Marine plastics : monitoring media of persistent organic pollutants (POPs) and carrier of POPs to marine organisms

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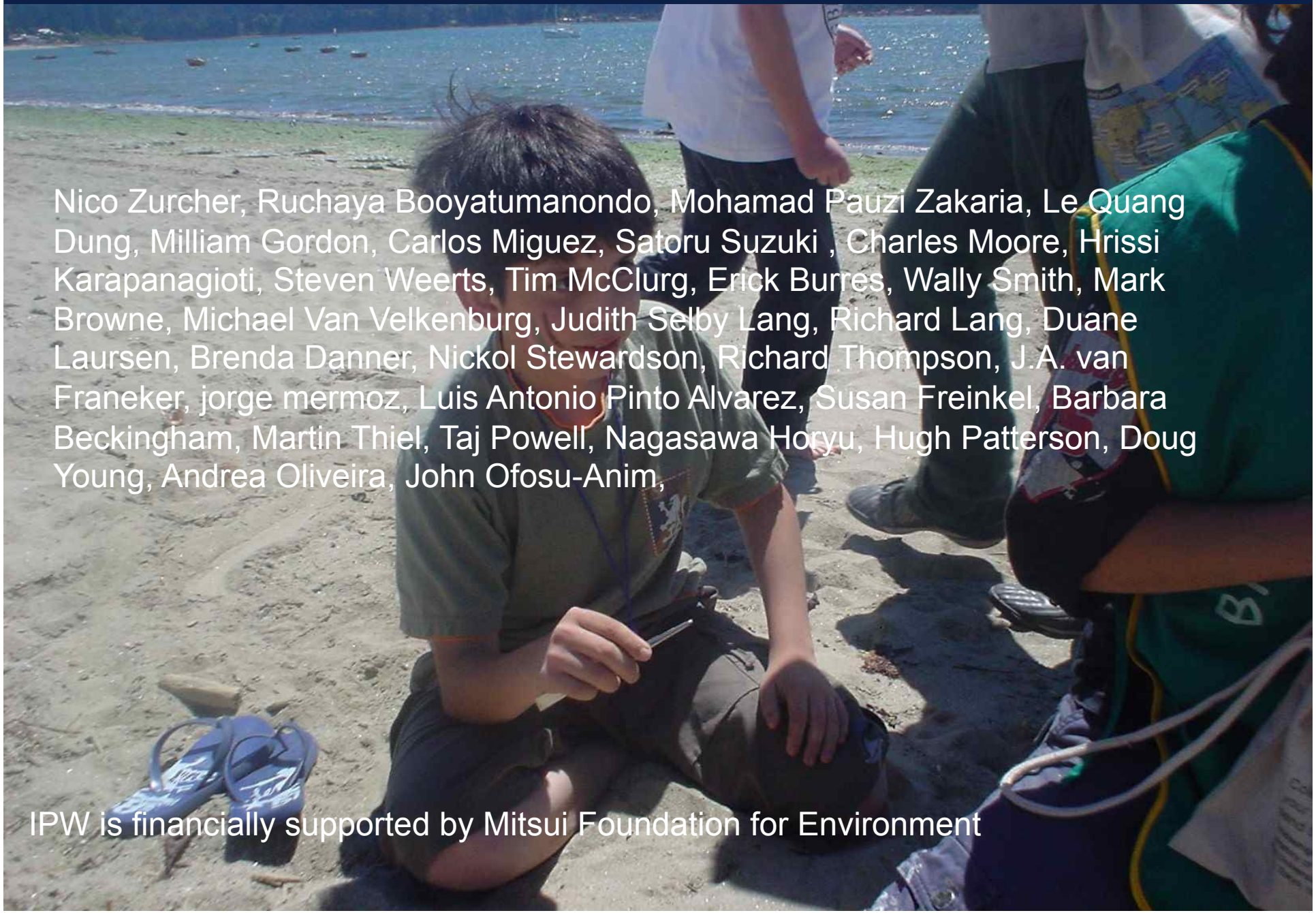
Hokkaido University

Acknowledgement



Nico Zurcher, Ruchaya Booyatumanondo, Mohamad Pauzi Zakaria, Le Quang Dung, Milliam Gordon, Carlos Miguez, Satoru Suzuki , Charles Moore, Hrissi Karapanagioti, Steven Weerts, Tim McClurg, Erick Burres, Wally Smith, Mark Browne, Michael Van Velkenburg, Judith Selby Lang, Richard Lang, Duane Laursen, Brenda Danner, Nickol Stewardson, Richard Thompson, J.A. van Franeker, jorge mermoz, Luis Antonio Pinto Alvarez, Susan Freinkel, Barbara Beckingham, Martin Thiel, Taj Powell, Nagasawa Horyu, Hugh Patterson, Doug Young, Andrea Oliveira, John Ofosu-Anim,

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Topics

- ✓Introduction of International Pellet Watch
- ✓Latest results of the International Pellet Watch.
- ✓Application of Pellet Watch to study temporal trend of PCB pollution .

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Trashes on high-tide line on our beaches

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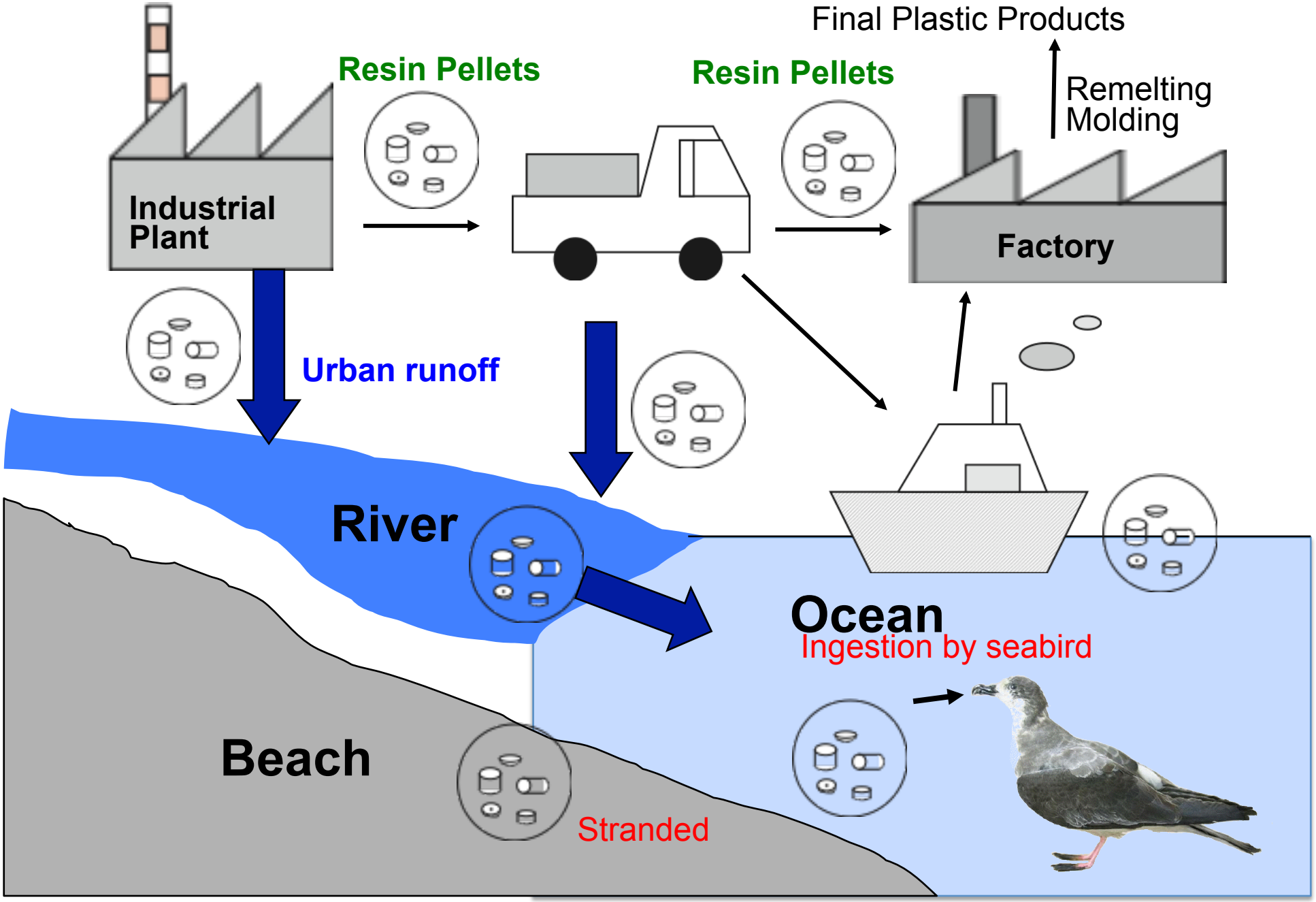
Plastic Resin Pellets

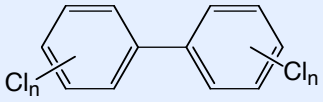
Resin pellets, industrial feedstock of user plastics, are spilled during transport and manufacturing and they are widely distributed in the ocean



Plastic resin pellets can be found all over the globe

Pellets accumulate persistent organic pollutants (POPs) from seawater

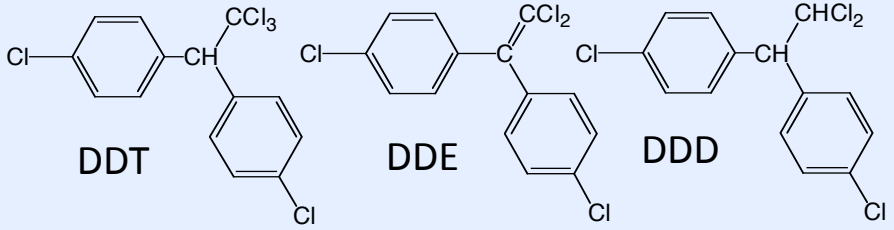
PCBs



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

adsorption from ambient seawater

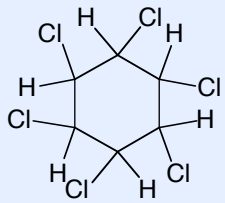
DDTs



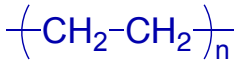
- DDT and its metabolites such as DDE and DDD.
- DDT was used as insecticides
- Endocrine disrupting chemicals

Pellet

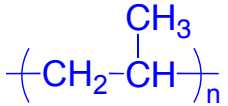
HCH



- Insecticide

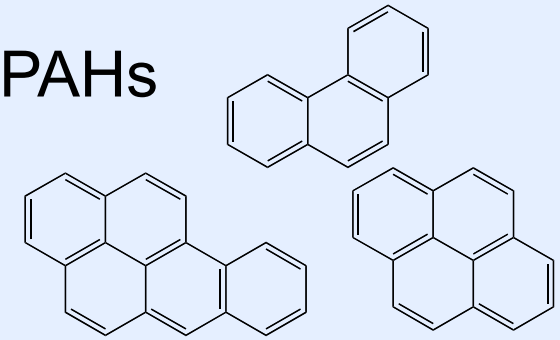


Polyethylene (PE)



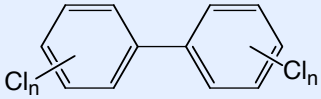
Polyprorylene (PP)

PAHs



Pellets accumulate POPs from seawater

PCBs



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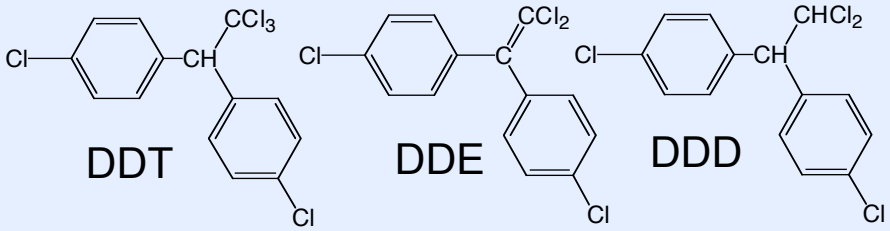
DDTs



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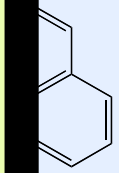
HCH



Concentration factor is estimated to be ~ 10^5 to ~10^6.

If we have 5 pieces (i.e. 1 g) of pellets, it corresponds to 10 L to 100 L of seawater.

International Pellet Watch

Global Monitoring of Persistent Organic Pollutants (POPs) Using Beached Plastic Resin Pellets

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MARINE POLLUTION BULLETIN
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Since 2005

Editorial

Call for pellets! International Pellet Watch Global Monitoring of POPs using beached plastic resin pellets

To monitor global distribution of POPs

To understand chemical risk of microplastics

waters, eventually leading to the ocean. Because of their environmental persistence, they are distributed widely in

Fig. 1. Plastic resin pellets.

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doi:10.1016/j.marpolbul.2006.10.010

ched plastic resin pellets.

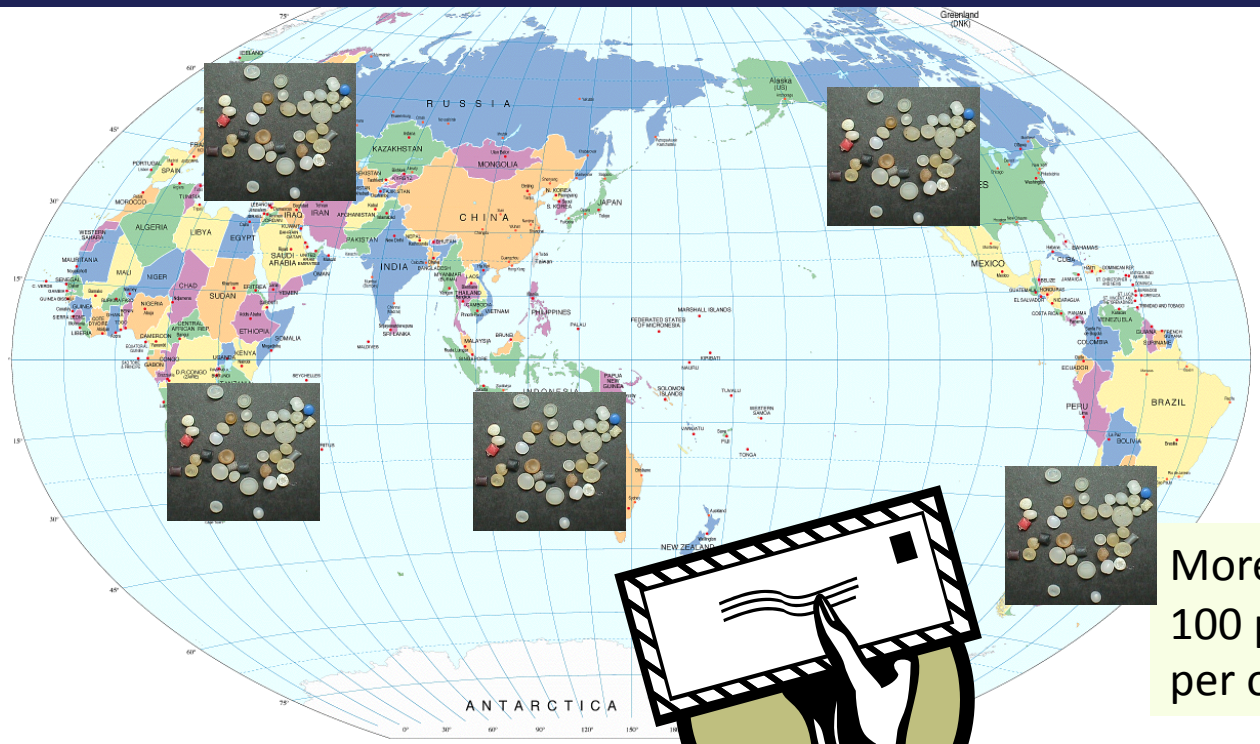
In the International Pellet Watch project, we ask people from all countries to collect plastic resin pellets on their nearby beaches and send them to our laboratory via air-mail. No cooling nor freezing is necessary during shipment. People just need to put the pellets into a paper envelope and post it to us. To get representative data, we need 100–200 pieces of pellets (preferably yellowed pellets) from each location. Organic micro-pollutants in the pellets will be analyzed in our laboratory. Based on the analytical results, global distributions of these organic micro-pollutants will be mapped. Results will be sent to the participants through e-mail and will be released on the web as well.

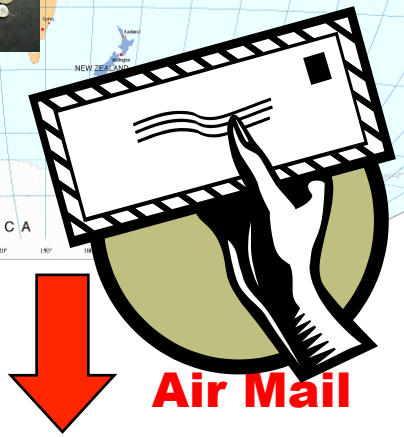
The purpose of International Pellet Watch is to understand the current status of global POPs pollution, and the advantage of Pellet Watch is its extremely low cost of sampling and shipping as compared with conventional monitoring using water, sediment and biological samples. Further, we can draw global POPs pollution maps for a very low cost. Already several NGOs who conduct beach clean-up projects are helping with sample collection.

So far, our spatial coverage is very limited and of course the strength of the programme will be related to the coverage

International Pellet Watch

Global Monitoring of Persistent Organic Pollutants (POPs) Using Beached Plastic Resin Pellets

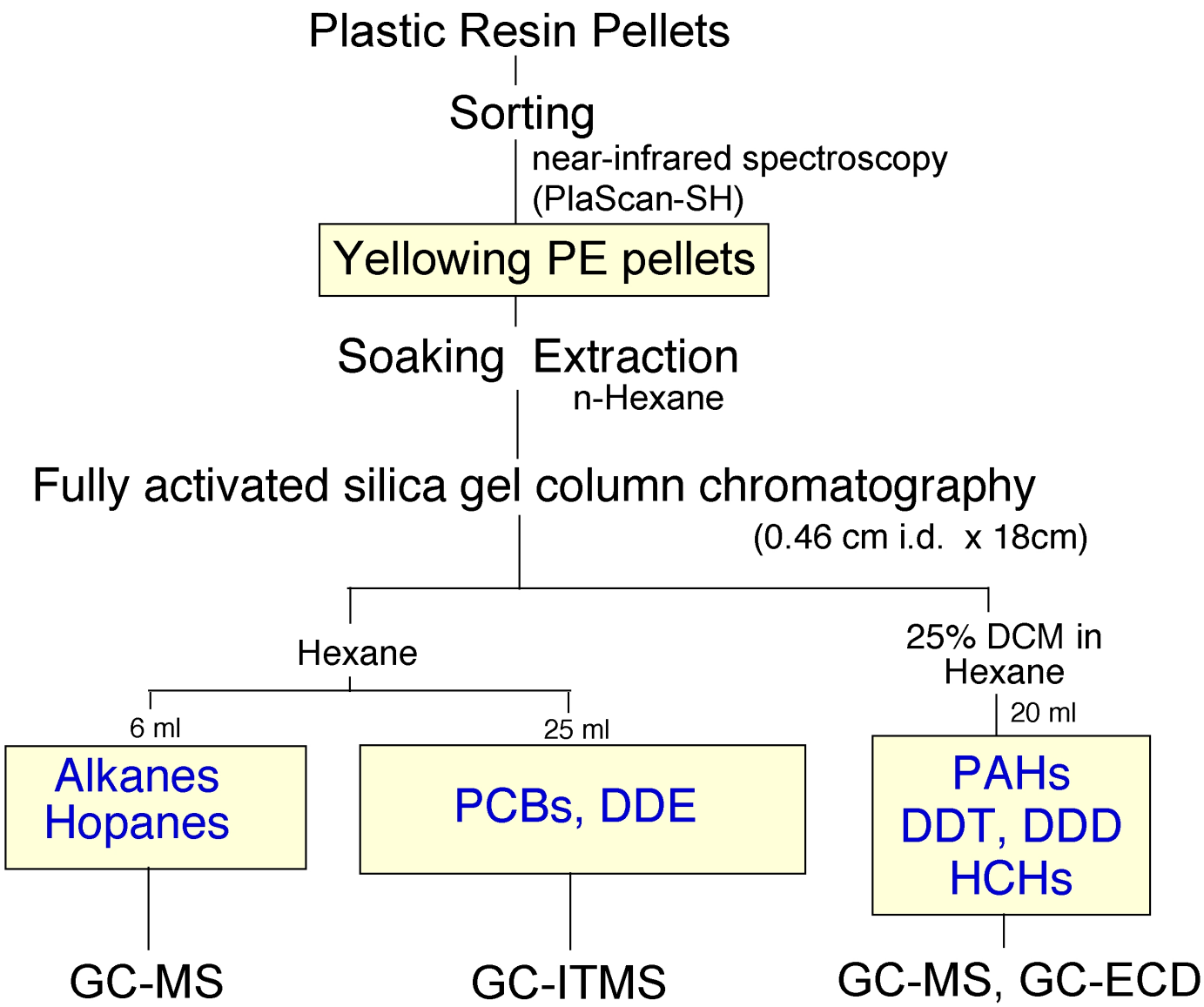




More than 50 pieces (~ 100 pieces)
per one location

Laboratory of Organic Geochemistry, Dr. Hideshige Takada,
Tokyo University of Agriculture and Technology,
Fuchu, Tokyo 183-8509, Japan

Analytical Procedure of POPs in Pellets



Samurai Mass-spec. (double-swords)

Scientific collaboration with

Thermo
ELECTRON CORPORATION

Polaris Q GC-MS/MS

Laboratory of Organic Geochemistry
Dr. Hideshige Takada,
Tokyo University of Agriculture and Technology,
Fuchu, Tokyo 183-8509, Japan

More than 50 pieces (~100 pieces) per one location

Sorting

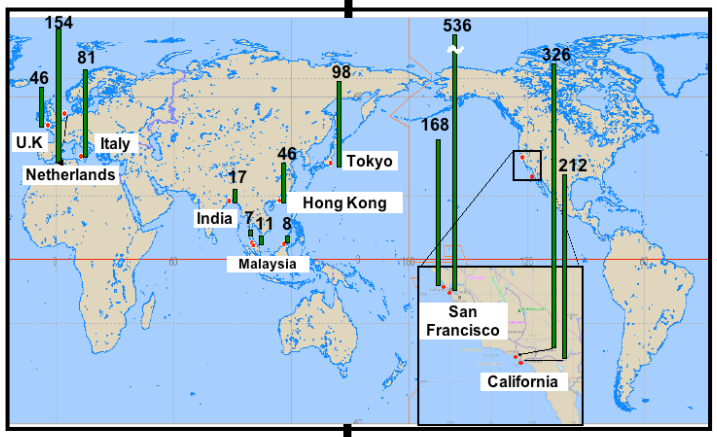
PE, yellowing pellets

Analysis for POPs (PCBs, organochlorines, PAHs)

By GC-MS/MS, GC-MS, GC-ECD

more than 5 pools of 5 pellets
to exclude sporadic high concentration

Mapping POPs pollution



- **Sending the data** via Internet to the collaborators
- **Releasing** the results on **web**

Advantage of International Pellet Watch

Extremely low cost for sampling and shipping

No special training is necessary for sampling

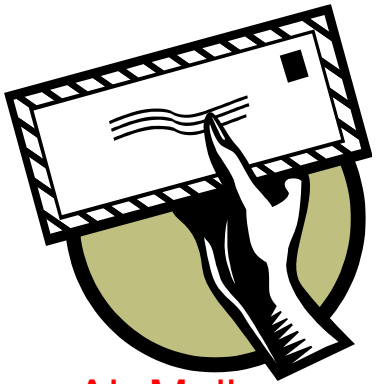
↓

World citizens can join

↓

Wide area (globe) can be monitored using minimal cost

3,000 USD



Air Mail

~1 USD

Importance of sustainable Global monitoring of POPs

Stockholm Convention (UNEP : United Nation Environment Program)

Media for Global Monitoring

Water
Sediment
Biological samples (e.g., mussel)

Monitoring with low cost

~200 locations from 40 countries

Topics

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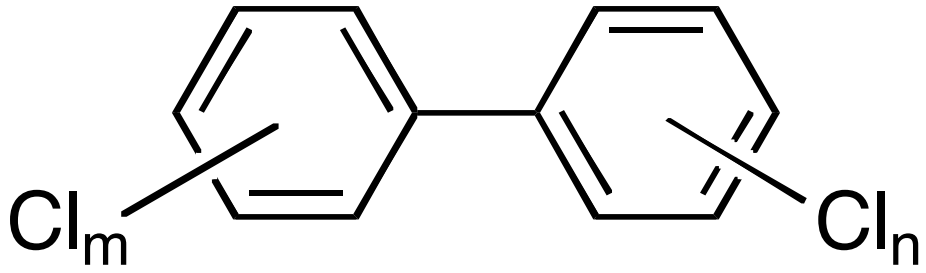
✓Latest results of the International Pellet Watch.

✓Application of Pellet Watch to study temporal trend of PCB pollution.

Polychlorinated biphenyls (PCBs)



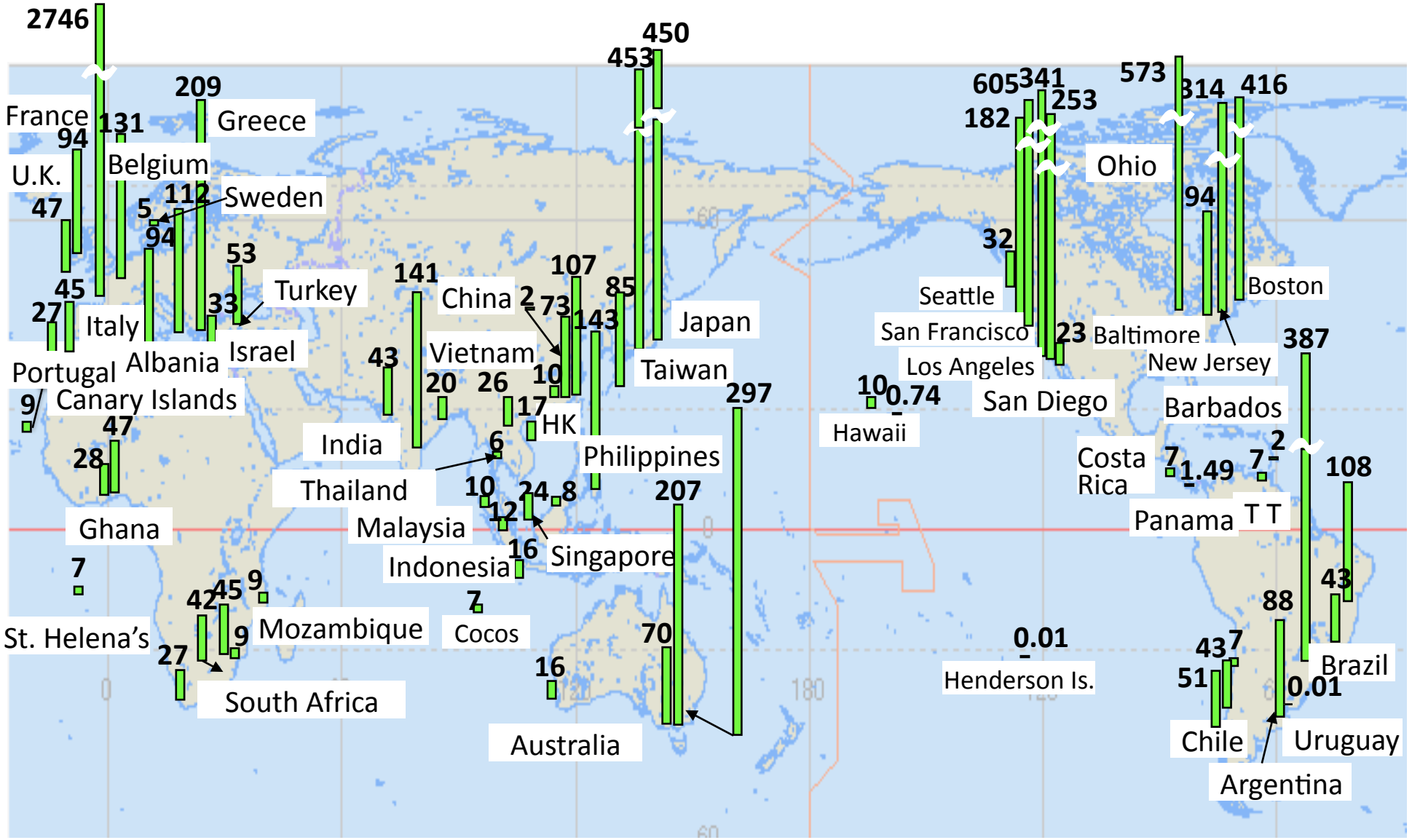
m + n = 1 - 10

Commercial PCBs mixtures were used in a wide variety of applications, including

Dielectric fluids in capacitors and transformers
Heat transfer fluid
Copying paper
Carbonless copy paper
Adhesives
Sealant

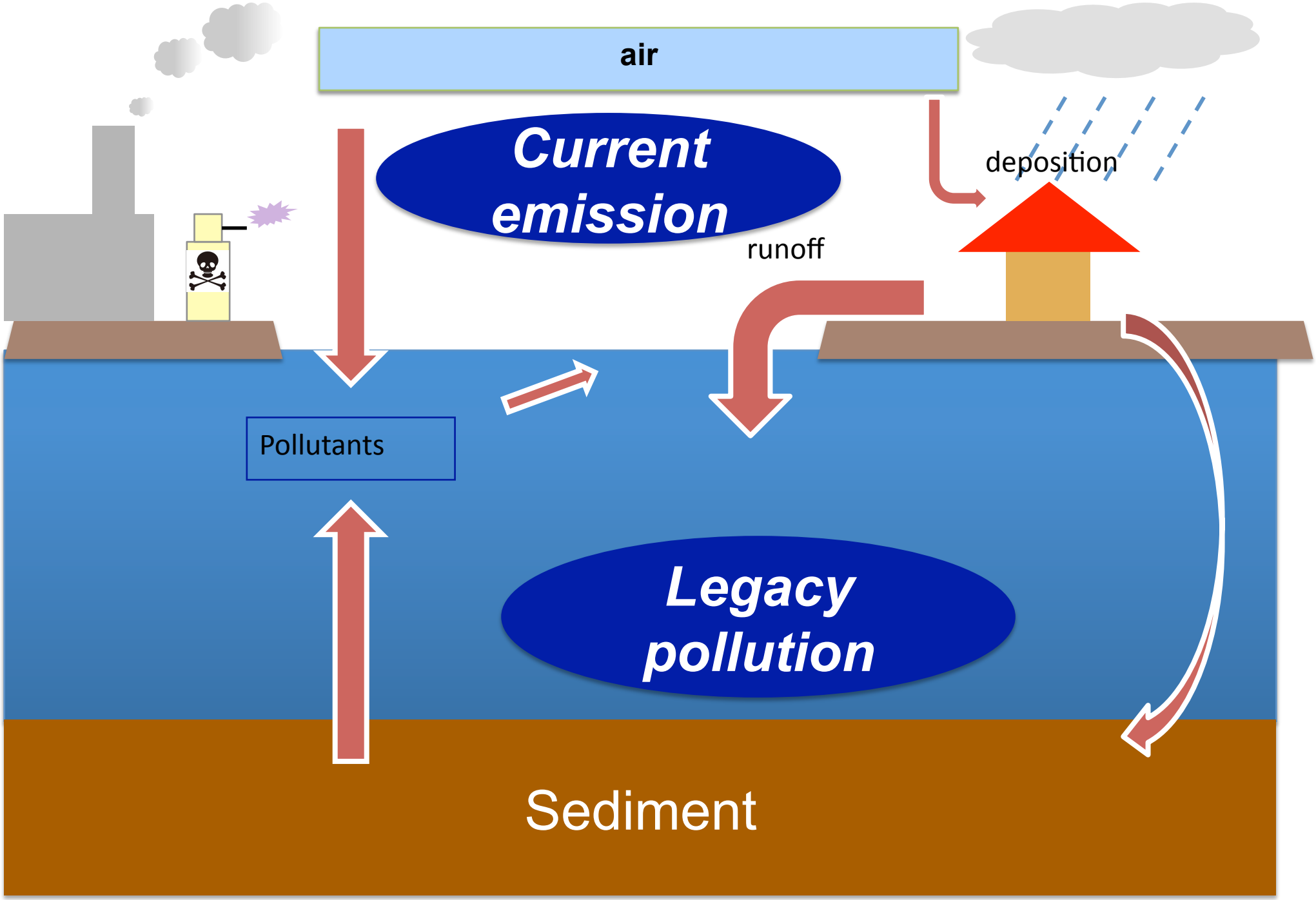
PCBs were used from 1950s to early 1970s in industrialized countries.

Their usage was banned in 1970s

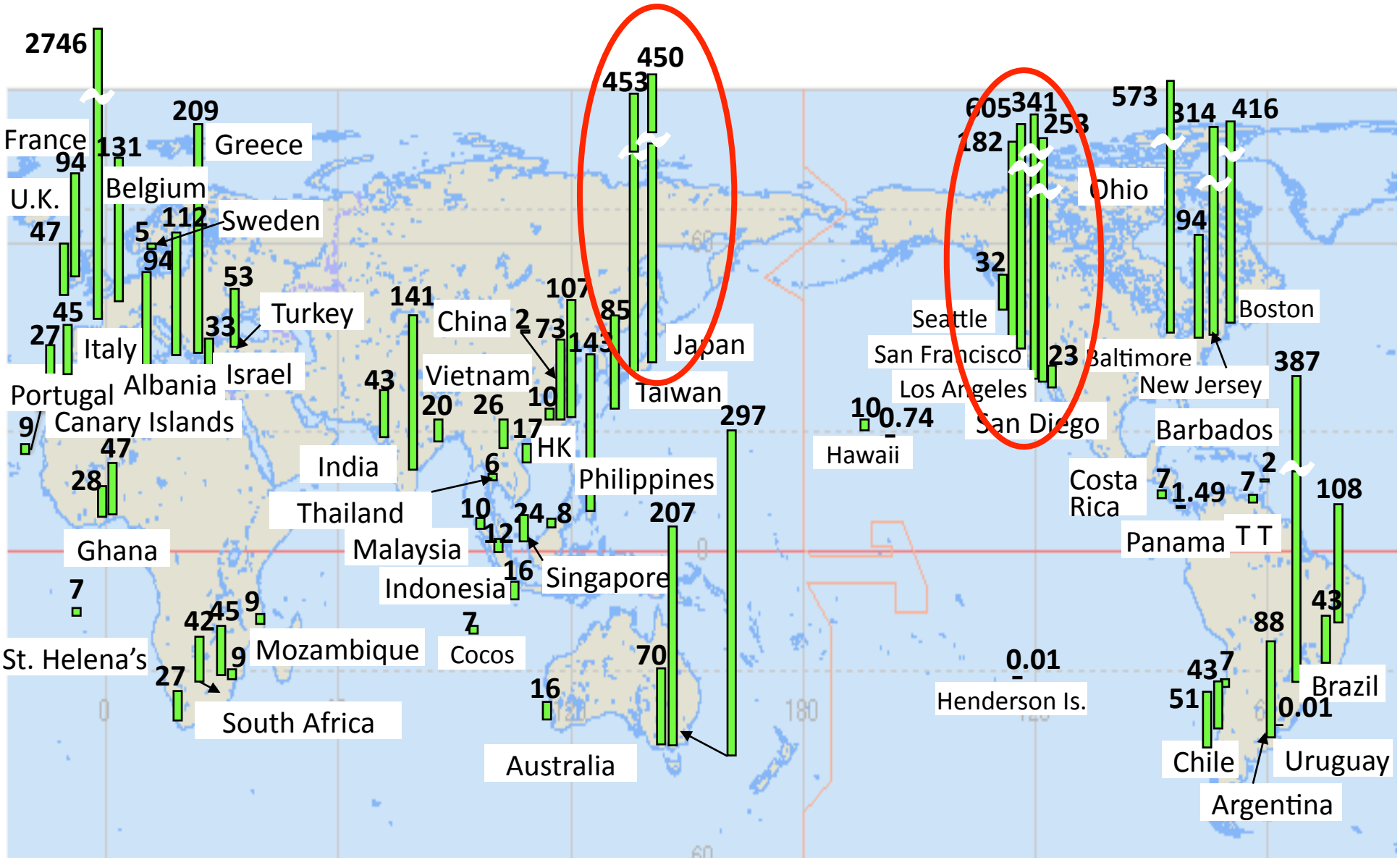


Concentration of PCBs* in beached plastic resin pellet (ng/g-pellet)

*sum of concentrations of CB#66, 101, 110, 149, 118, 105, 153, 138, 128, 187, 180, 170, 206


air
Current emission
deposition
runoff
Pollutants
Legacy pollution
Sediment

Concentration of PCBs* in beached plastic resin pellet (ng/g-pellet)



*sum of concentrations of CB#66, 101, 110, 149, 118, 105, 153, 138, 128, 187, 180, 170, 206

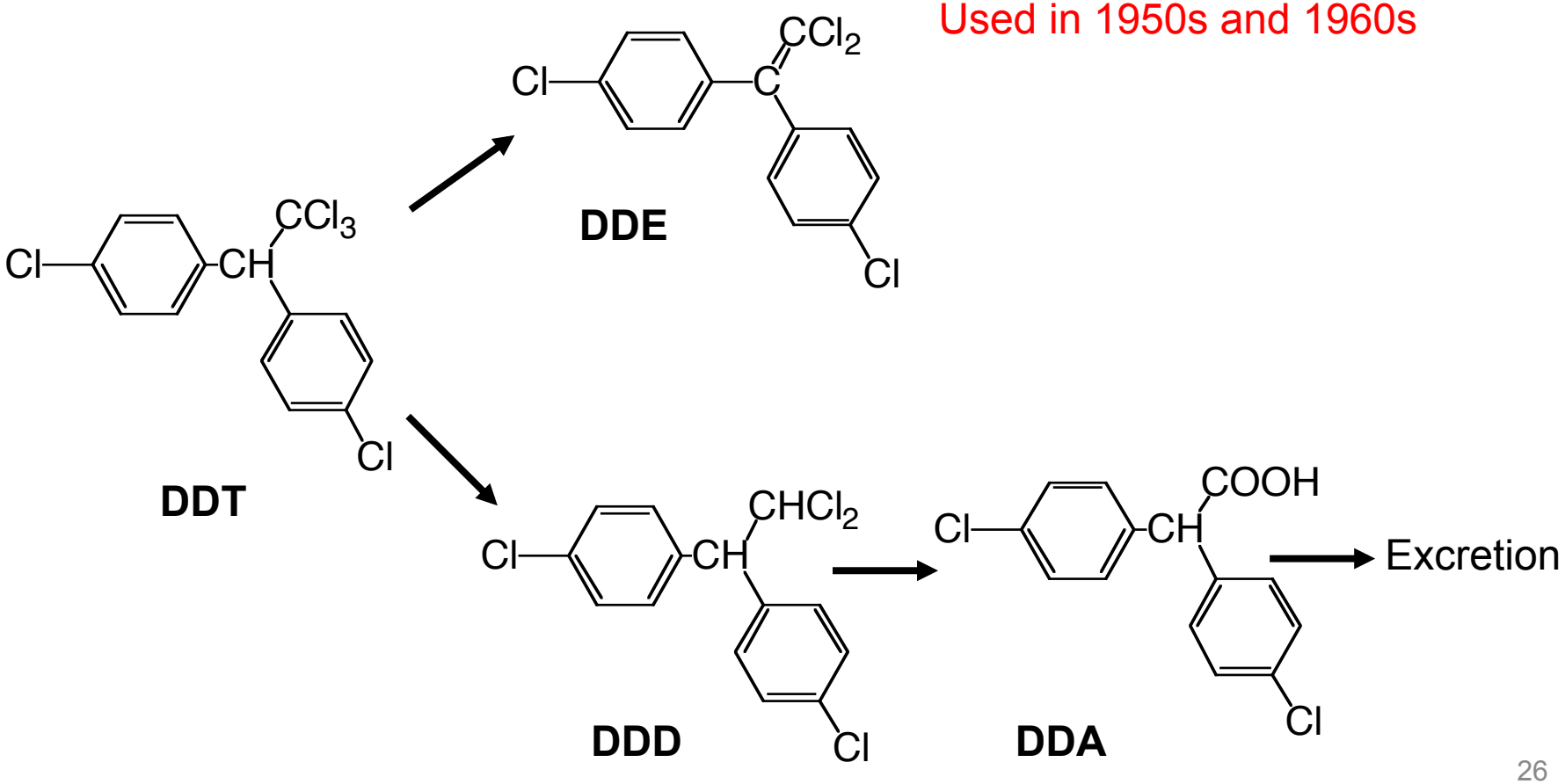
DDT and its degradation products

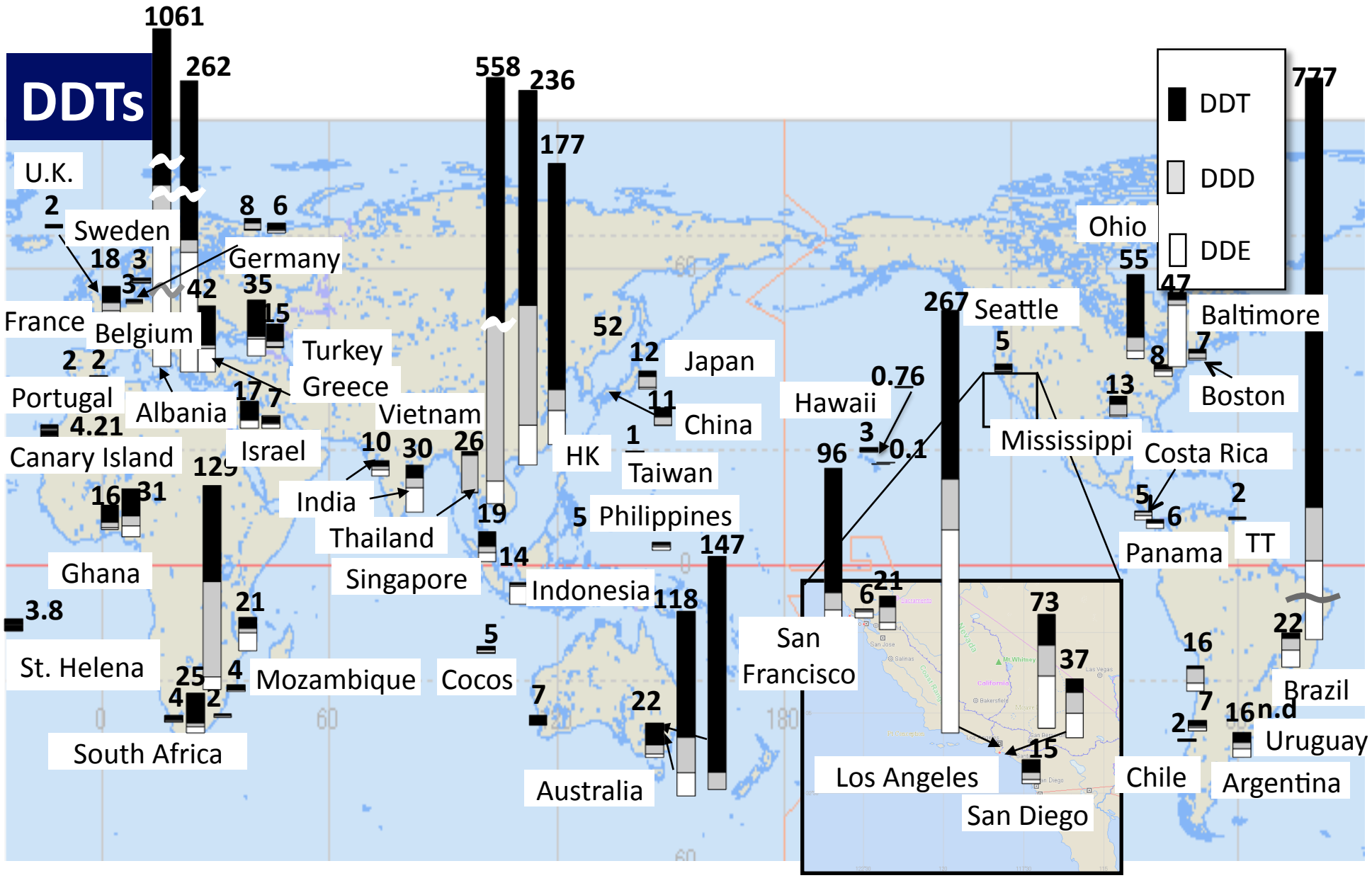
DDT (**D**ichloro-**d**iphenyl-**t**richloroethane)

DDE (**D**ichloro-**d**iphenyl-dichloro**e**thylene)
DDD (**D**ichloro-**d**iphenyl-**d**ichloroethane)
DDA (**D**icloro-**d**iphenyl-**a**cetic acid)

Insecticide

Used in 1950s and 1960s





Concentration of DDTs in beached plastic resin pellet (ng/g-pellet)

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International Pellet Watch

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Since 2005

Editorial

Call for pellets! International Pellet Watch Global Monitoring of POPs using beached plastic resin pellets

On our beaches, we see various quantities of many materials (e.g., seaweed, driftwood, trash, plastic fragments, cigarette ends) along the high-tide line. Among them, we can commonly find plastic resin pellets. Recently we have started a global monitoring programme of persistent organic pollutants (POPs) using these stranded plastic resin pellets (International Pellet Watch: http://www.tuat.ac.jp/~gaia/ipw/index.html).

Plastic resin pellets are small granules, generally with shape of a cylinder or a disk with a diameter of a few mm (Fig. 1). These plastic particles are the industrial raw material of plastics which are transported to manufacturing sites where "user plastics" are made by re-melting the pellets and molding them into the final products. Resin pellets can be unintentionally released to the environment, both during manufacturing and transport. The released resin pellets are carried by surface run-off, streams and river waters, eventually leading to the ocean. Because of their environmental persistence, they are distributed widely in the ocean and are now found on beaches all over the world. In 2001, we revealed the existence of various organic micropollutants (i.e., polychlorinated biphenyls: PCBs, DDE, and nonylphenol) in these stranded plastic resin pellets collected on beaches (Mato et al., 2001).

Fig. 1. Plastic resin pellets.

Because of the hydrophobic nature of the plastic surfaces, hydrophobic pollutants such as PCBs and DDTs are adsorbed to the pellets from the surrounding seawater with concentration factors of up to 10^6. We observed a weak correlation between PCBs concentrations in plastic resin pellets collected on beaches with levels in traditional monitoring media (i.e., mussels), although large piece-to-piece variability of PCB concentrations was also observed (Endo et al., 2005). Because the resin pellets are distributed on beaches the world over, and because collection and shipping of the pellets are easy, we propose global monitoring of persistent organic pollutants (POPs) using these beached plastic resin pellets.

In the International Pellet Watch project, we ask people from all countries to collect plastic resin pellets on their nearby beaches and send them to our laboratory via airmail. No cooling nor freezing is necessary during shipment. People just need to put the pellets into a paper envelope and post it to us. To get representative data, we need 100–200 pieces of pellets (preferably yellowed pellets) from each location. Organic micro-pollutants in the pellets will be analyzed in our laboratory. Based on the analytical results, global distributions of these organic micro-pollutants will be mapped. Results will be sent to the participants through e-mail and will be released on the web as well.

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Conclusions

International Pellet Watch (IPW) is useful tool to understand spatial pattern of pollution by POPs.

Tokyo Bay, US west coasts, Hong Kong, Vietnam, Sydney coasts were indentified as hot spots of POPs

IPW is useful also to understand temporal trends in POPs.

Substantial decreasing trend (40 % - 80%) was observed for PCBs in Los Angeles coast during last 5 years.

No decrease was detected for PCBs in Tokyo Bay during last decade

Call for pellets

Our areal coverage is still limited.

We call pellets from north pacific area
e.g., China, Koreas, Russia, Canada