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Viewpoint – Ocean plastic pollution: A convenient but distracting truth?

Richard Stafford[a,*], Peter J.S. Jones[b]

[a] Department of Life and Environmental Sciences, Bournemouth University, Fern Barrow Poole, BH12 5BB, UK
[b] Department of Geography, University College London, Gower Street, London, WC1E 6BT, UK

"… plastic pollution has been overemphasized by the media, government, and ultimately the public as the major threat to marine environments at the expense of climate change and biodiversity loss."

Plastic Pollution- a Global Issue

- Global plastic production reached 335 million tons in 2016.
- At least 268,940 tons of plastics float at the surface of the ocean.
- ~ 206 kg of plastics are discharged in the ocean every second

Image: taken from Google

References: Plastics Europe, 2018; Eriksen et al., 2014; Jambeck et al., 2015).

Impact of Plastic Pollution on Marine Organisms in the Philippines

Highlight: *"Microplastics in Marine Sediments and Rabbitfish (Siganus fuscescens) from Selected Coastal Areas of Negros Oriental"*

Edwin F. Romano, Jr.,Ph.D.*(Chemistry)*

Philippines' Contribution to Plastic Pollution

- The country is ranked as the 3rd most significant contributor of marine litter to the oceans.
- 0.28 million metric tons of plastics reaching the oceans every year.

Image: taken from inquirer.net

Reference: Jambeck et al.2015.Plastic wastes input from land to the ocean.Science 347, 768-771.

Marine Species Negatively Affected by Marine Litter in the Philippines

Table 1. Marine species negatively affected by marine litter in the Philippines according to the Facebook pages scanned.

Species	Common name	Type of interaction			Number of individuals	IUCN red list status
		Ingestion	Entanglement	Other		
Cetaceans						
Kogia breviceps	Pygmy sperm whale	2			2	Data deficient[a]
Physeter macrocephalus	Sperm whale	1		1	2	Vulnerable[a]
Kogia sima	Dwarf sperm whale	1			1	Data deficient[a]
Orcaella brevirostris	Irrawaddy dolphin		2		2	Critically endangered[a]
Peponocephala electra	Melon-headed whale	1			1	Data deficient[a]
Grampus griseus	Risso's dolphin	2			2	Data deficient[a]
Mesoplodon densirostris	Blainville's beaked whale	2			2	Data deficient[a]
Mesoplodon hotaula	Deraniyagala's beaked whale	1			1	No status
Globicephala macrorhyncus	Short-finned pilot whale	1			1	Data deficient[a]
Steno bredanensis	Rough-toothed dolphin	1			1	Least concern[b]
Balaenoptera edeni	Bryde's whale	1			1	Data deficient[b]
Marine turtle						
Eretmochelys imbricata	Hawksbill turtle		1		1	Endangered[b]
Lepidochelys olivacea	Olive-ridley sea turtle		1		1	Vulnerable[b]
Chelonia mydas	Green sea turtle	4	5		9	Endangered[b]
Dermochelys coriacea	Leatherback sea turtle	1	2		3	Vulnerable[b]
Fish						
Lampris sp.	Moonfish	1			1	Least concern[b]
Mobula sp.	Manta ray		1		1	Vulnerable[b]
Total		19	12	1	32	

[a] Alava et al. (2012).
[b] IUCN red list of threatened species.

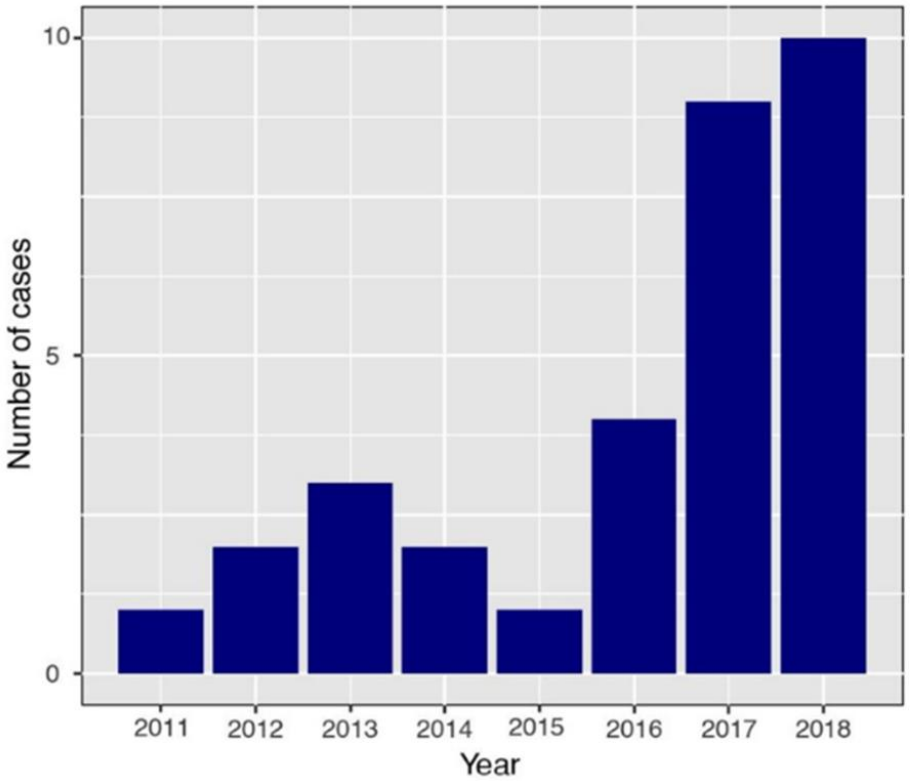
Reference: Abreo, N. A. S., Thompson, K. F., Arabejo, G. F. P., & Superio, M. D. A. ,2019.

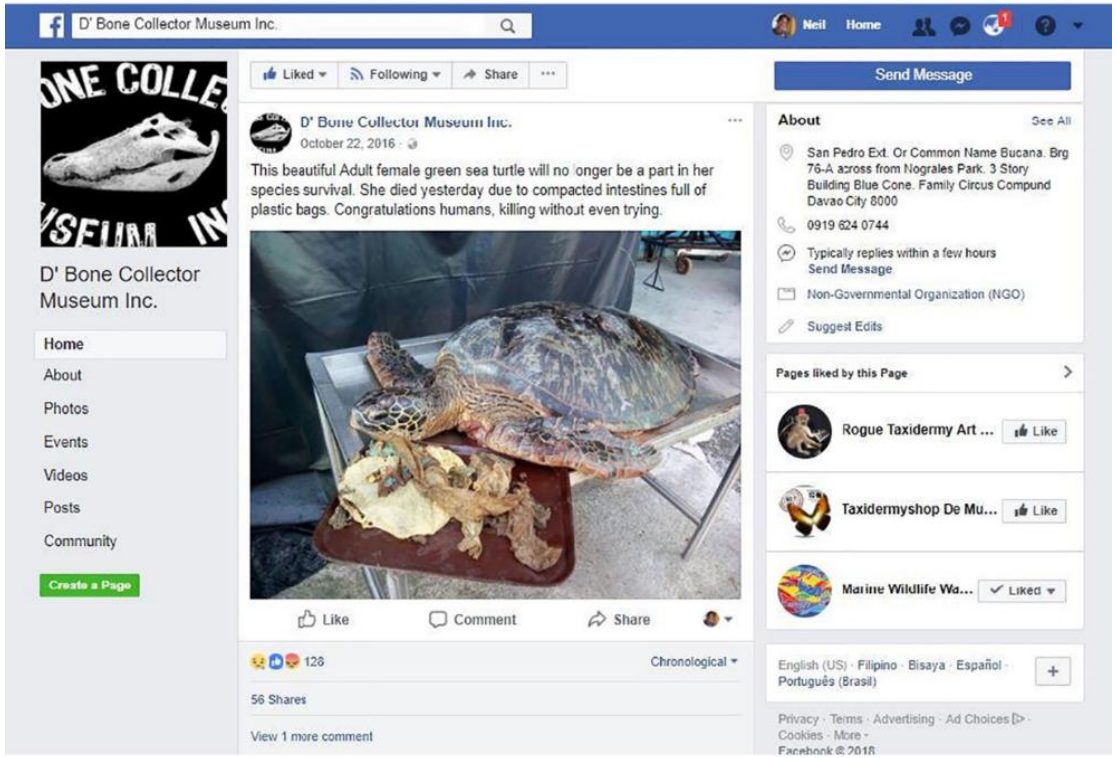
Marine Species Negatively Affected by Marine Litter in the Philippines

SPECIES	INGESTION	ENTANGLEMENT
CETECEANS	13	2
MARINE TURLE	5	9
FISH	1	1

Reference: Abreo, N. A. S., Thompson, K. F., Arabejo, G. F. P., & Superio, M. D. A. ,2019.

Marine Species Negatively Affected by Marine Litter in the Philippines



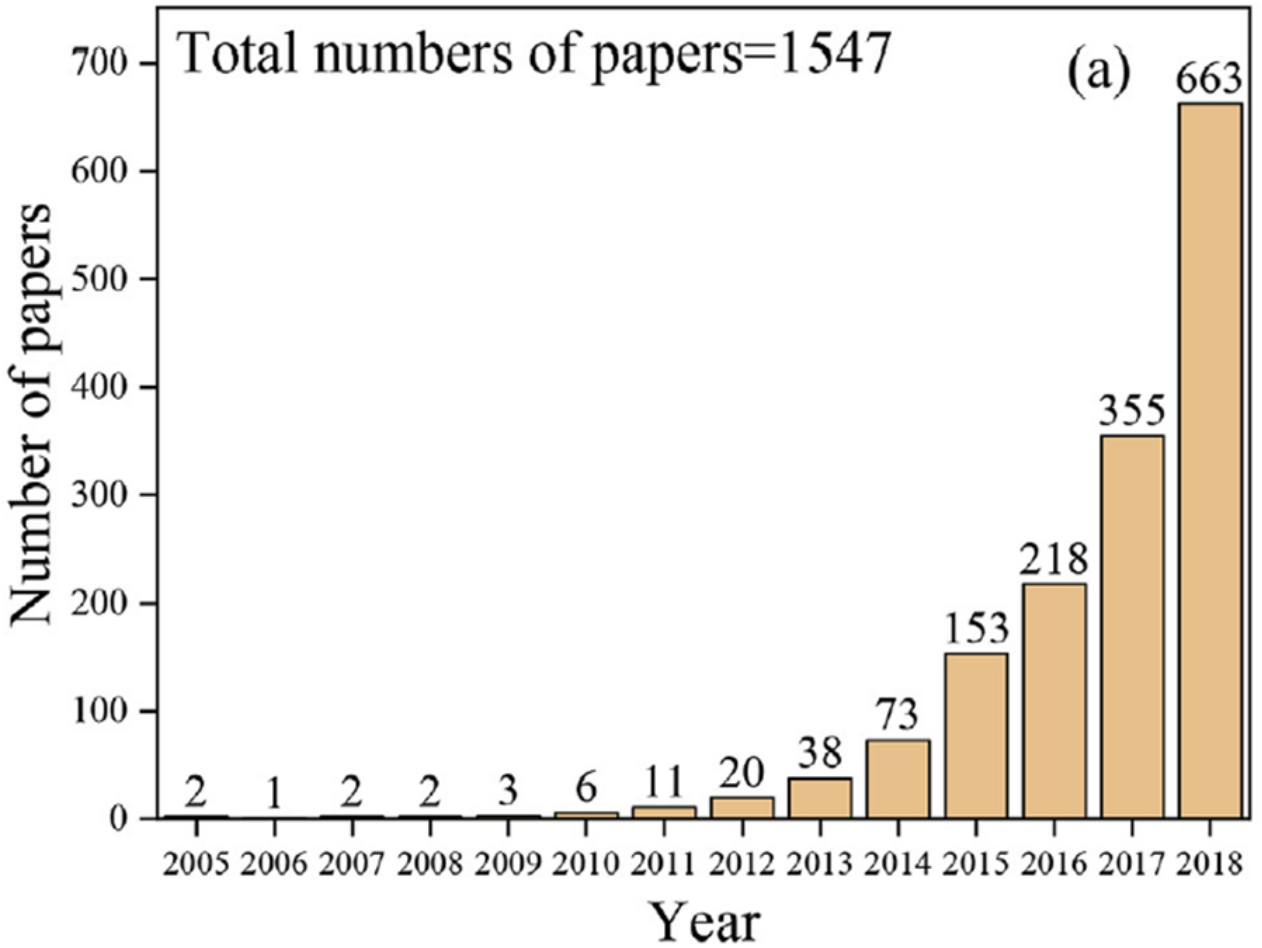


- Marine litter and megafauna interactions in the Philippines from 2011 to 2018 as determined by posts on Facebook (n-32).
- Direct mortality of green turtle as a result of plastic ingestion. This case was posted on the Facebook page of D' Bone Collector Museum, Inc.

Reference: Abreo, N. A. S., Thompson, K. F., Arabejo, G. F. P., & Superio, M. D. A. ,2019.

Microplastic Pollution

Microplastic Publications



- Number of published papers on microplastics (2005-2018).

Reference: Yao, P., Zhou, B., Lu, Y. H., Yin, Y., Zong, Y. Q., Chen, M. Te, & O'Donnell, Z. ,2019.

What are Microplastics?

- Microplastics are made up of particles that differ in size (< 1 mm), specific density, chemical composition, and shape.

Categories:

-**Primary microplastics** are intentionally manufactured (*e.g* cosmetics).

-***Secondary microplastics*** are produced during the weathering of plastics.

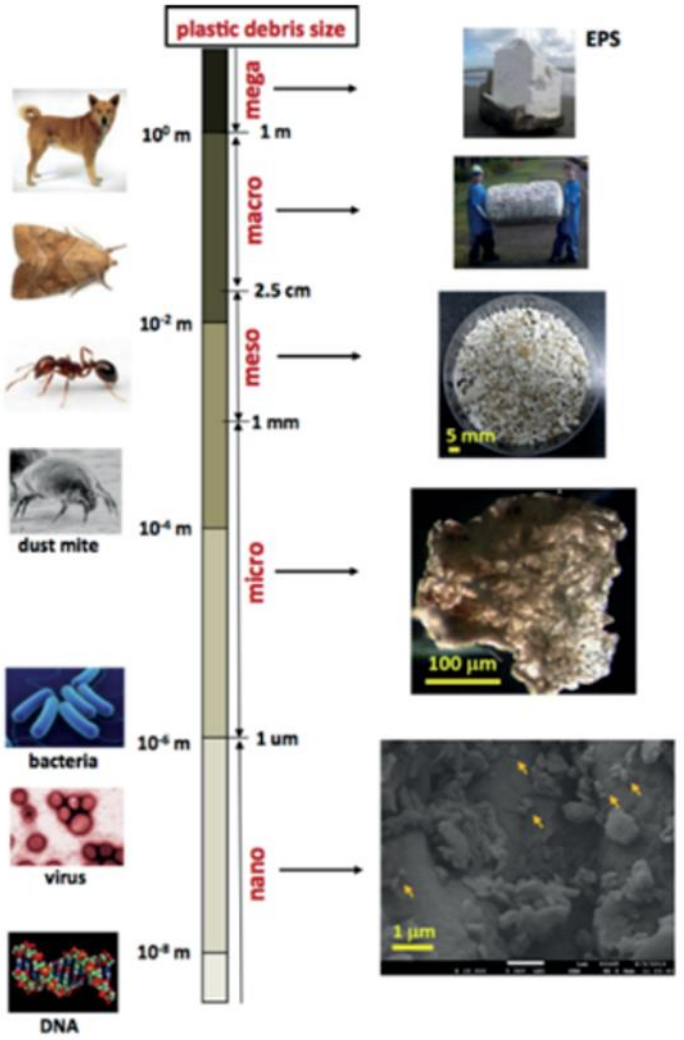


Image: taken from GESAMP

Reference: Duis, K., & Coors, A. ,2016

Impact of Microplastic Pollution on Marine Organisms

- Block digestive tracts
- Diminish the urge to eat
- Alter feeding behavior
- Death

Reference: Cole et al., 2015; Guzzetti et al., 2018; Strungaru et al., 2019.

Impact of Microplastic Pollution on Marine Organisms

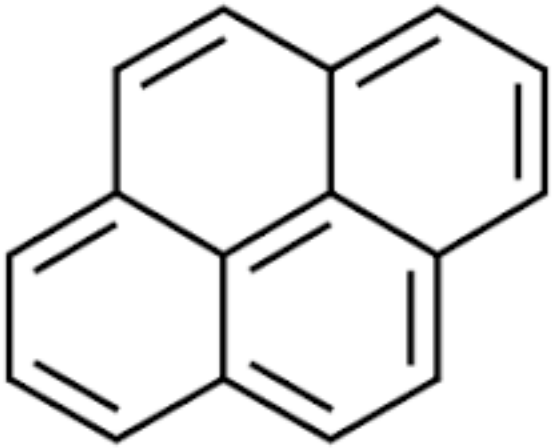
Chemical contamination (adsorption of persistent hydrophobic compounds such as

- polycyclic aromatic hydrocarbons (PAHs),
- polychlorinated biphenyls (PCBs)
- pesticides

Reference: Bakir et al., 2014) ;Wilcox et al., 2016.

Chemical Contamination of Microplastics: A Simulation

- Adsorption of pyrene on polyethylene (PE) and polystyrene (PS) microplastics
- Transfer of model PAH from contaminated microplastics to exposed mussels
- Tissue localization of microplastics



Reference: Fattorini, D., Gorbi, S., D'Errico, G., Pauletto, M., Avio, C. G., Regoli, F.,Milan, M., 2015.

Chemical Contamination of Microplastics: A Simulation

Cellular effects include:

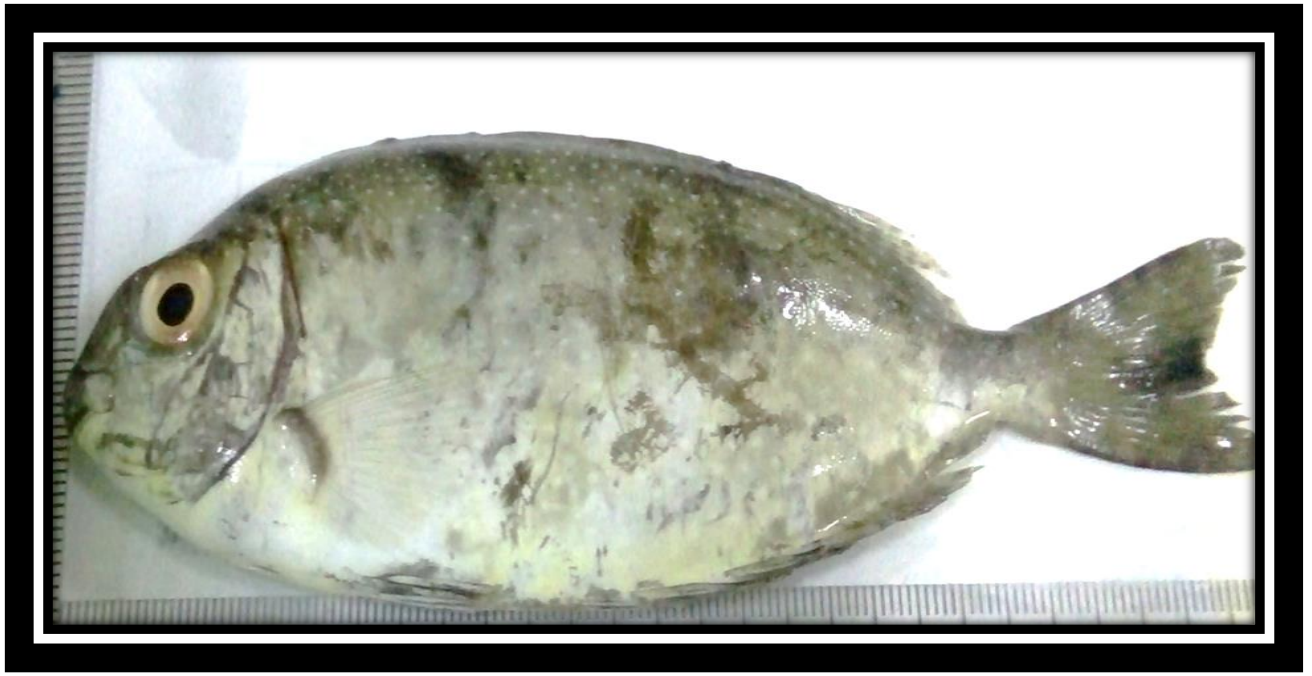
- alterations of immunological responses
- peroxisomal proliferation
- neurotoxic effects
- onset of genotoxicity
- changes in gene expression profile

Reference: Fattorini, D., Gorbi, S., D'Errico, G., Pauletto, M., Avio, C. G., Regoli, F.,Milan, M., 2015.

Microplastics in Marine Sediments and Rabbitfish (Siganus fuscescens) from Selected Coastal Areas of Negros Oriental

Rabbitfish (Siganus fuscescens)

- Benthic herbivore
- Targeted by local fishermen
- Commonly sold in the market



Objectives

- Determine the concentration of microplastics in marine sediments, and fish (guts and gills).
- Characterize microplastics in terms of shape, color, size and type

Methodolgy

Sample Collection → Sample Preparation → Determination of Total Mass of Solids → Chemical Digestion 10% KOH → Density Separation using $ZnCl_2$ → *Filtration and drying* → Determination of Microplastics Concentration → Identification of Microplastics → *Microscope (Shape & Size)*, *FT-IR (Type)* → Data Analysis

Removal of Fish Gut and Gills

Microscope

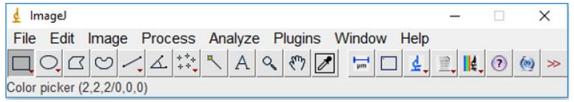
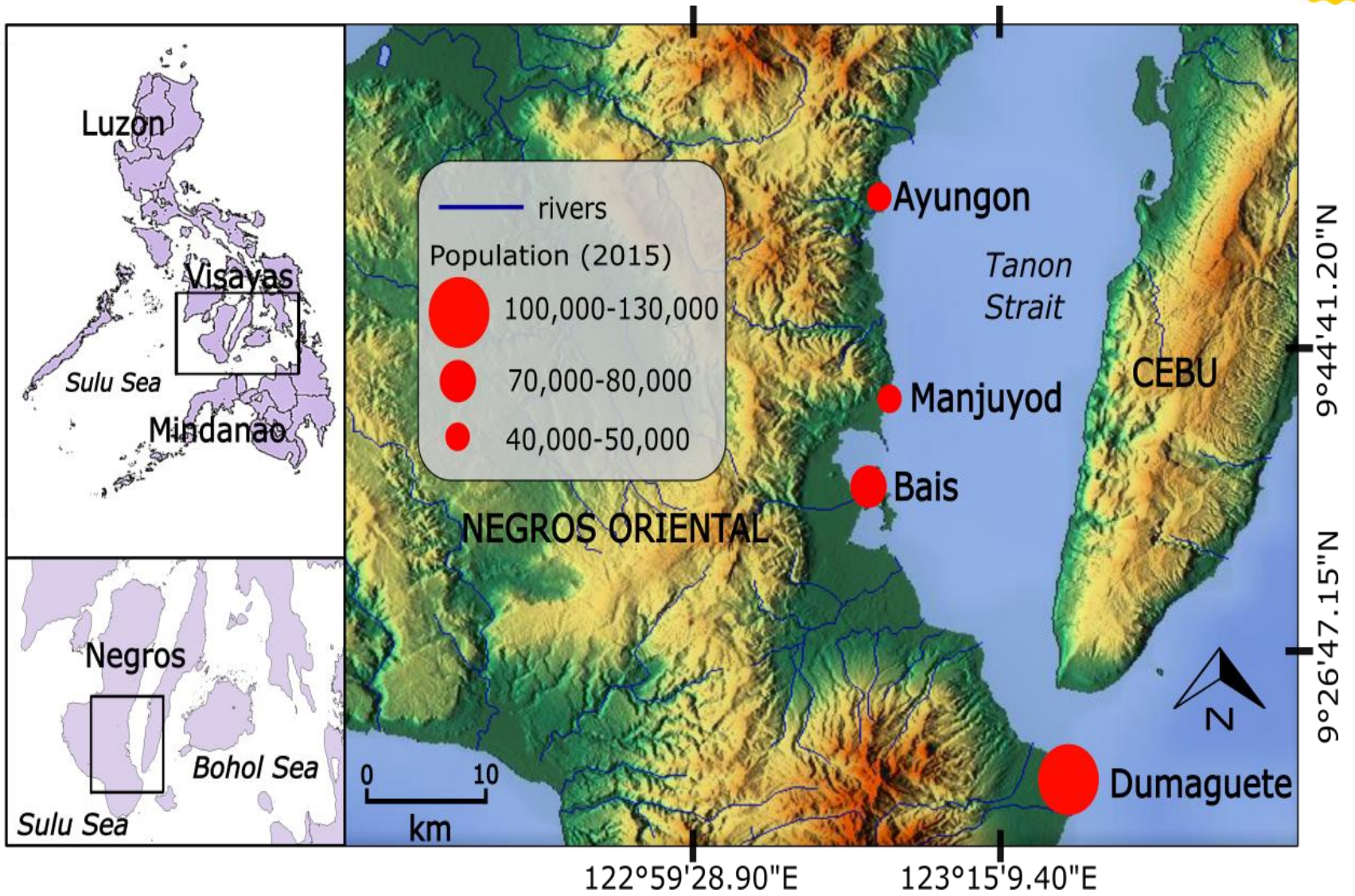


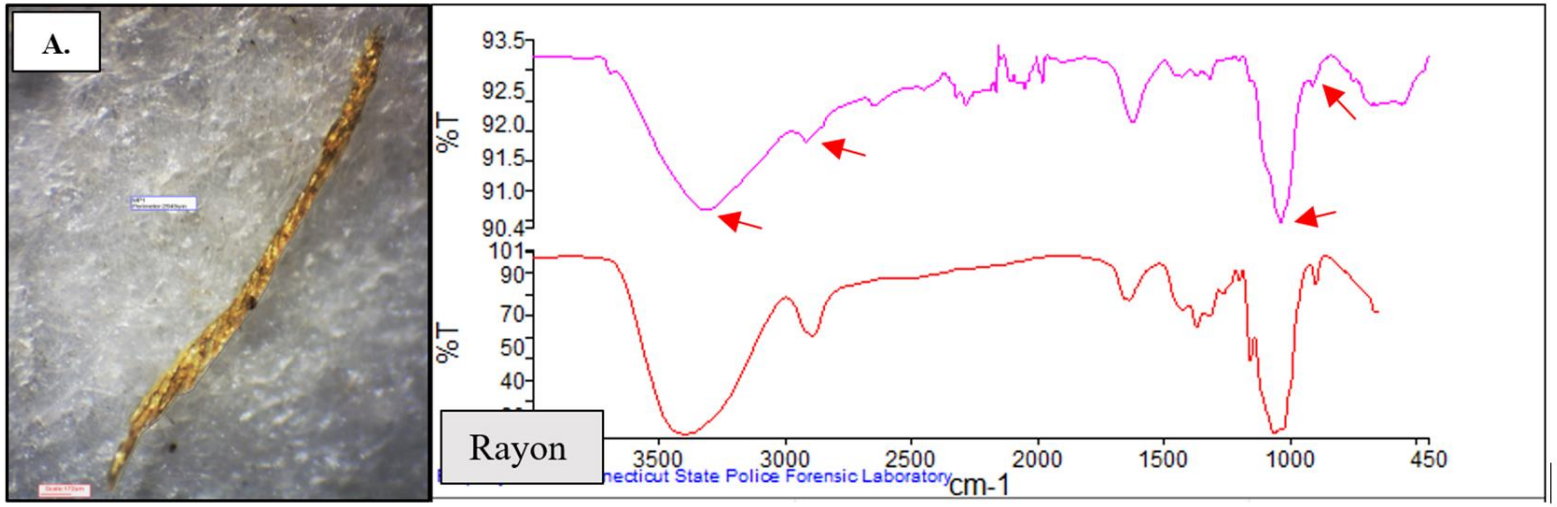
Image J Software

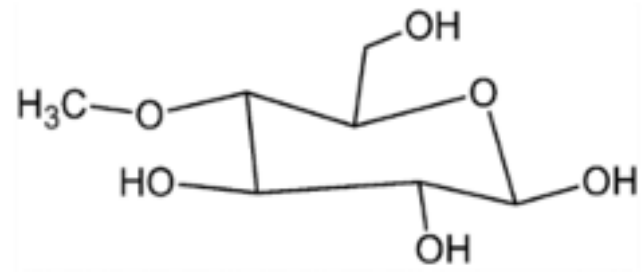
ATR-FTIR

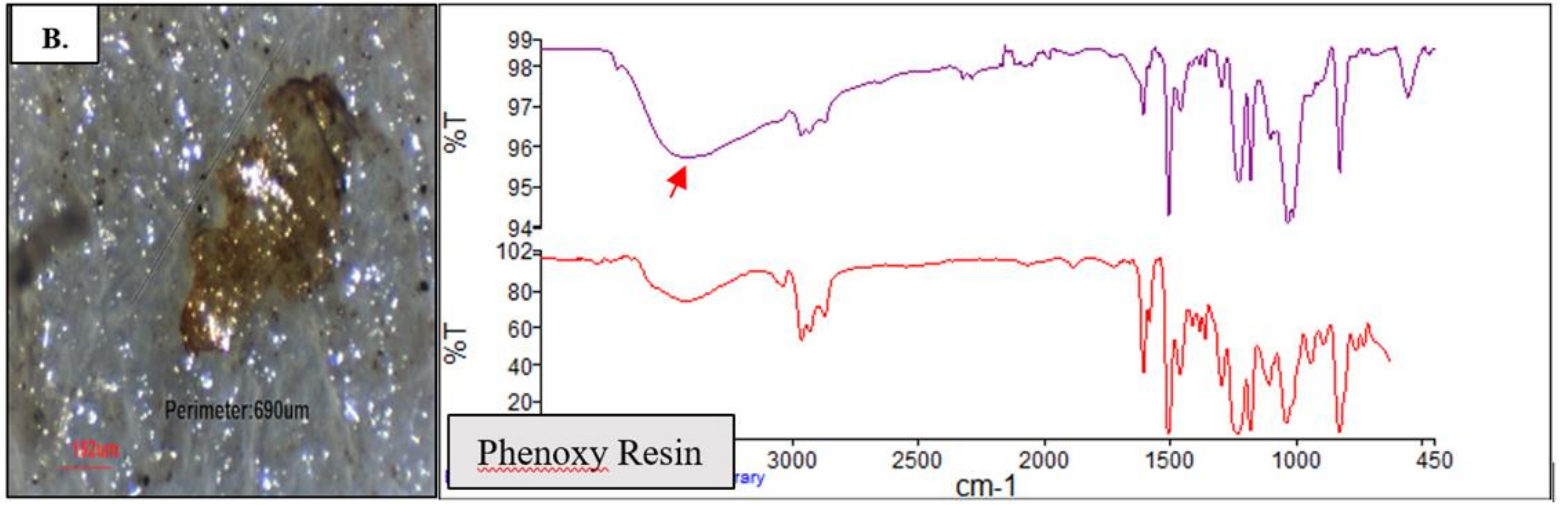
Sampling Sites

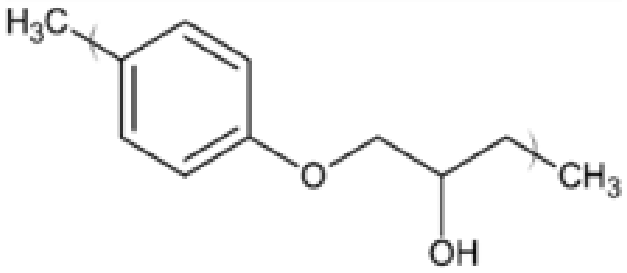


Characterization of Microplastics in Sediments

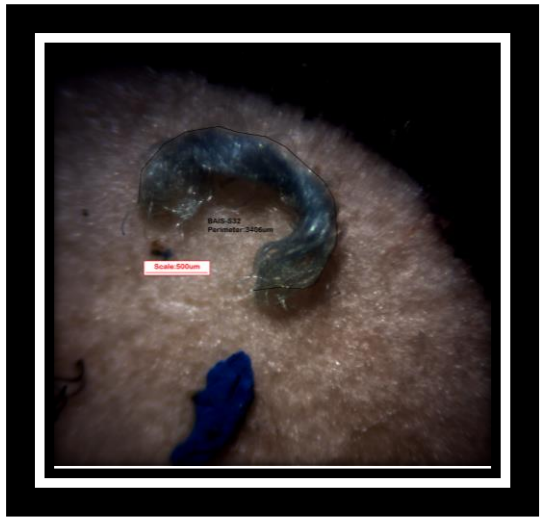




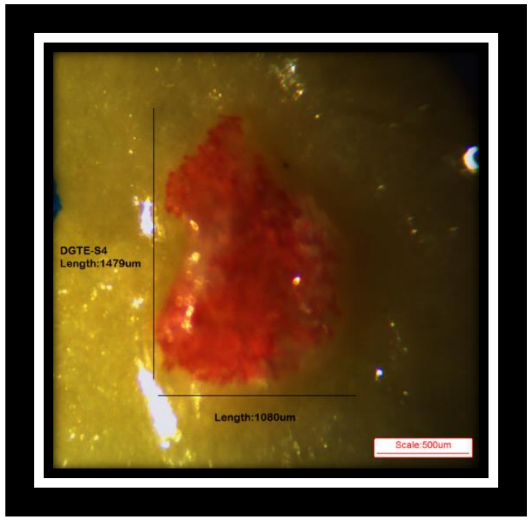




Characterization of Microplastics in Fish Gut

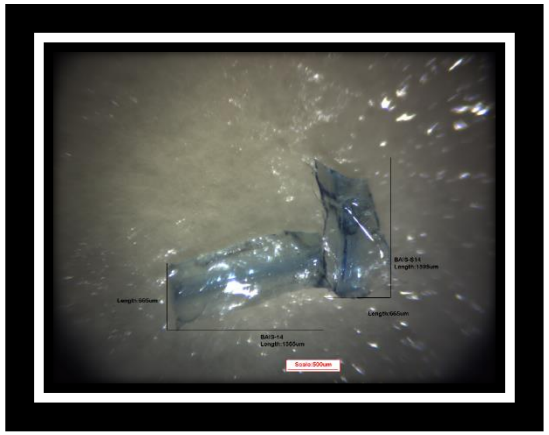


Polyethylene

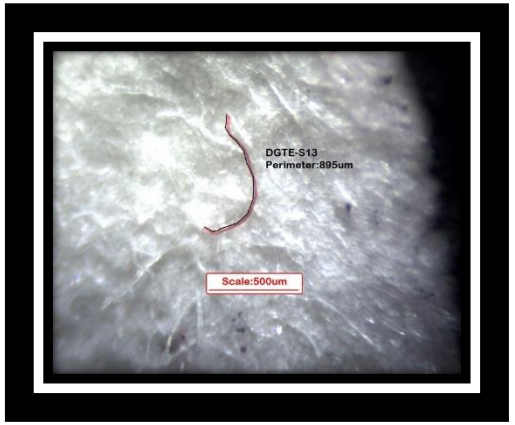


Acrylonitrile Butadiene Styrene

Ethylene- vinyl acetate

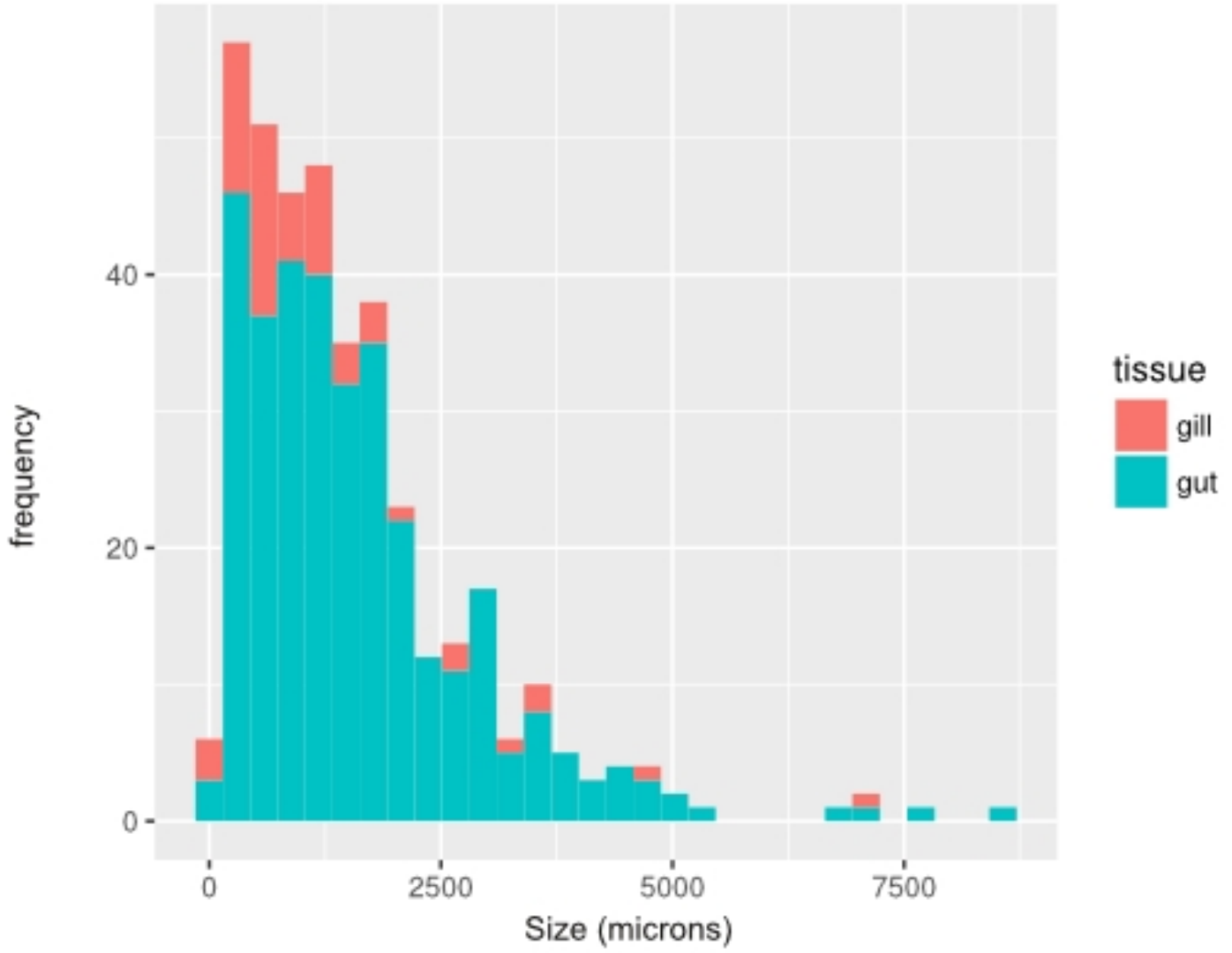


Polypropylene

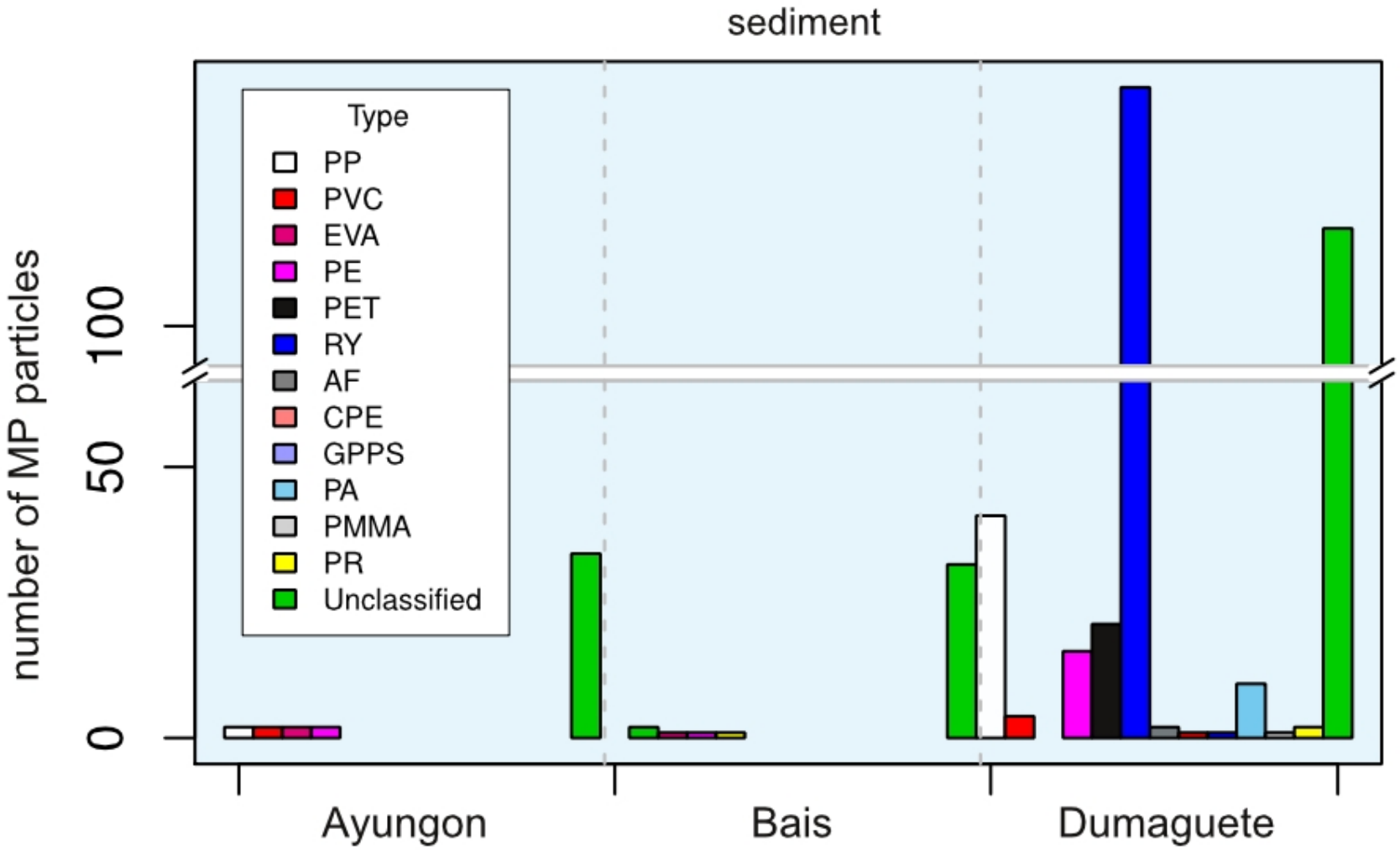


Polystyrene

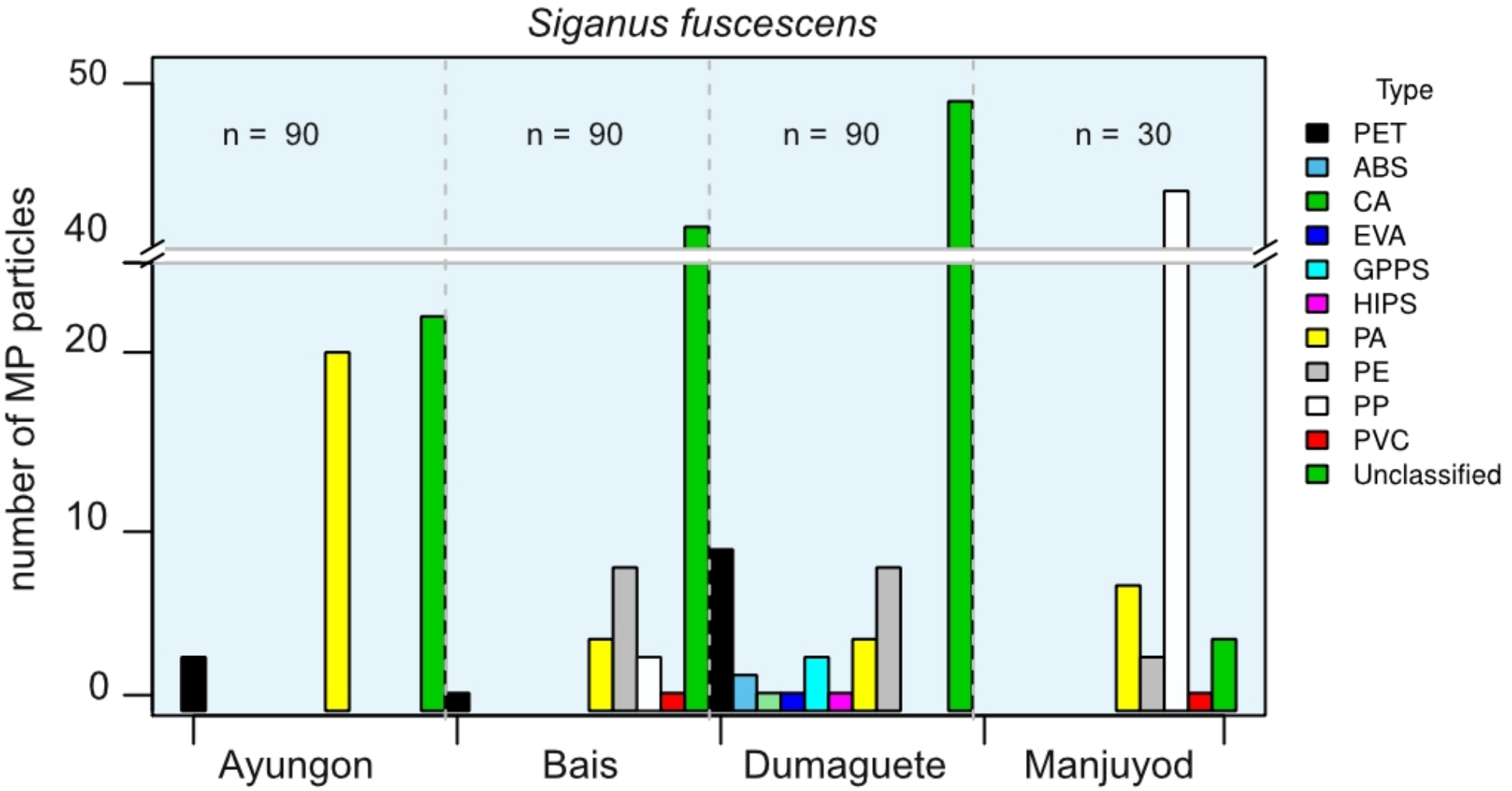
Microplastic Size



Microplastic Abundance in Sediments



Microplastic Abundance in Fish



Summary of Findings

- Rabbitfish and marine sediments in Negros Oriental are contaminated with microplastics.
- Rayon, polypropylene, polyethylene terephthalate, and polyethylene are most abundant microplastics in marine sediments.
- Polypropylene, polyamide, polyethylene, and polyethylene terephthalate are most abundant microplastics in fish.
- Abundance and diversity of microplastics are directly correlated with population density in a particular area.

Future Direction

Quantify and characterize:

- Microplastics in sea water,and other marine organisms.
- Microplastics in freshwater and sewage outlets.
- Contaminants present in microplastics (*e.g.* heavy metals, PAH, pesticides, etc).

Method:

- Employ micro FTIR for characterization of microplastics.
- Increase number of sampling sites.

Microplastics Research Team

- DR. ANGEL ALCALA- **National Scientist** & **Chairperson of SUAKCREM**
- DR. JORGE EMMANUEL- **BALIK SCIENTIST/Silliman University**
- DR. BETH POLIDORO- **ARIZONA STATE UNIVERSITY**
- DR. EDWIN ROMANO- **Chemistry Dept. NORSU**
- LILIBETH BUCOL,MSBio- **Biology Dept. NORSU**
- ABNER BUCOL,MSBio- **SUAKCREM**
- DR. ROBERT Guino-o-**Biology Dept. Silliman University**

Impact of Plastic Pollution on Marine Organisms in the Philippines

The time for action is NOW. It's never too late to do something.

-Antoine de Saint-Exupery

Acknowledgement

- Dr. Angel Alcala
- Dr. Jorge Emmanuel
- National Academy of Science and Technology and **DOST**
- Dr. Joel P. Limson- University President, NORSU
- Biology and Chemistry students of NORSU.
- Mr. and Mrs. Abner Bucol

Thank you for listening!

NEGROS ORIENTAL STATE UNIVERSITY

Density

Sample	Density (g/cm3)
Seawater	1.02-1.03
Rayon	1.46-1.54
Polypropylene	0.855-0.946
Polyethylene	0.88–0.96 g/cm^3
Polyethylene Terephthalate	1.38
Polyamide	1.14

What are Plastics?

- They are synthetic materials made from a wide range of organic polymers (*e.g.* polyethylene, PVC, nylon, etc.) that can be moulded into shape while soft, and then set into a rigid or slightly elastic form.

-Oxford Dictionary

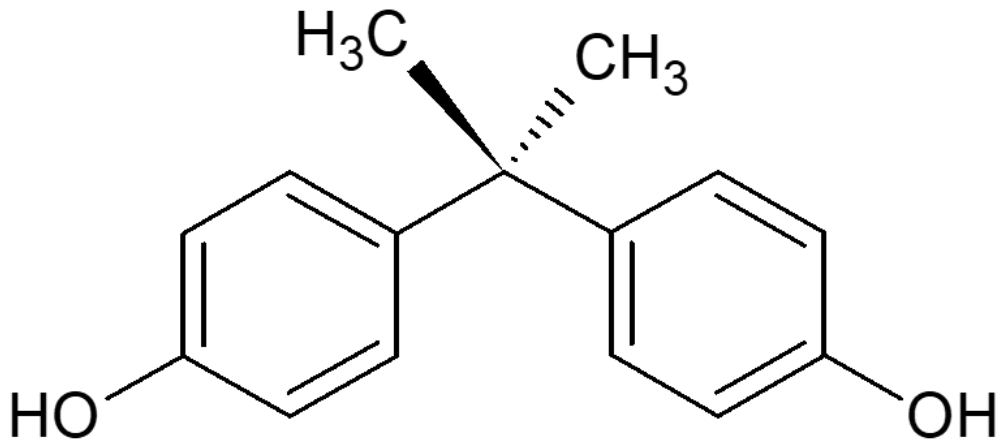
Image: taken from Google

Plastic Formulation

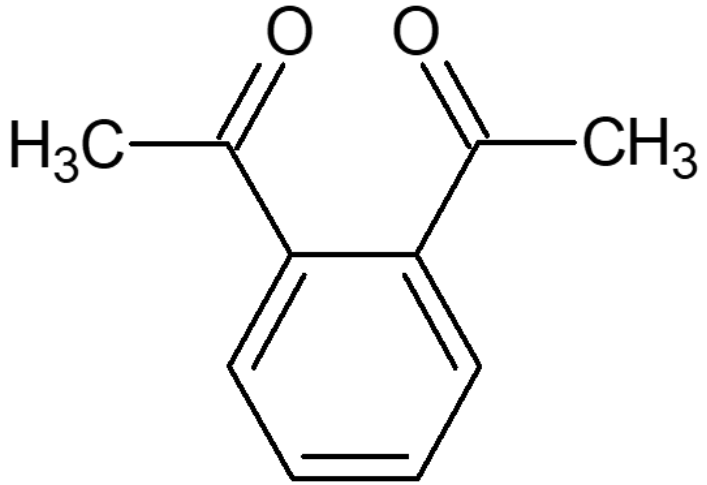
In order to optimize the properties of packaging materials (*i*.e., durability, elasticity, color, etc.), a variety of additives is used in the formulation such as:

- ***stabilizers***
- ***antioxidants***
- ***coupling agents***
- ***pigments***

Endocrine Disruptor Compounds



Bisphenol A

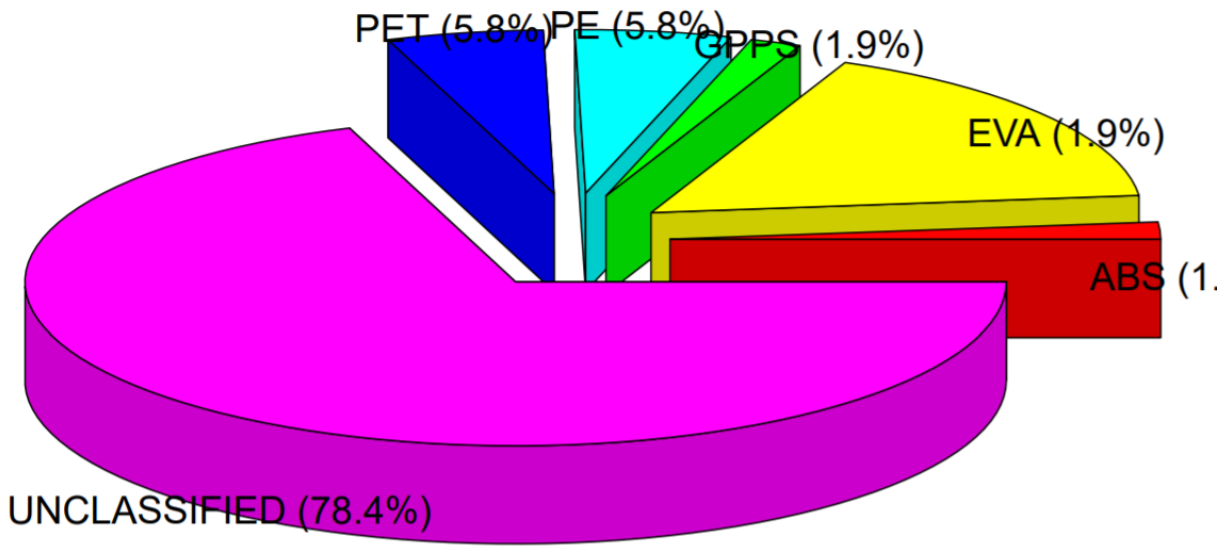


Phthalate

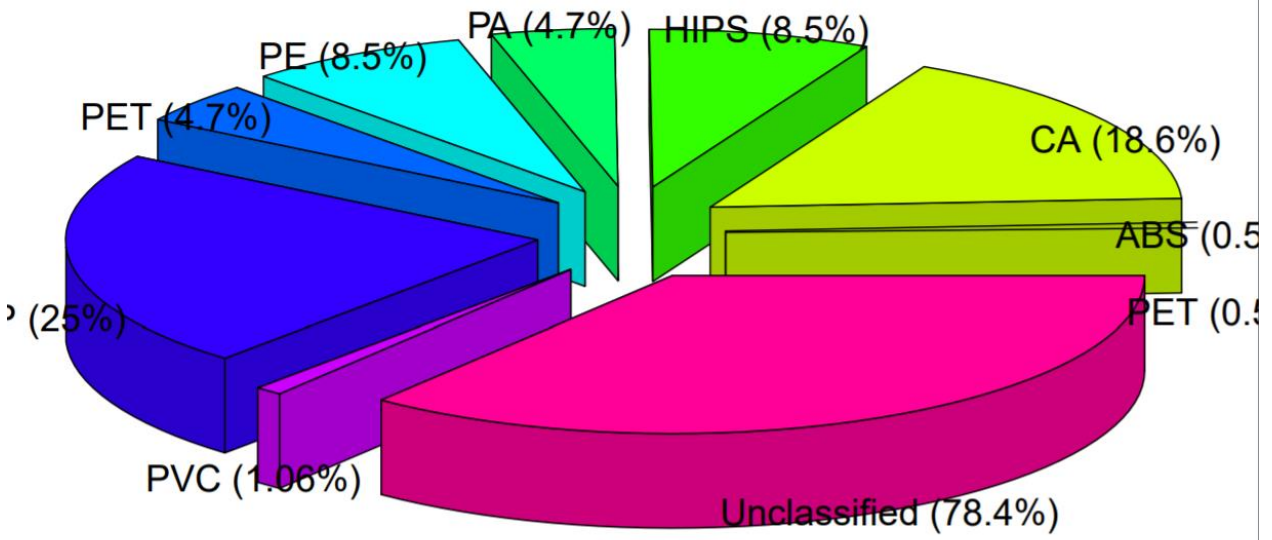
- Endocrine disruptors are chemicals that may interfere with the body's endocrine system and produce adverse developmental, reproductive, neurological, and immune effects in both humans and wildlife.

- Plasticizers present in each plastic
- Environmental crises
- Epipelagic feeding
- Necropsy
- Stranding
- haemolymph

Types of Polymers in Fish

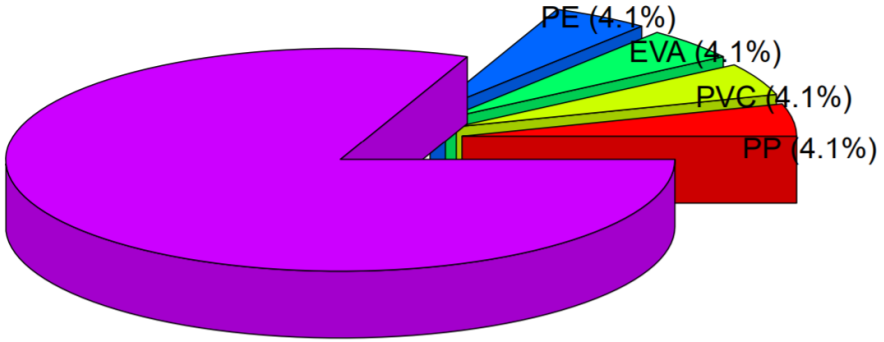


GILLS

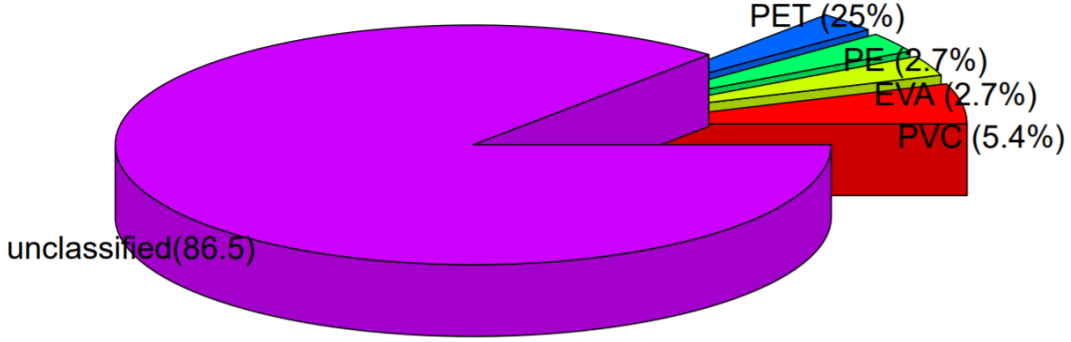


GUT

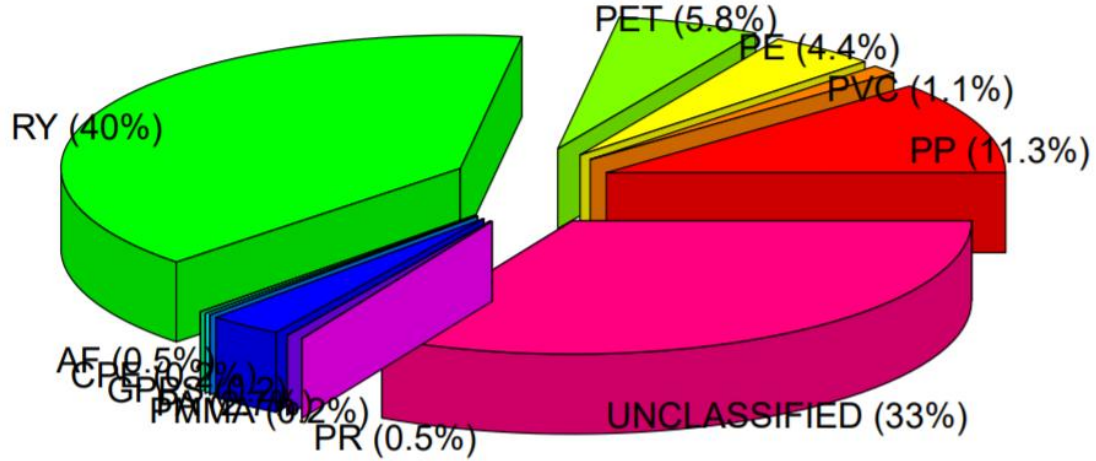
Types of Polymers in Sediments



Ayungon



Bais



Dumaguete

Study 1: Assessment of Microplastic Pollution in Coastal Sediments of Dumaguete City

Objectives:

(1) Identify the shape, size, and type of microplastics present in marine sediments.

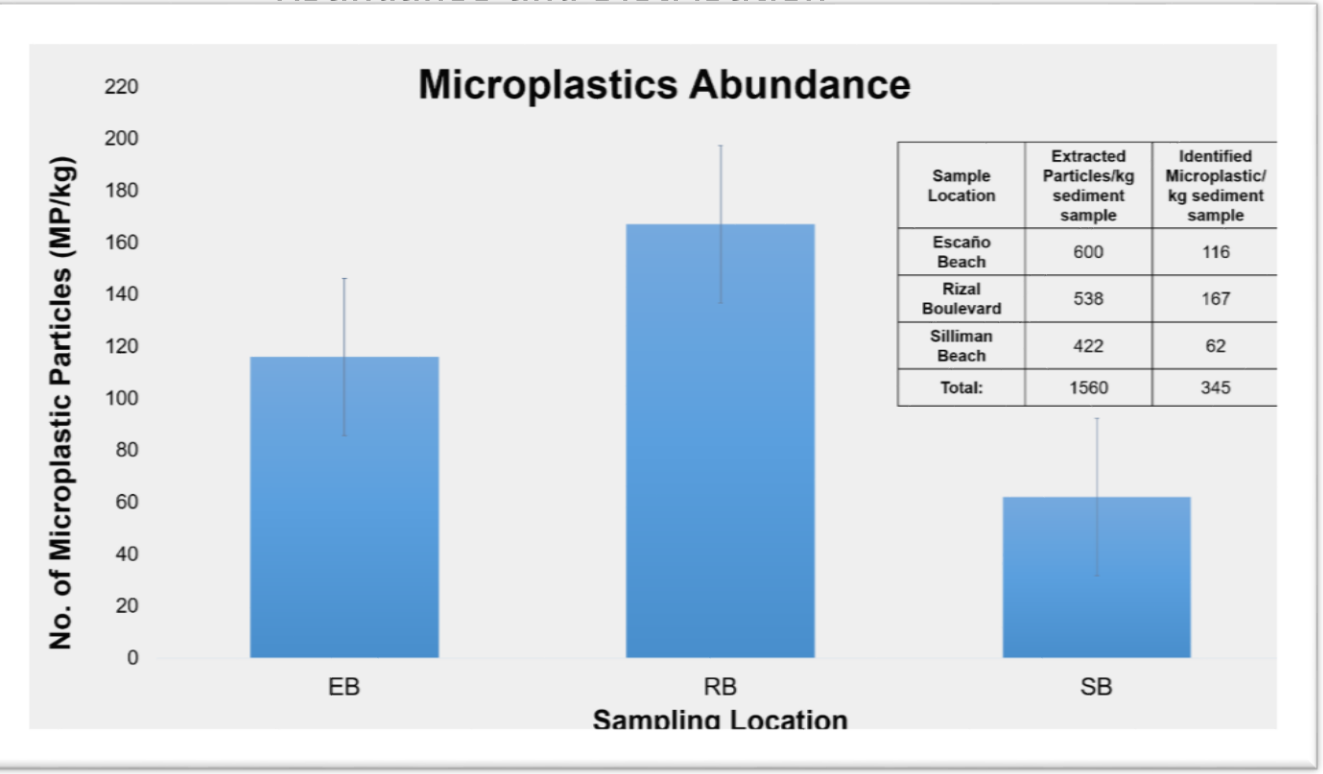
(2) Quantify the amount of microplastics present in marine sediments.

(3) Compare microplastic contamination in different coastal sites and sampling periods.

Sampling Sites in Dumaguete City

Results

Abundance and Distribution



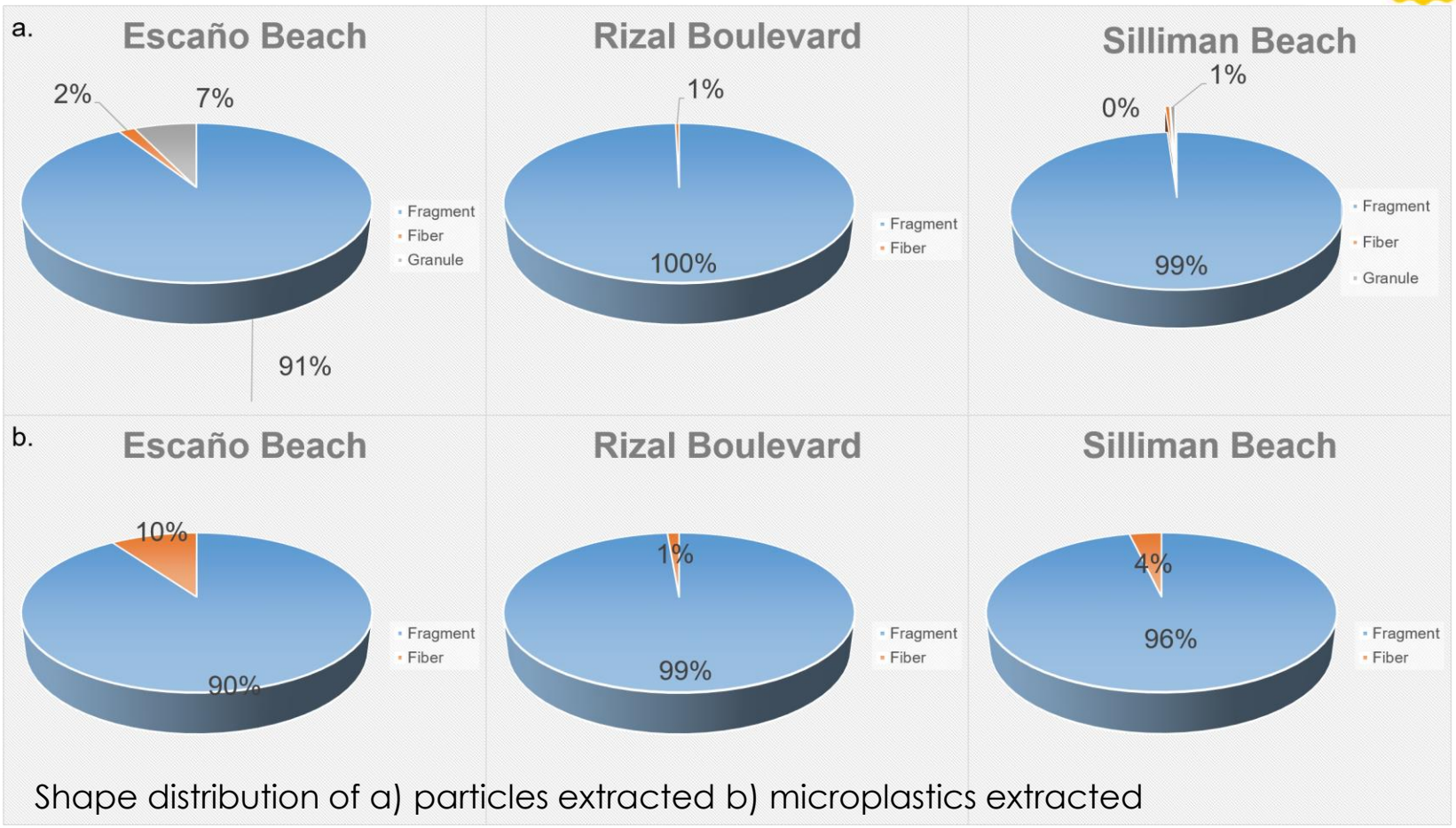
Sample Location	Extracted Particles/kg sediment sample	Identified Microplastic/ kg sediment sample
Escaño Beach	600	116
Rizal Boulevard	538	167
Silliman Beach	422	62
Total:	1560	345

Sampling Location	Sampling Period	Number of Microplastic
EB	BS	5
	DS	6
	AS	41
RB	BS	27
	DS	14
	AS	36
SB	BS	1
	DS	4
	AS	23

- Rizal Boulevard has the highest microplastic contamination.
- Microplastic contamination increases after summer.

Results

Shape



Shape distribution of a) particles extracted b) microplastics extracted

- Fragment is the most abundant form of microplastics.

Results

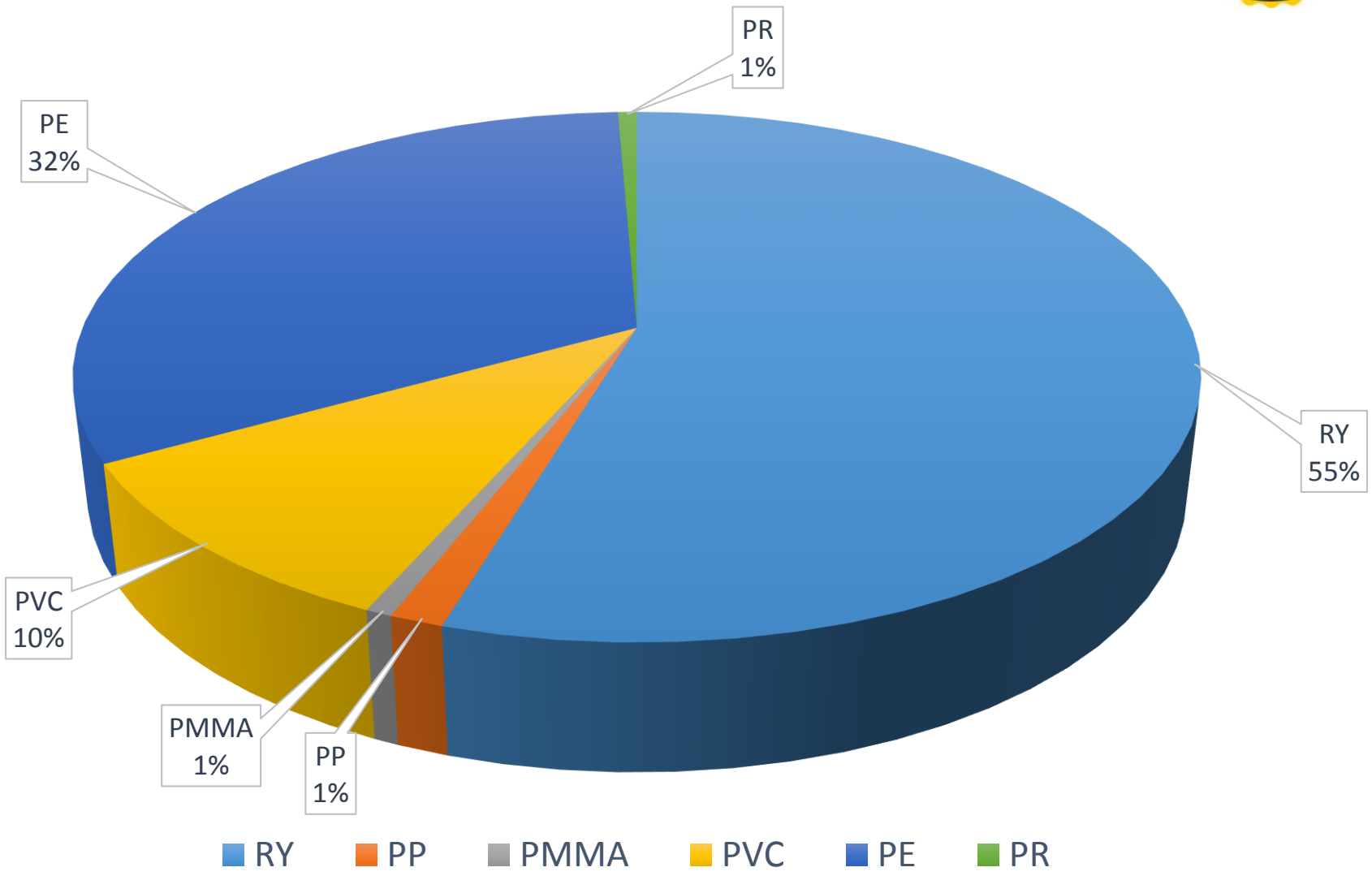
Size

Sampling Location	Sampling Period	No. of Microplastic	Type and No.	Size Range (micrometer)
EB	BS	5	(3) Rayon (2) PVC	493-1594
	DS	6	(2) Rayon (2) PVC (2) PE	432- 2388
	AS	41	(22) Rayon (1) PVC (18) PE	212 – 3566
RB	BS	27	(22) Rayon (3) PVC (1) PE (1) PMMA	346 – 1680
	DS	14	(5) Rayon (8) PVC (1) Phenoxyresin	538 -1832
	AS	36	(5) Rayon (29) PE	324 – 4827
SB	BS	1	(1) Rayon	171
	DS	4	(2) Rayon (2) PP	256 – 700
	AS	23	(23) Rayon	170 – 538

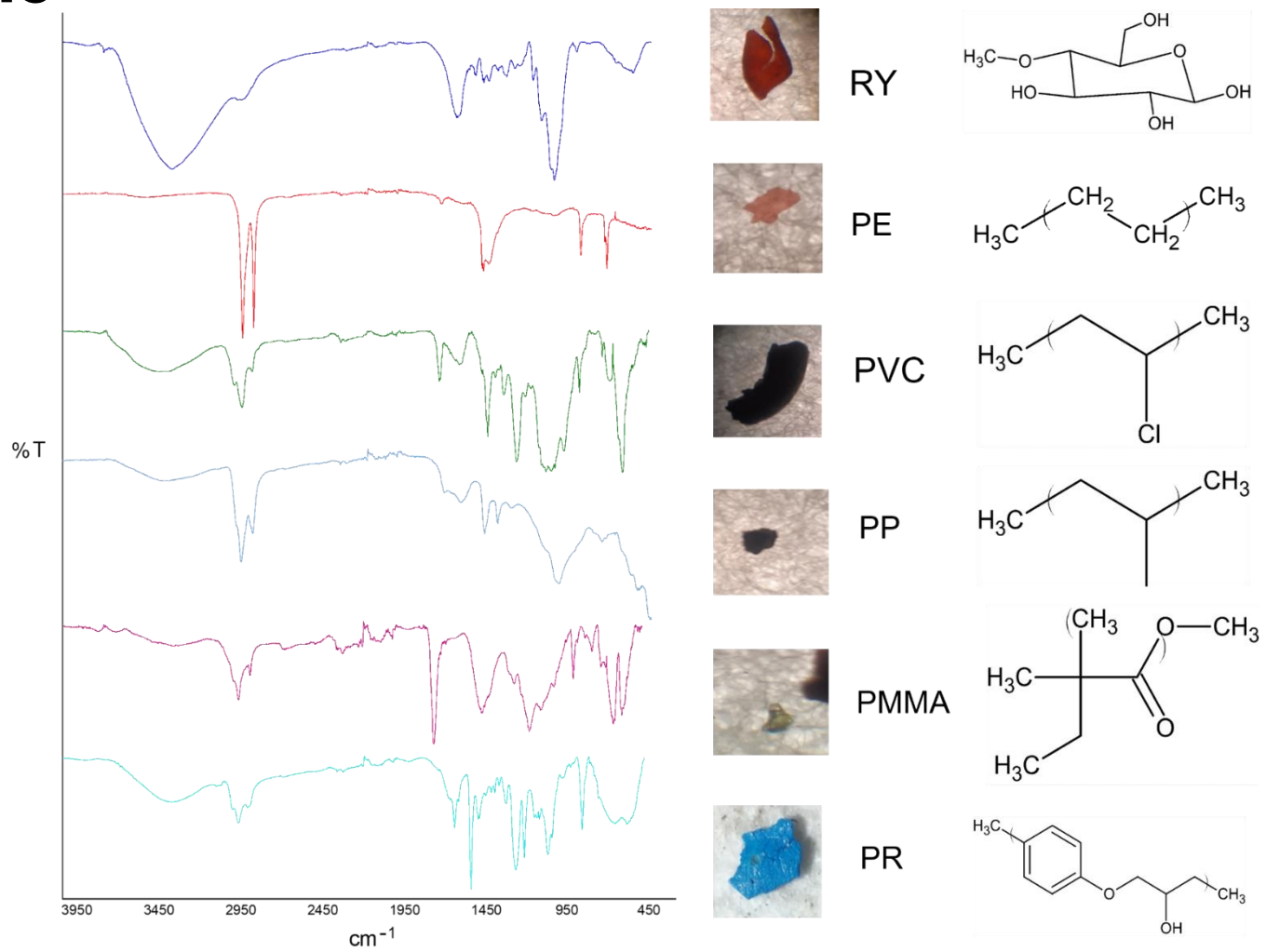
- Size of microplastics = 170µm-4827µm

Results

Type



Results



- Samples spectra were compared with the spectral library of polymers using the Perkin Elmer Spectrum 2 software.

Marine Pollution Bulletin

journal homepage: www.elsevier.com/locate/marpolbul

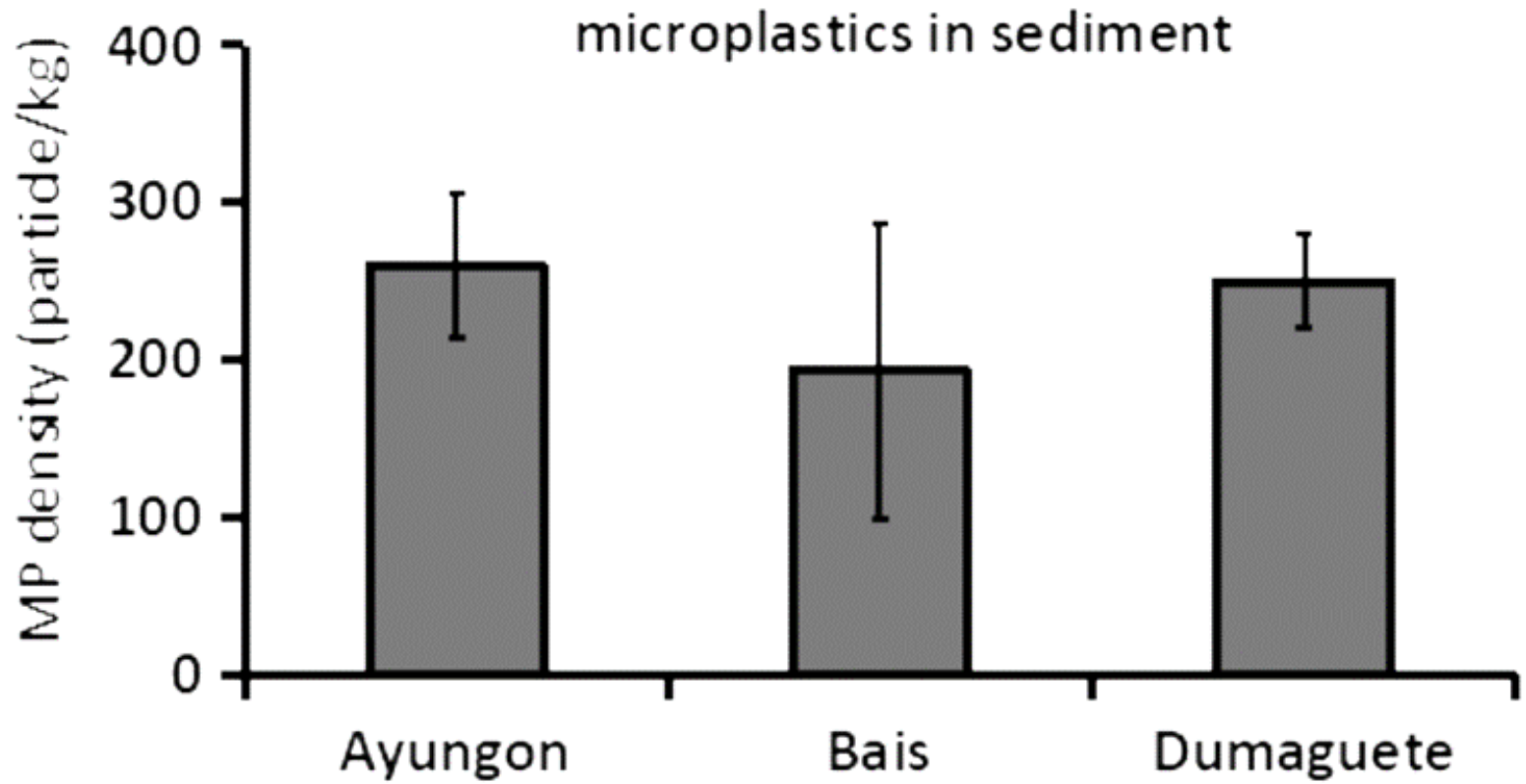
Review

Synthetic microfibers in the marine environment: A review on their occurrence [illegible]water and sediments

J. Gago*, O. Carretero, A.V. Filgueiras, L. Viñas

Instituto Español de Oceanografía (IEO), Subida a Radio Faro, 50-52, 36390 Vigo, Spain

- Microfibers in sediments range from 1.4 to 40 items per 50 mL or 13.15 to 39.48 items per 250 g dry weight. In the case of water, microfibers values ranges from 0 to 450 items·m−3 or from 503 to 459,681 items·km−2. Blue is the most common color in seawater and sediments, followed by transparent and black in the case of seawater, and black and colorful in sediments. Related with polymer type, polypropylene is the most common in water and sediments, followed by poly-
- ethylene in water and polyester in water and sediments. Some polymers were described only in water samples: high-density polyethylene, low-density polyethylene and cellophane, whilst only rayon was reported in sedi- ments.
- 1.


microplastics in sediment
MP density (partide/kg)
400
300
200
100
0
Ayungon
Bais
Dumaguete