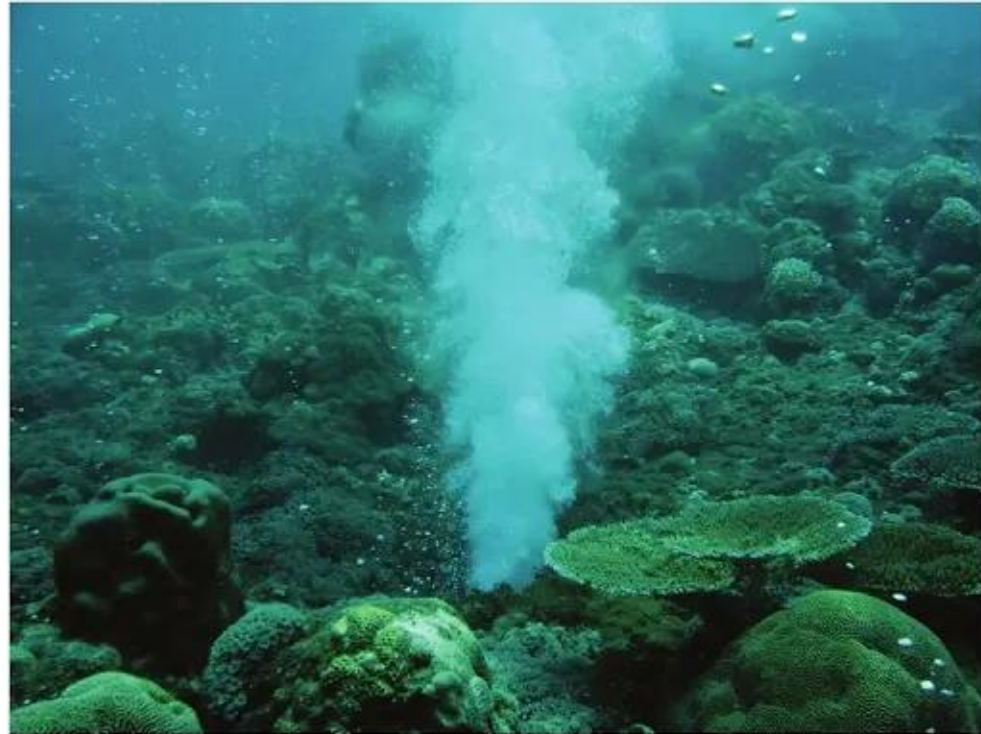


Shallow-sea hydrothermal vents



Tingloy Island, Philippines



Ambitle Island, Papua New Guinea (Karlen et al., 2010, Pacific Science)

1
00:00:09,589 --> 00:00:07,510
throughout history

2
00:00:12,150 --> 00:00:09,599
hydrothermal systems in the natural

3
00:00:16,070 --> 00:00:12,160
world have often surprised scientists

4
00:00:19,189 --> 00:00:16,080
in unprecedented chemistries and biology

5
00:00:21,029 --> 00:00:19,199
for example the discovery and study of

6
00:00:23,189 --> 00:00:21,039
the grand prismatic hot spring

7
00:00:24,070 --> 00:00:23,199
or the lost city alkaline hydrothermal

8
00:00:26,390 --> 00:00:24,080
vents

9
00:00:27,269 --> 00:00:26,400
pushed our understanding of the limits

10
00:00:29,589 --> 00:00:27,279
of life

11
00:00:31,029 --> 00:00:29,599
and reshaped theories on how life may

12
00:00:33,190 --> 00:00:31,039
have emerged

13
00:00:34,709 --> 00:00:33,200

and whether it might exist outside our

14

00:00:36,790 --> 00:00:34,719

planet

15

00:00:38,790 --> 00:00:36,800

this is one reason why hydrothermal

16

00:00:44,389 --> 00:00:38,800

systems are key targets

17

00:00:46,869 --> 00:00:44,399

in the field of master biology much of

18

00:00:49,190 --> 00:00:46,879

our understanding of how life may thrive

19

00:00:50,150 --> 00:00:49,200

outside the ideal conditions in our

20

00:00:51,830 --> 00:00:50,160

planet

21

00:00:55,110 --> 00:00:51,840

comes from our knowledge on the

22

00:00:58,150 --> 00:00:55,120

versatility of microorganisms

23

00:01:00,069 --> 00:00:58,160

as almost all known organisms that exist

24

00:01:03,349 --> 00:01:00,079

at the boundary conditions

25

00:01:09,350 --> 00:01:03,359

or what we may call poly extremophiles

26

00:01:12,950 --> 00:01:12,310

this exclusivity is tied in with the

27

00:01:15,109 --> 00:01:12,960

fact

28

00:01:16,070 --> 00:01:15,119

that some of the microbes that exist

29

00:01:18,550 --> 00:01:16,080

today

30

00:01:19,270 --> 00:01:18,560

actually resemble what early life may

31

00:01:24,149 --> 00:01:19,280

have looked like

32

00:01:26,550 --> 00:01:24,159

and behaved like press the extremophiles

33

00:01:29,670 --> 00:01:26,560

life used to thrive in very different

34

00:01:32,390 --> 00:01:29,680

and much harsher conditions

35

00:01:32,710 --> 00:01:32,400

one example of such microbial present

36

00:01:36,149 --> 00:01:32,720

day

37

00:01:38,390 --> 00:01:36,159

analog are the microaerophilic iron

38

00:01:40,870 --> 00:01:38,400

oxidizers

39

00:01:42,069 --> 00:01:40,880

these are proposed to resemble ancient

40

00:01:44,389 --> 00:01:42,079

microbes

41

00:01:45,990 --> 00:01:44,399

that may have contributed to iron

42

00:01:48,710 --> 00:01:46,000

depositions

43

00:01:50,550 --> 00:01:48,720

in the early earth producing some of the

44

00:01:54,469 --> 00:01:50,560

banded iron formations

45

00:01:57,510 --> 00:01:54,479

observed in the geological record

46

00:01:59,190 --> 00:01:57,520

over the last decade this mechanism of

47

00:02:01,190 --> 00:01:59,200

iron oxidation

48

00:02:02,950 --> 00:02:01,200

and the diversity and distribution of

49

00:02:06,830 --> 00:02:02,960

its microbial agents

50

00:02:09,589 --> 00:02:06,840

have gained much interest in research

51
00:02:10,790 --> 00:02:09,599
historically marine iron oxidizing

52
00:02:13,670 --> 00:02:10,800
bacteria

53
00:02:15,830 --> 00:02:13,680
have first been described in iron-rich

54
00:02:21,350 --> 00:02:15,840
shallow hydrothermal systems

55
00:02:27,430 --> 00:02:24,550
shallow sea hydrothermal vents

56
00:02:29,990 --> 00:02:27,440
are hot spots for microbial taxonomic

57
00:02:32,070 --> 00:02:30,000
and metabolic diversity

58
00:02:33,030 --> 00:02:32,080
they are submerged vents just like the

59
00:02:36,150 --> 00:02:33,040
more popular

60
00:02:37,910 --> 00:02:36,160
deep sea hydrothermal vents but because

61
00:02:41,430 --> 00:02:37,920
of the lower pressure

62
00:02:43,830 --> 00:02:41,440
there's high discharge of gas

63
00:02:45,030 --> 00:02:43,840

this process of gas exsolution or

64

00:02:48,309 --> 00:02:45,040

degassing

65

00:02:51,190 --> 00:02:48,319

often leads to acidic fluids and enhance

66

00:02:54,390 --> 00:02:51,200

leaching of metals such as iron and

67

00:02:58,390 --> 00:02:57,030

this characteristic is true for our

68

00:03:01,750 --> 00:02:58,400

study site

69

00:03:03,190 --> 00:03:01,760

which is a 15 meter deep carbon dioxide

70

00:03:05,509 --> 00:03:03,200

gas rich

71

00:03:08,309 --> 00:03:05,519

shallow hydrothermal vent in mabini

72

00:03:11,509 --> 00:03:08,319

batangas philippines

73

00:03:12,550 --> 00:03:11,519

we observed acidic fluids reaching

74

00:03:16,229 --> 00:03:12,560

temperatures

75

00:03:18,309 --> 00:03:16,239

up to 87.5 degrees celsius

76

00:03:19,750 --> 00:03:18,319

we have also observed high iron

77

00:03:22,470 --> 00:03:19,760

concentrations

78

00:03:23,350 --> 00:03:22,480

and low dissolved oxygen ideal

79

00:03:30,830 --> 00:03:23,360

conditions

80

00:03:35,270 --> 00:03:33,030

oxidation

81

00:03:36,309 --> 00:03:35,280

as extension of our marker gene

82

00:03:39,509 --> 00:03:36,319

sequencing

83

00:03:41,190 --> 00:03:39,519

for the survey of microbial diversity we

84

00:03:43,670 --> 00:03:41,200

used an annotation tool

85

00:03:47,110 --> 00:03:43,680

called fabri-tax or functional

86

00:03:49,430 --> 00:03:47,120

annotation of prokaryotic dexa

87

00:03:50,869 --> 00:03:49,440

this is a diagram produced using

88

00:03:53,830 --> 00:03:50,879

co-inertia analysis

89

00:03:54,550 --> 00:03:53,840

that fits two ordination plots together

90

00:03:56,309 --> 00:03:54,560

to

91

00:03:58,470 --> 00:03:56,319

measure correlation between two

92

00:04:00,710 --> 00:03:58,480

variables

93

00:04:03,429 --> 00:04:00,720

what we essentially see is that the

94

00:04:05,589 --> 00:04:03,439

clustering from the functional profiles

95

00:04:08,470 --> 00:04:05,599

fit well with clustering from

96

00:04:11,110 --> 00:04:08,480

geochemical data

97

00:04:13,589 --> 00:04:11,120

vent specific variables represent the

98

00:04:15,589 --> 00:04:13,599

upper and lower left quadrants

99

00:04:17,670 --> 00:04:15,599

along with functions more commonly

100

00:04:20,870 --> 00:04:17,680

observed in extremophiles

101

00:04:23,990 --> 00:04:20,880

such as methanotrophy methylotrophy

102

00:04:26,550 --> 00:04:24,000

and hydrogen oxidation this

103

00:04:27,749 --> 00:04:26,560

also shows that fibrotax can be an

104

00:04:30,870 --> 00:04:27,759

effective tool

105

00:04:33,189 --> 00:04:30,880

in analyzing sequence data sets together

106

00:04:36,310 --> 00:04:33,199

with geochemistry

107

00:04:37,590 --> 00:04:36,320

albeit it is only based on pure culture

108

00:04:39,990 --> 00:04:37,600

studies

109

00:04:41,990 --> 00:04:40,000

with this limitation in mind we show

110

00:04:47,990 --> 00:04:42,000

here that it can be used for data

111

00:04:51,909 --> 00:04:50,469

following our interest in microbial iron

112

00:04:53,790 --> 00:04:51,919

oxidation

113

00:04:54,950 --> 00:04:53,800

we were able to detect zeta

114

00:04:58,550 --> 00:04:54,960

proteobacteria

115

00:05:00,629 --> 00:04:58,560

in all of our vent samples this novel

116

00:05:03,029 --> 00:05:00,639

class of proteobacteria

117

00:05:03,749 --> 00:05:03,039

that are known for microbial iron

118

00:05:08,390 --> 00:05:03,759

oxidation

119

00:05:12,550 --> 00:05:11,150

to recap we were able to detect zeta

120

00:05:14,710 --> 00:05:12,560

proteobacteria

121

00:05:17,749 --> 00:05:14,720

in the same samples where we've detected

122

00:05:19,909 --> 00:05:17,759

a wide range of predicted metabolism

123

00:05:21,590 --> 00:05:19,919

including those typical in other extreme

124

00:05:23,590 --> 00:05:21,600

environments

125

00:05:26,550 --> 00:05:23,600

we were then curious of the potential

126
00:05:27,029 --> 00:05:26,560
role of zeta proteobacteria in our vet

127
00:05:34,870 --> 00:05:27,039
mats

128
00:05:36,950 --> 00:05:34,880
no cellulose

129
00:05:38,469 --> 00:05:36,960
and scattered individual cells within

130
00:05:42,070 --> 00:05:38,479
the mat matrix

131
00:05:44,150 --> 00:05:42,080
as visualized in our clsm images

132
00:05:45,670 --> 00:05:44,160
this characteristic along with the

133
00:05:47,430 --> 00:05:45,680
filamentous structure

134
00:05:49,749 --> 00:05:47,440
that were not affected by either

135
00:05:52,469 --> 00:05:49,759
cellulose or dna strain

136
00:05:55,270 --> 00:05:52,479
is consisted with microscopic images of

137
00:05:58,430 --> 00:05:55,280
math forming iron oxide stocks

138
00:06:00,390 --> 00:05:58,440

of microbial iron oxidizers like zeta

139

00:06:02,390 --> 00:06:00,400

proteobacteria

140

00:06:04,550 --> 00:06:02,400

these stocks or filaments have been

141

00:06:07,990 --> 00:06:04,560

described to take advantage

142

00:06:13,350 --> 00:06:08,000

of maintained microaerophilic conditions

143

00:06:17,110 --> 00:06:15,430

we also had the opportunity to look

144

00:06:19,749 --> 00:06:17,120

further into our 16s

145

00:06:20,870 --> 00:06:19,759

gene markers against data using zeta

146

00:06:23,430 --> 00:06:20,880

hunter

147

00:06:25,670 --> 00:06:23,440

a tool that allows us to resolve zeta

148

00:06:27,510 --> 00:06:25,680

protobacteria in our samples

149

00:06:29,110 --> 00:06:27,520

to set out to use from a curated

150

00:06:31,670 --> 00:06:29,120

database

151
00:06:32,150 --> 00:06:31,680
from this we detected zeta audios that

152
00:06:34,830 --> 00:06:32,160
match

153
00:06:37,350 --> 00:06:34,840
six previously described data

154
00:06:40,550 --> 00:06:37,360
proteobacterial odus

155
00:06:44,790 --> 00:06:40,560
namely zeta otu 1 3

156
00:06:46,469 --> 00:06:44,800
4 21 36 and 59

157
00:06:48,150 --> 00:06:46,479
two of these have cultural

158
00:06:51,909 --> 00:06:48,160
representatives described

159
00:06:54,469 --> 00:06:51,919
in other studies zeta audio 3

160
00:06:56,390 --> 00:06:54,479
represented by two strains isolated from

161
00:06:59,270 --> 00:06:56,400
low iron sediments

162
00:07:00,830 --> 00:06:59,280
and zeta odu36 represented by the

163
00:07:05,430 --> 00:07:00,840

maripofunda strain

164

00:07:09,589 --> 00:07:05,440

ekf m39 isolated from the luigi

165

00:07:13,990 --> 00:07:12,390

obtaining these data otu abundances also

166

00:07:17,510 --> 00:07:14,000

allowed us to analyze zeta

167

00:07:19,670 --> 00:07:17,520

proteobacteria with our geochemical data

168

00:07:20,870 --> 00:07:19,680

by fitting the ordination of these two

169

00:07:23,189 --> 00:07:20,880

datasets

170

00:07:25,749 --> 00:07:23,199

we see clustering event samples to the

171

00:07:27,749 --> 00:07:25,759

upper and lower left quadrants

172

00:07:29,189 --> 00:07:27,759

represented by both fence specific

173

00:07:32,230 --> 00:07:29,199

variables which is high

174

00:07:35,510 --> 00:07:32,240

iron arsenic and organic carbon

175

00:07:39,350 --> 00:07:37,670

from our data we would like to highlight

176

00:07:43,110 --> 00:07:39,360

the potential for discovering

177

00:07:45,510 --> 00:07:43,120

new zeta proteobacteria taxa moreover

178

00:07:47,589 --> 00:07:45,520

how their abundance strongly coincides

179

00:07:49,909 --> 00:07:47,599

with our geochemical data

180

00:07:51,909 --> 00:07:49,919

might inform future hypotheses on the

181

00:07:53,909 --> 00:07:51,919

drivers of the diversity

182

00:07:55,110 --> 00:07:53,919

distribution and biogeochemical

183

00:07:57,350 --> 00:07:55,120

importance

184

00:07:58,390 --> 00:07:57,360

of microbial iron oxidizers from the

185

00:08:03,909 --> 00:07:58,400

earth's

186

00:08:07,110 --> 00:08:05,830

to share the future direction of our

187

00:08:09,430 --> 00:08:07,120

research

188

00:08:11,029 --> 00:08:09,440

here is some data on fatty acids from

189

00:08:11,990 --> 00:08:11,039

the viable components of our

190

00:08:15,110 --> 00:08:12,000

rust-colored matte

191

00:08:17,749 --> 00:08:15,120

samples the lengths are more typically

192

00:08:20,390 --> 00:08:17,759

observed in bacteria and literature

193

00:08:22,710 --> 00:08:20,400

and a certain compound monounsaturated

194

00:08:24,629 --> 00:08:22,720

20 carbon fatty acid

195

00:08:28,309 --> 00:08:24,639

is more often seen in hydrothermal

196

00:08:30,790 --> 00:08:28,319

microbial streamers than algal mats

197

00:08:33,350 --> 00:08:30,800

few literature data are available in the

198

00:08:34,870 --> 00:08:33,360

fatty acid composition of biogenic iron

199

00:08:38,070 --> 00:08:34,880

oxide mats

200

00:08:40,230 --> 00:08:38,080

and in zeta proteobacteria cultures

201
00:08:43,269 --> 00:08:40,240
we anticipate that our data will be

202
00:08:46,150 --> 00:08:43,279
useful in tandem with our future efforts

203
00:08:48,230 --> 00:08:46,160
in isolating and characterizing iron

204
00:08:53,750 --> 00:08:48,240
oxidizers and other microbes

205
00:08:56,870 --> 00:08:56,150
this presentation is part of a bigger

206
00:08:59,670 --> 00:08:56,880
paper

207
00:09:02,070 --> 00:08:59,680
on the microbiome and biogeochemistry of

208
00:09:03,990 --> 00:09:02,080
the mabini shallow hydrothermal vent

209
00:09:05,509 --> 00:09:04,000
that we have since submitted and is

210
00:09:11,910 --> 00:09:05,519
currently being

211
00:09:16,630 --> 00:09:14,230
this research would not be possible with

212
00:09:19,750 --> 00:09:16,640
the help of the following individuals

213
00:09:21,829 --> 00:09:19,760

and organizations we think planet dive

214

00:09:25,030 --> 00:09:21,839

resort of mabini

215

00:09:26,310 --> 00:09:25,040

for their assistance we also thank jason

216

00:09:28,870 --> 00:09:26,320

valaibo

217

00:09:30,070 --> 00:09:28,880

chica domingo for joining us in sample

218

00:09:32,949 --> 00:09:30,080

and data collection

219

00:09:36,150 --> 00:09:32,959

via scuba diving thermo fisher

220

00:09:39,190 --> 00:09:36,160

scientific and brownson asia's tech for

221

00:09:41,110 --> 00:09:39,200

technical and logistic assistance

222

00:09:43,590 --> 00:09:41,120

and this research was supported by the

223

00:09:45,590 --> 00:09:43,600

department of science and technology

224

00:09:47,990 --> 00:09:45,600

university of the philippines and chad