Research and development of marine biodegradable plastics with degradation initiation switch function

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Japan Agency for Marine-Earth Science and Technology (JAMSTEC)

The role of JAMSTEC in this project

<u>Goals (FY 2029)</u>：Prove the biodegradability of newly developed materials through the project at *in situ* conditions of the ocean including the deep-sea.

1-4. Development of new materials based on polysaccharides

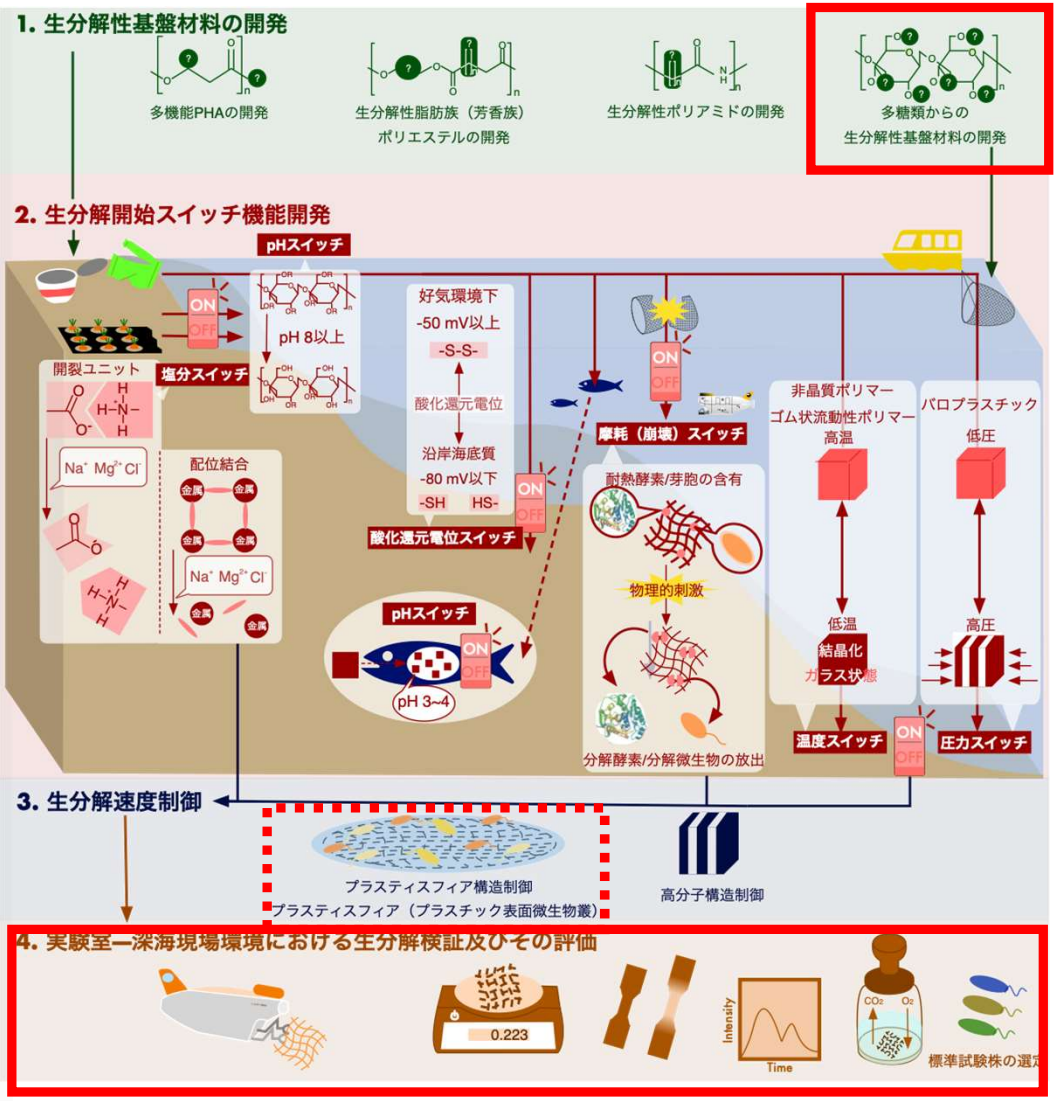
Develop novel materials based on polysaccharides with high marine biodegradability.

4-1-3. *In situ* biodegradability tests in the ocean including the deep-sea

Deploy and recover newly developed materials in the ocean including deep-sea environments every half year. Investigate the distributional patterns of plastic materials in the ocean. Obtain environmental parameters including faunal/floral compositions that have affects on degradation switches.

4-2-2. Meta-omics analysis of plastisphere correlating with biodegradation.

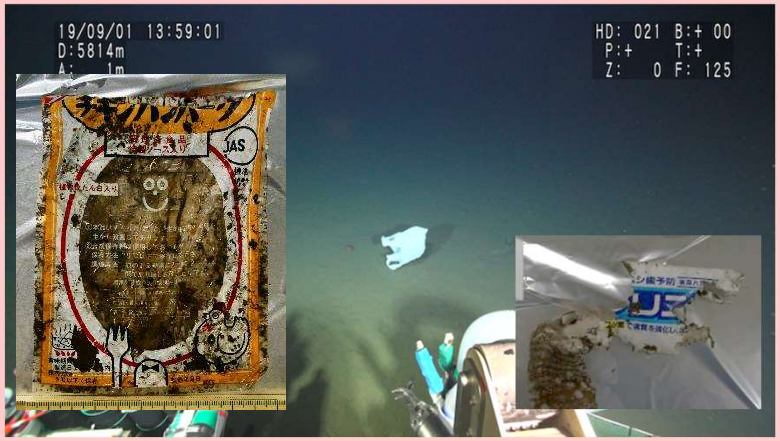
Using NGS, meta-omics analysis will be conducted to identify the microbes and enzymes related to plastic biodegradation in marine environments.



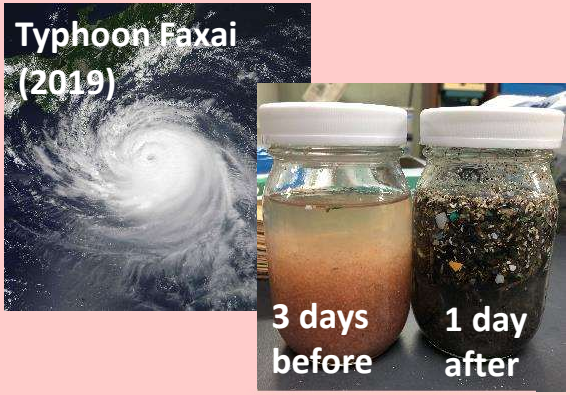
1-4. Development of new materials based on polysaccharides:

Transparent paper board as an alternative to conventional plastics

Recent discovery by Nakajima et al. (Research Institute for Global Change (RIGC))



Single use plastics on the deep-sea



Outflows from land by natural disasters are unavoidable

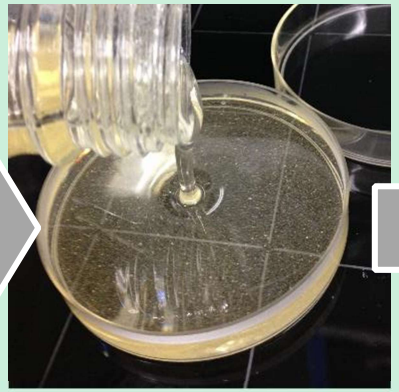
3 requirements for novel materials

1. Marine biodegradable
→ in case of mismanagement

2. Transparent
→ To meet users' request

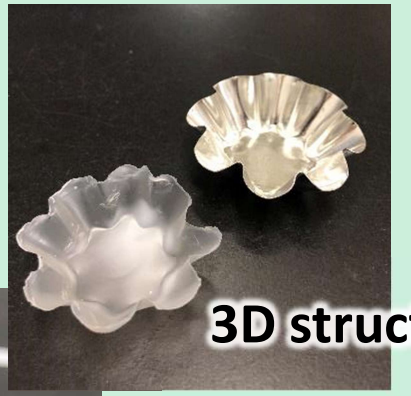
3. Mono-component
→ Easy to recycle

Development of a new material meeting the 3 requirements

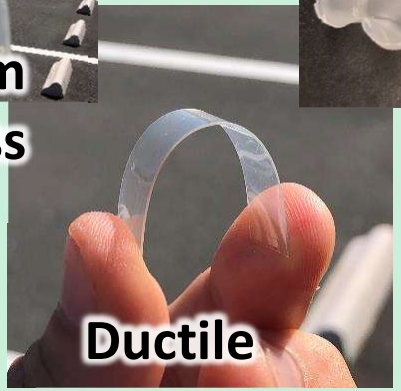


Dissolving and shaping cellulose

Up to 2 mm
in thickness



3D structure



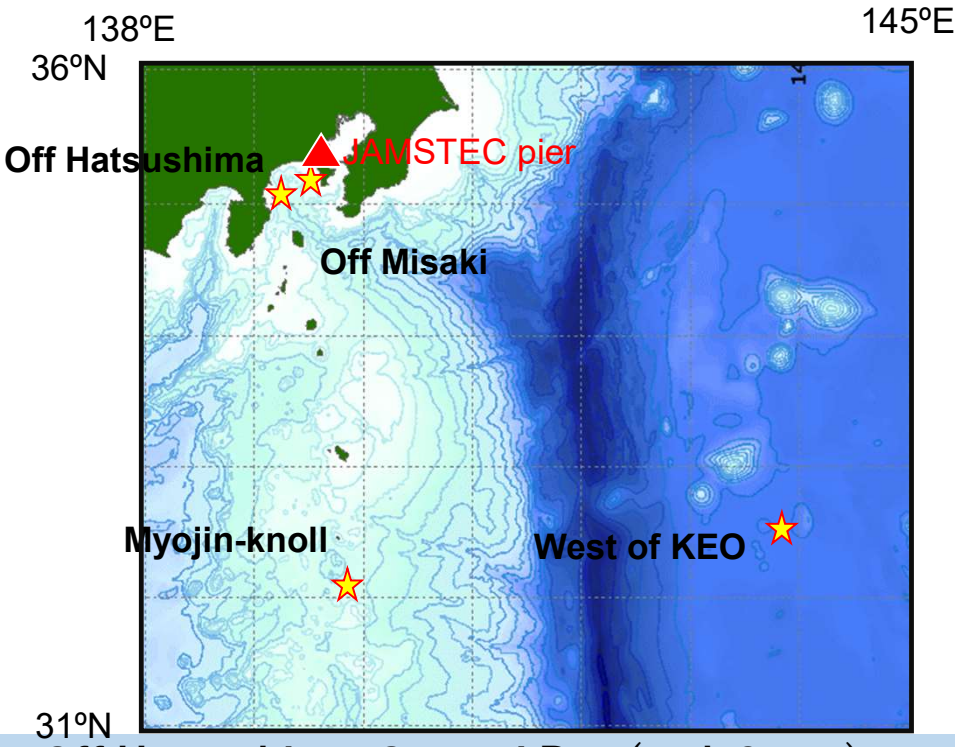
Ductile

Same component as paper but superior property

PCT/JP2020/039874

4-1-3. *In situ* biodegradability tests in the ocean including the deep-sea

■Performed cruises on Feb, May, and Oct 2021 and deploy/recover novel materials. They were provided to biodegradability tests and meta-omics analyses.



・Off Hatsushima, Sagami Bay (w.d. 854m) :
Pre-existing site since the previous NEDO project

・Off Misaki, Sagami Bay (757m) :
High accumulation of plastic debris from Kanto area

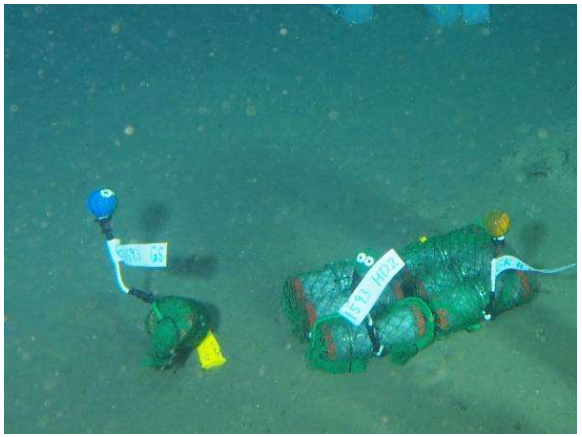
・West of KEO abyssal plain (5502m) :
The largest environment on the Earth covering 70% of the seafloor

・Myojin-knoll hydrothermal area (1294m) :
Wide environmental ranges and high microbial biomass

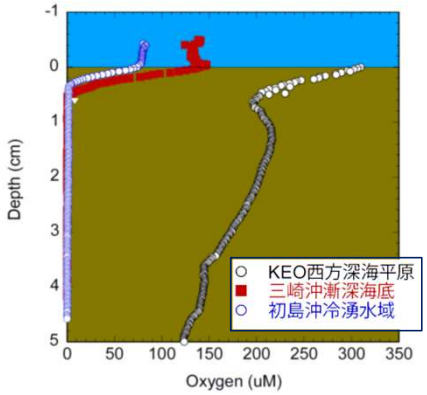
・JAMSTEC pier (0 to 5m) :
Flexible deploy/recover, seasonal changes in environments, effects of sunlight and wave actions.

1) Put novel materials into chambers

2) Carry with the manned submersible *Shinkai6500*



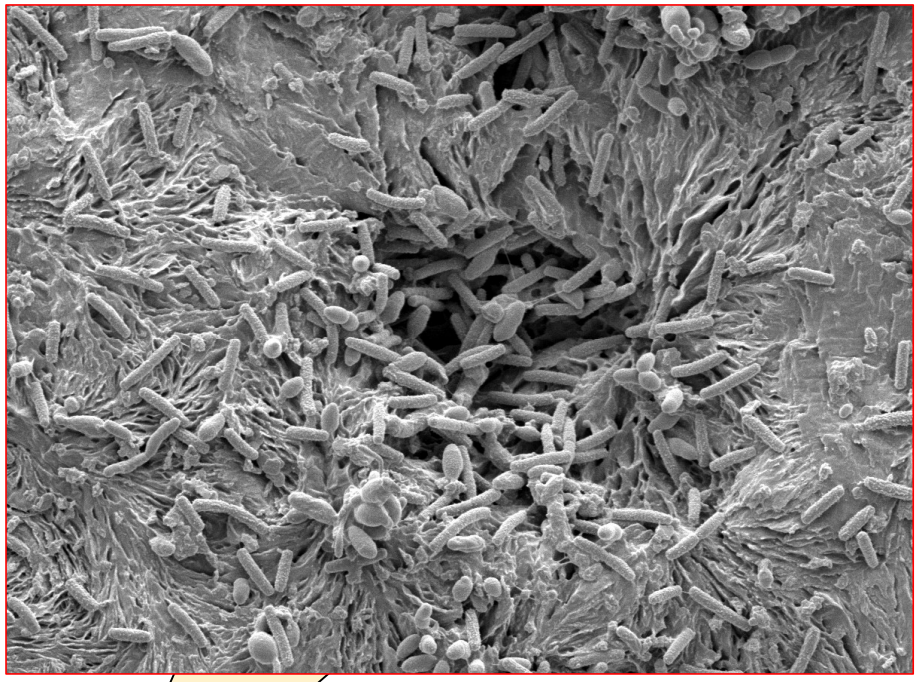
3) Deploy/recover with the Shinkai6500 and also collect environmental samples



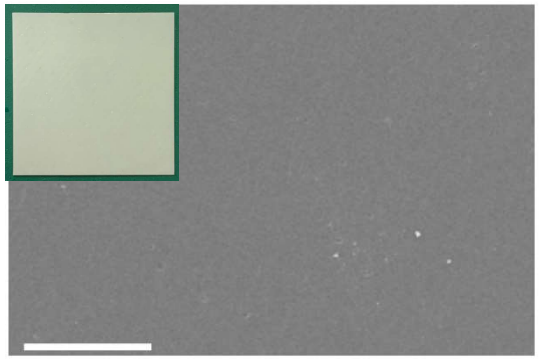
4) Measure environmental parameters (temp, sal, DO, pH, ORP, etc)

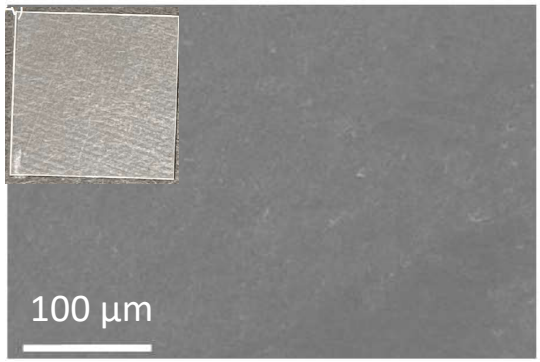
4-2-2. Meta-omics analysis of plastisphere correlating with biodegradation

Marine biodegradation test



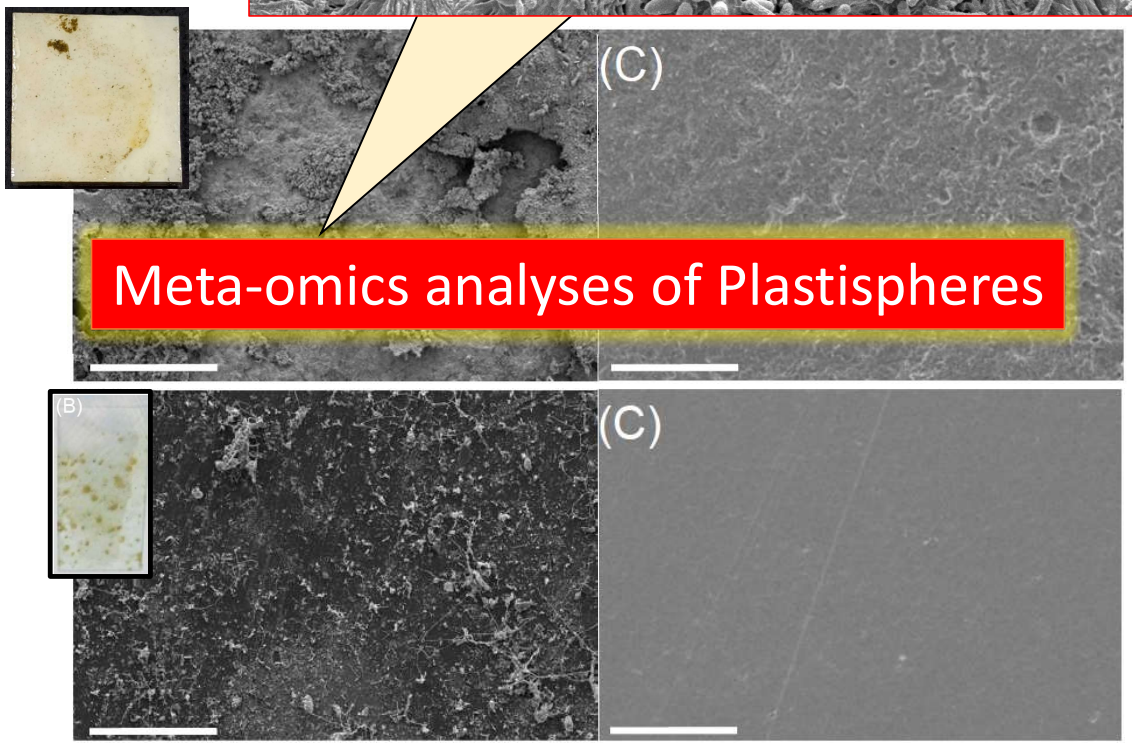
Marine biodegradable plastic





Marine **non-**biodegradable plastic

1.5 months



Before detachment of biofilm

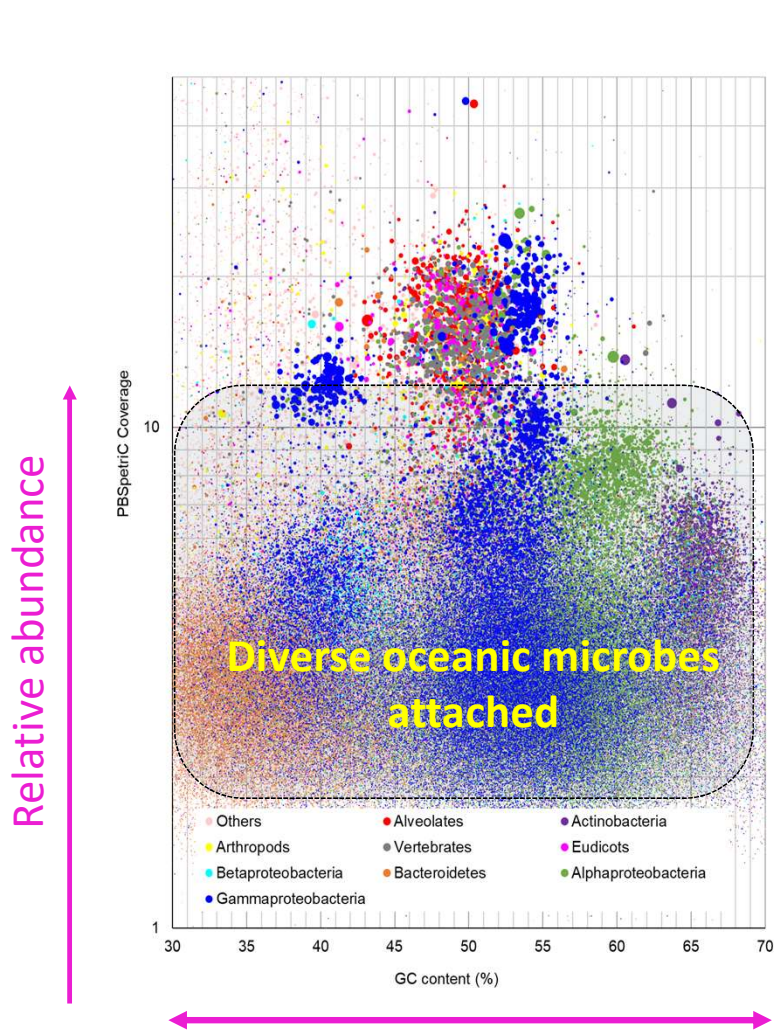
After detachment of biofilm

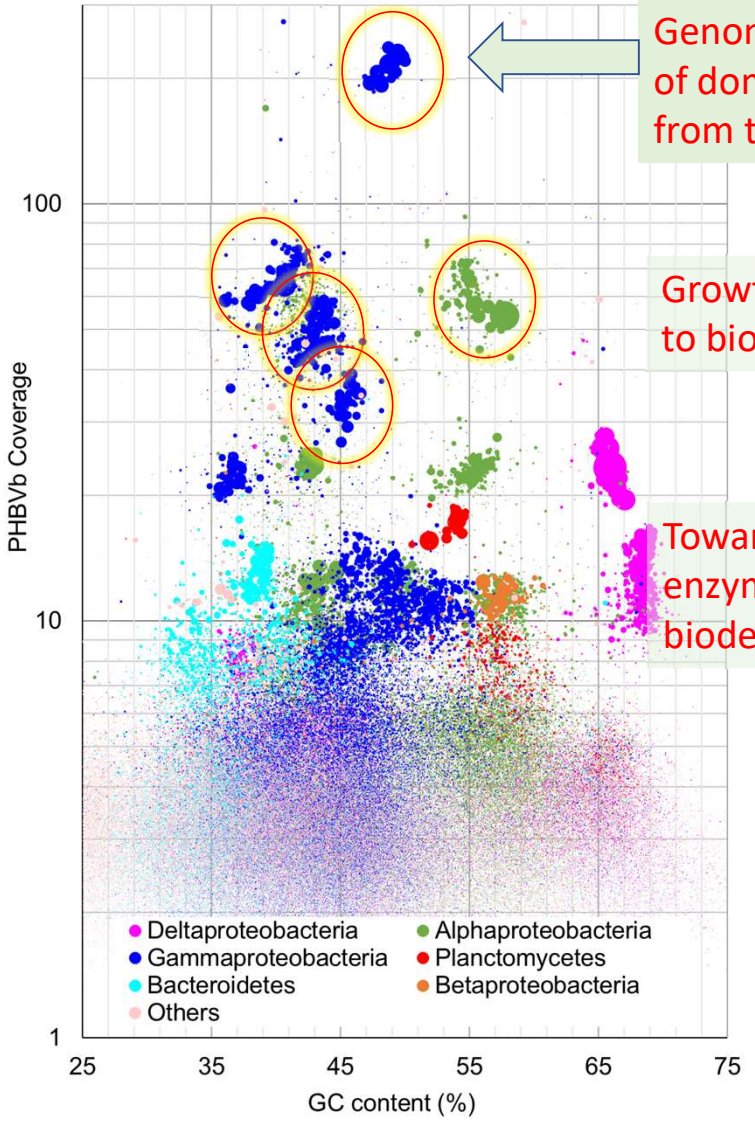
4-2-2. Meta-omics analysis of plastisphere correlating with biodegradation:

Comparative analyses for plastisphere metagenomes

Plastisphere on marine **non-**biodegradable plastic

Plastisphere on marine biodegradable plastic

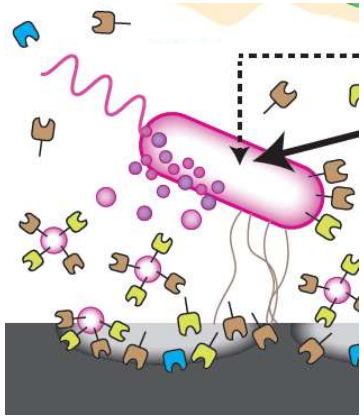




Genome recovery of dominant microbes from the metagenome

Growth of microbes related to biodegradation of plastic

Toward identification of enzymes for marine biodegradation

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