

Food or a free ride?

The ability of a marine microbial community to degrade plastics

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Microbiology Society 2019
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INTRODUCTION – PLASTICS IN THE OCEAN



WHAT HAPPENS TO A PLASTIC BOTTLE IN THE OCEANS?

IS IT BEING DEGRADED? WHO IS DEGRADING IT?

OBJECTIVES:

1. Fundamental understanding of marine microbial communities
2. Are plastics degraded?
3. Are the additives and contaminants of plastics being degraded?



UNDERSTANDING MARINE MICROBIAL COMMUNITY DYNAMICS

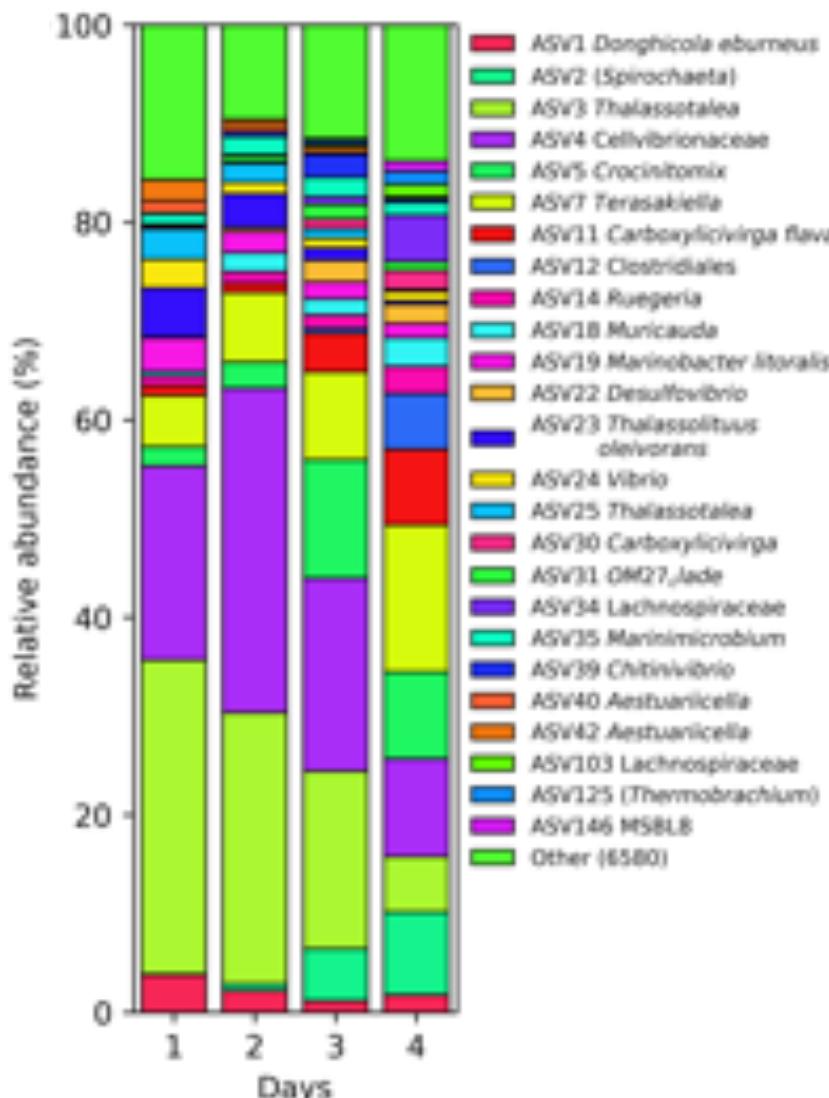


CHITIN



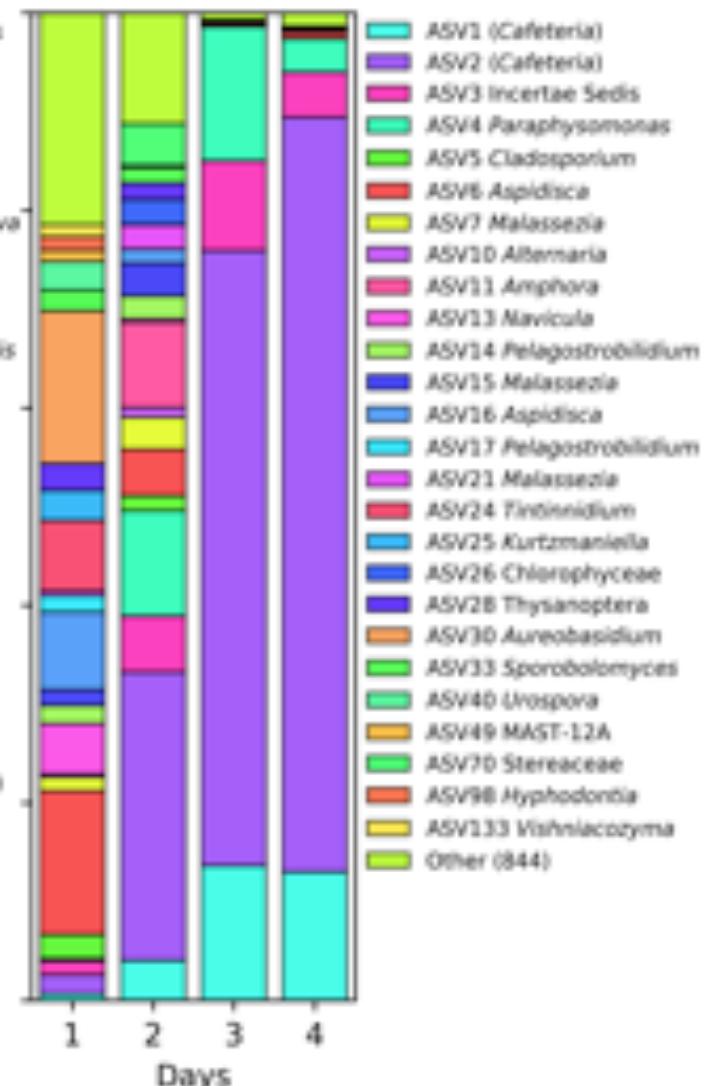
16S rRNA gene

Prokaryotes



18S rRNA gene

Eukaryotes



UNDERSTANDING MARINE MICROBIAL COMMUNITY DYNAMICS

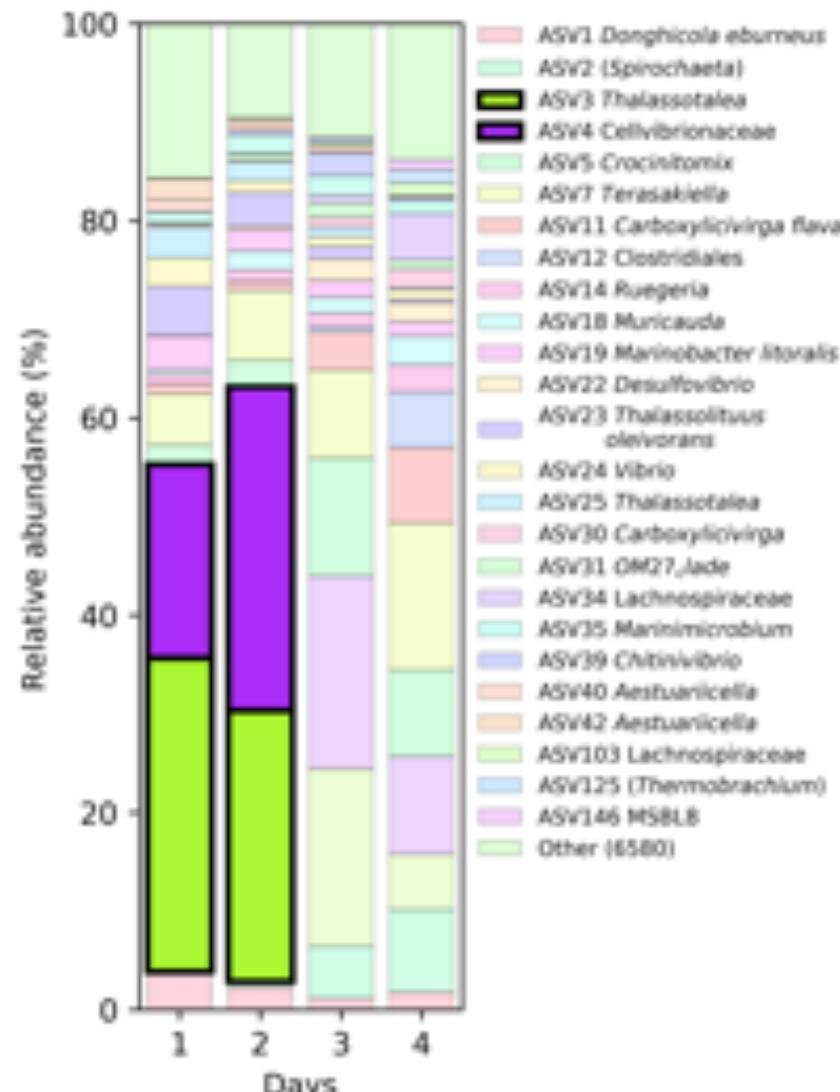


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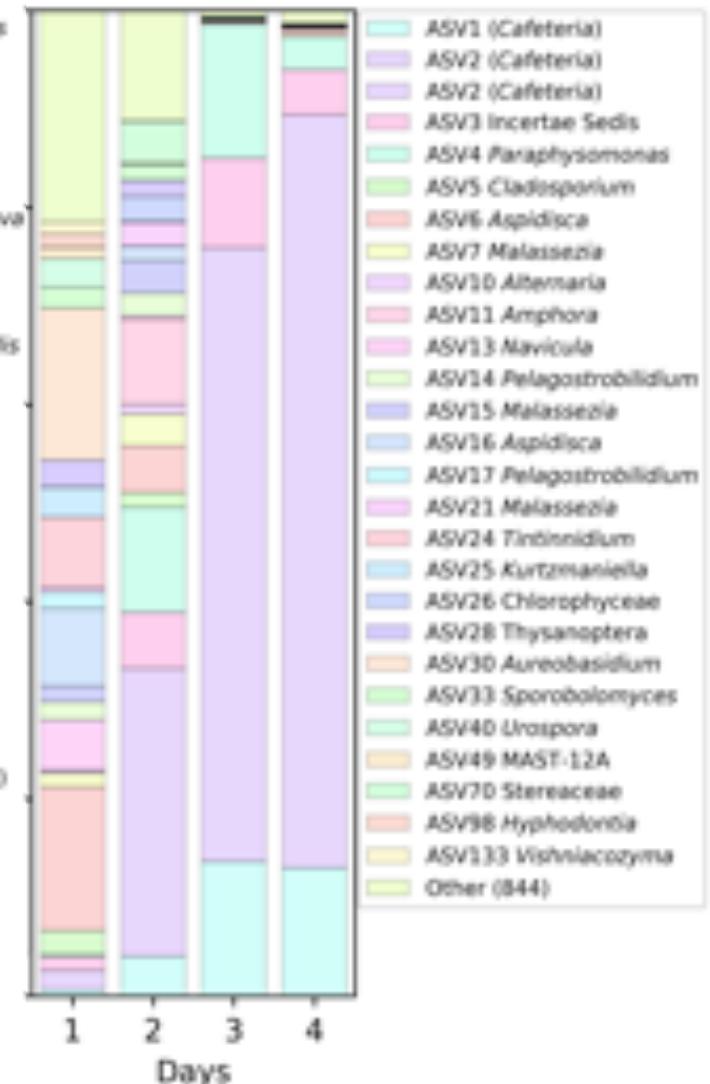
16S rRNA gene

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UNDERSTANDING MARINE MICROBIAL COMMUNITY DYNAMICS

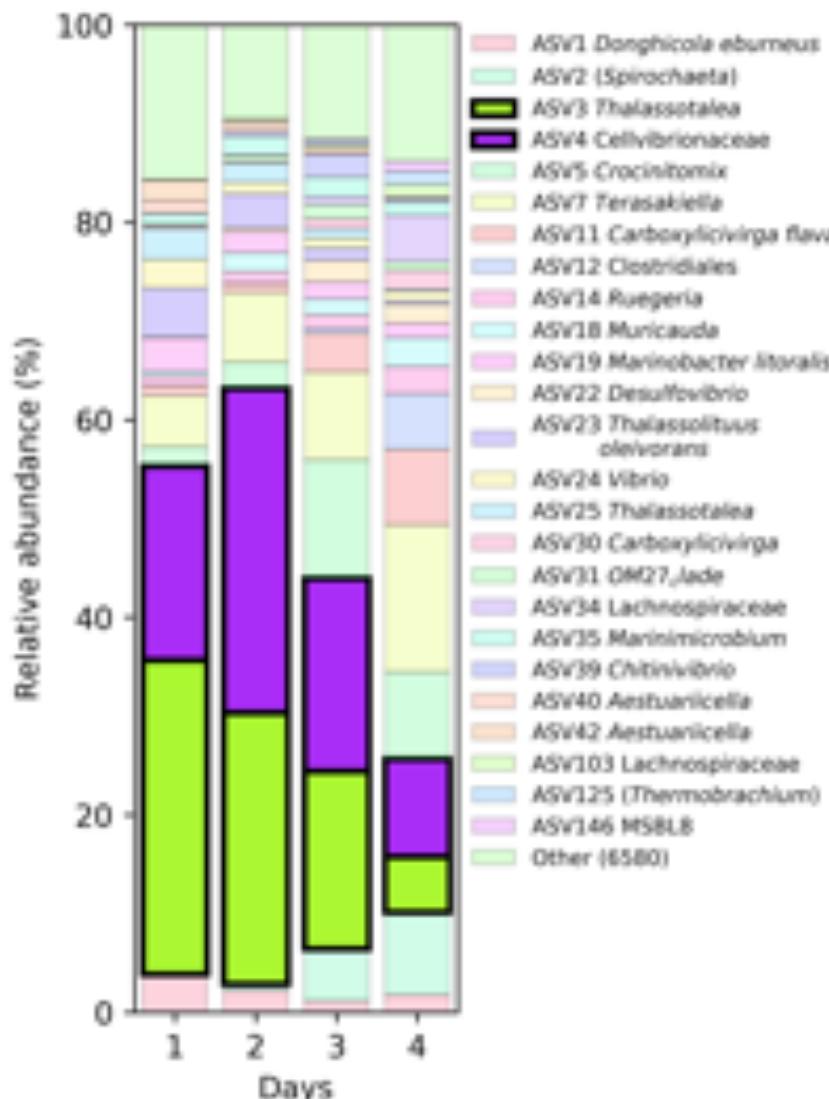


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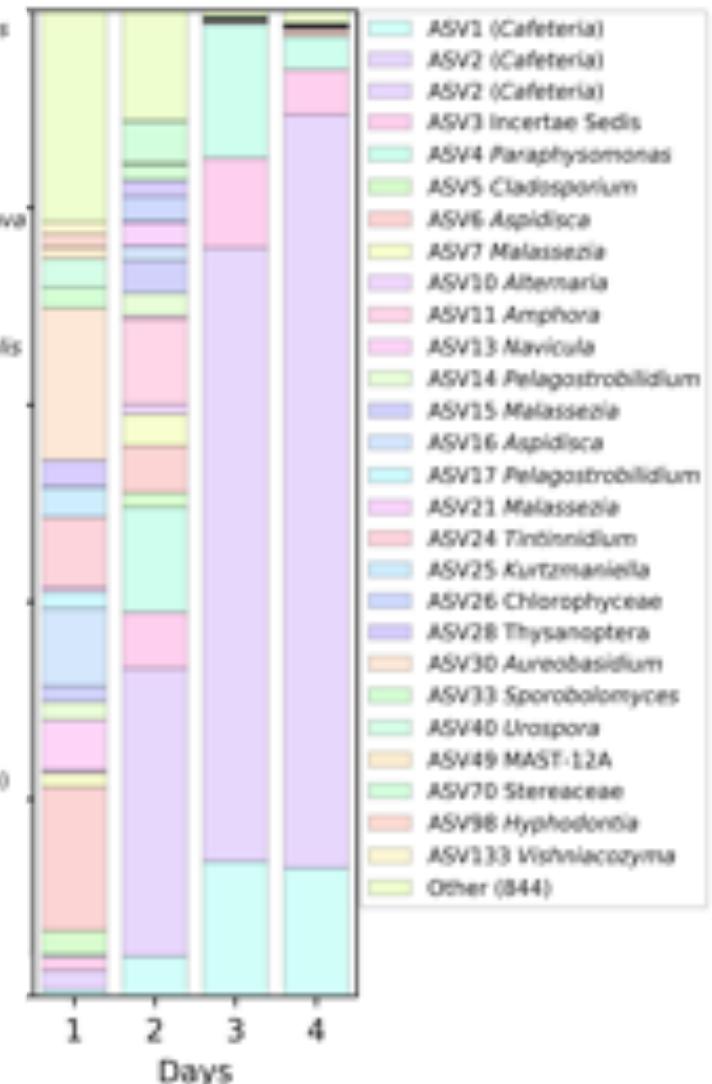
16S rRNA gene

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18S rRNA gene

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UNDERSTANDING MARINE MICROBIAL COMMUNITY DYNAMICS

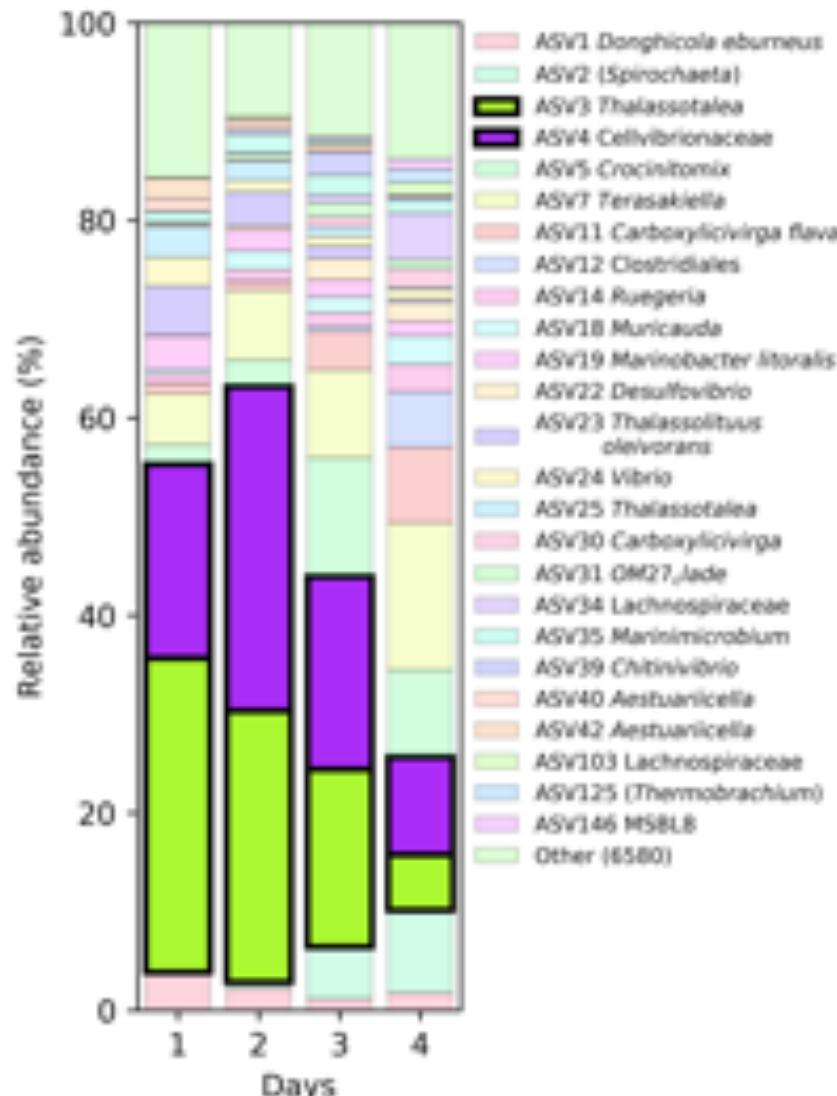


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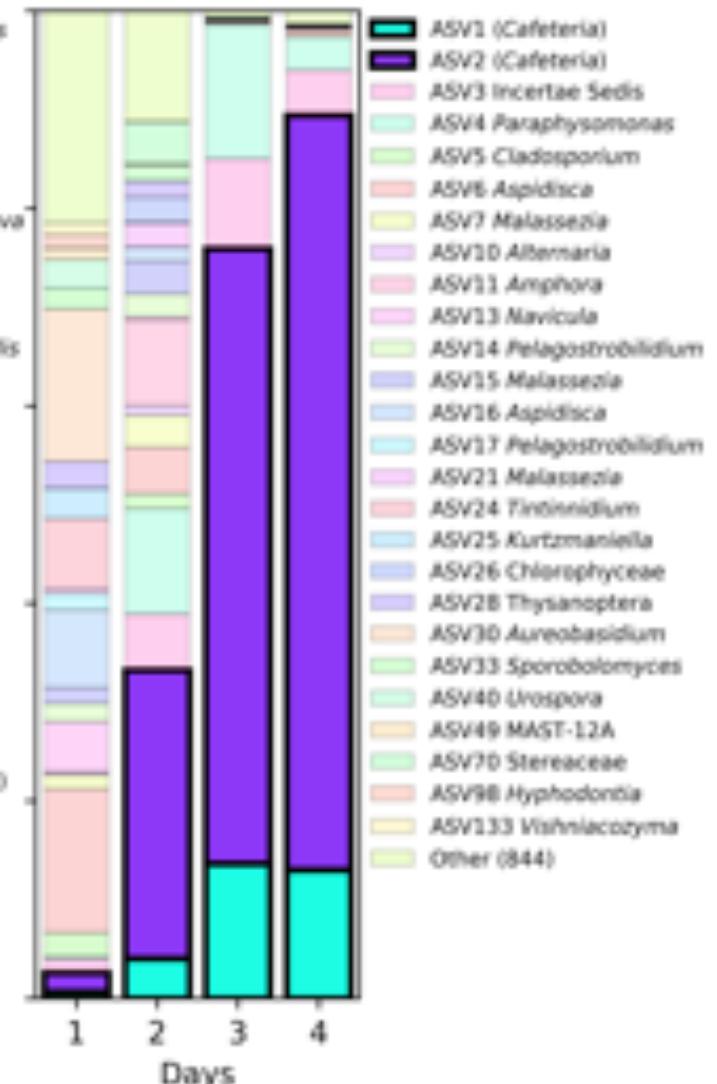
16S rRNA gene

Prokaryotes



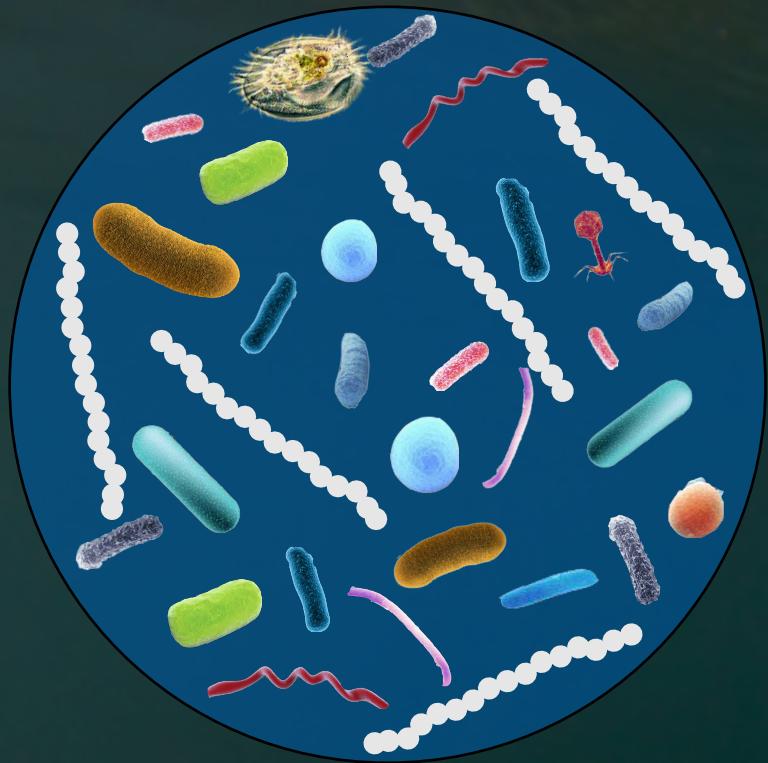
18S rRNA gene

Eukaryotes

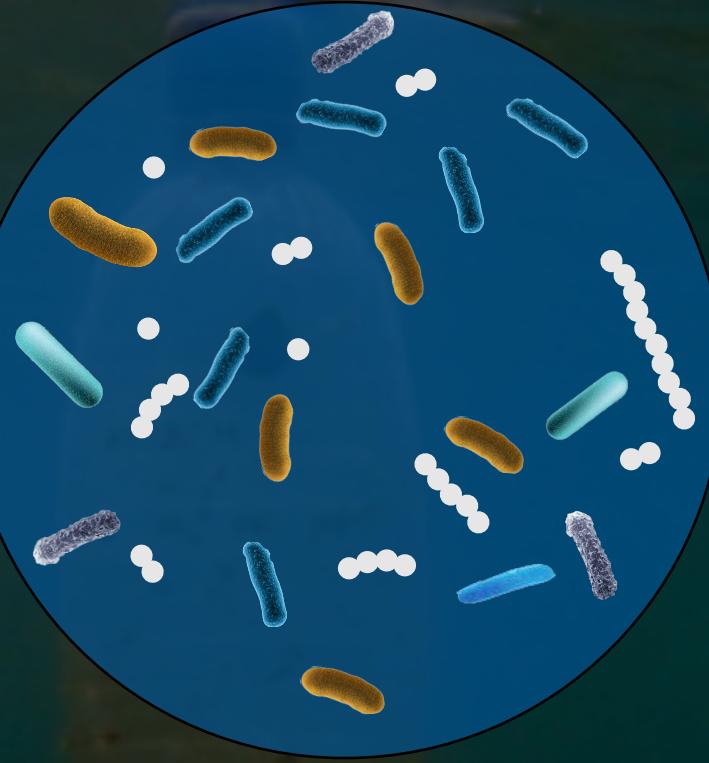


MARINE MICROBIAL COMMUNITY DYNAMICS

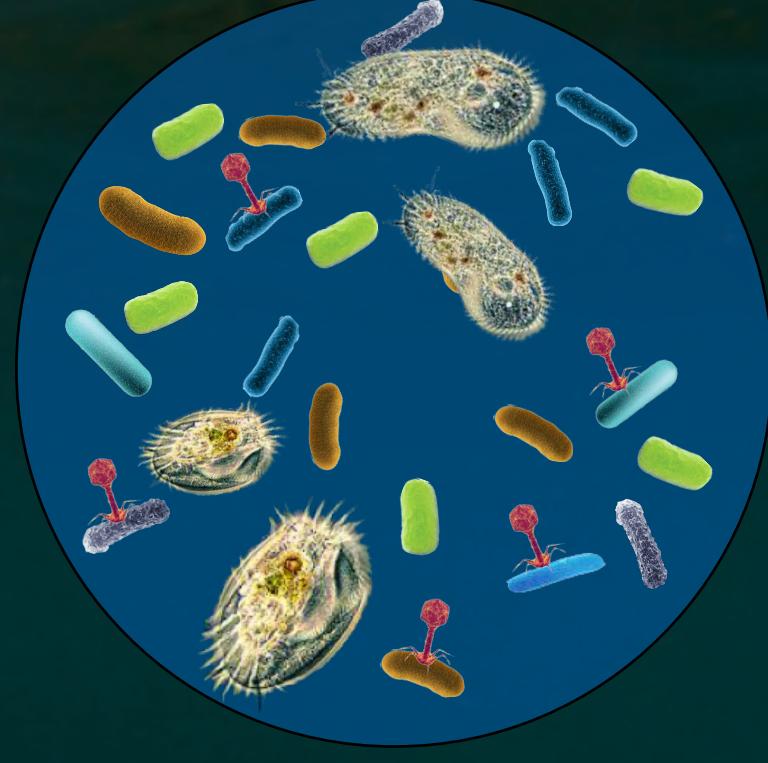
COLONISATION



SELECTION



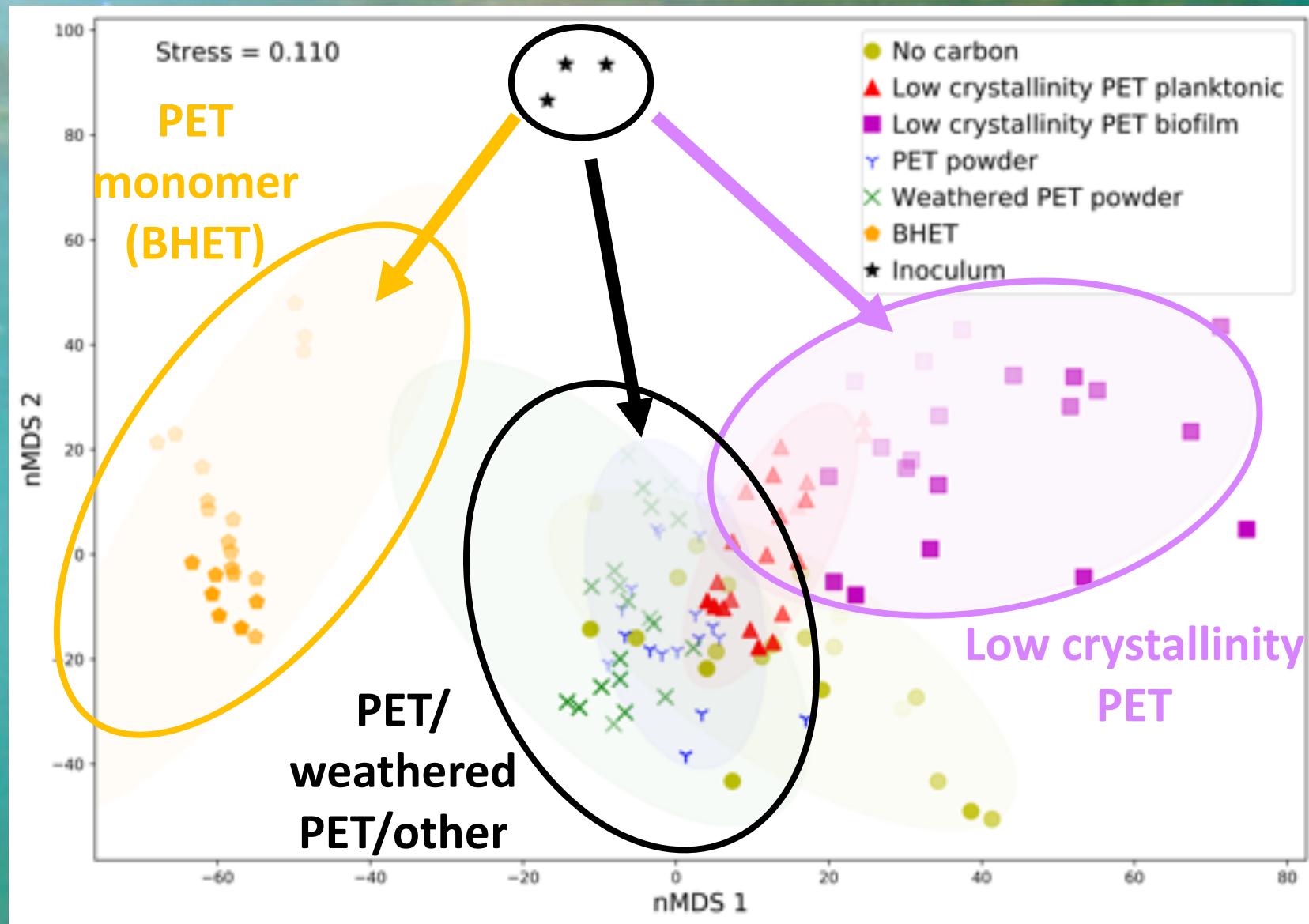
SUCCESSION



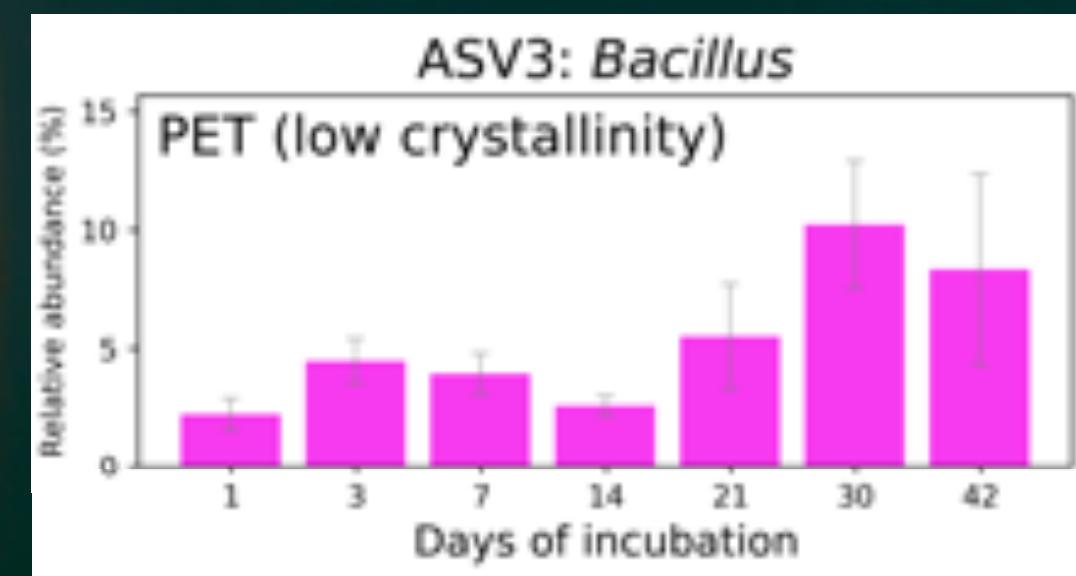
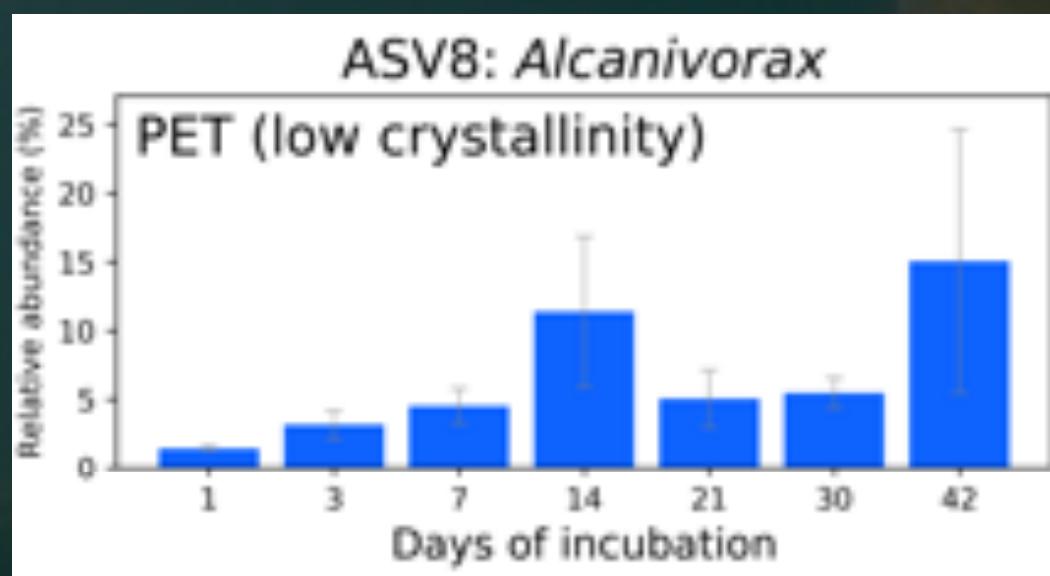
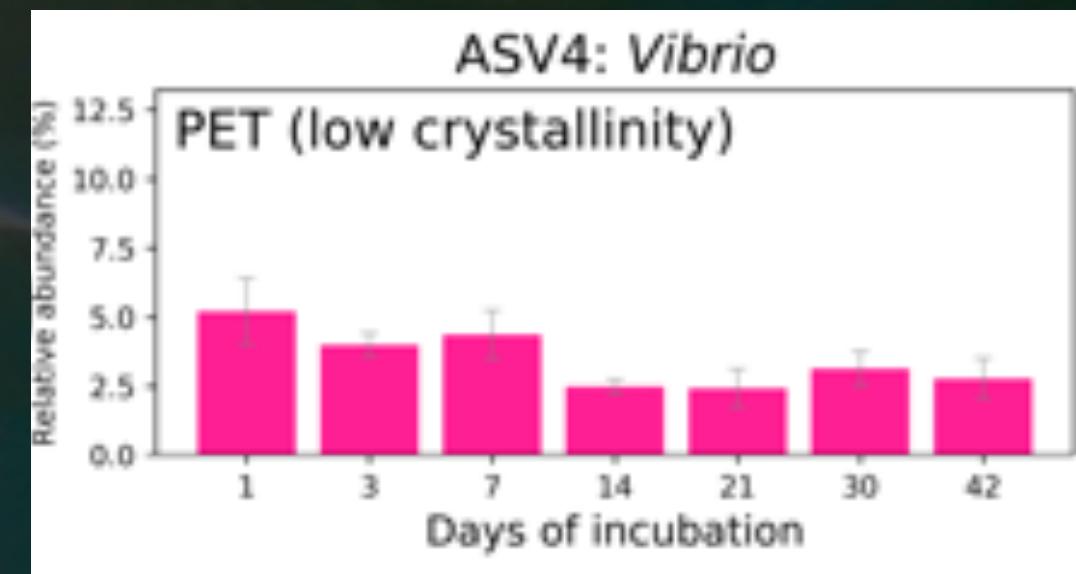
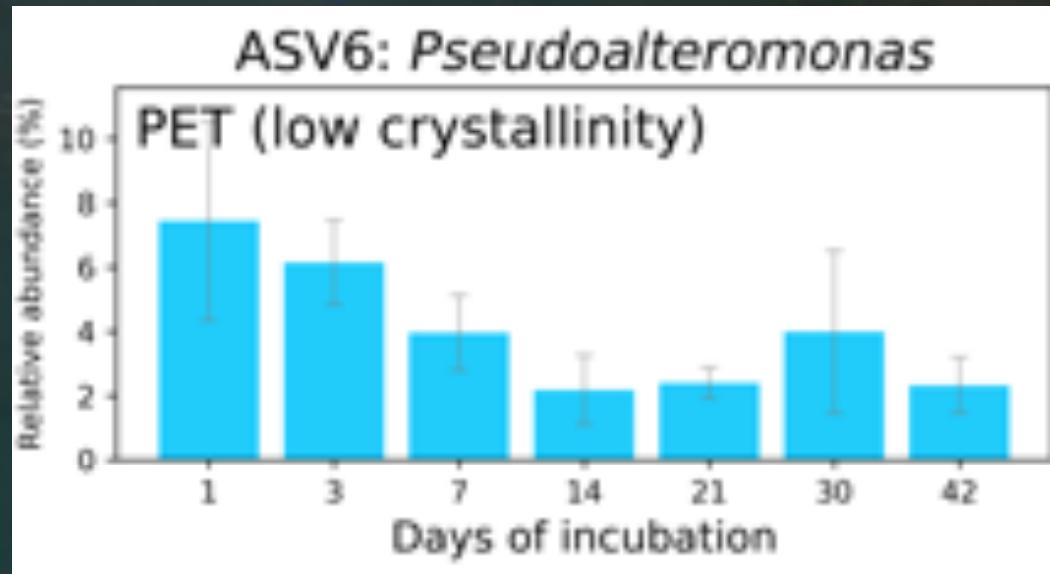
Enrichment of members that can
degrade

Community succeeded by:
Cheaters
Grazers
Viruses

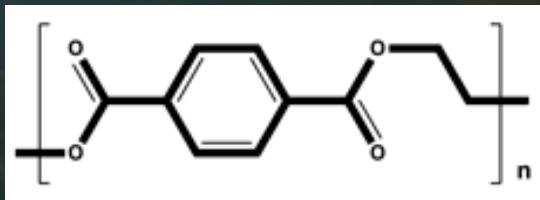
PET DEGRADATION BY A MICROBIAL COMMUNITY



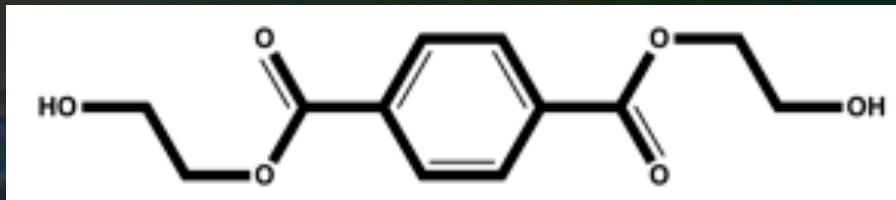
PET DEGRADATION BY A MICROBIAL COMMUNITY



PET-DEGRADING ISOLATES



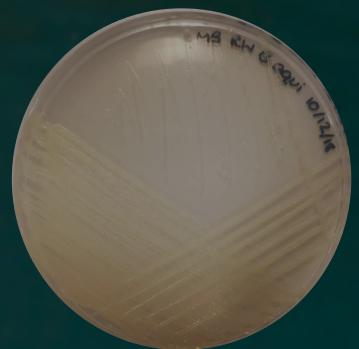
PET



PET monomer (BHET)



Thioclava sp.
(Alphaproteobacteria)



Bacillus sp.
(Firmicutes)

Proteogenomic characterisation

Genomes sequenced



Proteomics



Analysis of proteomics



PET-DEGRADING ISOLATES

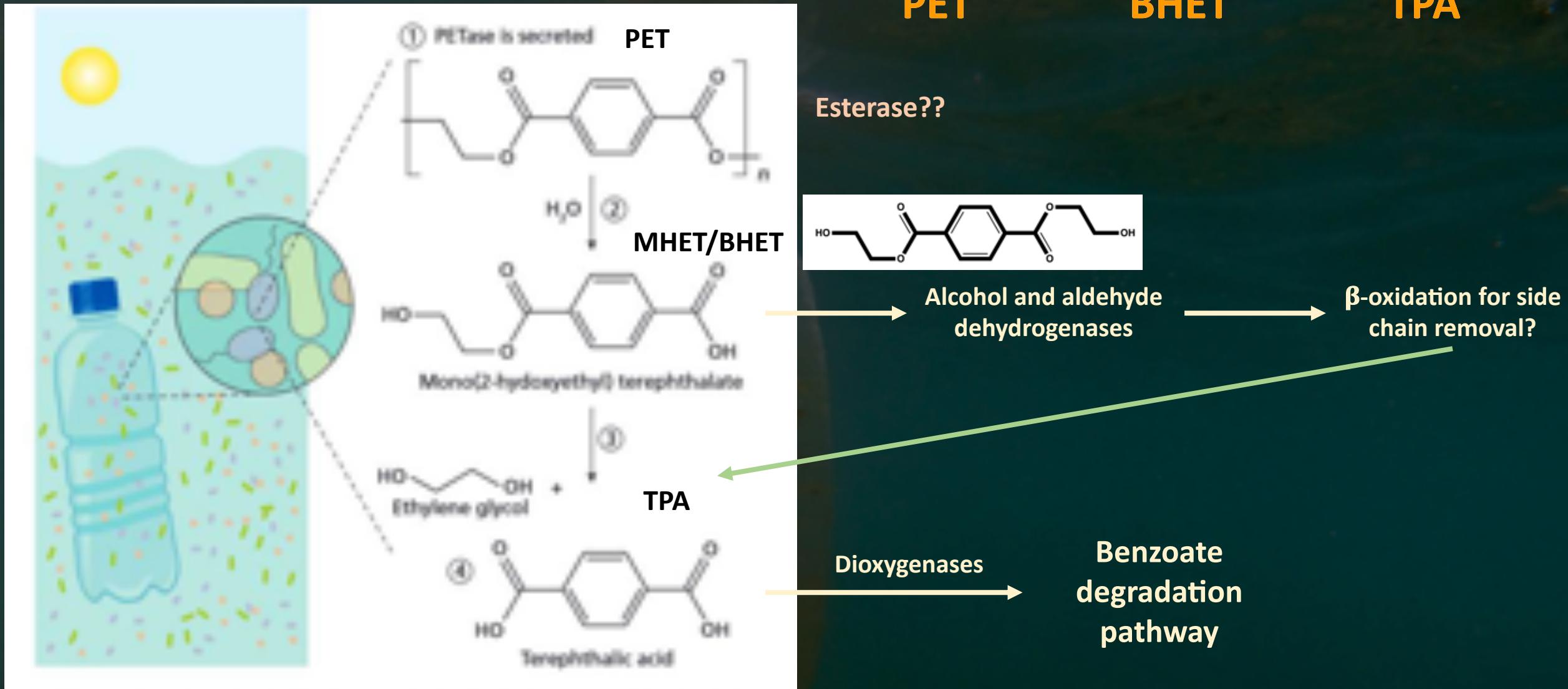


Figure: Wright (2019) *Biological Sciences Review* (magazine article)

TOXIC CHEMICALS ASSOCIATED WITH PLASTICS - PLASTICIZERS



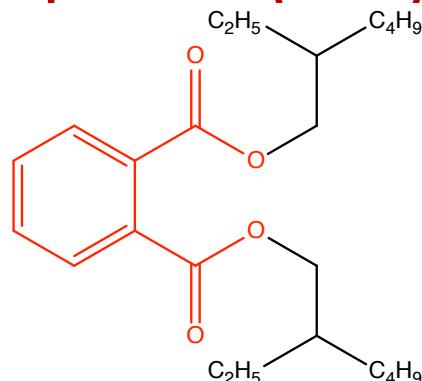
TOXIC CHEMICALS ASSOCIATED WITH PLASTICS - PLASTICIZERS



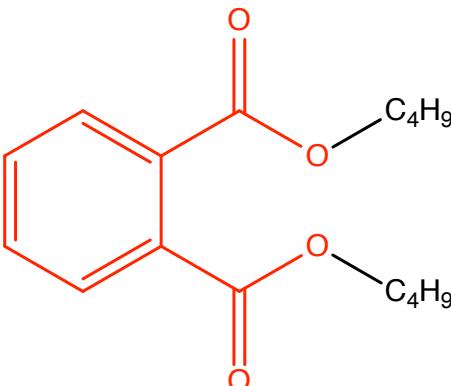
TOXIC CHEMICALS ASSOCIATED WITH PLASTICS - PLASTICIZERS

Phthalic acid esters
Toxic

Bis(2-ethylhexyl phthalate (DEHP))

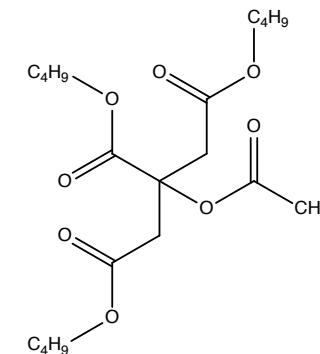


Dibutyl phthalate (DBP)



Citrate
Biodegradable

Acetyl tributyl citrate (ATBC)



ISOLATES

42

10

2

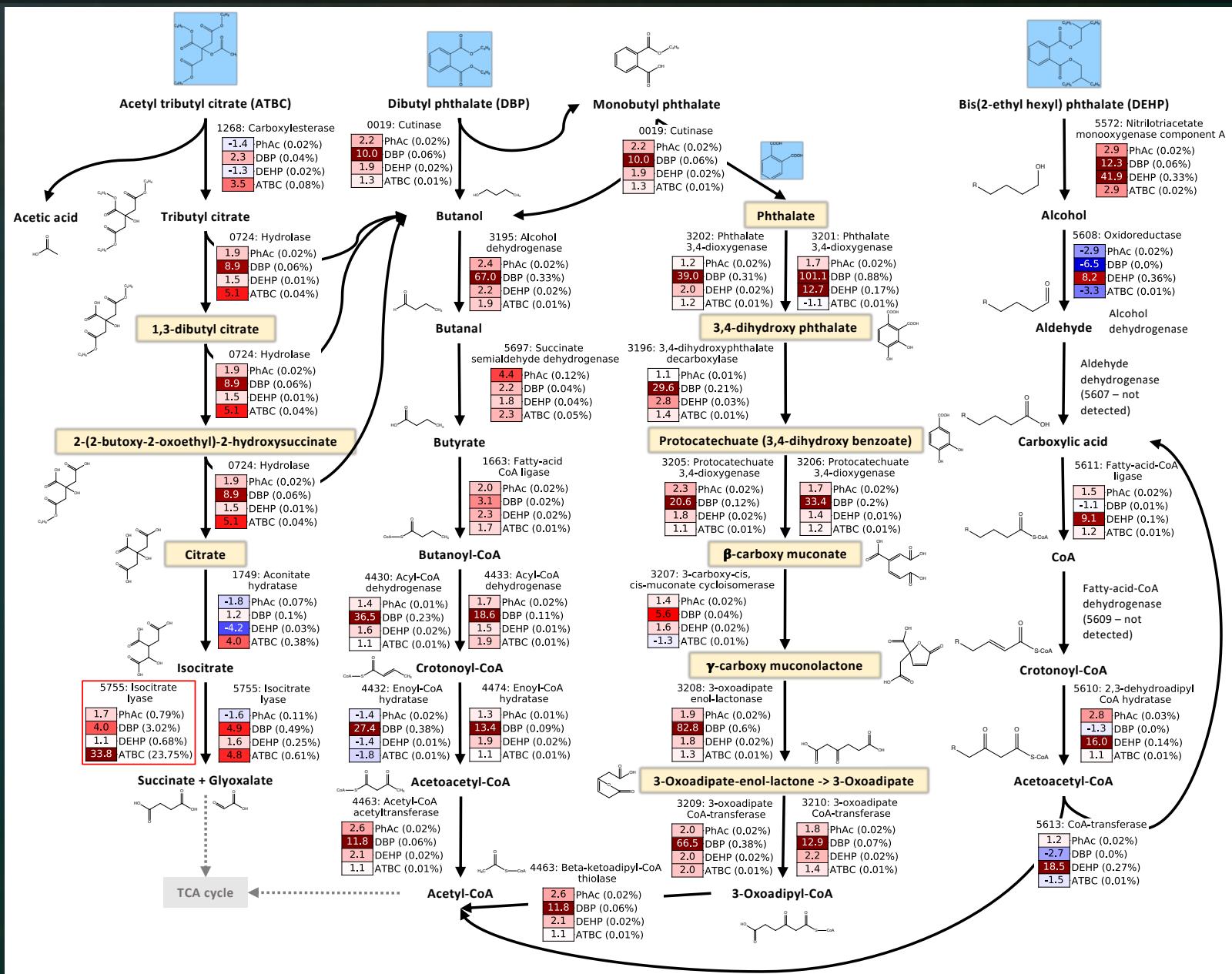
Halomonas sp. ATBC28

Mycobacterium sp. DBP42



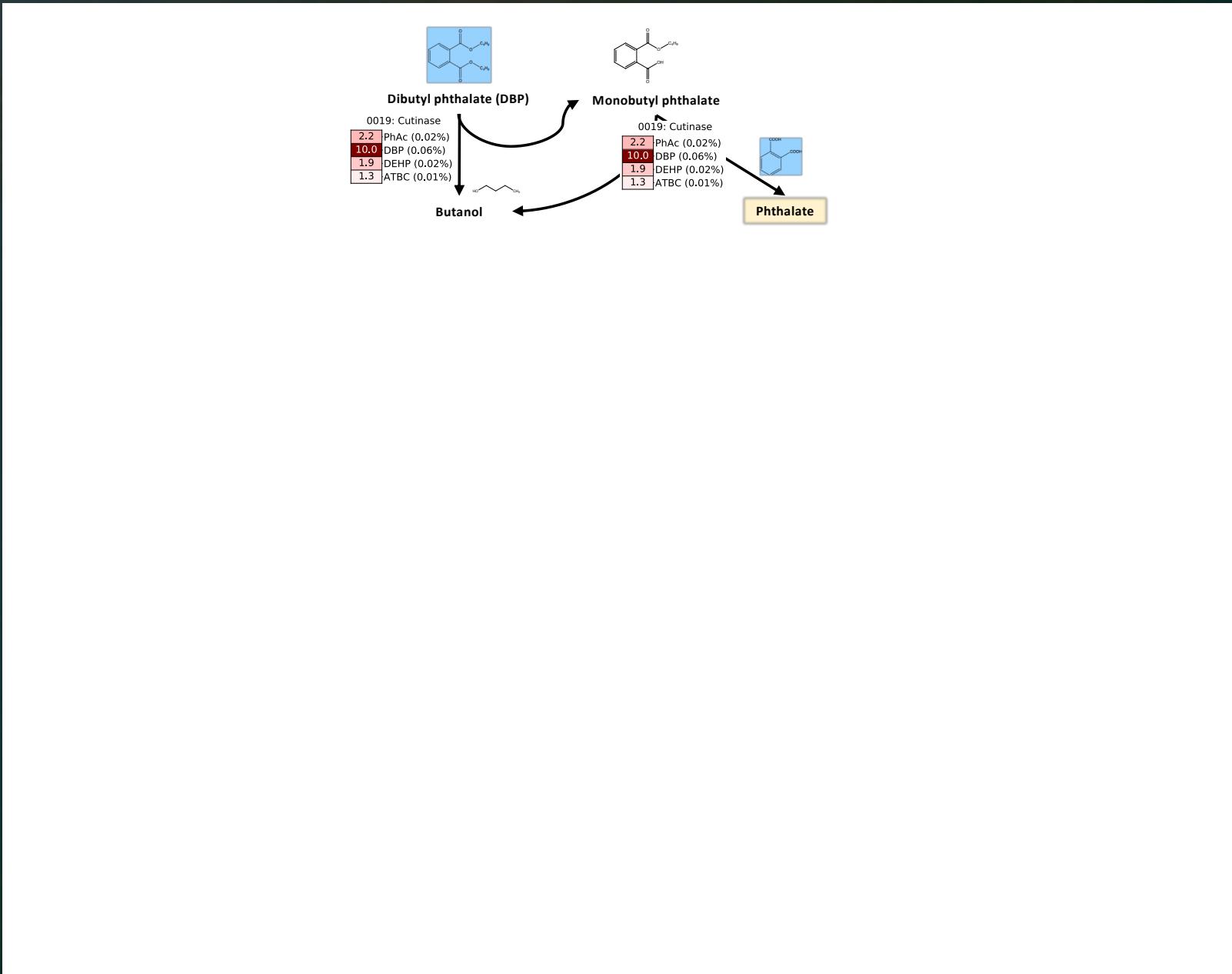
Proteogenomic
analysis

PLASTICIZER DEGRADATION BY MYCOBACTERIUM SP. DBP42



Yellow = confirmed by metabolomics

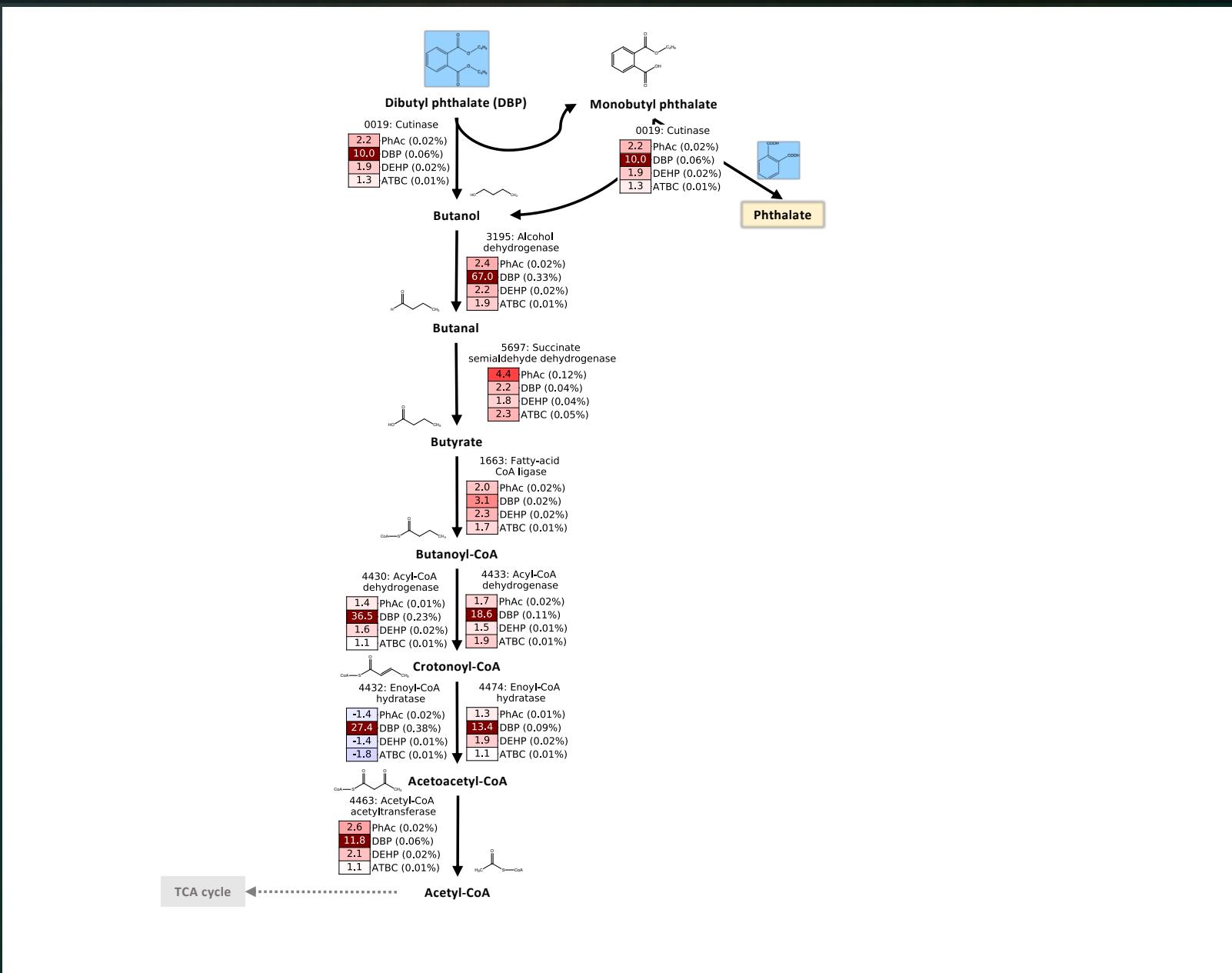
DIBUTYL PHTHALATE DEGRADATION BY *MYCOBACTERIUM* SP. DBP42



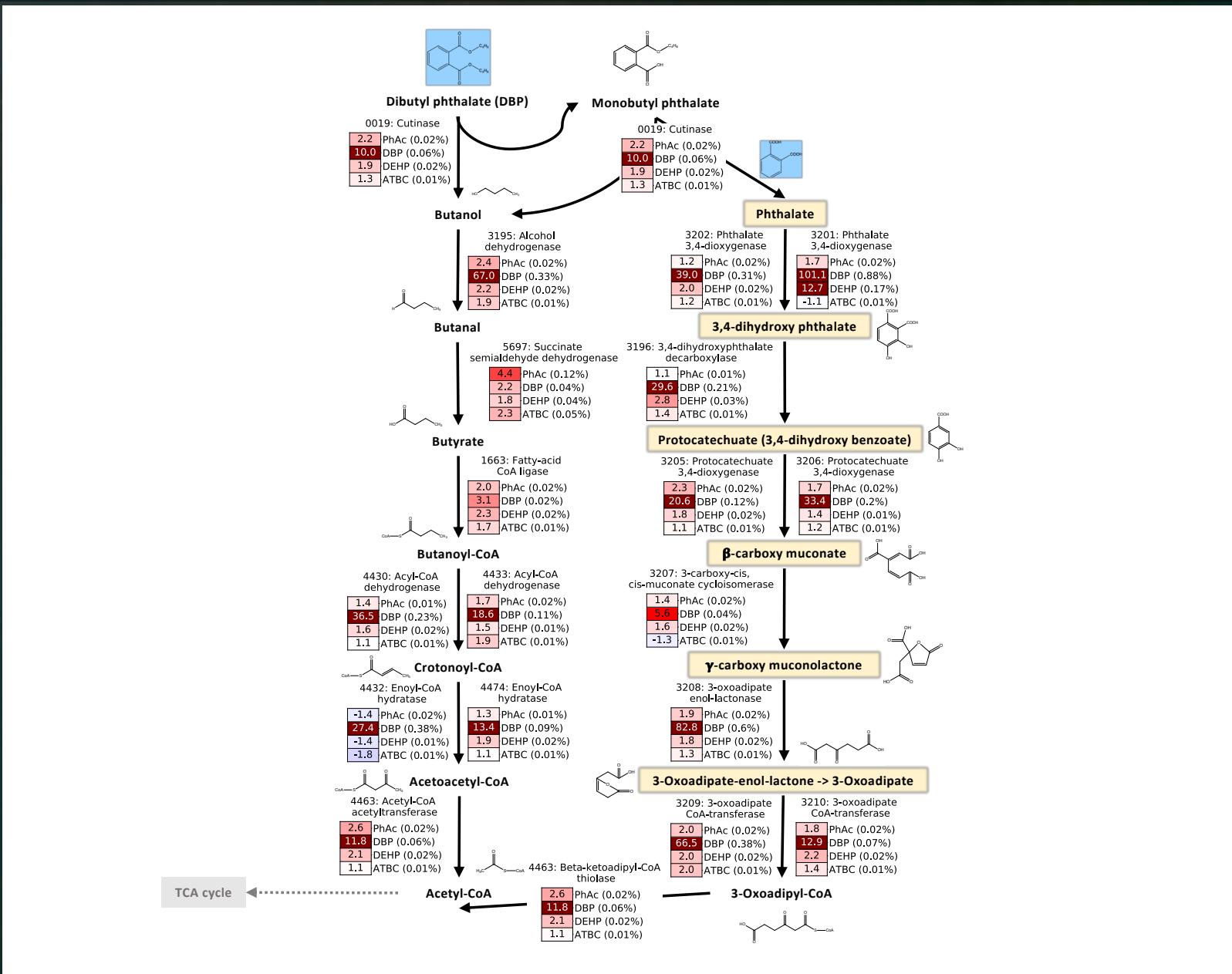
DBP:
Cutinase
removes side
chains
↓
butanol and
phthalic acid

Yellow = confirmed by
metabolomics

BUTANOL DEGRADATION BY *MYCOBACTERIUM* SP. DBP42

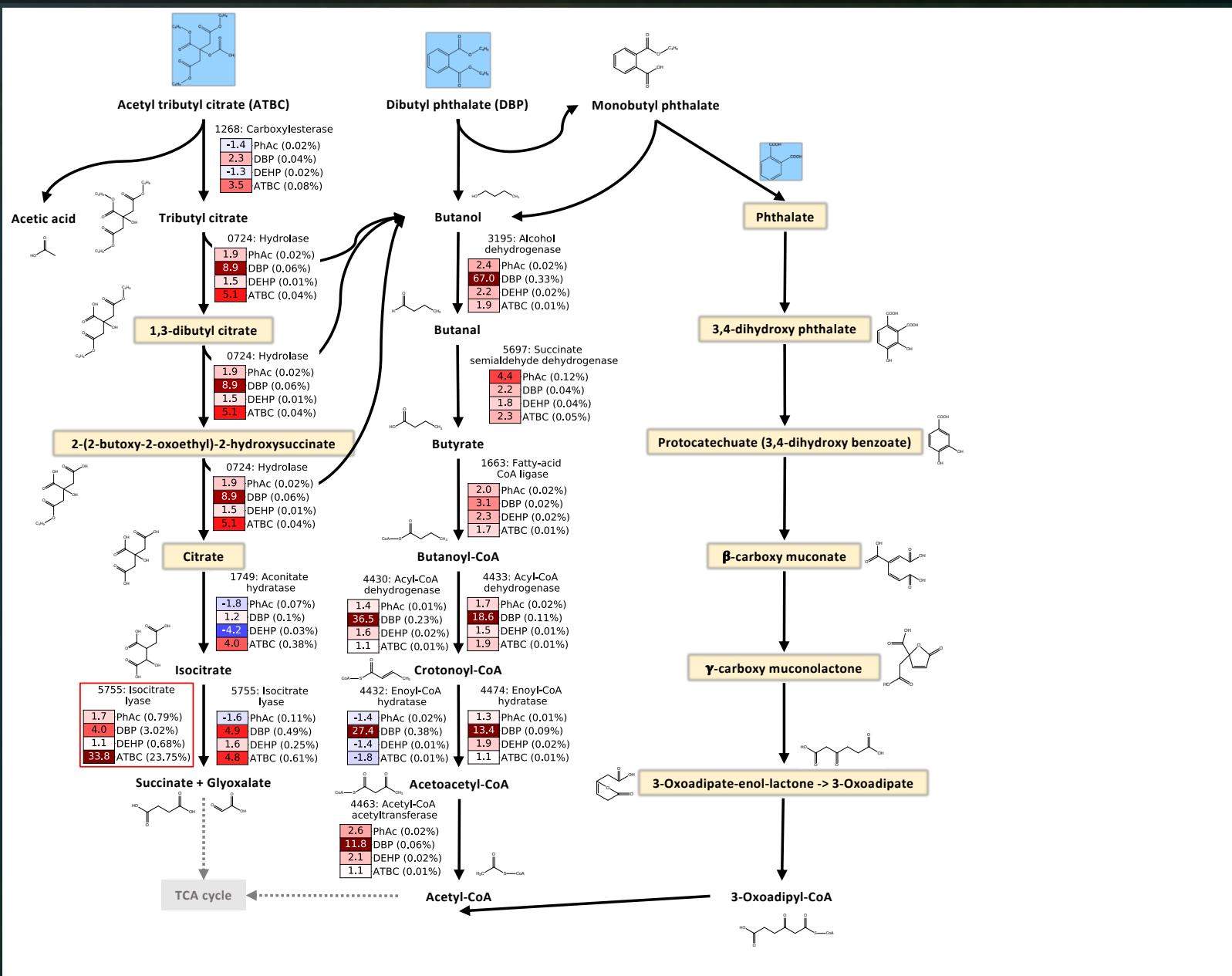


PHthalate DEGRADATION BY MYCOBACTERIUM SP. DBP42



Phthalate:
Benzoate
degradation
pathway
↓
Acetyl-CoA

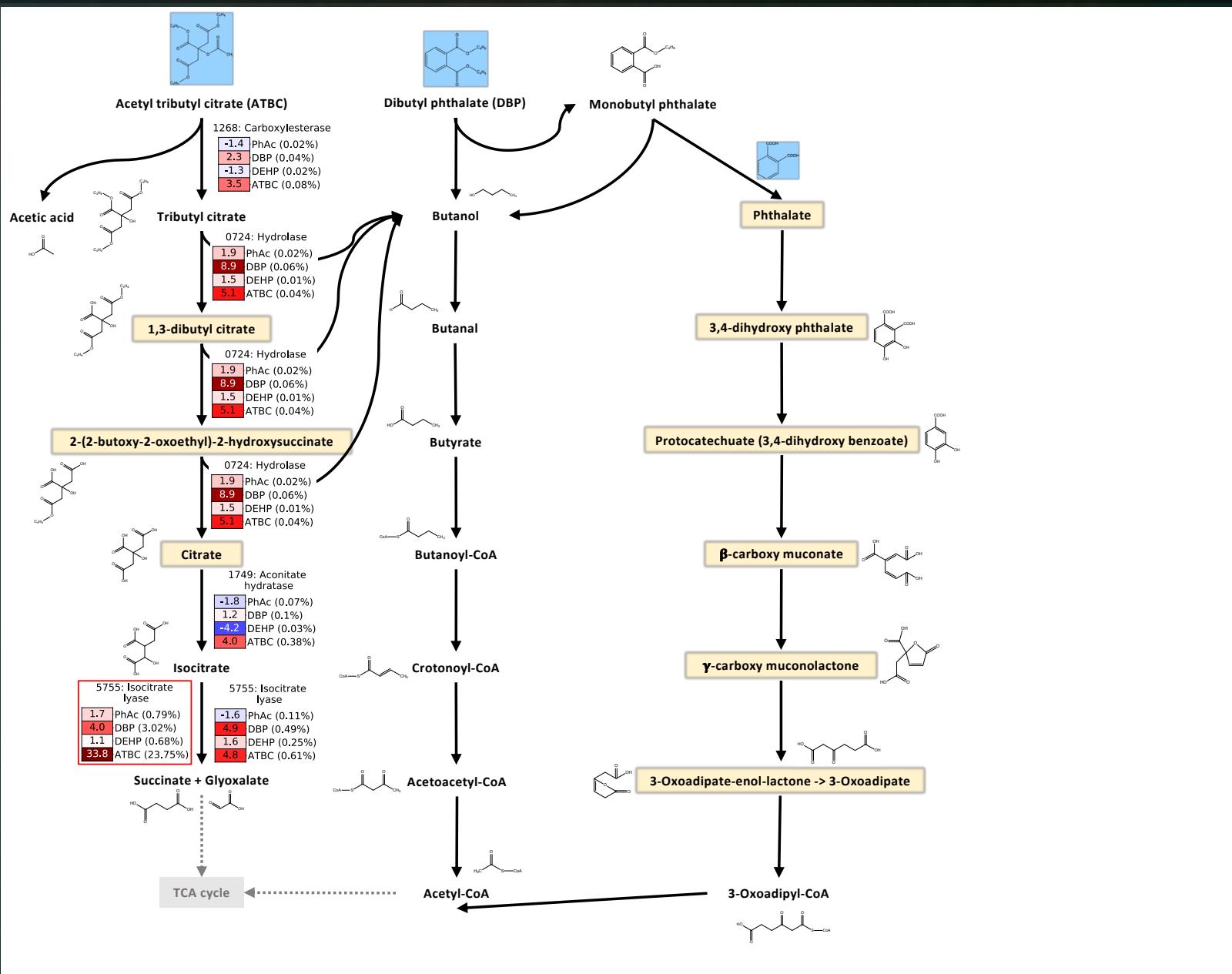
ACETYL TRIBUTYL CITRATE DEGRADATION BY *MYCOBACTERIUM* SP. DBP42



ATBC:
Esterase/
hydrolase
remove side-
chains
↓
butanol and
citrate

Yellow = confirmed by
metabolomics

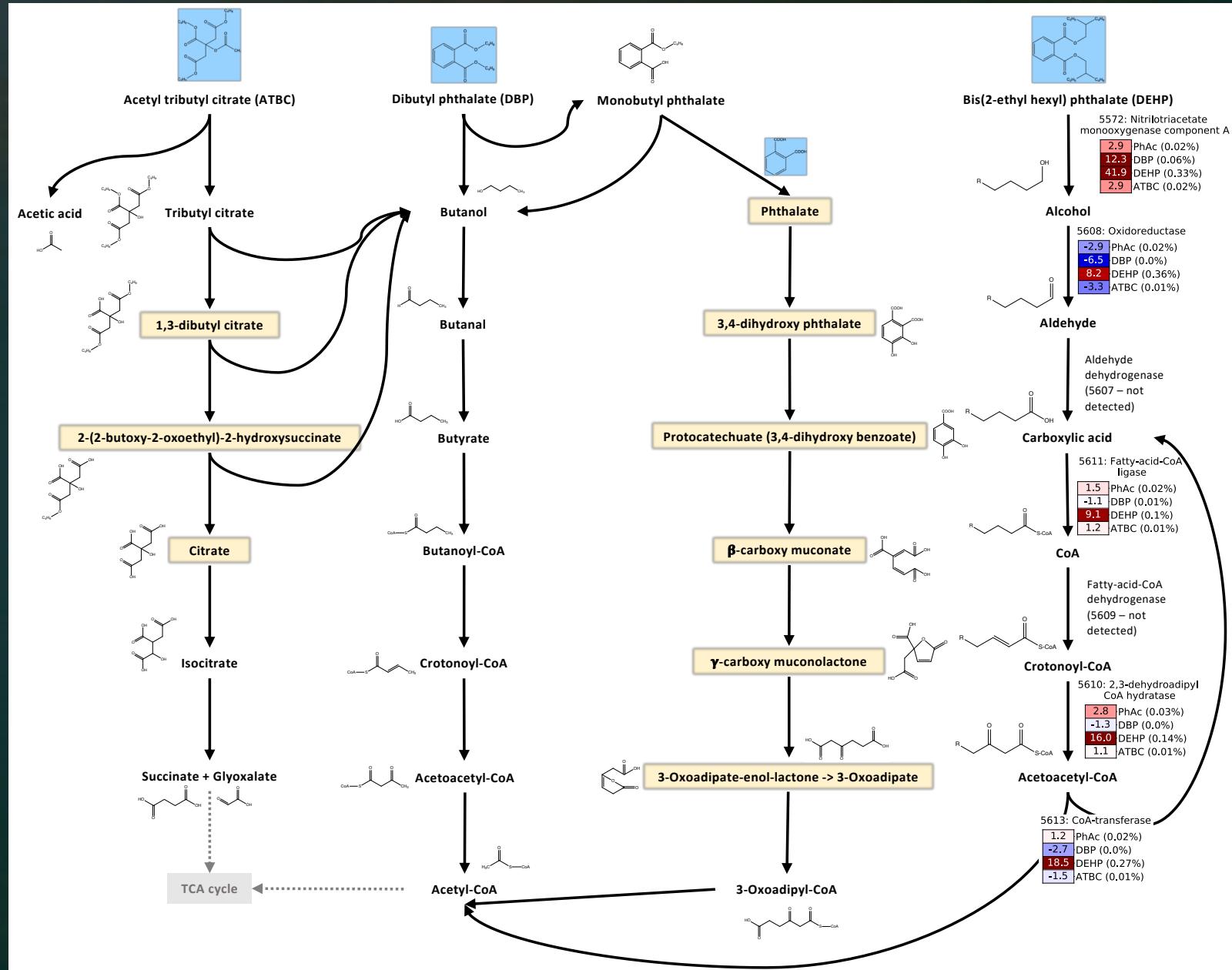
ACETYL TRIBUTYL CITRATE DEGRADATION BY *MYCOBACTERIUM* SP. DBP42



ATBC:
Esterase/
hydrolase
remove side-
chains
↓
butanol and
citrate
↓
Only citrate used

Yellow = confirmed by
metabolomics

BIS(2-ETHYL HEXYL) PHTHALATE DEGRADATION BY *MYCOBACTERIUM* SP. DBP42



DEHP:
Long-chain fatty acid β -oxidation
↓
Acetyl-CoA

SUMMARY



Community
succession on
chitin



PET community
succession



Plasticizer
proteogenomics

Are plastics
being
biodegraded?

ACKNOWLEDGEMENTS

Supervisors: Joseph Christie-Oleza
Matthew Gibson

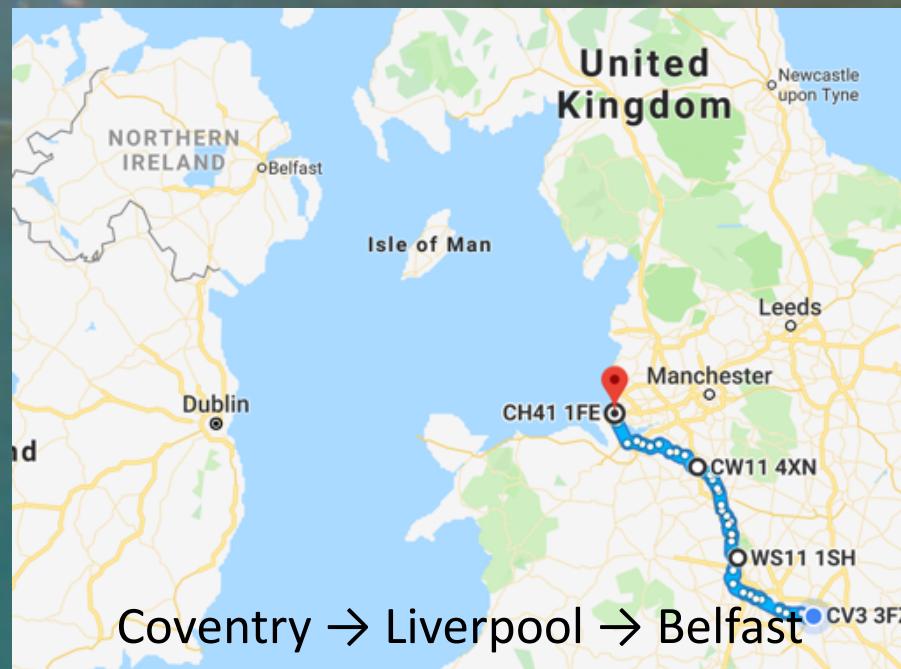
Christie-Oleza group:



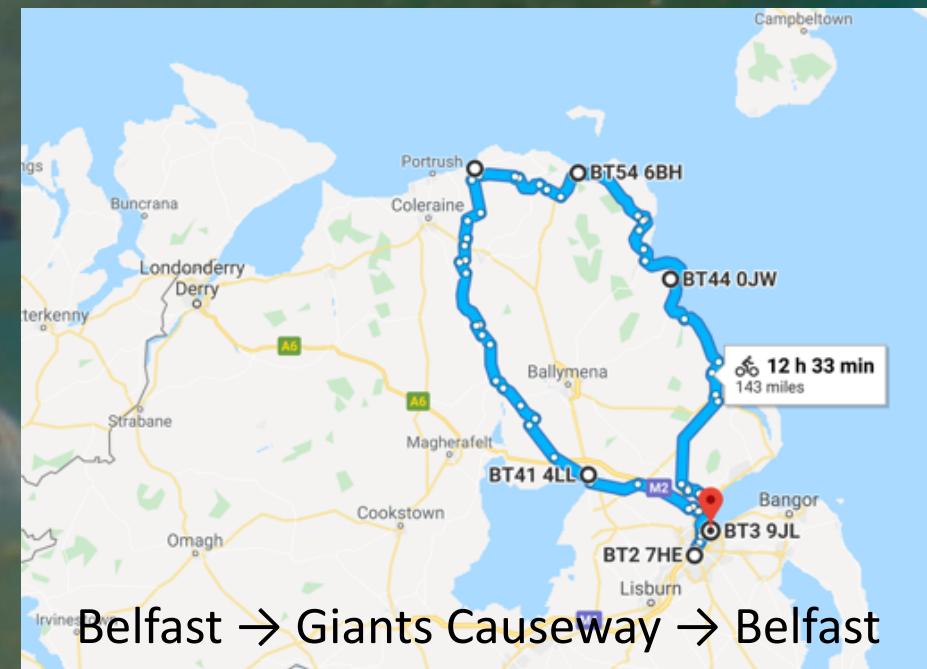
Travel grant



#cycletobelfast



Coventry → Liverpool → Belfast



Belfast → Giants Causeway → Belfast



<https://www.justgiving.com/fundraising/robyn-wright3>

Thanks for listening!
QUESTIONS?



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