# インターナショナルペレットウォッチ：化学汚染物質の輸送媒体としての海洋プラスチック

高田秀重

東京農工大学 農学部 環境資源科学科


URBAN THROWAWAYS ON THEIR WAY
TO **“AWAY”** >>> NAMELY; THE **OCEAN**
**LONG BEACH, CALIFORNIA, 2005**

# CITARUM RIVER, INDONESIA


LAGOS, NIGERIA


MUMBAI, INDIA

New Delhi, India

Marcus Eriksen, Photo


Yamuna River, New Dehli,
India
Marcus Eriksen, Photo

# Yamuna River, New Delhi,   India

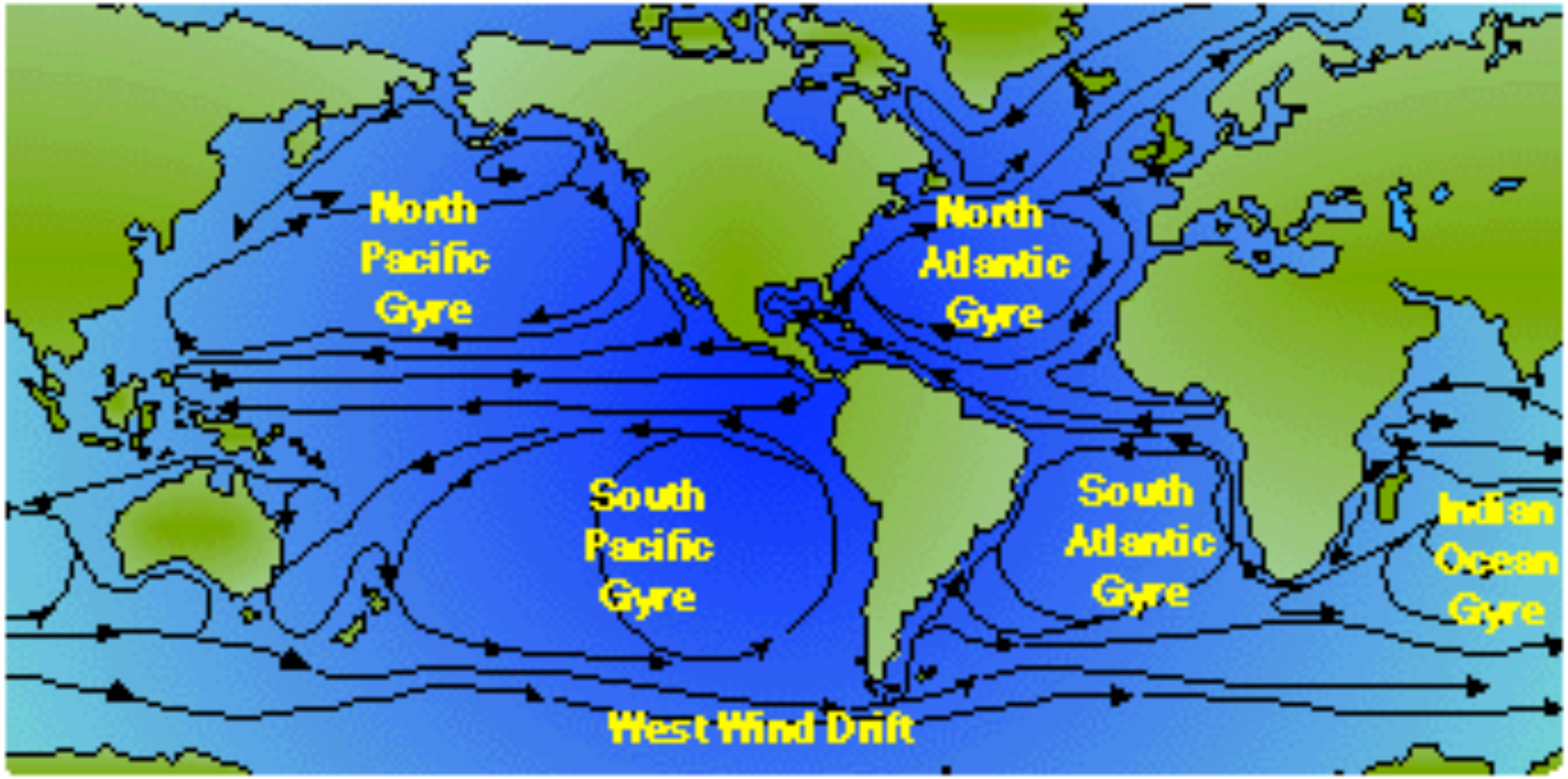
Photo: Manan Vastsyayana

# 海岸に打ち上げられるプラスチック

マニラ湾


KAMILO BEACH
BIG ISLAND

# 外洋にもプラスチックゴミが溜まる場所がある

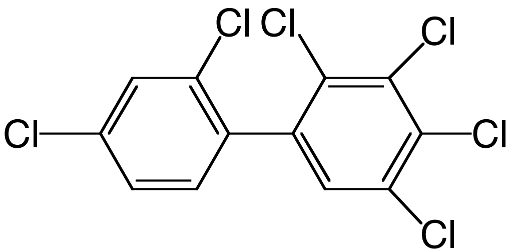


# プランクトンの６倍も多い量のプラスチックが太平洋の真ん中にある

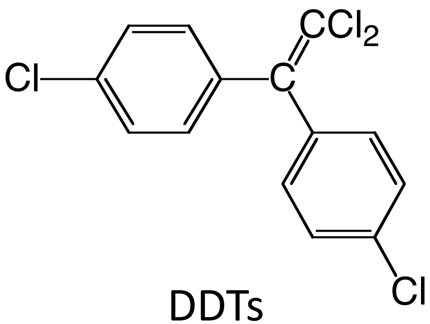
# プラスチックは有害化学物質の運び屋

海水中から吸着される化学物質

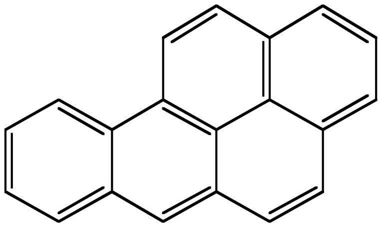
添加剤として含まれる化学物質



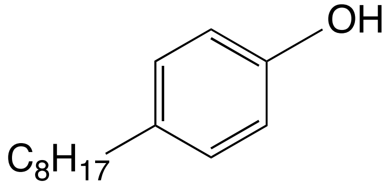

Polychlorinated biphenyl (PCBs)



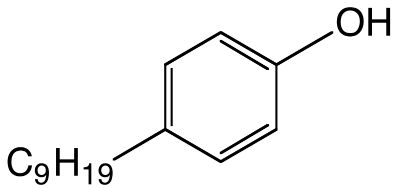

DDTs



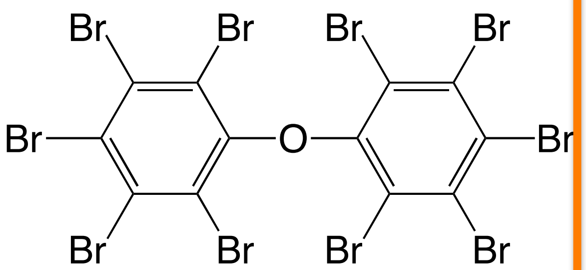
Polycyclic aromatic hydrocarbons (PAHs)



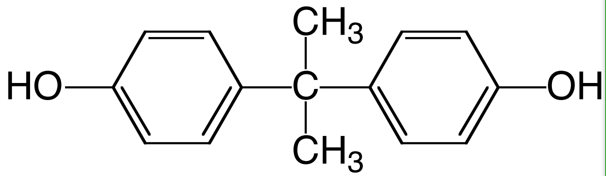

Octylphenol




Nonylphenol




Polybrominated diphenyl ethers (PBDEs)

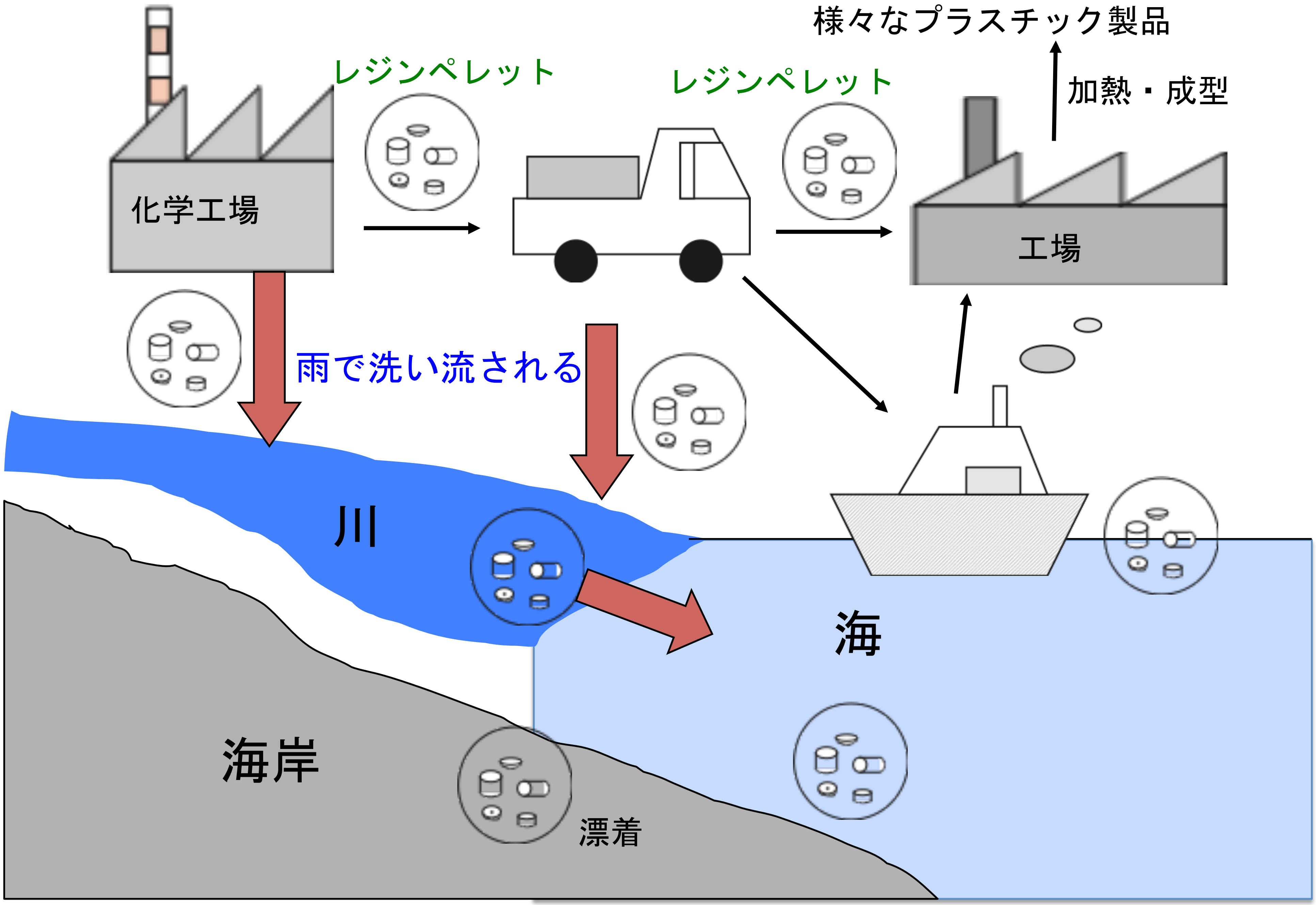



Bisphenol A

# プラスチックレジンペレット：
# プラスチック製品の中間材料

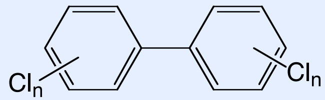
# プラスチックゴミの中をよく見るとペレットがある

# レジンペレットとは？何故海岸に漂着しているのか？



# プラスチックは周辺海水中からPOPsを吸着する

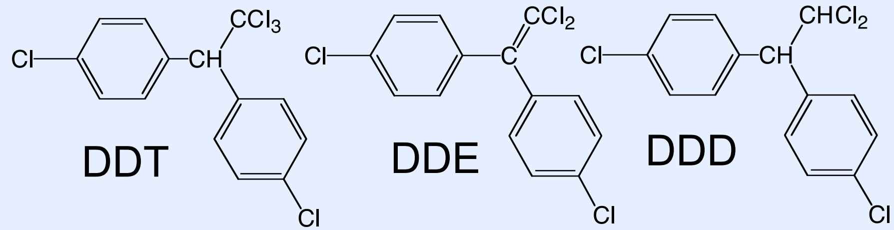
## PCBs




- Industrial products for a variety of uses including dielectric fluid, heat medium, and lubricants.
- Endocrine disrupting chemicals

**周辺海水中から吸着**

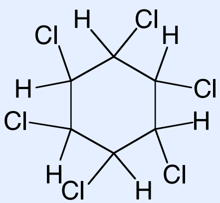
## DDTs




- DDT and its metabolites such as DDE and DDD.
- DDT was used as insecticides
- Endocrine disrupting chemicals

プラスチック

## HCH




- Insecticide

$-(CH_2-CH_2)_n-$

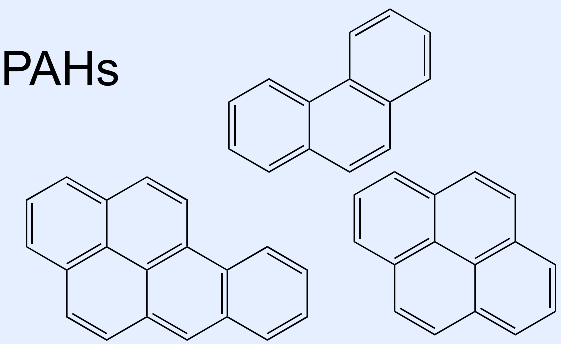
Polyethylene (PE)

$CH_3$

$-(CH_2-CH)_n-$

Polyprorylene (PP)

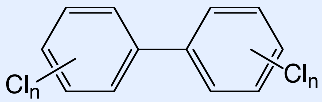
## PAHs



Mato *et al*. (2001), *ES&T*

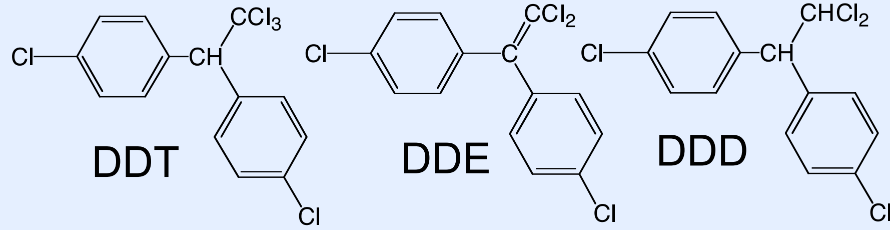
# プラスチックは周辺海水中からPOPsを吸着する

PCBs




- Industrial products for a variety of uses including dielectric fluid, heat medium, and lubricants.
- Endocrine disrupting chemicals

DDTs

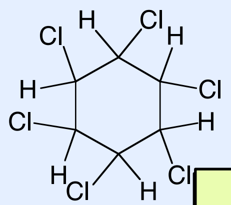



- DDT and its metabolites such as DDE and DDD.
- DDT was used as insecticides
- Endocrine disrupting chemicals

**周辺海水中から吸着**

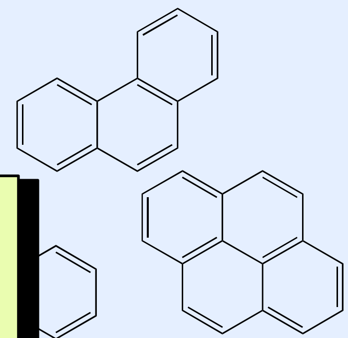
プラスチック

HCH




- Insecticide

PAHs



**プラスチック中の汚染物質濃度は周辺海水中の十万倍～百万倍**

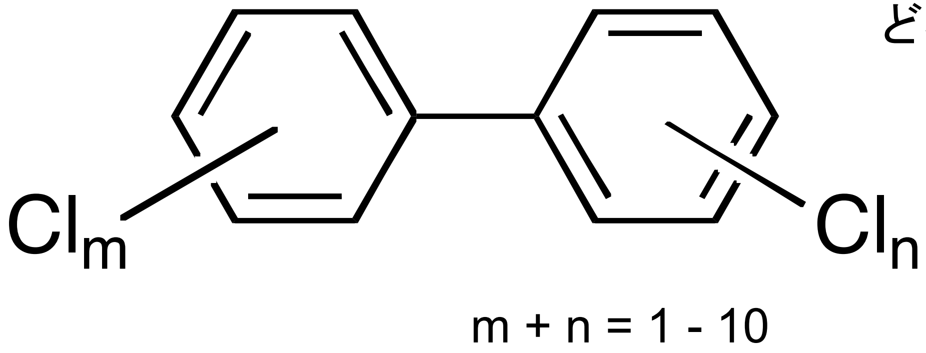
# インターナショナル ペレットウオッチ:
# 海岸漂着プラスチックを用いた有害化学物質モニタリング


インターネットや雑誌で
世界の人にペレットの採
取と送付を呼びかける

東京農工大学　環境資源科学科 水環境保全学研究室

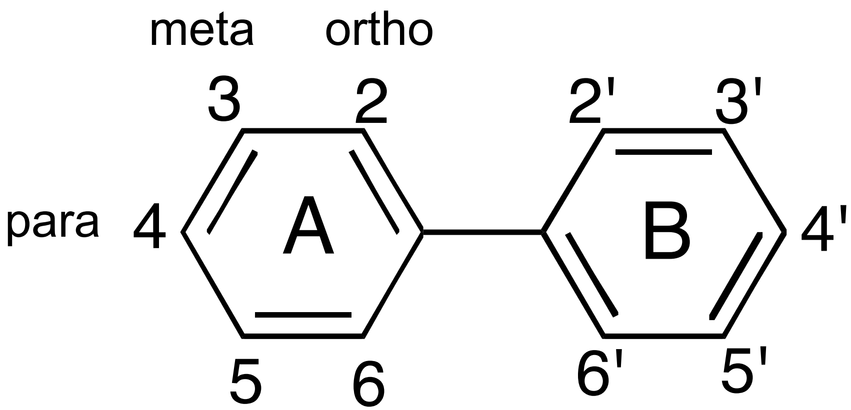

CSIR
WNNR
CONGELLA 4013
3403
Dr Hideshige Takada
Laboratory of Organic Chemistry
Institute of Symbiotic Science and Technology
Tokyo University of Agriculture and Technology
3-5-8 Saiwaicho
Fuchu
Tokyo 183-8509
JAPAN
Dept of Chemistry
Univ. of PATRAS
26500 PATRA
GREECE
Dr Hideshige TAKADA
Laboratory of Organic Geochemistry
Tokyo University of Agriculture and Technology
Fuchu, Tokyo 183-8509
JAPAN
Miriam Gordon
California Coastal Commission
45 Fremont St, Ste2000
SF, CA 94105
U.S. POSTAGE
$2.75
Laboratory of Organic Geochemistry
Dr. Hideshige Takada
Tokyo University of Agriculture & Technology
Fuchu, Tokyo 183-8509
JAPAN
UNITED STATES POSTAL SERVICE
PAR AVION
AIR MAIL
United States Postal Service
Customs Declaration
Plastic fragments collected on beach
Port Townsend
Marine Science Center
532 Battery Way
Port Townsend, WA 98368
U.S. POSTAGE
$0.90
Laboratory of Organic Geochemistry
Dr Hideshige TAKADA
Tokyo University of Agriculture and Technology
Fuchu, Tokyo 183-8509
JAPAN
UNITED STATES POSTAL SERVICE
PAR AVION
AIRMAIL
A
ROYAL MAIL
13.02.07
Dr Hideshige TAKADA
LABORATORY OF ORGANIC GEOCHEMISTRY,
TOKYO UNIVERSITY OF AGRICULTURE AND TECHNOLOGY,
FUCHU,
TOKYO 183-8509,
JAPAN

# ポリ塩化ビフェニル(PCBs)の分析結果




トランス、コンデンサー、　熱媒体など様々な工業用途で使用された。

1960年代に使われ、
1970年代初頭に使用禁止



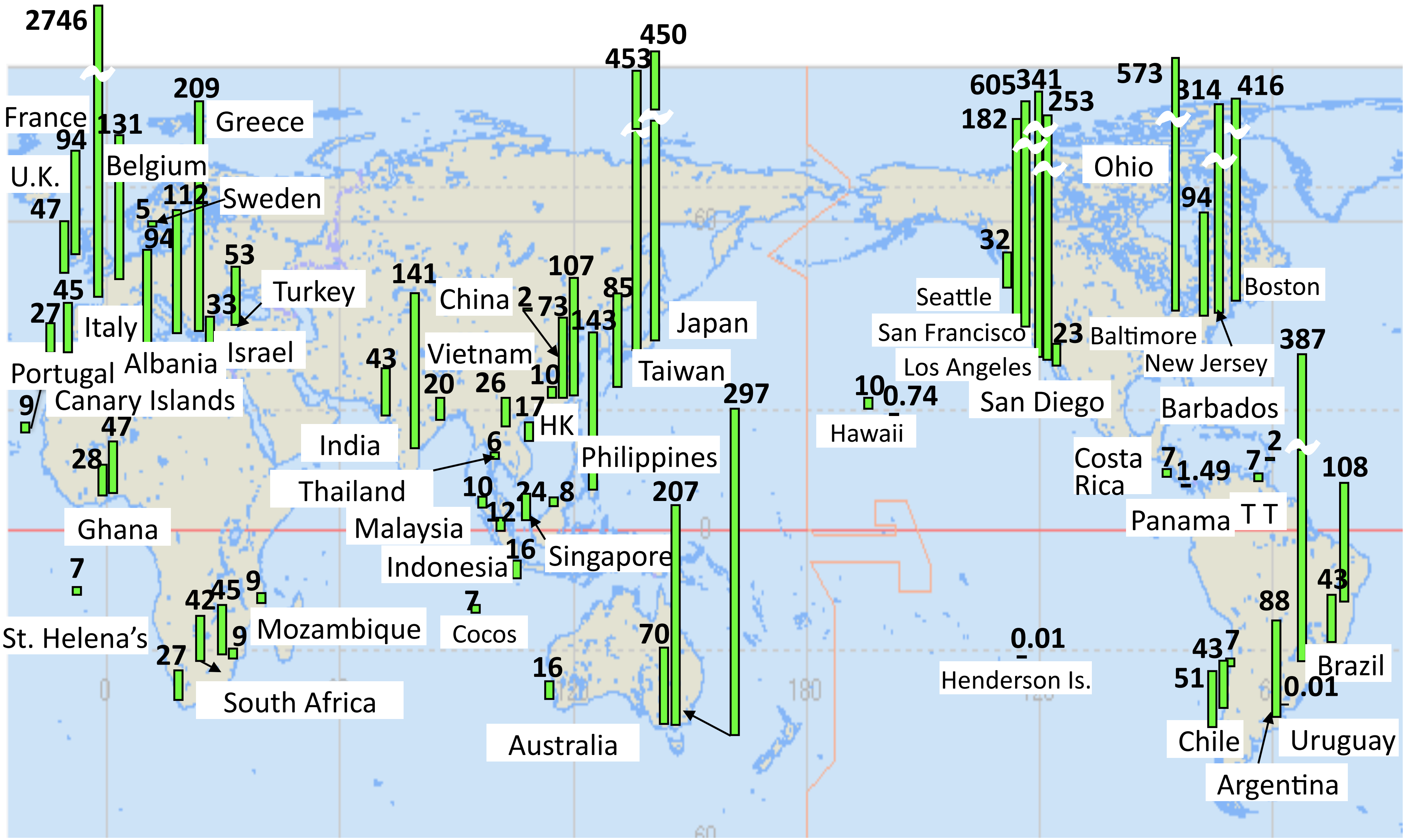

カネミ油症

奇形、発ガン

免疫力の低下

脳神経系に影響

# プラスチックは浮いて流され、世界中の海岸に有害化学物質を運ぶ




レジンペレット中のPCBs濃度(ng/g)

# ペレットは海のプラスチックの一部、大部分はプラスチック破片

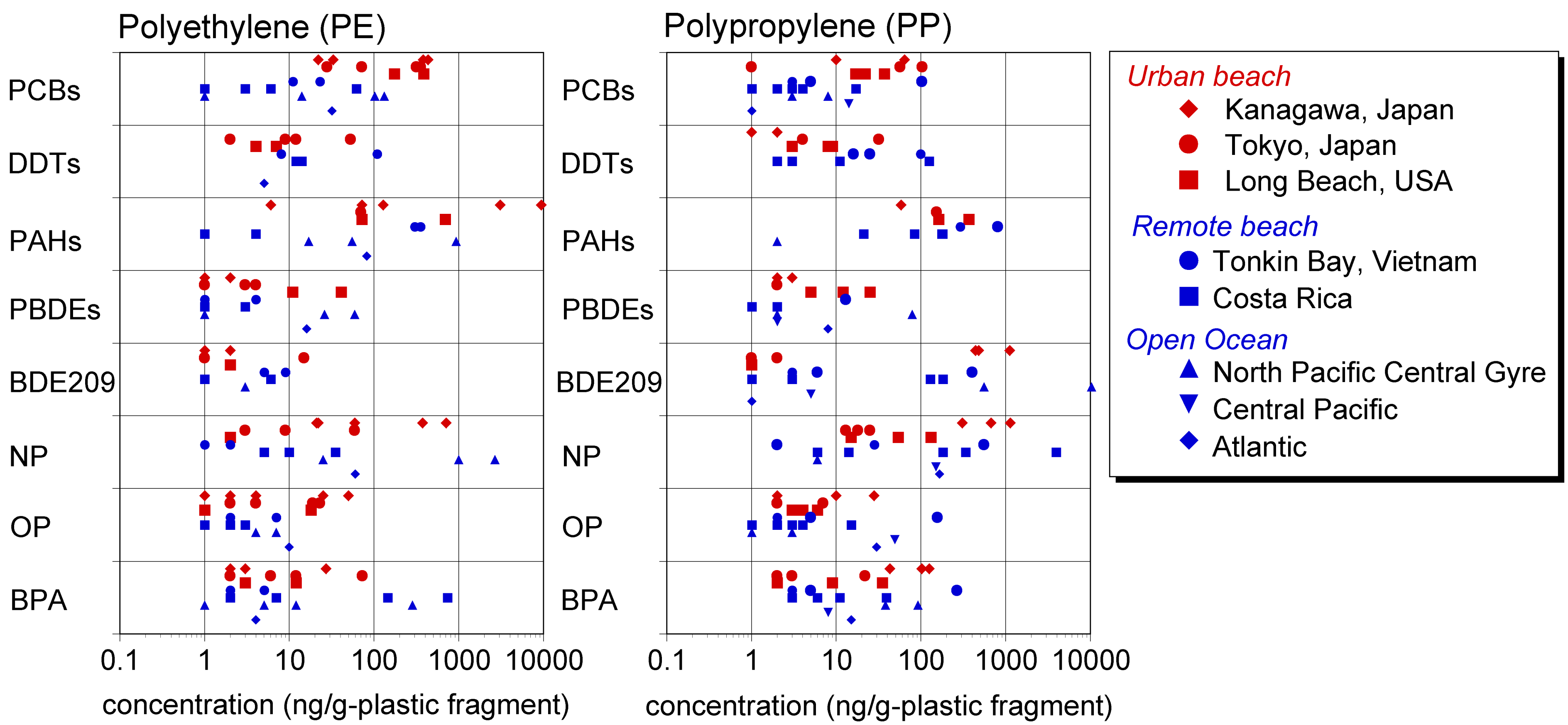
イースター島 Anakena Beachの
プラスチック破片

# イースター島 Anakena Beachのプラスチック破片

# 世界各地の海岸や外洋を漂流しているプラスチック破片の分析


- Urban beach
- Rural beach
- Open ocean

# プラスチック破片には吸着した化学物質と添加剤の両方がふくまれる

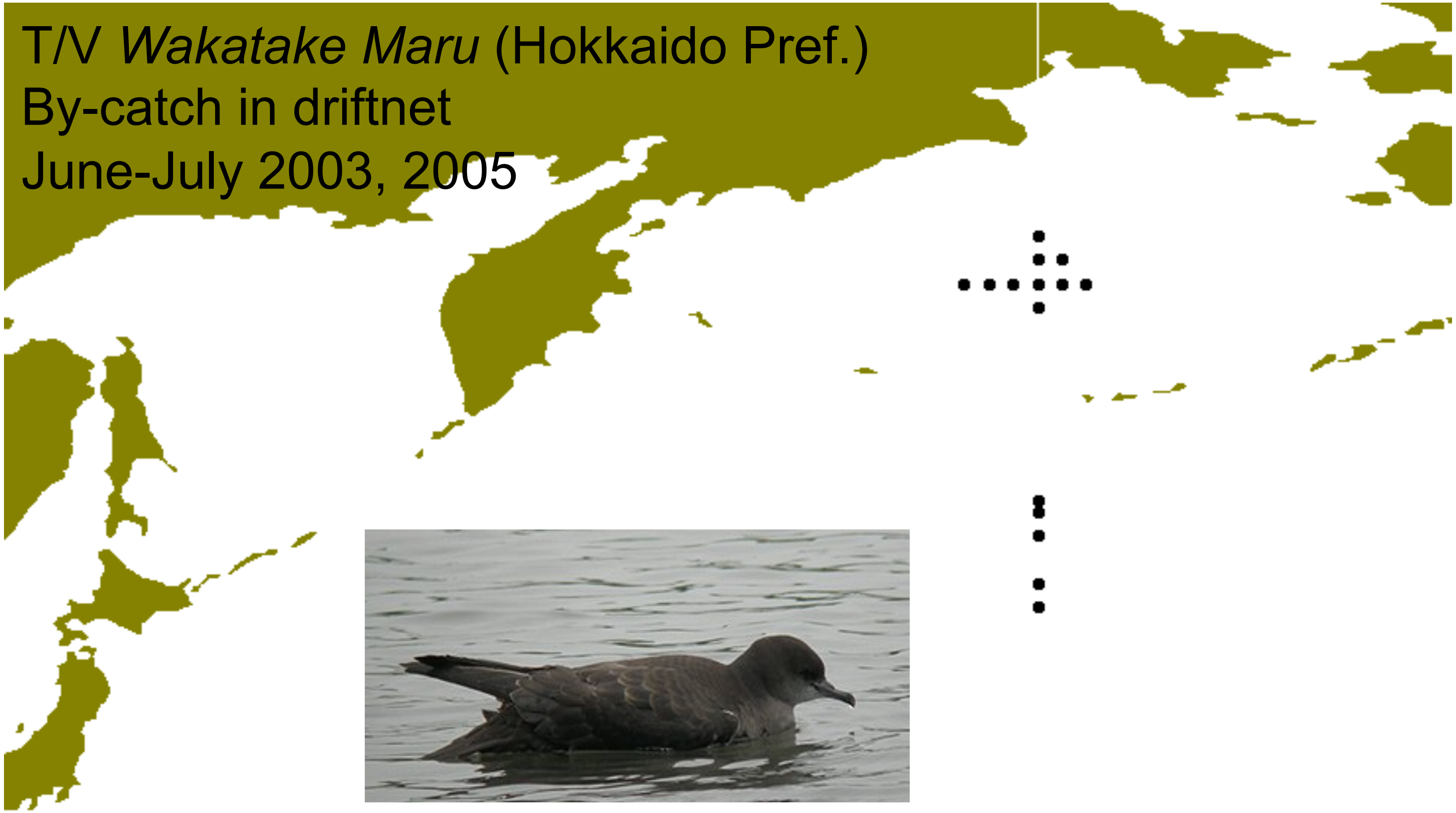



Both sorption-derived and additive-derived chemicals ranging from 1 ng/g to 10,000 ng/g

# 海の生物がプラスチックを誤飲・摂食する


ミッドウエー島のアホウドリ

# 北部北太平洋で混獲により採取された海鳥12個体を分析した




**Short-tailed shearwater**
***Puffinus tenuirostris***

# 全ての個体の消化管からプラスチックを検出




# 東京湾海水中のプラスチック微細片

# プラスチック微細片は二枚貝等の体内に蓄積される

*Environ. Sci. Technol.* **2008,** *42,* 5026–5031

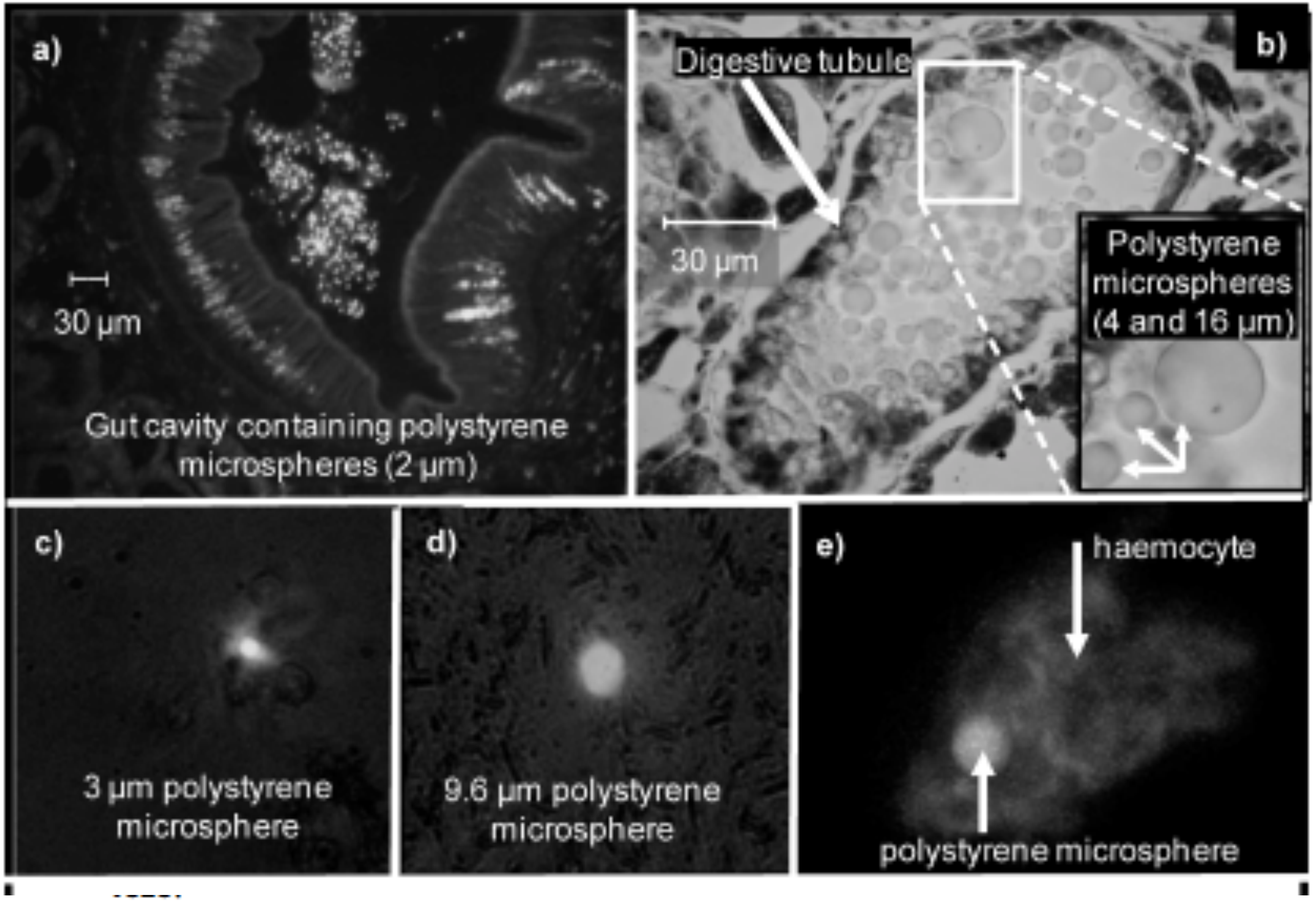
## Ingested Microscopic Plastic Translocates to the Circulatory System of the Mussel, *Mytilus edulis* (L.)

MARK A. BROWNE,*,† AWANTHA DISSANAYAKE,† TAMARA S. GALLOWAY,‡ DAVID M. LOWE,§ AND RICHARD C. THOMPSON†

*School of Biological Sciences, University of Plymouth, Drake Circus, Plymouth, PL4 8AA, U.K., University of Exeter, Prince of Wales Road, Exeter, EX4 4PS, U.K., and Plymouth Marine Laboratory, Prospect Place, Plymouth, PL1 3DH, U.K.*

Plastics debris is accumulating in the environment and is fragmenting into smaller pieces; as it does, the potential for ingestion by animals increases. The consequences of macroplastic debris for wildlife are well documented, however the impacts of microplastic (<1 mm) are poorly understood. The mussel, *Mytilus edulis*, was used to investigate ingestion, translocation, and accumulation of this debris. Initial experiments showed that upon ingestion, microplastic accumulated in the gut. Mussels were subsequently exposed to treatments containing seawater and microplastic (3.0 or 9.6 $\mu$m). After transfer to clean conditions, microplastic was tracked in the hemolymph. Particles translocated from the gut to the circulatory system within 3 days and persisted for over 48 days. Abundance of microplastic was greatest after 12 days and declined thereafter. Smaller particles were more abundant than larger particles and our data indicate as plastic fragments into smaller particles, the potential for accumulation in the tissues of an organism increases. The short-term pulse exposure used here did not result in significant biological effects. However, plastics are exceedingly durable and so further work using a wider range of organisms, polymers, and periods of exposure will be required to establish the biological consequences of this debris.

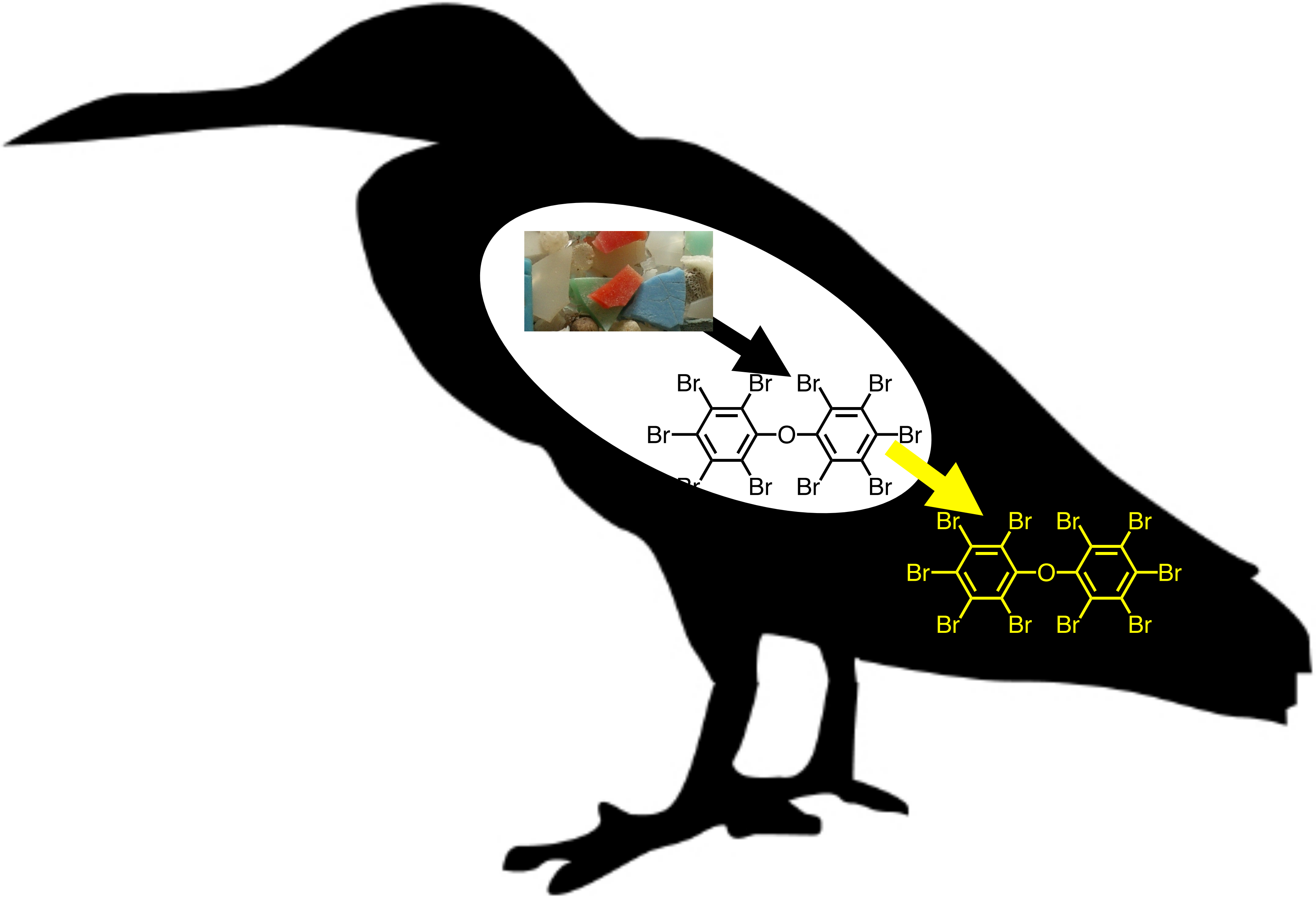
# 1mm以下の微細プラスチックが二枚貝の体内にも取り込まれる



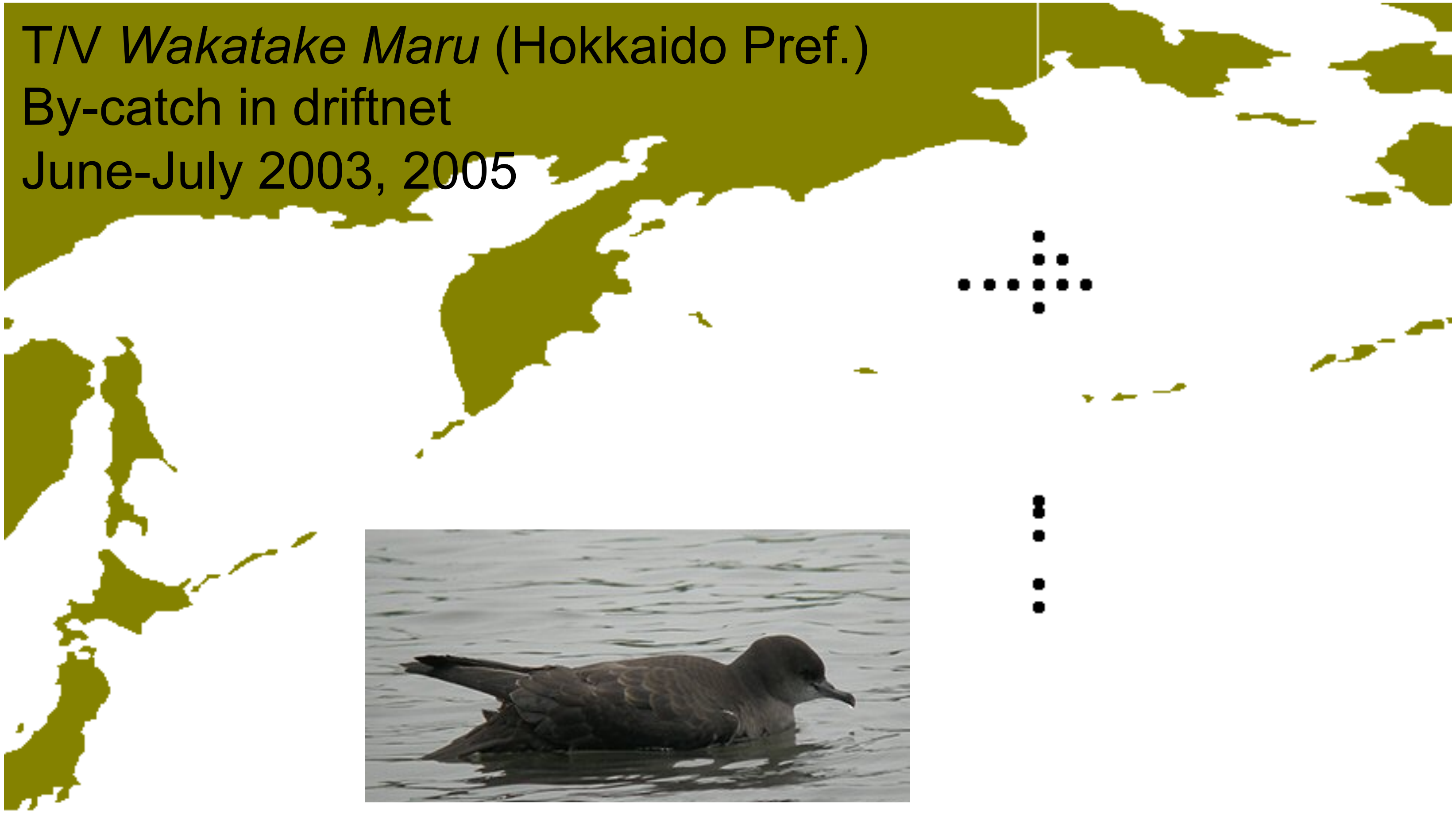


Browne, M.A., Dissanayake, A., Galloway, T.S., Lowe, D.M., Thompson, R.C., 2008. Ingested microscopic plastic translocates to the circulatory system of the mussel, *Mytilus edulis* (L.). Environ. Sci. Technol. 42, 5026–5031.

# プラスチックに含まれる有害化学物質も生物組織に移行する



# 北部北太平洋で混獲により採取された海鳥12個体を分析した

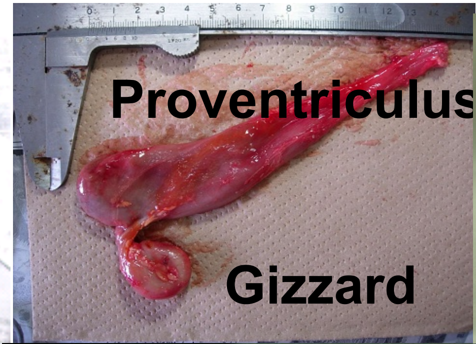


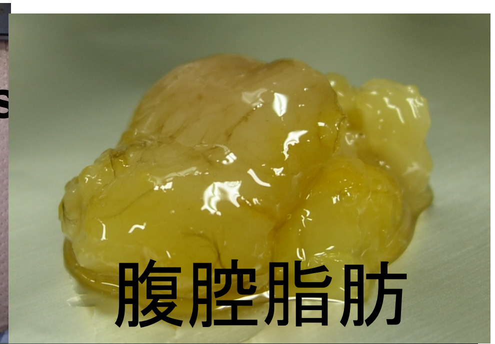

**Short-tailed shearwater**
***Puffinus tenuirostris***

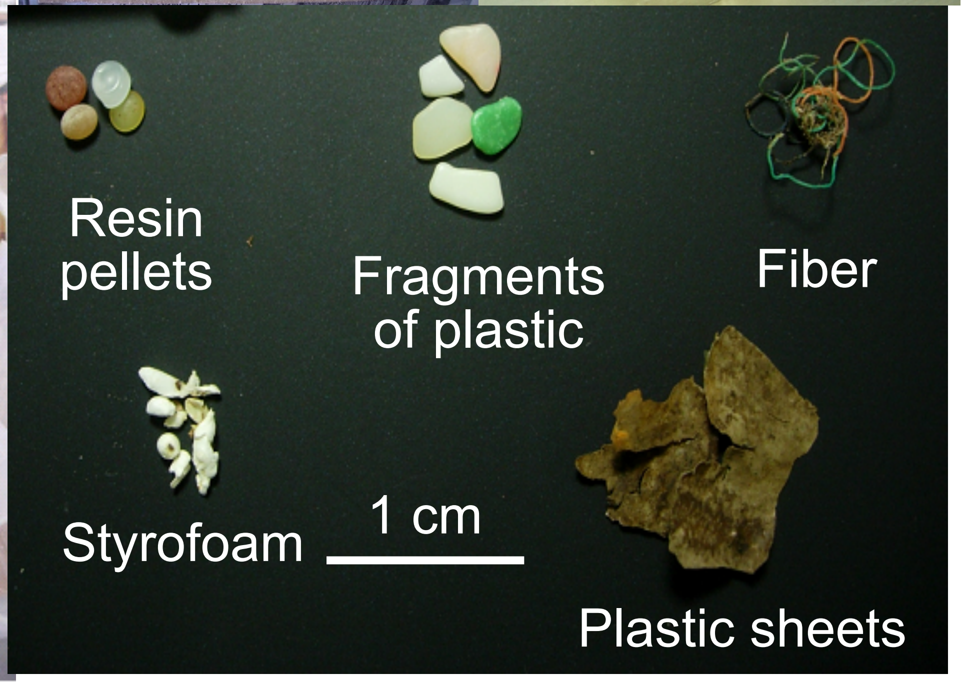
# 全ての個体の消化管内からはプラスチックが検出された




# 混獲で採取されたハシボソミズナギドリの腹腔脂肪を分析

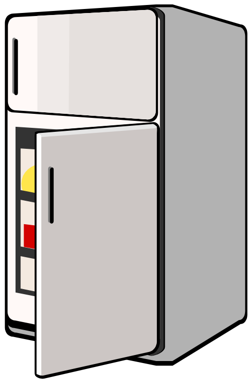


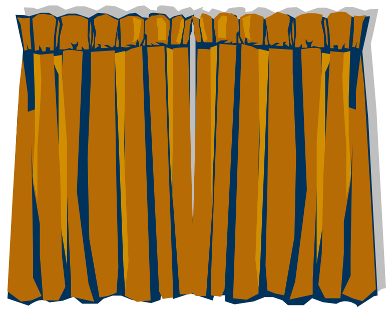
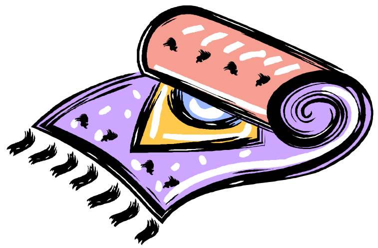



# PBDEs：難燃剤

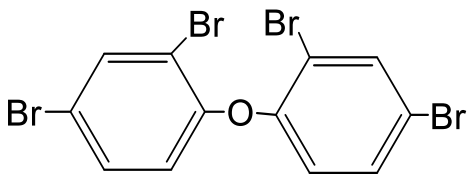
電化製品や織物に広く添加されている。



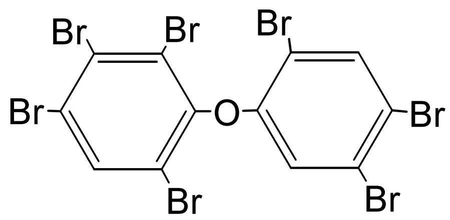

## ３つの製品がある

**ペンタ BDE**
（４臭素、５臭素化物）



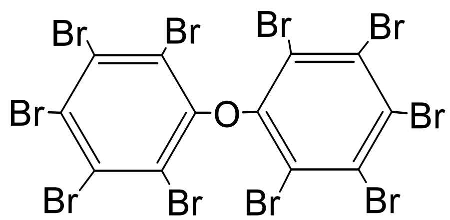

例えば, BDE47

**オクタ BDE**
（７臭素、８臭素化物）



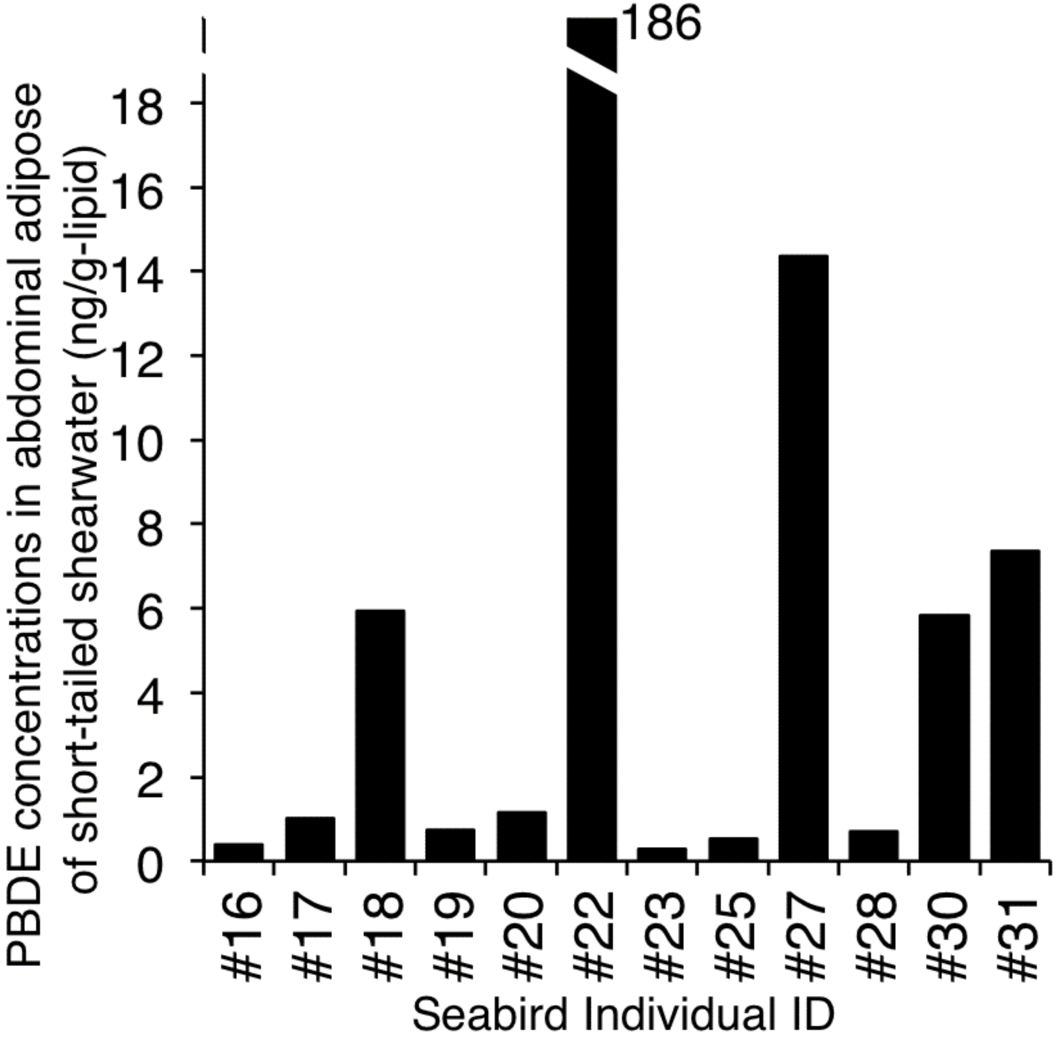

例えば, BDE183

**デカBDE**
（10臭素化物）




BDE209

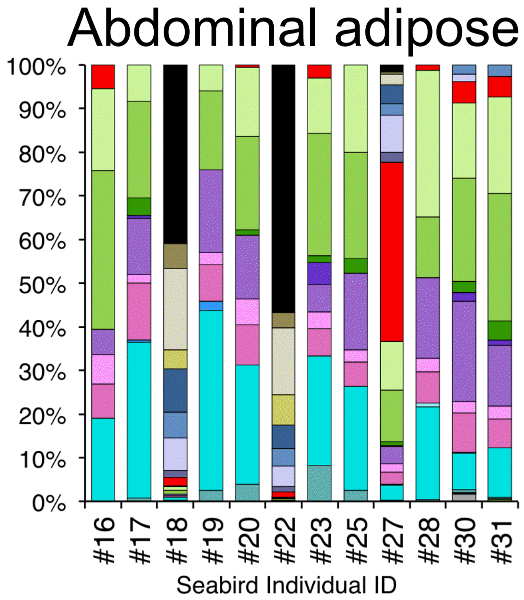
# PBDEs detected in the abdominal adipose of the short-tailed shearwater

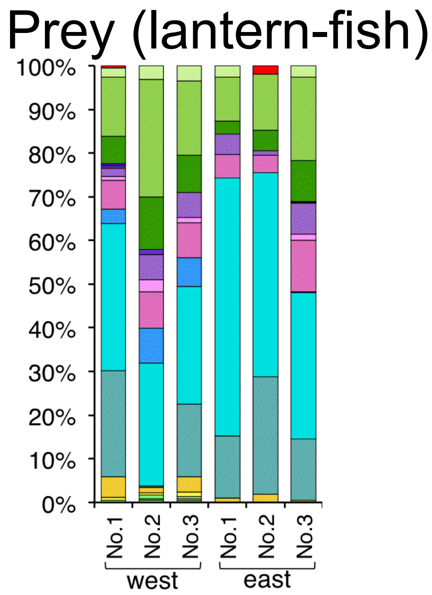


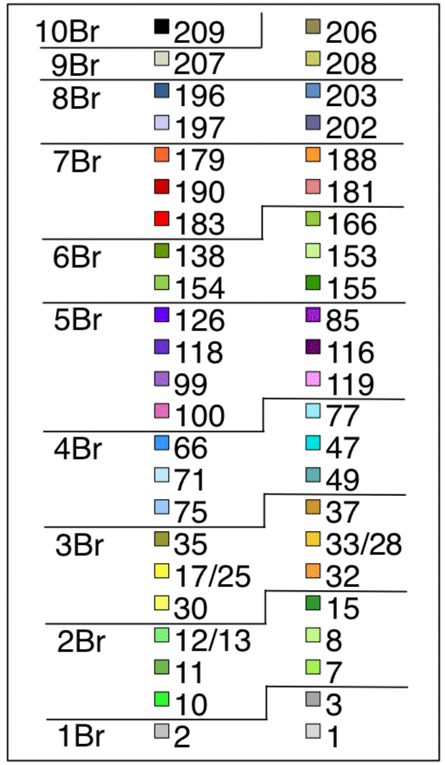

PBDEs were detected in abdominal adipose of all the individuals.

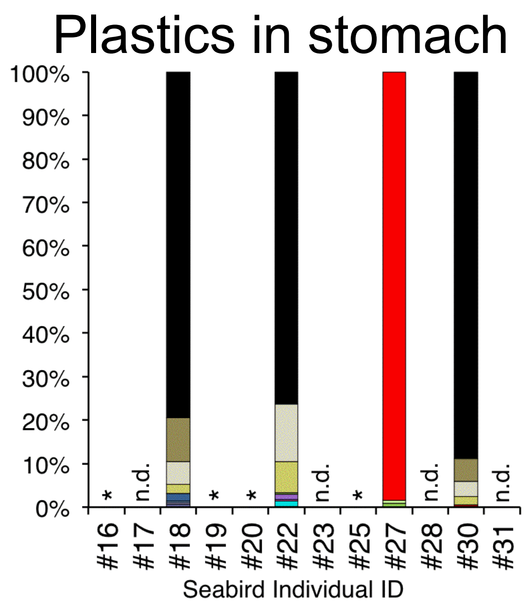
Blank
BDE#47 : 0.0006 ng/g-lipid
BDE#209 :0.03 ng/g-lipid

# Composition of BDE congeners in seabird adipose, plastics in the stomachs, and their prey.



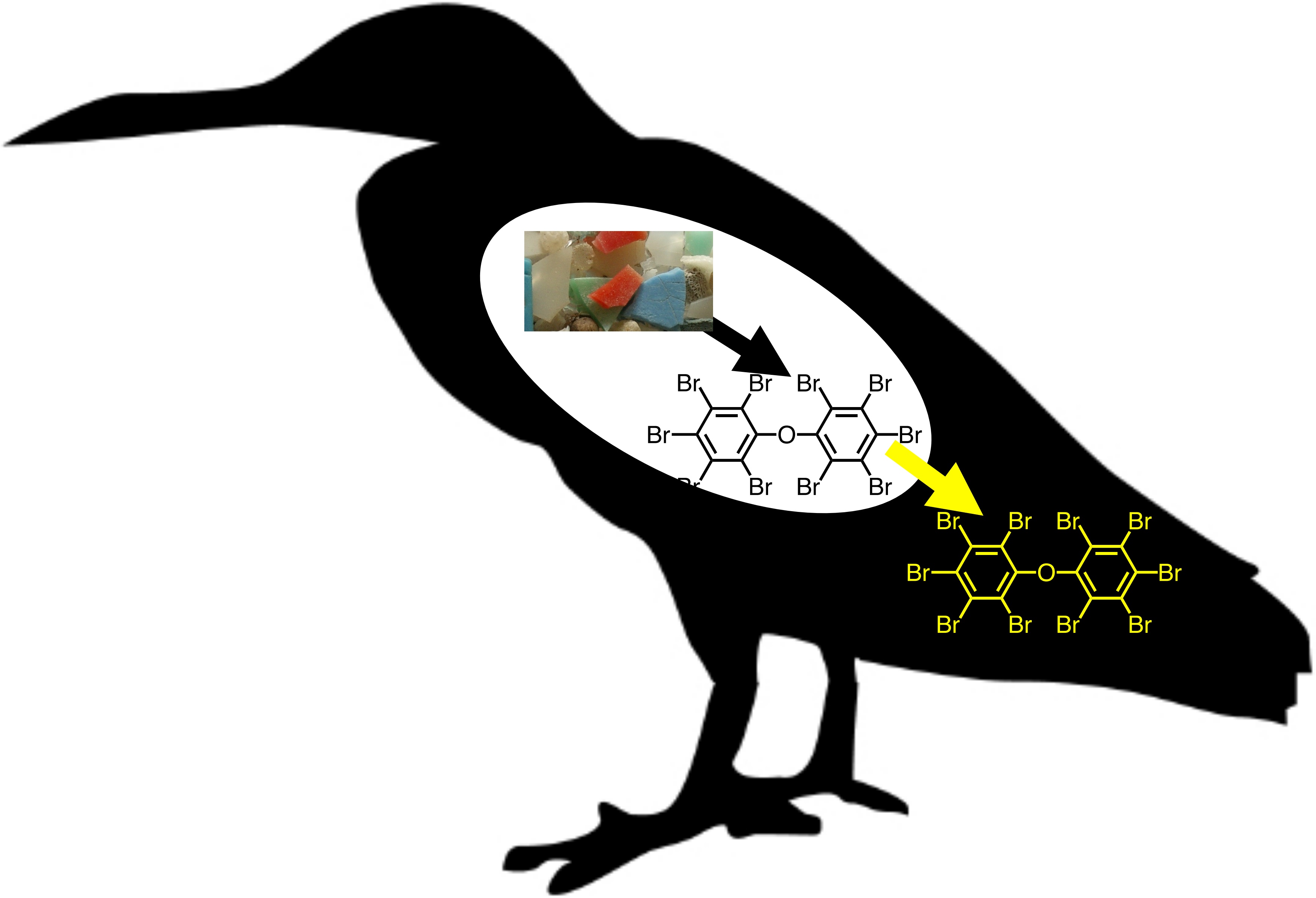




Lower brominated congeners were derived from natural prey, whereas higher brominated congeners were derived from ingested plastics.

# 北太平洋の渡り鳥にプラスチックを摂食し、その中の
# 有害化学物質が海鳥の脂肪に蓄積



# 1 mm以下の微細プラスチックが食物連鎖の低次の生物に化学物質を運び、かつ生物学的機能に影響を与えている

## Ingested plastic transfers hazardous chemicals to fish and induces hepatic stress

Chelsea M. Rochman[1], Eunha Hoh[2], Tomofumi Kurobe[1] & Swee J. Teh[1]

## Microplastic ingestion decreases energy reserves in marine worms

Stephanie L. Wright[1], Darren Rowe[1], Richard C. Thompson[2], and Tamara S. Galloway[1,*]

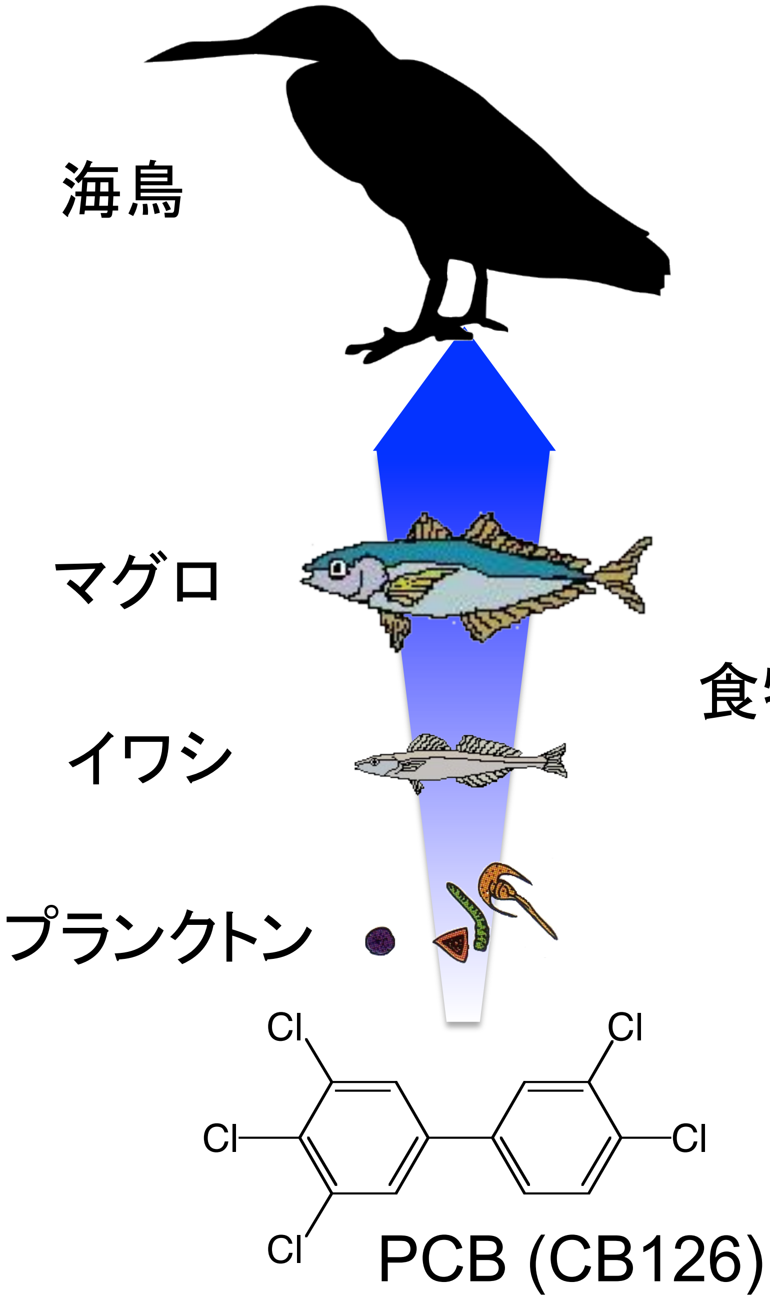
## Microplastic Moves Pollutants and Additives to Worms, Reducing Functions Linked to Health and Biodiversity

Mark Anthony Browne,[1,2,*] Stewart J. Niven,[1,3,4] Tamara S. Galloway,[5] Steve J. Rowland,[4] and Richard C. Thompson[1]
[1]School of Marine Science & Engineering, Plymouth University, Drake Circus, Plymouth PL4 8AA, UK
[2]National Center for Ecological Analysis & Synthesis, University of California, Santa Barbara, 735 State Street, Suite 300, Santa Barbara, CA 93101-3351, USA
[3]Waters Canada, Guelph, ON N1H 6H9, Canada
[4]School of Geography, Earth and Environmental Sciences, Plymouth University, Plymouth PL4 8AA, UK
[5]College of Life & Environmental Sciences, University of Exeter, Exeter EX4 4PS, UK

Animals from sedimentary ha
plastic can accumulate concer
times greater than those in se
more microplastic in habitats
downwind [4].

Surprisingly, the relative imp
tic versus sediments as vecto
of animals is poorly understo
lating the gut of lugworms ind
mulate from seawater to mi
greater transfer from micropla
ral organic carbon is scarce [9]
for fish predict that eating m
burdens of pollutants becaus

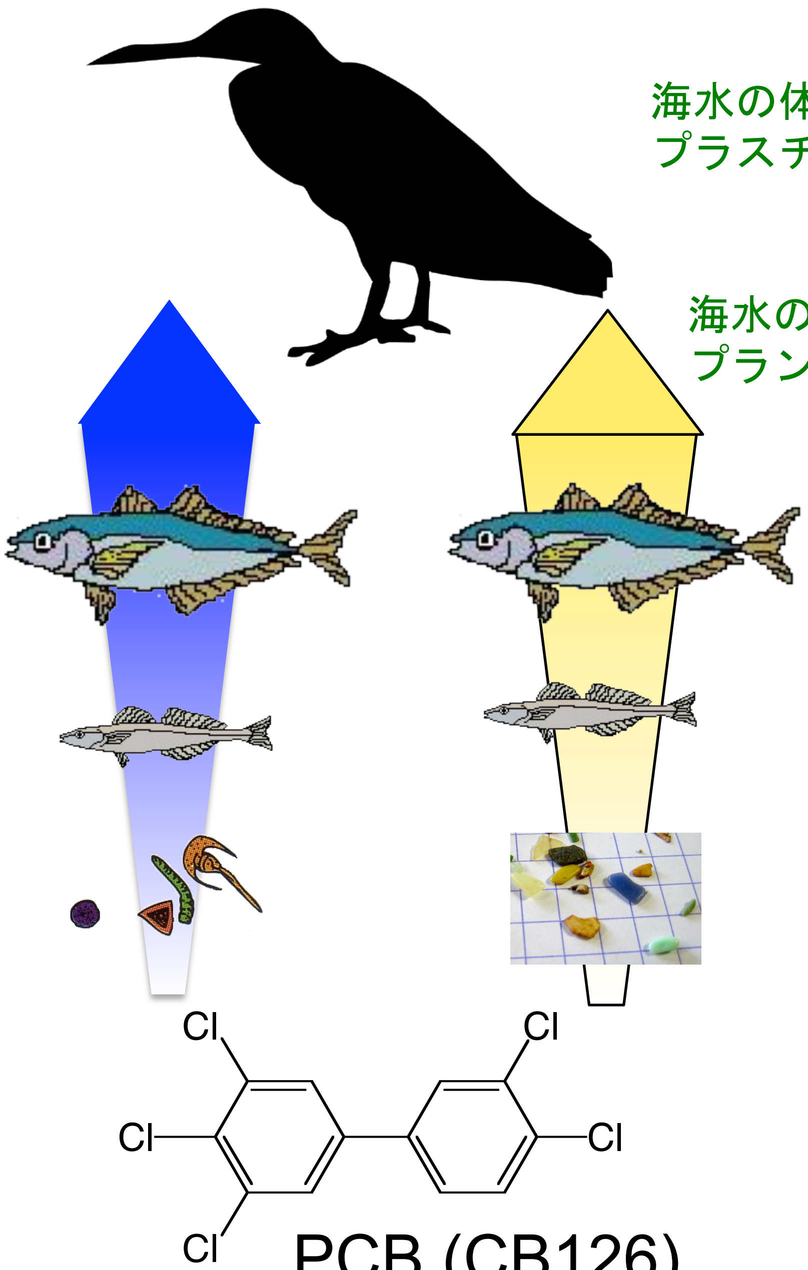
# 食物連鎖における汚染物質の濃度増幅




生態系の高次に位置する生物は
濃度増幅された汚染物質に
曝露されている

食物連鎖を通した濃度増幅

# 黄色信号　：プラスチック微細片による暴露量＞プランクトンによる暴露量



PCB (CB126)

海水の体積当たりの
プラスチック微細片量 ✖ プラスチック微細片中の
汚染物質濃度

V

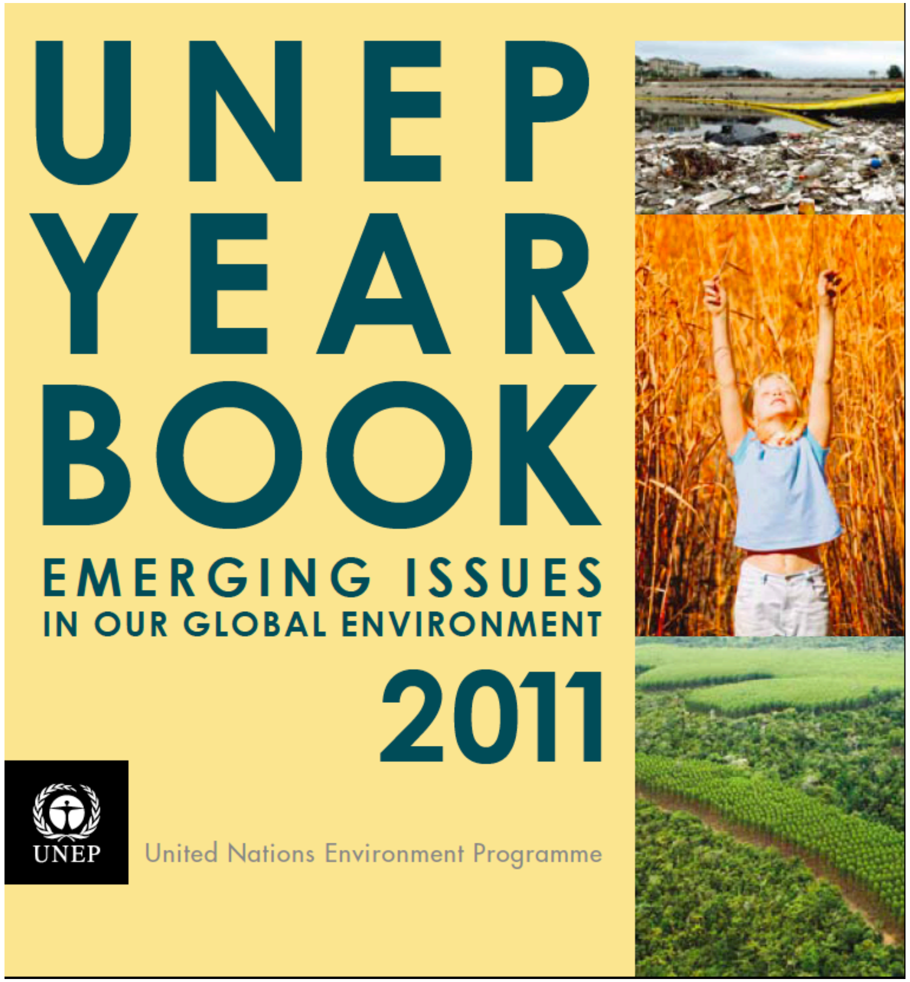
海水の体積当たりの
プランクトン量 ✖ プランクトン中の
汚染物質濃度

プラスチック量が多くなると、プラスチックへの濃縮量がプランクトンと同等になる。

**黄色信号**

# マイクロプラスチックの問題に国際機関も注目

国連環境計画の年鑑




## Plastic Debris in the Ocean

Every year large amounts of plastic debris enter the ocean, where it slowly fragments and accumulates in convergence zones. Scientists are concerned about the possible impacts of small plastic fragments—microplastics—in the environment. The role of plastics as a vector for transporting chemicals and species in the ocean is as yet poorly understood, but it is a potential threat to ecosystems and human health. Improved waste management is the key to preventing plastic and other types of litter from entering the ocean.

The ocean has become a global repository for much of the waste we generate. Marine debris includes timber, glass, metal and plastic from many different sources. Recently, the accumulation and possible impacts of microplastic particles in the ocean have been recognized as an emerging environmental issue. Some scientists are increasingly concerned about the potential impact of releases of persistent bio-accumulating and toxic compounds (PBTs) from plastic debris. At the same time, the fishing and tourism industries in many parts of the world are affected economically by plastic entering nets, fouling propellers and other equipment, and washing up on beaches. Despite international efforts to stem the flow of plastic debris, it continues to accumulate and impact the marine environment. To reduce the quantity of plastic entering the ocean, existing management instruments need to be made more effective and all aspects of waste treatment and disposal need to be improved.

Several common types of plastic are buoyant and have been transported by ocean currents to the remotest regions of the planet, including the Arctic and Antarctic (Barnes et al. 2010). Media attention has focused on reports of the relatively high incidence of plastic debris in areas of the ocean referred to as 'convergence zones' or 'ocean gyres'. This has given rise to the widespread use of terms like 'plastic soup', 'garbage patch' and 'ocean landfill'. Such terms are rather misleading in that much of the plastic debris in the ocean consists of fragments that are very small in size while the areas where they are floating are not, for example, distinguishable on satellite images. Nevertheless, publicity resulting from media reports and from the activities of several NGOs has helped to raise public and political awareness of the global scale of the plastic debris problem, together with the larger issue of marine litter.

**Microplastics** are generally considered to be plastic particles smaller than 5 millimetres in diameter (Arthur et al. 2009).

**Persistent, bio-accumulating and toxic substances (PBTs)** have a range of chronic health effects, including endocrine disruption, mutagenicity and carcinogenicity. A subset is regulated under the Stockholm Convention on Persistent Organic Pollutants (POPs).

### Assessing the extent of the problem

It is difficult to quantify the amounts and sources of plastic and other types of debris entering the ocean. Land-based sources include poorly managed landfills, riverine transport, untreated sewage and storm water discharges, industrial and manufacturing facilities with inadequate controls, wind-blown debris, recreational use of coastal areas, and tourist activities (Barnes et al. 2009). These sources are thought to dominate the overall supply of marine debris, but there are important regional variations. For example, shipping and fisheries are significant contributors in the East Asian Seas region and the southern North Sea (UNEP/COBSEA 2009, Galgani et al. 2010). In general, more litter is found closer to population centres, including a greater proportion of consumer plastic items such as bottles, shopping bags and personal hygiene products (Ocean Conservancy 2010).

The greatest technological development of modern plastics occurred during the first half of the 20th century. Their production and use have continued to expand rapidly up to the present day (**Figure 1**). In many sectors, they have become a popular material for packaging (**Box 1**). A major benefit of their use in the food industry is that it can extend shelf life, thus decreasing the risk of infection and reducing food waste.

Ship- and platform-based sources of plastic litter in the ocean include fishing and recreational vessels, cruise liners, merchant shipping, oil and gas platforms, and aquaculture facilities (**Figure 2**).

*Authors: Peter Kershaw (chair), Saido Katsuhiko, Sangjin Lee, Jon Samseth and Doug Woodring*
*Science writer: John Smith*

# 2010年以降、欧米の学会での特別セッションが多数開催され、UNEPやGESAMPなどの環境や海洋関係の国際機関もワークショップを開催

2010 Feb. American Geological Union (AGU) meeting

2010 May Society of Ecotoxicology and Chemistry (SETAC) Europe

2010 June GESAMP Workshop, Paris

2010 Sep. International Symposium in Matsuyama

2010 Nov. SETAC North America

2010 Nov. NOAA Tacoma workshop

2011 Mar. International Marine Debris Conference, Hawaii

2011 May SETAC Europe

2012 May SETAC Europe

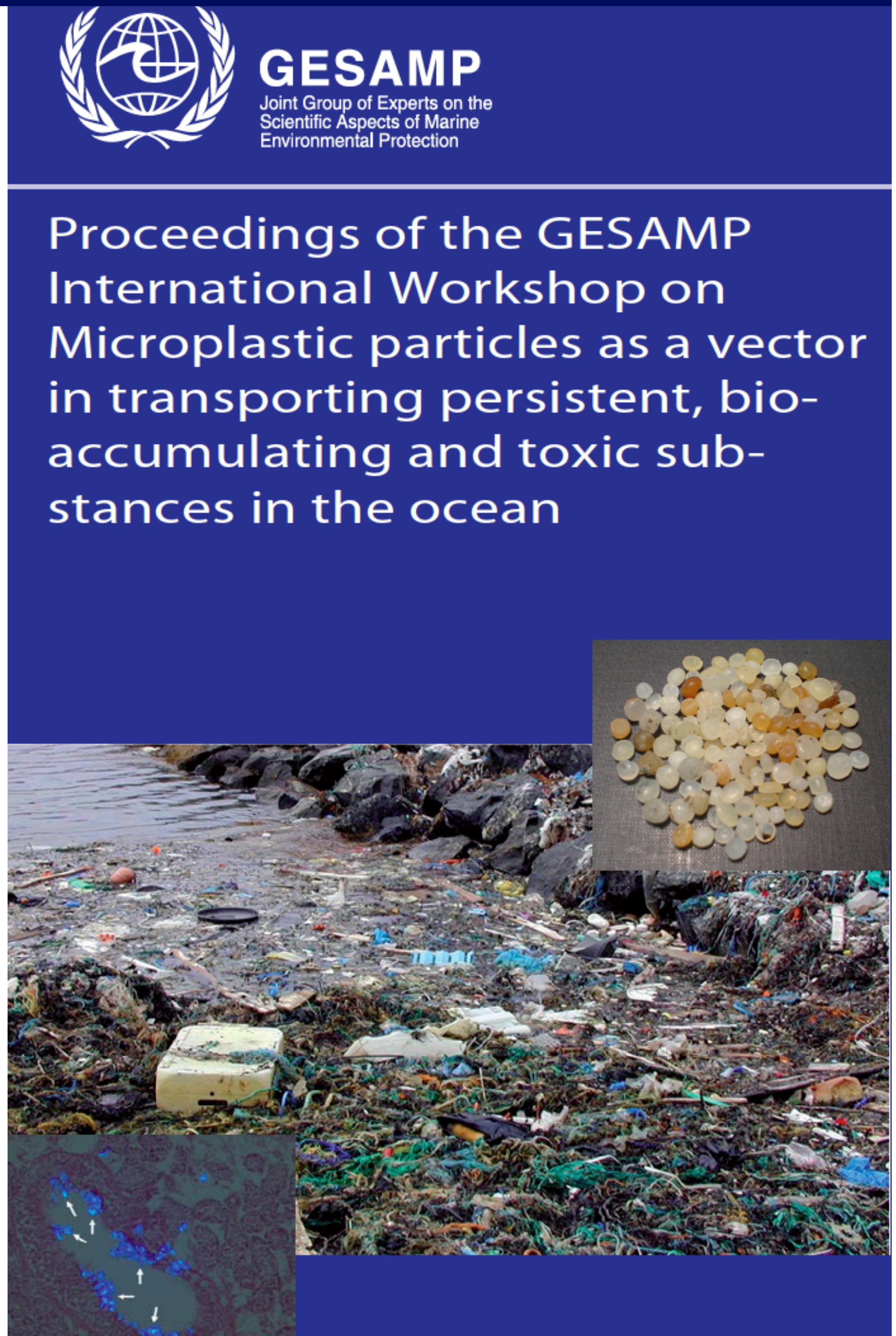
2013 June GESAMP Working group

# マイクロプラスチックの問題に国際機関も注目

GESAMP

海洋環境保護のための科学的知見を提供する専門家グループ

日本は？



# 海ゴミから海洋プラスチックへ視点の転換が必要
# プラスチックは有害化学物質の曝露源

・飲食に使えば、添加剤が直接私たちの身体に入ってくる。

・埋め立てれば、有害化学物質が溶け出し、
　地下水や河川を汚染する

・燃やせばダイオキシンが発生する

・海に入れば、微細片となり、化学物質を遠くまで運ぶ。

・プラスチックを誤って食べる生物に有害化学物質を運ぶ

# プラスチックによる汚染低減のために

・予防原則に基づく、科学者、行政のイニシアティブ

・プラスチック、
特に使い捨てのものの使用を極力避ける。

レジ袋、ペットボトル飲料、コンビニ弁当等

No single-use plastic!