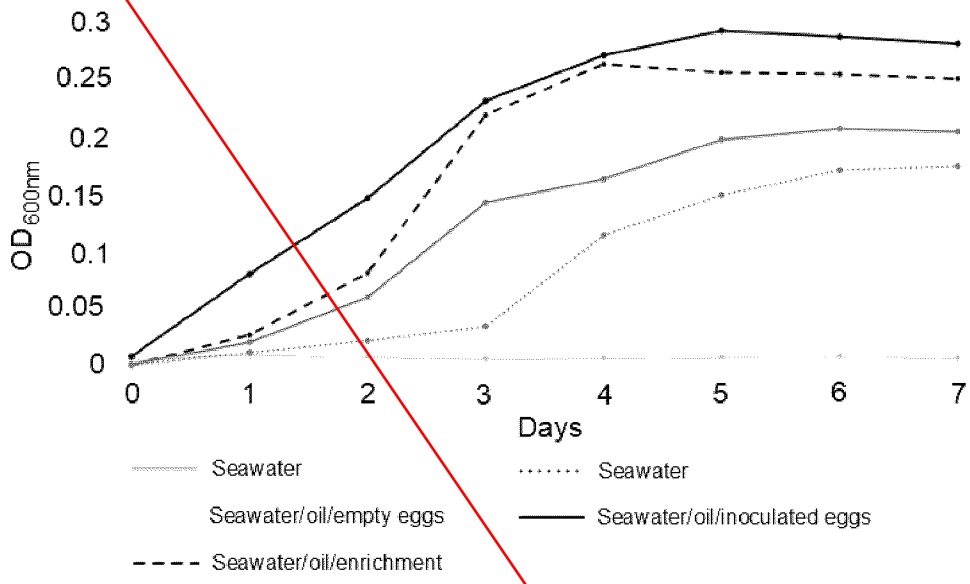

0.3
0.25
0.2
0.15
0.1
0.05
0
OD600nm
0
1
2
3
4
5
6
7
Days
Seawater
Seawater
Seawater/oil/empty eggs
Seawater/oil/inoculated eggs
Seawater/oil/enrichment

FIG. 1

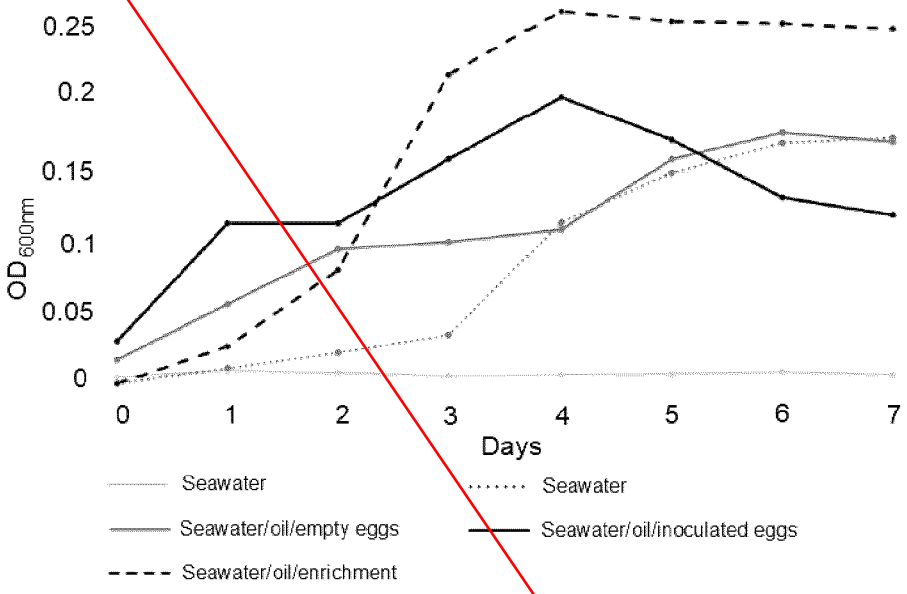

0.25
0.2
0.15
0.1
0.05
0
OD600nm
0
1
2
3
4
5
6
7
Days
Seawater
Seawater
Seawater/oil/empty eggs
Seawater/oil/inoculated eggs
Seawater/oil/enrichment

FIG. 2

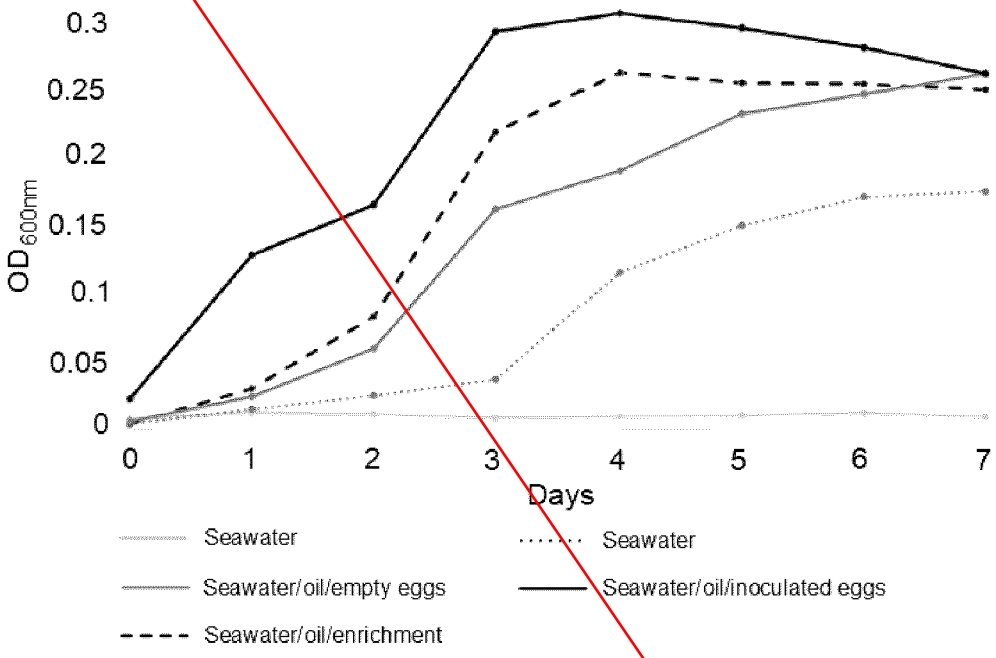

0.3
0.25
0.2
0.15
0.1
0.05
0
OD600nm
0
1
2
3
4
5
6
7
Days
Seawater
Seawater
Seawater/oil/empty eggs
Seawater/oil/inoculated eggs
Seawater/oil/enrichment

FIG. 3

FIG. 4A

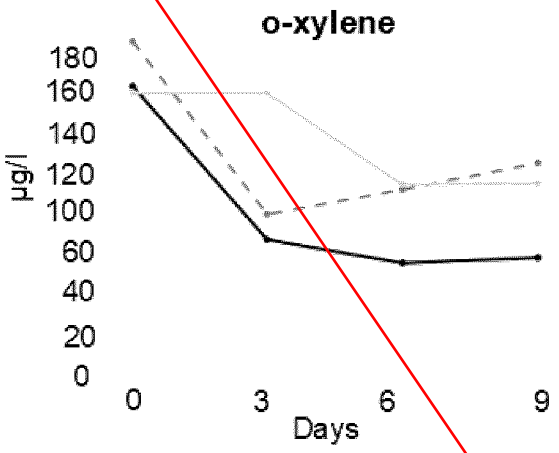


FIG. 4B

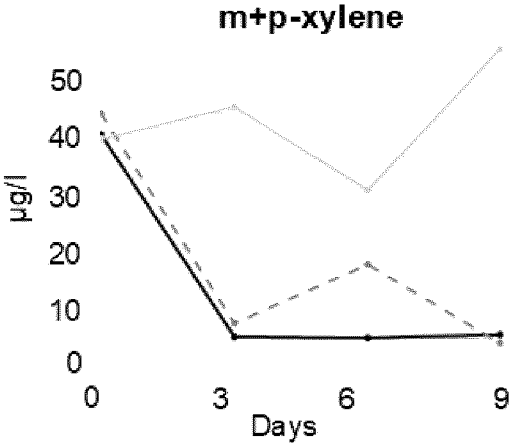


FIG. 4C

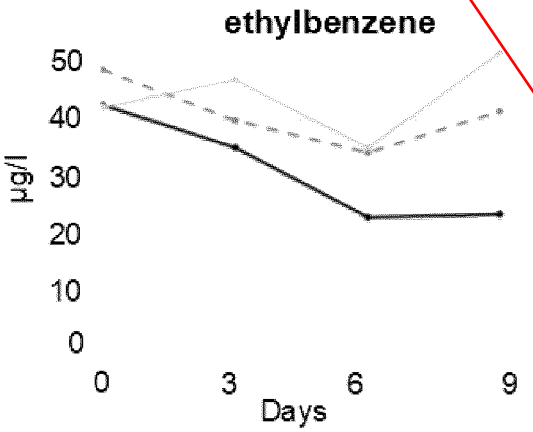


FIG. 4D

	Enriched Copepod carcass	Enriched seawater
Ethylbenzene	-55%	-20%
m+p+xylene	-88%	-91%
o-xylene	-40%	10%

Reduction of non acute toxic compounds compared to natural degradation

Seawater

Seawater/oil/inoculated eggs

Seawater/oil/enrichment

FIG. 4

FIG. 5A

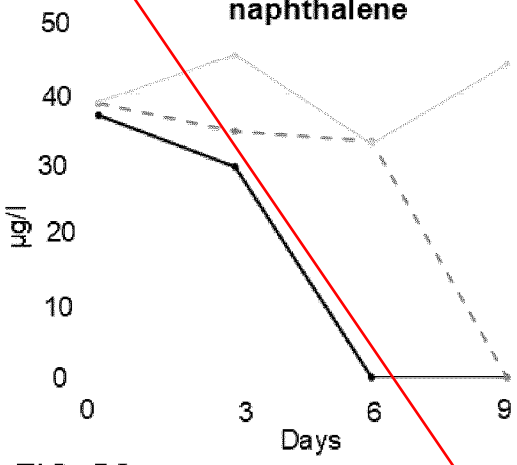


FIG. 5B

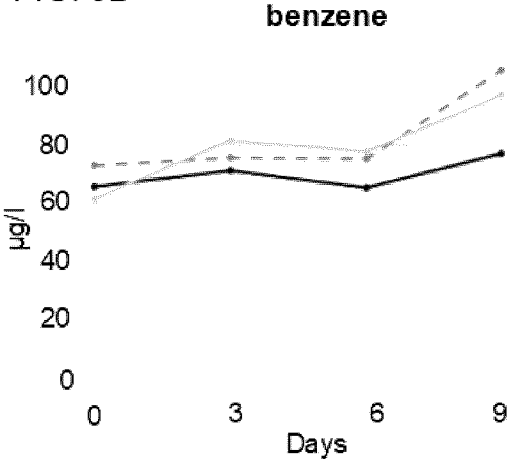


FIG. 5C

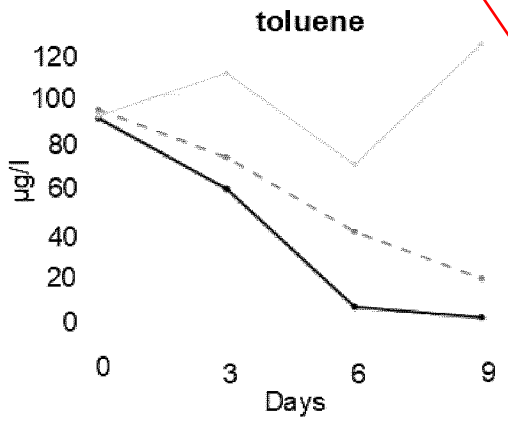


FIG. 5D

	Enriched Copepod carcass	Enriched seawater
Naphthalene	Not detectable	Not detectable
Toluene	-99.4%	-85%
Benzene	-21%	9%

Reduction of highly toxic compounds compared to natural degradation

Seawater

Seawater/oil/inoculated eggs

Seawater/oil/enrichment

FIG. 5

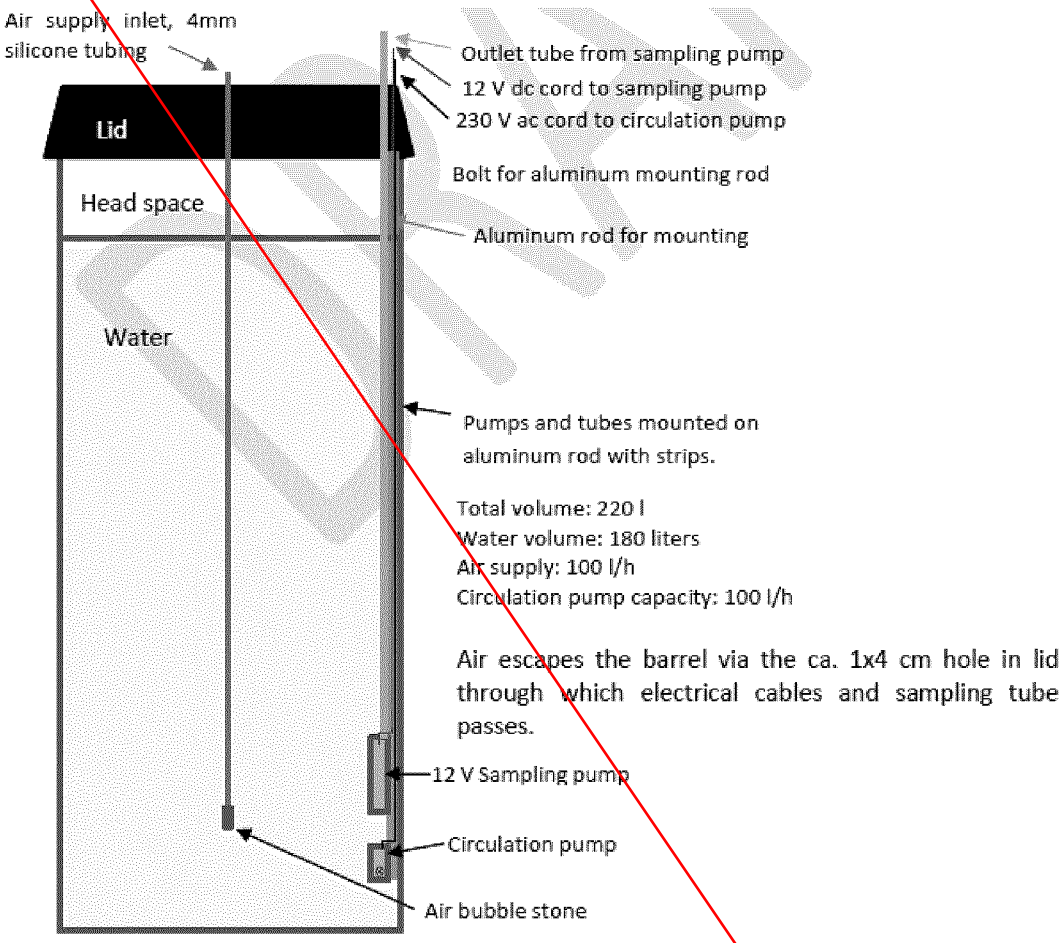

Air supply inlet, 4mm silicone tubing
Lid
Head space
Water
Outlet tube from sampling pump
12 V dc cord to sampling pump
230 V ac cord to circulation pump
Bolt for aluminum mounting rod
Aluminum rod for mounting
Pumps and tubes mounted on aluminum rod with strips.
Total volume: 220 l
Water volume: 180 liters
Air supply: 100 l/h
Circulation pump capacity: 100 l/h
Air escapes the barrel via the ca. 1x4 cm hole in lid through which electrical cables and sampling tube passes.
12 V Sampling pump
Circulation pump
Air bubble stone

FIG. 6

FIG. 7A pH

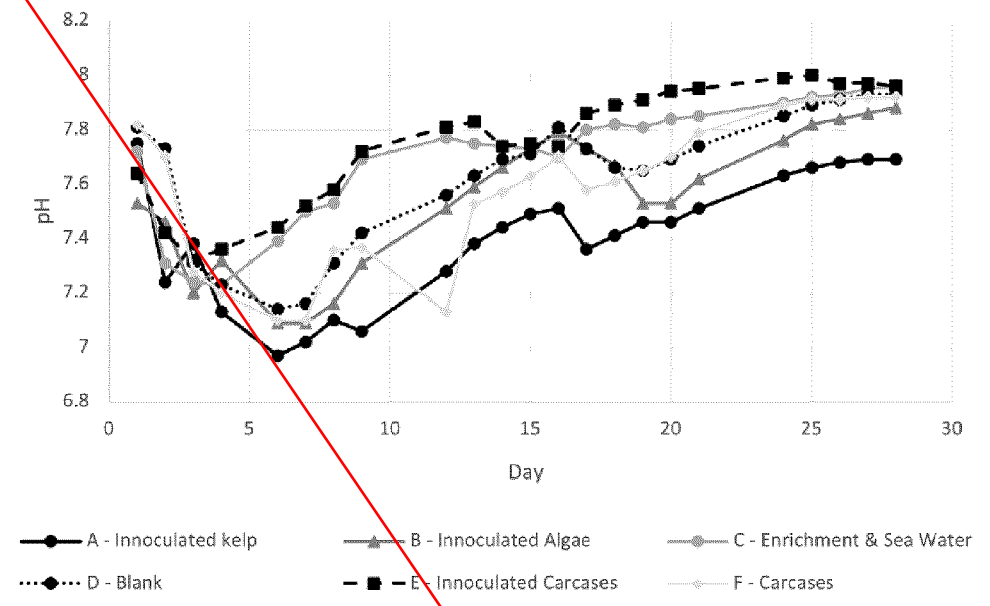


FIG. 7B ORP

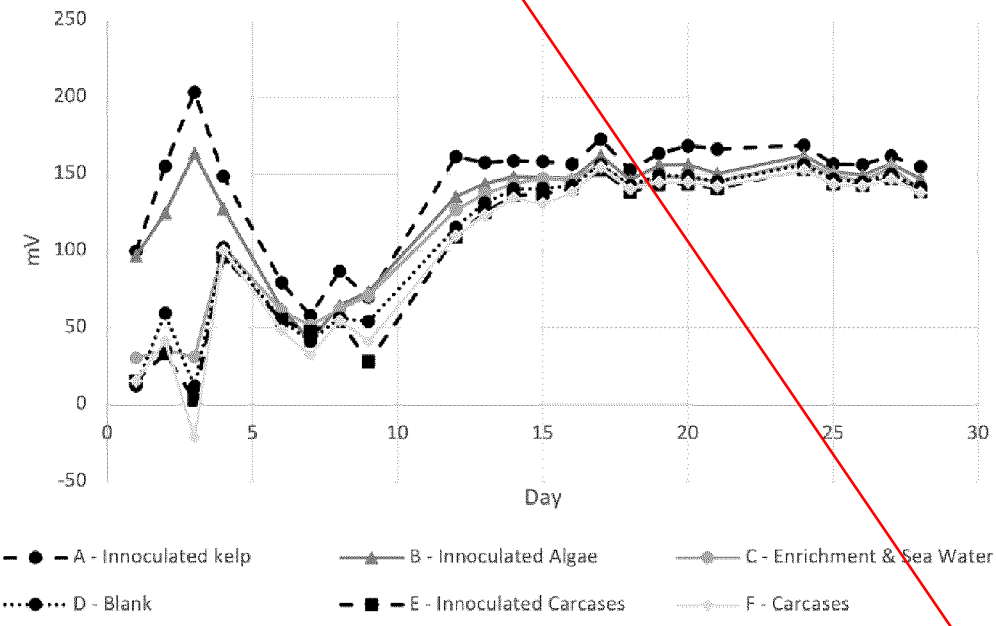


FIG. 7

FIG. 8A Turbidity

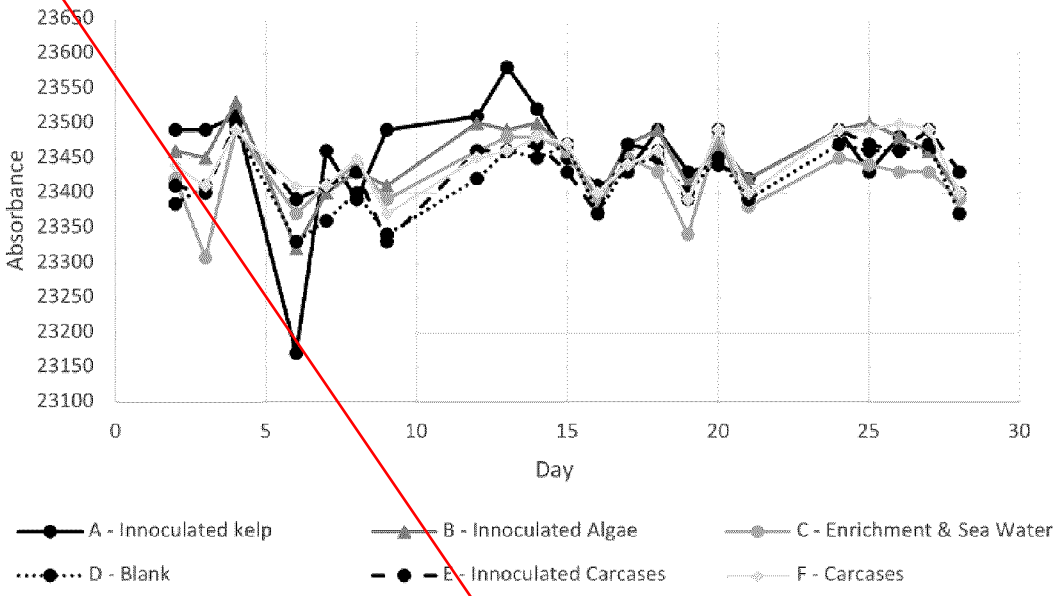


FIG. 8B Optical Density

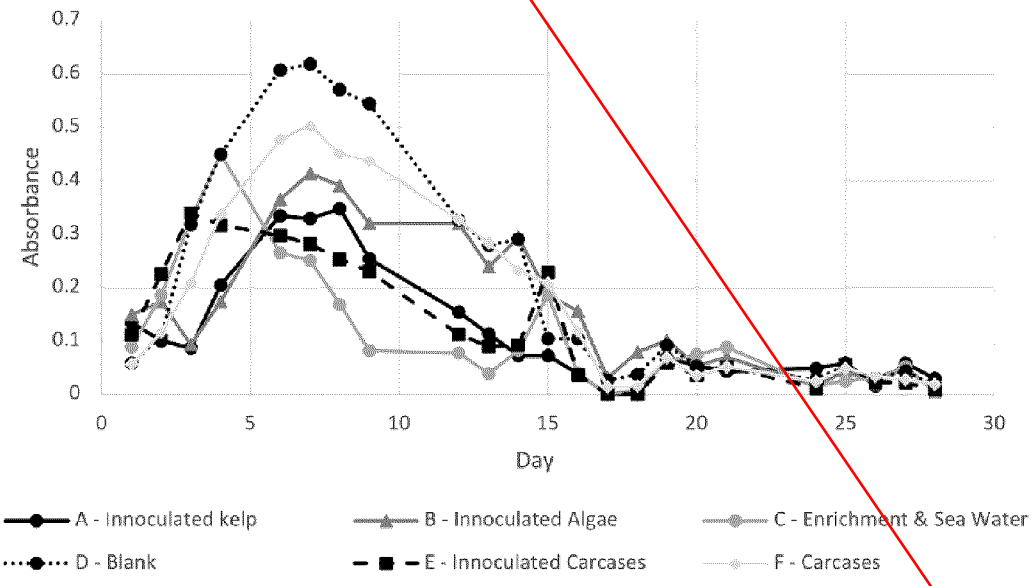


FIG. 8

FIG. 9A: Inoculated kelp

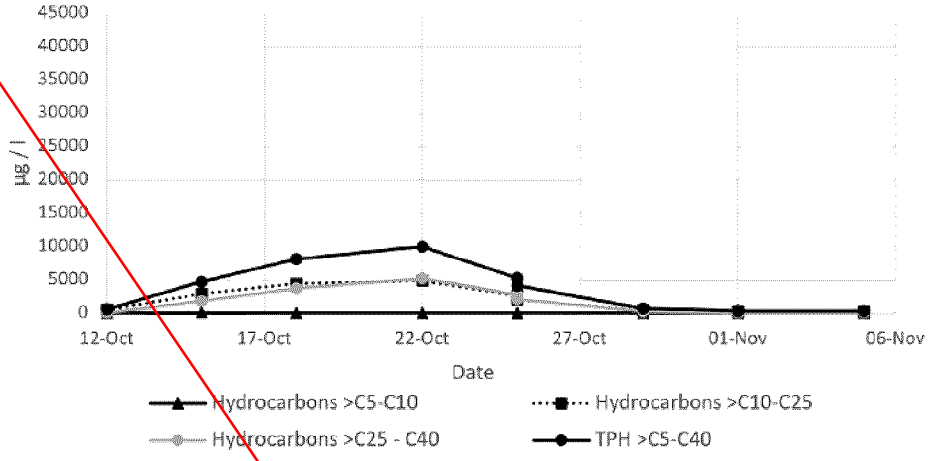


FIG. 9B: Inoculated algae

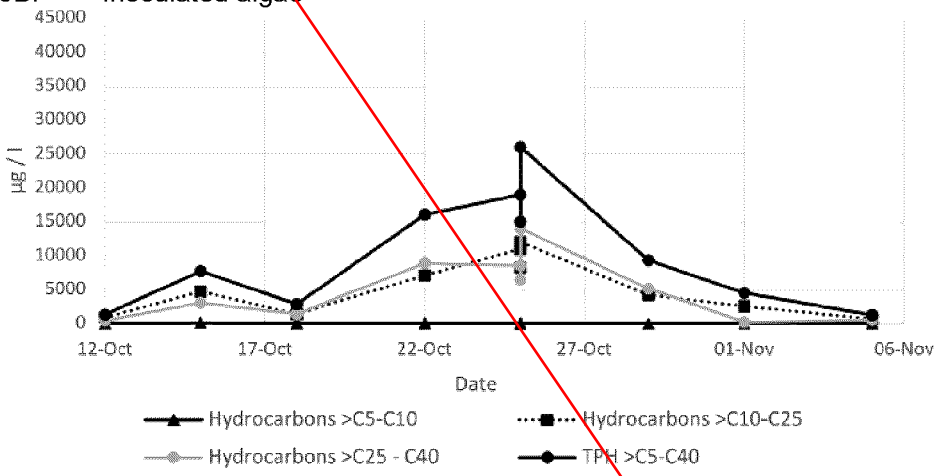


FIG. 9C: Enrichment & seawater

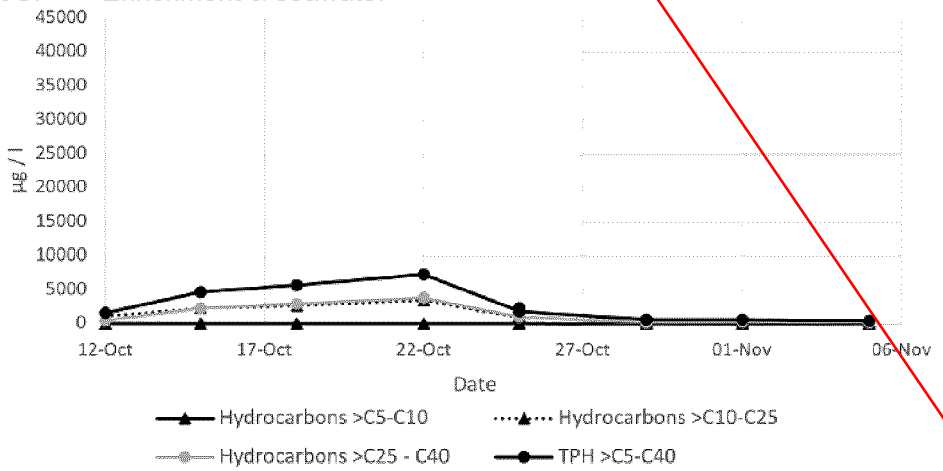


FIG. 9D: Control

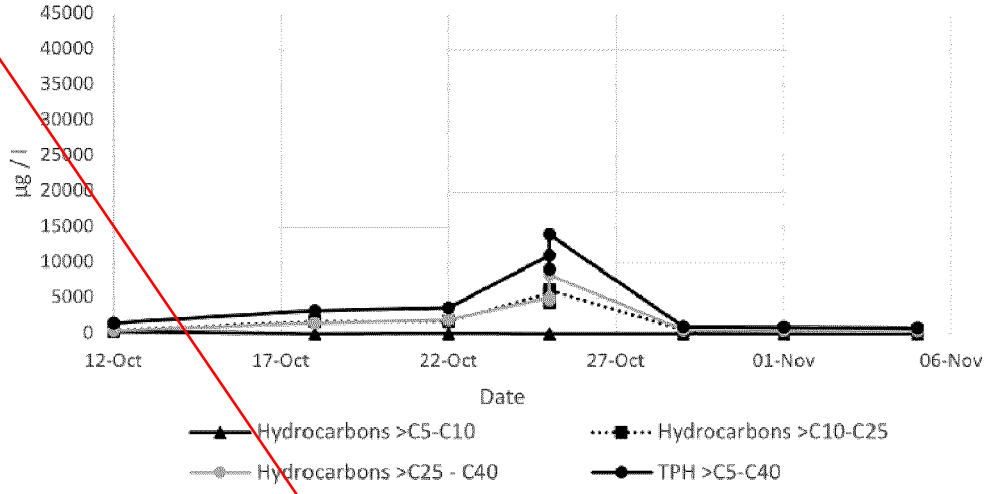


FIG. 9E: Inoculated copepod carcasses

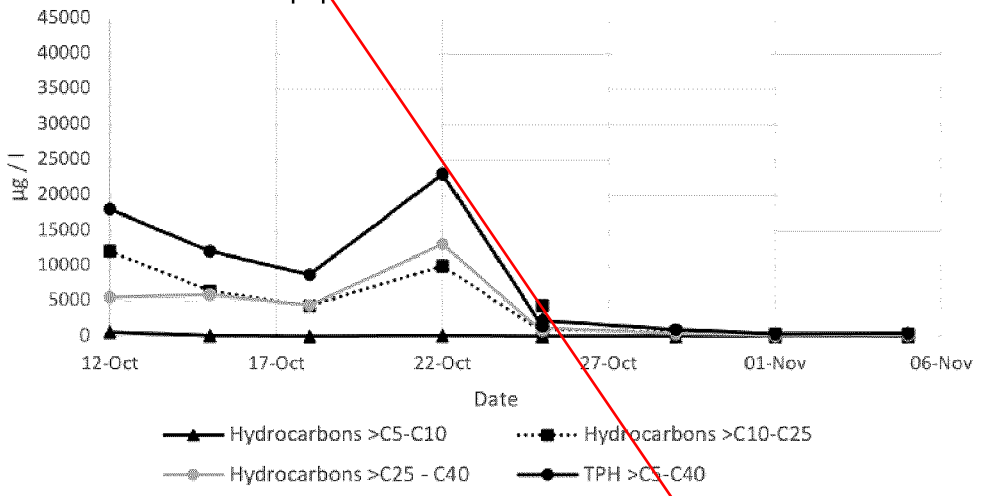
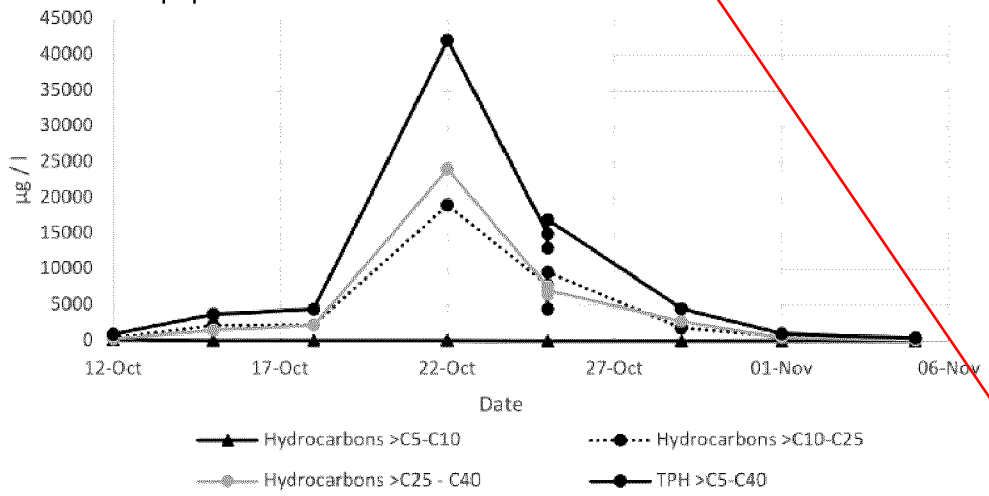


FIG. 9F: Copepod carcasses



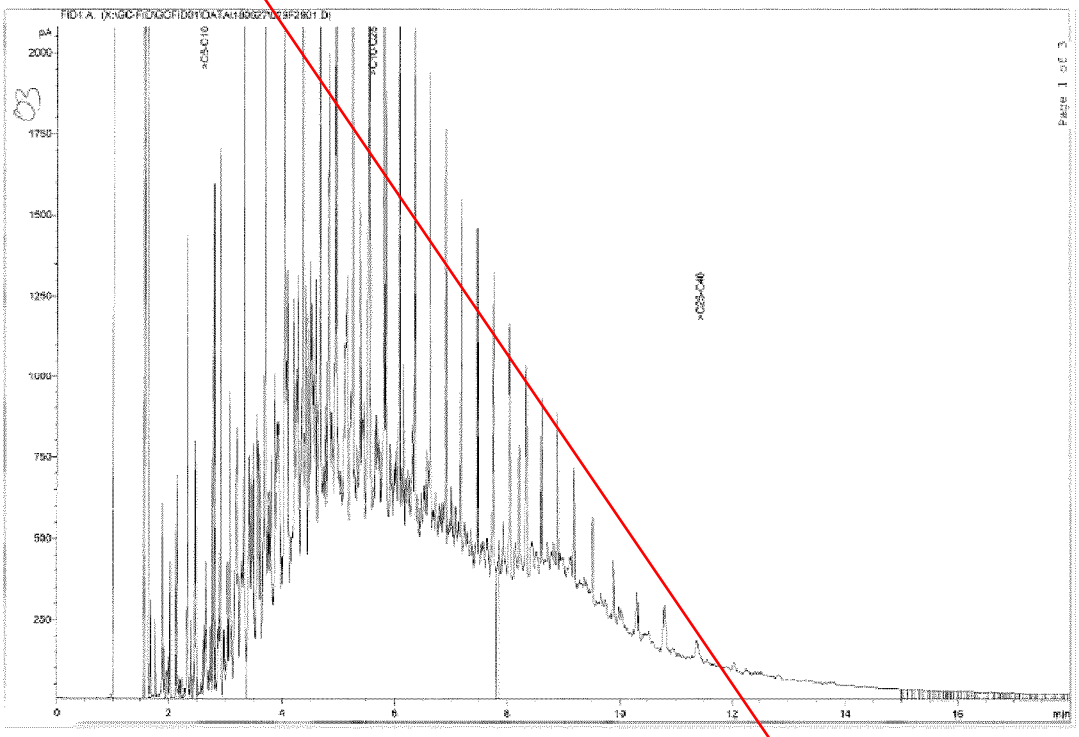

pA
2000
1750
1500
1250
1000
750
500
250
0
2
4
6
8
10
12
14
16
min
Page 1 of 3

FIG. 10

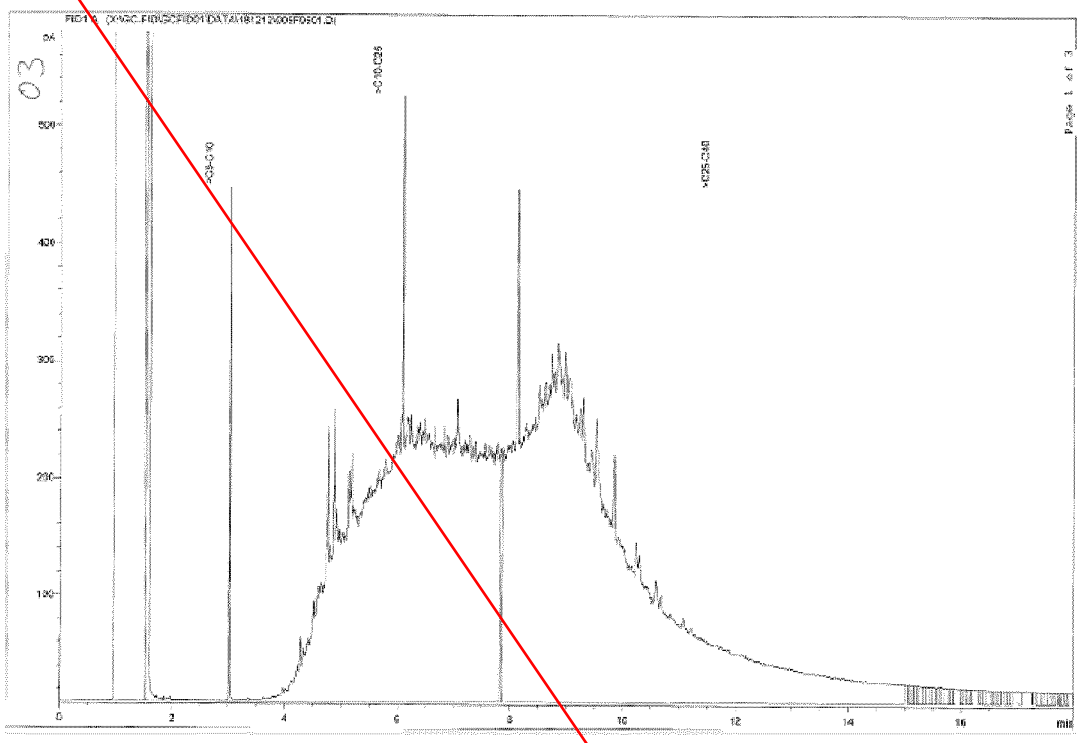


FIG. 11

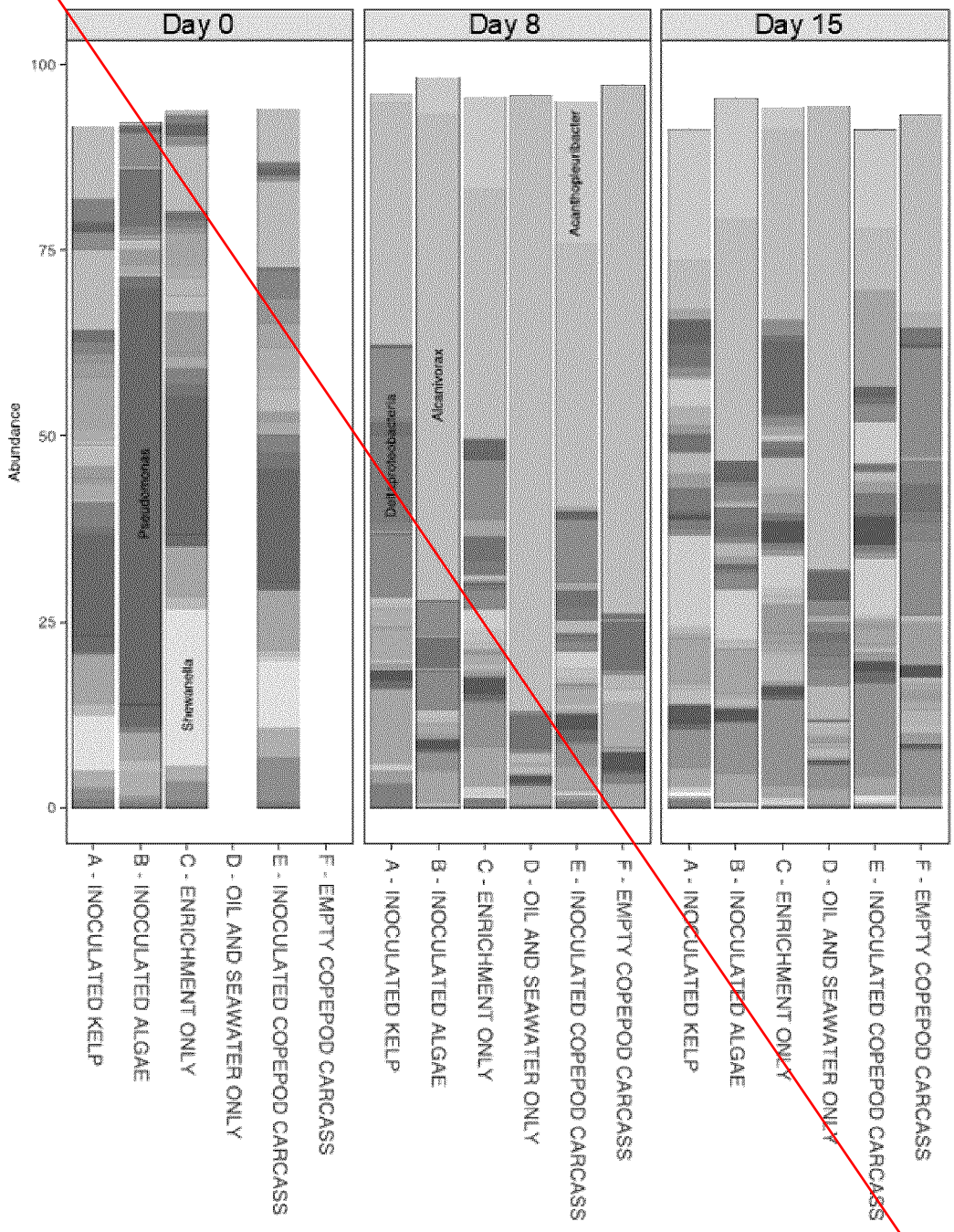

Day 0
Day 8
Day 15
Abundance
100
75
50
25
0
Pseudomonas
Shewanella
Deltaproteobacteria
Alcanivorax
Acanthopleuribacter
A - INOCULATED KELP
B - INOCULATED ALGAE
C - ENRICHMENT ONLY
D - OIL AND SEAWATER ONLY
E - INOCULATED COPEPOD CARCASS
F - EMPTY COPEPOD CARCASS

FIG. 12A

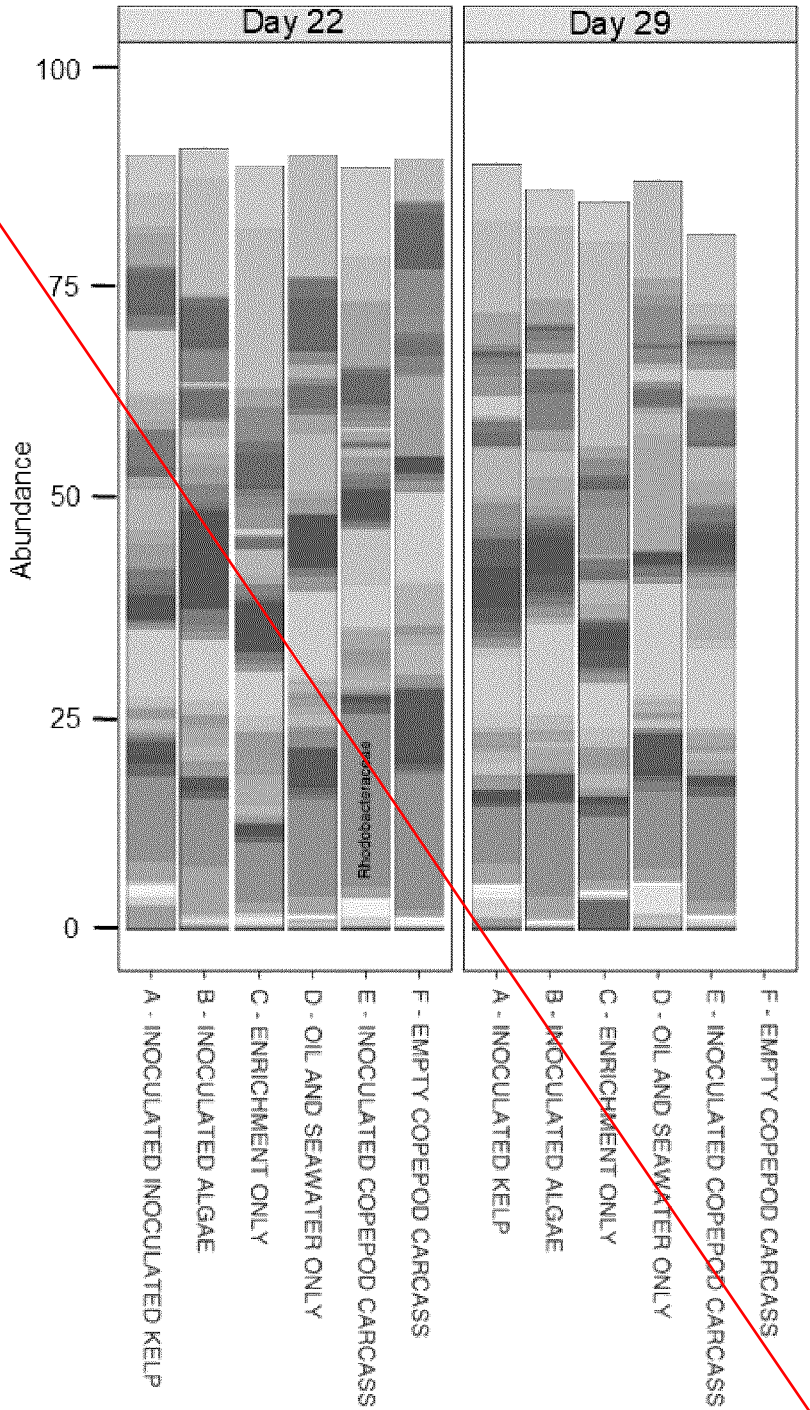

Day 22
Day 29
100
75
50
25
0
Abundance
Mycobacteriaceae
A - INOCULATED INOCULATED KELP
B - INOCULATED ALGAE
C - ENRICHMENT ONLY
D - OIL AND SEAWATER ONLY
E - INOCULATED COPEPOD CARCASS
F - EMPTY COPEPOD CARCASS
A - INOCULATED KELP
B - INOCULATED ALGAE
C - ENRICHMENT ONLY
D - OIL AND SEAWATER ONLY
E - INOCULATED COPEPOD CARCASS
F - EMPTY COPEPOD CARCASS

FIG. 12B


Acanthopleuribacter_ASV370
Alcanivorax_ASV1242
Alphaproteobacteria_ASV1415
Alphaproteobacteria_ASV1537
Alphaproteobacteria_ASV1642
Alphaproteobacteria_ASV1647
Alteromonadaceae_ASV824
Alteromonadaceae_ASV830
Alteromonadales_ASV1223
Arenibacter_ASV174
Bacteria_ASV688
BD7-11_ASV381
C1-B045_ASV894
Caldilineaceae_ASV695
Cellvibrionaceae_ASV886
Cerasicoccus_ASV287
Cerasicoccus_ASV288
Chitinophagaceae_ASV248
Chlamydiales_ASV701
Cobetia_ASV1102
Coxiella_ASV870
Criblamydiaceae_ASV706
Cryomorphaceae bacterium IMCC2672_ASV38
Cryomorphaceae_ASV209
Cryomorphaceae_ASV37
Cryomorphaceae_ASV41
Cycloclasticus_ASV890
Deltaproteobacteria_ASV773
Flavobacteriaceae_ASV118
Flavobacteriaceae_ASV125
Flavobacteriaceae_ASV165
Flavobacteriaceae_ASV190
Flavobacteriaceae_ASV75
Flavobacteriaceae_ASV81
Flavobacteriaceae_ASV92
Flavobacterium_ASV139
Francisella_ASV878
Francisellaceae_ASV875
Gammaproteobacteria_ASV1024
Gammaproteobacteria_ASV1031
Gammaproteobacteria_ASV1046
Gammaproteobacteria_ASV1050
Gammaproteobacteria_ASV1108
Gammaproteobacteria_ASV1119
Gammaproteobacteria_ASV1274
Gammaproteobacteria_ASV1277
Gammaproteobacteria_ASV1279
Gammaproteobacteria_ASV849
Gammaproteobacteria_ASV865
Gammaproteobacteria_ASV951
Gammaproteobacteria_ASV959
Gammaproteobacteria_ASV983
Gimesia_ASV503
Halieaceae_ASV1178
Halobacteriovorax_ASV782
Hyphomonadaceae_ASV1502
Idiomarina_ASV1066
JGI 0000069-P22_ASV325
Kordiimonas_ASV1541
Legionella sp. LHG-1BW4_ASV1001
Marinobacter_ASV943
Marinobacterium_ASV1260
Methylophagaceae_ASV1304
Micavibrionales_ASV1355
Muricauda_ASV187
Neptuniibacter_ASV1257
NS9 marine group_ASV53
Oleispira_ASV956
Parvibaculum_ASV1547
Phycisphaeraceae_ASV417
Planctomycetales_ASV507
planctomycete DDSW1318_ASV492
Pseudohongiella_ASV1115
Pseudohongiella_ASV1202
Pseudomonas_ASV917
Pseudomonas_ASV919
Pseudomonas_ASV921
Puniceispirillales_ASV1438
Rhodobacteraceae_ASV1587
Rhodobacteraceae_ASV1602
Rhodobacteraceae_ASV1747
Rhodobacteraceae_ASV1754
Rhodobacteraceae_ASV1760
Rhodobacteraceae_ASV1767
Saccharospirillaceae_ASV1091
Shewanella_ASV1219
Sneathiella_ASV1521
SS1-B-02-17_ASV338
SS1-B-02-17_ASV340
Sulfurimonas_ASV802
Terasakiellaceae_ASV1406
Thalassospira_ASV1713
Vibrio_ASV1211
Vitellibacter_ASV159
Winogradskyella_ASV103
Zhongshania_ASV1294

FIG. 12C

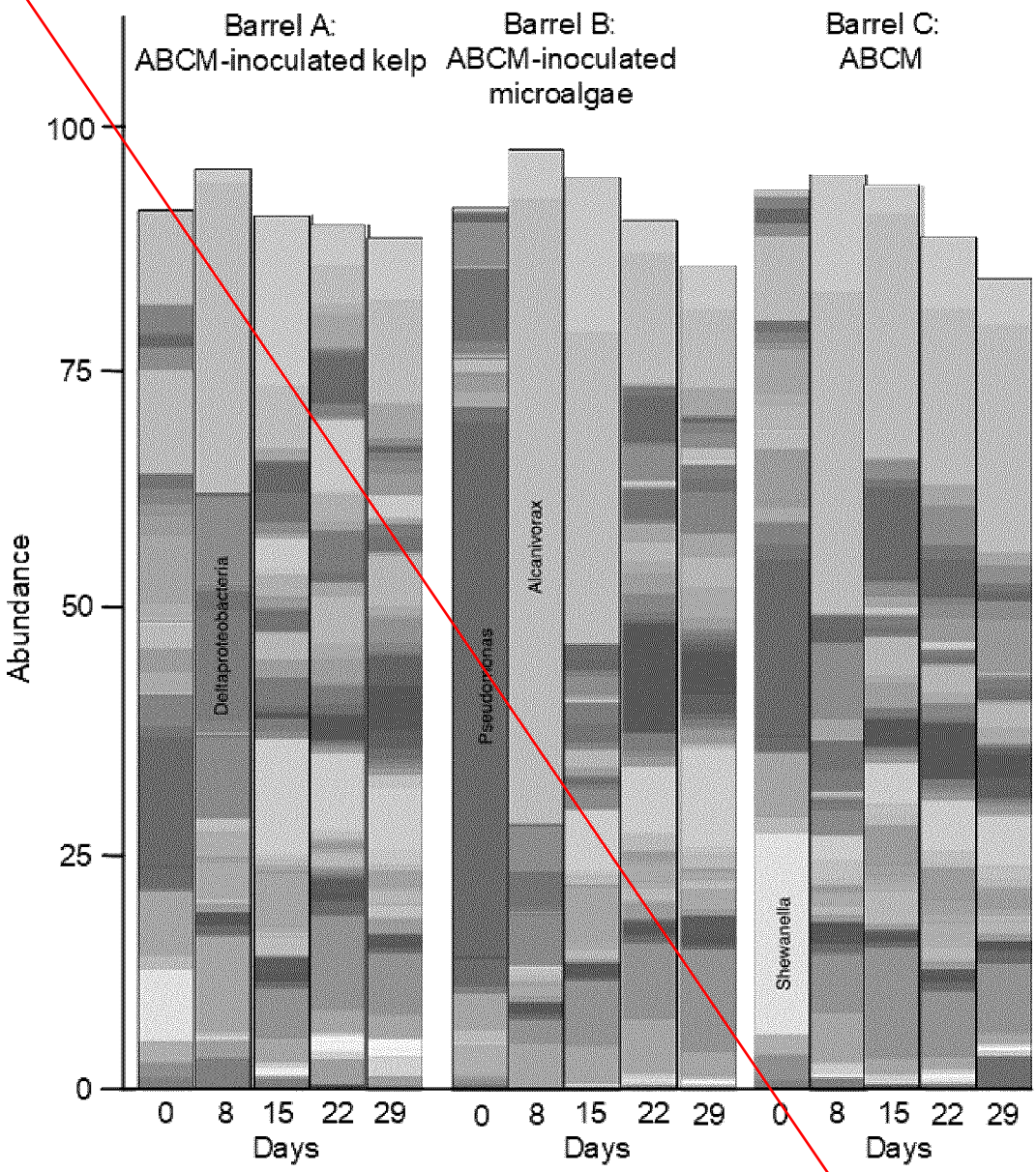

Barrel A:
ABCM-inoculated kelp
Barrel B:
ABCM-inoculated
microalgae
Barrel C:
ABCM
Abundance
100
75
50
25
0
Deltaproteobacteria
Pseudomonas
Alcanivorax
Shewanella
0 8 15 22 29
Days
0 8 15 22 29
Days
0 8 15 22 29
Days

FIG. 13A

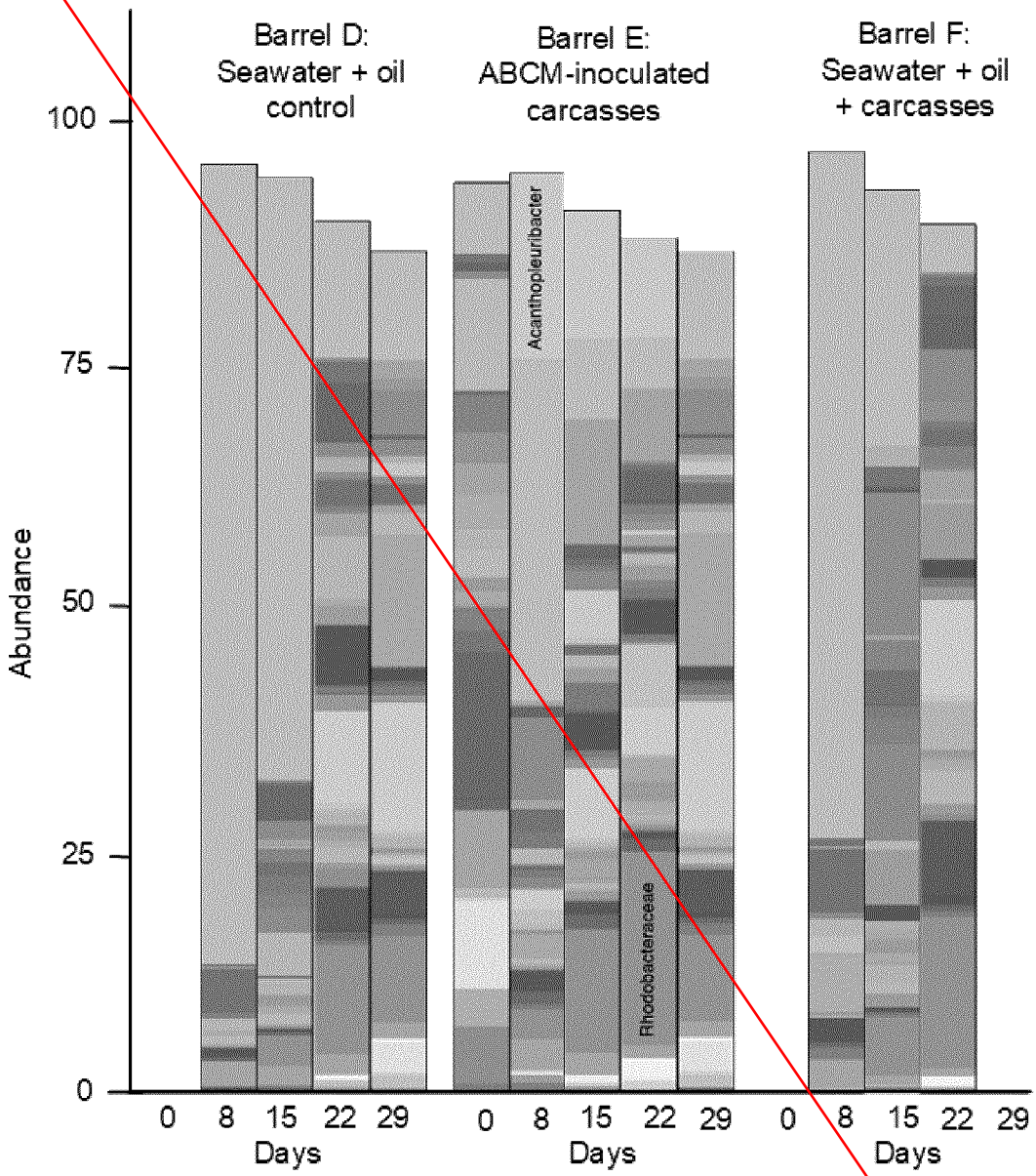

Barrel D:
Seawater + oil
control
Barrel E:
ABCM-inoculated
carcasses
Barrel F:
Seawater + oil
+ carcasses
Abundance
100
75
50
25
0
Acanthopleuribacter
Rhodobacteraceae
0 8 15 22 29
Days
0 8 15 22 29
Days
0 8 15 22 29
Days

FIG. 13B

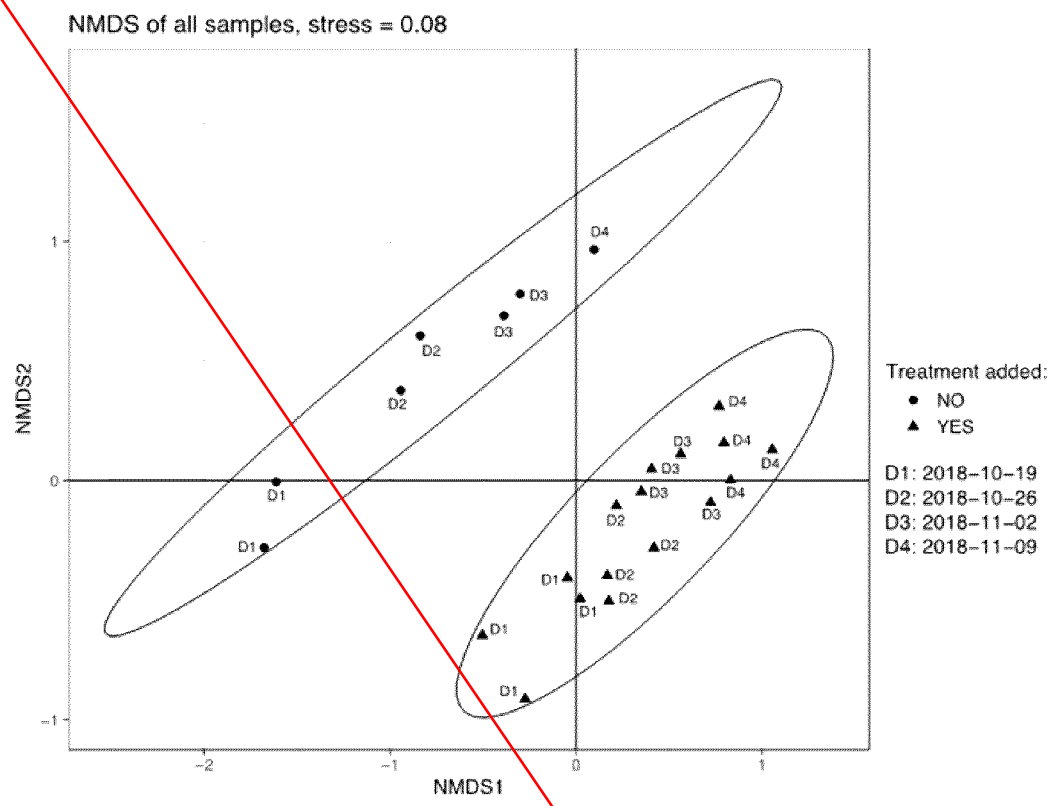

NMDS of all samples, stress = 0.08
NMDS2
NMDS1
1
0
−1
−2
−1
0
1
Treatment added:
NO
YES
D1: 2018−10−19
D2: 2018−10−26
D3: 2018−11−02
D4: 2018−11−09

FIG. 14

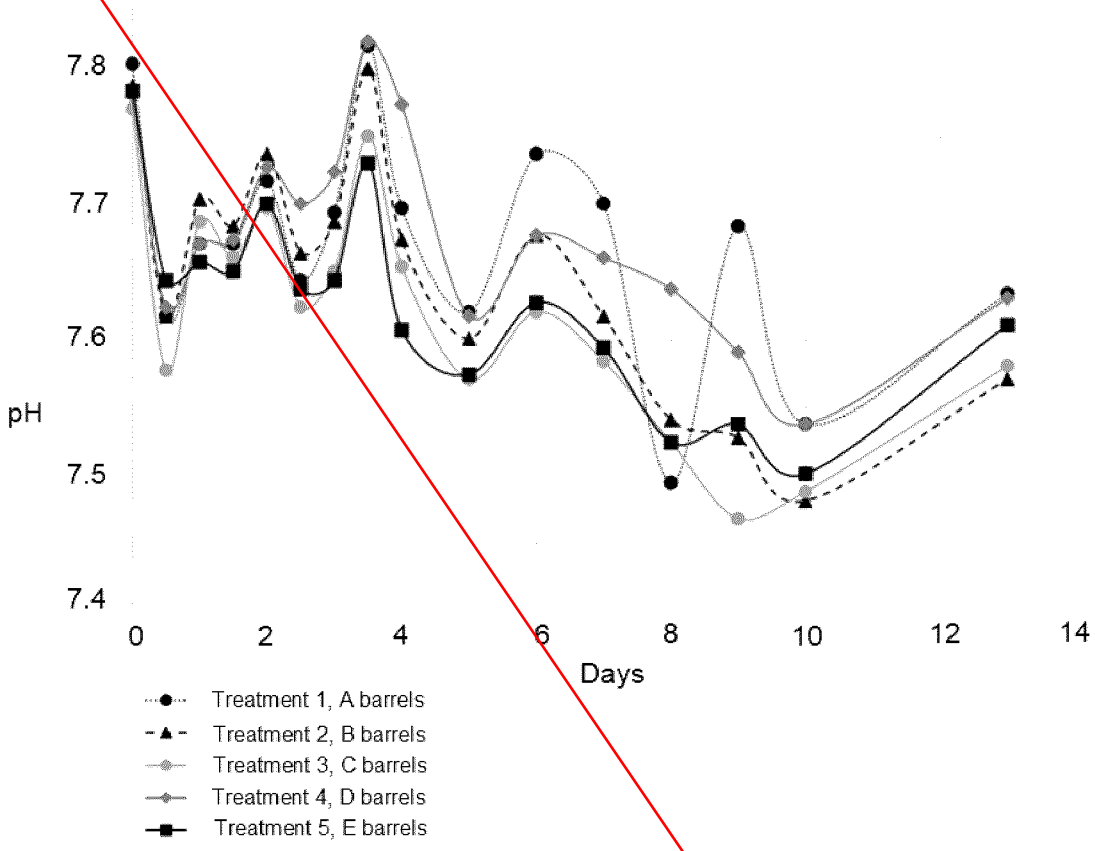

7.8
7.7
7.6
7.5
7.4
pH
0
2
4
6
8
10
12
14
Days
Treatment 1, A barrels
Treatment 2, B barrels
Treatment 3, C barrels
Treatment 4, D barrels
Treatment 5, E barrels

FIG. 15

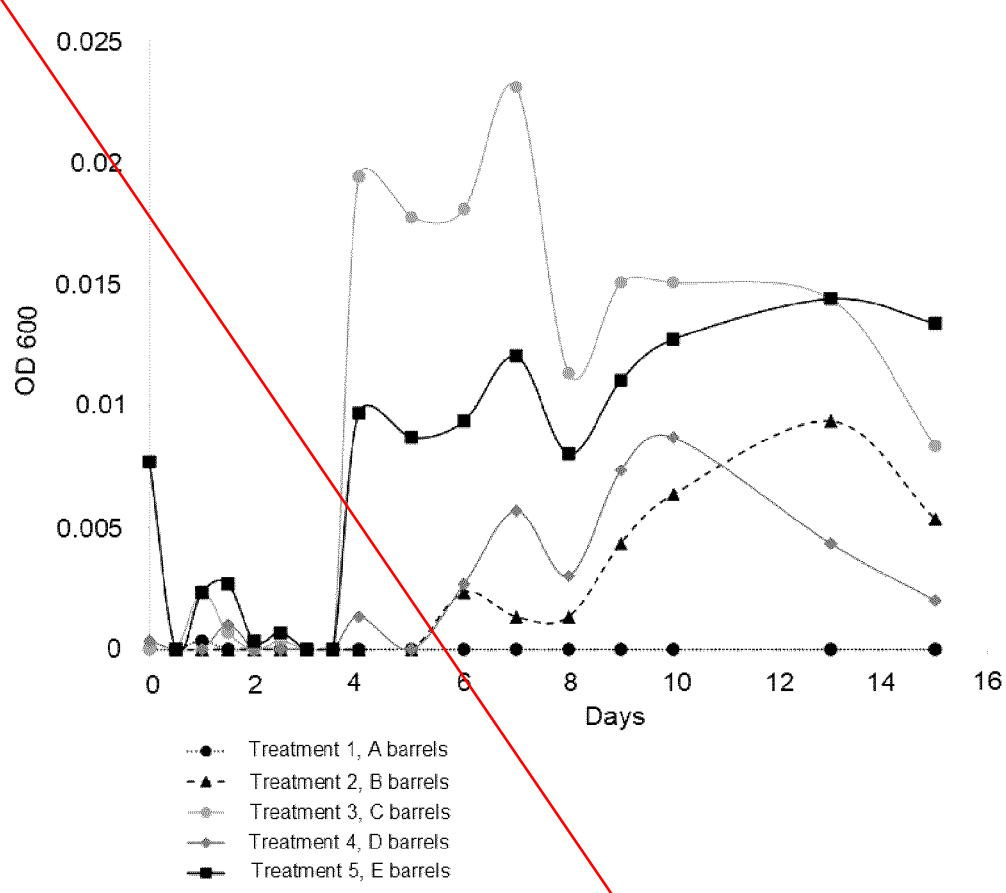

0.025
0.02
0.015
0.01
0.005
0
OD 600
0
2
4
6
8
10
12
14
16
Days
Treatment 1, A barrels
Treatment 2, B barrels
Treatment 3, C barrels
Treatment 4, D barrels
Treatment 5, E barrels

FIG. 16

FIG. 17A Biodegradation in barrel B2-1

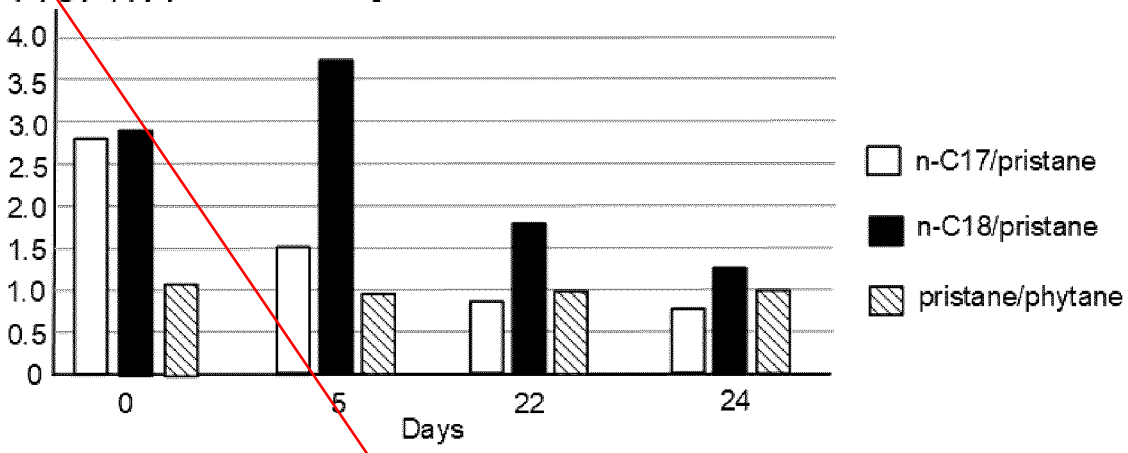


FIG. 17B Biodegradation in barrel C1-1

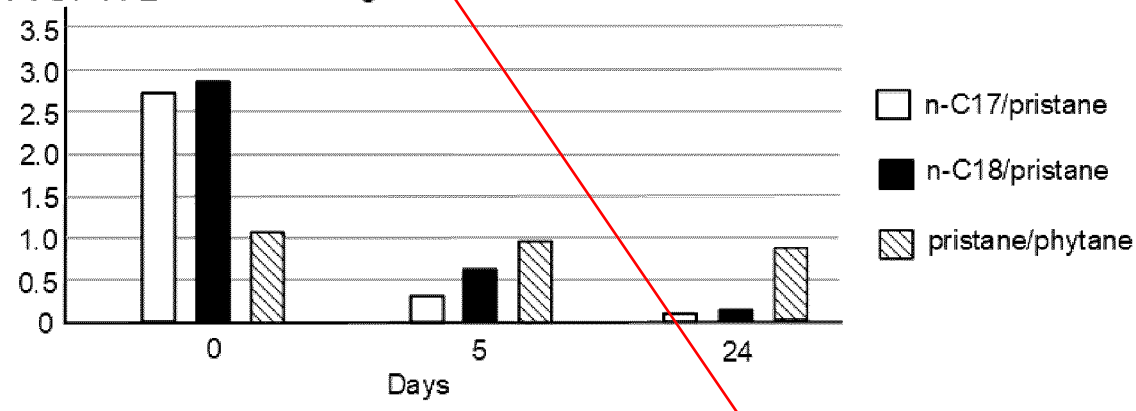


FIG. 17C Biodegradation in barrel E3-1

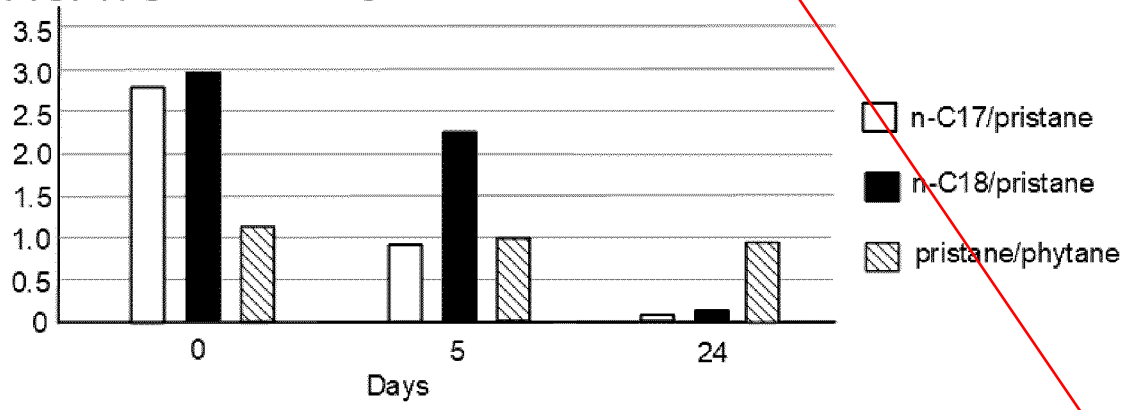


FIG. 17

FIG. 18A

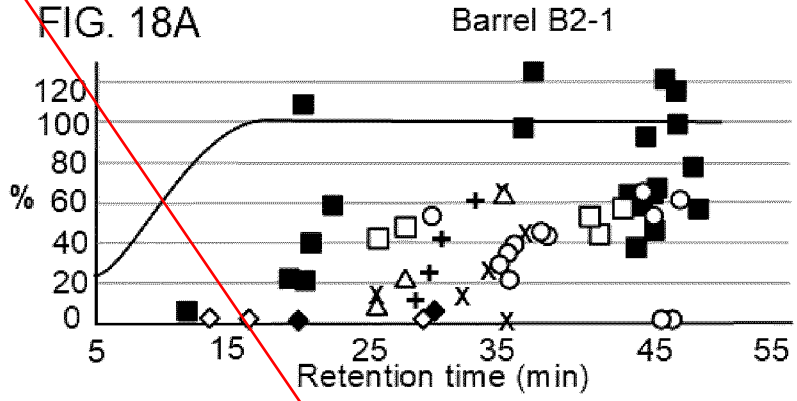
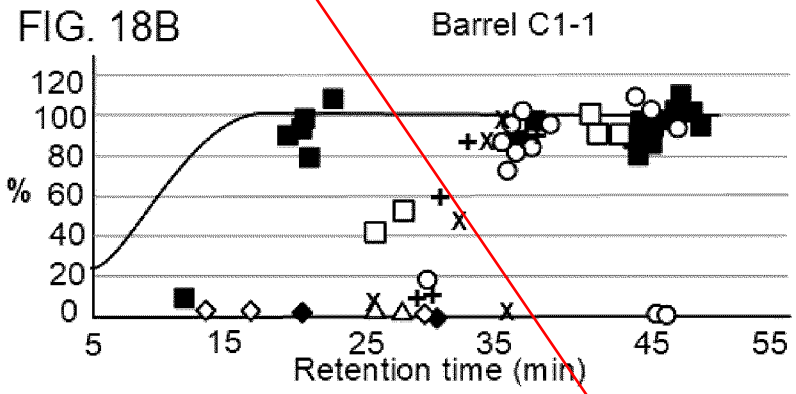


FIG. 18B



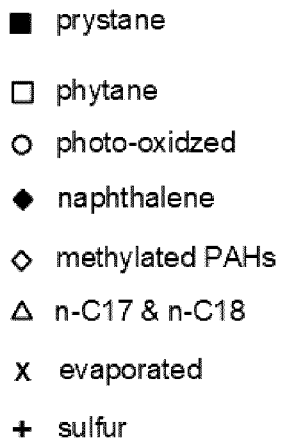


FIG. 18C

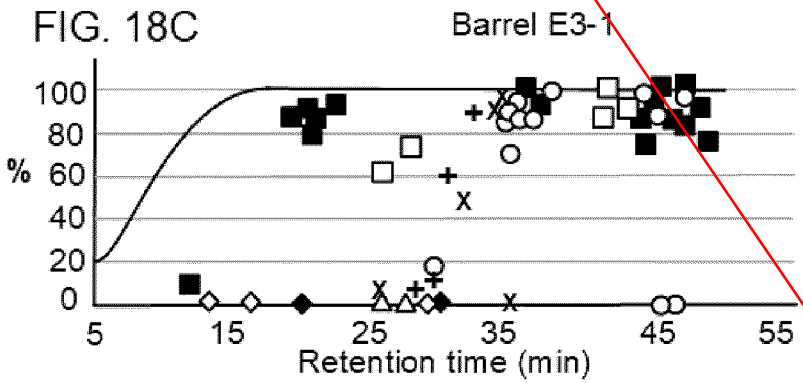


FIG. 18

FIG. 19A

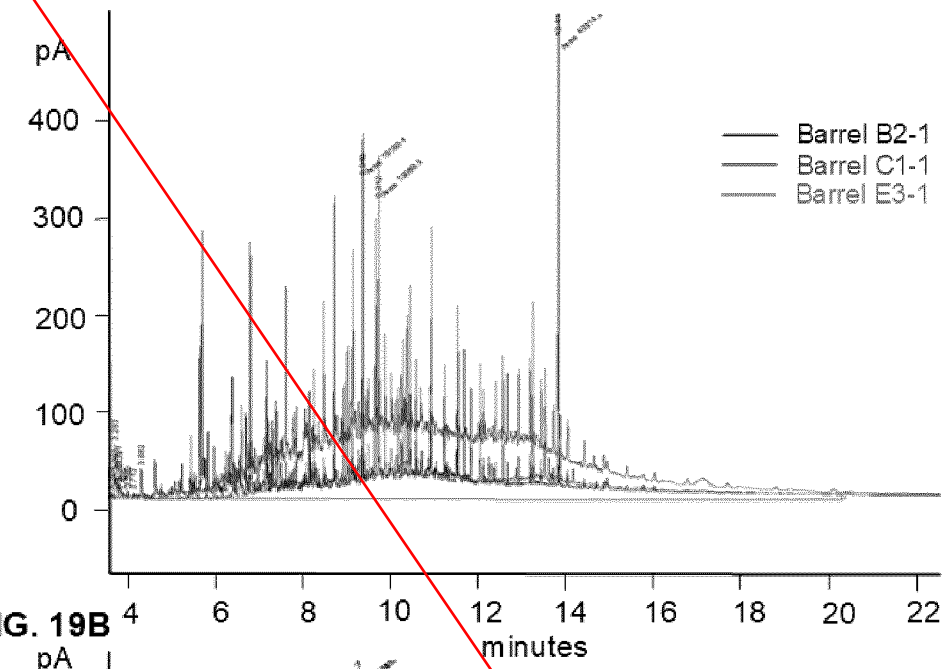


FIG. 19B

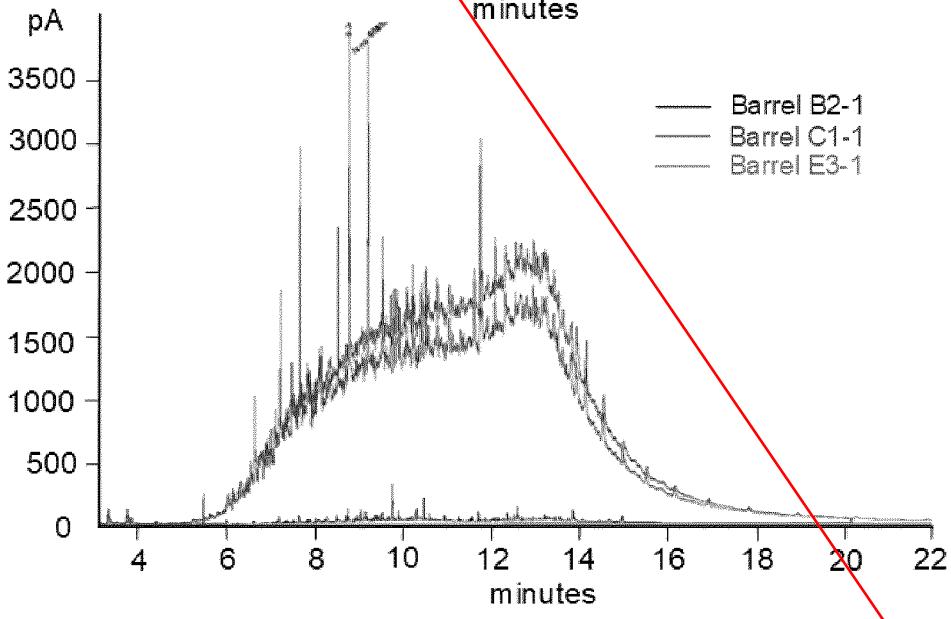


FIG. 19

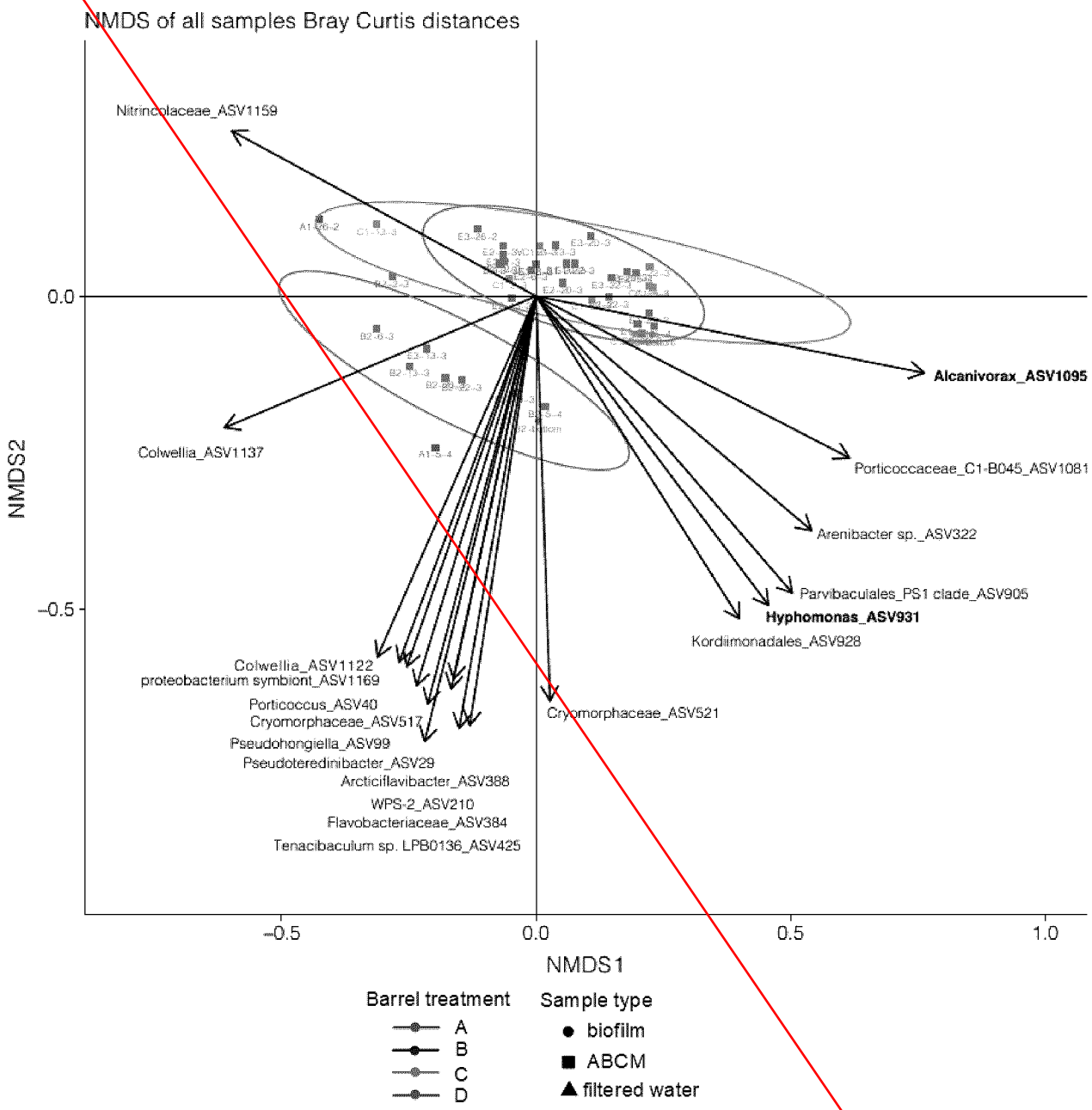

NMDS of all samples Bray Curtis distances
Nitrincolaceae_ASV1159
Alcanivorax_ASV1095
Colwellia_ASV1137
Porticoccaceae_C1-B045_ASV1081
Arenibacter sp._ASV322
Parvibaculales_PS1 clade_ASV905
Hyphomonas_ASV931
Kordiimonadales_ASV928
Colwellia_ASV1122
proteobacterium symbiont_ASV1169
Porticoccus_ASV40
Cryomorphaceae_ASV517
Pseudohongiella_ASV99
Pseudoteredinibacter_ASV29
Arcticiflavibacter_ASV388
WPS-2_ASV210
Flavobacteriaceae_ASV384
Tenacibaculum sp. LPB0136_ASV425
Cryomorphaceae_ASV521
NMDS1
NMDS2
0.0
−0.5
−0.5
0.0
0.5
1.0
Barrel treatment
A
B
C
D
Sample type
biofilm
ABCM
filtered water

FIG. 20

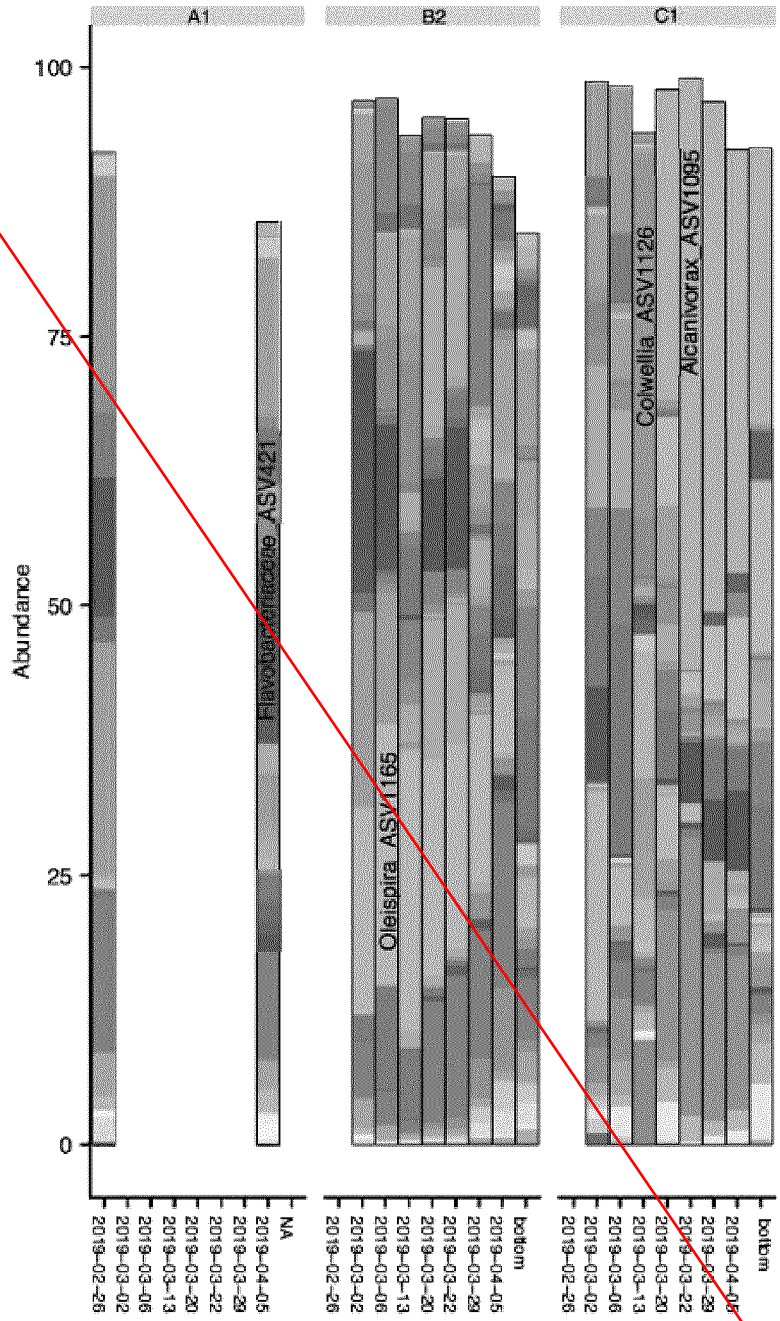

A1
B2
C1
100
75
50
25
0
Abundance
Flavobacteriaceae_ASV421
Oleispira_ASV1165
Colwellia_ASV1126
Alcanivorax_ASV1095
2019-02-26
2019-03-02
2019-03-06
2019-03-13
2019-03-20
2019-03-22
2019-03-29
2019-04-05
NA
bottom

FIG. 21A

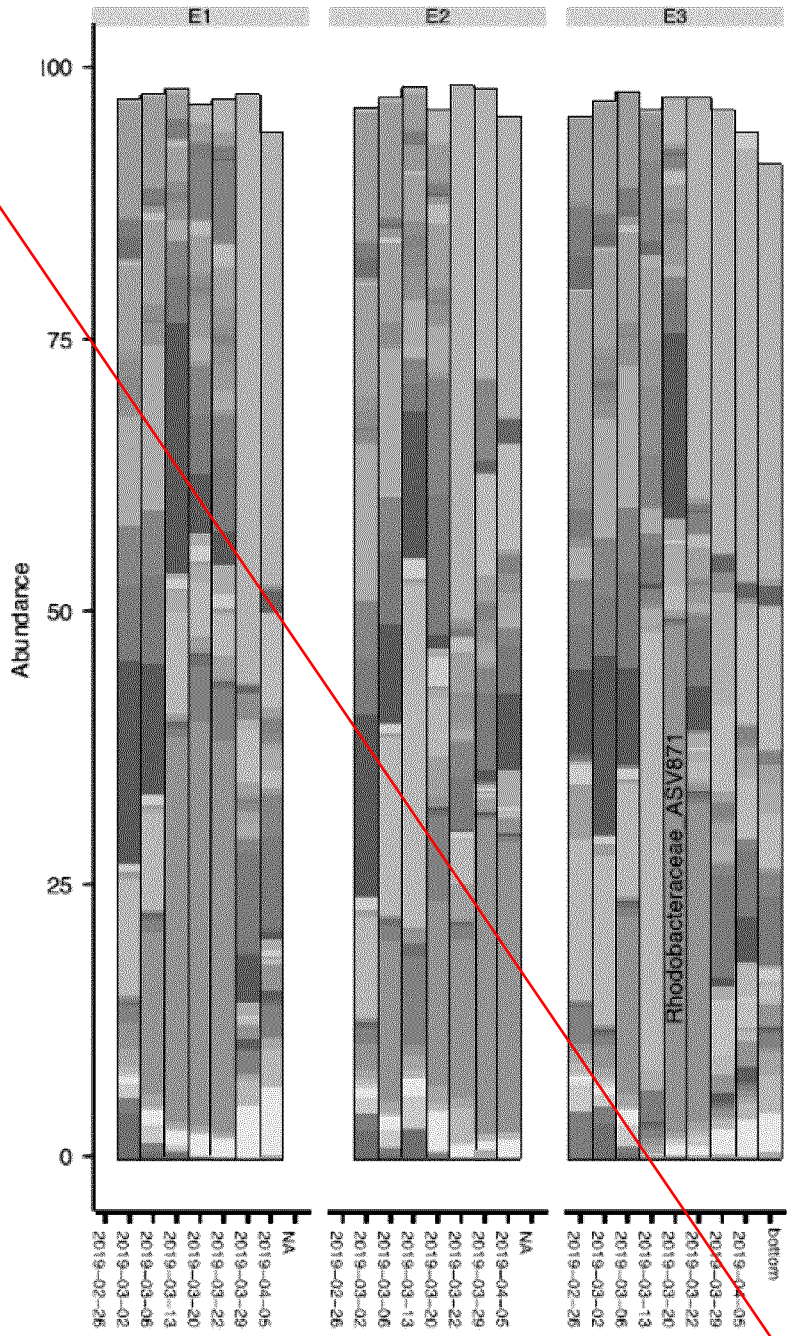

E1
E2
E3
100
75
50
25
0
Abundance
Rhodobacteraceae ASV671
2019-02-26
2019-03-02
2019-03-06
2019-03-13
2019-03-20
2019-03-22
2019-03-29
2019-04-05
NA
bottom

FIG. 21B


Absconditabacteriales (SR1)_ASV607
Aestuariicella_ASV26
Alcanivorax_ASV1095
Alteromonadaceae_ASV1050
Amphritea_ASV1176
Arcobacter_ASV1003
Arcobacter_ASV1006
Arcobacter_ASV989
Arcobacter_ASV991
Arenibacter_ASV322
Bacteria_ASV710
Bacteria_ASV712
Bacteria_ASV738
Bacteriovoracaceae_ASV971
Bacteriovoracaceae_ASV973
bacterium episymbiont of Kiwa sp._ASV495
Bdellovibrio_ASV185
C1−B045_ASV1081
Cafeteria_ASV634
Candidatus Nitrosopumilus_ASV642
Chitinophagales_ASV542
Chloroplast_ASV631
Colwellia_ASV1119
Colwellia_ASV1125
Colwellia_ASV1126
Colwellia_ASV1134
Crocinitomix_ASV538
Cryomorphaceae_ASV457
Cryomorphaceae_ASV461
Cryomorphaceae_ASV488
Cryomorphaceae_ASV500
Cryomorphaceae_ASV510
Cryomorphaceae_ASV519
Cryomorphaceae_ASV541
Cyclobacterium_ASV587
Cycloclasticus_ASV1065
DEV007_ASV153
DEV007_ASV156
Dokdonia_ASV439
Euryarchaeota archaeon SCGC
Flavobacteriaceae_ASV314
Flavobacteriaceae_ASV357

FIG. 21C

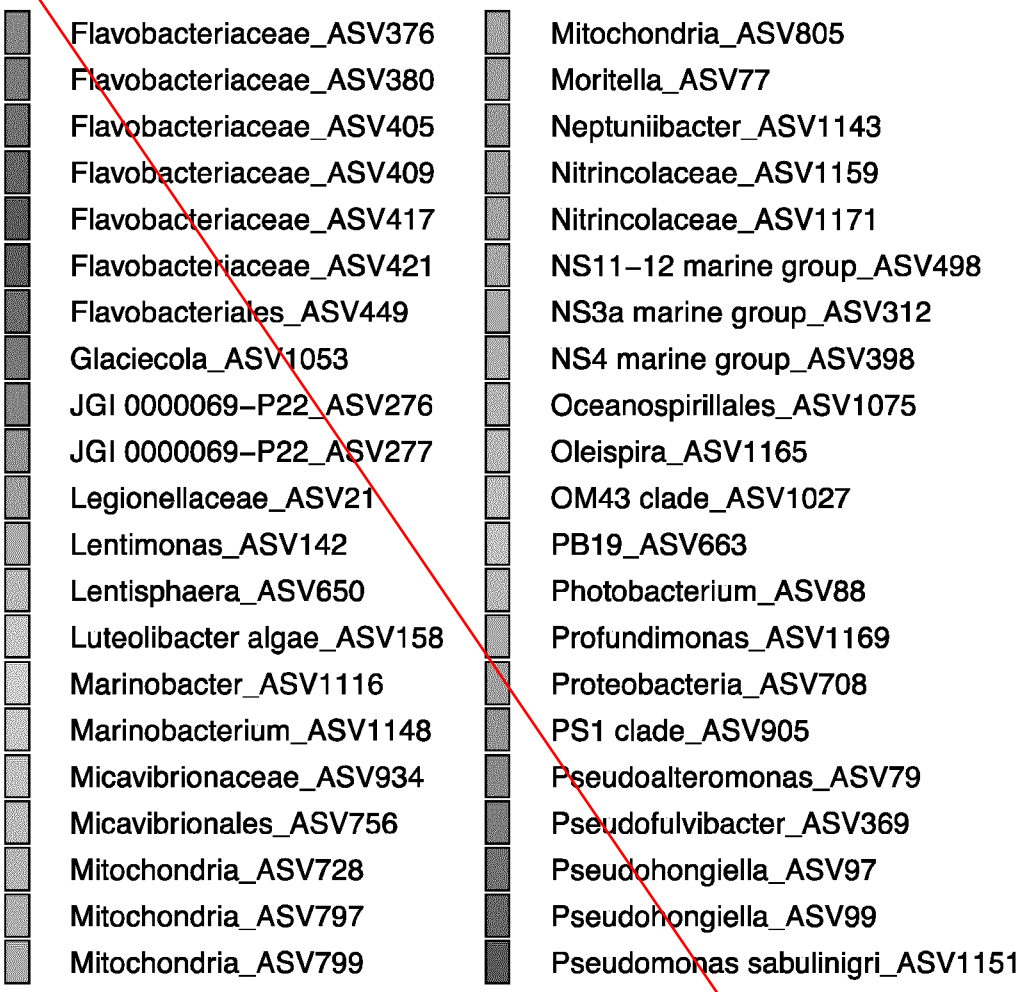

Flavobacteriaceae_ASV376
Flavobacteriaceae_ASV380
Flavobacteriaceae_ASV405
Flavobacteriaceae_ASV409
Flavobacteriaceae_ASV417
Flavobacteriaceae_ASV421
Flavobacteriales_ASV449
Glaciecola_ASV1053
JGI 0000069-P22_ASV276
JGI 0000069-P22_ASV277
Legionellaceae_ASV21
Lentimonas_ASV142
Lentisphaera_ASV650
Luteolibacter algae_ASV158
Marinobacter_ASV1116
Marinobacterium_ASV1148
Micavibrionaceae_ASV934
Micavibrionales_ASV756
Mitochondria_ASV728
Mitochondria_ASV797
Mitochondria_ASV799
Mitochondria_ASV805
Moritella_ASV77
Neptuniibacter_ASV1143
Nitrincolaceae_ASV1159
Nitrincolaceae_ASV1171
NS11-12 marine group_ASV498
NS3a marine group_ASV312
NS4 marine group_ASV398
Oceanospirillales_ASV1075
Oleispira_ASV1165
OM43 clade_ASV1027
PB19_ASV663
Photobacterium_ASV88
Profundimonas_ASV1169
Proteobacteria_ASV708
PS1 clade_ASV905
Pseudoalteromonas_ASV79
Pseudofulvibacter_ASV369
Pseudohongiella_ASV97
Pseudohongiella_ASV99
Pseudomonas sabulinigri_ASV1151

FIG. 21D

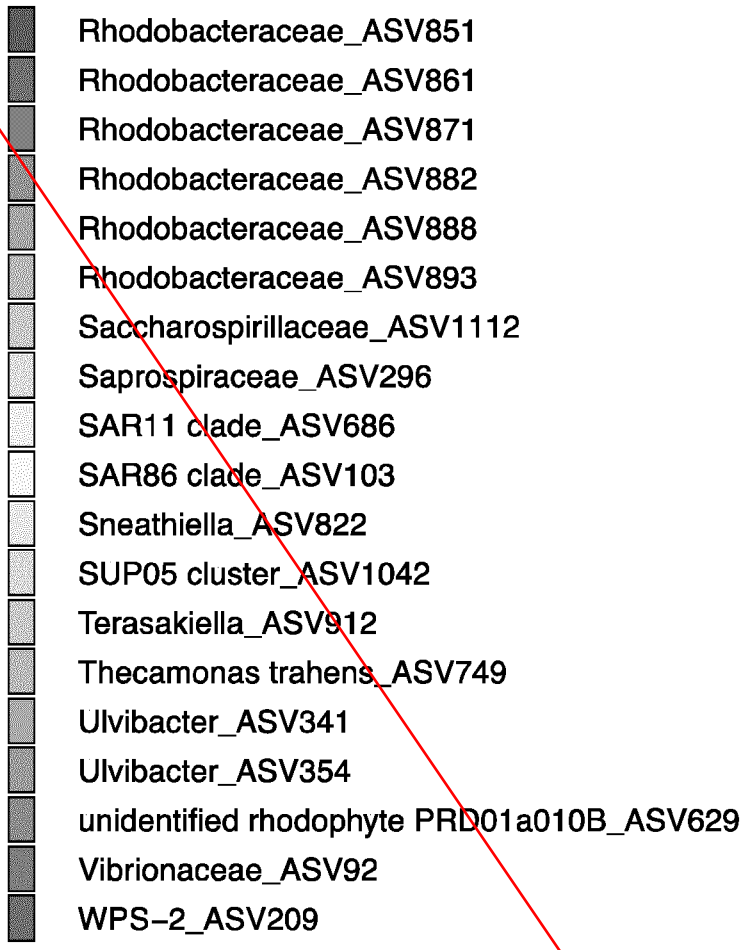

Rhodobacteraceae_ASV851
Rhodobacteraceae_ASV861
Rhodobacteraceae_ASV871
Rhodobacteraceae_ASV882
Rhodobacteraceae_ASV888
Rhodobacteraceae_ASV893
Saccharospirillaceae_ASV1112
Saprospiraceae_ASV296
SAR11 clade_ASV686
SAR86 clade_ASV103
Sneathiella_ASV822
SUP05 cluster_ASV1042
Terasakiella_ASV912
Thecamonas trahens_ASV749
Ulvibacter_ASV341
Ulvibacter_ASV354
unidentified rhodophyte PRD01a010B_ASV629
Vibrionaceae_ASV92
WPS−2_ASV209

FIG. 21E

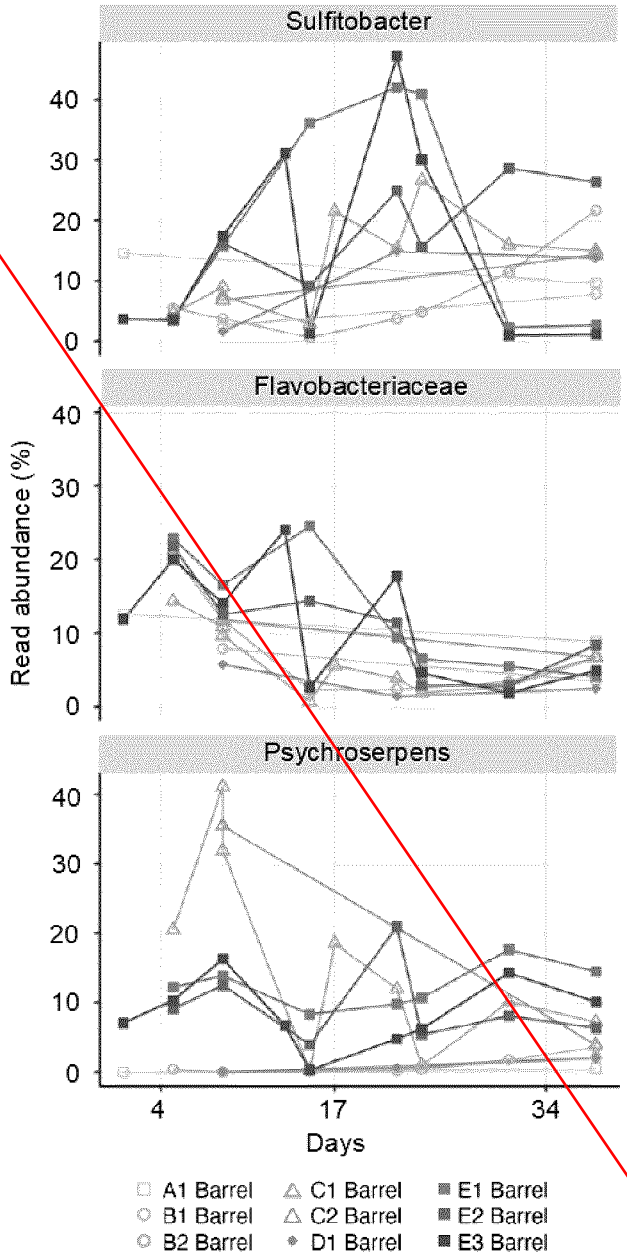

Sulfitobacter
Flavobacteriaceae
Psychroserpens
Read abundance (%)
0
10
20
30
40
4
17
34
Days
A1 Barrel
B1 Barrel
B2 Barrel
C1 Barrel
C2 Barrel
D1 Barrel
E1 Barrel
E2 Barrel
E3 Barrel

FIG. 22A

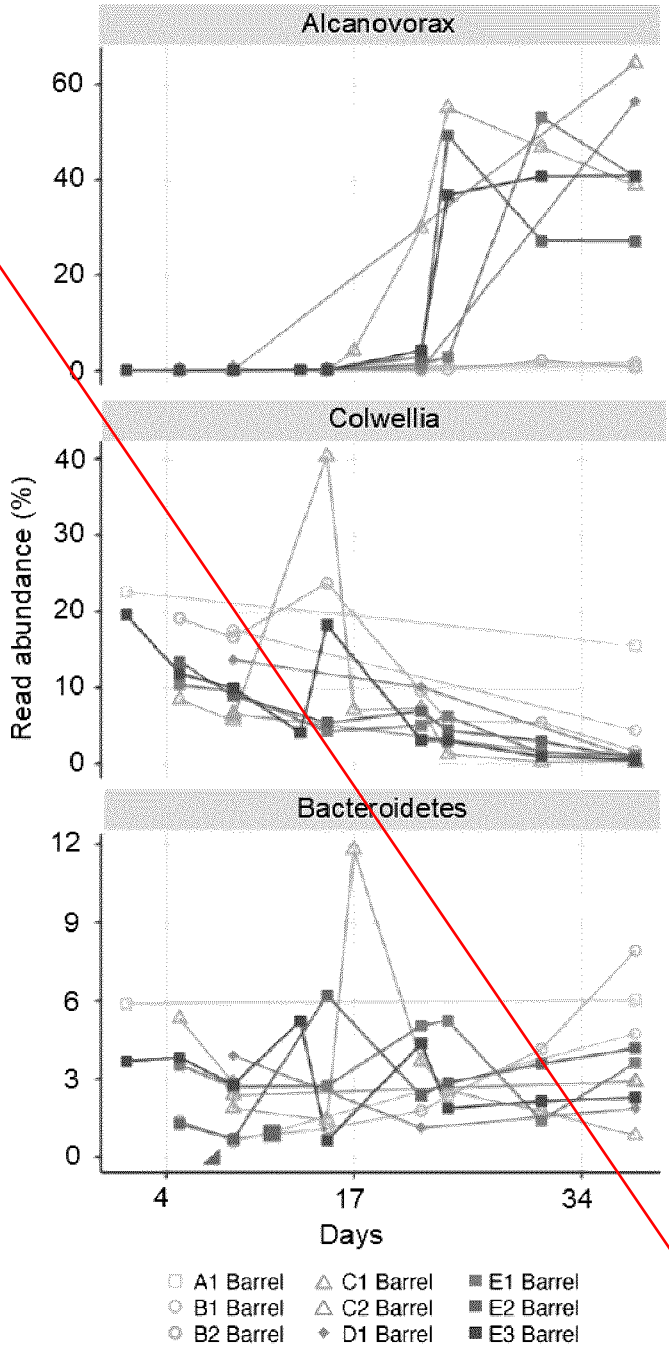

Alcanovorax
Colwellia
Bacteroidetes
Read abundance (%)
Days
4
17
34
A1 Barrel
B1 Barrel
B2 Barrel
C1 Barrel
C2 Barrel
D1 Barrel
E1 Barrel
E2 Barrel
E3 Barrel

FIG. 22B

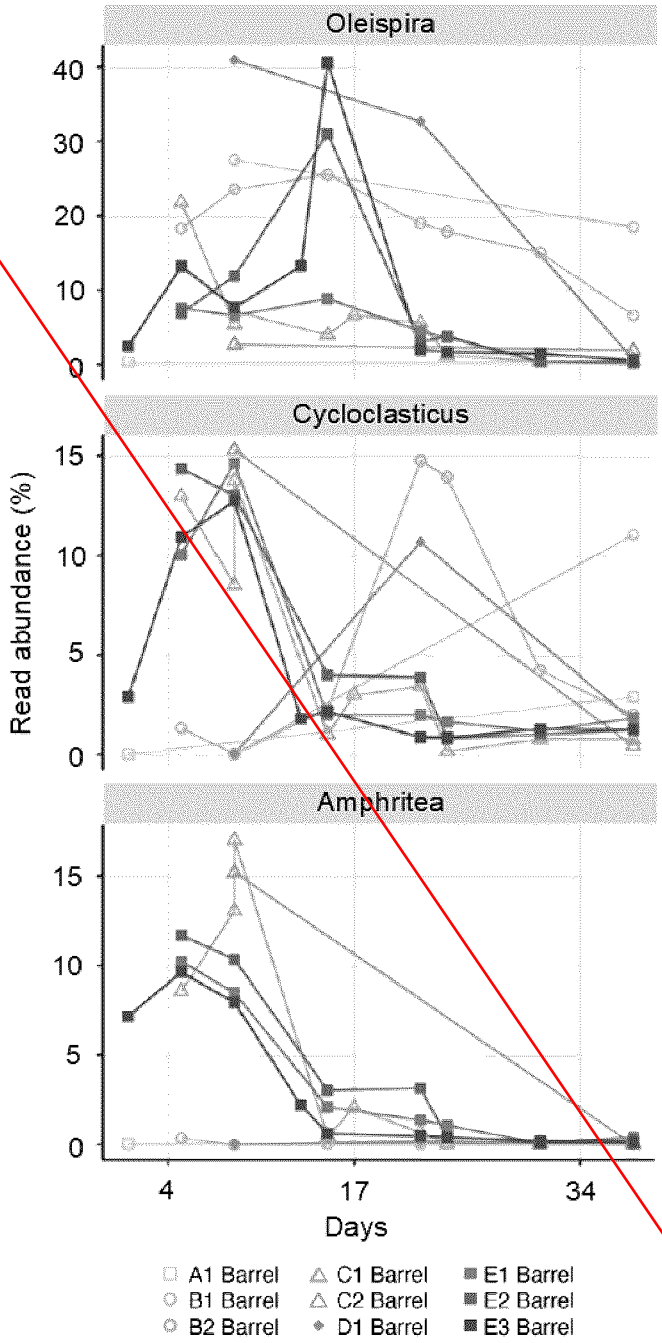

Oleispira
Cycloclasticus
Amphritea
Read abundance (%)
40
30
20
10
0
15
10
5
0
4
17
34
Days
A1 Barrel
B1 Barrel
B2 Barrel
C1 Barrel
C2 Barrel
D1 Barrel
E1 Barrel
E2 Barrel
E3 Barrel

FIG. 22C

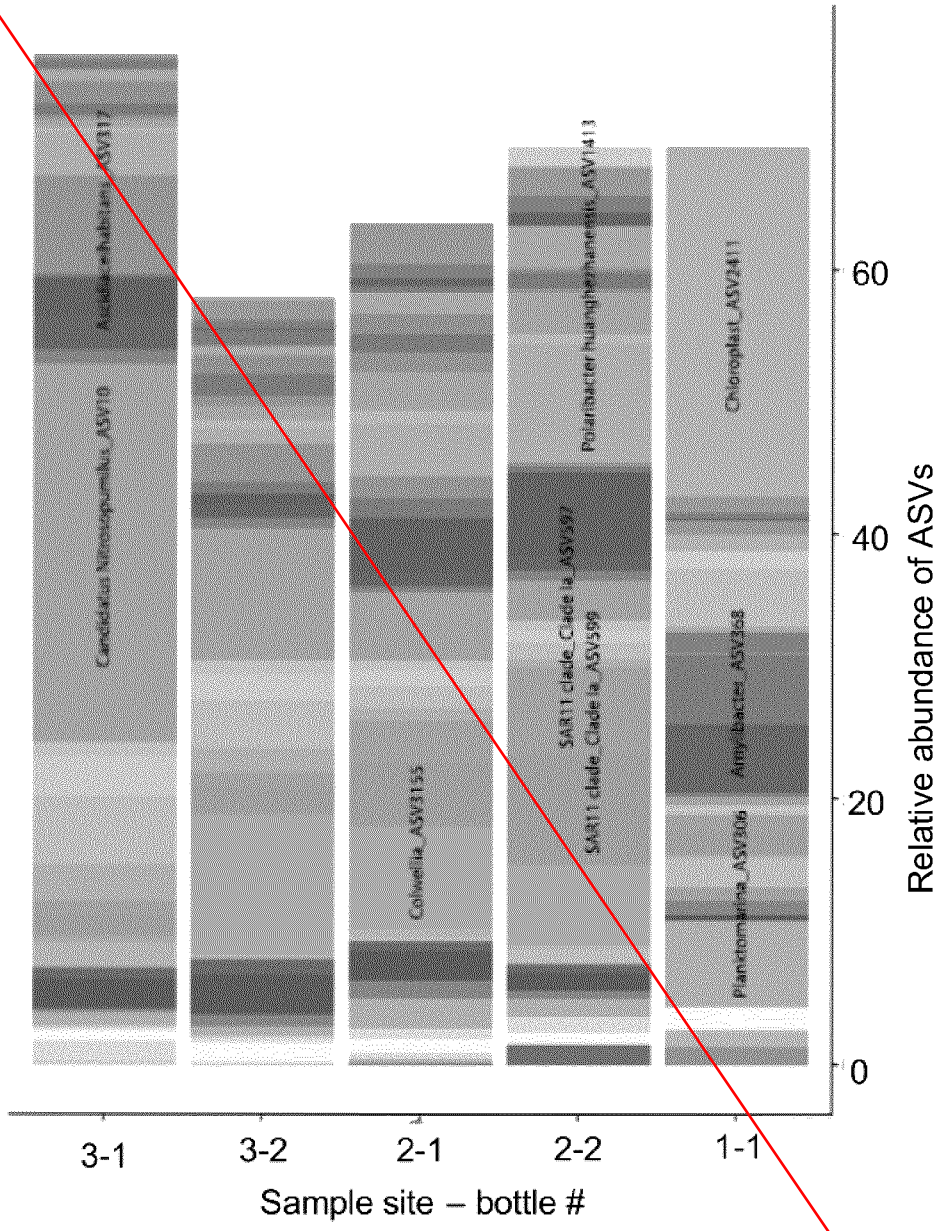

Candidatus Nitrosopumilus_ASV10
Colwellia_ASV3155
SAR11 clade_Clade Ia_ASV597
SAR11 clade_Clade Ia_ASV599
Polaribacter huanghaehanensis_ASV1413
Chloroplast_ASV2411
Amylibacter_ASV368
Planktomarina_ASV306
0
20
40
60
Relative abundance of ASVs
3-1
3-2
2-1
2-2
1-1
Sample site – bottle #

FIG. 23A

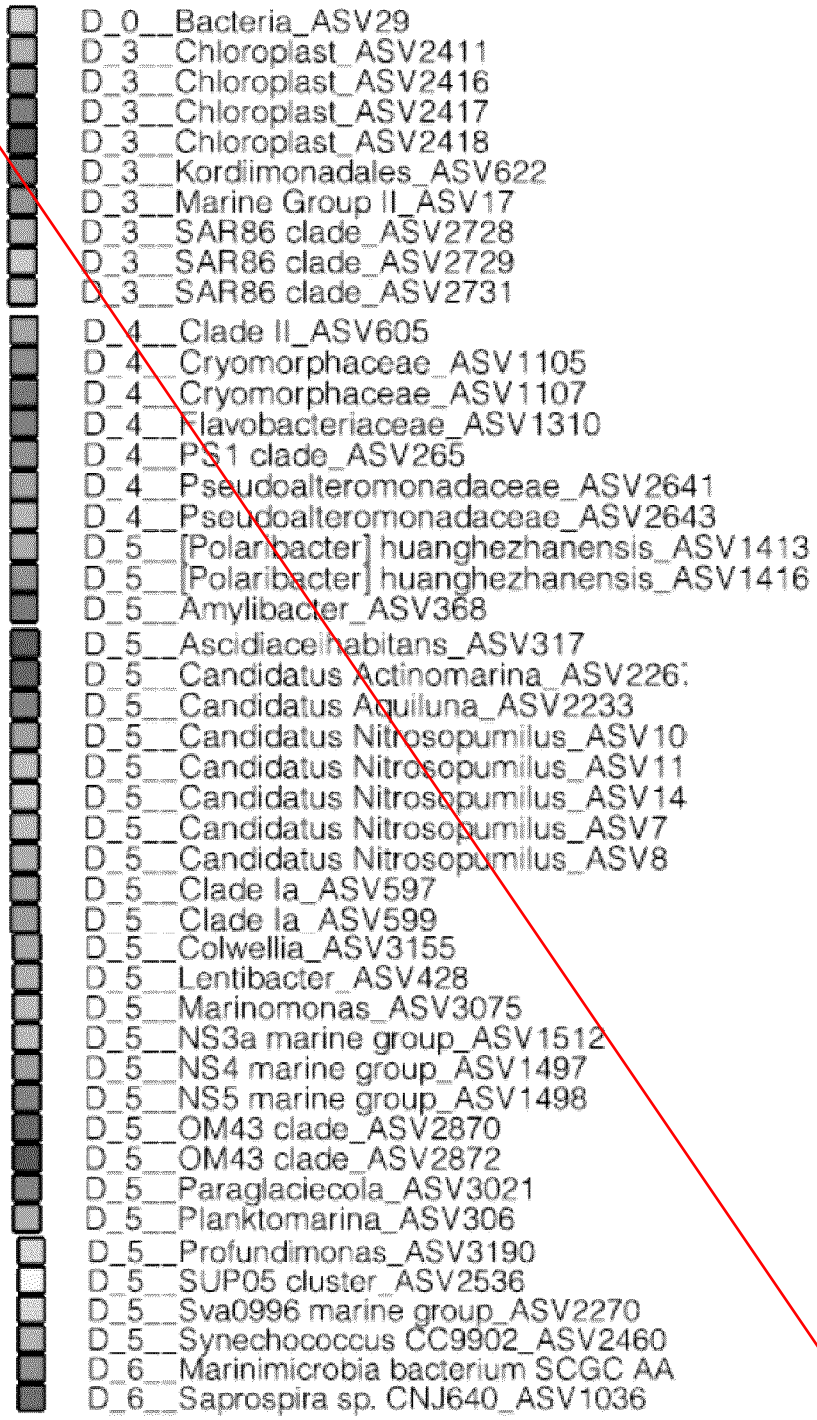

D_0__Bacteria_ASV29
D_3__Chloroplast_ASV2411
D_3__Chloroplast_ASV2416
D_3__Chloroplast_ASV2417
D_3__Chloroplast_ASV2418
D_3__Kordiimonadales_ASV622
D_3__Marine Group II_ASV17
D_3__SAR86 clade_ASV2728
D_3__SAR86 clade_ASV2729
D_3__SAR86 clade_ASV2731
D_4__Clade II_ASV605
D_4__Cryomorphaceae_ASV1105
D_4__Cryomorphaceae_ASV1107
D_4__Flavobacteriaceae_ASV1310
D_4__PS1 clade_ASV265
D_4__Pseudoalteromonadaceae_ASV2641
D_4__Pseudoalteromonadaceae_ASV2643
D_5__[Polaribacter] huanghezhanensis_ASV1413
D_5__[Polaribacter] huanghezhanensis_ASV1416
D_5__Amylibacter_ASV368
D_5__Ascidiaceihabitans_ASV317
D_5__Candidatus Actinomarina_ASV226
D_5__Candidatus Aquiluna_ASV2233
D_5__Candidatus Nitrosopumilus_ASV10
D_5__Candidatus Nitrosopumilus_ASV11
D_5__Candidatus Nitrosopumilus_ASV14
D_5__Candidatus Nitrosopumilus_ASV7
D_5__Candidatus Nitrosopumilus_ASV8
D_5__Clade Ia_ASV597
D_5__Clade Ia_ASV599
D_5__Colwellia_ASV3155
D_5__Lentibacter_ASV428
D_5__Marinomonas_ASV3075
D_5__NS3a marine group_ASV1512
D_5__NS4 marine group_ASV1497
D_5__NS5 marine group_ASV1498
D_5__OM43 clade_ASV2870
D_5__OM43 clade_ASV2872
D_5__Paraglaciecola_ASV3021
D_5__Planktomarina_ASV306
D_5__Profundimonas_ASV3190
D_5__SUP05 cluster_ASV2536
D_5__Sva0996 marine group_ASV2270
D_5__Synechococcus CC9902_ASV2460
D_6__Marinimicrobia bacterium SCGC AA
D_6__Saprospira sp. CNJ640_ASV1036

FIG. 23B

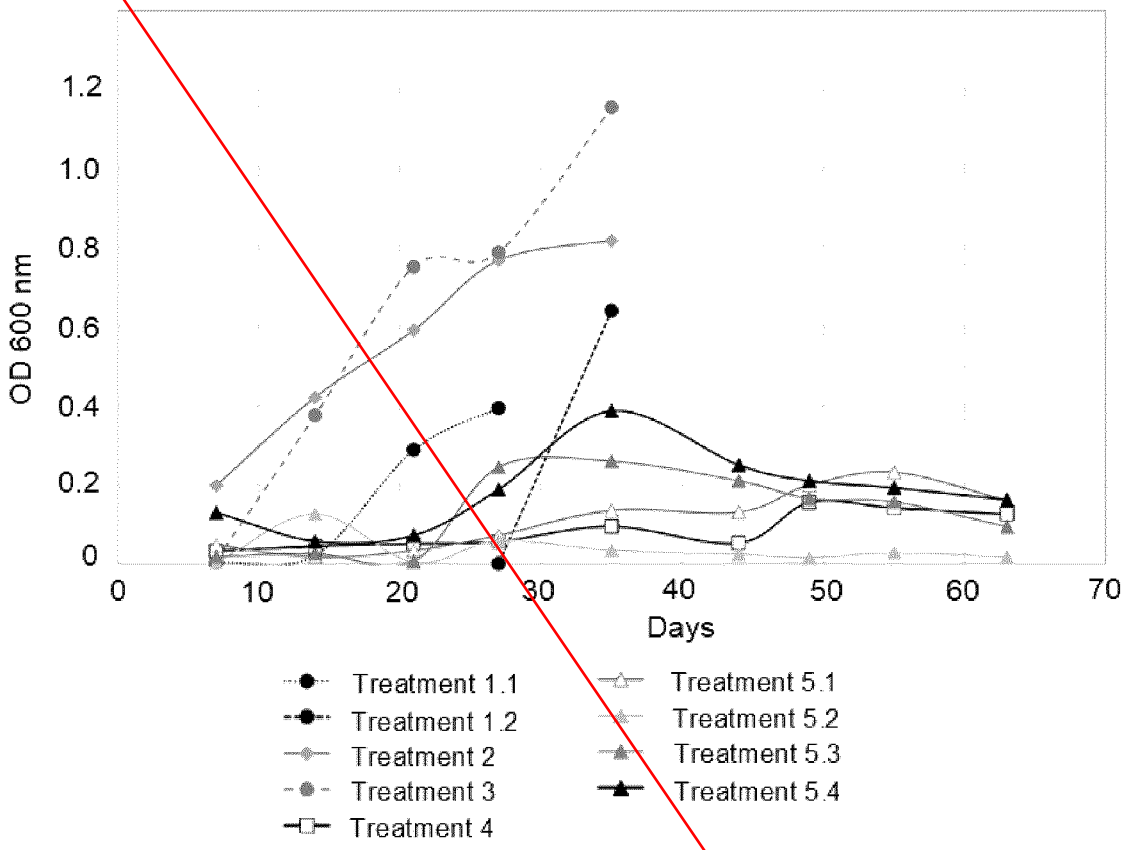

OD 600 nm
1.2
1.0
0.8
0.6
0.4
0.2
0
0
10
20
30
40
50
60
70
Days
Treatment 1.1
Treatment 1.2
Treatment 2
Treatment 3
Treatment 4
Treatment 5.1
Treatment 5.2
Treatment 5.3
Treatment 5.4

FIG. 24

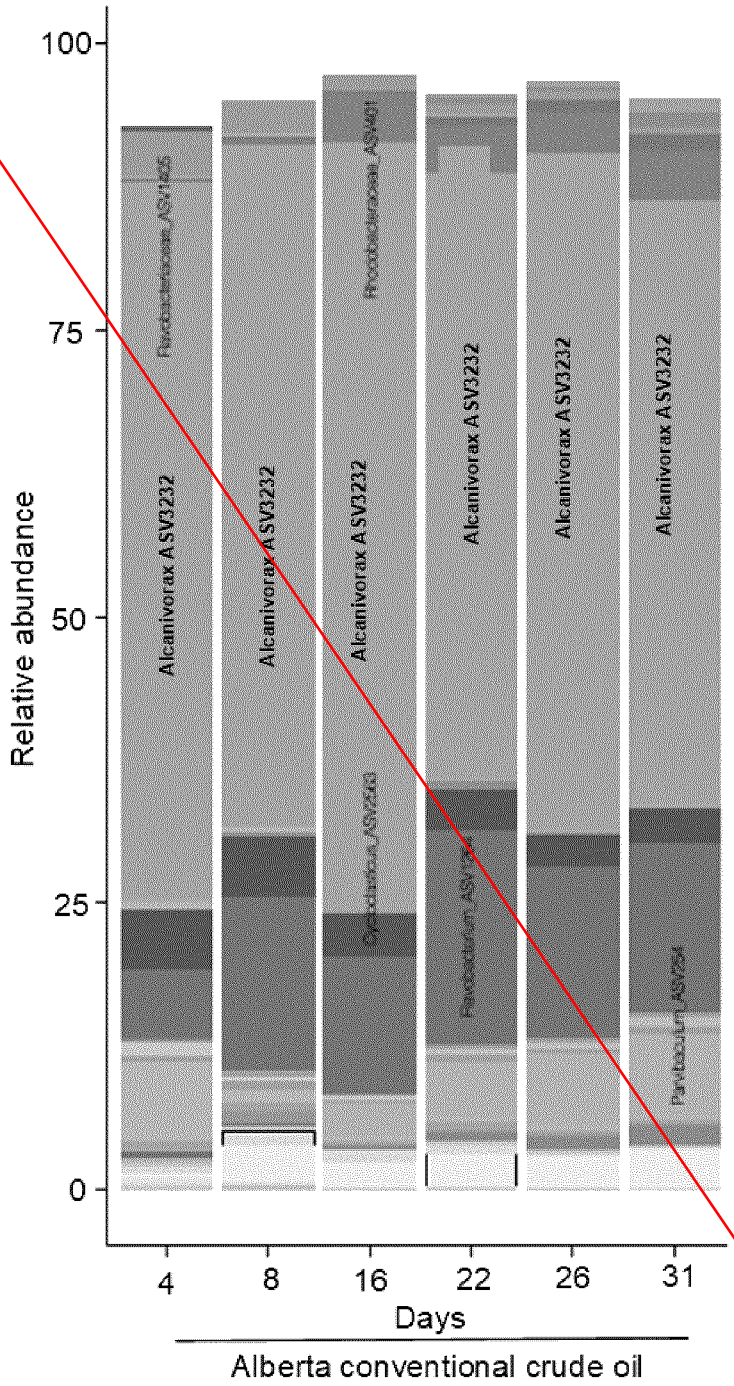

100
75
50
25
0
Relative abundance
Alcanivorax ASV3232
Alcanivorax ASV3232
Alcanivorax ASV3232
Alcanivorax ASV3232
Alcanivorax ASV3232
Alcanivorax ASV3232
4
8
16
22
26
31
Days
Alberta conventional crude oil

FIG. 25A

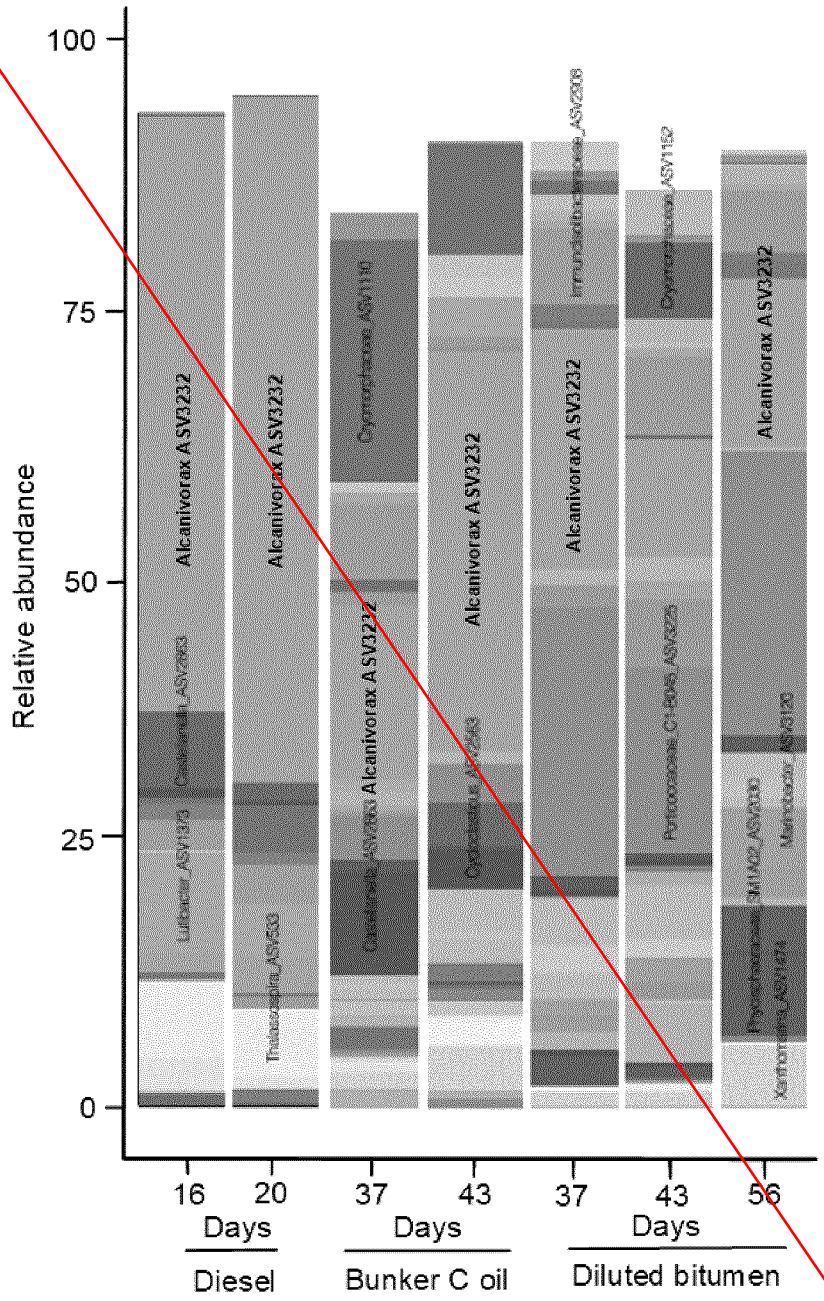

Relative abundance
100
75
50
25
0
Alcanivorax ASV3232
Alcanivorax ASV3232
Alcanivorax ASV3232
Alcanivorax ASV3232
Alcanivorax ASV3232
Alcanivorax ASV3232
16
20
37
43
37
43
56
Days
Days
Days
Diesel
Bunker C oil
Diluted bitumen

FIG. 25B

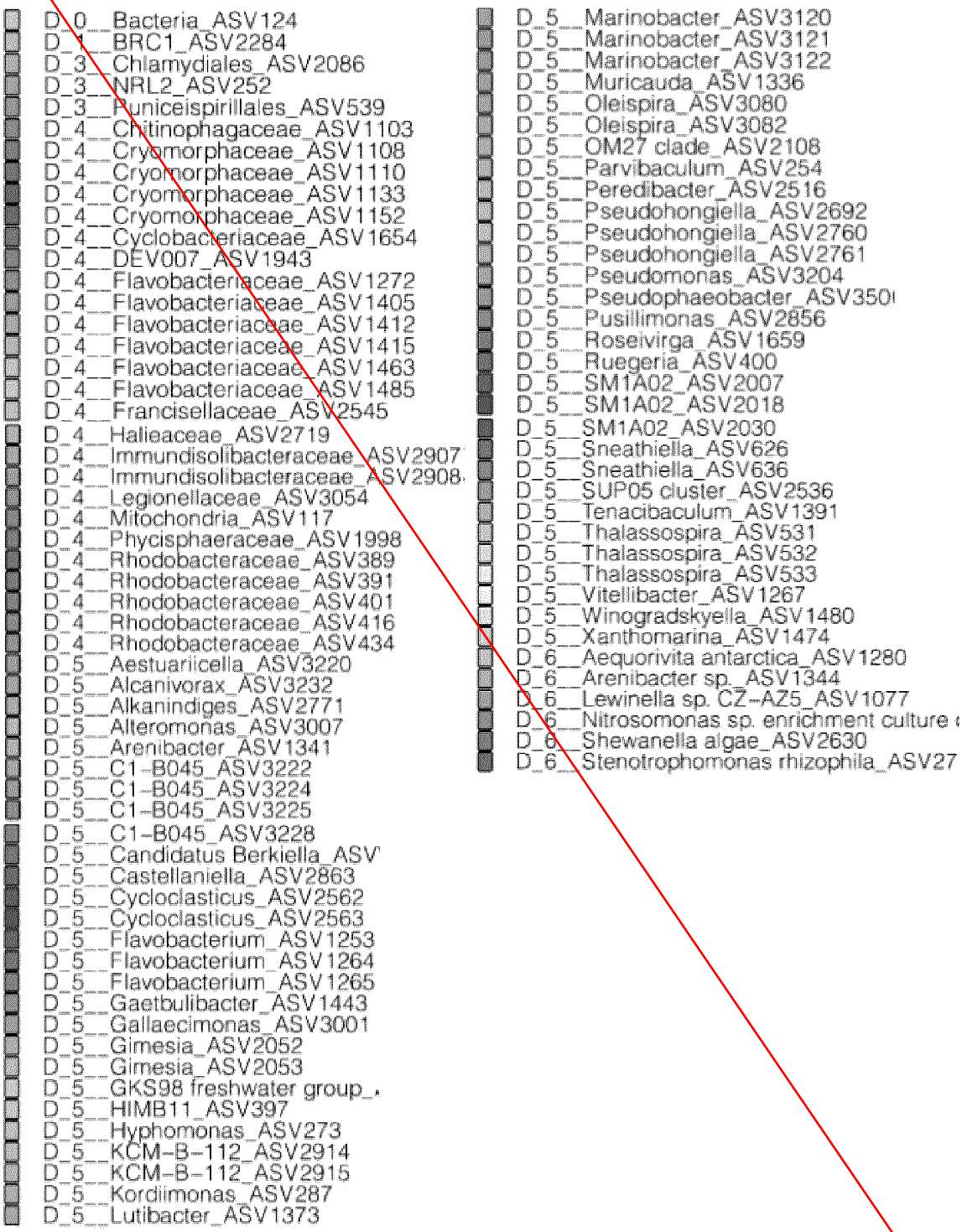

D_0__Bacteria_ASV124
D_1__BRC1_ASV2284
D_3__Chlamydiales_ASV2086
D_3__NRL2_ASV252
D_3__Puniceispirillales_ASV539
D_4__Chitinophagaceae_ASV1103
D_4__Cryomorphaceae_ASV1108
D_4__Cryomorphaceae_ASV1110
D_4__Cryomorphaceae_ASV1133
D_4__Cryomorphaceae_ASV1152
D_4__Cyclobacteriaceae_ASV1654
D_4__DEV007_ASV1943
D_4__Flavobacteriaceae_ASV1272
D_4__Flavobacteriaceae_ASV1405
D_4__Flavobacteriaceae_ASV1412
D_4__Flavobacteriaceae_ASV1415
D_4__Flavobacteriaceae_ASV1463
D_4__Flavobacteriaceae_ASV1485
D_4__Francisellaceae_ASV2545
D_4__Halieaceae_ASV2719
D_4__Immundisolibacteraceae_ASV2907
D_4__Immundisolibacteraceae_ASV2908
D_4__Legionellaceae_ASV3054
D_4__Mitochondria_ASV117
D_4__Phycisphaeraceae_ASV1998
D_4__Rhodobacteraceae_ASV389
D_4__Rhodobacteraceae_ASV391
D_4__Rhodobacteraceae_ASV401
D_4__Rhodobacteraceae_ASV416
D_4__Rhodobacteraceae_ASV434
D_5__Aestuariicella_ASV3220
D_5__Alcanivorax_ASV3232
D_5__Alkanindiges_ASV2771
D_5__Alteromonas_ASV3007
D_5__Arenibacter_ASV1341
D_5__C1-B045_ASV3222
D_5__C1-B045_ASV3224
D_5__C1-B045_ASV3225
D_5__C1-B045_ASV3228
D_5__Candidatus Berkiella_ASV
D_5__Castellaniella_ASV2863
D_5__Cycloclasticus_ASV2562
D_5__Cycloclasticus_ASV2563
D_5__Flavobacterium_ASV1253
D_5__Flavobacterium_ASV1264
D_5__Flavobacterium_ASV1265
D_5__Gaetbulibacter_ASV1443
D_5__Gallaecimonas_ASV3001
D_5__Gimesia_ASV2052
D_5__Gimesia_ASV2053
D_5__GKS98 freshwater group_
D_5__HIMB11_ASV397
D_5__Hyphomonas_ASV273
D_5__KCM-B-112_ASV2914
D_5__KCM-B-112_ASV2915
D_5__Kordiimonas_ASV287
D_5__Lutibacter_ASV1373
D_5__Marinobacter_ASV3120
D_5__Marinobacter_ASV3121
D_5__Marinobacter_ASV3122
D_5__Muricauda_ASV1336
D_5__Oleispira_ASV3080
D_5__Oleispira_ASV3082
D_5__OM27 clade_ASV2108
D_5__Parvibaculum_ASV254
D_5__Peredibacter_ASV2516
D_5__Pseudohongiella_ASV2692
D_5__Pseudohongiella_ASV2760
D_5__Pseudohongiella_ASV2761
D_5__Pseudomonas_ASV3204
D_5__Pseudophaeobacter_ASV350
D_5__Pusillimonas_ASV2856
D_5__Roseivirga_ASV1659
D_5__Ruegeria_ASV400
D_5__SM1A02_ASV2007
D_5__SM1A02_ASV2018
D_5__SM1A02_ASV2030
D_5__Sneathiella_ASV626
D_5__Sneathiella_ASV636
D_5__SUP05 cluster_ASV2536
D_5__Tenacibaculum_ASV1391
D_5__Thalassospira_ASV531
D_5__Thalassospira_ASV532
D_5__Thalassospira_ASV533
D_5__Vitellibacter_ASV1267
D_5__Winogradskyella_ASV1480
D_5__Xanthomarina_ASV1474
D_6__Aequorivita antarctica_ASV1280
D_6__Arenibacter sp._ASV1344
D_6__Lewinella sp. CZ-AZ5_ASV1077
D_6__Nitrosomonas sp. enrichment culture
D_6__Shewanella algae_ASV2630
D_6__Stenotrophomonas rhizophila_ASV27

FIG. 25C

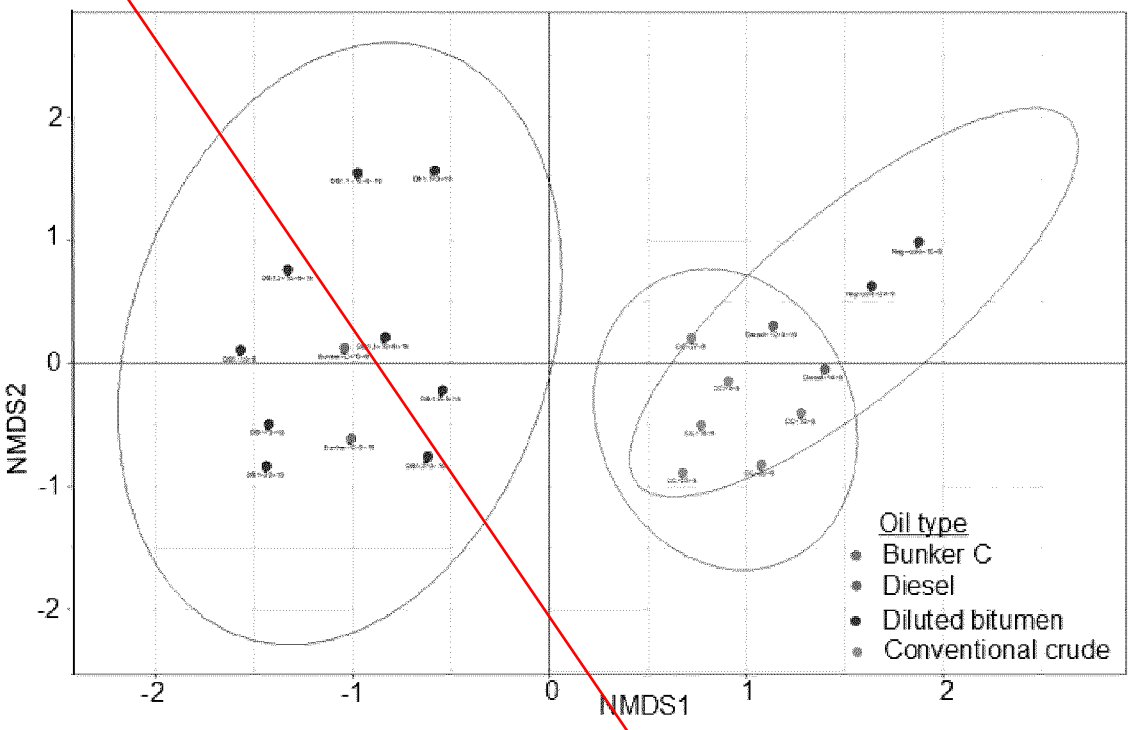

NMDS2
NMDS1
2
1
0
-1
-2
-2
-1
0
1
2
Oil type
Bunker C
Diesel
Diluted bitumen
Conventional crude

FIG. 26

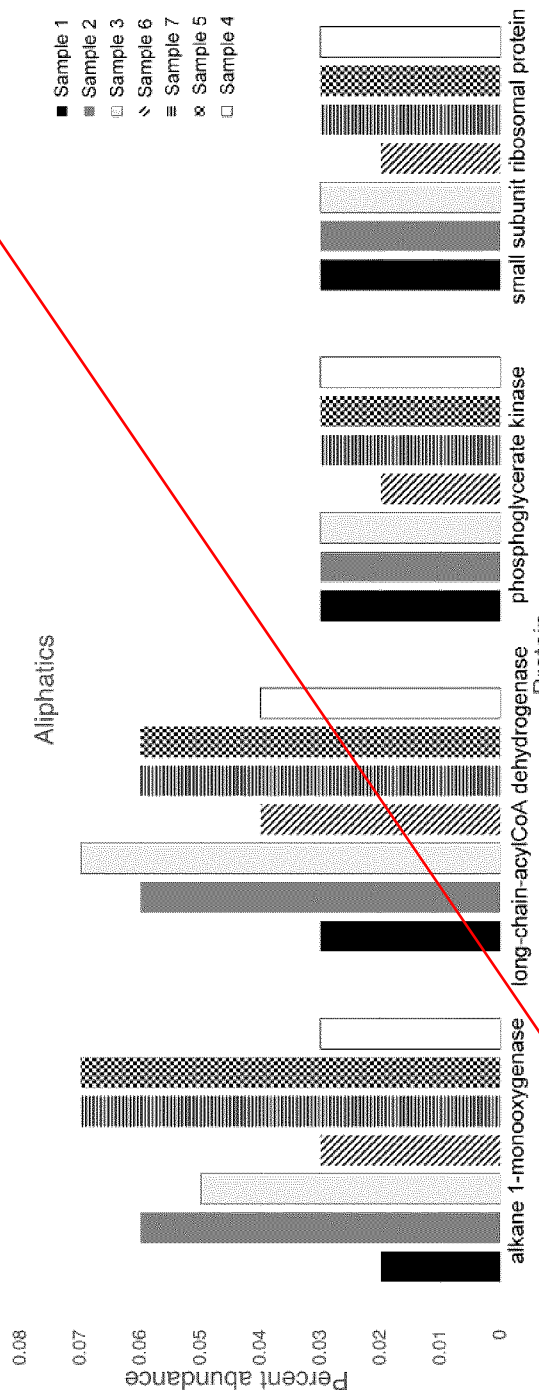

Sample 1
Sample 2
Sample 3
Sample 6
Sample 7
Sample 5
Sample 4
Aliphatics
alkane 1-monooxygenase
long-chain-acyl-CoA dehydrogenase
phosphoglycerate kinase
small subunit ribosomal protein
Protein
Percent abundance
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0

FIG. 27

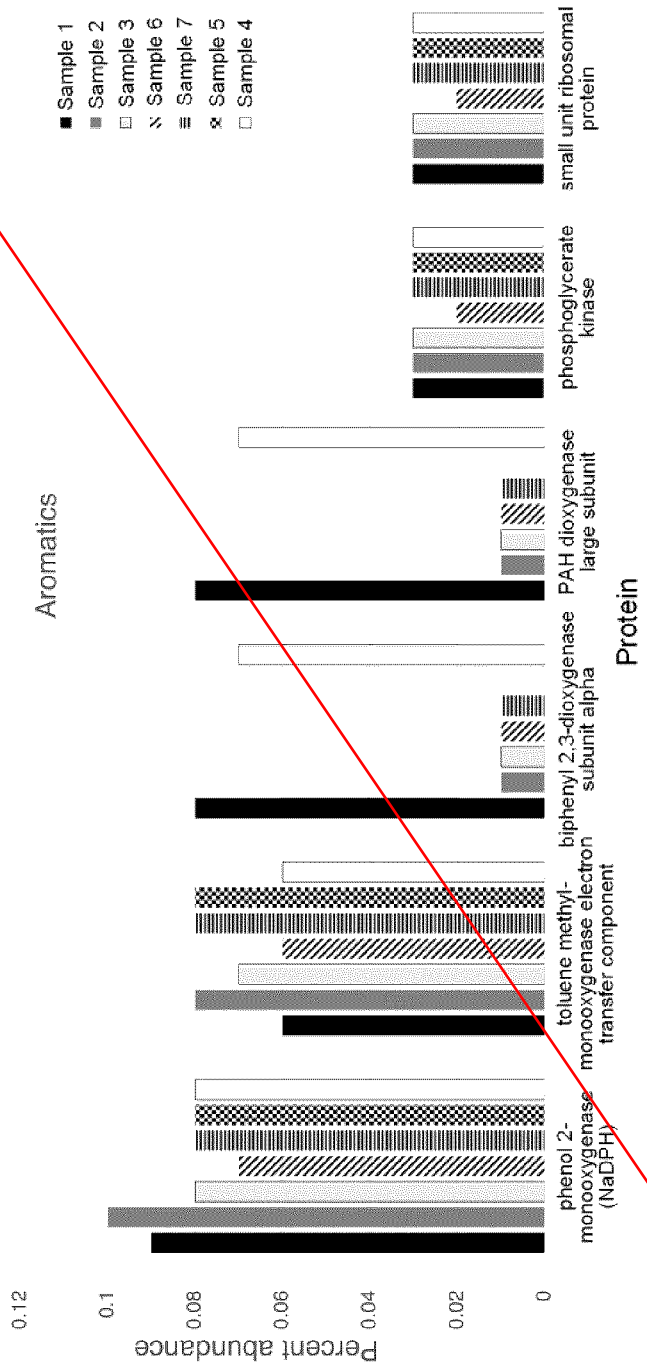

Sample 1
Sample 2
Sample 3
Sample 6
Sample 7
Sample 5
Sample 4
Aromatics
Percent abundance
0.12
0.1
0.08
0.06
0.04
0.02
0
phenol 2-monooxygenase (NaDPH)
toluene methyl-monooxygenase electron transfer component
biphenyl 2,3-dioxygenase subunit alpha
PAH dioxygenase large subunit
phosphoglycerate kinase
small unit ribosomal protein
Protein

FIG. 28

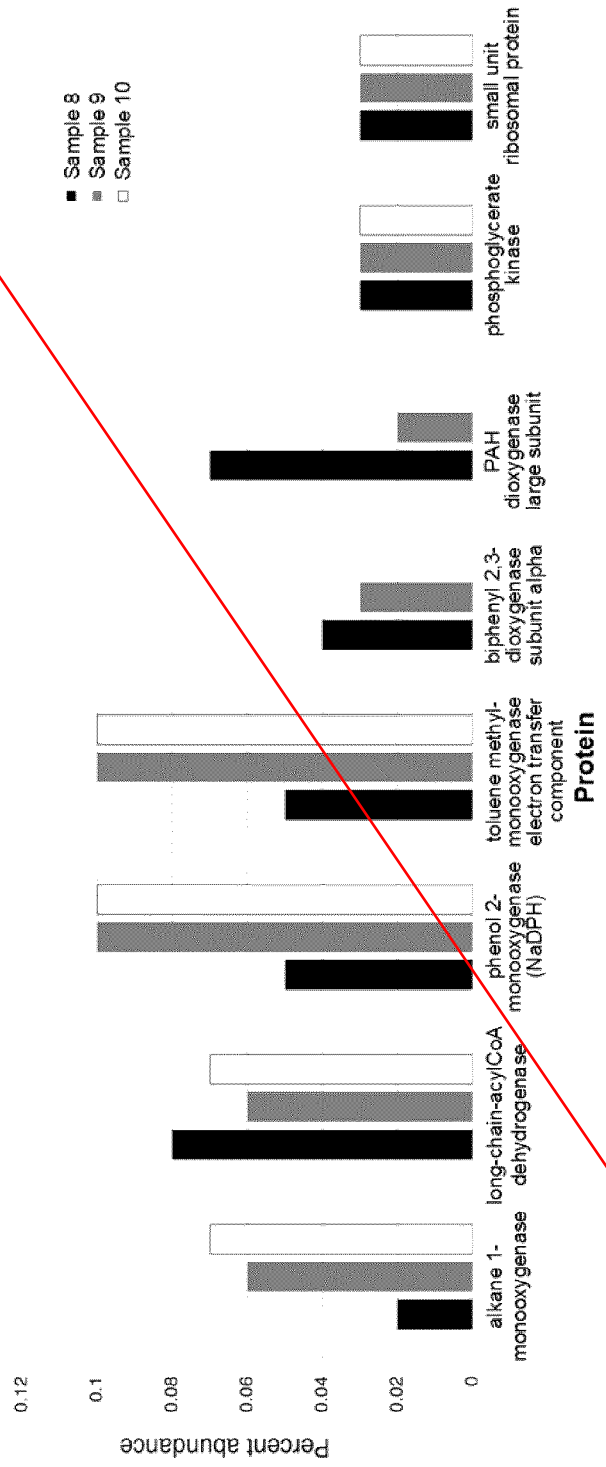

Sample 8
Sample 9
Sample 10
Percent abundance
0.12
0.1
0.08
0.06
0.04
0.02
0
alkane 1-monooxygenase
long-chain-acylCoA dehydrogenase
phenol 2-monooxygenase (NaDPH)
toluene methyl-monooxygenase electron transfer component
biphenyl 2,3-dioxygenase subunit alpha
PAH dioxygenase large subunit
phosphoglycerate kinase
small unit ribosomal protein
Protein

FIG. 29

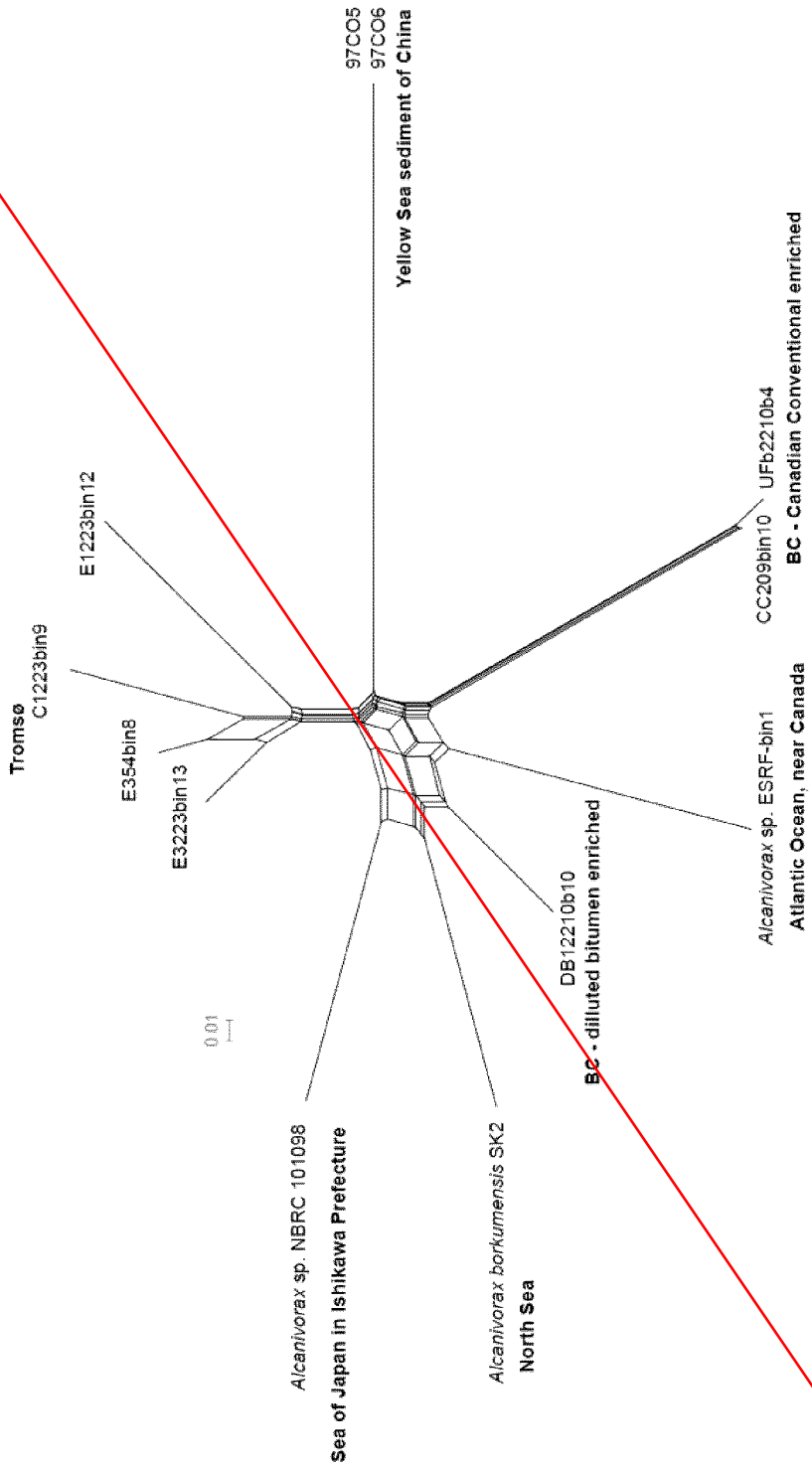

97CO5
97CO6
Yellow Sea sediment of China
E1223bin12
C1223bin9
Tromsø
E354bin8
E3223bin13
0.01
UFb2210b4
CC209bin10
BC - Canadian Conventional enriched
Alcanivorax sp. ESRF-bin1
Atlantic Ocean, near Canada
DB12210b10
BC - diluted bitumen enriched
Alcanivorax sp. NBRC 101098
Sea of Japan in Ishikawa Prefecture
Alcanivorax borkumensis SK2
North Sea

FIG. 29

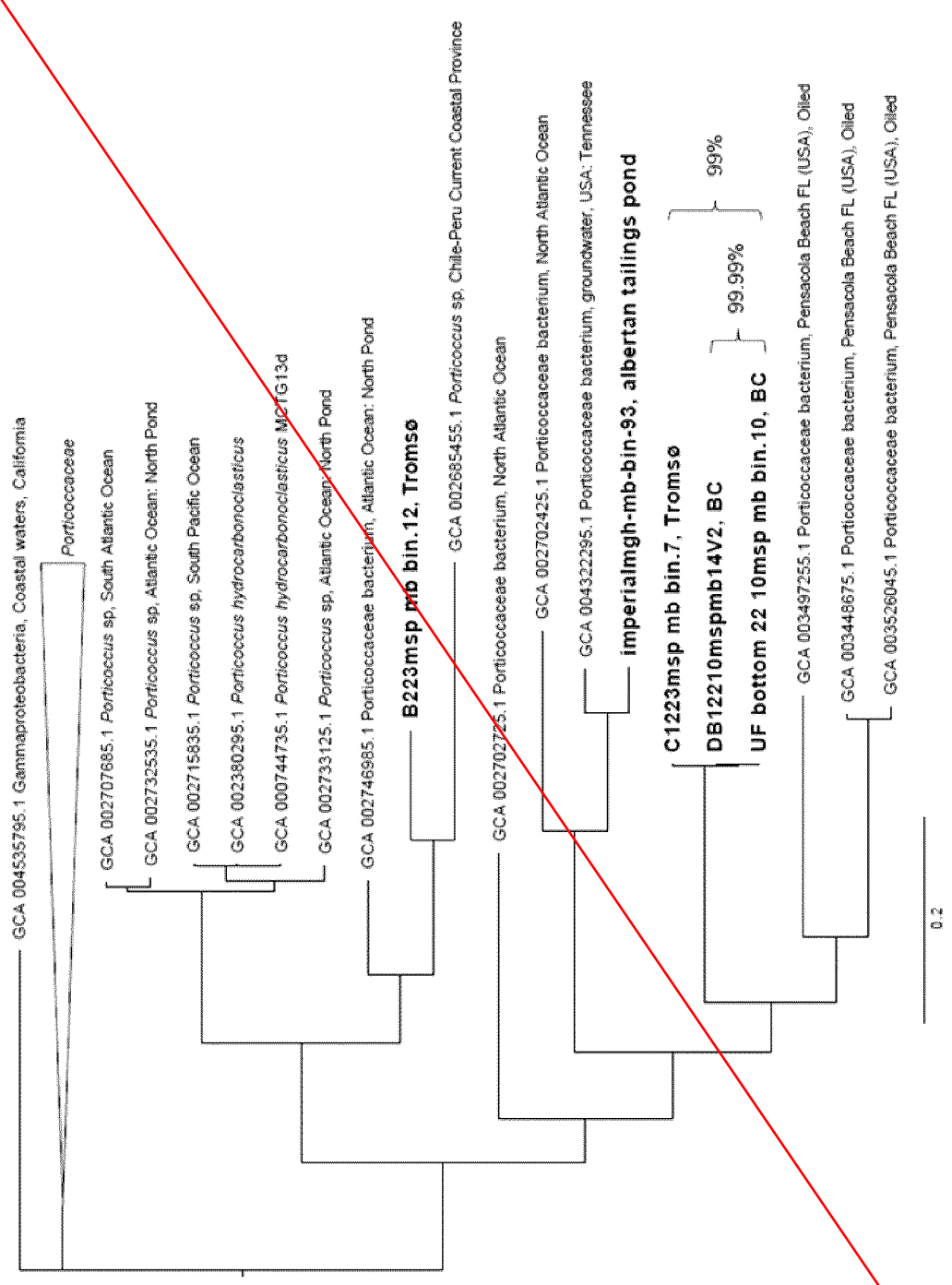

GCA 004535795.1 Gammaproteobacteria, Coastal waters, California
Porticoccaceae
GCA 002707685.1 Porticoccus sp, South Atlantic Ocean
GCA 002732535.1 Porticoccus sp, Atlantic Ocean: North Pond
GCA 002715835.1 Porticoccus sp, South Pacific Ocean
GCA 002380295.1 Porticoccus hydrocarbonoclasticus
GCA 000744735.1 Porticoccus hydrocarbonoclasticus M2TG13d
GCA 002733125.1 Porticoccus sp, Atlantic Ocean: North Pond
GCA 002746985.1 Porticoccaceae bacterium, Atlantic Ocean: North Pond
B223msp mb bin.12, Tromsø
GCA 002685455.1 Porticoccus sp, Chile-Peru Current Coastal Province
GCA 002702725.1 Porticoccaceae bacterium, North Atlantic Ocean
GCA 002702425.1 Porticoccaceae bacterium, North Atlantic Ocean
GCA 004322295.1 Porticoccaceae bacterium, groundwater, USA: Tennessee
imperialmgh-mb-bin-93, albertan tailings pond
C1223msp mb bin.7, Tromsø
DB12210mspmb14V2, BC
UF bottom 22 10msp mb bin.10, BC
99%
99.99%
GCA 003497255.1 Porticoccaceae bacterium, Pensacola Beach FL (USA), Oiled
GCA 003448675.1 Porticoccaceae bacterium, Pensacola Beach FL (USA), Oiled
GCA 003526045.1 Porticoccaceae bacterium, Pensacola Beach FL (USA), Oiled
0.2

FIG. 30

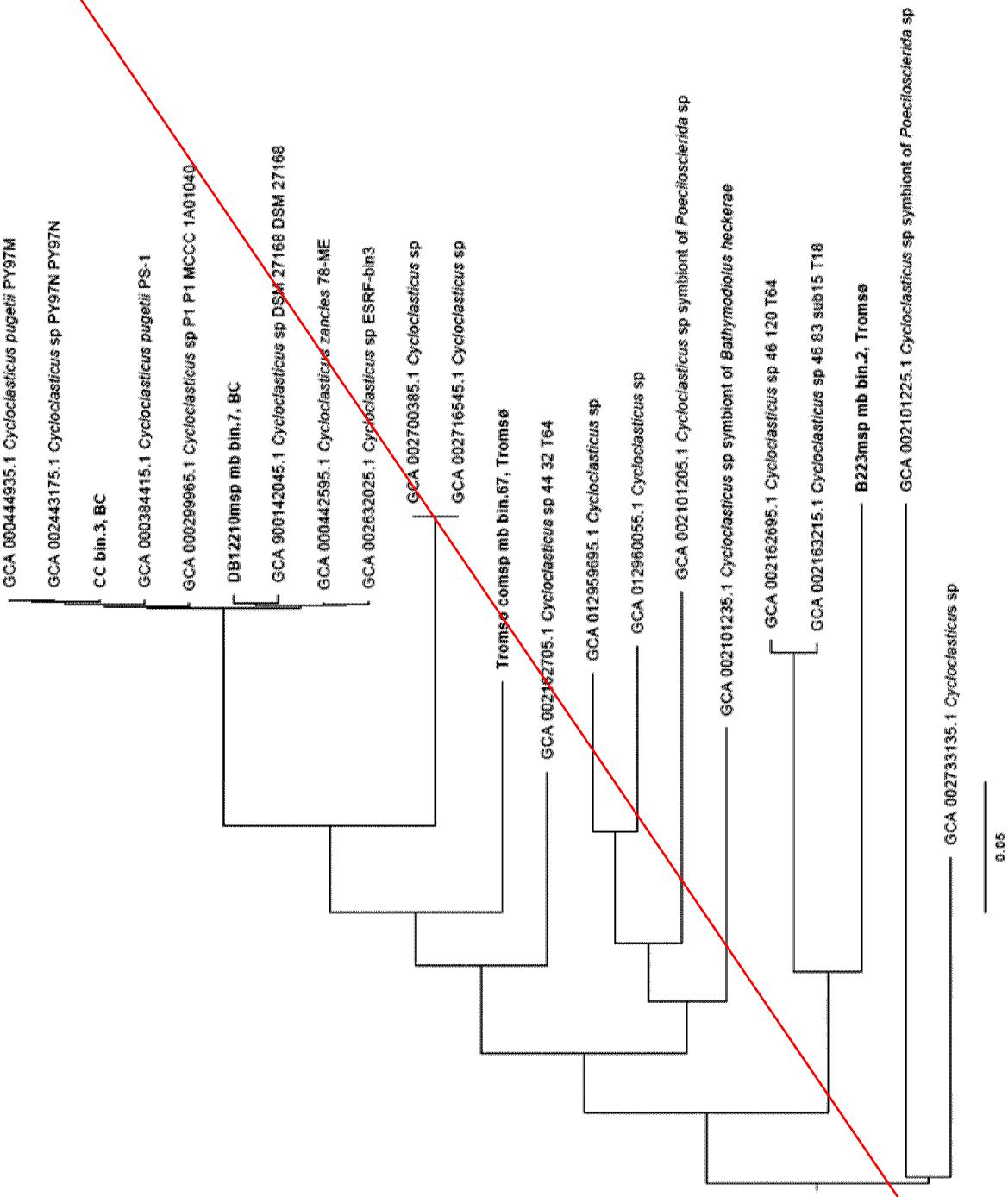

GCA 000444935.1 Cycloclasticus pugetii PY97M
GCA 002443175.1 Cycloclasticus sp PY97N PY97N
CC bin.3, BC
GCA 000384415.1 Cycloclasticus pugetii PS-1
GCA 000299965.1 Cycloclasticus sp P1 P1 MCCC 1A01040
DB12210msp mb bin.7, BC
GCA 900142045.1 Cycloclasticus sp DSM 27168 DSM 27168
GCA 000442595.1 Cycloclasticus zancles 78-ME
GCA 002632025.1 Cycloclasticus sp ESRF-bin3
GCA 002700385.1 Cycloclasticus sp
GCA 002716545.1 Cycloclasticus sp
Tromso comsp mb bin.67, Tromso
GCA 002162705.1 Cycloclasticus sp 44 32 T64
GCA 012959695.1 Cycloclasticus sp
GCA 012960055.1 Cycloclasticus sp
GCA 002101205.1 Cycloclasticus sp symbiont of Poecilosclerida sp
GCA 002101235.1 Cycloclasticus sp symbiont of Bathymodiolus heckerae
GCA 002162695.1 Cycloclasticus sp 46 120 T64
GCA 002163215.1 Cycloclasticus sp 46 83 sub15 T18
B223msp mb bin.2, Tromso
GCA 002101225.1 Cycloclasticus sp symbiont of Poecilosclerida sp
GCA 002733135.1 Cycloclasticus sp
0.05

FIG. 32

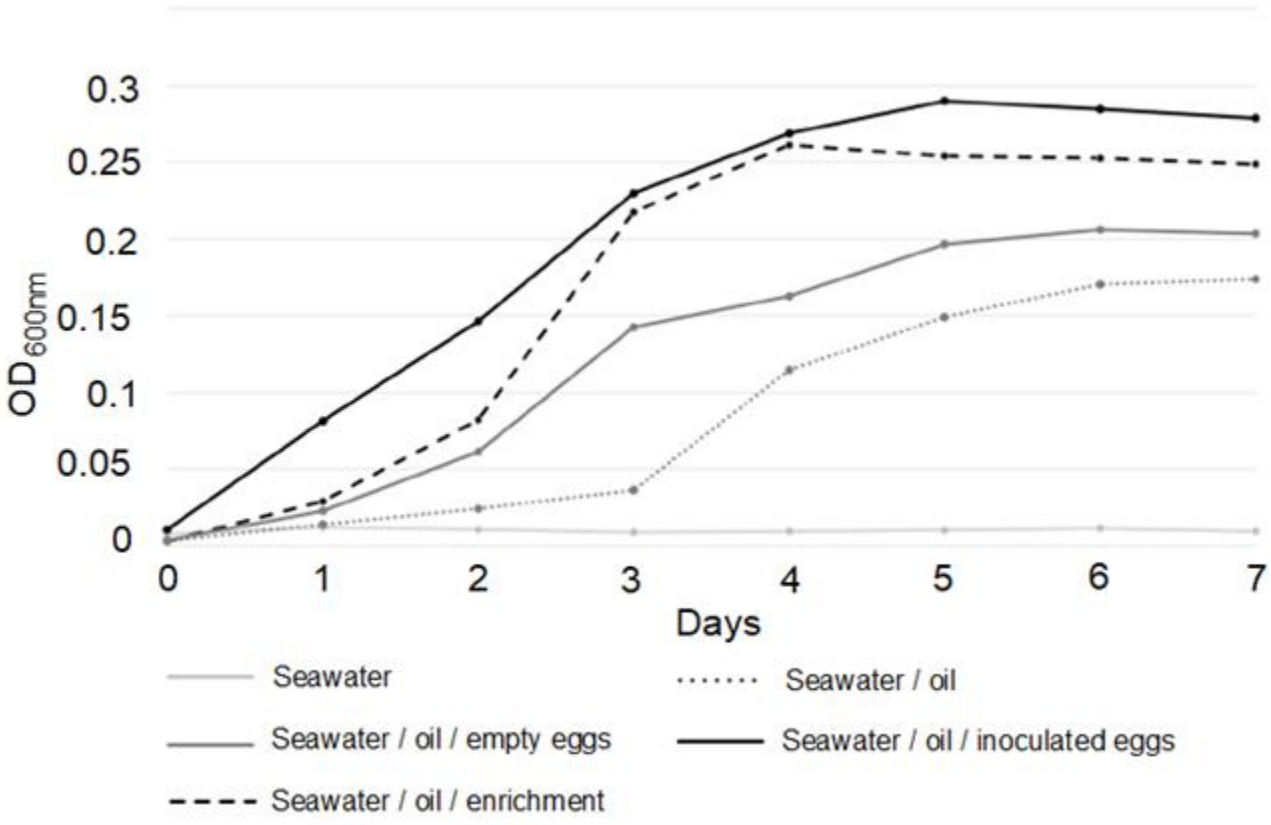

0.3
0.25
0.2
0.15
0.1
0.05
0
OD600nm
0
1
2
3
4
5
6
7
Days
Seawater
Seawater / oil
Seawater / oil / empty eggs
Seawater / oil / inoculated eggs
Seawater / oil / enrichment

FIG. 1

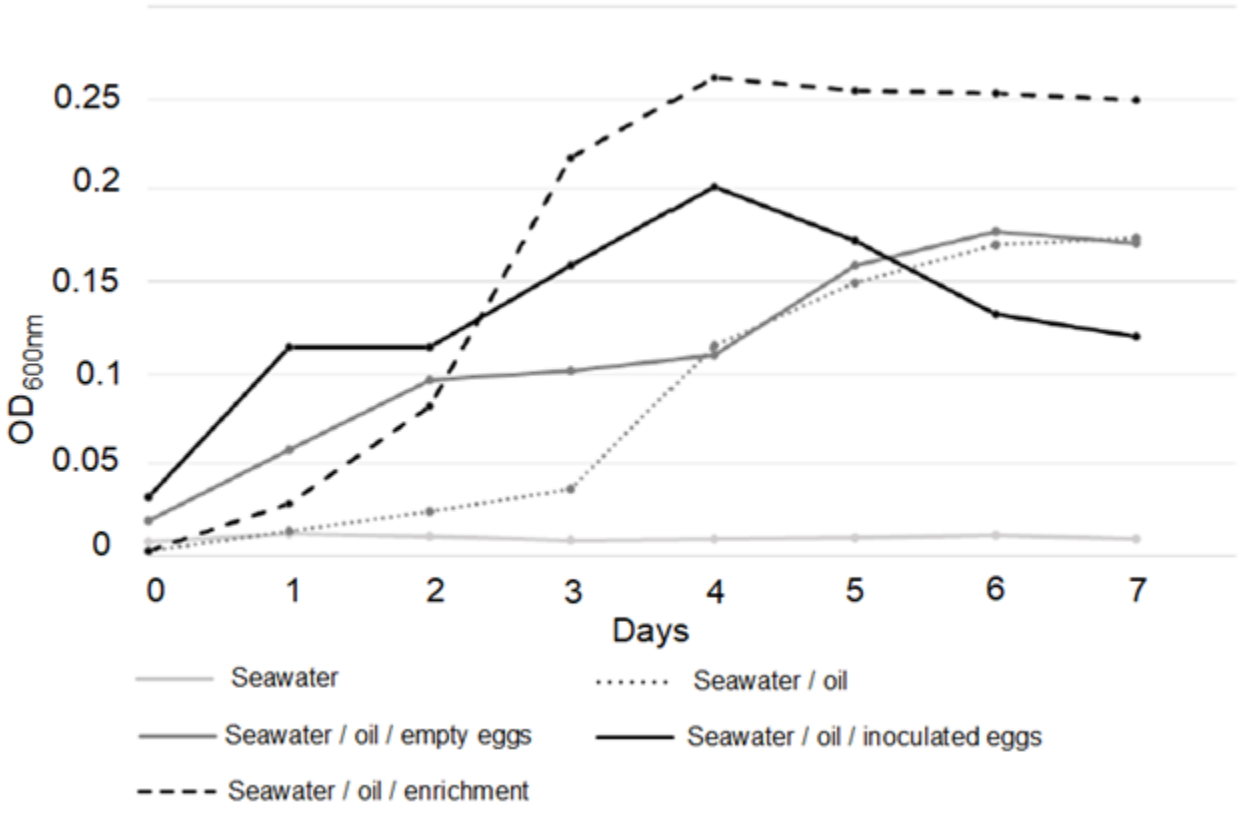

0.25
0.2
0.15
0.1
0.05
0
OD600nm
0
1
2
3
4
5
6
7
Days
Seawater
Seawater / oil
Seawater / oil / empty eggs
Seawater / oil / inoculated eggs
Seawater / oil / enrichment

FIG. 2

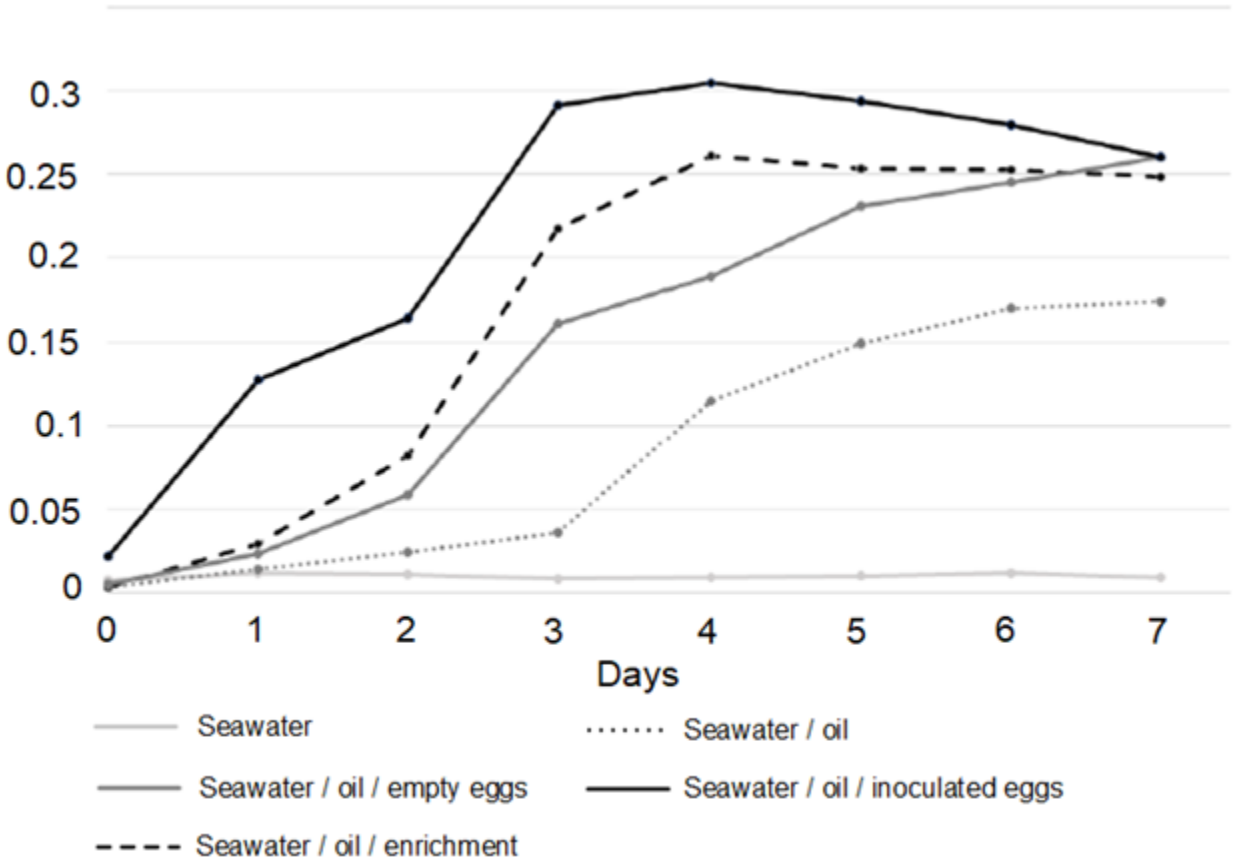

0.3
0.25
0.2
0.15
0.1
0.05
0
0
1
2
3
4
5
6
7
Days
Seawater
Seawater / oil
Seawater / oil / empty eggs
Seawater / oil / inoculated eggs
Seawater / oil / enrichment

FIG. 3

FIG. 4A

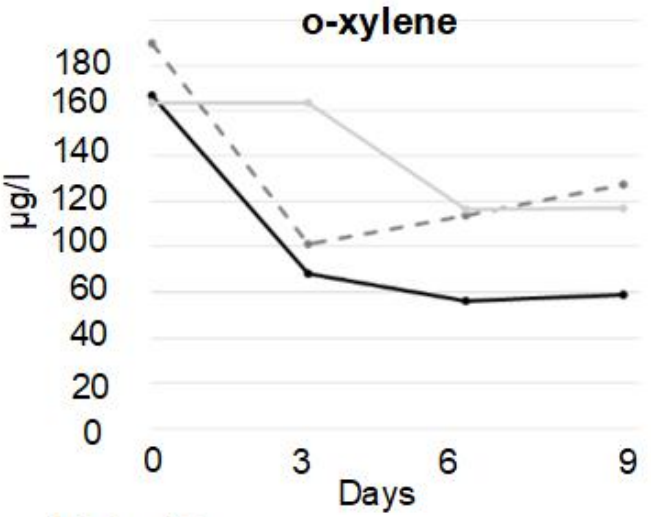


FIG. 4B

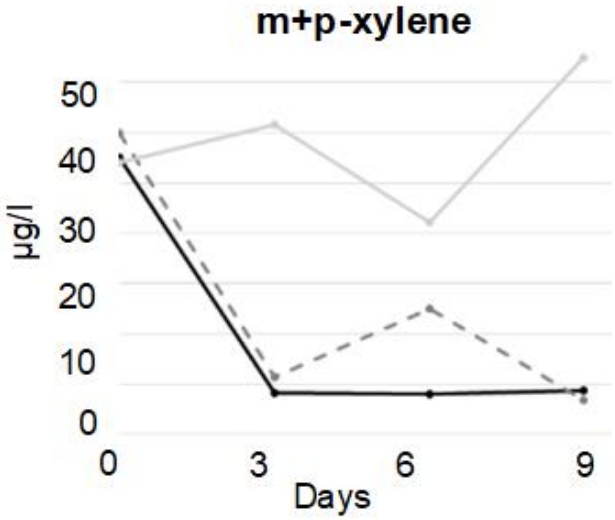


FIG. 4C

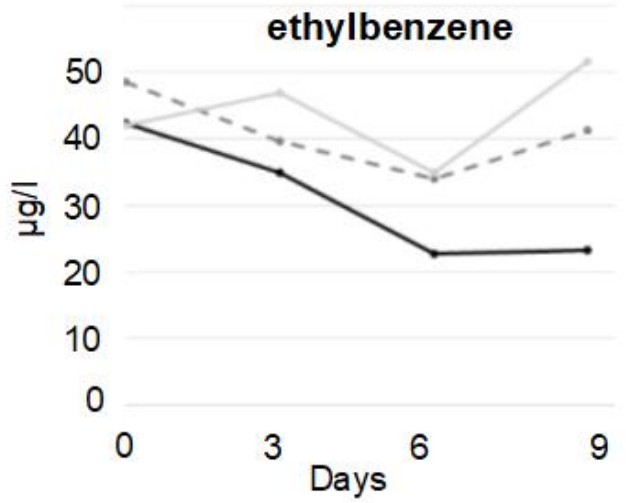


FIG. 4D

	Enriched Copepod carcass	Enriched seawater
Ethylbenzene	-55%	-20%
m+p+xylene	-88%	-91%
o-xylene	-40%	10%

Reduction of non acute toxic compounds compared to natural degradation

Seawater

Seawater/oil/inoculated eggs

Seawater/oil/enrichment

FIG. 4

FIG. 5A

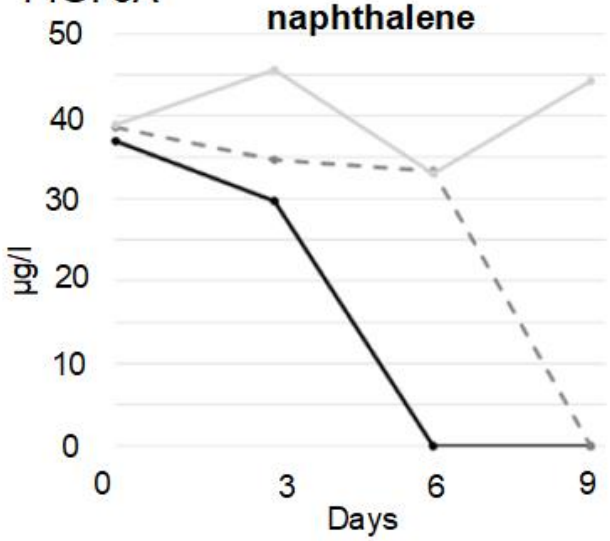


FIG. 5B

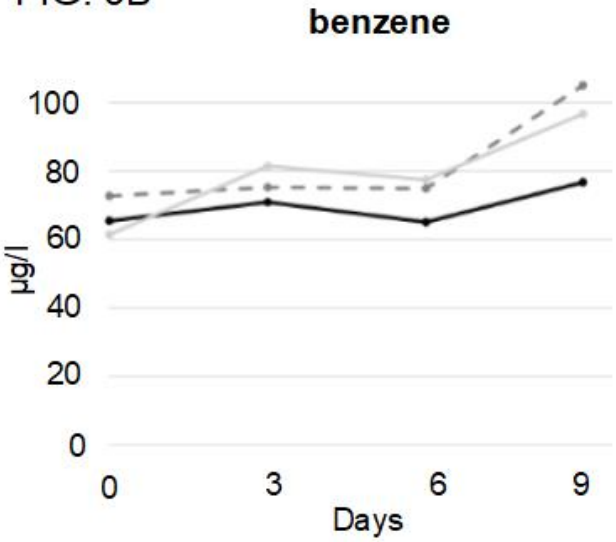


FIG. 5C

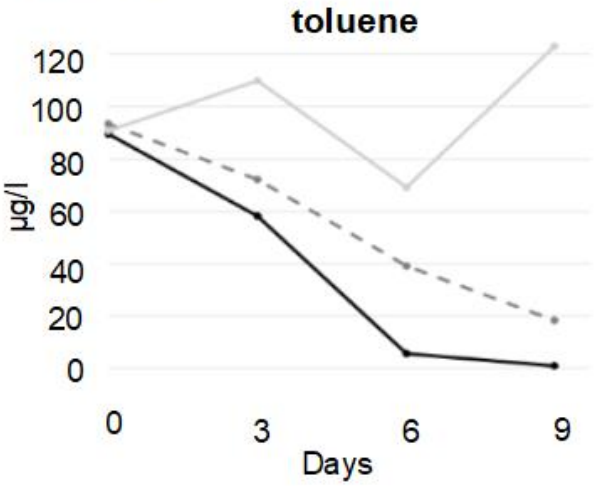


FIG. 5D

	Enriched Copepod carcass	Enriched seawater
Naphthalene	Not detectable	Not detectable
Toluene	-99.4%	-85%
Benzene	-21%	9%

Reduction of highly toxic compounds compared to natural degradation

Seawater

Seawater/oil/inoculated eggs

Seawater/oil/enrichment

FIG. 5

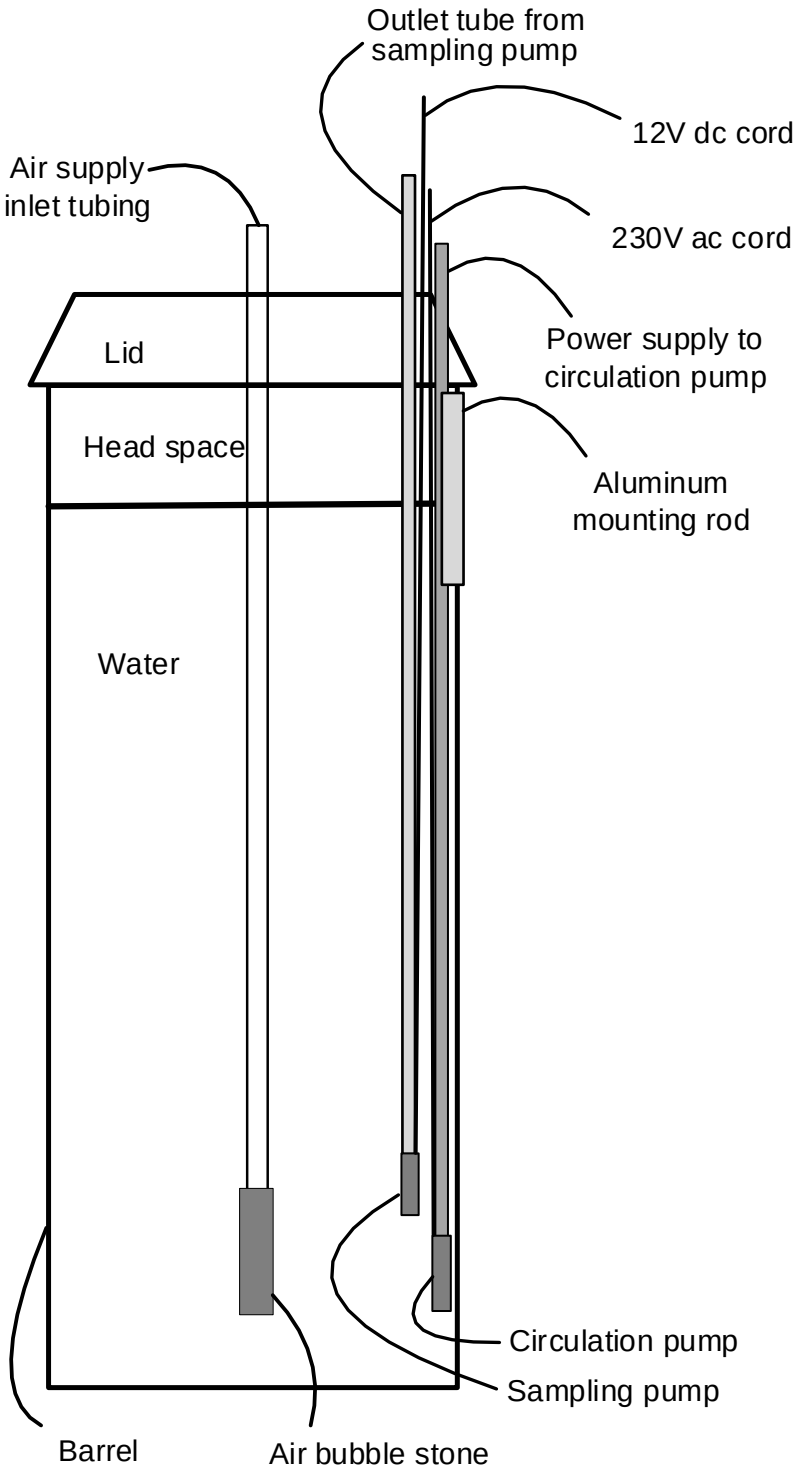

Outlet tube from sampling pump
12V dc cord
Air supply inlet tubing
230V ac cord
Power supply to circulation pump
Lid
Head space
Aluminum mounting rod
Water
Circulation pump
Sampling pump
Barrel
Air bubble stone

FIG. 6

FIG. 7A pH

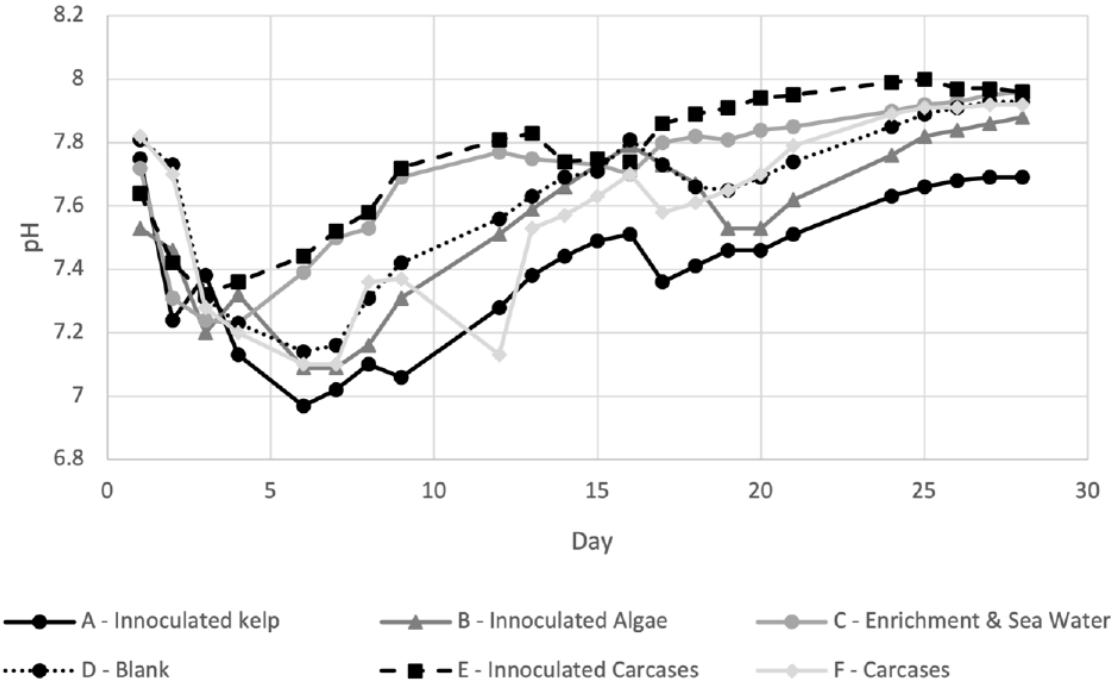


FIG. 7B ORP

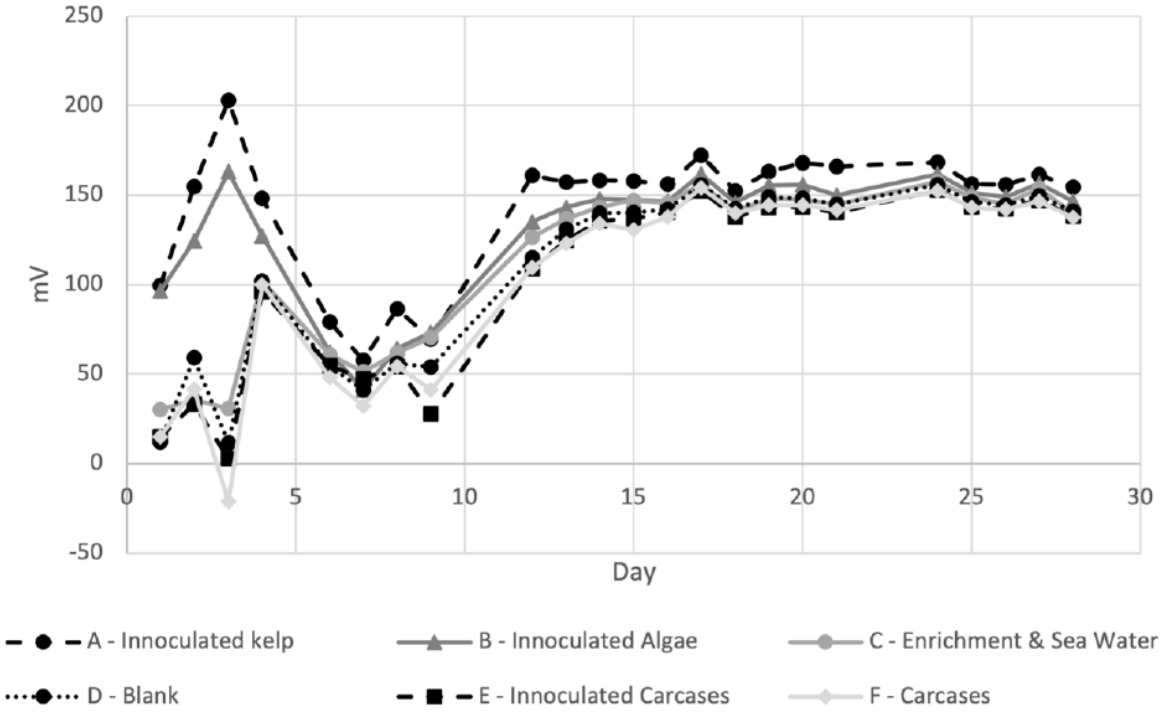


FIG. 7

FIG. 8A Turbidity

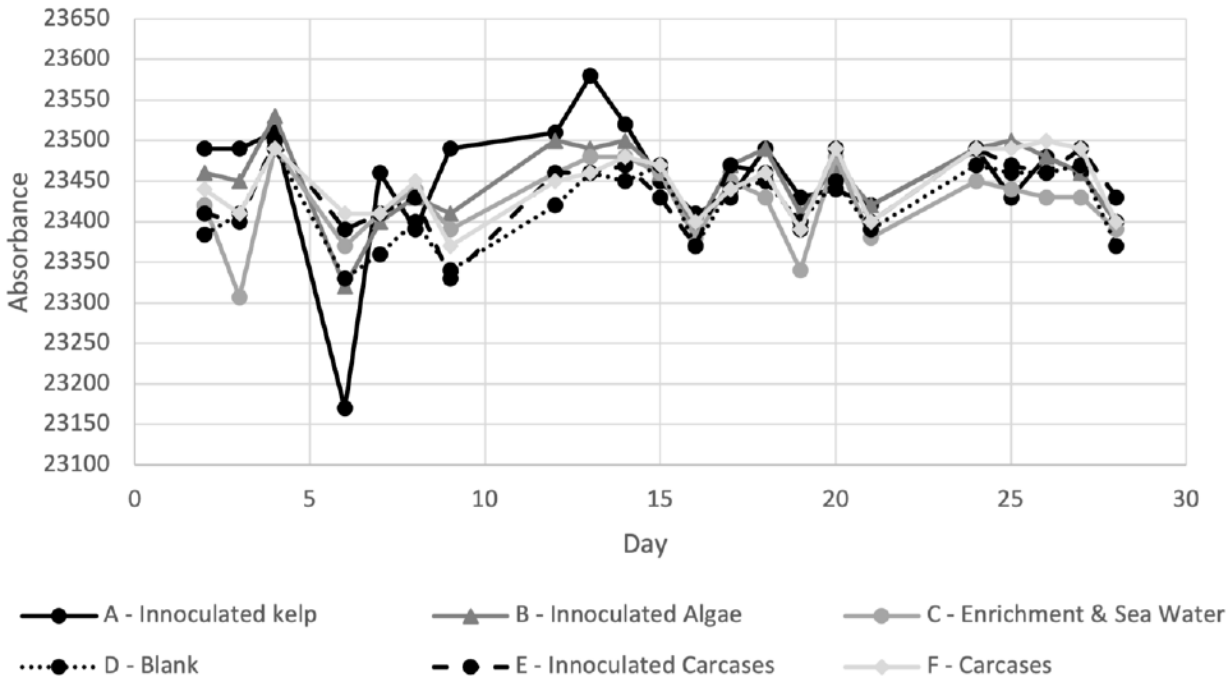


FIG. 8B Optical Density

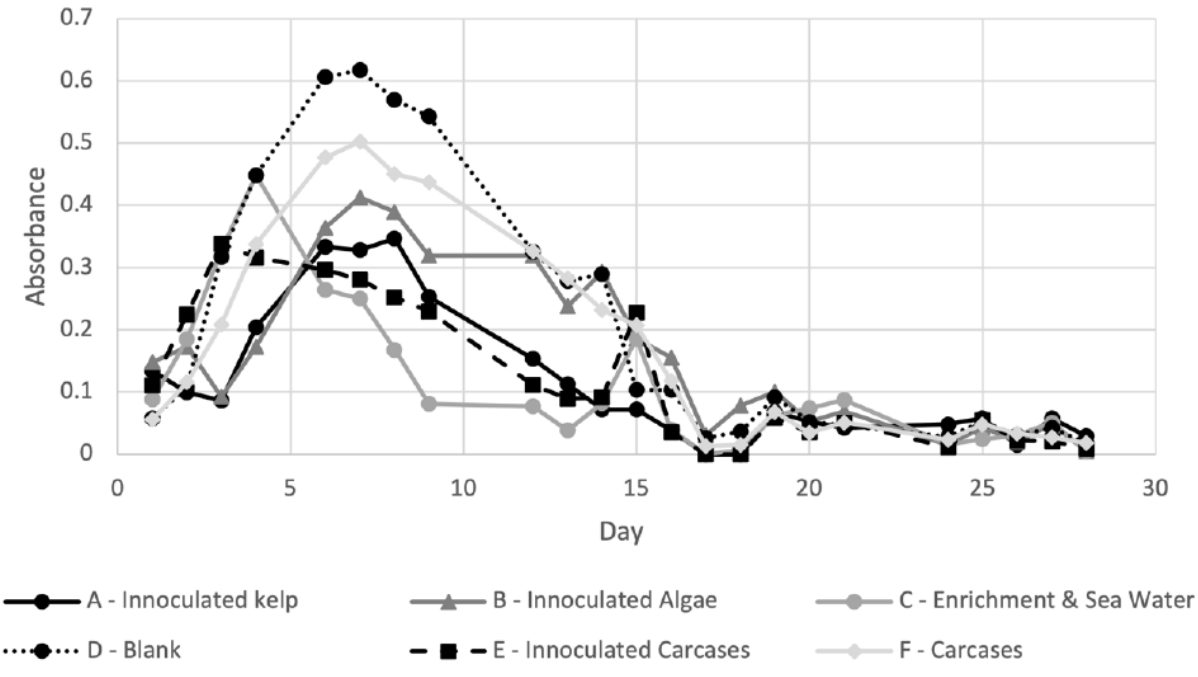


FIG. 8

FIG. 9A: Inoculated kelp

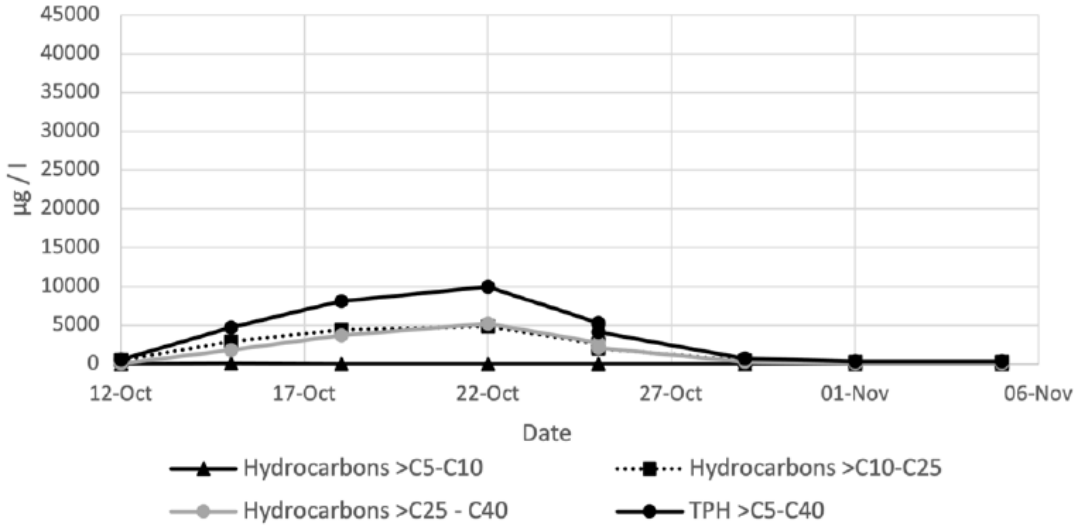


FIG. 9B: Inoculated algae

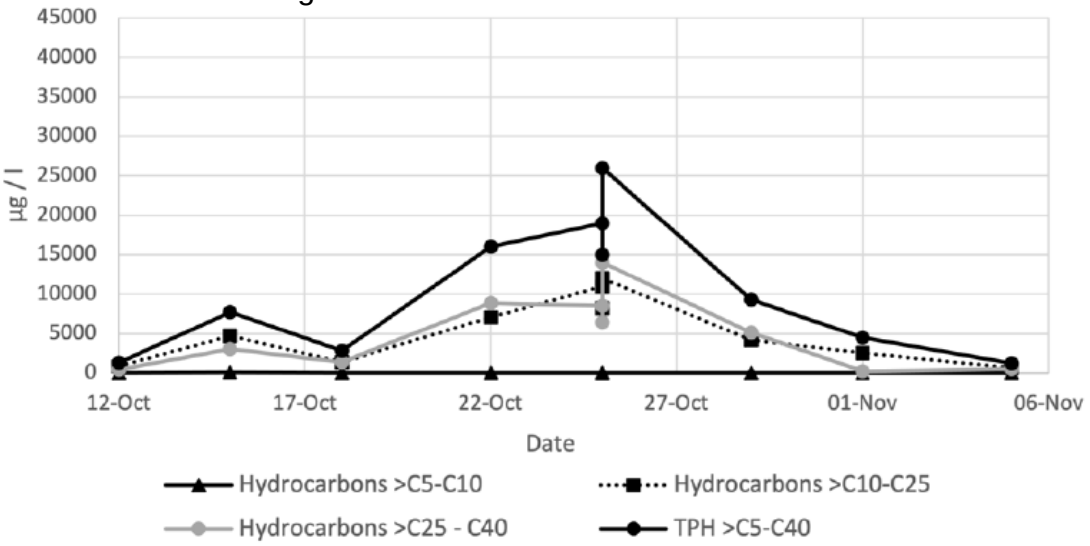


FIG. 9C: Enrichment & seawater

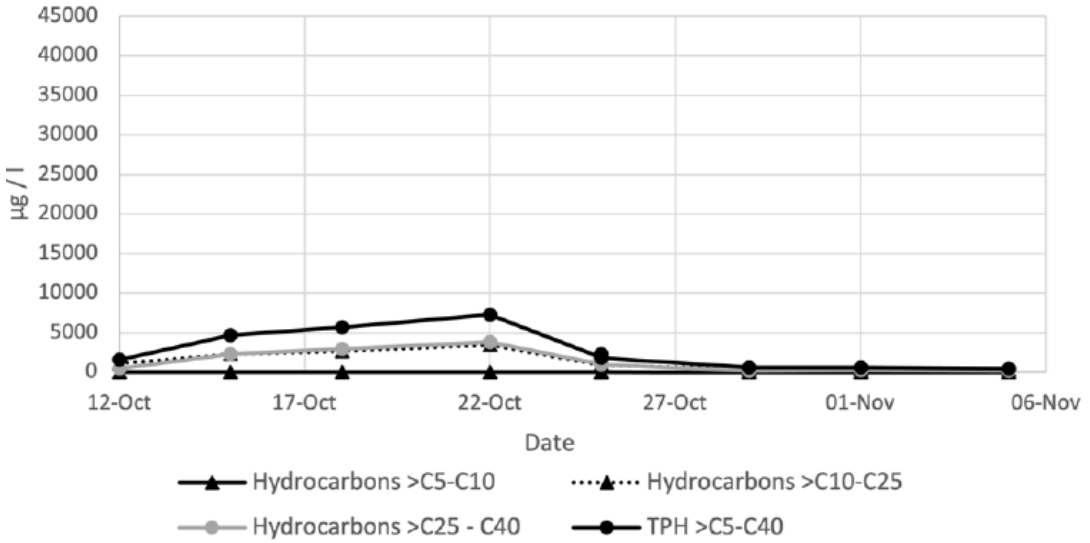


FIG. 9D: Control

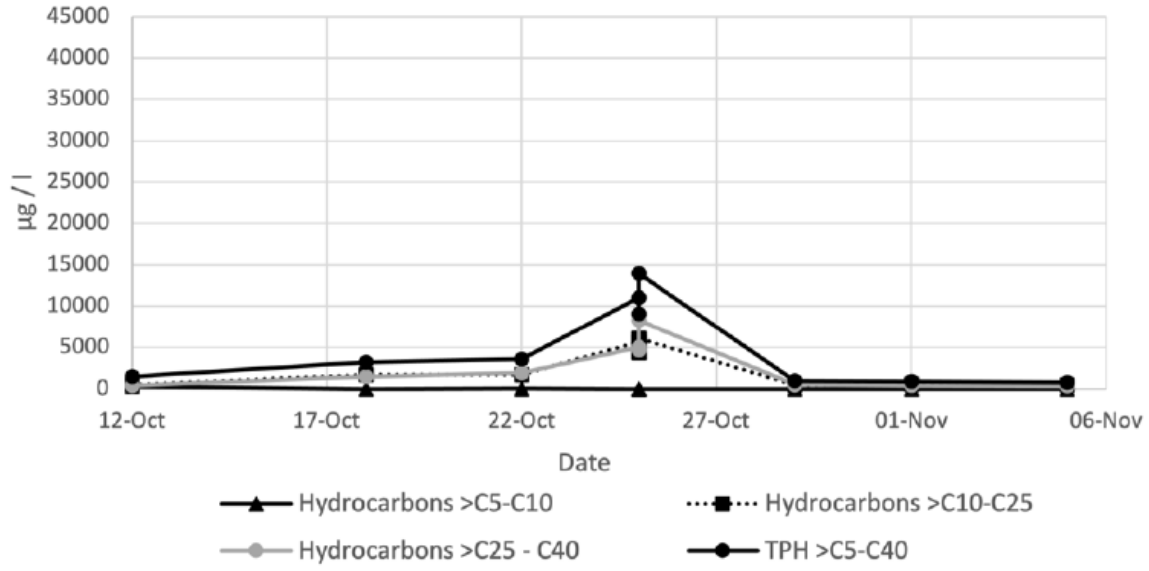


FIG. 9E: Inoculated copepod carcasses

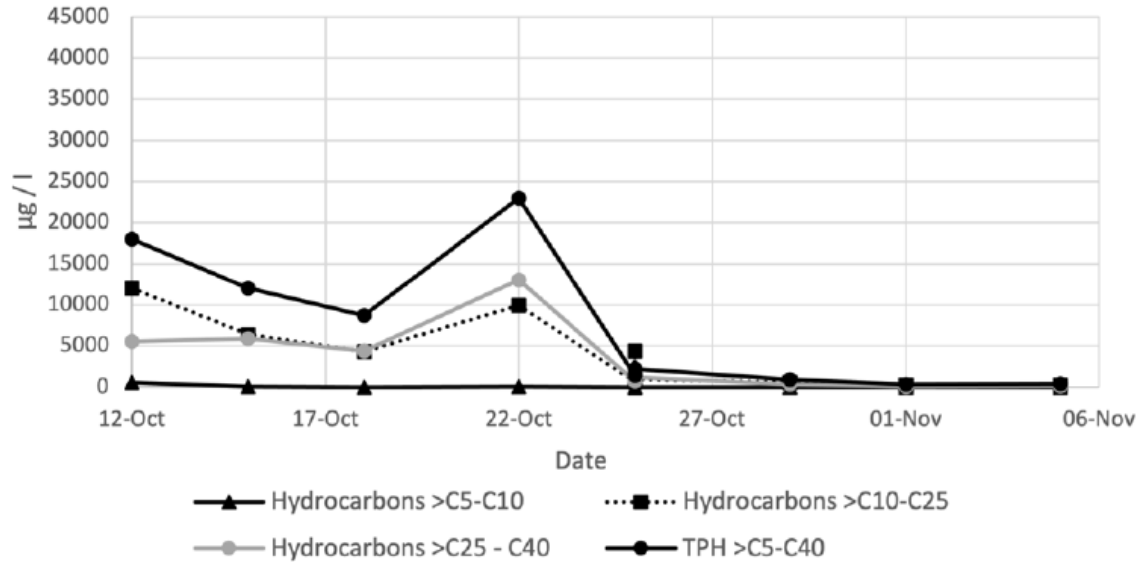
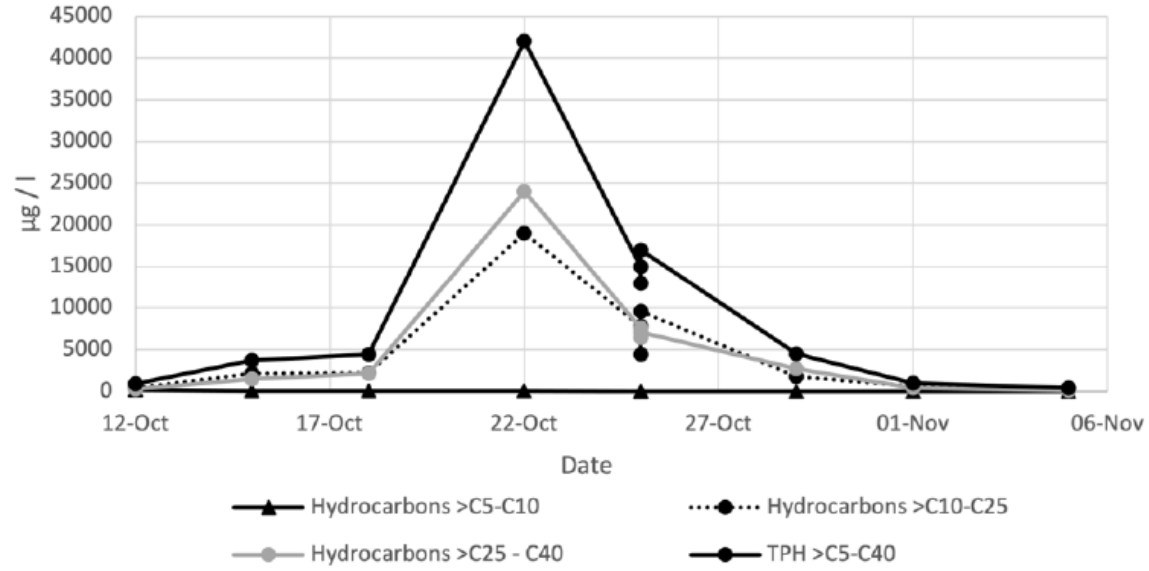


FIG. 9F: Copepod carcasses



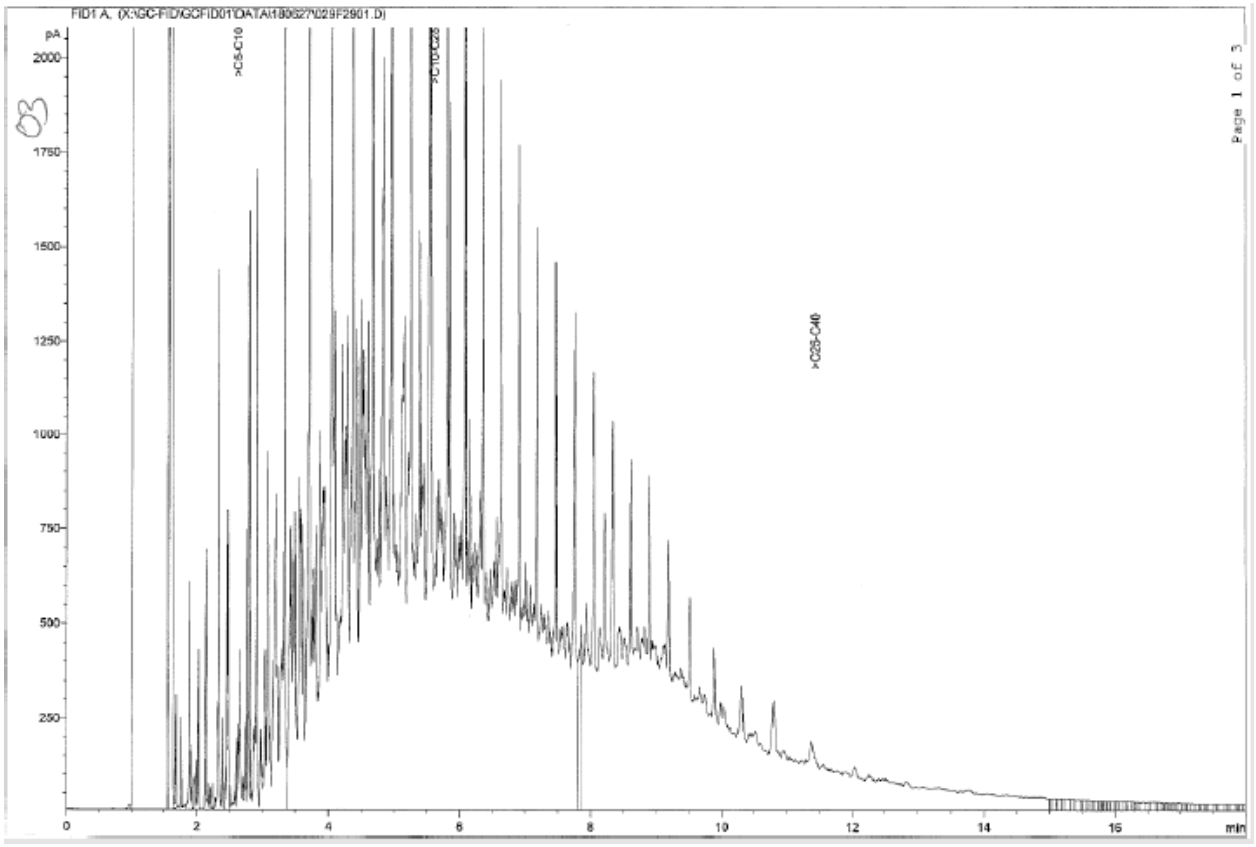

FID1 A, (X:\GC-FID\GCFID01\DATA\180627\029F2901.D)
pA
2000
1750
1500
1250
1000
750
500
250
>C5-C10
>C10-C25
>C25-C40
Page 1 of 3
0
2
4
6
8
10
12
14
16
min

FIG. 10

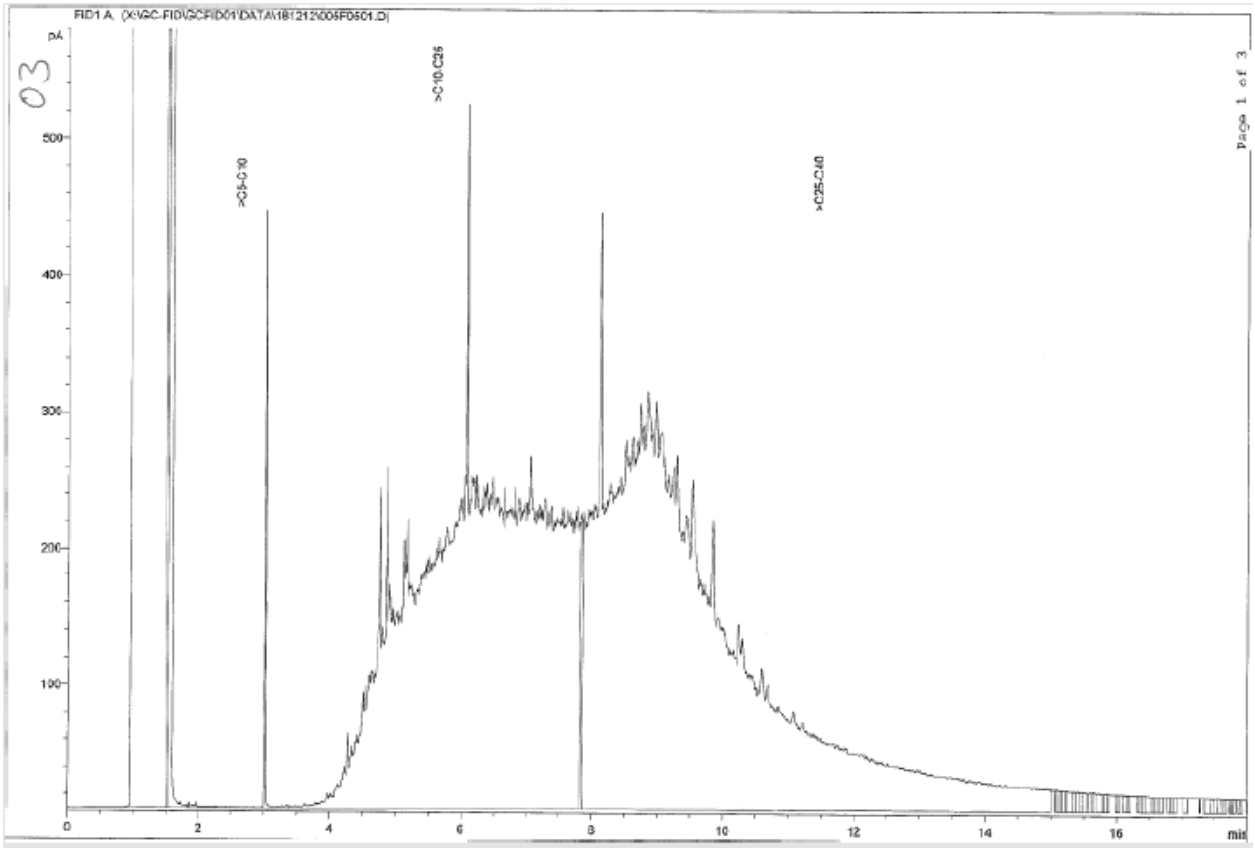

FID1 A, (X:\GC-FID\GCFID01\DATA\181212\0005F0501.D)
pA
03
>C8-C10
>C10-C25
>C25-C40
Page 1 of 3
500
400
300
200
100
0
2
4
6
8
10
12
14
16
min

FIG. 11

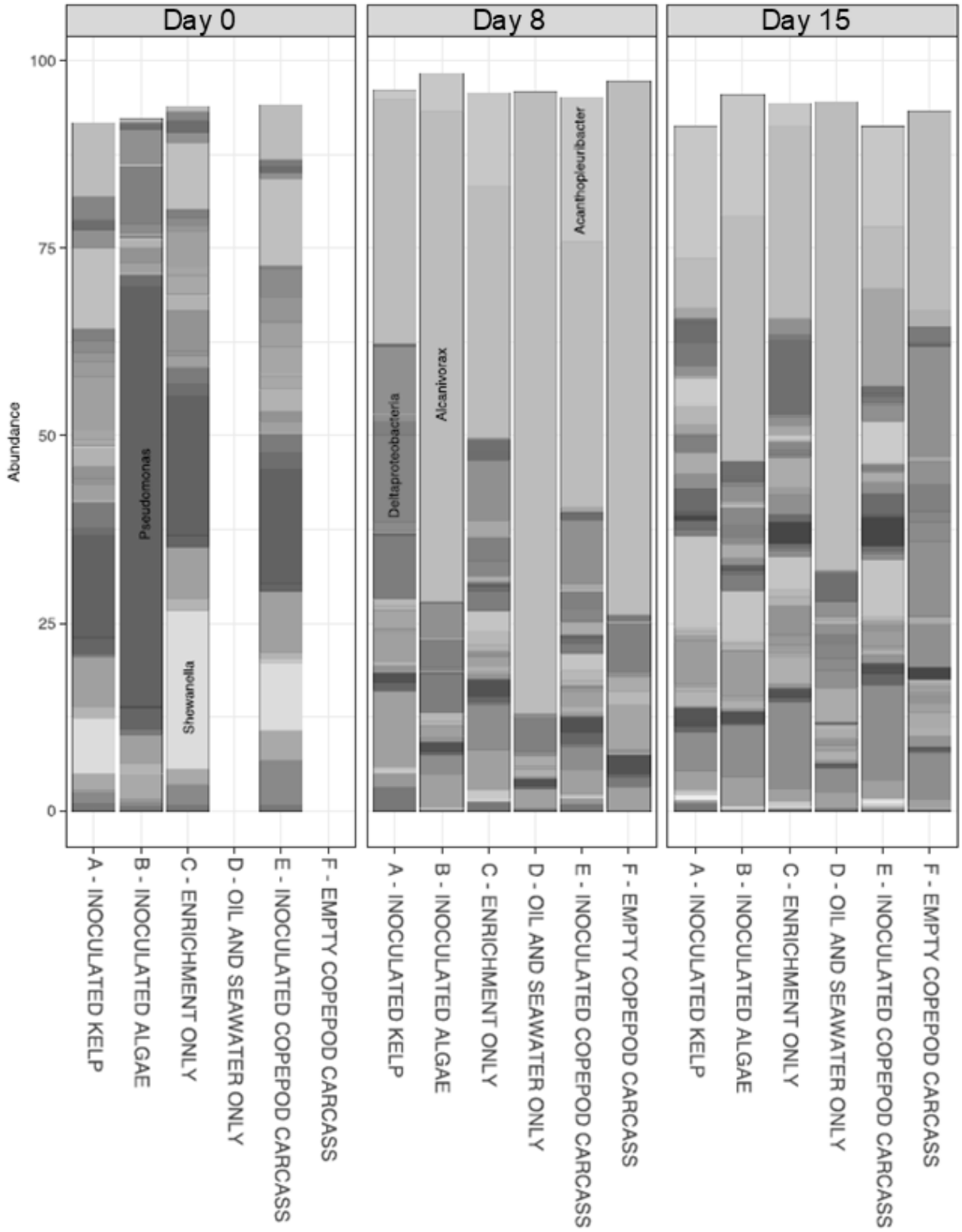

Day 0
Day 8
Day 15
Abundance
100
75
50
25
0
Pseudomonas
Shewanella
Deltaproteobacteria
Alcanivorax
Acanthopleuribacter
A - INOCULATED KELP
B - INOCULATED ALGAE
C - ENRICHMENT ONLY
D - OIL AND SEAWATER ONLY
E - INOCULATED COPEPOD CARCASS
F - EMPTY COPEPOD CARCASS

FIG. 12A

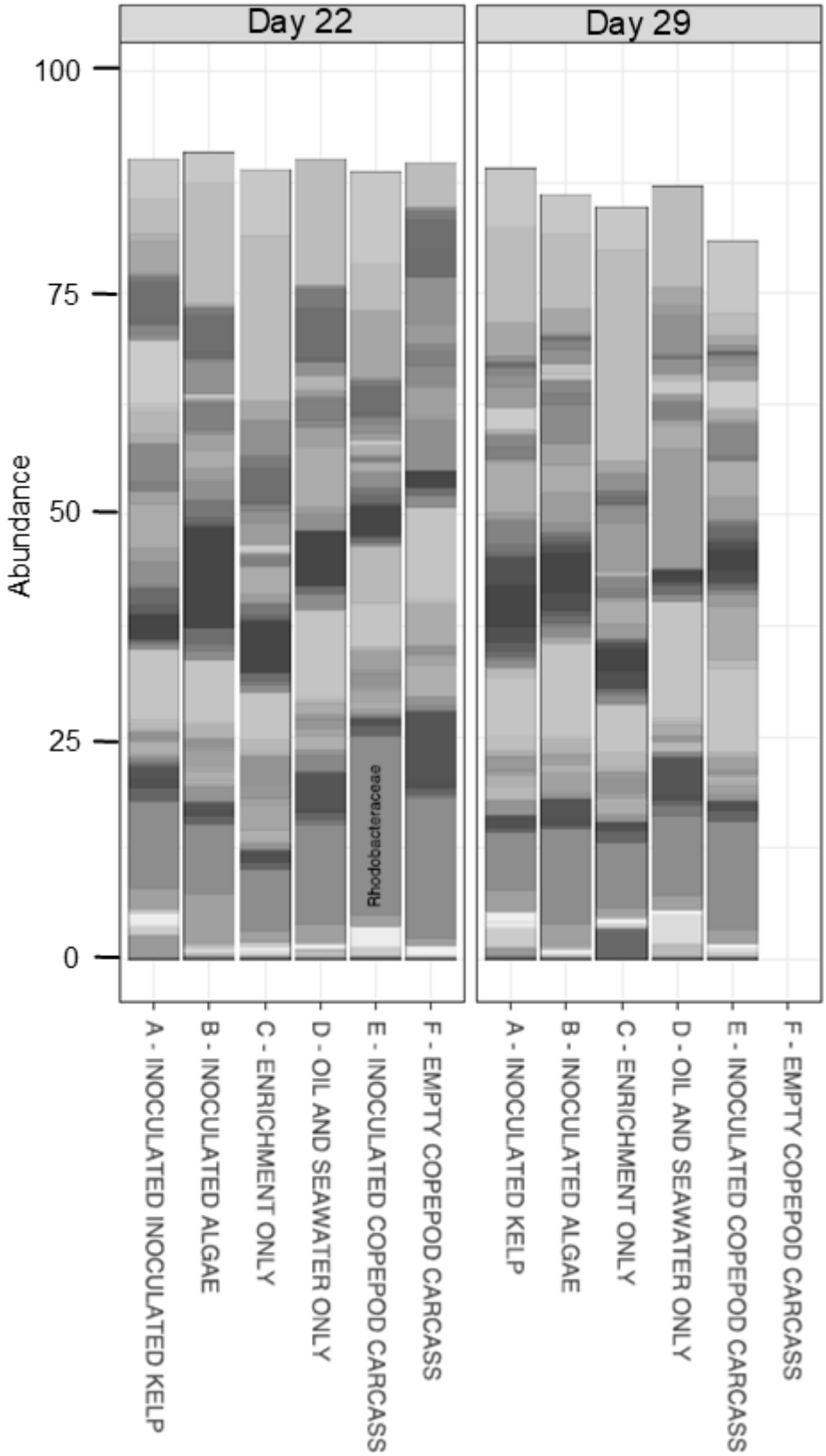

Day 22
Day 29
100
75
50
25
0
Abundance
Rhodobacteraceae
A - INOCULATED INOCULATED KELP
B - INOCULATED ALGAE
C - ENRICHMENT ONLY
D - OIL AND SEAWATER ONLY
E - INOCULATED COPEPOD CARCASS
F - EMPTY COPEPOD CARCASS
A - INOCULATED KELP
B - INOCULATED ALGAE
C - ENRICHMENT ONLY
D - OIL AND SEAWATER ONLY
E - INOCULATED COPEPOD CARCASS
F - EMPTY COPEPOD CARCASS

FIG. 12B

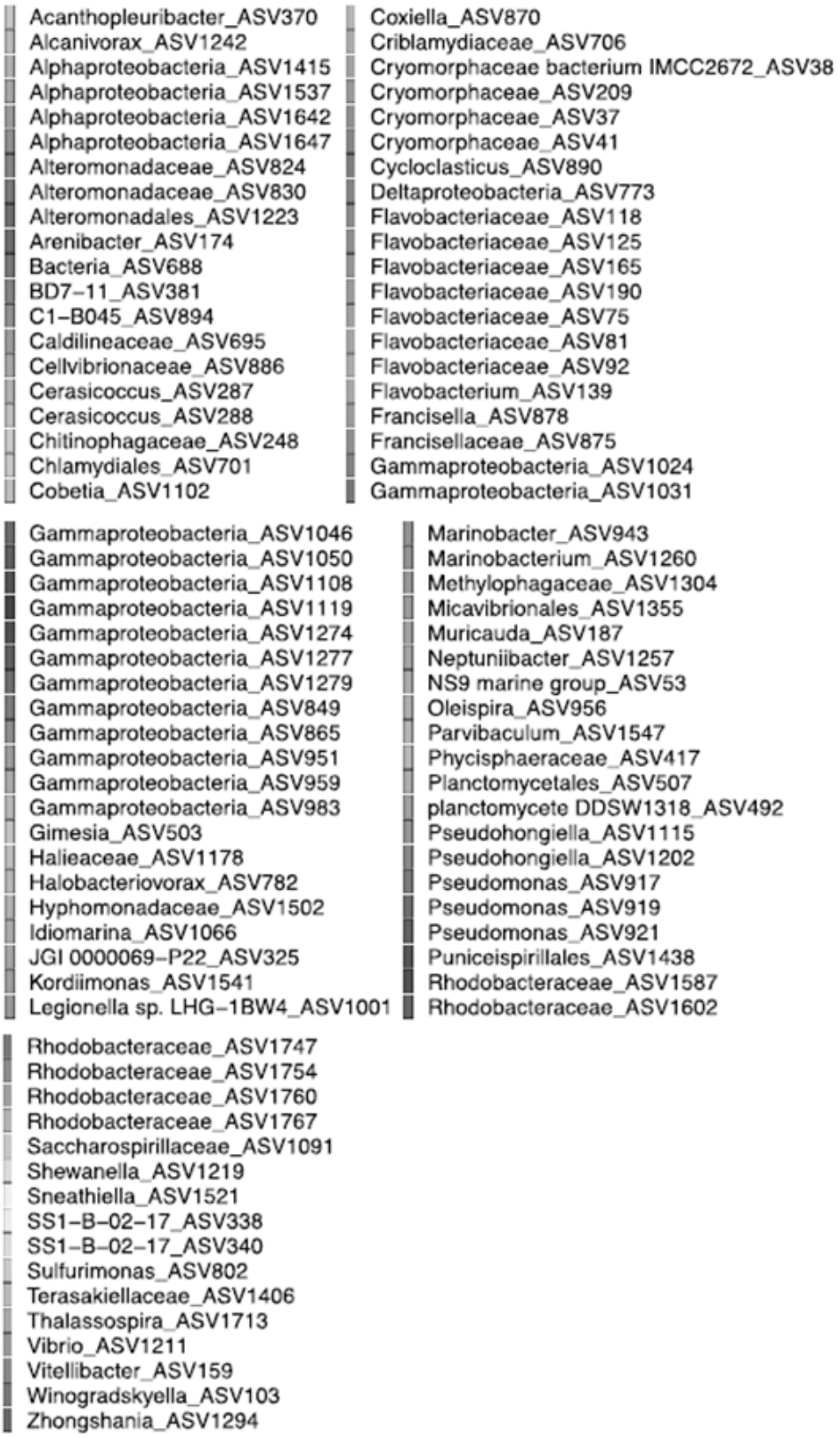

Acanthopleuribacter_ASV370
Alcanivorax_ASV1242
Alphaproteobacteria_ASV1415
Alphaproteobacteria_ASV1537
Alphaproteobacteria_ASV1642
Alphaproteobacteria_ASV1647
Alteromonadaceae_ASV824
Alteromonadaceae_ASV830
Alteromonadales_ASV1223
Arenibacter_ASV174
Bacteria_ASV688
BD7-11_ASV381
C1-B045_ASV894
Caldilineaceae_ASV695
Cellvibrionaceae_ASV886
Cerasicoccus_ASV287
Cerasicoccus_ASV288
Chitinophagaceae_ASV248
Chlamydiales_ASV701
Cobetia_ASV1102
Coxiella_ASV870
Criblamydiaceae_ASV706
Cryomorphaceae bacterium IMCC2672_ASV38
Cryomorphaceae_ASV209
Cryomorphaceae_ASV37
Cryomorphaceae_ASV41
Cycloclasticus_ASV890
Deltaproteobacteria_ASV773
Flavobacteriaceae_ASV118
Flavobacteriaceae_ASV125
Flavobacteriaceae_ASV165
Flavobacteriaceae_ASV190
Flavobacteriaceae_ASV75
Flavobacteriaceae_ASV81
Flavobacteriaceae_ASV92
Flavobacterium_ASV139
Francisella_ASV878
Francisellaceae_ASV875
Gammaproteobacteria_ASV1024
Gammaproteobacteria_ASV1031
Gammaproteobacteria_ASV1046
Gammaproteobacteria_ASV1050
Gammaproteobacteria_ASV1108
Gammaproteobacteria_ASV1119
Gammaproteobacteria_ASV1274
Gammaproteobacteria_ASV1277
Gammaproteobacteria_ASV1279
Gammaproteobacteria_ASV849
Gammaproteobacteria_ASV865
Gammaproteobacteria_ASV951
Gammaproteobacteria_ASV959
Gammaproteobacteria_ASV983
Gimesia_ASV503
Halieaceae_ASV1178
Halobacteriovorax_ASV782
Hyphomonadaceae_ASV1502
Idiomarina_ASV1066
JGI 0000069-P22_ASV325
Kordiimonas_ASV1541
Legionella sp. LHG-1BW4_ASV1001
Marinobacter_ASV943
Marinobacterium_ASV1260
Methylophagaceae_ASV1304
Micavibrionales_ASV1355
Muricauda_ASV187
Neptuniibacter_ASV1257
NS9 marine group_ASV53
Oleispira_ASV956
Parvibaculum_ASV1547
Phycisphaeraceae_ASV417
Planctomycetales_ASV507
planctomycete DDSW1318_ASV492
Pseudohongiella_ASV1115
Pseudohongiella_ASV1202
Pseudomonas_ASV917
Pseudomonas_ASV919
Pseudomonas_ASV921
Puniceispirillales_ASV1438
Rhodobacteraceae_ASV1587
Rhodobacteraceae_ASV1602
Rhodobacteraceae_ASV1747
Rhodobacteraceae_ASV1754
Rhodobacteraceae_ASV1760
Rhodobacteraceae_ASV1767
Saccharospirillaceae_ASV1091
Shewanella_ASV1219
Sneathiella_ASV1521
SS1-B-02-17_ASV338
SS1-B-02-17_ASV340
Sulfurimonas_ASV802
Terasakiellaceae_ASV1406
Thalassospira_ASV1713
Vibrio_ASV1211
Vitellibacter_ASV159
Winogradskyella_ASV103
Zhongshania_ASV1294

FIG. 12C

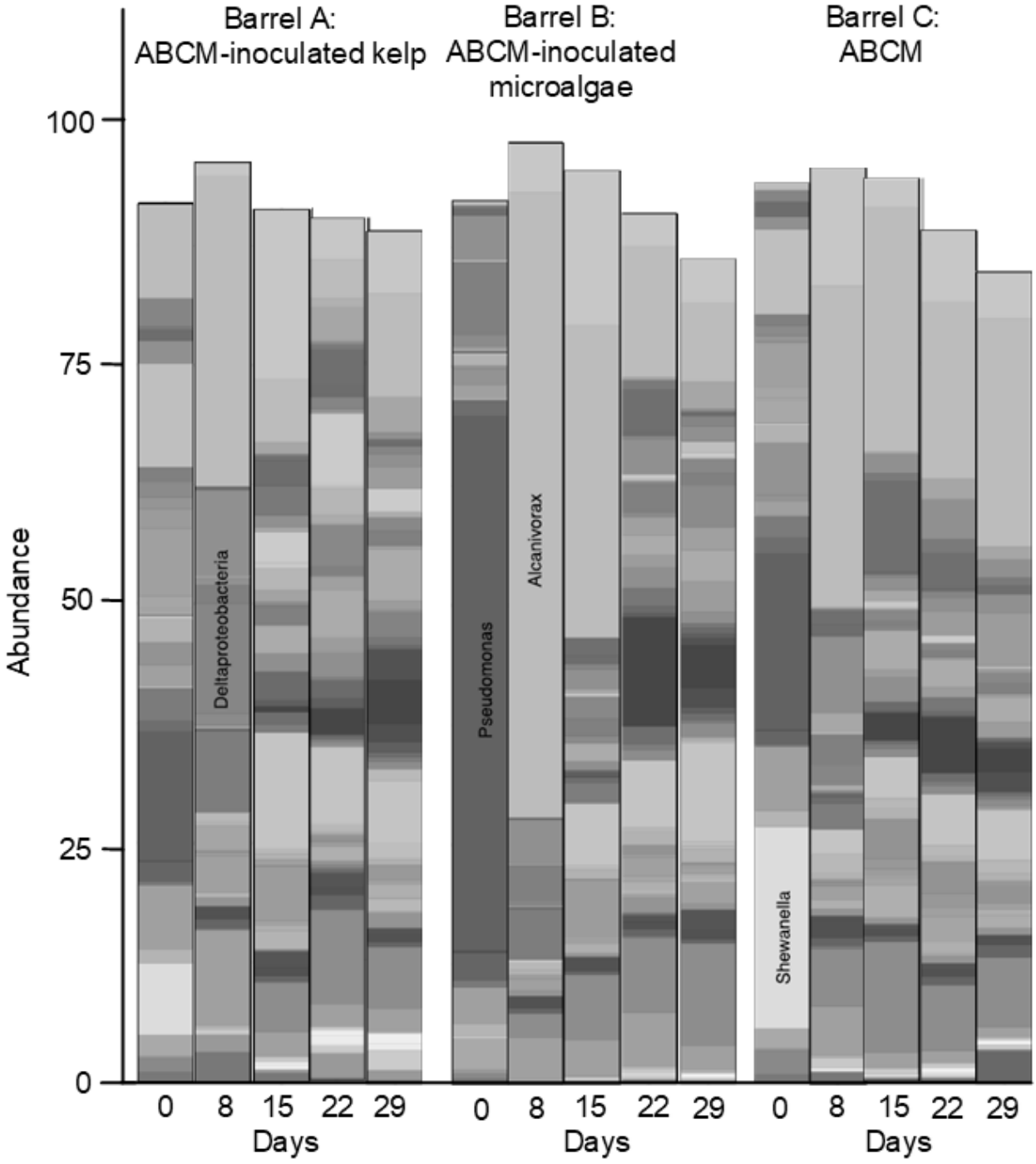

Barrel A:
ABCM-inoculated kelp
Barrel B:
ABCM-inoculated
microalgae
Barrel C:
ABCM
Abundance
100
75
50
25
0
Deltaproteobacteria
Pseudomonas
Alcanivorax
Shewanella
0
8
15
22
29
Days

FIG. 13A

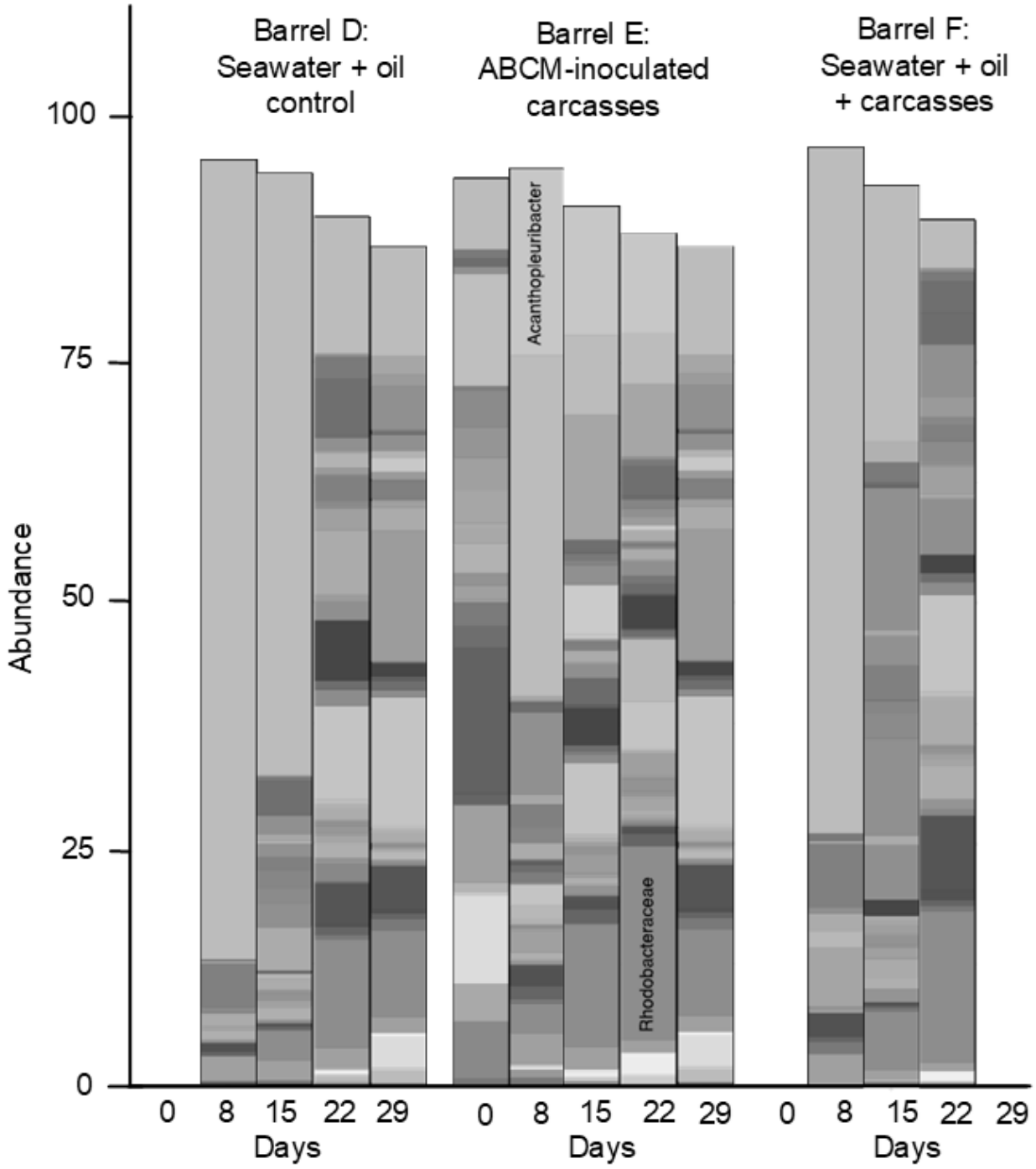

Barrel D:
Seawater + oil
control
Barrel E:
ABCM-inoculated
carcasses
Barrel F:
Seawater + oil
+ carcasses
Abundance
100
75
50
25
0
Acanthopleuribacter
Rhodobacteraceae
0 8 15 22 29
Days
0 8 15 22 29
Days
0 8 15 22 29
Days

FIG. 13B

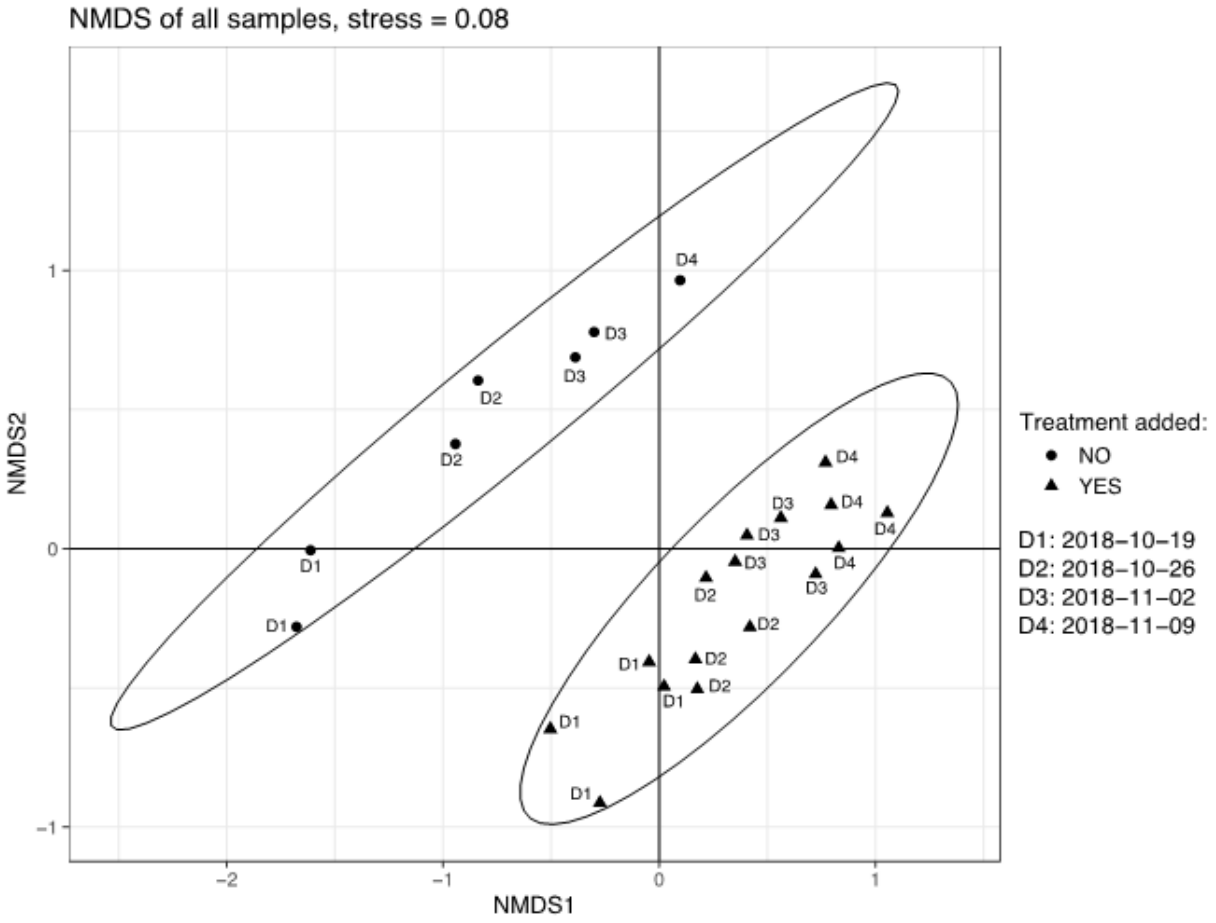

NMDS of all samples, stress = 0.08
NMDS2
NMDS1
1
0
−1
−2
−1
0
1
Treatment added:
NO
YES
D1: 2018−10−19
D2: 2018−10−26
D3: 2018−11−02
D4: 2018−11−09

FIG. 14

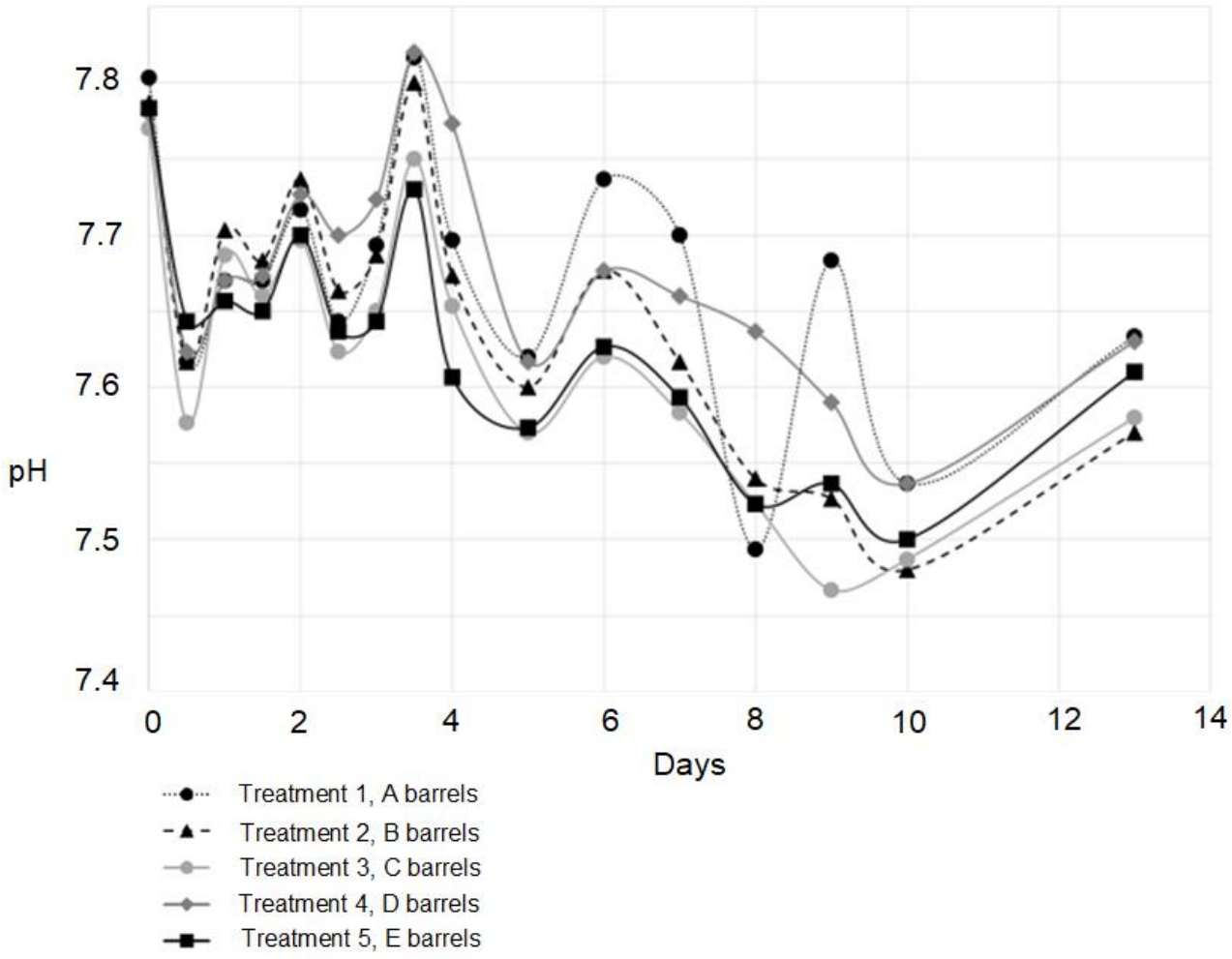

7.8
7.7
7.6
7.5
7.4
pH
0
2
4
6
8
10
12
14
Days
Treatment 1, A barrels
Treatment 2, B barrels
Treatment 3, C barrels
Treatment 4, D barrels
Treatment 5, E barrels

FIG. 15

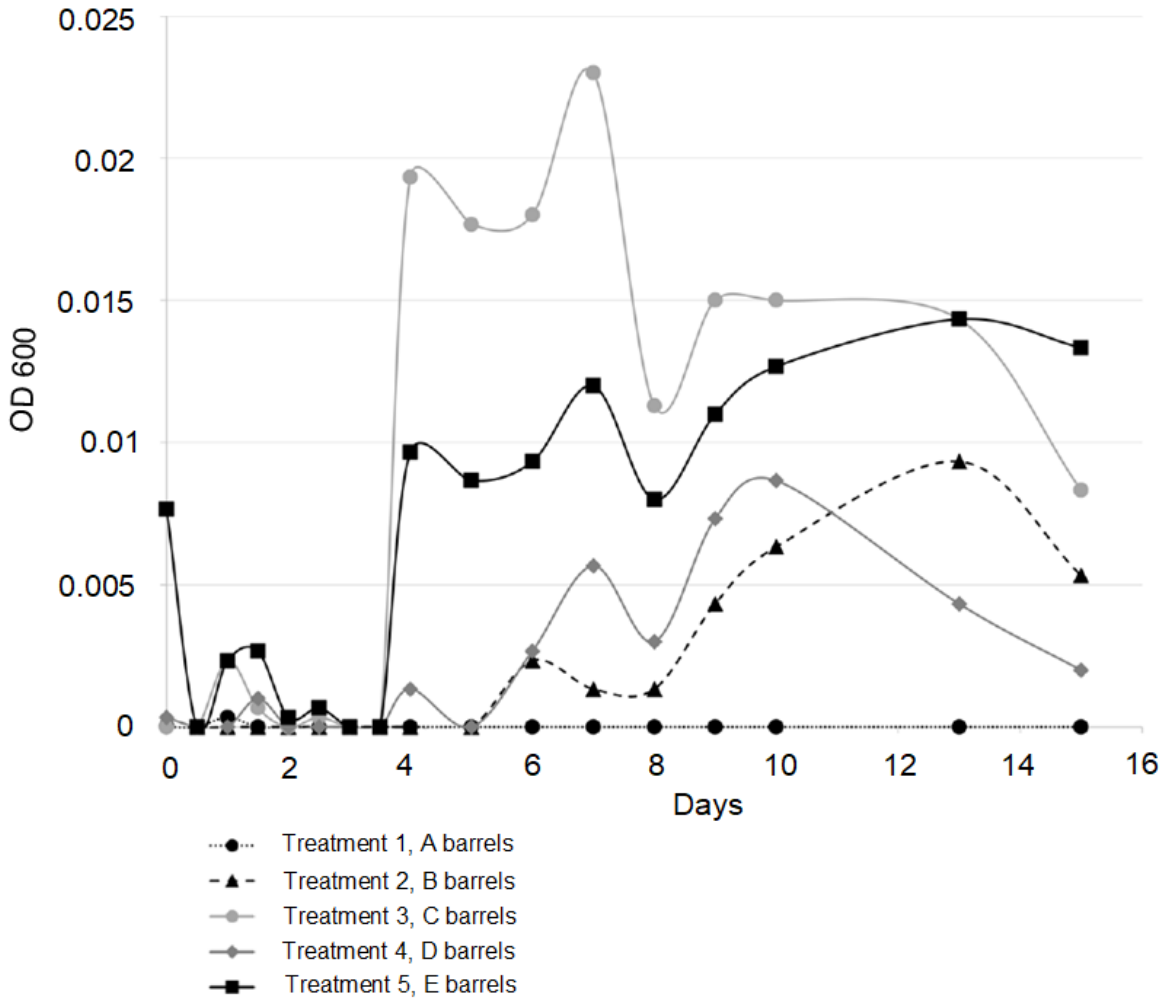

0.025
0.02
0.015
0.01
0.005
0
OD 600
0
2
4
6
8
10
12
14
16
Days
Treatment 1, A barrels
Treatment 2, B barrels
Treatment 3, C barrels
Treatment 4, D barrels
Treatment 5, E barrels

FIG. 16

FIG. 17A

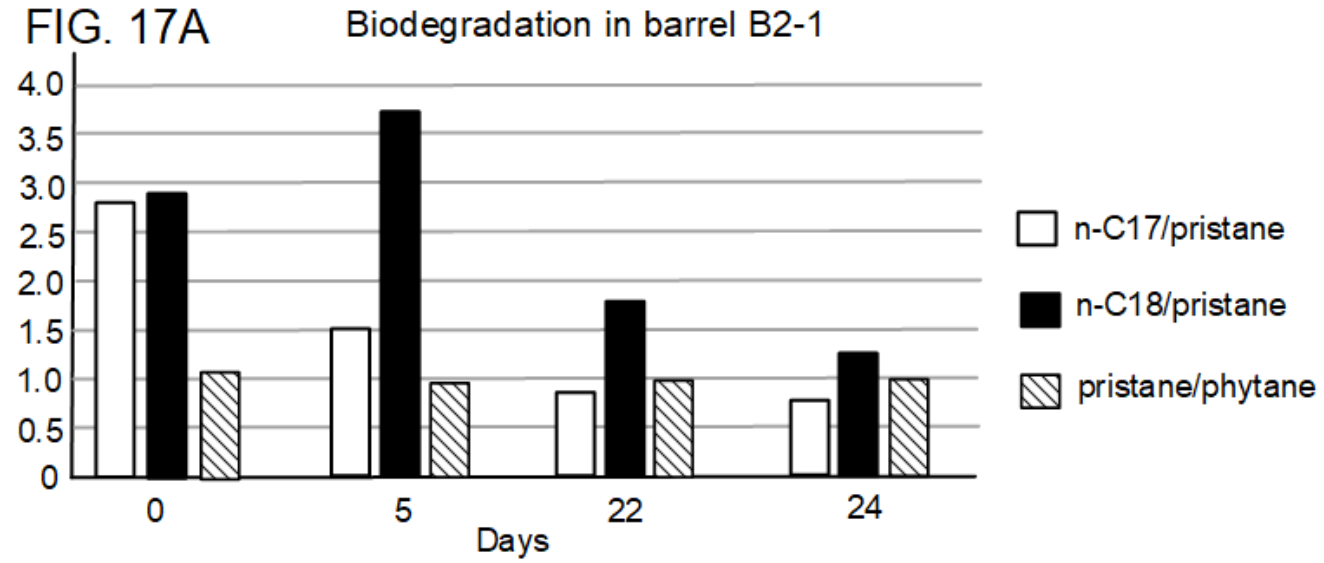


FIG. 17B

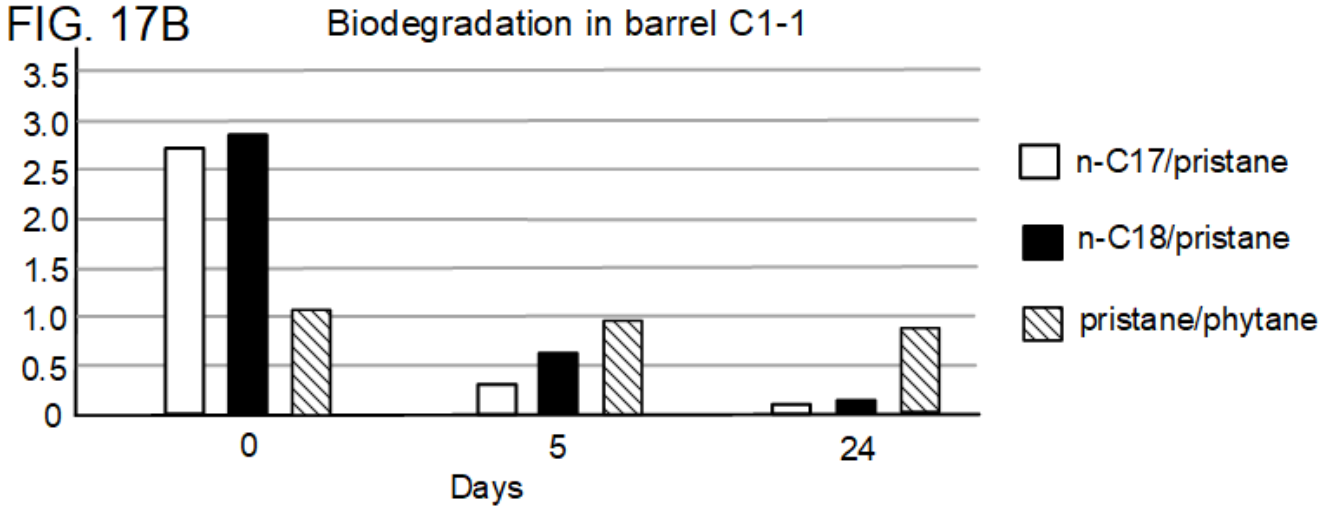


FIG. 17C

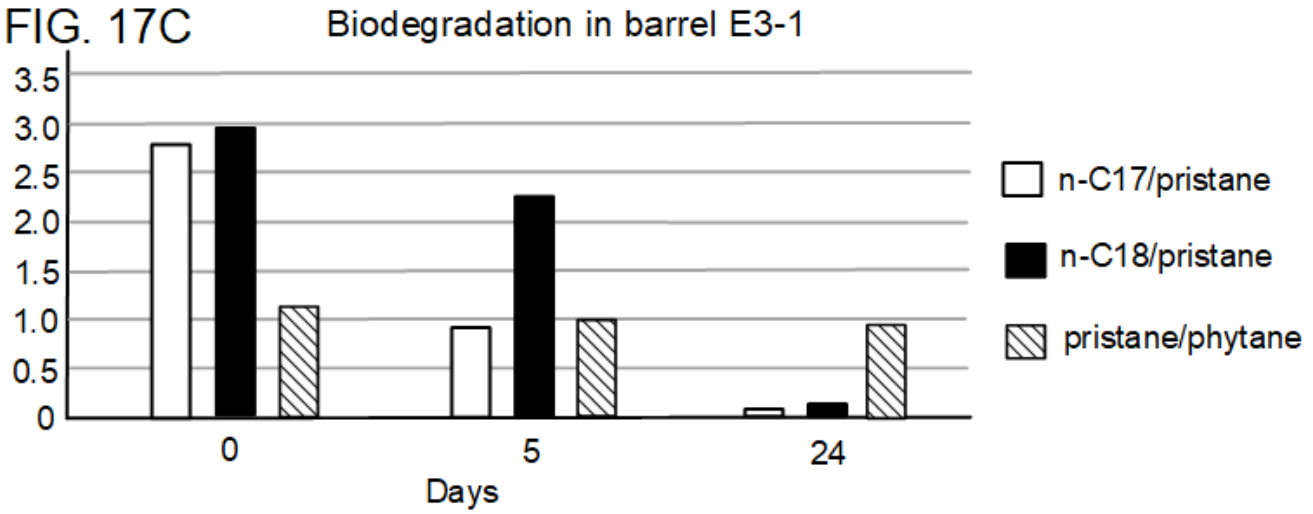


FIG. 17

FIG. 18A

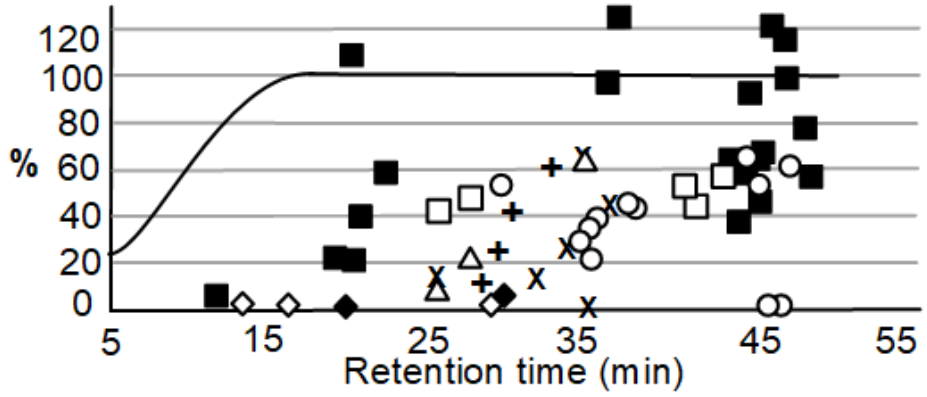


FIG. 18B

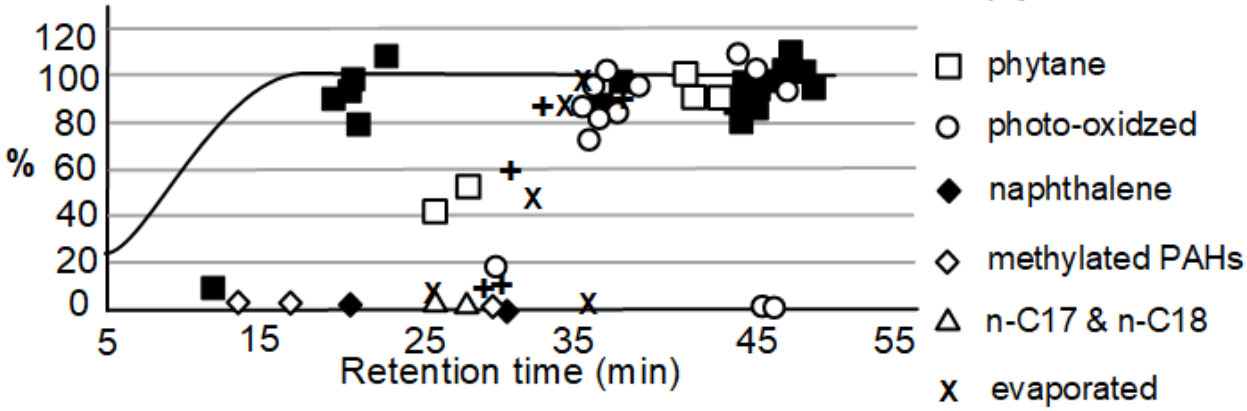


FIG. 18C

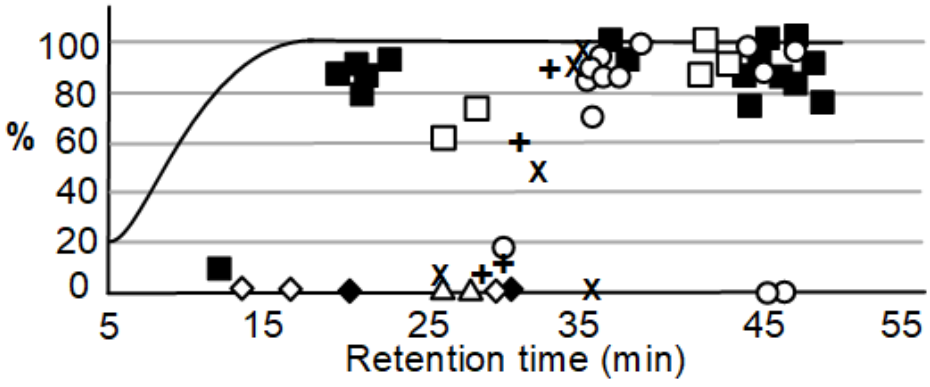


FIG. 18

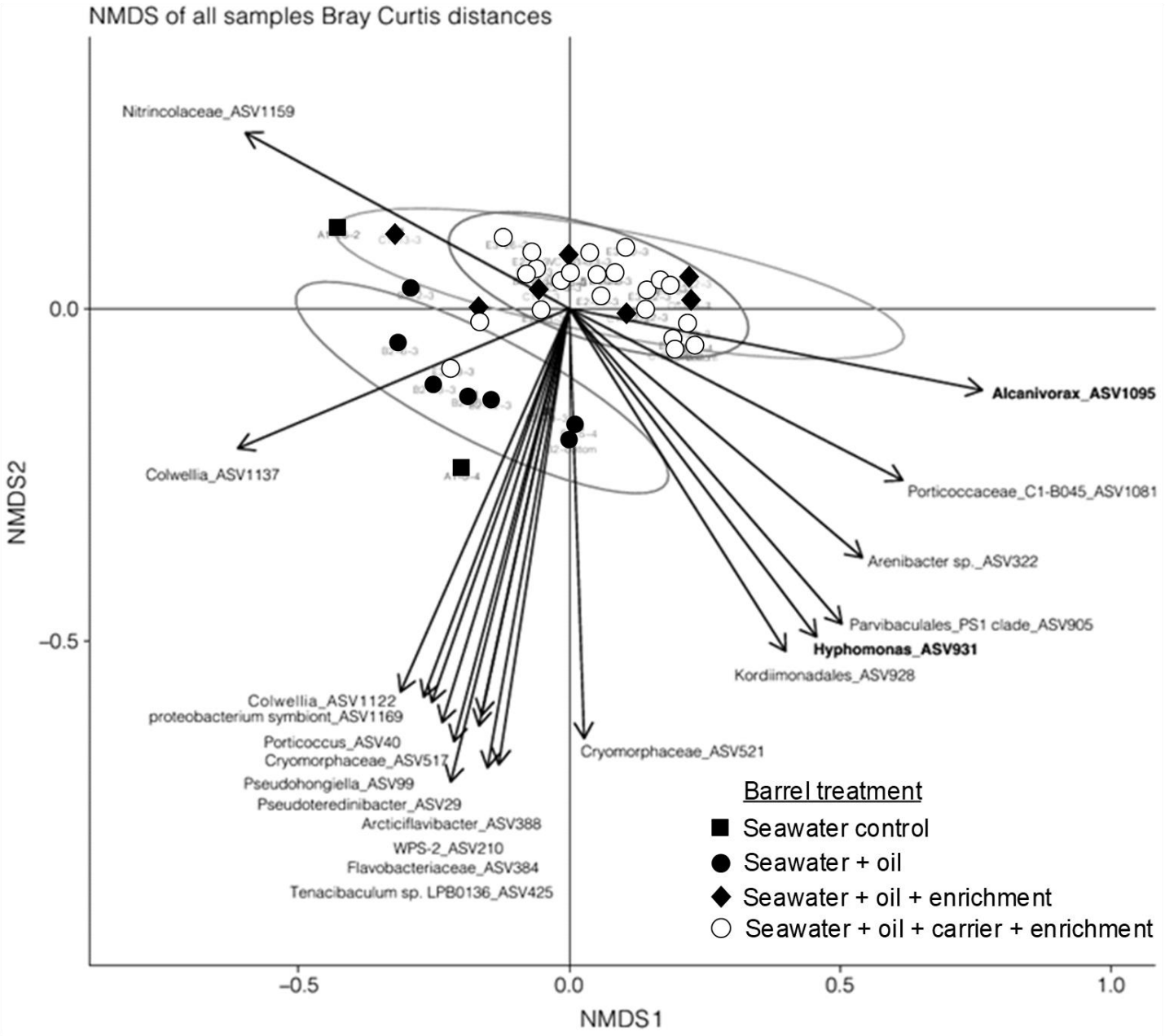

NMDS of all samples Bray Curtis distances
Nitrincolaceae_ASV1159
Alcanivorax_ASV1095
Porticoccaceae_C1-B045_ASV1081
Arenibacter sp._ASV322
Parvibaculales_PS1 clade_ASV905
Hyphomonas_ASV931
Kordiimonadales_ASV928
Cryomorphaceae_ASV521
Colwellia_ASV1137
Colwellia_ASV1122
proteobacterium symbiont_ASV1169
Porticoccus_ASV40
Cryomorphaceae_ASV517
Pseudohongiella_ASV99
Pseudoteredinibacter_ASV29
Arcticiflavibacter_ASV388
WPS-2_ASV210
Flavobacteriaceae_ASV384
Tenacibaculum sp. LPB0136_ASV425
Barrel treatment
Seawater control
Seawater + oil
Seawater + oil + enrichment
Seawater + oil + carrier + enrichment
NMDS2
NMDS1
0.0
−0.5
−0.5
0.0
0.5
1.0

FIG. 19

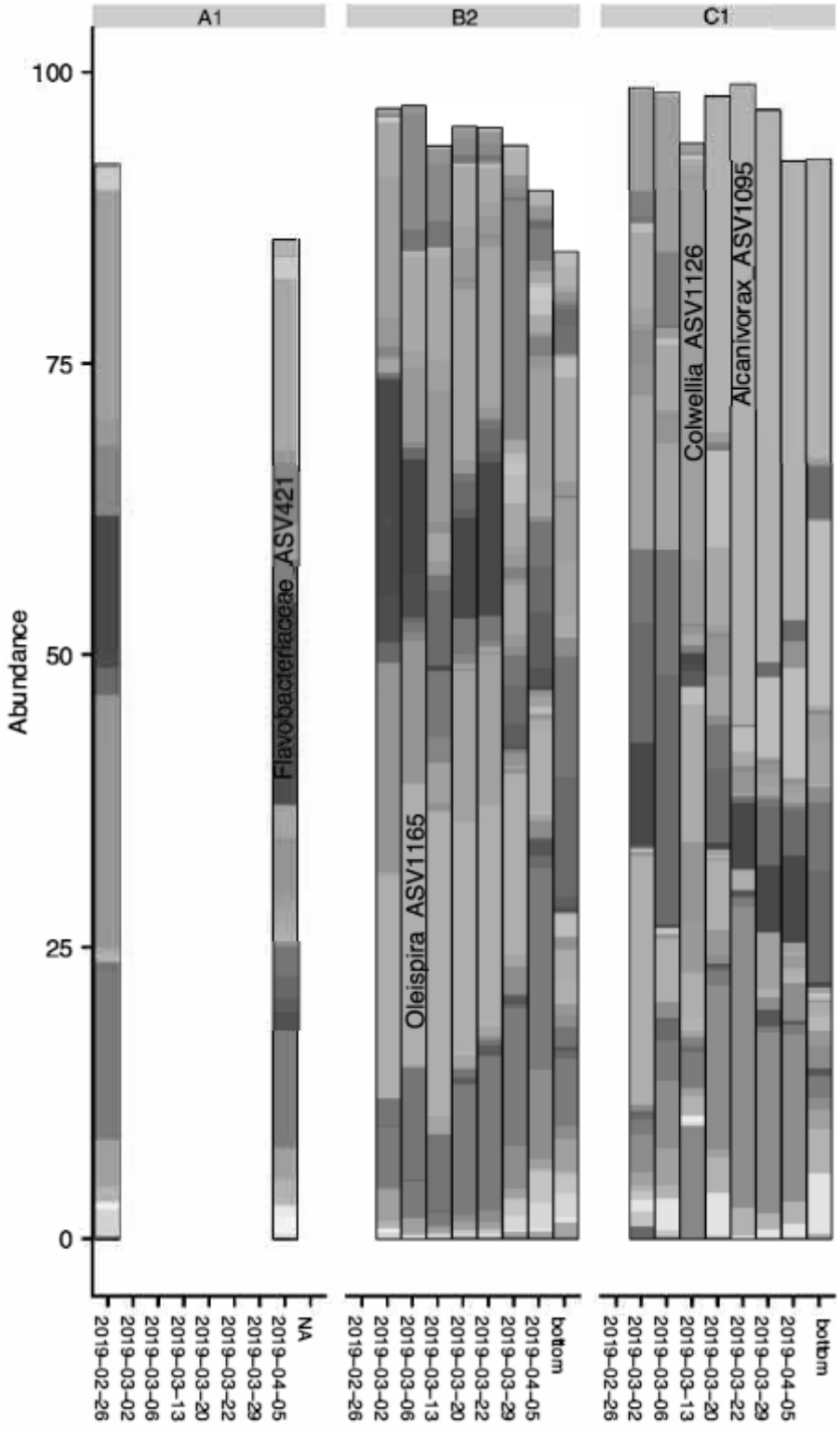

A1
B2
C1
Abundance
100
75
50
25
0
Flavobacteriaceae_ASV421
Oleispira_ASV1165
Colwellia_ASV1126
Alcanivorax_ASV1095
2019-02-26
2019-03-02
2019-03-06
2019-03-13
2019-03-20
2019-03-22
2019-03-29
2019-04-05
NA
bottom

FIG. 20A

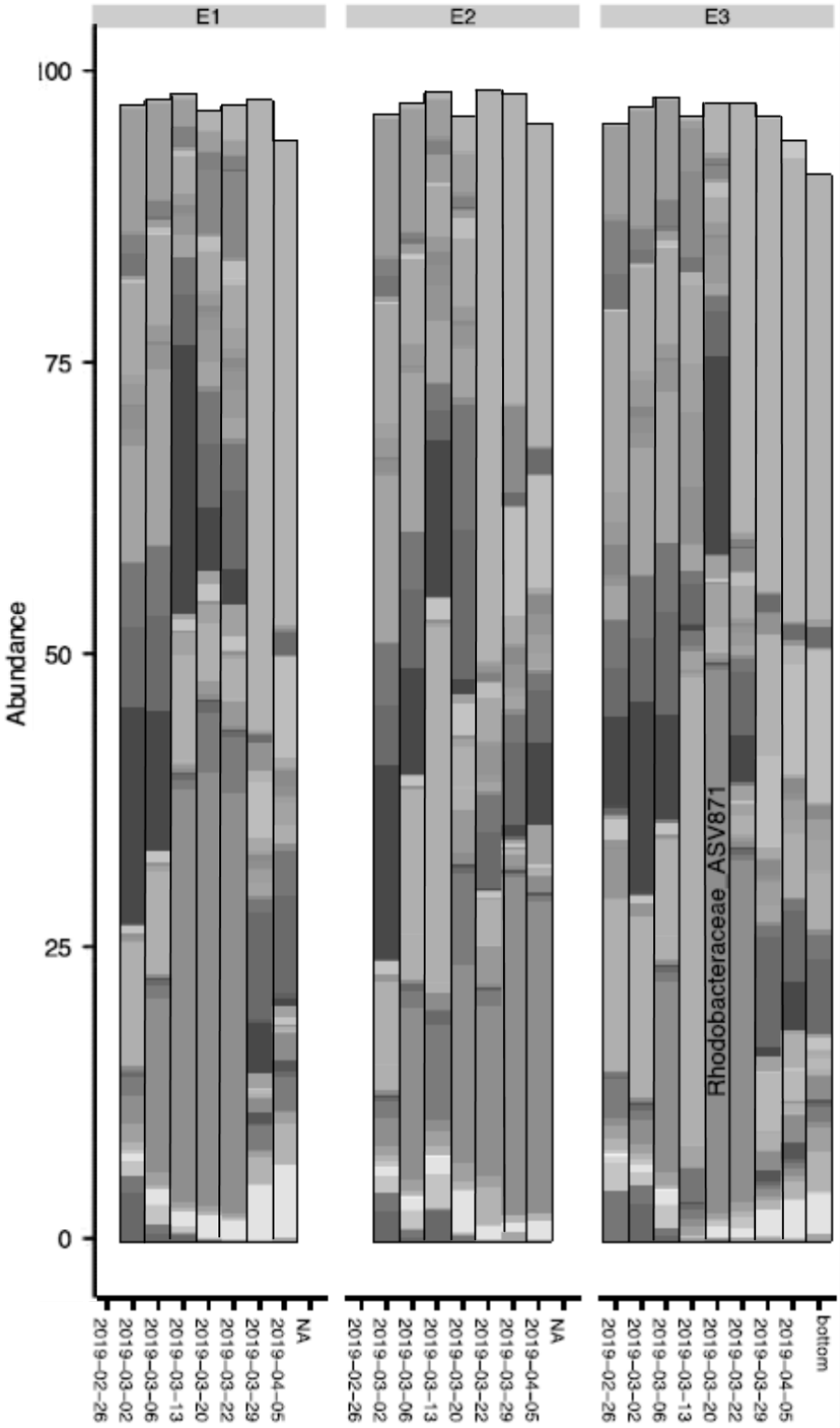

E1
E2
E3
100
75
50
25
0
Abundance
Rhodobacteraceae ASV871
2019-02-26
2019-03-02
2019-03-06
2019-03-13
2019-03-20
2019-03-22
2019-03-29
2019-04-05
NA
bottom

FIG. 20B


Absconditabacteriales (SR1)_ASV607
Aestuariicella_ASV26
Alcanivorax_ASV1095
Alteromonadaceae_ASV1050
Amphritea_ASV1176
Arcobacter_ASV1003
Arcobacter_ASV1006
Arcobacter_ASV989
Arcobacter_ASV991
Arenibacter_ASV322
Bacteria_ASV710
Bacteria_ASV712
Bacteria_ASV738
Bacteriovoracaceae_ASV971
Bacteriovoracaceae_ASV973
bacterium episymbiont of Kiwa sp._ASV495
Bdellovibrio_ASV185
C1−B045_ASV1081
Cafeteria_ASV634
Candidatus Nitrosopumilus_ASV642
Chitinophagales_ASV542
Chloroplast_ASV631
Colwellia_ASV1119
Colwellia_ASV1125
Colwellia_ASV1126
Colwellia_ASV1134
Crocinitomix_ASV538
Cryomorphaceae_ASV457
Cryomorphaceae_ASV461
Cryomorphaceae_ASV488
Cryomorphaceae_ASV500
Cryomorphaceae_ASV510
Cryomorphaceae_ASV519
Cryomorphaceae_ASV541
Cyclobacterium_ASV587
Cycloclasticus_ASV1065
DEV007_ASV153
DEV007_ASV156
Dokdonia_ASV439
Euryarchaeota archaeon SCGC
Flavobacteriaceae_ASV314
Flavobacteriaceae_ASV357

FIG. 20C


Flavobacteriaceae_ASV376
Flavobacteriaceae_ASV380
Flavobacteriaceae_ASV405
Flavobacteriaceae_ASV409
Flavobacteriaceae_ASV417
Flavobacteriaceae_ASV421
Flavobacteriales_ASV449
Glaciecola_ASV1053
JGI 0000069–P22_ASV276
JGI 0000069–P22_ASV277
Legionellaceae_ASV21
Lentimonas_ASV142
Lentisphaera_ASV650
Luteolibacter algae_ASV158
Marinobacter_ASV1116
Marinobacterium_ASV1148
Micavibrionaceae_ASV934
Micavibrionales_ASV756
Mitochondria_ASV728
Mitochondria_ASV797
Mitochondria_ASV799
Mitochondria_ASV805
Moritella_ASV77
Neptuniibacter_ASV1143
Nitrincolaceae_ASV1159
Nitrincolaceae_ASV1171
NS11–12 marine group_ASV498
NS3a marine group_ASV312
NS4 marine group_ASV398
Oceanospirillales_ASV1075
Oleispira_ASV1165
OM43 clade_ASV1027
PB19_ASV663
Photobacterium_ASV88
Profundimonas_ASV1169
Proteobacteria_ASV708
PS1 clade_ASV905
Pseudoalteromonas_ASV79
Pseudofulvibacter_ASV369
Pseudohongiella_ASV97
Pseudohongiella_ASV99
Pseudomonas sabulinigri_ASV1151

FIG. 20D

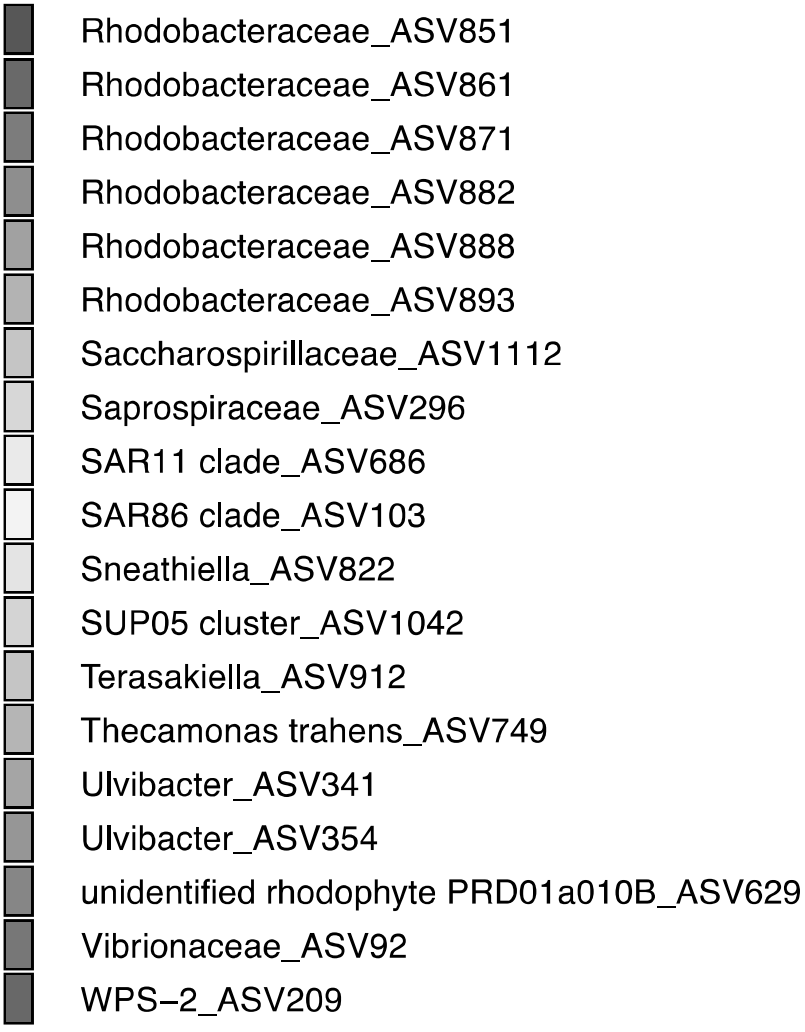

Rhodobacteraceae_ASV851
Rhodobacteraceae_ASV861
Rhodobacteraceae_ASV871
Rhodobacteraceae_ASV882
Rhodobacteraceae_ASV888
Rhodobacteraceae_ASV893
Saccharospirillaceae_ASV1112
Saprospiraceae_ASV296
SAR11 clade_ASV686
SAR86 clade_ASV103
Sneathiella_ASV822
SUP05 cluster_ASV1042
Terasakiella_ASV912
Thecamonas trahens_ASV749
Ulvibacter_ASV341
Ulvibacter_ASV354
unidentified rhodophyte PRD01a010B_ASV629
Vibrionaceae_ASV92
WPS–2_ASV209

FIG. 20E

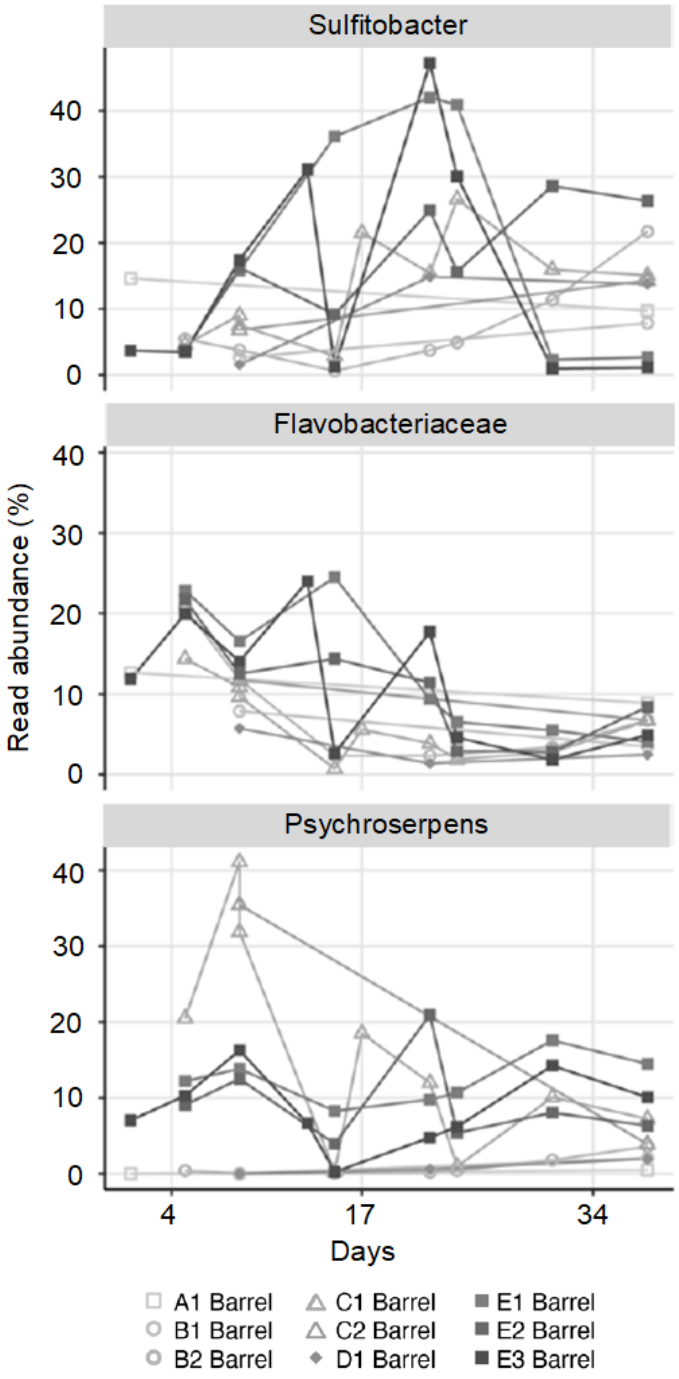

Sulfitobacter
Flavobacteriaceae
Psychroserpens
Read abundance (%)
0
10
20
30
40
4
17
34
Days
A1 Barrel
B1 Barrel
B2 Barrel
C1 Barrel
C2 Barrel
D1 Barrel
E1 Barrel
E2 Barrel
E3 Barrel

FIG. 21A

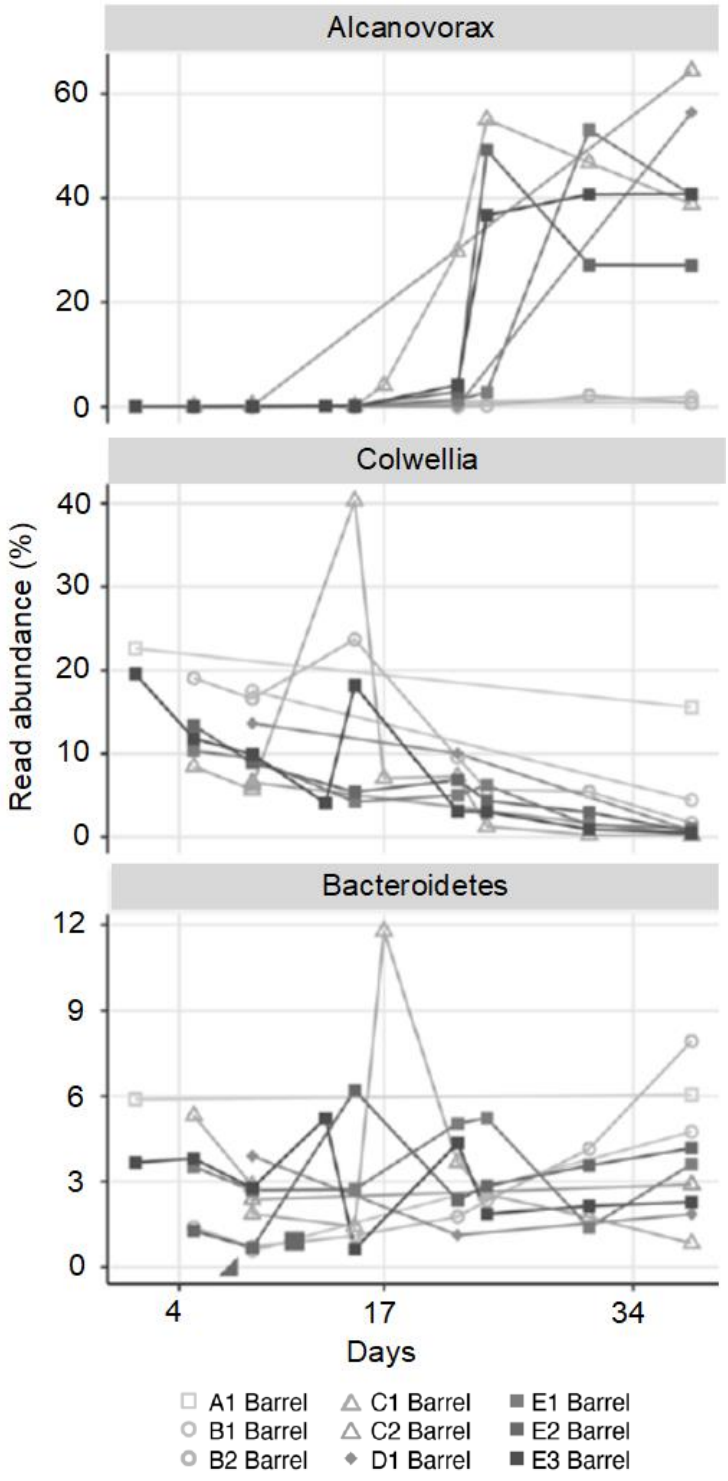

Alcanovorax
60
40
20
0
Colwellia
40
30
20
10
0
Read abundance (%)
Bacteroidetes
12
9
6
3
0
4
17
34
Days
A1 Barrel
B1 Barrel
B2 Barrel
C1 Barrel
C2 Barrel
D1 Barrel
E1 Barrel
E2 Barrel
E3 Barrel

FIG. 21B

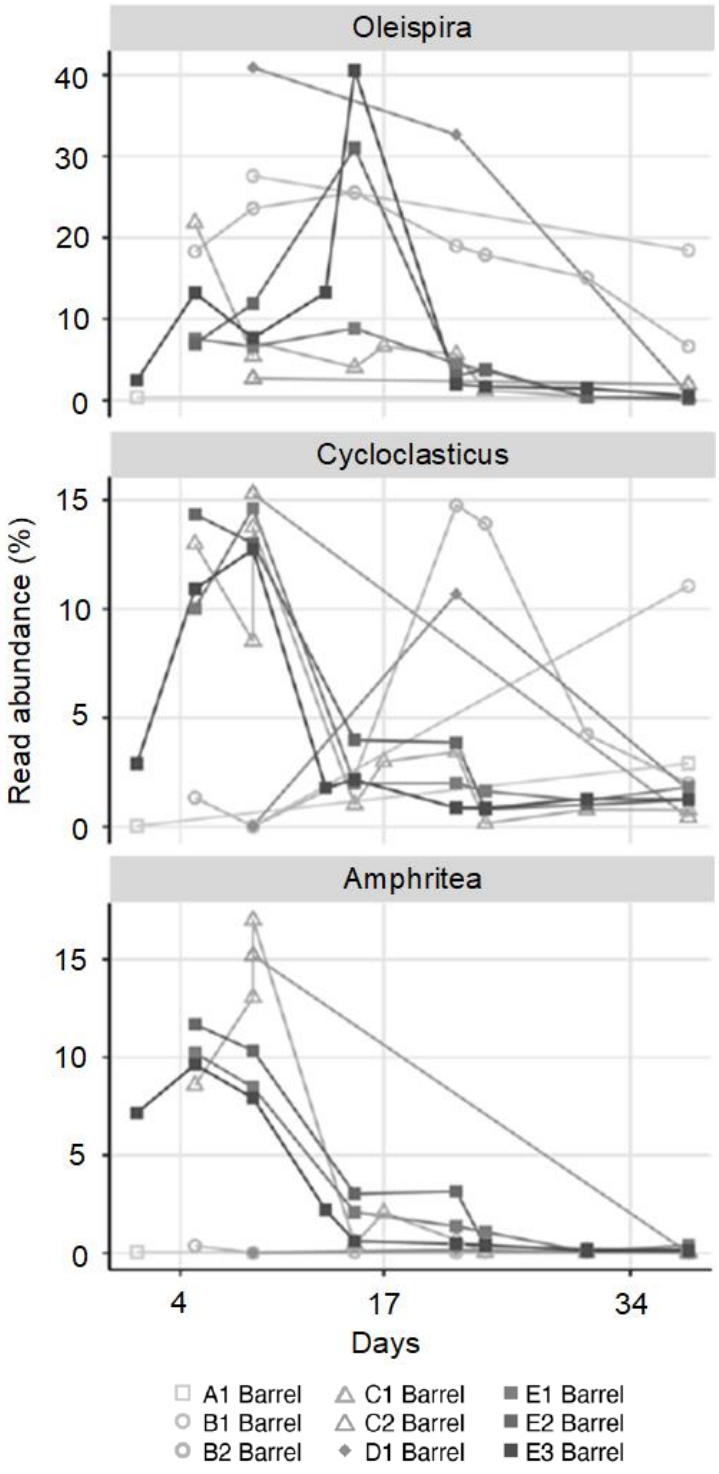

Oleispira
Cycloclasticus
Amphritea
Read abundance (%)
40
30
20
10
0
15
10
5
0
15
10
5
0
4
17
34
Days
A1 Barrel
B1 Barrel
B2 Barrel
C1 Barrel
C2 Barrel
D1 Barrel
E1 Barrel
E2 Barrel
E3 Barrel

FIG. 21C

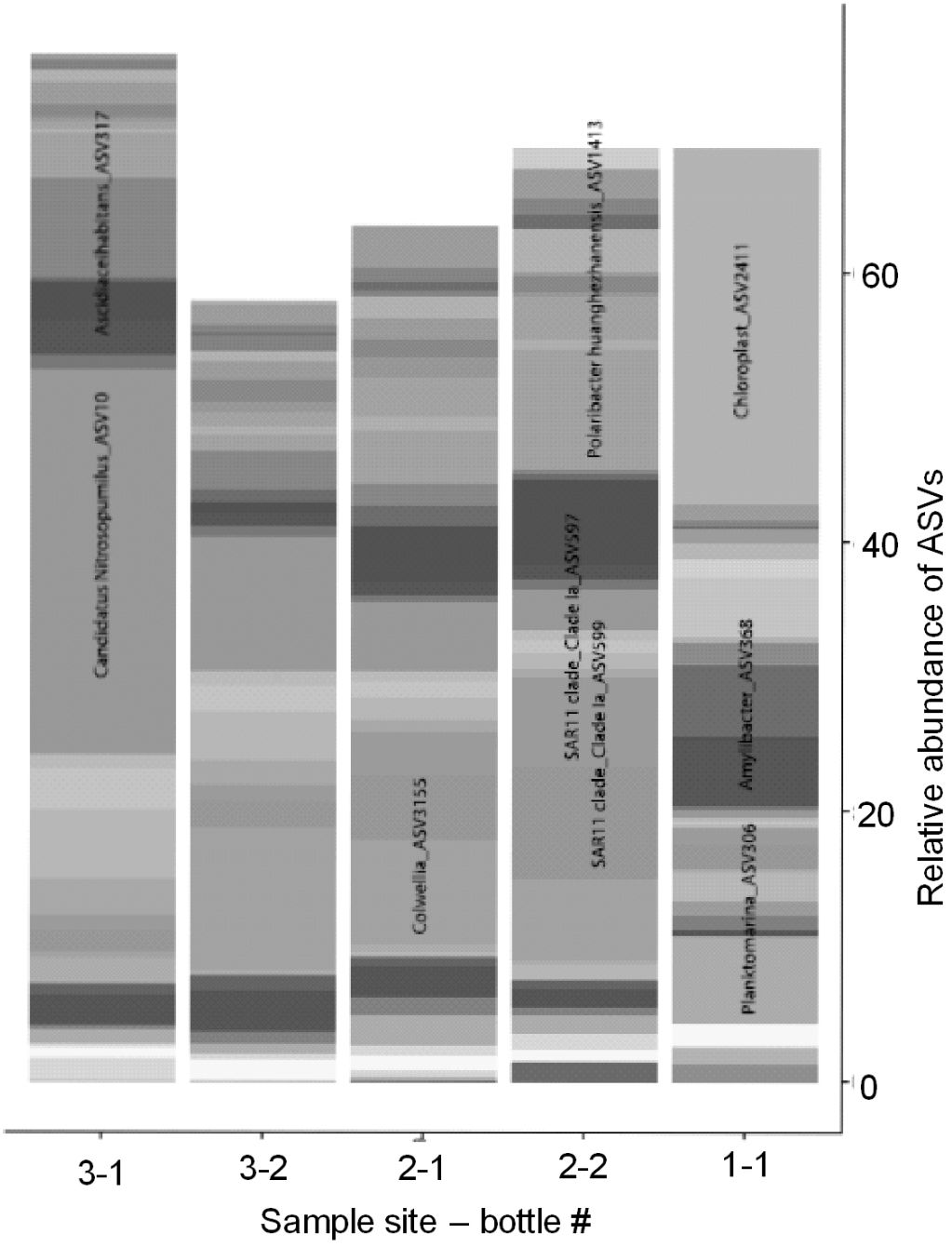

Candidatus Nitrosopumilus_ASV10
Acidiferrobacteraceae_ASV317
Colwellia_ASV3155
SAR11 clade_Clade Ia_ASV599
SAR11 clade_Clade Ia_ASV597
Polaribacter huanghezhanensis_ASV1413
Planktomarina_ASV306
Amylibacter_ASV368
Chloroplast_ASV2411
0
20
40
60
Relative abundance of ASVs
3-1
3-2
2-1
2-2
1-1
Sample site – bottle #

FIG. 22A

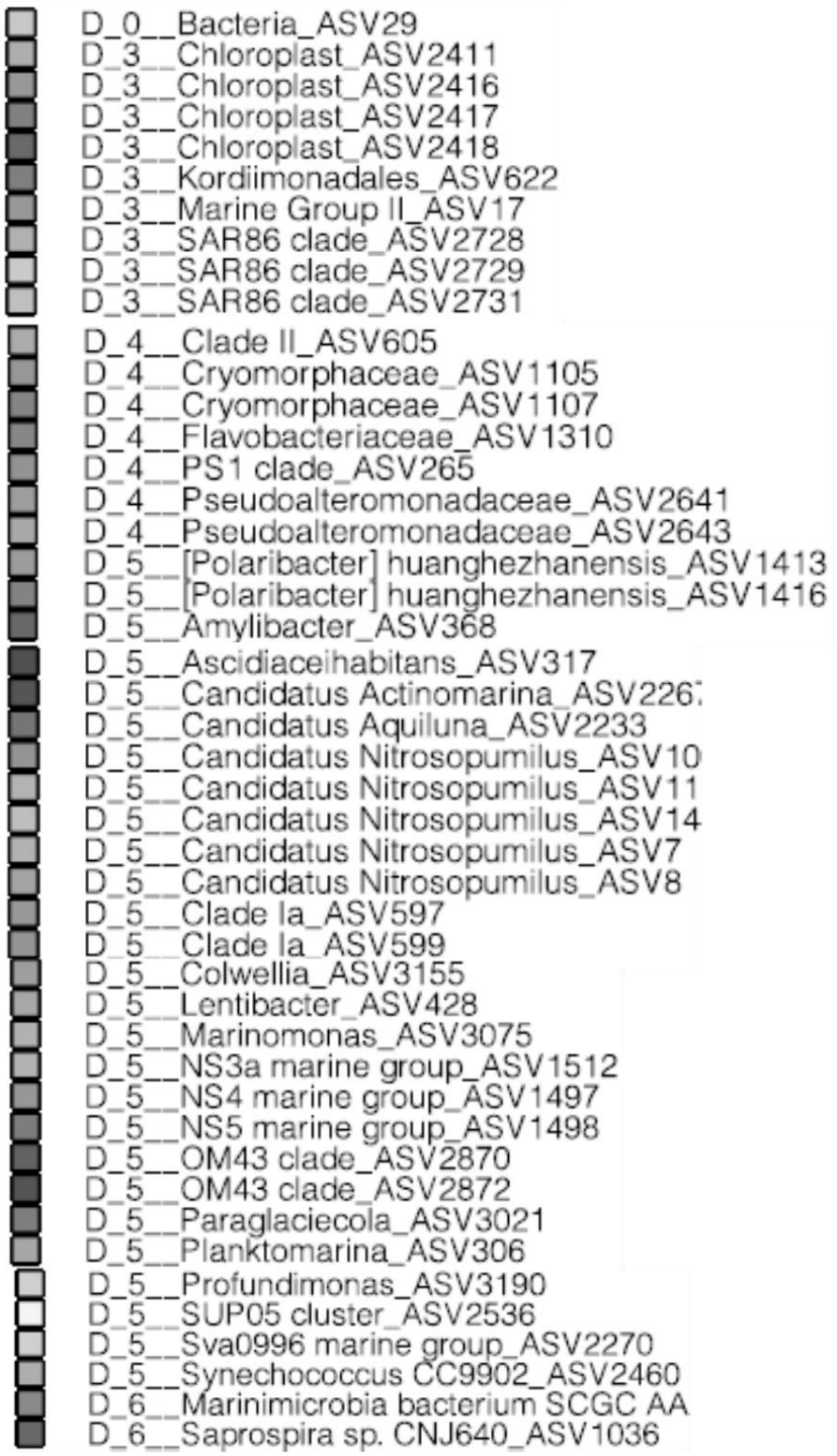

D_0__Bacteria_ASV29
D_3__Chloroplast_ASV2411
D_3__Chloroplast_ASV2416
D_3__Chloroplast_ASV2417
D_3__Chloroplast_ASV2418
D_3__Kordiimonadales_ASV622
D_3__Marine Group II_ASV17
D_3__SAR86 clade_ASV2728
D_3__SAR86 clade_ASV2729
D_3__SAR86 clade_ASV2731
D_4__Clade II_ASV605
D_4__Cryomorphaceae_ASV1105
D_4__Cryomorphaceae_ASV1107
D_4__Flavobacteriaceae_ASV1310
D_4__PS1 clade_ASV265
D_4__Pseudoalteromonadaceae_ASV2641
D_4__Pseudoalteromonadaceae_ASV2643
D_5__[Polaribacter] huanghezhanensis_ASV1413
D_5__[Polaribacter] huanghezhanensis_ASV1416
D_5__Amylibacter_ASV368
D_5__Ascidiaceihabitans_ASV317
D_5__Candidatus Actinomarina_ASV226
D_5__Candidatus Aquiluna_ASV2233
D_5__Candidatus Nitrosopumilus_ASV10
D_5__Candidatus Nitrosopumilus_ASV11
D_5__Candidatus Nitrosopumilus_ASV14
D_5__Candidatus Nitrosopumilus_ASV7
D_5__Candidatus Nitrosopumilus_ASV8
D_5__Clade Ia_ASV597
D_5__Clade Ia_ASV599
D_5__Colwellia_ASV3155
D_5__Lentibacter_ASV428
D_5__Marinomonas_ASV3075
D_5__NS3a marine group_ASV1512
D_5__NS4 marine group_ASV1497
D_5__NS5 marine group_ASV1498
D_5__OM43 clade_ASV2870
D_5__OM43 clade_ASV2872
D_5__Paraglaciecola_ASV3021
D_5__Planktomarina_ASV306
D_5__Profundimonas_ASV3190
D_5__SUP05 cluster_ASV2536
D_5__Sva0996 marine group_ASV2270
D_5__Synechococcus CC9902_ASV2460
D_6__Marinimicrobia bacterium SCGC AA
D_6__Saprospira sp. CNJ640_ASV1036

FIG. 22B

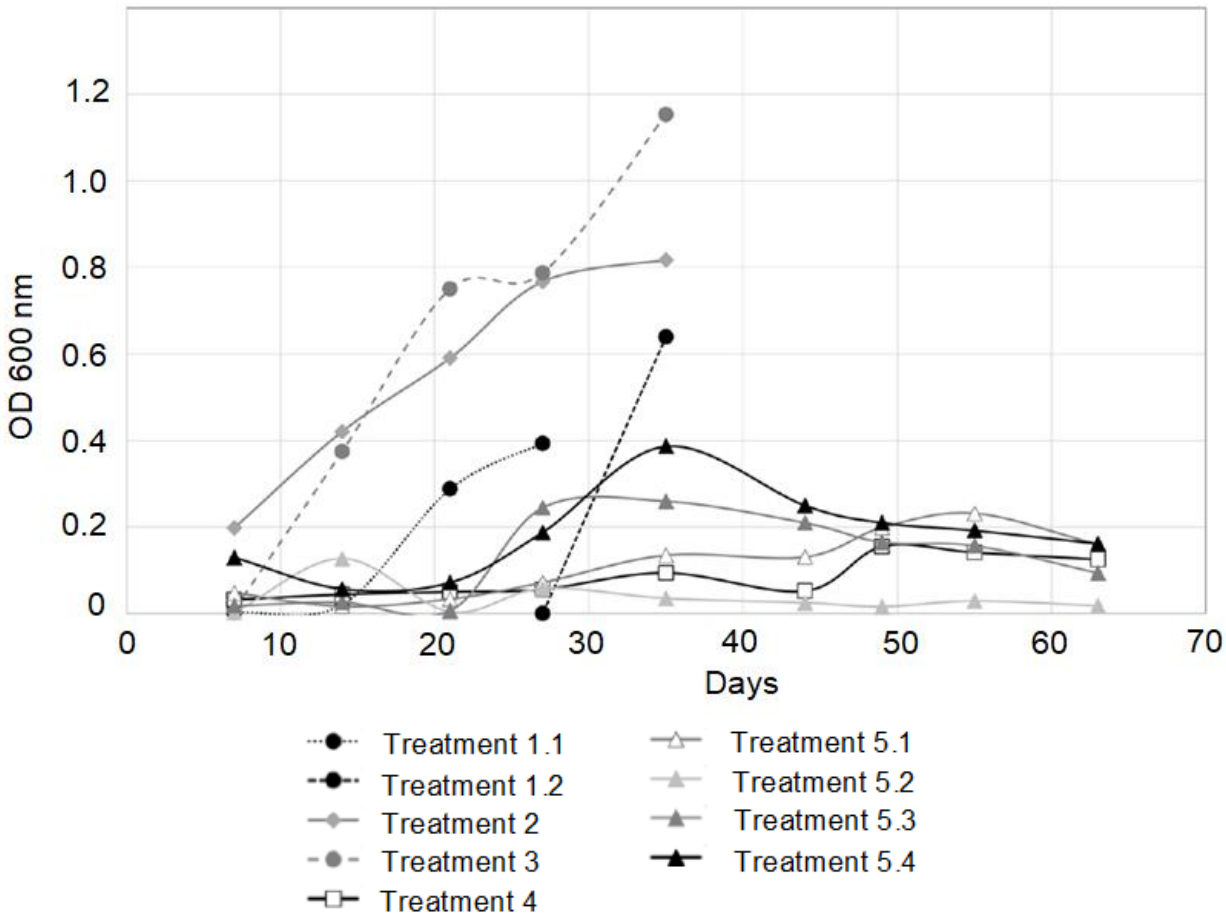

OD 600 nm
1.2
1.0
0.8
0.6
0.4
0.2
0
0
10
20
30
40
50
60
70
Days
Treatment 1.1
Treatment 1.2
Treatment 2
Treatment 3
Treatment 4
Treatment 5.1
Treatment 5.2
Treatment 5.3
Treatment 5.4

FIG. 23

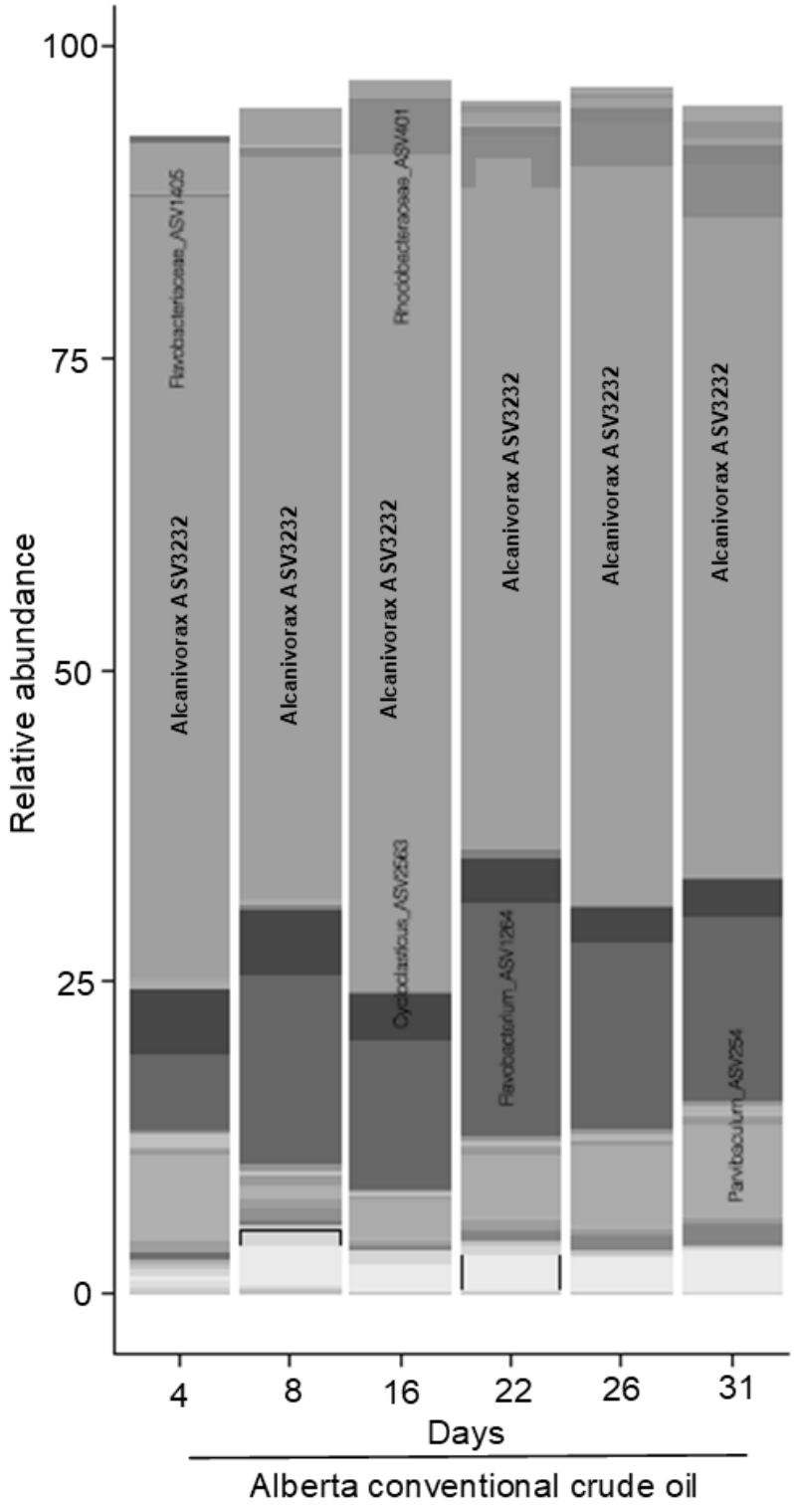

100
75
50
25
0
Relative abundance
Alcanivorax A SV3232
Flavobacteriaceae_ASV1405
Alcanivorax A SV3232
Alcanivorax A SV3232
Rhodobacteraceae_ASV401
Cycloclasticus_ASV2563
Alcanivorax A SV3232
Flavobacterium_ASV1264
Alcanivorax A SV3232
Alcanivorax A SV3232
Parvibaculum_ASV254
4
8
16
22
26
31
Days
Alberta conventional crude oil

FIG. 24A

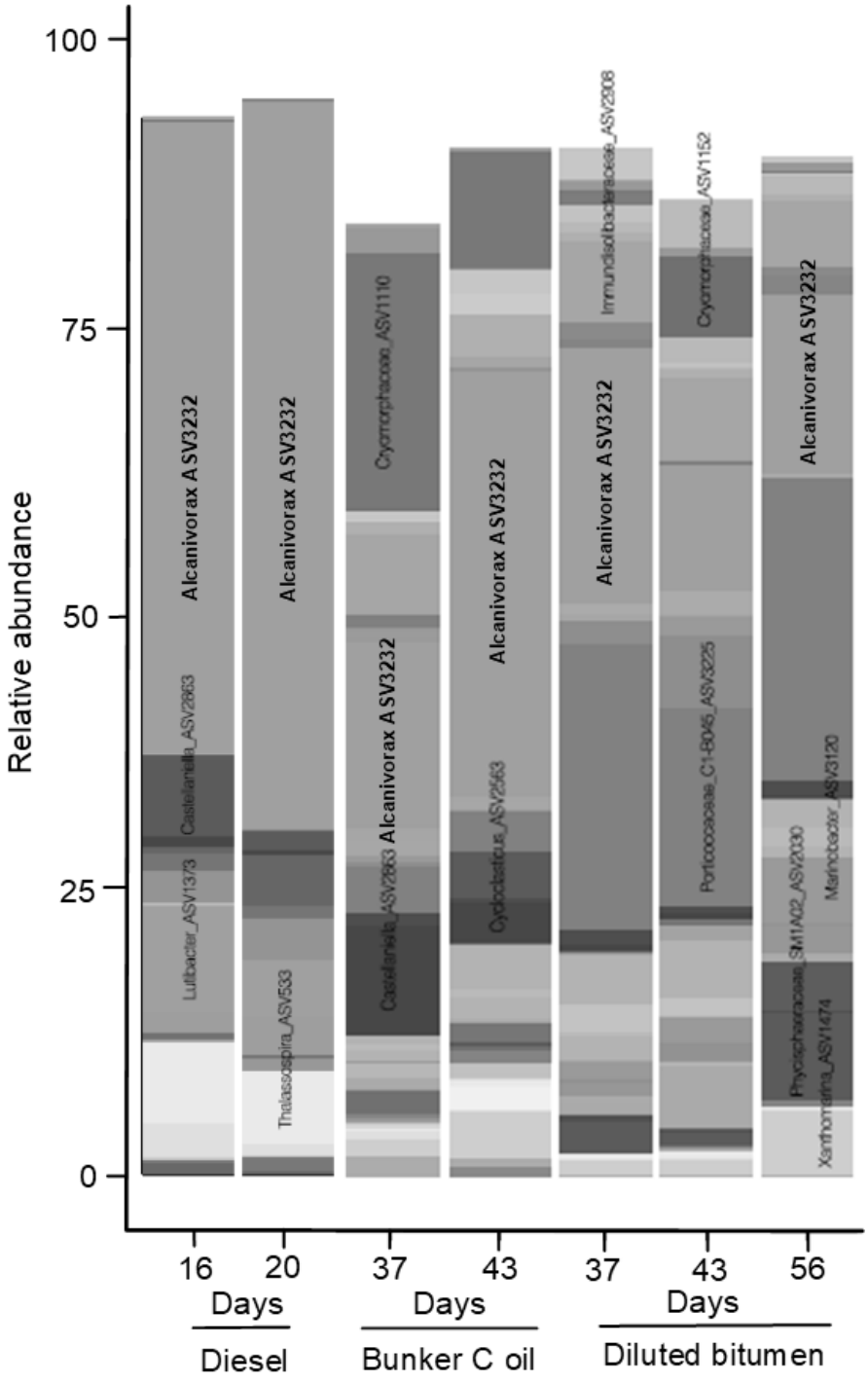

100
75
50
25
0
Relative abundance
Alcanivorax ASV3232
Castellaniella_ASV2863
Lutibacter_ASV1373
Alcanivorax ASV3232
Thalassospira_ASV533
Cyanorphacoon_ASV1110
Alcanivorax ASV3232
Castellaniella_ASV2863
Alcanivorax ASV3232
Cyclobacterius_ASV2563
Immundisolibacteraceae_ASV2908
Alcanivorax ASV3232
Cyanorphacoon_ASV1152
Portococcaceae_C1-B045_ASV3225
Alcanivorax ASV3232
Phycisphaeraceae_SM1A02_ASV2030
Marinobacter_ASV3120
Xanthomarina_ASV1474
16
20
37
43
37
43
56
Days
Days
Days
Diesel
Bunker C oil
Diluted bitumen

FIG. 24B

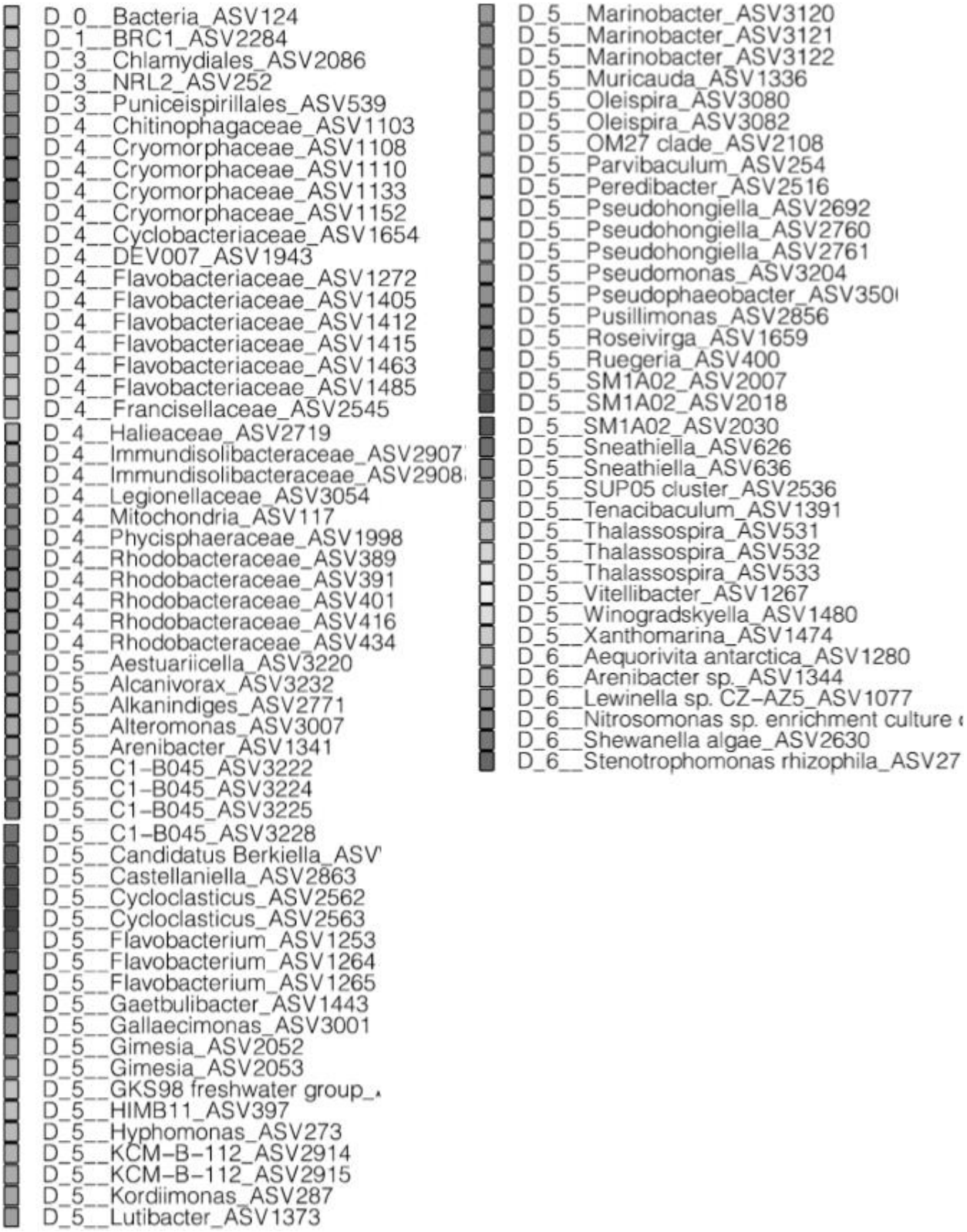

D_0__Bacteria_ASV124
D_1__BRC1_ASV2284
D_3__Chlamydiales_ASV2086
D_3__NRL2_ASV252
D_3__Puniceispirillales_ASV539
D_4__Chitinophagaceae_ASV1103
D_4__Cryomorphaceae_ASV1108
D_4__Cryomorphaceae_ASV1110
D_4__Cryomorphaceae_ASV1133
D_4__Cryomorphaceae_ASV1152
D_4__Cyclobacteriaceae_ASV1654
D_4__DEV007_ASV1943
D_4__Flavobacteriaceae_ASV1272
D_4__Flavobacteriaceae_ASV1405
D_4__Flavobacteriaceae_ASV1412
D_4__Flavobacteriaceae_ASV1415
D_4__Flavobacteriaceae_ASV1463
D_4__Flavobacteriaceae_ASV1485
D_4__Francisellaceae_ASV2545
D_4__Halieaceae_ASV2719
D_4__Immundisolibacteraceae_ASV2907
D_4__Immundisolibacteraceae_ASV2908
D_4__Legionellaceae_ASV3054
D_4__Mitochondria_ASV117
D_4__Phycisphaeraceae_ASV1998
D_4__Rhodobacteraceae_ASV389
D_4__Rhodobacteraceae_ASV391
D_4__Rhodobacteraceae_ASV401
D_4__Rhodobacteraceae_ASV416
D_4__Rhodobacteraceae_ASV434
D_5__Aestuariicella_ASV3220
D_5__Alcanivorax_ASV3232
D_5__Alkanindiges_ASV2771
D_5__Alteromonas_ASV3007
D_5__Arenibacter_ASV1341
D_5__C1-B045_ASV3222
D_5__C1-B045_ASV3224
D_5__C1-B045_ASV3225
D_5__C1-B045_ASV3228
D_5__Candidatus Berkiella_ASV
D_5__Castellaniella_ASV2863
D_5__Cycloclasticus_ASV2562
D_5__Cycloclasticus_ASV2563
D_5__Flavobacterium_ASV1253
D_5__Flavobacterium_ASV1264
D_5__Flavobacterium_ASV1265
D_5__Gaetbulibacter_ASV1443
D_5__Gallaecimonas_ASV3001
D_5__Gimesia_ASV2052
D_5__Gimesia_ASV2053
D_5__GKS98 freshwater group_
D_5__HIMB11_ASV397
D_5__Hyphomonas_ASV273
D_5__KCM-B-112_ASV2914
D_5__KCM-B-112_ASV2915
D_5__Kordiimonas_ASV287
D_5__Lutibacter_ASV1373
D_5__Marinobacter_ASV3120
D_5__Marinobacter_ASV3121
D_5__Marinobacter_ASV3122
D_5__Muricauda_ASV1336
D_5__Oleispira_ASV3080
D_5__Oleispira_ASV3082
D_5__OM27 clade_ASV2108
D_5__Parvibaculum_ASV254
D_5__Peredibacter_ASV2516
D_5__Pseudohongiella_ASV2692
D_5__Pseudohongiella_ASV2760
D_5__Pseudohongiella_ASV2761
D_5__Pseudomonas_ASV3204
D_5__Pseudophaeobacter_ASV350
D_5__Pusillimonas_ASV2856
D_5__Roseivirga_ASV1659
D_5__Ruegeria_ASV400
D_5__SM1A02_ASV2007
D_5__SM1A02_ASV2018
D_5__SM1A02_ASV2030
D_5__Sneathiella_ASV626
D_5__Sneathiella_ASV636
D_5__SUP05 cluster_ASV2536
D_5__Tenacibaculum_ASV1391
D_5__Thalassospira_ASV531
D_5__Thalassospira_ASV532
D_5__Thalassospira_ASV533
D_5__Vitellibacter_ASV1267
D_5__Winogradskyella_ASV1480
D_5__Xanthomarina_ASV1474
D_6__Aequorivita antarctica_ASV1280
D_6__Arenibacter sp._ASV1344
D_6__Lewinella sp. CZ-AZ5_ASV1077
D_6__Nitrosomonas sp. enrichment culture
D_6__Shewanella algae_ASV2630
D_6__Stenotrophomonas rhizophila_ASV27

FIG. 24C

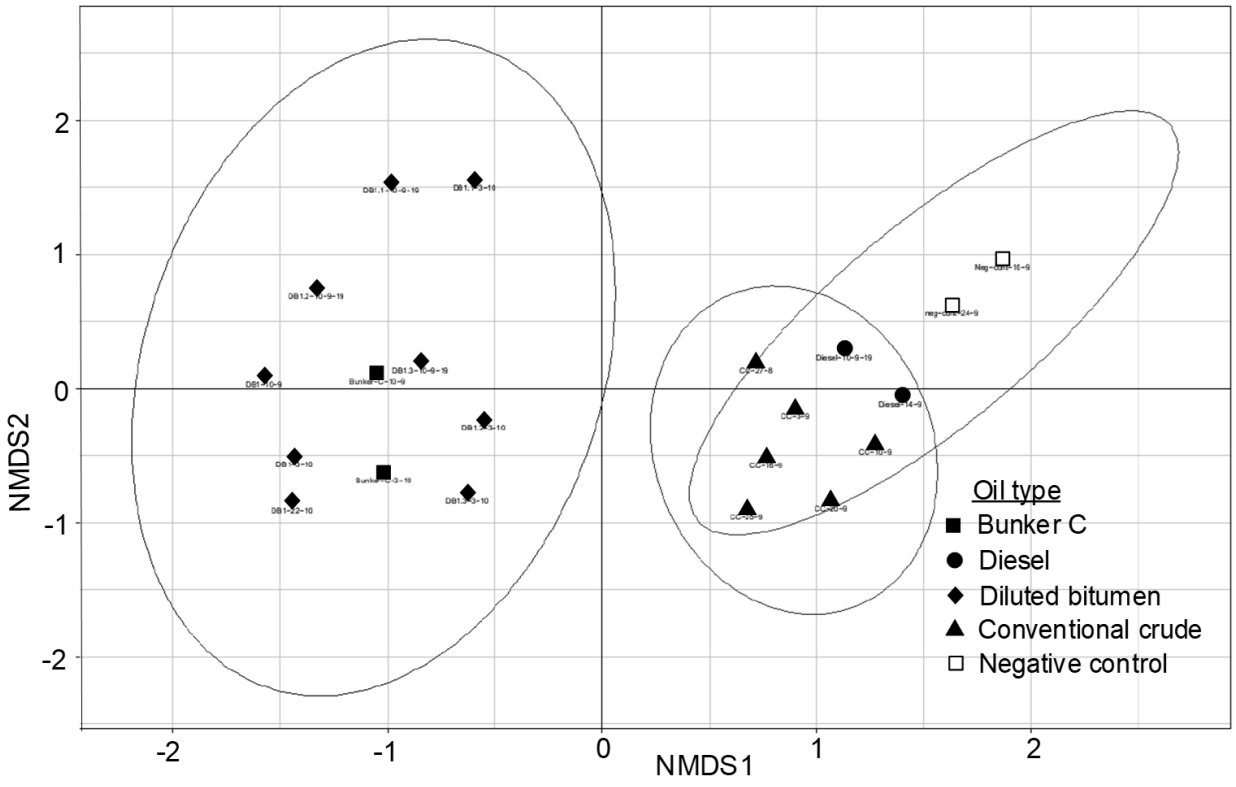

NMDS2
NMDS1
2
1
0
-1
-2
-2
-1
0
1
2
Oil type
Bunker C
Diesel
Diluted bitumen
Conventional crude
Negative control

FIG. 25

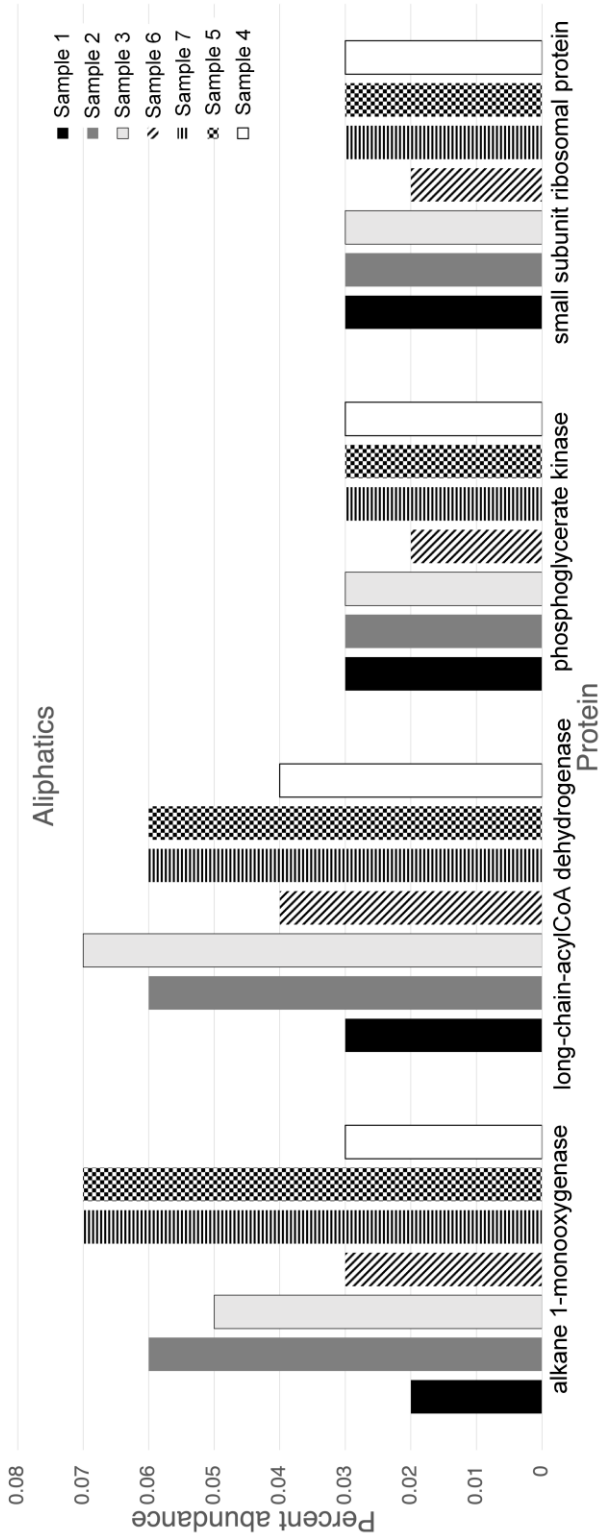

Sample 1
Sample 2
Sample 3
Sample 6
Sample 7
Sample 5
Sample 4
Aliphatics
alkane 1-monooxygenase
long-chain-acylCoA dehydrogenase
phosphoglycerate kinase
small subunit ribosomal protein
Protein
Percent abundance
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0

FIG. 26

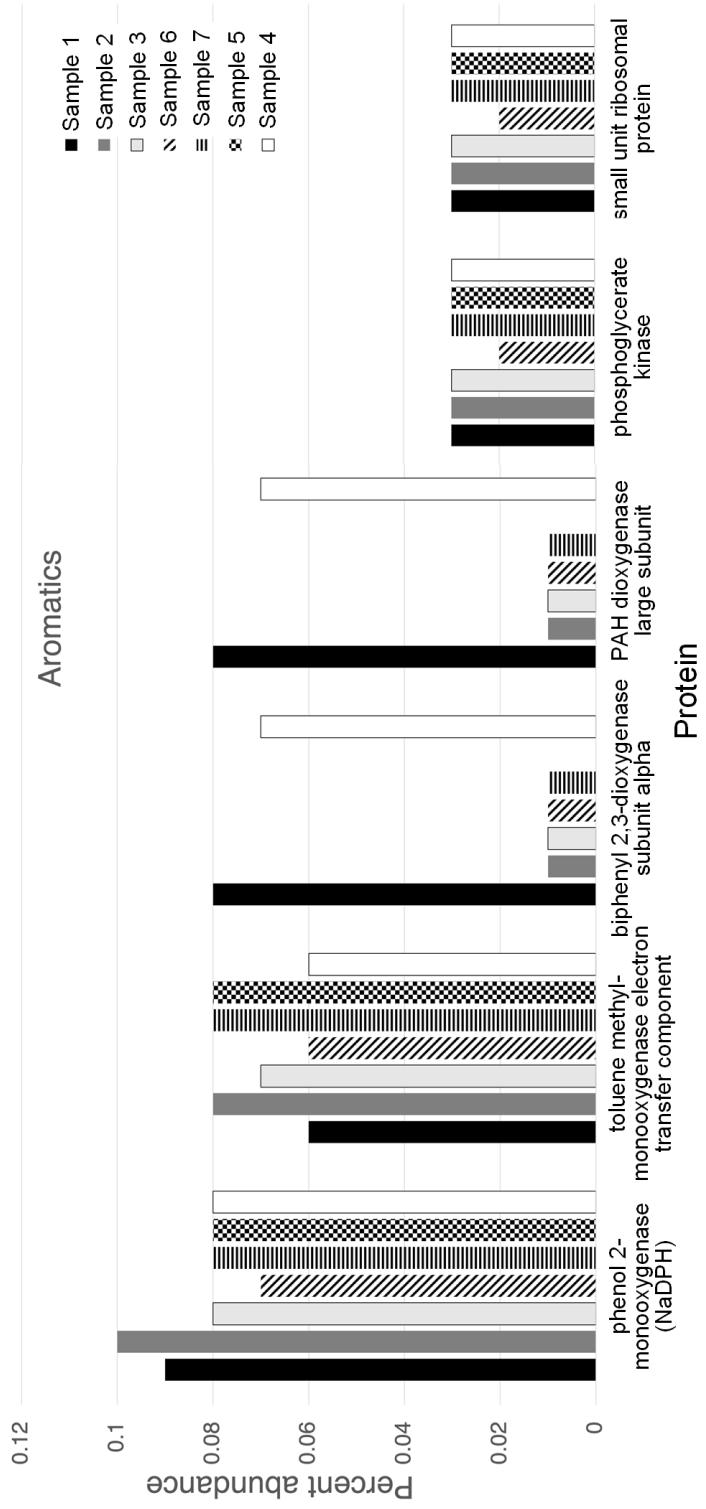

Aromatics
Sample 1
Sample 2
Sample 3
Sample 6
Sample 7
Sample 5
Sample 4
Percent abundance
0.12
0.1
0.08
0.06
0.04
0.02
0
phenol 2-monooxygenase (NaDPH)
toluene methyl-monooxygenase electron transfer component
biphenyl 2,3-dioxygenase subunit alpha
PAH dioxygenase large subunit
phosphoglycerate kinase
small unit ribosomal protein
Protein

FIG. 27

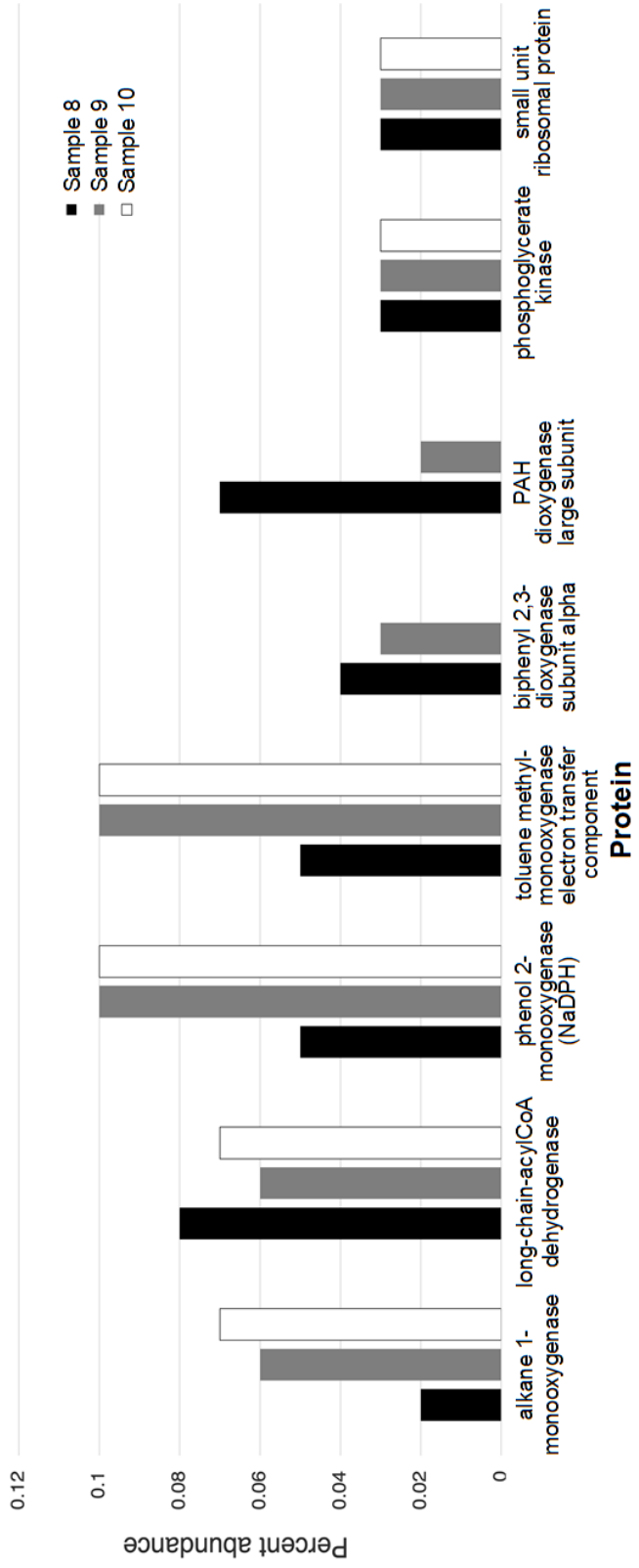

Sample 8
Sample 9
Sample 10
Percent abundance
0.12
0.1
0.08
0.06
0.04
0.02
0
alkane 1-monooxygenase
long-chain-acylCoA dehydrogenase
phenol 2-monooxygenase (NaDPH)
toluene methyl-monooxygenase electron transfer component
biphenyl 2,3-dioxygenase subunit alpha
PAH dioxygenase large subunit
phosphoglycerate kinase
small unit ribosomal protein
Protein

FIG. 28

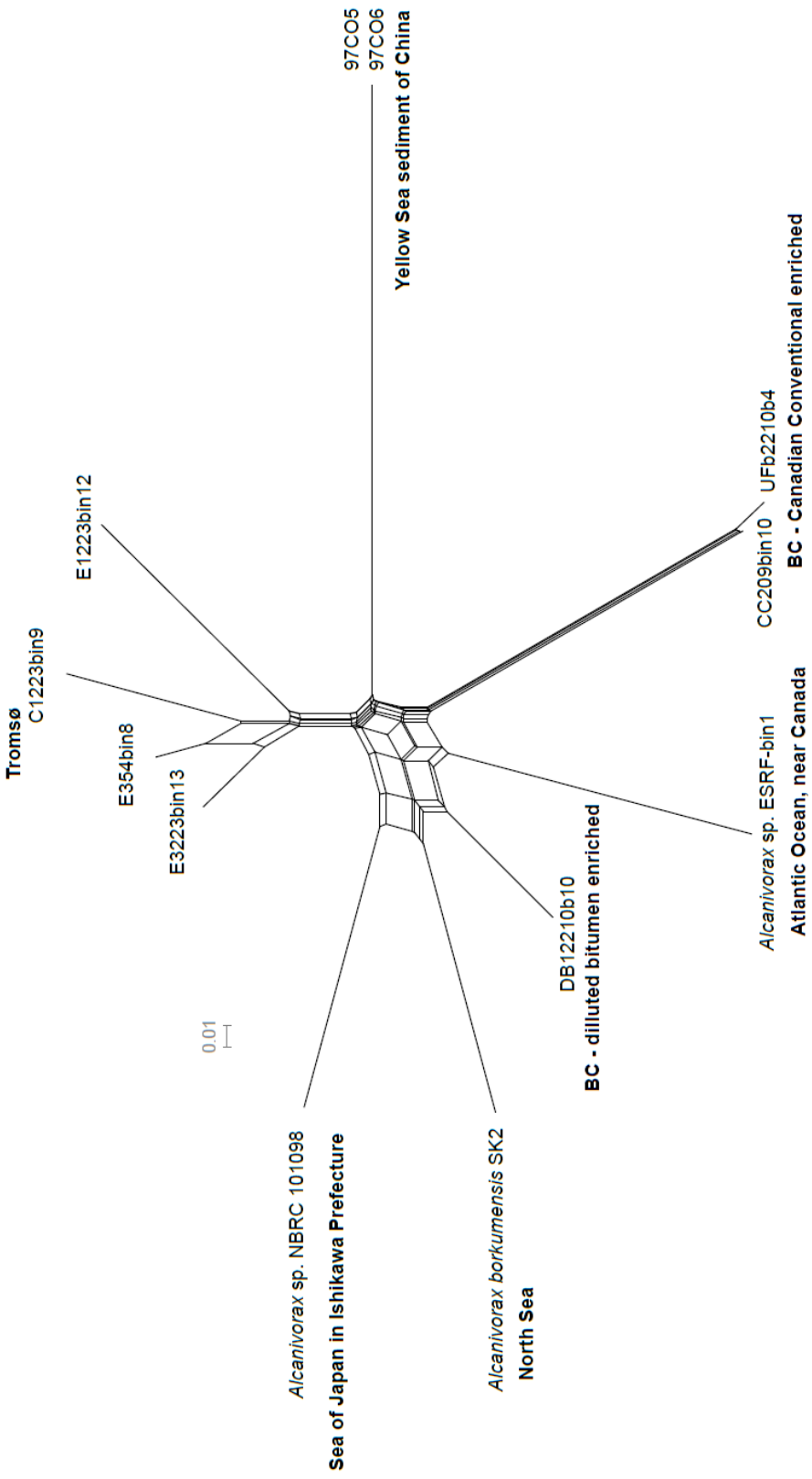

97CO5
97CO6
Yellow Sea sediment of China
E1223bin12
Tromsø
C1223bin9
E354bin8
E3223bin13
0.01
CC209bin10
UFb2210b4
BC - Canadian Conventional enriched
Alcanivorax sp. ESRF-bin1
Atlantic Ocean, near Canada
DB12210b10
BC - dilluted bitumen enriched
Alcanivorax borkumensis SK2
North Sea
Alcanivorax sp. NBRC 101098
Sea of Japan in Ishikawa Prefecture

FIG. 29

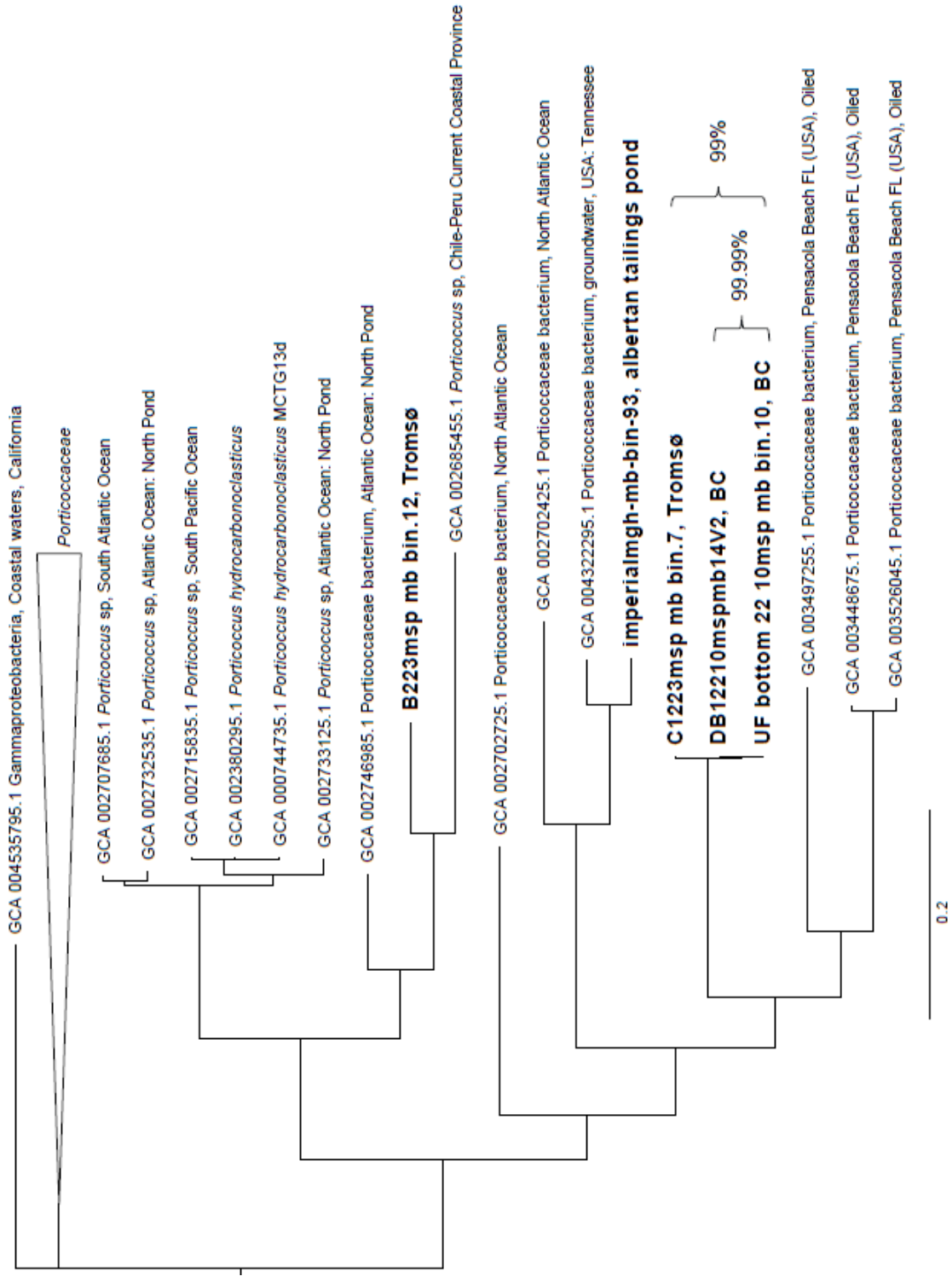

GCA 004535795.1 Gammaproteobacteria, Coastal waters, California
Porticoccaceae
GCA 002707685.1 Porticoccus sp, South Atlantic Ocean
GCA 002732535.1 Porticoccus sp, Atlantic Ocean: North Pond
GCA 002715835.1 Porticoccus sp, South Pacific Ocean
GCA 023800295.1 Porticoccus hydrocarbonoclasticus
GCA 000744735.1 Porticoccus hydrocarbonoclasticus MCTG13d
GCA 002733125.1 Porticoccus sp, Atlantic Ocean: North Pond
GCA 002746985.1 Porticoccaceae bacterium, Atlantic Ocean: North Pond
B223msp mb bin.12, Tromsø
GCA 002685455.1 Porticoccus sp, Chile-Peru Current Coastal Province
GCA 002702725.1 Porticoccaceae bacterium, North Atlantic Ocean
GCA 002702425.1 Porticoccaceae bacterium, North Atlantic Ocean
GCA 004322295.1 Porticoccaceae bacterium, groundwater, USA: Tennessee
imperialmgh-mb-bin-93, albertan tailings pond
C1223msp mb bin.7, Tromsø
DB12210mspmb14V2, BC
UF bottom 22 10msp mb bin.10, BC
99%
99.99%
GCA 003497255.1 Porticoccaceae bacterium, Pensacola Beach FL (USA), Oiled
GCA 003448675.1 Porticoccaceae bacterium, Pensacola Beach FL (USA), Oiled
GCA 003526045.1 Porticoccaceae bacterium, Pensacola Beach FL (USA), Oiled
0.2

FIG. 30

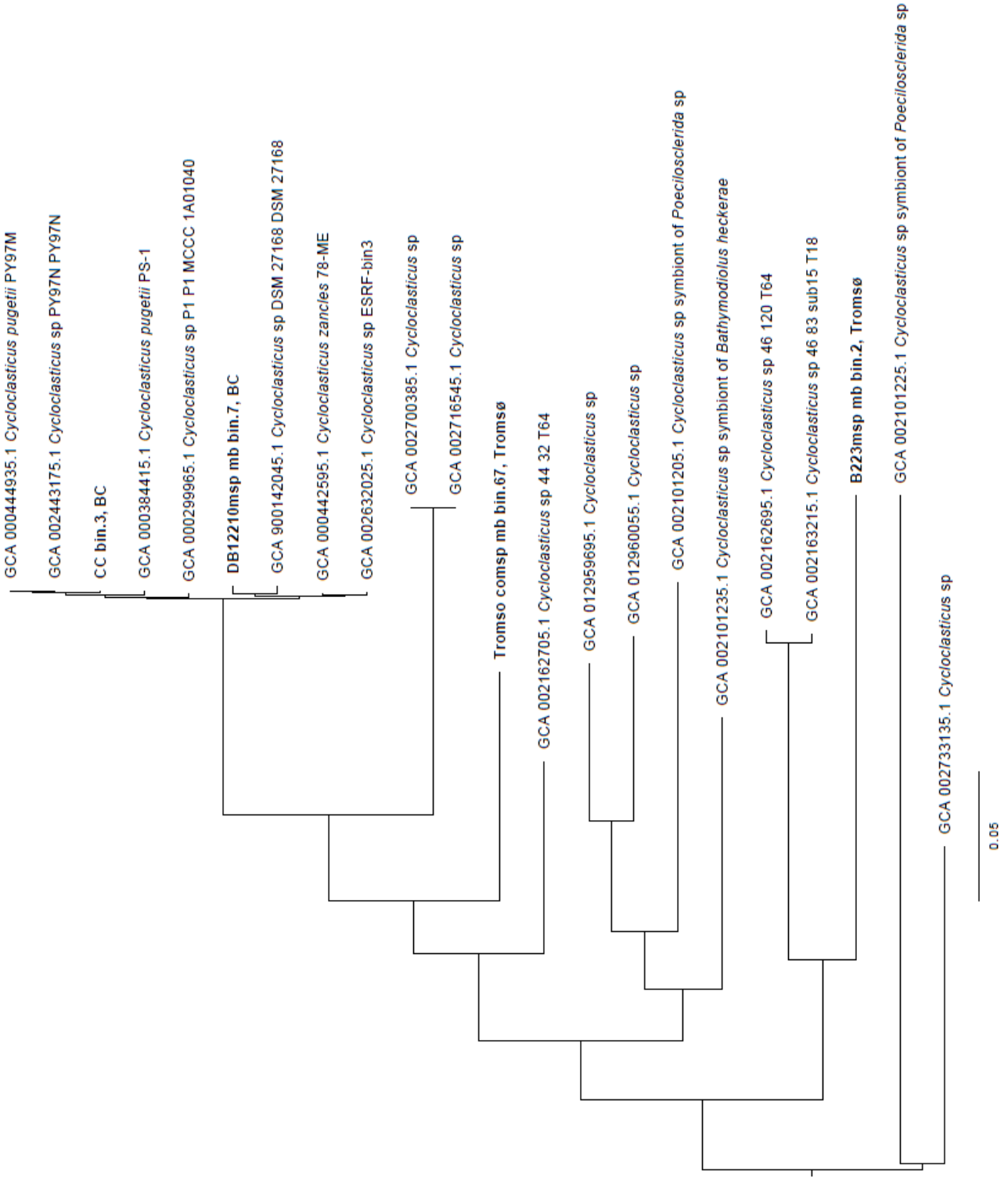

GCA 000444935.1 Cycloclasticus pugetii PY97M
GCA 002443175.1 Cycloclasticus sp PY97N PY97N
CC bin.3, BC
GCA 000384415.1 Cycloclasticus pugetii PS-1
GCA 000299965.1 Cycloclasticus sp P1 P1 MCCC 1A01040
DB12210msp mb bin.7, BC
GCA 900142045.1 Cycloclasticus sp DSM 27168 DSM 27168
GCA 000442595.1 Cycloclasticus zancles 78-ME
GCA 002632025.1 Cycloclasticus sp ESRF-bin3
GCA 002700385.1 Cycloclasticus sp
GCA 002716545.1 Cycloclasticus sp
Tromso comsp mb bin.67, Tromsø
GCA 002162705.1 Cycloclasticus sp 44 32 T64
GCA 012959695.1 Cycloclasticus sp
GCA 012960055.1 Cycloclasticus sp
GCA 002101205.1 Cycloclasticus sp symbiont of Poecilosclerida sp
GCA 002101235.1 Cycloclasticus sp symbiont of Bathymodiolus heckerae
GCA 002162695.1 Cycloclasticus sp 46 120 T64
GCA 002163215.1 Cycloclasticus sp 46 83 sub15 T18
B223msp mb bin.2, Tromsø
GCA 002101225.1 Cycloclasticus sp symbiont of Poecilosclerida sp
GCA 002733135.1 Cycloclasticus sp
0.05

FIG. 31