Ostreopsis blooms

Sarah-Jeanne Royer, Magda Vila and Elisa Berdalet

MAPMAS workshop

Friday October 6th 2017

Plastic waste inputs from land into the ocean

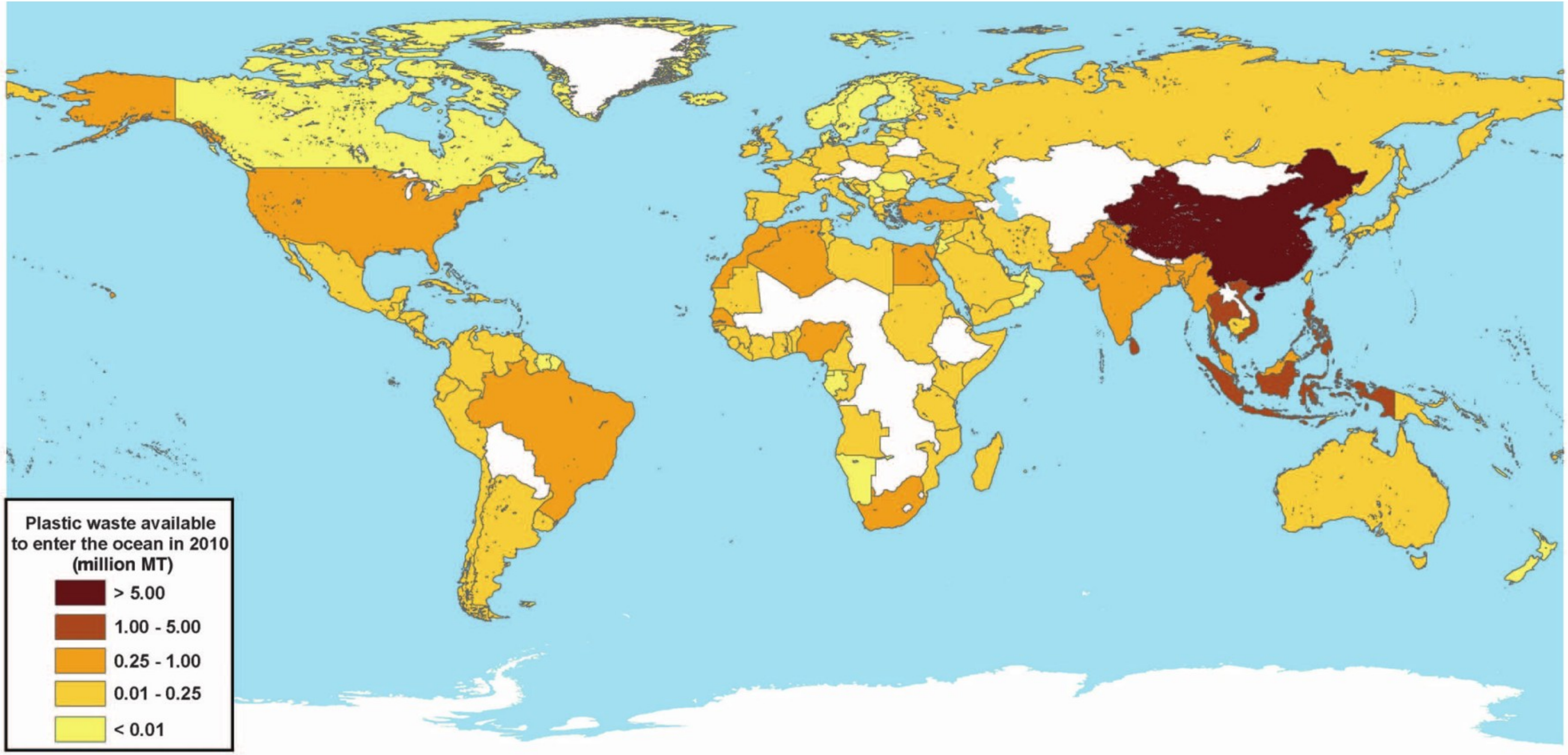

Fig. 1. Global map with each country shaded according to the estimated mass of mismanaged plastic waste [millions of metric tons (MT)] generated in 2010 by populations living within 50 km of the coast. We considered 192 countries. Countries not included in the study are shaded white.

Jambeck et al., 2015, Science.

Plastic waste inputs from land into the ocean

MARINE POLLUTION

Plastic waste inputs from land into the ocean

Jenna R. Jambeck,[1*] Roland Geyer,[2] Chris Wilcox,[3] Theodore R. Siegler,[4] Miriam Perryman,[1] Anthony Andrady,[5] Ramani Narayan,[6] Kara Lavender Law[7]

Plastic debris in the marine environment is widely documented, but the quantity of plastic entering the ocean from waste generated on land is unknown. By linking worldwide data on solid waste, population density, and economic status, we estimated the mass of land-based plastic waste entering the ocean. We calculate that 275 million metric tons (MT) of plastic waste was generated in 192 coastal countries in 2010 with 4.8 to 12.7 million MT entering the ocean. Population size and the quality of waste management systems largely determine which countries contribute the greatest mass of uncaptured waste available to become plastic marine debris. Without waste management infrastructure improvements, the cumulative quantity of plastic waste available to enter the ocean from land is predicted to increase by an order of magnitude by 2025.

Fig. 1. Global map with each country shaded according to the estimated mass of mismanaged plastic waste [millions of metric tons (MT)] generated in 2010 by populations living within 50 km of the coast. We considered 192 countries. Countries not included in the study are shaded white.

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Plastic waste inputs from land into the ocean

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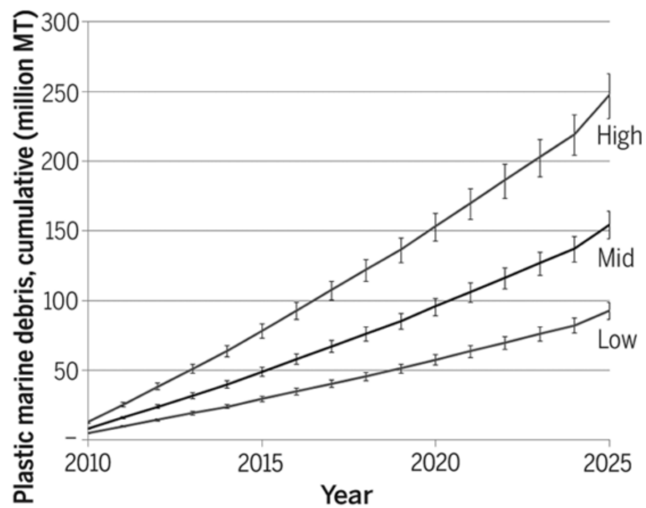

Fig. 2. Estimated mass of mismanaged plastic waste (millions of metric tons) input to the ocean by populations living within 50 km of a coast in 192 countries, plotted as a cumulative sum from 2010 to 2025. Estimates reflect assumed conversion rates of mismanaged plastic waste to marine debris (high, 40%; mid, 25%; low, 15%). Error bars were generated using mean and standard error from the predictive models for mismanaged waste fraction and percent plastic in the waste stream (*12*).

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Jambeck et al., 2015, Science.

Plastic production

SCIENCE ADVANCES | RESEARCH ARTICLE

PLASTICS

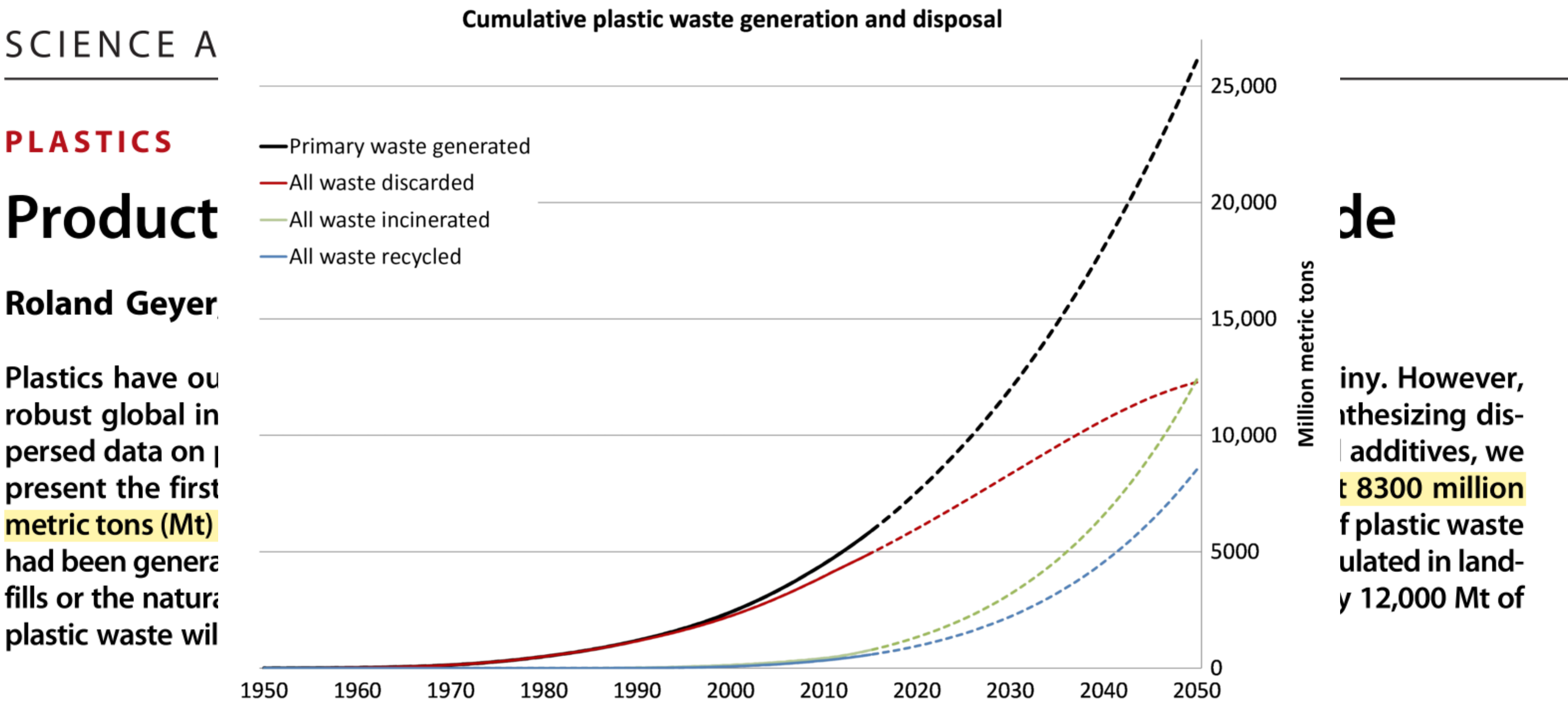
Production, use, and fate of all plastics ever made

Roland Geyer,[1]* Jenna R. Jambeck,[2] Kara Lavender Law[3]

Plastics have outgrown most man-made materials and have long been under environmental scrutiny. However, robust global information, particularly about their end-of-life fate, is lacking. By identifying and synthesizing dispersed data on production, use, and end-of-life management of polymer resins, synthetic fibers, and additives, we present the first global analysis of all mass-produced plastics ever manufactured. We estimate that 8300 million metric tons (Mt) as of virgin plastics have been produced to date. As of 2015, approximately 6300 Mt of plastic waste had been generated, around 9% of which had been recycled, 12% was incinerated, and 79% was accumulated in landfills or the natural environment. If current production and waste management trends continue, roughly 12,000 Mt of plastic waste will be in landfills or in the natural environment by 2050.

Geyer et al., 2017, Science Advances.

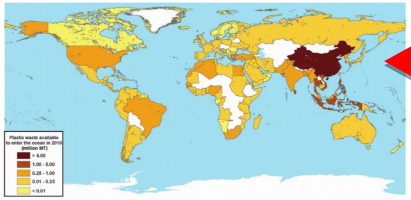
Plastic production



Geyer et al., 2017, Science Advances.

Plastic pollution – local based

Asia



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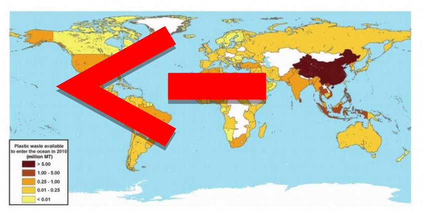
Plastic pollution – marine based

Hawai’i



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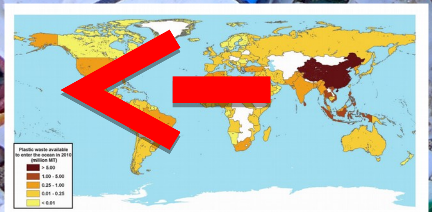

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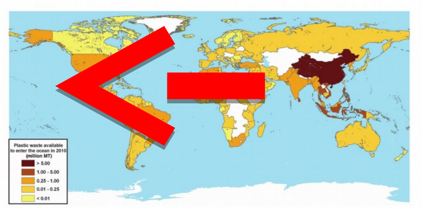

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c types

a water (buoyancy)

- It is expected to increase in the next decades - global demand for polyethylene resins will rise 4.0 percent per year to 99.6 million metric tons in 2018, valued at $164 billion (World Polyethylene, 2014)

Some Common Addition Polymers

Name(s)	Formula	Monomer
Polyethylene low density (LDPE)	$-(CH_2\text{-}CH_2)_n-$	ethylene $CH_2=CH_2$
Polyethylene high density (HDPE)	$-(CH_2\text{-}CH_2)_n-$	ethylene $CH_2=CH_2$
Polypropylene (PP) different grades	$-[CH_2\text{-}CH(CH_3)]_n-$	propylene $CH_2=CHCH_3$
Poly(vinyl chloride) (PVC)	$-(CH_2\text{-}CHCl)_n-$	vinyl chloride $CH_2=CHCl$
Poly(vinylidene chloride) (Saran A)	$-(CH_2\text{-}CCl_2)_n-$	vinylidene chloride $CH_2=CCl_2$
Polystyrene (PS)	$-[CH_2\text{-}CH(C_6H_5)]_n-$	styrene $CH_2=CHC_6H_5$
Polyacrylonitrile (PAN, Orlon, Acrilan)	$-(CH_2\text{-}CHCN)_n-$	acrylonitrile $CH_2=CHCN$
Polytetrafluoroethylene (PTFE, Teflon)	$-(CF_2\text{-}CF_2)_n-$	tetrafluoroethylene $CF_2=CF_2$
Poly(methyl methacrylate) (PMMA, Lucite, Plexiglas)	$-[CH_2\text{-}C(CH_3)CO_2CH_3]_n-$	methyl methacrylate $CH_2=C(CH_3)CO_2CH_3$
Poly(vinyl acetate) (PVAc)	$-(CH_2\text{-}CHOCOCH_3)_n-$	vinyl acetate $CH_2=CHOCOCH_3$
cis-Polyisoprene natural rubber	$-[CH_2\text{-}CH=C(CH_3)\text{-}CH_2]_n-$	isoprene $CH_2=CH\text{-}C(CH_3)=CH_2$
Polychloroprene (cis + trans) (Neoprene)	$-[CH_2\text{-}CH=CCl\text{-}CH_2]_n-$	chloroprene $CH_2=CH\text{-}CCl=CH_2$

Plastic pollution

Deleterious effects on the marine environment:

Plastic pollution

Deleterious effects on the marine environment:

- Pollution
- Entanglement and ingestion by wildlife, the modification of habitats
- Transport of alien species, ultimately toxic and harmful ones. *Ostreopsis sp.*

Plastic pollution

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Plastic pollution

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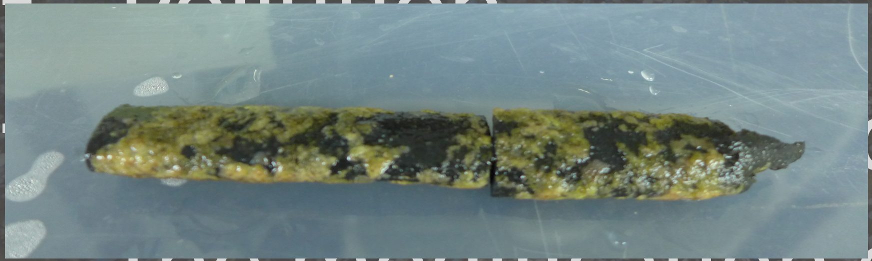
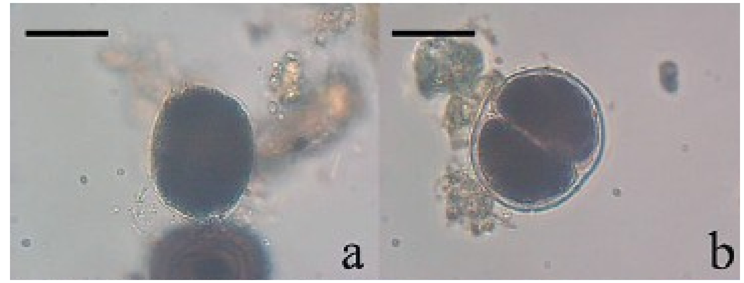
on the marine

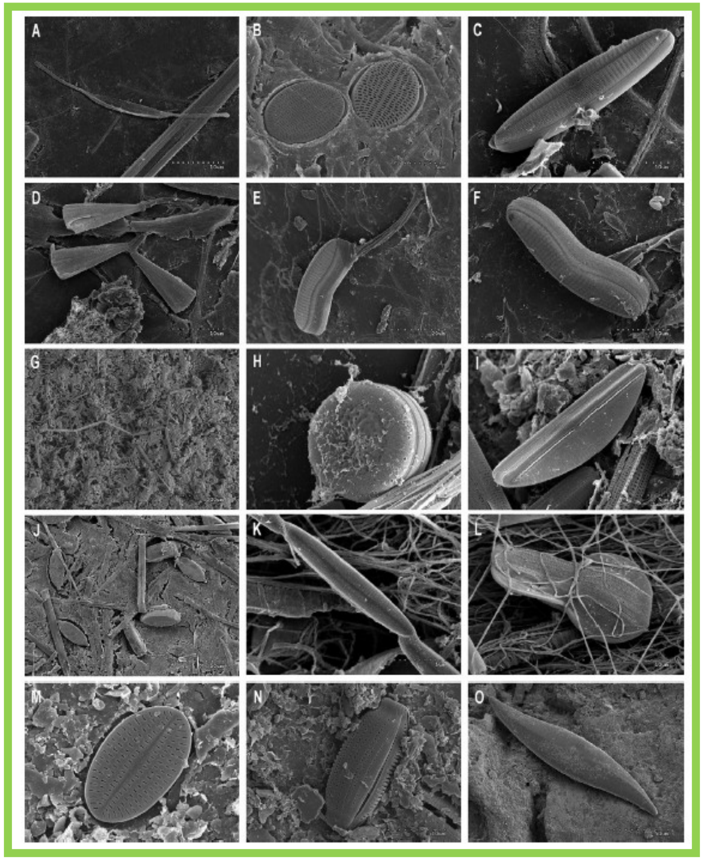


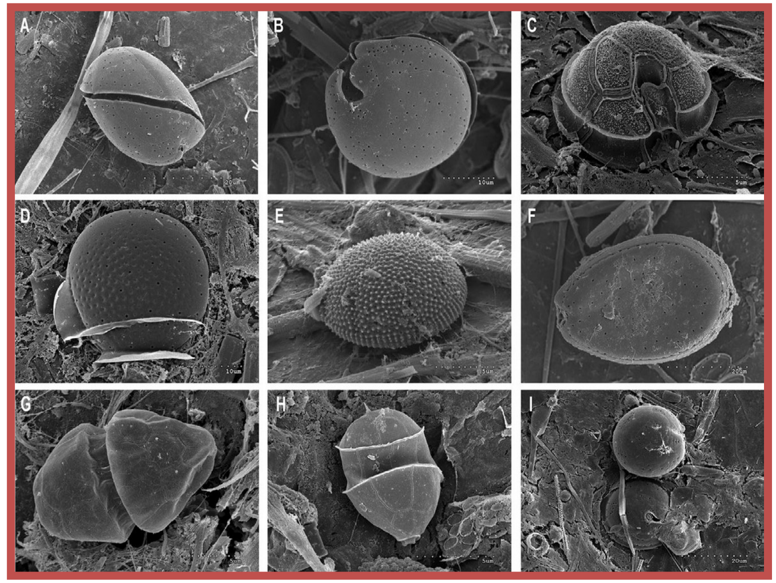
the modification of habitats

- Transport of alien species, ultimately toxic and harmful ones. *Ostreopsis sp.*



Drifting plastic debris are potential vectors for microalgae dispersal



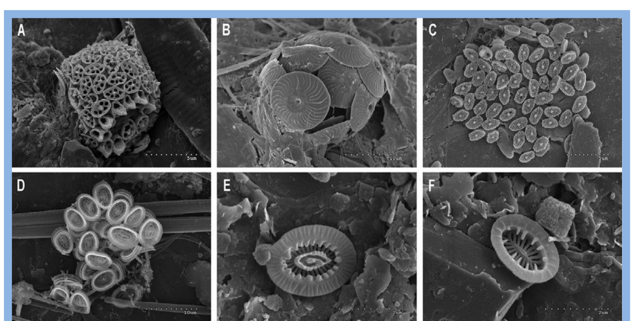


Dinoflagellates occurred in more than 50% of the pelagic marine plastic debris (MPD) sampled, but rarely (13%) on benthic MPDs.

Diatoms appeared in almost 100% of both benthic and pelagic MPDs.

Table 1. – Frequency of occurrence (%) of the most abundant taxonomic group on pelagic and benthic marine plastic debris (MPD).

Group	Pelagic MPD n= 26	Benthic MPD n=16
Diatoms	100	94
Fungi	85	13
Dinoflagellates	58	13
Coccolithophores	35	50
Protozoa	27	56
Faecal pellet	23	13
Bryozoa	4	44



Coccolithophores are found on both benthic and pelagic MPDs.

Masó et al., 2016

Global occurrence of the genus *Ostreopsis*

Masó et al., 2003

Rhodes et al. 2011

Toxic (palytoxin analogues):

- Mass mortalities of benthic fauna (sea urchins, crabs,…)
- Respiratory irritation in humans (Mediterranean beaches) by means of aerosols
- Palytoxicosis (by ingestion of contaminated fishes in tropical areas) (??)

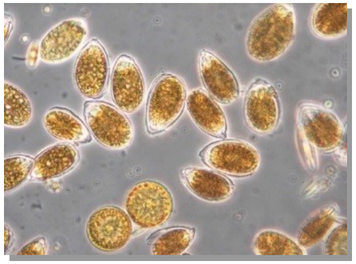
Distribution of *Ostreopsis* spp. along the Mediterranean and Atlantic coasts

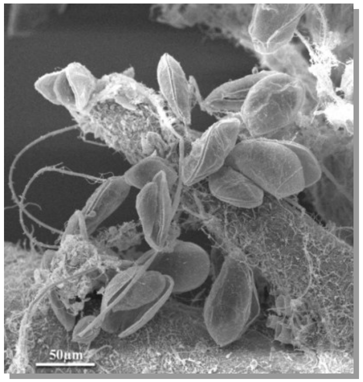
● Respiratory syndromes
△ No human illness

Empty triangles indicate sites where blooms occurred but no human illness was recorded. Filled dots indicate sites where a respiratory syndrome was recorded in humans concomitant with blooms.

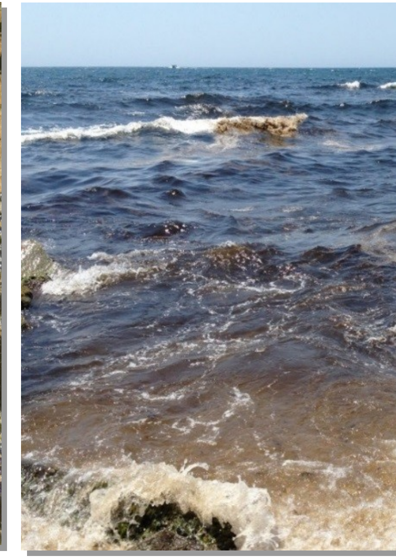
Ciminiello et al. 2014

Microscopy images of *Ostreopsis* cf. *ovata*





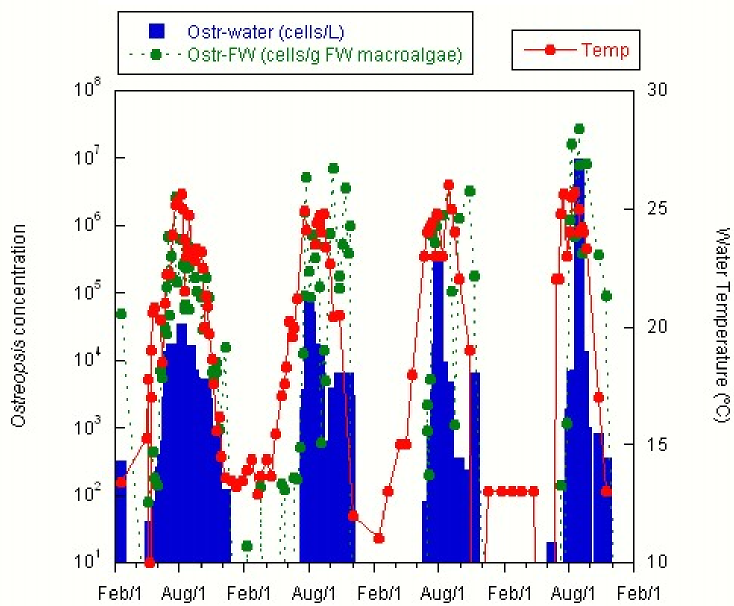
Ostreopsis bloom in the water column



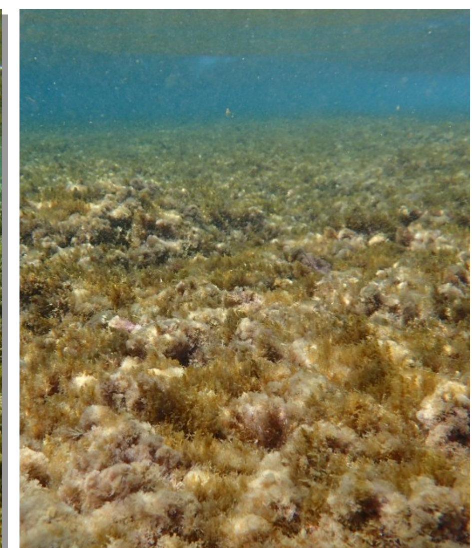
Llavaneres (catalan coast)

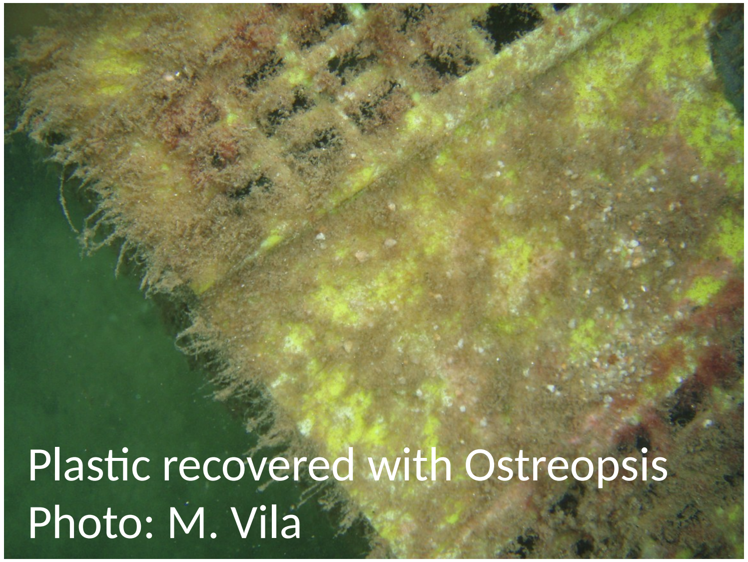
10^4-10^5 (!0^6) cells·L^{-1}

10^6 cells·g^{-1} FW



Macroalgae covered by the mucilage embedded *Ostreopsis* bloom





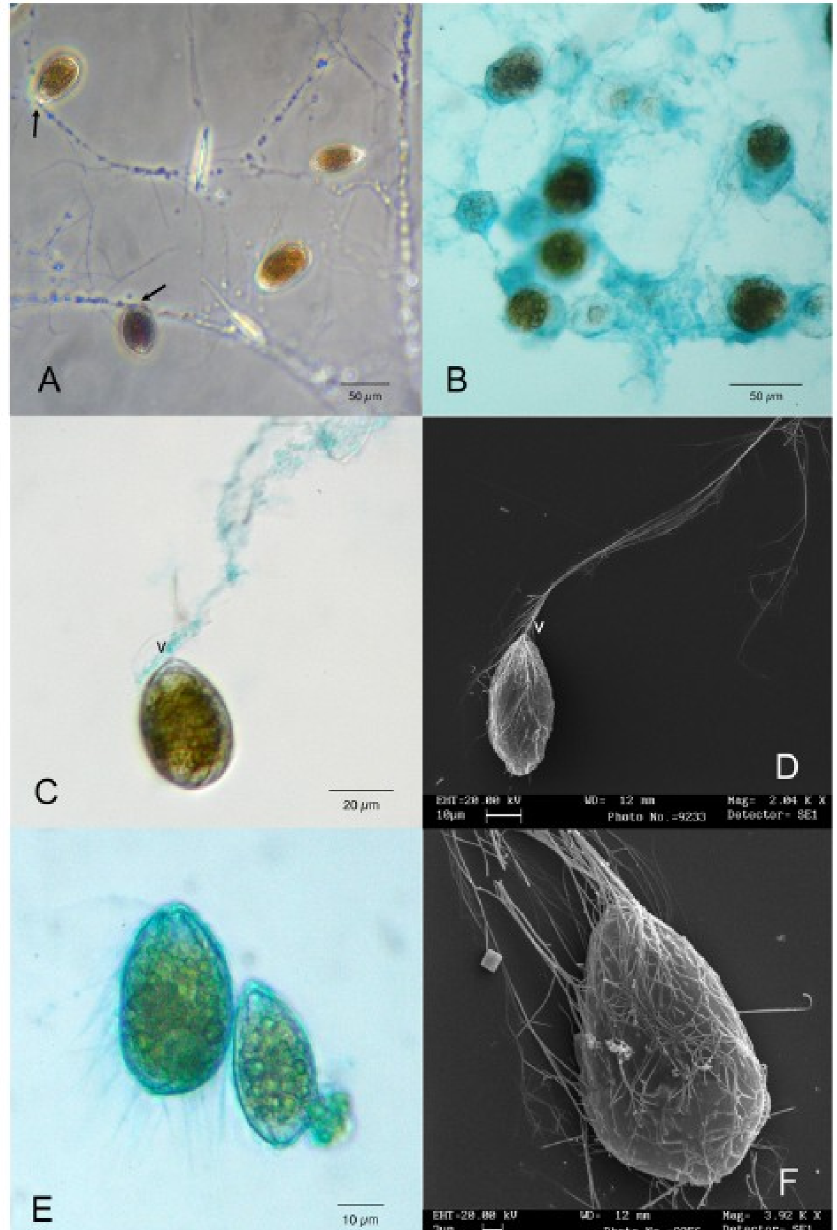
Plastic recovered with Ostreopsis
Photo: M. Vila

Experiment ongoing:

- Drinking water bottle
- Zip bags
- Cleaning towels

Plastic recovered with Ostreopsis
Photo: E. Flo

Cells and a complex network of tiny filaments
Honsell et al. 2013



Hypothesis: Plastics can contribute to the invasion of *Ostreopsis* in the Mediterranean Sea and other marine areas.

Open questions:

- How plastic chemical composition affects *Ostreopsis* colonization?
- How the distribution of *Ostreopsis* attached to plastic is affected by water circulation in coastal areas? Is it dependent on the chemical characteristics of the plastics?

Important challenge:

Characterize water circulation in coastal and shallow waters using low spatio/temporal scales (ca. hours, meters).

Mahalo for your attention!

Institut de Ciències del Mar ICM

CSIC
Consejo Superior de Investigaciones Científicas

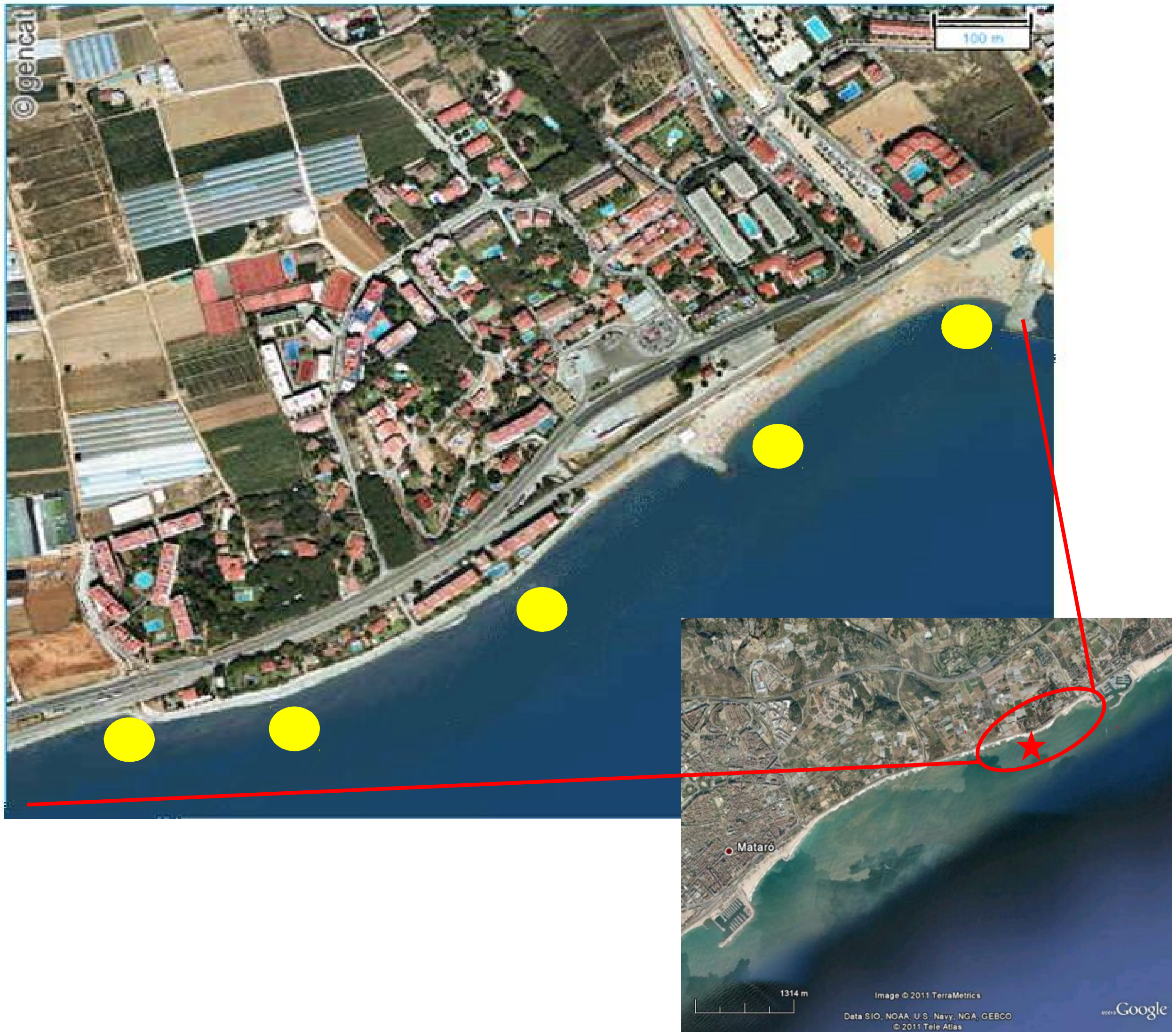
University of Hawai'i

C-MORE
center for microbial oceanography: research and education

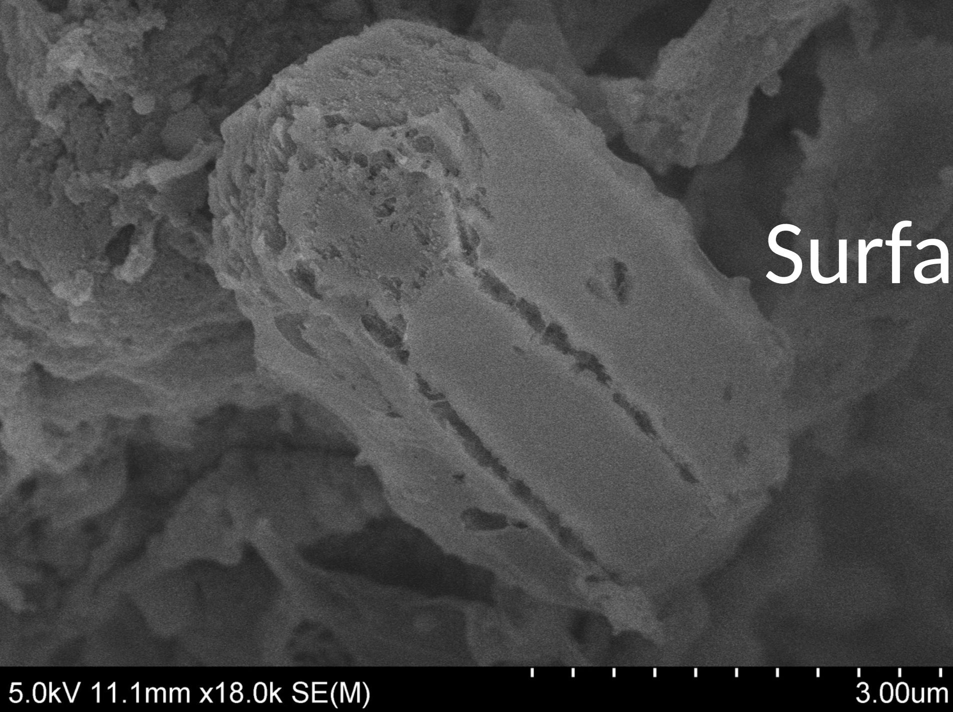
OSTREORISK

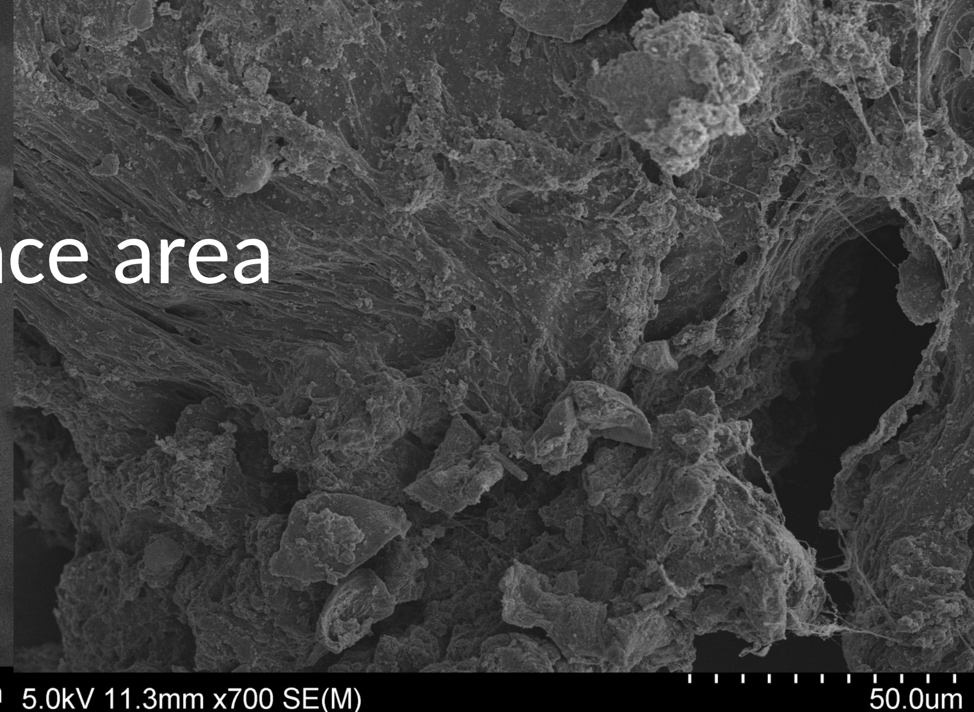
MAPMAS
International Workshop on Marine Pollution and Maritime Safety

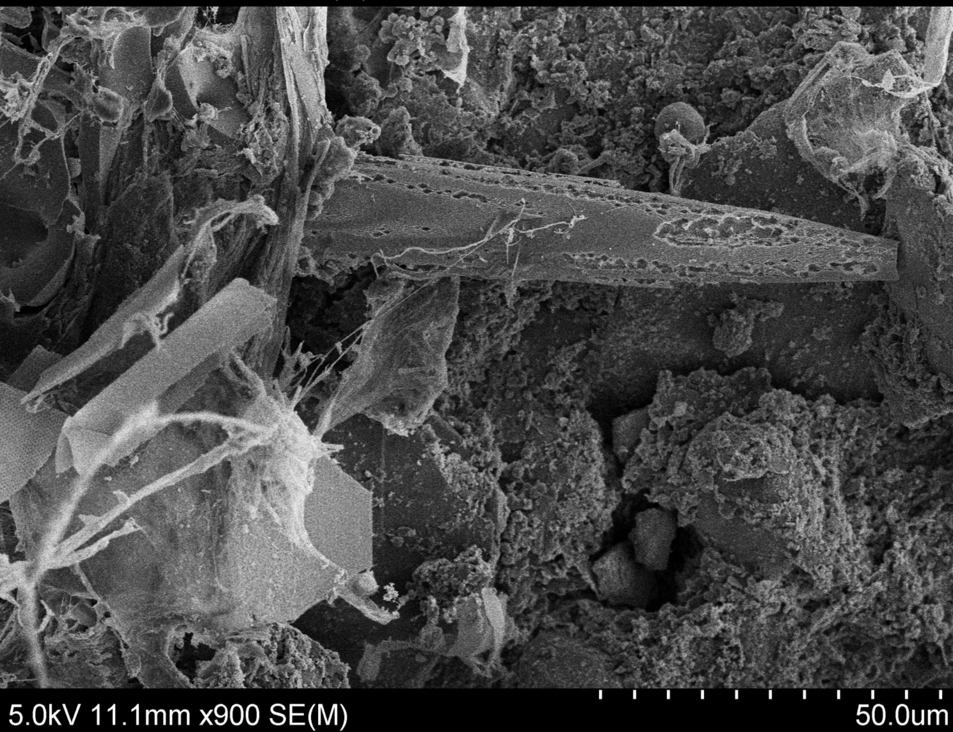
A case study: Llavaneres beach – joint epidemiology and ecology

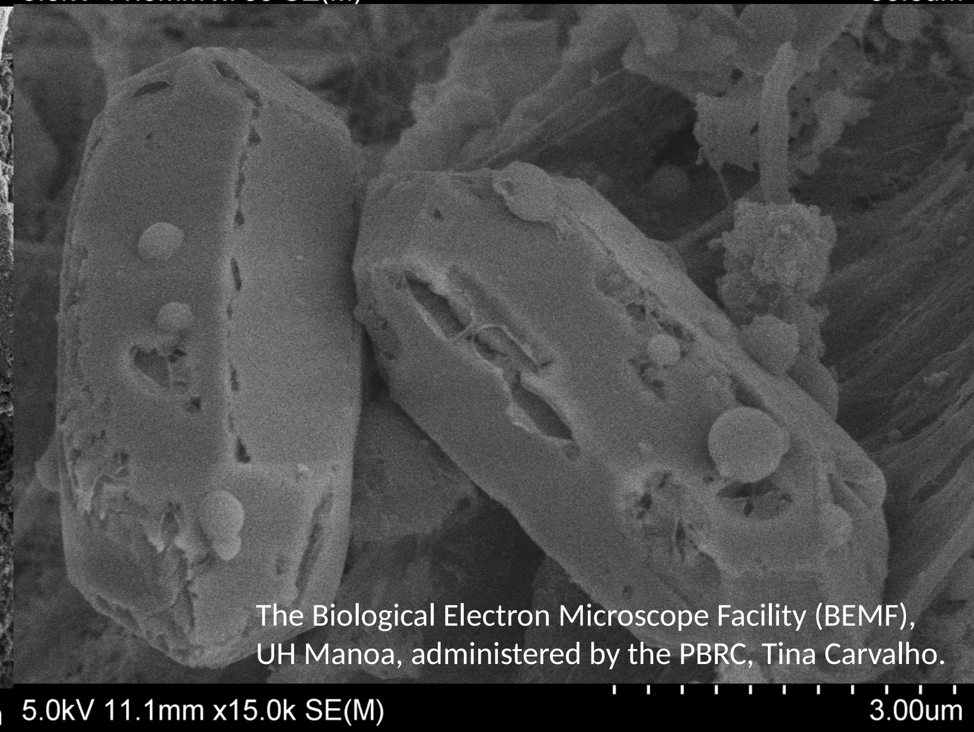


Surface area



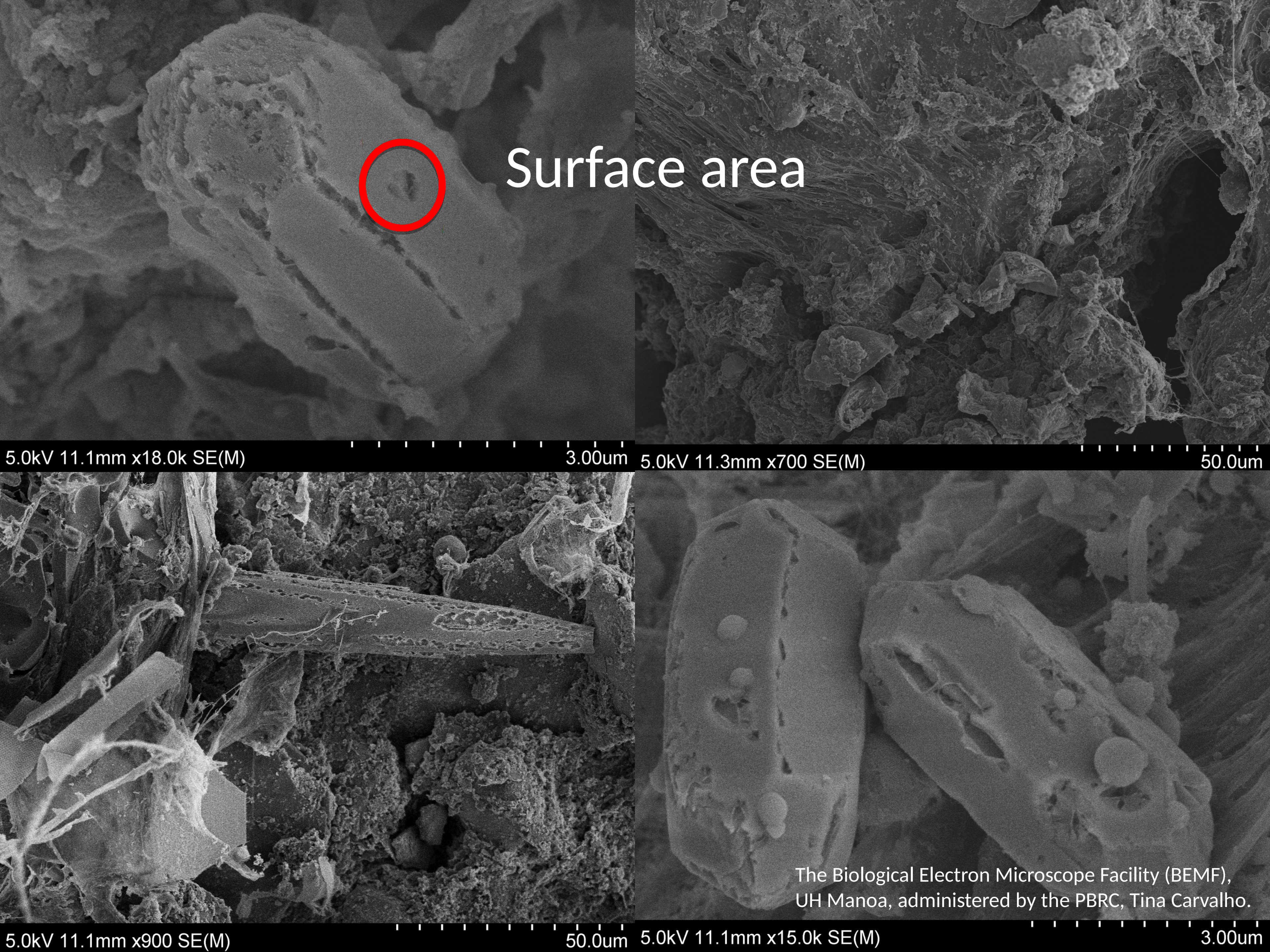






The Biological Electron Microscope Facility (BEMF), UH Manoa, administered by the PBRC, Tina Carvalho.

Surface area



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Life Magazine
1955

Celebrated
Throwaway
Living

Plastic waste across the oceans

RESEARCH ARTICLE

Plastic Pollution in the World's Oceans: More than 5 Trillion Plastic Pieces Weighing over 250,000 Tons Afloat at Sea

Marcus Eriksen[1*], Laurent C. M. Lebreton[2], Henry S. Carson[3,4], Martin Thiel[5,6,7], Charles J. Moore[8], Jose C. Borerro[9], Francois Galgani[10], Peter G. Ryan[11], Julia Reisser[12]

Figure 3. Model results for global weight density in four size classes. Model prediction of global weight density (g km^{-2}; see colorbar) for each of four size classes (0.33–1.00 mm, 1.01–4.75 mm, 4.76–200 mm, and >200 mm). The majority of global weight is from the largest size class.

Erikson et al., 2014: Plastic Pollution in the World's Oceans

The Global Methane Budget & plastic waste

RESEARCH ARTICLE

Plastic Pollution in the World's Oceans: More than 5 Trillion Plastic Pieces Weighin

at at Sea

70% = LDPE

Marcus Eriksen

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