --> 00:03:16,620
more than 10 years to accomplish is

66
00:03:20,630 --> 00:03:19,110
preferable to document that uh would lay

67
00:03:25,150 --> 00:03:20,640
out goals that we can accomplish

68
00:03:27,920 --> 00:03:25,160
relatively easily um when so uh

69
00:03:30,970 --> 00:03:27,930
evolution advanced life is the catch-all

70
00:03:33,410 --> 00:03:30,980
phrase that nASA uses to describe two

71
00:03:35,539 --> 00:03:33,420
different topics the first is the

72
00:03:37,130 --> 00:03:35,549
evolution of multicellularity so them

73
00:03:39,830 --> 00:03:37,140
once you have life and you have

74
00:03:43,400 --> 00:03:39,840
unicellular life how do you go from a

75
00:03:45,020 --> 00:03:43,410
single cell living alone to an organism

76
00:03:48,920 --> 00:03:45,030
that's got multiple cells that form

77
00:03:52,330 --> 00:03:48,930
tissues and and develop the second area

78
00:03:54,770 --> 00:03:52,340
weekend cat put into this category is

79
00:03:59,120 --> 00:03:54,780
macro evolutionary processes and

80
00:04:01,009 --> 00:03:59,130
especially the processes of how what

81
00:04:03,020 --> 00:04:01,019
call of things that cause and they and

82
00:04:05,390 --> 00:04:03,030
house because isn't respond to mass

83
00:04:08,750 --> 00:04:05,400
extinction events like the KT bolide

84
00:04:13,430 --> 00:04:08,760
impact uh or whatever happened at the

85
00:04:15,349 --> 00:04:13,440
thermo Triassic boundary and a bit all

86
00:04:17,259 --> 00:04:15,359
of this research is focused on trying to

87
00:04:20,839 --> 00:04:17,269
understand the conditions that lead to

88
00:04:23,180 --> 00:04:20,849

aid and development of complex

89
00:04:24,310 --> 00:04:23,190
life on earth I'm so that when we go

90
00:04:26,890 --> 00:04:24,320
looking out the source

91
00:04:29,740 --> 00:04:26,900
assuming beyond we have some sense of

92
00:04:32,080 --> 00:04:29,750
what we're looking for a defined where

93
00:04:38,830 --> 00:04:32,090
the odds of finding complex life you

94
00:04:41,080 --> 00:04:38,840
know so that is that sort of thing the

95
00:04:42,910 --> 00:04:41,090
purpose of this meeting is to kick this

96
00:04:44,620 --> 00:04:42,920
thing off for this particular theme

97
00:04:48,370 --> 00:04:44,630
there are five themes are investigating

98
00:04:50,110 --> 00:04:48,380
and over the course of hopefully least

99
00:04:53,350 --> 00:04:50,120
this week we'll have a series of online

100
00:04:56,770 --> 00:04:53,360
discussions prompted by the discussion

101
00:05:00,370 --> 00:04:56,780
we're having today that you'll all take

102
00:05:01,750 --> 00:05:00,380
part in I hope and from those those

103
00:05:05,290 --> 00:05:01,760
discussions are going to influence the

104
00:05:07,450 --> 00:05:05,300
road map in in two ways first um the

105
00:05:08,560 --> 00:05:07,460
ideas you guys come up with the open

106
00:05:11,050 --> 00:05:08,570
compelling questions are going to

107
00:05:13,960 --> 00:05:11,060
influence hopefully heavily the people

108
00:05:15,640 --> 00:05:13,970
who actually write the road map more

109
00:05:19,360 --> 00:05:15,650
directly the people who write the road

110
00:05:22,540 --> 00:05:19,370
map will be chosen partially from active

111
00:05:24,130 --> 00:05:22,550
contributors to the discussions because

112
00:05:25,840 --> 00:05:24,140
clearly people who are active in the

113
00:05:28,030 --> 00:05:25,850

discussions have something to say and

114
00:05:30,100 --> 00:05:28,040
hopefully it's a good thing to say and

115
00:05:34,990 --> 00:05:30,110
so we'll invite them to help us write

116
00:05:36,760 --> 00:05:35,000
the the roadmap so that's pretty much

117
00:05:39,910 --> 00:05:36,770
all I have if you have any questions

118
00:05:41,740 --> 00:05:39,920
about anything please ask them now I'll

119
00:05:44,620 --> 00:05:41,750
be here all day but this is intended to

120
00:05:48,400 --> 00:05:44,630
be a community event so I hopefully

121
00:05:51,520 --> 00:05:48,410
won't talk very much recycle manage my

122
00:05:54,190 --> 00:05:51,530
question please yes Frank for those

123
00:05:58,870 --> 00:05:54,200
people who wish to to join or people who

124
00:06:04,270 --> 00:05:58,880
are not here for this kickoff you know

125
00:06:06,400 --> 00:06:04,280
what you did more to us instructions so

126
00:06:08,260 --> 00:06:06,410
that one could invite people that we

127
00:06:11,350 --> 00:06:08,270
think should be part of this to this

128
00:06:15,310 --> 00:06:11,360
conversation sure Andy are you gonna put

129
00:06:17,290 --> 00:06:15,320
that information up at the end uh in

130
00:06:19,270 --> 00:06:17,300
order to be able sorry just to be clear

131
00:06:21,600 --> 00:06:19,280
Frank you're asking for people to take

132
00:06:24,340 --> 00:06:21,610
part in the discussions in the website

133
00:06:27,160 --> 00:06:24,350
that's correct yes yes there may be

134
00:06:31,960 --> 00:06:27,170
people that have not been contacted who

135
00:06:34,600 --> 00:06:31,970
should be absolutely ok so well thing

136
00:06:36,580 --> 00:06:34,610
it's almost like he can read my mind if

137
00:06:37,820 --> 00:06:36,590
you have a look in the chat window there

138
00:06:40,820 --> 00:06:37,830

you'll see that Mike

139
00:06:44,630 --> 00:06:40,830
just put up the address of the web

140
00:06:49,880 --> 00:06:44,640
socket I don't need Siri I just need

141
00:06:53,150 --> 00:06:49,890
Mike um and it's very simple go there

142
00:06:56,060 --> 00:06:53,160
it's open registration anyone can sign

143
00:06:59,120 --> 00:06:56,070
up and then there are a series of

144
00:07:01,670 --> 00:06:59,130
discussion for where we'll be picking up

145
00:07:05,450 --> 00:07:01,680
these questions and the other thing is

146
00:07:08,150 --> 00:07:05,460
mike tells me probably by tomorrow west

147
00:07:09,830 --> 00:07:08,160
coast time the video of both this

148
00:07:12,380 --> 00:07:09,840
session and the previous one will have

149
00:07:15,740 --> 00:07:12,390
been crunched and be on the website so

150
00:07:17,930 --> 00:07:15,750
if people want to actually listen and

151
00:07:23,660 --> 00:07:17,940
watch what was said then they can do

152
00:07:26,960 --> 00:07:23,670
that as well so should be open to all so

153
00:07:29,900 --> 00:07:26,970
Frank just taking that as my lead-in um

154
00:07:31,730 --> 00:07:29,910
let's do some introductions who are you

155
00:07:34,970 --> 00:07:31,740
where you're from why are you interested

156
00:07:36,890 --> 00:07:34,980
in this ok so my name is Frank rose and

157
00:07:41,300 --> 00:07:36,900
so I and I'm a professor at the

158
00:07:44,600 --> 00:07:41,310
University of Montana and I've been a

159
00:07:48,380 --> 00:07:44,610
nasa astrobiology researcher for a

160
00:07:50,990 --> 00:07:48,390
number of years interested in this

161
00:07:54,890 --> 00:07:51,000
particular topic as well as mechanisms

162
00:07:59,930 --> 00:07:54,900
of speciation and in our current

163
00:08:03,860 --> 00:07:59,940

iteration of our astrobiology work we

164
00:08:07,810 --> 00:08:03,870
have two parallel projects one ecoline

165
00:08:12,140 --> 00:08:07,820
looking at evolutionists metabolic

166
00:08:14,270 --> 00:08:12,150
cooperation in simple systems and in

167
00:08:18,280 --> 00:08:14,280
using chlamydomonas reinhardtii I

168
00:08:21,370 --> 00:08:18,290
looking at experimental methods for

169
00:08:23,810 --> 00:08:21,380
attempting the independent evolution of

170
00:08:27,830 --> 00:08:23,820
multicellularity a trait that has

171
00:08:31,910 --> 00:08:27,840
evolved multiple times in the vulva seen

172
00:08:34,219 --> 00:08:31,920
algae of which clammy is a member so

173
00:08:37,390 --> 00:08:34,229
I've had long-standing interest in this

174
00:08:40,850 --> 00:08:37,400
really from graduate school onwards and

175
00:08:50,040 --> 00:08:40,860
am grateful for the opportunity through

176
00:08:56,800 --> 00:08:52,620
if there's somebody coming on after me

177
00:08:58,210 --> 00:08:56,810
Andy I think you're okay he's when my

178
00:09:03,280 --> 00:08:58,220
lips move but you can't hear anything

179
00:09:05,740 --> 00:09:03,290
I've hit the mute button that yeah I'll

180
00:09:08,710 --> 00:09:05,750
take it from there um sure what was

181
00:09:11,670 --> 00:09:08,720
happening I'm a professor of geology at

182
00:09:14,740 --> 00:09:11,680
juniata college in pennsylvania and

183
00:09:18,180 --> 00:09:14,750
miami paleontologist here my main

184
00:09:21,730 --> 00:09:18,190
interest is in macro evolution and

185
00:09:23,320 --> 00:09:21,740
specifically the biotic effects of

186
00:09:25,180 --> 00:09:23,330
climate change how that affects things

187
00:09:28,630 --> 00:09:25,190
on a macro ecological and macro

188
00:09:30,610 --> 00:09:28,640

evolutionary scale I my recent research

189
00:09:32,950 --> 00:09:30,620
is supported by nasa astrobiology which

190
00:09:36,070 --> 00:09:32,960
is how i got involved in this and that

191
00:09:43,480 --> 00:09:36,080
is a on the latitudinal diversity

192
00:09:46,690 --> 00:09:43,490
gradient over time okay thank you all

193
00:09:49,690 --> 00:09:46,700
right what happened prior to this

194
00:09:54,010 --> 00:09:49,700
webinar was that Frank and that and I

195
00:09:58,360 --> 00:09:54,020
got together and skip over this slide

196
00:10:03,210 --> 00:09:58,370
for a moment and we talked about what

197
00:10:06,070 --> 00:10:03,220
might be interesting questions to help

198
00:10:07,720 --> 00:10:06,080
frame our discussion and the

199
00:10:11,470 --> 00:10:07,730
instructions were very much these

200
00:10:13,750 --> 00:10:11,480
questions were supposed to illuminate

201
00:10:16,150 --> 00:10:13,760
but not constrained in any way the

202
00:10:21,940 --> 00:10:16,160
discussions so what we thought would be

203
00:10:23,790 --> 00:10:21,950
interesting now is to to start moving

204
00:10:27,160 --> 00:10:23,800
through some of these questions and

205
00:10:29,260 --> 00:10:27,170
invite audience thoughts as we go along

206
00:10:31,090 --> 00:10:29,270
and then towards the end we'll pick it

207
00:10:34,930 --> 00:10:31,100
up and and give the participants chance

208
00:10:37,770 --> 00:10:34,940
to to ask questions directly so if we

209
00:10:40,900 --> 00:10:37,780
have a look at the the first question um

210
00:10:43,720 --> 00:10:40,910
evolutionary transitions no Frank I know

211
00:10:45,670 --> 00:10:43,730
that that you'd written this one down as

212
00:10:48,100 --> 00:10:45,680
part of the session that that you and

213
00:10:50,920 --> 00:10:48,110

Matt and I were in can I start with you

214
00:10:53,680 --> 00:10:50,930
and this is obviously in the context of

215
00:10:55,300 --> 00:10:53,690
the roadmap and what is it that we

216
00:10:58,480 --> 00:10:55,310
should be thinking about over the next

217
00:11:00,120 --> 00:10:58,490
10 years vamps from this perspective to

218
00:11:04,770 --> 00:11:00,130
start with

219
00:11:08,400 --> 00:11:04,780
so when I when I wrote the questions or

220
00:11:13,830 --> 00:11:08,410
in this particular question my thoughts

221
00:11:16,130 --> 00:11:13,840
were being guided by actually buy a book

222
00:11:19,890 --> 00:11:16,140
that came out a number of years ago

223
00:11:23,100 --> 00:11:19,900
which was actually called the major

224
00:11:26,280 --> 00:11:23,110
transitions in evolution and it was a it

225
00:11:31,260 --> 00:11:26,290
was a piece by john maynard smith and a

226
00:11:35,940 --> 00:11:31,270
oz oz mary and they identified a number

227
00:11:39,180 --> 00:11:35,950
of major evolutionary transitions some

228
00:11:42,080 --> 00:11:39,190
of which may fall more under the purview

229
00:11:47,280 --> 00:11:42,090
of the prebiotic folks so for example

230
00:11:51,210 --> 00:11:47,290
they identified the one transition being

231
00:11:53,400 --> 00:11:51,220
that from populations of molecules for

232
00:11:57,330 --> 00:11:53,410
replicating molecules to populations of

233
00:12:01,970 --> 00:11:57,340
molecules in compartments the evolution

234
00:12:06,390 --> 00:12:01,980
of chromosomes the evolution of DNA as

235
00:12:10,370 --> 00:12:06,400
genes what I was thinking about was that

236
00:12:13,290 --> 00:12:10,380
those things fell to the other group and

237
00:12:15,980 --> 00:12:13,300
what evolutionary transitions I had

238
00:12:19,350 --> 00:12:15,990

envisioned and certainly the group is

239
00:12:21,900 --> 00:12:19,360
unconstrained I guess and it's and it's

240
00:12:24,200 --> 00:12:21,910
what it can throw out there I was

241
00:12:28,980 --> 00:12:24,210
thinking about those transitions like

242
00:12:32,570 --> 00:12:28,990
though that from prokaryote to eukaryote

243
00:12:35,810 --> 00:12:32,580
and implicit in that the acquisition of

244
00:12:39,570 --> 00:12:35,820
organelles which almost certainly were

245
00:12:44,060 --> 00:12:39,580
independent cellular entities and

246
00:12:47,940 --> 00:12:44,070
resolving the conflicts that that arose

247
00:12:50,310 --> 00:12:47,950
in in the formation of organelles and

248
00:12:54,030 --> 00:12:50,320
the formation of what we recognize as

249
00:12:56,850 --> 00:12:54,040
you carry us I would think also thinking

250
00:13:00,360 --> 00:12:56,860
about transitions from a sexual clones

251
00:13:05,550 --> 00:13:00,370
to to sexual populations and the

252
00:13:07,590 --> 00:13:05,560
evolution of sex not just in terms of

253
00:13:09,990 --> 00:13:07,600
lateral gene transfer which is

254
00:13:12,519 --> 00:13:10,000
unidirectional in the prokaryotic world

255
00:13:16,179 --> 00:13:12,529
but bi-directional as it is

256
00:13:20,139 --> 00:13:16,189
amongst most eukaryotes likewise I was

257
00:13:24,309 --> 00:13:20,149
thinking of a third transition namely

258
00:13:27,009 --> 00:13:24,319
that from unicellular organisms most

259
00:13:32,530 --> 00:13:27,019
likely protists of some variety way back

260
00:13:37,379 --> 00:13:32,540
when to multicellular organisms but I

261
00:13:39,610 --> 00:13:37,389
was also thinking about higher order

262
00:13:42,660 --> 00:13:39,620
evolutionary transitions which actually

263
00:13:45,639 --> 00:13:42,670

could have important implications for

264
00:13:49,179 --> 00:13:45,649
the evolution of complex life elsewhere

265
00:13:51,879 --> 00:13:49,189
in the universe namely the the

266
00:13:56,410 --> 00:13:51,889
transition that has occurred from that

267
00:13:59,619 --> 00:13:56,420
of solitary multicellular individuals to

268
00:14:02,980 --> 00:13:59,629
that of colonies in other words the

269
00:14:07,869 --> 00:14:02,990
evolution of eusociality actually falls

270
00:14:12,790 --> 00:14:07,879
within these ETS that I have that I was

271
00:14:14,850 --> 00:14:12,800
thinking about so for example the youth

272
00:14:18,309 --> 00:14:14,860
sociality we have the formation of

273
00:14:20,530 --> 00:14:18,319
castes where certain individuals forego

274
00:14:23,590 --> 00:14:20,540
reproduction in the same way that

275
00:14:28,480 --> 00:14:23,600
somatic cells for go reproduction and

276
00:14:30,879 --> 00:14:28,490
entrust that to to the germline and then

277
00:14:36,629 --> 00:14:30,889
of course you know other transition than

278
00:14:45,280 --> 00:14:40,600
identified were those in primate

279
00:14:48,069 --> 00:14:45,290
societies which evolved elaborate

280
00:14:52,780 --> 00:14:48,079
communication systems languages which

281
00:14:56,290 --> 00:14:52,790
enabled memes so I was in summary then

282
00:14:59,710 --> 00:14:56,300
sort of leading the the prebiotic of a

283
00:15:01,449 --> 00:14:59,720
molecular evolution of replicating

284
00:15:04,389 --> 00:15:01,459
molecules and the formation of

285
00:15:07,480 --> 00:15:04,399
compartments evolution of chromosomes to

286
00:15:10,960 --> 00:15:07,490
our colleagues concerned with prebiotic

287
00:15:13,650 --> 00:15:10,970
evolution and evolutionary transitions

288
00:15:17,619 --> 00:15:13,660

that I had envisioned for this group

289
00:15:20,980 --> 00:15:17,629
were those that are basically to

290
00:15:23,199 --> 00:15:20,990
eukaryotes evolution of sex evolution of

291
00:15:25,010 --> 00:15:23,209
multicellularity evolution of

292
00:15:29,780 --> 00:15:25,020
eusociality and

293
00:15:33,800 --> 00:15:29,790
evolution of language if math elite pack

294
00:15:36,290 --> 00:15:33,810
onto the end of that you know the first

295
00:15:39,560 --> 00:15:36,300
thing I think is that as far as so far

296
00:15:41,240 --> 00:15:39,570
as I know there is not a group of major

297
00:15:43,250 --> 00:15:41,250
evolutionary transitions that have kind

298
00:15:45,590 --> 00:15:43,260
of been defined across the field I think

299
00:15:47,510 --> 00:15:45,600
if people put together their own list

300
00:15:49,310 --> 00:15:47,520
they would they would have some in

301
00:15:51,890 --> 00:15:49,320
common but it would also have a lot of

302
00:15:53,690 --> 00:15:51,900
these events that were not uncommon and

303
00:15:55,580 --> 00:15:53,700
so I think that you know the field we

304
00:15:57,890 --> 00:15:55,590
don't necessarily even have a common

305
00:16:00,470 --> 00:15:57,900
understanding of what the major

306
00:16:03,560 --> 00:16:00,480
transitions are or really even what what

307
00:16:07,190 --> 00:16:03,570
major means in that respect there are

308
00:16:08,570 --> 00:16:07,200
things I think are not as important in

309
00:16:10,820 --> 00:16:08,580
terms you know if I was making a list of

310
00:16:12,800 --> 00:16:10,830
the major events i put the same things

311
00:16:15,890 --> 00:16:12,810
on there that Frank put you know

312
00:16:19,010 --> 00:16:15,900
evolution of multicellularity I probably

313
00:16:22,790 --> 00:16:19,020

also put things like evolution of

314
00:16:24,700 --> 00:16:22,800
bilateral symmetry or ahead you know

315
00:16:27,860 --> 00:16:24,710
having a head something like that

316
00:16:32,240 --> 00:16:27,870
further back in time the evolution of

317
00:16:35,180 --> 00:16:32,250
respiration you know of oxygen breathers

318
00:16:37,280 --> 00:16:35,190
and things like that but I'd also

319
00:16:40,570 --> 00:16:37,290
probably put things that are less maybe

320
00:16:43,280 --> 00:16:40,580
monumental in terms of the overall

321
00:16:45,410 --> 00:16:43,290
history of life on Earth but which are

322
00:16:48,140 --> 00:16:45,420
of kind of particular importance to

323
00:16:53,600 --> 00:16:48,150
humans things like evolving an internal

324
00:16:56,890 --> 00:16:53,610
skeleton vertebrates evolving things

325
00:17:00,890 --> 00:16:56,900
like you know venture the amniotic egg

326
00:17:02,630 --> 00:17:00,900
then eventually you know live earth and

327
00:17:05,600 --> 00:17:02,640
then I might also add in things like

328
00:17:08,210 --> 00:17:05,610
mass extinctions which the grand scheme

329
00:17:10,130 --> 00:17:08,220
of things really just reshuffle that the

330
00:17:12,520 --> 00:17:10,140
kinds of complex life that are around

331
00:17:16,220 --> 00:17:12,530
and it changes what's dominated at times

332
00:17:19,070 --> 00:17:16,230
without really creating any new new kind

333
00:17:21,079 --> 00:17:19,080
of life in the sense that moving from

334
00:17:23,540 --> 00:17:21,089
unicellular to multicellular did but

335
00:17:25,190 --> 00:17:23,550
which you know nonetheless you know

336
00:17:28,430 --> 00:17:25,200
things like the KT you know radically

337
00:17:30,320 --> 00:17:28,440
altered what kind of life are around and

338
00:17:31,970 --> 00:17:30,330

maybe even those effects are even

339
00:17:34,250 --> 00:17:31,980
continuing today I think some papers

340
00:17:36,980 --> 00:17:34,260
recently has come out showing that you

341
00:17:38,720 --> 00:17:36,990
can still sort of observe the effects of

342
00:17:41,900 --> 00:17:38,730
the KT and things like the

343
00:17:43,159 --> 00:17:41,910
PETM in the modern biota so I probably

344
00:17:49,789 --> 00:17:43,169
put those in that in that same category

345
00:17:53,330 --> 00:17:49,799
of major evolutionary transitions great

346
00:17:55,360 --> 00:17:53,340
you're adding to this basically to sign

347
00:17:58,990 --> 00:17:55,370
of kind of summarize major metabolic

348
00:18:02,120 --> 00:17:59,000
innovations major architectural

349
00:18:07,039 --> 00:18:02,130
innovations you know within clades and

350
00:18:11,570 --> 00:18:07,049
then evolution of diverse developmental

351
00:18:16,070 --> 00:18:11,580
strategies as well as the the you know

352
00:18:20,620 --> 00:18:16,080
these challenges and opportunities of a

353
00:18:27,070 --> 00:18:24,890
but let me just ask you that fascinating

354
00:18:32,000 --> 00:18:27,080
opening how would one go about

355
00:18:34,159 --> 00:18:32,010
researching this because I love the

356
00:18:36,110 --> 00:18:34,169
thought of spending NASA's money and

357
00:18:39,409 --> 00:18:36,120
let's assume you were given large

358
00:18:42,020 --> 00:18:39,419
quantities of hit what would it mean in

359
00:18:47,000 --> 00:18:42,030
terms of a research roadmap what what

360
00:18:49,700 --> 00:18:47,010
would you be looking to do I've always

361
00:18:53,539 --> 00:18:49,710
been struck by the fact of how much of

362
00:18:56,120 --> 00:18:53,549
that research is discovery-based how

363
00:18:58,220 --> 00:18:56,130

much it's really relying on on the

364
00:19:00,710 --> 00:18:58,230
generation of new data not simply the

365
00:19:02,480 --> 00:19:00,720
analysis of existing data that's not to

366
00:19:05,060 --> 00:19:02,490
say that you know analysis of existing

367
00:19:09,289 --> 00:19:05,070
data is not important I do that a lot

368
00:19:11,590 --> 00:19:09,299
but I'm just constantly surprised by how

369
00:19:13,700 --> 00:19:11,600
much we we don't know and I think what

370
00:19:15,530 --> 00:19:13,710
this isn't really an experimental

371
00:19:20,210 --> 00:19:15,540
approach but more discovery funding is

372
00:19:23,570 --> 00:19:20,220
really important I think in that and

373
00:19:26,390 --> 00:19:23,580
Frank what would you do well I mean you

374
00:19:32,360 --> 00:19:26,400
know I'm an obsessive experimentalist

375
00:19:36,530 --> 00:19:32,370
and so so in my group we're trying to

376
00:19:39,620 --> 00:19:36,540
replicate using extant forms some of the

377
00:19:42,400 --> 00:19:39,630
let me just narrowly define and say

378
00:19:46,120 --> 00:19:42,410
these Maynard Smith slashes off Mary

379
00:19:49,640 --> 00:19:46,130
transitions like that of evolution of

380
00:19:52,400 --> 00:19:49,650
organelles evolution of multicellularity

381
00:19:56,660 --> 00:19:52,410
and cooperating systems but

382
00:20:00,140 --> 00:19:56,670
you know I would concur with Matt's

383
00:20:03,710 --> 00:20:00,150
remarks and add that some of those

384
00:20:06,650 --> 00:20:03,720
discoveries at least within with respect

385
00:20:10,010 --> 00:20:06,660
to sault ste innovations in metabolism

386
00:20:13,100 --> 00:20:10,020
and an architecture and developmental

387
00:20:17,180 --> 00:20:13,110
program you know some of these major

388
00:20:22,250 --> 00:20:17,190

innovations are there essentially how

389
00:20:25,010 --> 00:20:22,260
they're entombed within the within the

390
00:20:30,380 --> 00:20:25,020
sequence record that is to say the tree

391
00:20:33,710 --> 00:20:30,390
of life and the the code which basically

392
00:20:37,780 --> 00:20:33,720
gives us the tips of those branches

393
00:20:41,480 --> 00:20:37,790
today contains a lot of information that

394
00:20:45,250 --> 00:20:41,490
that would eliminate these questions

395
00:20:51,740 --> 00:20:45,260
about these these major anatomical and

396
00:20:54,920 --> 00:20:51,750
developmental innovations don't add one

397
00:20:57,320 --> 00:20:54,930
thing I this comment from Eric Smith

398
00:20:59,930 --> 00:20:57,330
about he points out that the major

399
00:21:01,340 --> 00:20:59,940
transitions here defined as defined are

400
00:21:04,280 --> 00:21:01,350
connected to the rise of atmospheric

401
00:21:07,280 --> 00:21:04,290
oxygen I think this important point that

402
00:21:08,930 --> 00:21:07,290
some evolutionary innovations are there

403
00:21:10,250 --> 00:21:08,940
they're hierarchically structured in the

404
00:21:12,140 --> 00:21:10,260
sense that some of them allow new

405
00:21:14,060 --> 00:21:12,150
evolutionary innovation and I think that

406
00:21:20,780 --> 00:21:14,070
kind of effect sort of hierarchy is an

407
00:21:23,420 --> 00:21:20,790
important area to explore absolutely can

408
00:21:26,840 --> 00:21:23,430
we also look at John John Cage well

409
00:21:29,660 --> 00:21:26,850
actually John Cage the second he's

410
00:21:36,590 --> 00:21:29,670
question which is which is about the

411
00:21:38,570 --> 00:21:36,600
thermal vents and Europa I don't know

412
00:21:44,360 --> 00:21:38,580
enough about it pacifically to comment

413
00:21:47,930 --> 00:21:44,370

frankly and I am I must join in with you

414
00:21:50,240 --> 00:21:47,940
there and if I guess there are a number

415
00:21:56,350 --> 00:21:50,250
of people who have joined since your

416
00:21:59,600 --> 00:21:56,360
initial introduction and Ian so maybe

417
00:22:03,320 --> 00:21:59,610
just indicate to them at approximately

418
00:22:05,330 --> 00:22:03,330
what time in this discussion people can

419
00:22:08,240 --> 00:22:05,340
come online and though

420
00:22:11,070 --> 00:22:08,250
regrettably invisible they will be

421
00:22:15,270 --> 00:22:11,080
certainly audible if I understand

422
00:22:18,870 --> 00:22:15,280
correctly yeah right and the answer is

423
00:22:21,060 --> 00:22:18,880
probably in about 20 minutes although it

424
00:22:25,860 --> 00:22:21,070
all depends on just how fascinating your

425
00:22:29,840 --> 00:22:25,870
conversation is ok let's move on and

426
00:22:33,540 --> 00:22:29,850
look at the comparative methods and

427
00:22:40,980 --> 00:22:33,550
we'll park John Cage question under hmm

428
00:22:43,980 --> 00:22:40,990
we need to do research on Matt Preston

429
00:22:46,140 --> 00:22:43,990
yeah okay all right so we kind of

430
00:22:48,510 --> 00:22:46,150
touched on this a moment ago I just

431
00:22:50,610 --> 00:22:48,520
noticed Yuri Gorby signing in whom I

432
00:22:55,170 --> 00:22:50,620
have not seen in a long time so although

433
00:22:59,060 --> 00:22:55,180
I don't see your yuriai I see your your

434
00:23:02,220 --> 00:22:59,070
footprint here so we talked about

435
00:23:07,970 --> 00:23:02,230
information about information Airy

436
00:23:13,070 --> 00:23:07,980
transitions that are embedded within the

437
00:23:16,230 --> 00:23:13,080
sequence data in the tree of life and so

438
00:23:18,900 --> 00:23:16,240

that is kind of what I was thinking

439
00:23:21,840 --> 00:23:18,910
about when I wrote the questions that we

440
00:23:23,940 --> 00:23:21,850
could seek or use comparative methods to

441
00:23:27,300 --> 00:23:23,950
draw strong inferences about mechanisms

442
00:23:29,700 --> 00:23:27,310
driving evolutionary transitions and to

443
00:23:33,570 --> 00:23:29,710
the extent that you know our molecular

444
00:23:38,060 --> 00:23:33,580
clock data can be roughly calibrated to

445
00:23:42,500 --> 00:23:38,070
the known events in the fossil record

446
00:23:46,620 --> 00:23:42,510
then we can sort of you know Rose

447
00:23:49,170 --> 00:23:46,630
retrospectively examined those the

448
00:23:53,330 --> 00:23:49,180
succession of those innovations in

449
00:23:56,550 --> 00:23:53,340
different groups over time in terms of

450
00:24:00,900 --> 00:23:56,560
experimental methods for the analysis of

451
00:24:04,860 --> 00:24:00,910
evolutionary transitions again I'm

452
00:24:07,590 --> 00:24:04,870
really thinking about taking say extant

453
00:24:08,880 --> 00:24:07,600
groups that have no history say for

454
00:24:12,650 --> 00:24:08,890
example in the transition from

455
00:24:16,760 --> 00:24:12,660
unicellular t2 multicellularity perhaps

456
00:24:18,749 --> 00:24:16,770
a number of you and the community read

457
00:24:21,539 --> 00:24:18,759
interesting paper out

458
00:24:23,939 --> 00:24:21,549
of Mike travisano slab at the University

459
00:24:26,810 --> 00:24:23,949
of Minnesota spearheaded by will

460
00:24:29,729 --> 00:24:26,820
Ratcliffe on the evolution of

461
00:24:31,619 --> 00:24:29,739
multicellularity in yeast and that's a

462
00:24:35,129 --> 00:24:31,629
very elegant piece of work which which

463
00:24:38,219 --> 00:24:35,139

has been criticized in some quarters by

464
00:24:41,789 --> 00:24:38,229
using an organism that has perhaps an

465
00:24:43,259 --> 00:24:41,799
ancestry of multicellularity and looking

466
00:24:45,719 --> 00:24:43,269
at a derived trade but there are plenty

467
00:24:47,879 --> 00:24:45,729
of organisms that are bona fide

468
00:24:52,889 --> 00:24:47,889
unicellular organisms on which we could

469
00:24:55,529 --> 00:24:52,899
do experimental evolution so in terms of

470
00:25:01,349 --> 00:24:55,539
methodology that that's what I had in

471
00:25:03,629 --> 00:25:01,359
mind but other people may have equally

472
00:25:07,769 --> 00:25:03,639
good or better ideas on this point it's

473
00:25:10,229 --> 00:25:07,779
matt how about how about you i think

474
00:25:11,609 --> 00:25:10,239
that uh yes certainly when I that that's

475
00:25:13,559 --> 00:25:11,619
the same understanding i have an

476
00:25:15,239 --> 00:25:13,569
experimental methods the major

477
00:25:19,499 --> 00:25:15,249
evolutionary did let me just jump in

478
00:25:21,539 --> 00:25:19,509
today back comparative I I really wanted

479
00:25:24,629 --> 00:25:21,549
to emphasize not just because you're a

480
00:25:27,119 --> 00:25:24,639
paleontologist but I wanted to emphasize

481
00:25:31,799 --> 00:25:27,129
that you know the the tree of life data

482
00:25:34,680 --> 00:25:31,809
you know it absolutely has to be mapped

483
00:25:38,039 --> 00:25:34,690
onto the the paleontological records

484
00:25:40,829 --> 00:25:38,049
though that's the the evolutionary

485
00:25:42,539 --> 00:25:40,839
transition that you know seems most

486
00:25:44,999 --> 00:25:42,549
important these days is the the one

487
00:25:48,749 --> 00:25:45,009
related to anthropogenic climate change

488
00:25:50,789 --> 00:25:48,759

and I've seen a number of interesting

489
00:25:53,039 --> 00:25:50,799
you know studies related to experimental

490
00:25:54,959 --> 00:25:53,049
manipulation of environments that mimic

491
00:25:56,819 --> 00:25:54,969
potential you know future conditions

492
00:26:00,299 --> 00:25:56,829
under under various scenarios of climate

493
00:26:03,119 --> 00:26:00,309
change and what happens to those

494
00:26:04,319 --> 00:26:03,129
organisms in those circumstances I you

495
00:26:06,689 --> 00:26:04,329
know I think that we have a lot to learn

496
00:26:08,699 --> 00:26:06,699
from studies like that and then of

497
00:26:11,879 --> 00:26:08,709
course there are you know plenty of

498
00:26:13,349 --> 00:26:11,889
analog environments in the past that in

499
00:26:15,449 --> 00:26:13,359
which earth history function is this

500
00:26:17,339 --> 00:26:15,459
natural laboratory that is manipulated

501
00:26:19,799 --> 00:26:17,349
the earth for us and then we can go back

502
00:26:22,109 --> 00:26:19,809
and look at the for example selectivity

503
00:26:24,689 --> 00:26:22,119
of extinctions or preferential

504
00:26:29,039 --> 00:26:24,699
origination after an extinction and see

505
00:26:30,930 --> 00:26:29,049
how those environmental events altered

506
00:26:32,169 --> 00:26:30,940
the the biota under conditions that we

507
00:26:34,960 --> 00:26:32,179
expect to be to be

508
00:26:41,859 --> 00:26:34,970
today I think those would be really

509
00:26:45,659 --> 00:26:41,869
informative studies to do before we move

510
00:26:48,759 --> 00:26:45,669
on I wanted to pick up Sean's question

511
00:26:51,129 --> 00:26:48,769
which you'll see in the live notes there

512
00:26:53,980 --> 00:26:51,139
I'm going to use it to sort of bridge

513
00:26:56,919 --> 00:26:53,990

the English evolutionary transitions and

514
00:26:58,779 --> 00:26:56,929
comparative methods so this is the one

515
00:27:01,899 --> 00:26:58,789
about the the presence or absence of o2

516
00:27:04,690 --> 00:27:01,909
and the possibilities of advanced life

517
00:27:06,580 --> 00:27:04,700
which obviously assurances for people

518
00:27:08,529 --> 00:27:06,590
interested in exoplanet missions would

519
00:27:13,149 --> 00:27:08,539
be very exciting what what are your

520
00:27:18,850 --> 00:27:13,159
thoughts about that in terms of the

521
00:27:20,769 --> 00:27:18,860
evolution of advanced life well I'll say

522
00:27:25,989 --> 00:27:20,779
that certainly we have life that's not

523
00:27:30,279 --> 00:27:25,999
that does not require oxygen but from my

524
00:27:32,379 --> 00:27:30,289
perspective as a multicellular kind of

525
00:27:34,570 --> 00:27:32,389
guy all the interesting stuff is

526
00:27:37,570 --> 00:27:34,580
happening on the oxygen breathers sorry

527
00:27:42,279 --> 00:27:37,580
Frank either you are going to anaerobic

528
00:27:47,799 --> 00:27:42,289
bacteria donya i do but i have worked on

529
00:27:54,180 --> 00:27:47,809
anaerobes I mean it's what's interesting

530
00:28:01,330 --> 00:27:58,989
electron acceptor tower say in

531
00:28:06,460 --> 00:28:01,340
sedimentary environments and there are

532
00:28:11,259 --> 00:28:06,470
obviously oxygen is is the king however

533
00:28:14,499 --> 00:28:11,269
you can get down to pretty good

534
00:28:20,399 --> 00:28:14,509
respiratory mechanisms that are based on

535
00:28:22,690 --> 00:28:20,409
on iron reduction or you know

536
00:28:27,119 --> 00:28:22,700
alternative electronic scepters that

537
00:28:30,489 --> 00:28:27,129
that are pretty energy efficient and

538
00:28:34,139 --> 00:28:30,499

while to my knowledge and maybe yeah

539
00:28:38,200 --> 00:28:34,149
maybe yuri can chime in on this point

540
00:28:41,879 --> 00:28:38,210
when we open it up for discussion but to

541
00:28:46,010 --> 00:28:41,889
while clearly there are cyanobacteria

542
00:28:49,460 --> 00:28:46,020
that exhibit the hallmark

543
00:28:52,180 --> 00:28:49,470
teachers of multicellular differentiated

544
00:28:56,930 --> 00:28:52,190
organisms to the best of my knowledge

545
00:29:00,230 --> 00:28:56,940
there are no anaerobes that that exhibit

546
00:29:02,570 --> 00:29:00,240
those those traits so I may just be

547
00:29:05,480 --> 00:29:02,580
exhibiting my ignorance of the

548
00:29:07,610 --> 00:29:05,490
literature the recent literature but I'd

549
00:29:11,030 --> 00:29:07,620
like to hear more on that from the

550
00:29:15,080 --> 00:29:11,040
community and you know really well are

551
00:29:17,930 --> 00:29:15,090
there any intrinsic limitations to the

552
00:29:25,630 --> 00:29:17,940
evolution of more quote unquote complex

553
00:29:28,610 --> 00:29:25,640
forms in in a toxic environment okay

554
00:29:30,830 --> 00:29:28,620
that's so those of us watching the

555
00:29:33,170 --> 00:29:30,840
Chapman you can see this has produced a

556
00:29:35,600 --> 00:29:33,180
little flurry of comments there which we

557
00:29:39,770 --> 00:29:35,610
will come back to I just wanted to pick

558
00:29:42,980 --> 00:29:39,780
up one thought though which is that it's

559
00:29:45,620 --> 00:29:42,990
one or two people had been asking these

560
00:29:48,230 --> 00:29:45,630
are sort of arbitrary distinctions we're

561
00:29:50,960 --> 00:29:48,240
making between prebiotic and advanced

562
00:29:53,570 --> 00:29:50,970
life and ultimately when we get to the

563
00:29:56,330 --> 00:29:53,580

road mapping workshop will be free to

564
00:29:58,640 --> 00:29:56,340
structure it any way we want it's just

565
00:30:01,250 --> 00:29:58,650
we sort of had to give titles so please

566
00:30:07,580 --> 00:30:01,260
don't feel that the decisions have

567
00:30:11,300 --> 00:30:07,590
already been made okay so let's move on

568
00:30:13,940 --> 00:30:11,310
to the power i want to add because i

569
00:30:16,940 --> 00:30:13,950
requested a comment from uri and one

570
00:30:20,770 --> 00:30:16,950
came very quickly and he made the the

571
00:30:25,960 --> 00:30:20,780
important point that there are anaerobic

572
00:30:29,450 --> 00:30:25,970
biofilms and of course biofilms are our

573
00:30:32,300 --> 00:30:29,460
multi cellular structure although it's I

574
00:30:34,240 --> 00:30:32,310
think an area for research and open

575
00:30:37,510 --> 00:30:34,250
discussion as to the degree of

576
00:30:44,270 --> 00:30:37,520
cooperativity and predictability of

577
00:30:50,620 --> 00:30:44,280
their assembly but clear and important

578
00:30:54,190 --> 00:30:50,630
point babe great thank you um all right

579
00:30:57,230 --> 00:30:54,200
single most important research problem

580
00:30:58,560 --> 00:30:57,240
what are your thoughts on where we might

581
00:31:02,759 --> 00:30:58,570
focus

582
00:31:04,710 --> 00:31:02,769
sources and effort for identifying the

583
00:31:12,930 --> 00:31:04,720
transition from simple to complex life

584
00:31:15,600 --> 00:31:12,940
forms but I'll be very brief here and

585
00:31:17,789 --> 00:31:15,610
maybe Matt can chime in this kind of

586
00:31:21,139 --> 00:31:17,799
follows on from the previous discussion

587
00:31:25,740 --> 00:31:21,149
as well as all the chatter here about

588
00:31:27,570 --> 00:31:25,750

about oxygen and it to me whether

589
00:31:30,480 --> 00:31:27,580
whether you're it's particularly if

590
00:31:32,909 --> 00:31:30,490
you're wanting to pursue an experimental

591
00:31:35,369 --> 00:31:32,919
approach to some of these questions you

592
00:31:38,220 --> 00:31:35,379
know finding the appropriate set of

593
00:31:41,999 --> 00:31:38,230
model organisms and the appropriate

594
00:31:44,539 --> 00:31:42,009
analog environment for performing these

595
00:31:47,369 --> 00:31:44,549
experiments seems to be of paramount

596
00:31:50,999 --> 00:31:47,379
importance and I would say that the

597
00:31:54,930 --> 00:31:51,009
various transitions that we have

598
00:31:57,619 --> 00:31:54,940
described that non-exhaustive list I

599
00:32:01,889 --> 00:31:57,629
know each of those transitions calls

600
00:32:07,499 --> 00:32:01,899
perhaps for a different model organism

601
00:32:09,690 --> 00:32:07,509
in a different analog environment for me

602
00:32:13,019 --> 00:32:09,700
I think that the most important research

603
00:32:16,049 --> 00:32:13,029
problem is really just a general just

604
00:32:20,220 --> 00:32:16,059
how resilient our Earth's ecosystems to

605
00:32:23,310 --> 00:32:20,230
environmental change what is the the

606
00:32:25,590 --> 00:32:23,320
rate and the and the length of time that

607
00:32:28,289 --> 00:32:25,600
a perturbation is applied how does that

608
00:32:29,999 --> 00:32:28,299
affect the outcome what what sort of

609
00:32:32,009 --> 00:32:30,009
organisms are better able to withstand

610
00:32:36,690 --> 00:32:32,019
environmental perturbations of whatever

611
00:32:41,970 --> 00:32:36,700
sort which ones are most at risk how do

612
00:32:43,710 --> 00:32:41,980
these structure the biosphere how is it

613
00:32:45,899 --> 00:32:43,720

affecting ecosystem functioning

614
00:32:48,060 --> 00:32:45,909
including things like nutrient cycling

615
00:32:51,539 --> 00:32:48,070
and that in the aftermath of the

616
00:32:54,499 --> 00:32:51,549
environmental perturbations you know how

617
00:32:57,899 --> 00:32:54,509
are different life history strategies

618
00:33:01,110 --> 00:32:57,909
helpful or harmful in getting organisms

619
00:33:05,460 --> 00:33:01,120
through those events anything I think

620
00:33:08,340 --> 00:33:05,470
around ecosystem resiliency is is an

621
00:33:11,910 --> 00:33:08,350
online you know the most paying for your

622
00:33:16,200 --> 00:33:14,820
I have to admit just picking up the chat

623
00:33:18,750 --> 00:33:16,210
window for a moment I do like the idea

624
00:33:21,330 --> 00:33:18,760
of one attempting to avoid being

625
00:33:25,050 --> 00:33:21,340
poisoned by the concept of oxygen as

626
00:33:28,680 --> 00:33:25,060
king to suffer oxy centric view of the

627
00:33:31,770 --> 00:33:28,690
last all right now I know one or two

628
00:33:34,620 --> 00:33:31,780
people have have jumped forward to this

629
00:33:38,490 --> 00:33:34,630
point already but let's have a look at

630
00:33:41,460 --> 00:33:38,500
sort of multicellularity and the super

631
00:33:44,010 --> 00:33:41,470
organisms and EO wilson and the rest

632
00:33:45,900 --> 00:33:44,020
when what are our thoughts around this

633
00:33:48,510 --> 00:33:45,910
where does it fit within any future

634
00:33:55,730 --> 00:33:48,520
roadmap what should we be thinking about

635
00:34:03,260 --> 00:33:55,740
here well when I put that down last week

636
00:34:07,800 --> 00:34:03,270
you know i think matt has i think wisely

637
00:34:12,150 --> 00:34:07,810
emphasized the sort of abiotic context

638
00:34:15,890 --> 00:34:12,160

in which these biological transitions

639
00:34:19,200 --> 00:34:15,900
occur and sort of biotic constraints or

640
00:34:23,190 --> 00:34:19,210
opportunity generators for advancements

641
00:34:27,300 --> 00:34:23,200
in the complexity of life the wording of

642
00:34:30,180 --> 00:34:27,310
this the wording of this last point on

643
00:34:32,970 --> 00:34:30,190
the on the PowerPoint slot is sort of

644
00:34:35,280 --> 00:34:32,980
explicitly population genetic and so

645
00:34:37,770 --> 00:34:35,290
what I was thinking of units and

646
00:34:42,180 --> 00:34:37,780
selection changing that is to say I'm

647
00:34:44,970 --> 00:34:42,190
thinking about you know is his selection

648
00:34:50,669 --> 00:34:44,980
focus you know on a molecule than is it

649
00:34:54,900 --> 00:34:50,679
focused on a cell and how our conflicts

650
00:34:56,850 --> 00:34:54,910
resolved between entities within the

651
00:35:00,150 --> 00:34:56,860
cell within the various plastids and

652
00:35:05,730 --> 00:35:00,160
then the nuclear genes and then on up

653
00:35:08,160 --> 00:35:05,740
the ladder even up to say cooperating

654
00:35:10,800 --> 00:35:08,170
metabolic systems like some of the

655
00:35:13,440 --> 00:35:10,810
people are talking about in the in the

656
00:35:17,160 --> 00:35:13,450
open chat you know is the unit of

657
00:35:19,050 --> 00:35:17,170
selection you know an interconnected

658
00:35:22,050 --> 00:35:19,060
biofilm or does the immunity of

659
00:35:25,050 --> 00:35:22,060
selection remain focused on a particular

660
00:35:30,390 --> 00:35:25,060
cell or even a group of cell

661
00:35:32,160 --> 00:35:30,400
you know within a biofilm so that that

662
00:35:40,880 --> 00:35:32,170
that's kind of what I was thinking about

663
00:35:43,350 --> 00:35:40,890

and so Matt want to chime in yeah i

664
00:35:46,350 --> 00:35:43,360
agree i think especially the unit of

665
00:35:48,120 --> 00:35:46,360
selection is is important in just

666
00:35:51,390 --> 00:35:48,130
understanding functionally how things

667
00:35:56,130 --> 00:35:51,400
are going to be able to adapt or or not

668
00:35:59,130 --> 00:35:56,140
to any sort of future change so i think

669
00:36:01,310 --> 00:35:59,140
that's important I have to confess I I

670
00:36:06,480 --> 00:36:01,320
don't actually follow the EO wilson

671
00:36:08,610 --> 00:36:06,490
superorganism thread that that carefully

672
00:36:11,270 --> 00:36:08,620
anymore but certainly the units of

673
00:36:13,620 --> 00:36:11,280
selection have been important in

674
00:36:15,570 --> 00:36:13,630
paleontology in evolutionary biology for

675
00:36:19,220 --> 00:36:15,580
a long time and that certainly will

676
00:36:22,980 --> 00:36:19,230
continue to be I I guess I've always

677
00:36:24,870 --> 00:36:22,990
sort of been impressed by the by how

678
00:36:30,380 --> 00:36:24,880
little we still know about really

679
00:36:32,490 --> 00:36:30,390
fundamental things about evolution like

680
00:36:34,410 --> 00:36:32,500
you know I don't know how far we've

681
00:36:35,790 --> 00:36:34,420
actually come since G Evelyn Hutchinson

682
00:36:38,550 --> 00:36:35,800
ask me why there are so many kinds of

683
00:36:40,170 --> 00:36:38,560
animals I'm not sure we actually even

684
00:36:44,700 --> 00:36:40,180
still know why there are so many kinds

685
00:36:48,090 --> 00:36:44,710
of animals and and that is that is a

686
00:36:49,830 --> 00:36:48,100
larger an overarching question to the

687
00:36:56,910 --> 00:36:49,840
units of selection question I think is

688
00:37:00,750 --> 00:36:56,920

important work absolutely all right um

689
00:37:03,030 --> 00:37:00,760
well at this point given the amount of

690
00:37:04,890 --> 00:37:03,040
chat in our chat window so our

691
00:37:09,090 --> 00:37:04,900
afternoons are a good time for chatting

692
00:37:12,870 --> 00:37:09,100
on this um let me go up into the

693
00:37:14,340 --> 00:37:12,880
participants know early i can see that

694
00:37:17,670 --> 00:37:14,350
you had your hand up for a while and

695
00:37:21,720 --> 00:37:17,680
we've also put your question into the

696
00:37:23,820 --> 00:37:21,730
live note do you want to expand on that

697
00:37:26,310 --> 00:37:23,830
at all basically you would you like to

698
00:37:29,250 --> 00:37:26,320
talk or you just want to give a response

699
00:37:34,810 --> 00:37:29,260
to that if you want to talk the star six

700
00:37:38,980 --> 00:37:34,820
to open your mic no that sounds hope

701
00:37:42,820 --> 00:37:38,990
book hello can you hear me know yes we

702
00:37:44,880 --> 00:37:42,830
can okay sorry because I had to put the

703
00:37:49,840 --> 00:37:44,890
phone down I didn't hear part of your

704
00:37:51,910 --> 00:37:49,850
your question so I think part of the

705
00:37:54,970 --> 00:37:51,920
reason why my end up is because I'm

706
00:37:57,010 --> 00:37:54,980
unfamiliar with this wisdom and but I

707
00:38:01,030 --> 00:37:57,020
think I still was thinking in terms of

708
00:38:03,960 --> 00:38:01,040
evolutionary transition that we could

709
00:38:07,210 --> 00:38:03,970
see them may be very generous

710
00:38:09,190 --> 00:38:07,220
specialization of molecules that may be

711
00:38:11,260 --> 00:38:09,200
in many respects with start with

712
00:38:13,450 --> 00:38:11,270
molecules that are generalists in many

713
00:38:16,000 --> 00:38:13,460

different ways and then they specialize

714
00:38:17,860 --> 00:38:16,010
themselves not only as DNA for genome

715
00:38:20,470 --> 00:38:17,870
and protein as major catalyst but also

716
00:38:22,690 --> 00:38:20,480
as membrane proteins that main able

717
00:38:25,380 --> 00:38:22,700
multicellularity and to get

718
00:38:29,320 --> 00:38:25,390
self-cleaning together so that we have

719
00:38:31,990 --> 00:38:29,330
specialization of molecules and that may

720
00:38:35,290 --> 00:38:32,000
be a focus on molecular evolution and

721
00:38:36,340 --> 00:38:35,300
less on the phenotype may give us more

722
00:38:41,680 --> 00:38:36,350
insight on the major evolutionary

723
00:38:43,510 --> 00:38:41,690
transition I still tend to think that a

724
00:38:47,290 --> 00:38:43,520
unit of selection is the individual I

725
00:38:50,190 --> 00:38:47,300
know there's obviously that's a you know

726
00:38:52,390 --> 00:38:50,200
heresy in some quarters but or

727
00:38:54,670 --> 00:38:52,400
traditionalist anyway but in that sense

728
00:38:56,260 --> 00:38:54,680
you know I think you know looking at the

729
00:38:57,820 --> 00:38:56,270
individual is that the package in which

730
00:39:01,780 --> 00:38:57,830
all these molecular things are happening

731
00:39:04,740 --> 00:39:01,790
is is a is important but but I agree

732
00:39:07,210 --> 00:39:04,750
that you know thinking of things sort of

733
00:39:11,560 --> 00:39:07,220
increasing hierarchically ordered levels

734
00:39:14,440 --> 00:39:11,570
of complexity is useful so in that sense

735
00:39:16,960 --> 00:39:14,450
for example we can evolve macromolecules

736
00:39:20,500 --> 00:39:16,970
in the fell in my lap and we can do

737
00:39:22,270 --> 00:39:20,510
experiment on that on evolution of manic

738
00:39:24,880 --> 00:39:22,280

molecules and for example we are

739
00:39:27,700 --> 00:39:24,890
starting to form our NP complexes so

740
00:39:29,740 --> 00:39:27,710
many involving are you molecule which is

741
00:39:33,280 --> 00:39:29,750
probably one type of specialization of

742
00:39:35,260 --> 00:39:33,290
forming from in catalytic are MPs and so

743
00:39:37,600 --> 00:39:35,270
what I want to say is that with those

744
00:39:40,120 --> 00:39:37,610
molecular for with this molecular focus

745
00:39:42,460 --> 00:39:40,130
we can we can do experiments we can look

746
00:39:46,380 --> 00:39:42,470
at populations we can get went data and

747
00:39:48,790 --> 00:39:46,390
we can we can get very quantitative data

748
00:39:51,870 --> 00:39:48,800
and so

749
00:39:57,220 --> 00:39:51,880
which may makes lots of things

750
00:39:58,900 --> 00:39:57,230
addressable quantitatively and as an

751
00:40:00,910 --> 00:39:58,910
evolutionary transition if we consider

752
00:40:03,610 --> 00:40:00,920
for example multicellularity as being

753
00:40:10,390 --> 00:40:03,620
the consequence of what which molecule

754
00:40:11,770 --> 00:40:10,400
is it that hotel together it was as far

755
00:40:15,220 --> 00:40:11,780
as I understood it was one major

756
00:40:16,600 --> 00:40:15,230
molecule that was holding cells together

757
00:40:20,560 --> 00:40:16,610
that enabled the rights of

758
00:40:23,590 --> 00:40:20,570
multicellularity but come correct well

759
00:40:25,630 --> 00:40:23,600
there that I don't know that perhaps in

760
00:40:28,060 --> 00:40:25,640
amongst animals but I think that in

761
00:40:33,040 --> 00:40:28,070
other multicellular groups there a

762
00:40:35,410 --> 00:40:33,050
variety of glycoproteins and lip of

763
00:40:40,890 --> 00:40:35,420

polysaccharides i think it's i think

764
00:40:48,160 --> 00:40:40,900
it's its tax on specific you know

765
00:40:52,290 --> 00:40:48,170
amongst protists and fungi so but there

766
00:40:58,660 --> 00:40:56,170
extracellular matrix compounds that act

767
00:41:01,480 --> 00:40:58,670
as the glue so that it's a finite set

768
00:41:04,330 --> 00:41:01,490
but it's not just one it's at least

769
00:41:07,960 --> 00:41:04,340
that's my understanding of dealing all

770
00:41:12,150 --> 00:41:07,970
the with the view across the periodic

771
00:41:14,560 --> 00:41:12,160
and well across the all three domains

772
00:41:17,380 --> 00:41:14,570
Frank what I would have to do does that

773
00:41:19,380 --> 00:41:17,390
does that imply that multicellularity

774
00:41:23,890 --> 00:41:19,390
arose independently in different groups

775
00:41:25,860 --> 00:41:23,900
it certainly did there are many

776
00:41:30,460 --> 00:41:25,870
independent evolutions of

777
00:41:33,490 --> 00:41:30,470
multicellularity even within fairly

778
00:41:36,580 --> 00:41:33,500
narrow clades such as the volta seeing

779
00:41:39,100 --> 00:41:36,590
algae everybody is you know all of us

780
00:41:41,170 --> 00:41:39,110
you know at some point you know peered

781
00:41:45,400 --> 00:41:41,180
and evolve Excel you know when we were

782
00:41:48,280 --> 00:41:45,410
probably in grammar school and within

783
00:41:50,890 --> 00:41:48,290
this clade of depending upon whether

784
00:41:52,720 --> 00:41:50,900
you're a lump or splitter say you know

785
00:41:54,630 --> 00:41:52,730
about twenty organisms you've had

786
00:41:57,610 --> 00:41:54,640
multiple and you've had multiple

787
00:42:00,340 --> 00:41:57,620
evolutions of multicellularity and so

788
00:42:01,730 --> 00:42:00,350

this appears to have happened a number

789
00:42:05,230 --> 00:42:01,740
of times

790
00:42:08,290 --> 00:42:05,240
not in a distant past some sometimes

791
00:42:12,470 --> 00:42:08,300
even within you know the last you know

792
00:42:17,530 --> 00:42:12,480
50 million years so yes there are after

793
00:42:19,640 --> 00:42:17,540
biology good go ahead no no no please

794
00:42:21,859 --> 00:42:19,650
what one thing just thinking about

795
00:42:23,900 --> 00:42:21,869
astrobiology here in general is which

796
00:42:25,940 --> 00:42:23,910
one of these so which one's of these

797
00:42:28,580 --> 00:42:25,950
major evolutionary transitions are the

798
00:42:30,980 --> 00:42:28,590
ones that are easy to do and have arisen

799
00:42:33,500 --> 00:42:30,990
multiple times and which ones have been

800
00:42:35,359 --> 00:42:33,510
unique and maybe chance events that are

801
00:42:36,830 --> 00:42:35,369
not likely to be repeated I guess I

802
00:42:39,710 --> 00:42:36,840
would expect that if we were looking on

803
00:42:40,910 --> 00:42:39,720
other planets that the the the out the

804
00:42:43,160 --> 00:42:40,920
evolutionary transitions that are

805
00:42:44,450 --> 00:42:43,170
repeated events here seem to be like the

806
00:42:46,670 --> 00:42:44,460
most likely to be the ones that are

807
00:42:48,260 --> 00:42:46,680
repeated elsewhere and the one graphic

808
00:42:52,070 --> 00:42:48,270
right out here are likely to be the

809
00:42:55,190 --> 00:42:52,080
Tampa nents there yeah so for example i

810
00:42:57,950 --> 00:42:55,200
mean i think that the transitions that

811
00:43:01,160 --> 00:42:57,960
doeth marion main Art Smith shows were

812
00:43:04,880 --> 00:43:01,170
ones that were had clearly happened not

813
00:43:08,000 --> 00:43:04,890

just once but multiple times and so it's

814
00:43:09,950 --> 00:43:08,010
it's that the eukaryotic cell there's

815
00:43:12,670 --> 00:43:09,960
not a eukaryotic cell there are many

816
00:43:17,720 --> 00:43:12,680
different kinds of eukaryotic cells and

817
00:43:20,599 --> 00:43:17,730
they have acquired their organelles in

818
00:43:22,310 --> 00:43:20,609
different ways but independently

819
00:43:26,540 --> 00:43:22,320
certainly the lineage that's given rise

820
00:43:29,240 --> 00:43:26,550
to animals acquired what is now or the

821
00:43:32,630 --> 00:43:29,250
winner you know just like they say

822
00:43:36,109 --> 00:43:32,640
history is written by the winners you

823
00:43:38,210 --> 00:43:36,119
know the evolutionary history is written

824
00:43:40,700 --> 00:43:38,220
by winners as well and so we have the

825
00:43:43,280 --> 00:43:40,710
winning modicon trian but there's no

826
00:43:45,670 --> 00:43:43,290
reason to suspect that in the early

827
00:43:50,030 --> 00:43:45,680
going that there were not many

828
00:43:52,220 --> 00:43:50,040
experiments that that gave the bigger

829
00:43:55,550 --> 00:43:52,230
bang for the buck that I you know that

830
00:44:00,560 --> 00:43:55,560
some alpha proteobacteria back when gays

831
00:44:02,900 --> 00:44:00,570
so there these transitions from

832
00:44:07,130 --> 00:44:02,910
prokaryote do you carry out to from a

833
00:44:10,099 --> 00:44:07,140
sexual to sexual organisms from protists

834
00:44:12,950 --> 00:44:10,109
to multicellular organisms you can show

835
00:44:15,170 --> 00:44:12,960
multiple evolutionary origins for all of

836
00:44:18,859 --> 00:44:15,180
these things

837
00:44:21,799 --> 00:44:18,869
so let me ask the participants now if

838
00:44:24,309 --> 00:44:21,809

there are other people who want to talk

839
00:44:27,920 --> 00:44:24,319
and as Mike just put in the chat window

840
00:44:30,290 --> 00:44:27,930
at the top of the screen right side of

841
00:44:33,049 --> 00:44:30,300
the camera you'll see a little person

842
00:44:35,329 --> 00:44:33,059
with a hand held up you can click on

843
00:44:41,059 --> 00:44:35,339
that and that lets me know and it so it

844
00:44:42,890 --> 00:44:41,069
pops you in the queue um and just while

845
00:44:45,230 --> 00:44:42,900
people are thinking about that and good

846
00:44:48,370 --> 00:44:45,240
comment in the chat window hear about

847
00:44:53,000 --> 00:44:48,380
from looks like i've only got initials

848
00:44:56,329 --> 00:44:53,010
ciw so this idea of taking 02 off the

849
00:44:58,579 --> 00:44:56,339
table does that mean that we define

850
00:45:02,390 --> 00:44:58,589
evolutionary complexity in terms of the

851
00:45:09,230 --> 00:45:02,400
emergence of metabolic complexity all

852
00:45:11,359 --> 00:45:09,240
the other to the same on that level you

853
00:45:14,599 --> 00:45:11,369
know I'm getting I'm getting comments

854
00:45:17,750 --> 00:45:14,609
here by is it Yuri Yuri can you actually

855
00:45:20,780 --> 00:45:17,760
chime in so that in fact he has his hand

856
00:45:23,630 --> 00:45:20,790
raised so rather than me you know

857
00:45:27,220 --> 00:45:23,640
distilling and possibly misinterpreting

858
00:45:32,299 --> 00:45:27,230
his remarks I'd like to hear from either

859
00:45:36,920 --> 00:45:32,309
him or Eric directly on these points so

860
00:45:40,579 --> 00:45:36,930
let's go with urea men Eric so Yuri it

861
00:45:43,730 --> 00:45:40,589
star six to unmute yourself a belief

862
00:45:45,470 --> 00:45:43,740
actually um but I can't classic on this

863
00:45:47,420 --> 00:45:45,480

telephone that I'm on because I'm i

864
00:45:52,160 --> 00:45:47,430
called it on a bike on yes you hear me

865
00:45:55,069 --> 00:45:52,170
you hear you perfect hyper for you um

866
00:45:58,609 --> 00:45:55,079
well it's good to hear your voice great

867
00:46:01,640 --> 00:45:58,619
thanks a lot might be here I just was

868
00:46:03,559 --> 00:46:01,650
made aware of this webinar from of my

869
00:46:06,170 --> 00:46:03,569
colleagues at university of southern

870
00:46:08,299 --> 00:46:06,180
california and i don't see them any of

871
00:46:11,480 --> 00:46:08,309
those I don't think on the line here so

872
00:46:14,870 --> 00:46:11,490
we were just awarded one of these uh any

873
00:46:16,700 --> 00:46:14,880
eyes and I've moved up here to Troy at

874
00:46:19,609 --> 00:46:16,710
Rensselaer Polytechnic Institute come up

875
00:46:23,109 --> 00:46:19,619
here in upstate New York I didn't want

876
00:46:26,240 --> 00:46:23,119
to just kind of go back a couple of

877
00:46:28,910 --> 00:46:26,250
comments or earth line back in the chat

878
00:46:31,010 --> 00:46:28,920
room where I put that

879
00:46:34,190 --> 00:46:31,020
a paper by my friends and colleagues at

880
00:46:37,490 --> 00:46:34,200
the University of ollies there are

881
00:46:40,210 --> 00:46:37,500
anaerobic eukaryotes I mean and again

882
00:46:42,280 --> 00:46:40,220
the religion age of mitochondrial

883
00:46:45,110 --> 00:46:42,290
different than the lineage of

884
00:46:46,880 --> 00:46:45,120
mitochondria that for us present I think

885
00:46:49,520 --> 00:46:46,890
we have rickettsia to convey Eric a

886
00:46:51,620 --> 00:46:49,530
Chilean engine mitochondria correct and

887
00:46:53,000 --> 00:46:51,630
I I guess I was trying to quickly

888
00:46:54,410 --> 00:46:53,010

through there but yeah I think it's

889
00:46:58,090 --> 00:46:54,420
either self a little bit so one of these

890
00:47:01,630 --> 00:46:58,100
sulfur organisms were the the

891
00:47:05,770 --> 00:47:01,640
predecessor for the family through

892
00:47:08,180 --> 00:47:05,780
molecular means the predecessor of the

893
00:47:10,520 --> 00:47:08,190
mitochondria and we then take worms and

894
00:47:12,620 --> 00:47:10,530
other foraminifera there's a number of

895
00:47:17,750 --> 00:47:12,630
them and so I don't think that again

896
00:47:21,250 --> 00:47:17,760
that we should our thoughts or the

897
00:47:23,840 --> 00:47:21,260
cotton our ideas to oxygen respiring

898
00:47:27,050 --> 00:47:23,850
eukaryotes since we do have examples

899
00:47:29,030 --> 00:47:27,060
here are key on this planet I think that

900
00:47:31,070 --> 00:47:29,040
this is absolutely possible that you

901
00:47:34,600 --> 00:47:31,080
could have divergent life-forms

902
00:47:37,880 --> 00:47:34,610
eukaryotic like life forms with with

903
00:47:41,600 --> 00:47:37,890
anaerobic mitochondria that operate is

904
00:47:44,540 --> 00:47:41,610
fine in the absence of oxygen so I I

905
00:47:48,980 --> 00:47:44,550
think that you know we shouldn't again

906
00:47:52,270 --> 00:47:48,990
limit are the possibilities by from our

907
00:47:55,130 --> 00:47:52,280
lack of knowledge of the complexity of

908
00:47:57,260 --> 00:47:55,140
biology that's I just wanted to make

909
00:47:59,960 --> 00:47:57,270
that point silly and the concept of

910
00:48:02,390 --> 00:47:59,970
multicellularity and biofilms upon many

911
00:48:05,120 --> 00:48:02,400
of us that study biofilms look at these

912
00:48:07,850 --> 00:48:05,130
not as single organisms in fact there's

913
00:48:14,600 --> 00:48:07,860

only a small percentage of organisms and

914
00:48:19,340 --> 00:48:14,610
multicellular or multi multi what is it

915
00:48:20,930 --> 00:48:19,350
you know diverse biofilms that can't

916
00:48:23,390 --> 00:48:20,940
live by themselves and so they are

917
00:48:25,070 --> 00:48:23,400
actually absolutely dependent on their

918
00:48:28,400 --> 00:48:25,080
community members and so in that sense

919
00:48:30,470 --> 00:48:28,410
it may not be considered a single

920
00:48:33,500 --> 00:48:30,480
organism but certainly react with an

921
00:48:38,060 --> 00:48:33,510
integrated tissue and you know that

922
00:48:40,550 --> 00:48:38,070
didn't those tissues that our energy can

923
00:48:41,470 --> 00:48:40,560
be shared now through electrical or

924
00:48:43,660 --> 00:48:41,480
through

925
00:48:47,109 --> 00:48:43,670
the pod lights that are released and

926
00:48:50,290 --> 00:48:47,119
then diffused other phones within that

927
00:48:52,620 --> 00:48:50,300
tissue and so again I think that this is

928
00:48:55,090 --> 00:48:52,630
something to continue think about a

929
00:48:57,070 --> 00:48:55,100
diversity and a generation of

930
00:49:00,880 --> 00:48:57,080
multicellular it sandwiches at least

931
00:49:09,070 --> 00:49:00,890
that could be considered that and by

932
00:49:12,160 --> 00:49:09,080
many of us they are excellent Eric do

933
00:49:18,700 --> 00:49:12,170
you want to and on that do you want take

934
00:49:22,030 --> 00:49:18,710
it in a different direction yes yes we

935
00:49:24,130 --> 00:49:22,040
can okay thank you if it's okay i just

936
00:49:26,200 --> 00:49:24,140
wanted to respond to thoughts that are

937
00:49:28,570 --> 00:49:26,210
generated by your point for which would

938
00:49:31,859 --> 00:49:28,580

then be slightly off-topic relative to

939
00:49:37,030 --> 00:49:31,869
the oxygen point let's go right ahead

940
00:49:40,000 --> 00:49:37,040
okay my thought is that what we care

941
00:49:43,570 --> 00:49:40,010
about in complicated life as in simple

942
00:49:46,680 --> 00:49:43,580
life is how architectures form that can

943
00:49:50,950 --> 00:49:46,690
take on and preserve and use patterns

944
00:49:53,470 --> 00:49:50,960
it's good to not prejudice that too much

945
00:49:55,930 --> 00:49:53,480
by thinking about a few familiar kinds

946
00:49:57,870 --> 00:49:55,940
of organization so if we ask what

947
00:50:00,550 --> 00:49:57,880
structures evolution at a bare minimum

948
00:50:02,080 --> 00:50:00,560
we have development in the broadest

949
00:50:04,330 --> 00:50:02,090
sense meaning sort of all the

950
00:50:06,609 --> 00:50:04,340
constructive activities with an ontogeny

951
00:50:09,070 --> 00:50:06,619
we have transmission we have selection

952
00:50:11,470 --> 00:50:09,080
and we have ecology and in all of these

953
00:50:14,349 --> 00:50:11,480
there can be hierarchical nested units

954
00:50:16,540 --> 00:50:14,359
of organization it's very good to talk

955
00:50:18,790 --> 00:50:16,550
about units of solution but it's also

956
00:50:20,710 --> 00:50:18,800
very good to recognize units of all the

957
00:50:22,810 --> 00:50:20,720
others because these are the things that

958
00:50:24,910 --> 00:50:22,820
determine how variation is structured

959
00:50:27,070 --> 00:50:24,920
they determine what the arenas are

960
00:50:29,770 --> 00:50:27,080
within which selection takes place and

961
00:50:31,620 --> 00:50:29,780
it strikes me that what we care about is

962
00:50:33,849 --> 00:50:31,630
the emergence of complexity in

963
00:50:34,870 --> 00:50:33,859

evolutionary dynamics and also an

964
00:50:37,330 --> 00:50:34,880
interaction with the boundary

965
00:50:41,859 --> 00:50:37,340
constraints and to use a language that

966
00:50:44,650 --> 00:50:41,869
keeps that field open to all to studying

967
00:50:46,510 --> 00:50:44,660
all of the relevant structures seems to

968
00:50:48,400 --> 00:50:46,520
be a healthy direction especially if

969
00:50:50,410 --> 00:50:48,410
you're trying to lay out a roadmap and I

970
00:50:53,140 --> 00:50:50,420
guess in one sense that was also where

971
00:50:54,730 --> 00:50:53,150
the oxygen point came from to recognize

972
00:50:55,390 --> 00:50:54,740
that all of these things really are

973
00:50:57,549 --> 00:50:55,400
system

974
00:50:59,529 --> 00:50:57,559
conversions within which we may

975
00:51:02,920 --> 00:50:59,539
recognize a certain kind of innovation

976
00:51:05,230 --> 00:51:02,930
as the marker of the event but often

977
00:51:07,390 --> 00:51:05,240
it's not the only determiner of the

978
00:51:13,079 --> 00:51:07,400
event as we see in many many transitions

979
00:51:17,549 --> 00:51:13,089
over and over again thank you guys

980
00:51:20,559 --> 00:51:17,559
thoughts on that no I'm in just an

981
00:51:28,260 --> 00:51:20,569
excellent point and certainly you know

982
00:51:31,870 --> 00:51:28,270
one to be it would be nice if perhaps

983
00:51:35,349 --> 00:51:31,880
Eric could well he has written some

984
00:51:40,329 --> 00:51:35,359
comments as the week goes on we'll some

985
00:51:42,940 --> 00:51:40,339
of the the notes be available to those

986
00:51:45,099 --> 00:51:42,950
people who log in and discuss because

987
00:51:48,670 --> 00:51:45,109
that's actually a point that I would

988
00:51:52,390 --> 00:51:48,680

like to see discussed further is very

989
00:51:54,029 --> 00:51:52,400
eloquently put you know in by Eric just

990
00:51:57,390 --> 00:51:54,039
now what a transcript of that be

991
00:52:00,670 --> 00:51:57,400
available from this point going forward

992
00:52:03,099 --> 00:52:00,680
yeah what will happen is we'll have the

993
00:52:06,730 --> 00:52:03,109
video process like tomorrow we'll have

994
00:52:09,039 --> 00:52:06,740
the transcript and we're going to

995
00:52:11,589 --> 00:52:09,049
experiment to see if we could break out

996
00:52:13,299 --> 00:52:11,599
any of these points in two separate

997
00:52:16,769 --> 00:52:13,309
threads so certainly I think it's

998
00:52:19,839 --> 00:52:16,779
particularly interesting to think about

999
00:52:22,089 --> 00:52:19,849
what are the assumptions or even

1000
00:52:25,720 --> 00:52:22,099
meta-level assumptions that we need to

1001
00:52:28,420 --> 00:52:25,730
be aware of in developing a roadmap so

1002
00:52:30,190 --> 00:52:28,430
over and above what questions might we

1003
00:52:32,710 --> 00:52:30,200
have it's also really interesting to

1004
00:52:34,750 --> 00:52:32,720
think about what assumptions we must try

1005
00:52:36,910 --> 00:52:34,760
and transcend in the development of the

1006
00:52:40,210 --> 00:52:36,920
roadmap and that sounds particularly

1007
00:52:43,029 --> 00:52:40,220
important and in fact Eric will will pop

1008
00:52:45,359 --> 00:52:43,039
the transcript tab you may want to raise

1009
00:52:48,130 --> 00:52:45,369
that as a completely separate question

1010
00:52:50,549 --> 00:52:48,140
in a thread just to make sure that we

1011
00:52:53,440 --> 00:52:50,559
don't come to butcher your language

1012
00:52:57,940 --> 00:52:53,450
unintentionally instead of breaking out

1013
00:53:01,420 --> 00:52:57,950

the threads on them um okay sean has

1014
00:53:04,620 --> 00:53:01,430
also been popping up some questions here

1015
00:53:07,660 --> 00:53:04,630
if you have a look in the live notes the

1016
00:53:09,640 --> 00:53:07,670
last one down do we have any clues on

1017
00:53:12,350 --> 00:53:09,650
what global signatures

1018
00:53:14,120 --> 00:53:12,360
and while you're thinking about that

1019
00:53:16,040 --> 00:53:14,130
just remind people we still got a couple

1020
00:53:18,830 --> 00:53:16,050
of minutes left if anyone else wants to

1021
00:53:22,760 --> 00:53:18,840
ask a question I'm stickier your hand in

1022
00:53:26,570 --> 00:53:22,770
the air and we'll come to you yeah this

1023
00:53:30,020 --> 00:53:26,580
is this was this was a question by seans

1024
00:53:31,790 --> 00:53:30,030
that correct and it was of the 10

1025
00:53:35,450 --> 00:53:31,800
questions that we generated the other

1026
00:53:38,450 --> 00:53:35,460
day while the second question was not

1027
00:53:43,010 --> 00:53:38,460
part of it that the first was in fact

1028
00:53:48,850 --> 00:53:43,020
almost exactly question number 7 that

1029
00:53:55,100 --> 00:53:51,770
Matt would since you the paleontologist

1030
00:54:00,740 --> 00:53:55,110
would you like to take a stab at that

1031
00:54:01,850 --> 00:54:00,750
and perhaps Yuri might also so that gets

1032
00:54:04,160 --> 00:54:01,860
the question I don't think have any

1033
00:54:06,470 --> 00:54:04,170
clues on what global signatures we could

1034
00:54:09,640 --> 00:54:06,480
look for from advanced life and a

1035
00:54:12,110 --> 00:54:09,650
globally anaerobic surface environment

1036
00:54:14,270 --> 00:54:12,120
you know from a remote sensing

1037
00:54:19,340 --> 00:54:14,280
standpoint I have no idea it's just not

1038
00:54:22,670 --> 00:54:19,350

my areas of specialization but I think

1039
00:54:24,320 --> 00:54:22,680
on a larger scale looking at life on

1040
00:54:27,200 --> 00:54:24,330
Earth and seeing under what conditions

1041
00:54:30,290 --> 00:54:27,210
life looks a certain way or does not and

1042
00:54:32,030 --> 00:54:30,300
then finding those analog environments

1043
00:54:34,070 --> 00:54:32,040
and other planets is actually answering

1044
00:54:35,450 --> 00:54:34,080
the same question it doesn't confirm

1045
00:54:37,490 --> 00:54:35,460
that there's life there it just means

1046
00:54:39,200 --> 00:54:37,500
that the possibility for life under

1047
00:54:41,480 --> 00:54:39,210
these particular circumstances is there

1048
00:54:43,400 --> 00:54:41,490
and you know maybe it's not as nice as

1049
00:54:45,500 --> 00:54:43,410
some sort of satellite they can beam the

1050
00:54:49,610 --> 00:54:45,510
planet and tell you what life is they're

1051
00:54:50,990 --> 00:54:49,620
not but I think it's a it does double

1052
00:54:53,570 --> 00:54:51,000
duty in the sense that it helps you

1053
00:54:56,930 --> 00:54:53,580
understand the presence of life are not

1054
00:54:58,990 --> 00:54:56,940
on other planets and also helps you

1055
00:55:01,760 --> 00:54:59,000
understand the life on on this planet

1056
00:55:04,160 --> 00:55:01,770
which does exist and so in that sense

1057
00:55:07,580 --> 00:55:04,170
it's a you know bang for your buck in

1058
00:55:11,630 --> 00:55:07,590
that regard to I also wanted to pick up

1059
00:55:13,430 --> 00:55:11,640
here on oles point that and sort of a

1060
00:55:17,690 --> 00:55:13,440
also Eric's point which was which is

1061
00:55:19,700 --> 00:55:17,700
excellent and one thing that that he

1062
00:55:21,080 --> 00:55:19,710
said is that there but they only said

1063
00:55:22,980 --> 00:55:21,090

there are many possibilities for major

1064
00:55:24,760 --> 00:55:22,990
evolutionary step and he was

1065
00:55:26,680 --> 00:55:24,770
referring to Frank's comment about

1066
00:55:28,480 --> 00:55:26,690
multicellularity evolving multiple times

1067
00:55:30,790 --> 00:55:28,490
and it strikes me that there are also

1068
00:55:32,770 --> 00:55:30,800
many physical environmental events in

1069
00:55:35,290 --> 00:55:32,780
Earth history that were not accompanied

1070
00:55:37,330 --> 00:55:35,300
by some sort of major evolutionary step

1071
00:55:40,480 --> 00:55:37,340
in some ways defining the major

1072
00:55:42,580 --> 00:55:40,490
evolutionary transitions is to say that

1073
00:55:45,370 --> 00:55:42,590
we have recognized that something major

1074
00:55:46,660 --> 00:55:45,380
happen to life at that time and then we

1075
00:55:48,610 --> 00:55:46,670
go looking for the cause of what

1076
00:55:50,500 --> 00:55:48,620
happened but there's also these times

1077
00:55:52,440 --> 00:55:50,510
when the when major environmental things

1078
00:55:56,200 --> 00:55:52,450
may have happened but that they were not

1079
00:55:57,820 --> 00:55:56,210
reflected then in in any anything

1080
00:56:01,960 --> 00:55:57,830
recognizable to us in the history of

1081
00:56:04,660 --> 00:56:01,970
life and so I don't think a useful

1082
00:56:06,340 --> 00:56:04,670
research direction is is something which

1083
00:56:08,280 --> 00:56:06,350
is not biological at all which is to

1084
00:56:11,170 --> 00:56:08,290
look at the absence of biological change

1085
00:56:14,650 --> 00:56:11,180
during times of major environmental

1086
00:56:16,330 --> 00:56:14,660
shifts so far as I'm as I know I don't

1087
00:56:18,100 --> 00:56:16,340
think many much of that would happen in

1088
00:56:22,210 --> 00:56:18,110

the phanerozoic but if you go back far

1089
00:56:24,010 --> 00:56:22,220
enough there may be times like that that

1090
00:56:27,520 --> 00:56:24,020
to me would be just as interesting and

1091
00:56:31,000 --> 00:56:27,530
understanding why things evolve

1092
00:56:39,100 --> 00:56:31,010
complexity you know it by looking at

1093
00:56:41,880 --> 00:56:39,110
when they don't ok and with that ladies

1094
00:56:44,950 --> 00:56:41,890
gentlemen I am I'm going to wrap this up

1095
00:56:47,110 --> 00:56:44,960
the recording will be available tomorrow

1096
00:56:49,540 --> 00:56:47,120
morning if you want to mention it to

1097
00:56:51,280 --> 00:56:49,550
your colleagues and we will send out a

1098
00:56:54,550 --> 00:56:51,290
newsletter to make sure everyone has

1099
00:56:57,130 --> 00:56:54,560
that the questions which Frank has been

1100
00:56:59,650 --> 00:56:57,140
referring to the additional questions

1101
00:57:01,570 --> 00:56:59,660
which they develop will be available on

1102
00:57:03,310 --> 00:57:01,580
the website however I've just had a

1103
00:57:05,410 --> 00:57:03,320
message from one of my colleagues saying

1104
00:57:06,850 --> 00:57:05,420
that apparently there's an ever so

1105
00:57:08,710 --> 00:57:06,860
slight problem with the way the

1106
00:57:11,860 --> 00:57:08,720
threading is working on the website

1107
00:57:14,560 --> 00:57:11,870
seemingly a kitten got in and monkeyed

1108
00:57:17,020 --> 00:57:14,570
around with ball of wool we we need to

1109
00:57:20,260 --> 00:57:17,030
straighten that out so the questions

1110
00:57:24,040 --> 00:57:20,270
won't be up today but as soon as we send

1111
00:57:26,590 --> 00:57:24,050
out the newsletter we will let you know

1112
00:57:31,210 --> 00:57:26,600
that it's back and that will want your

1113
00:57:33,880 --> 00:57:31,220

input on that um so thank you very much

1114
00:57:35,240 --> 00:57:33,890
very interesting discussion we shall all

1115
00:57:37,310 --> 00:57:35,250
go off from ponder