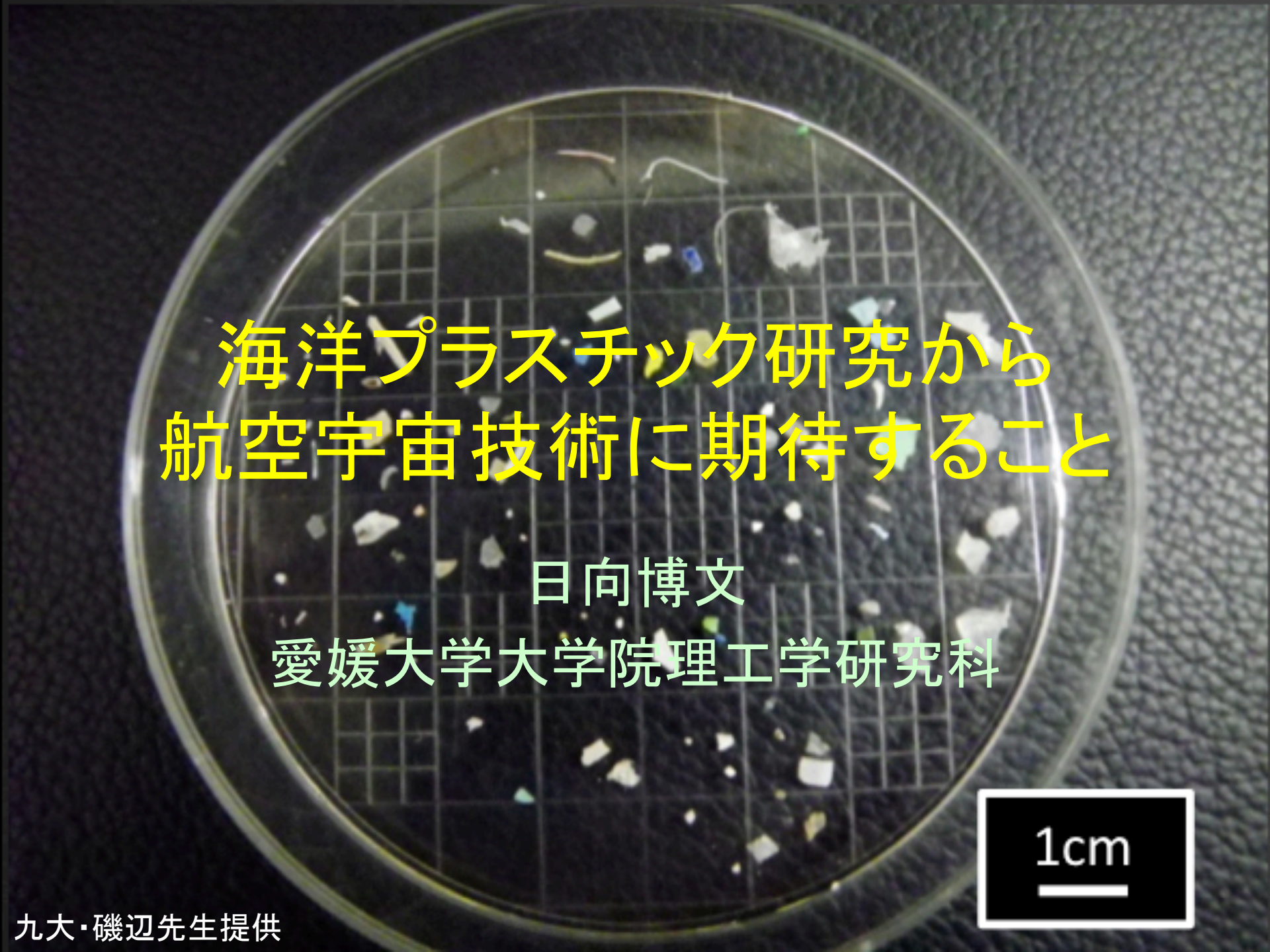
海洋プラスチック研究から
航空宇宙技術に期待すること
日向博文
愛媛大学大学院理工学研究科
1cm
九大・磯辺先生提供

謝　辞

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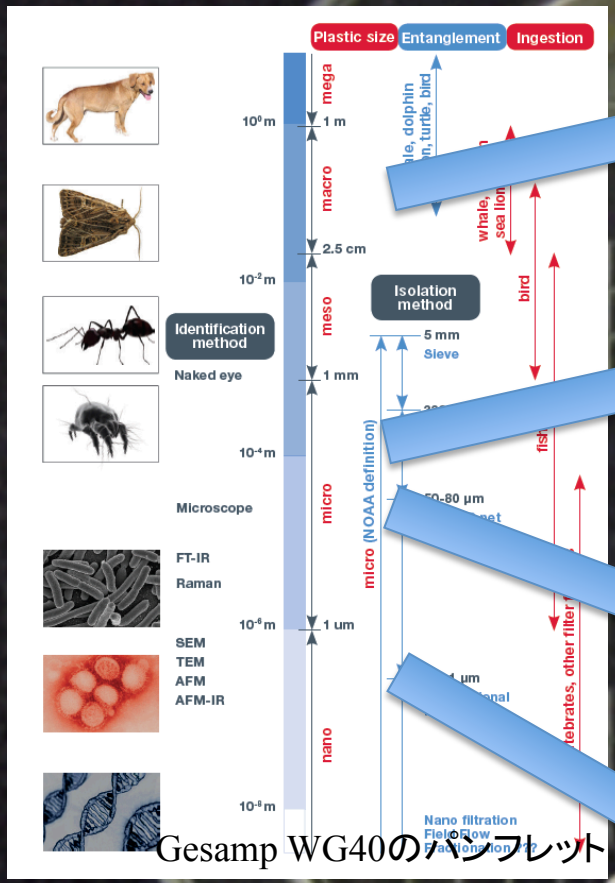
主な参考文献

* Kako, Shin'ichiro, Atsuhiko Isobe, and Shinya Magome. "Sequential monitoring of beach litter using webcams." *Marine pollution bulletin* 60.5 (2010): 775-779.
* Nakashima, Etsuko, et al. "Using aerial photography and in situ measurements to estimate the quantity of macro-litter on beaches." *Marine pollution bulletin* 62.4 (2011): 762-769.
* Kako, Shin'ichiro, et al. "Establishment of numerical beach-litter hindcast/forecast models: An application to Goto Islands, Japan." *Marine pollution bulletin* 62.2 (2011): 293-302.
* Kataoka, Tomoya, Hirofumi Hinata, and Shin'ichiro Kako. "A new technique for detecting colored macro plastic debris on beaches using webcam images and CIELUV." *Marine pollution bulletin* 64.9 (2012): 1829-1836.
* Kako, Shin'ichiro, Atsuhiko Isobe, and Shinya Magome. "Low altitude remote-sensing method to monitor marine and beach litter of various colors using a balloon equipped with a digital camera." *Marine pollution bulletin* 64.6 (2012): 1156-1162.
* Kataoka, Tomoya, Hirofumi Hinata, and Shigeru Kato. "Analysis of a beach as a time-invariant linear input/output system of marine litter." *Marine pollution bulletin* 77.1 (2013): 266-273.
* Kataoka, T., H. Hinata, and Y. Nihei. "Numerical estimation of inflow flux of floating natural macro-debris into Tokyo Bay." *Estuarine, Coastal and Shelf Science* 134 (2013): 69-79.
* Kako, Shin'ichiro, et al. "A decadal prediction of the quantity of plastic marine debris littered on beaches of the East Asian marginal seas." *Marine pollution bulletin* 81.1 (2014): 174-184.
* Isobe, Atsuhiko, et al. "Selective transport of microplastics and mesoplastics by drifting in coastal waters." *Marine pollution bulletin* 89.1 (2014): 324-330.
* Kataoka, Tomoya, and Hirofumi Hinata. "Evaluation of beach cleanup effects using linear system analysis." *Marine pollution bulletin* 91.1 (2015): 73-81.

マイクロプラスチックスとは？



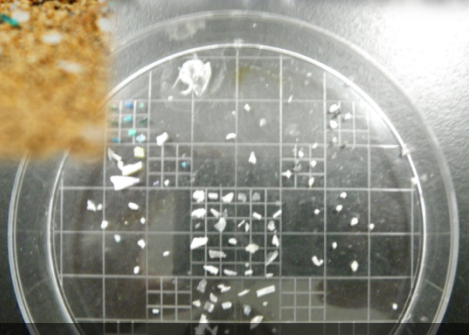
Gesamp WG40のパンフレット

漂流・漂着ゴミの約70%を占めるプラスチックゴミが，主には海岸で紫外線や熱によって劣化し、微細片化したもの。最近の定義では、5mm以下の大きさをマイクロプラスチックスと呼ぶことが多い。

九大・磯辺先生提供

～マクロプラスチックス
元の製品が判別できる程度の大きさ(撮影：石垣島・平野海岸)

～メソプラスチックス
5mm＜大きさ程度の微細片
(撮影：石垣島・伊野田海岸)



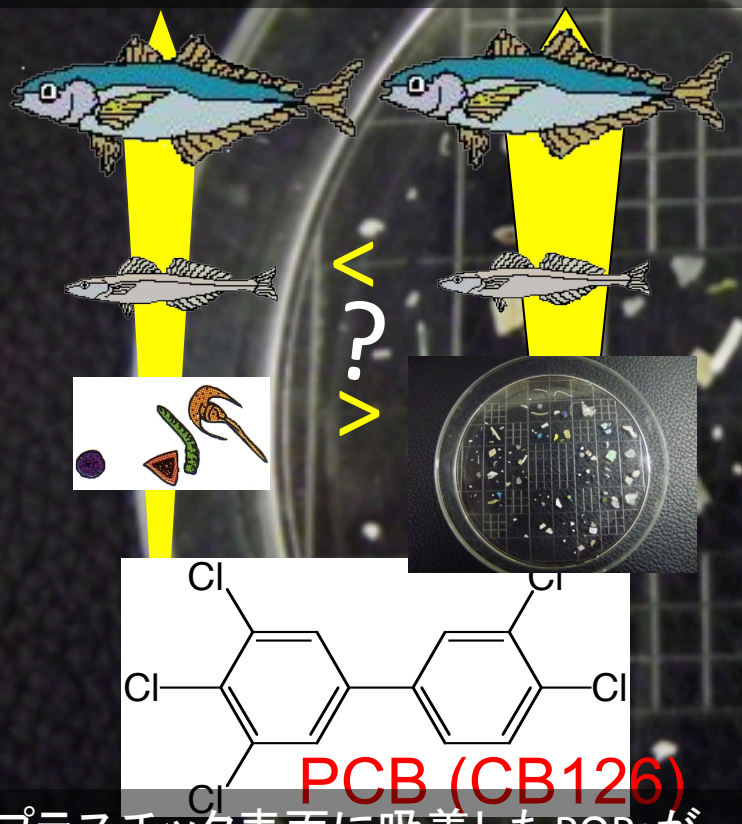
～マイクロプラスチックス
数μm＜大きさ＜5mm程度の微細片(採取：瀬戸内海・伊予灘)

～ナノプラスチックス
大きさ＜数μm程度の微細片
(Cole et al., *Env. Sci & Tech.*, in press)

マイクロプラスチックスの何が問題か？

九大・磯辺先生提供

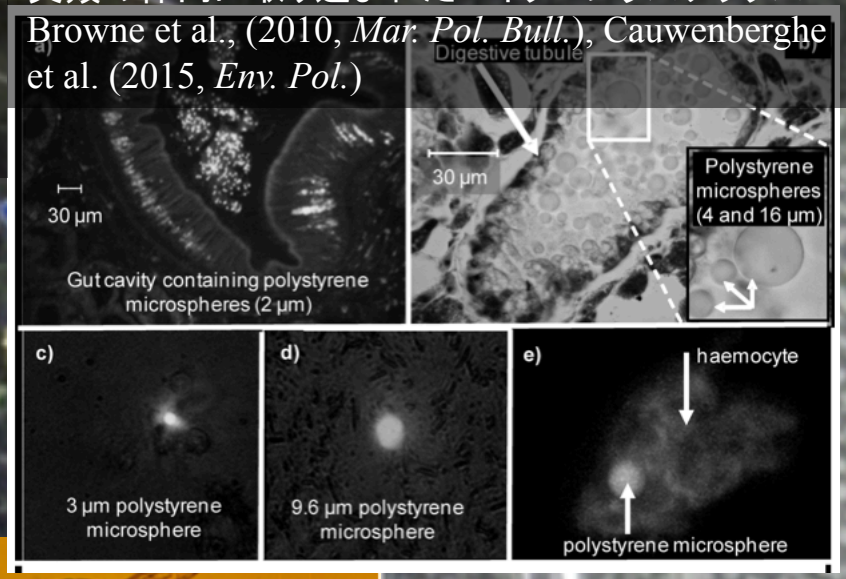
プランクトンと大きさが近接するマイクロプラスチックスは、誤食を通して容易に生態系に混入してしまう。



PCB (CB126)

プラスチック表面に吸着したPOPsが、浮遊物に吸着したものよりも多い場合、化学汚染物質の生物濃縮を「加速」させてしまう。(高田ほか, 2014「海洋と生物」特集号の指摘による)

貝類の体内に取り込まれたマイクロプラスチックス
Browne et al., (2010, *Mar. Pol. Bull.*), Cauwenberghe et al. (2015, *Env. Pol.*)



動物プランクトン(pelagic copepod)の体内への取り込みと摂食障害　Cole et al., (*Env. Sci. Tech, in press.*)

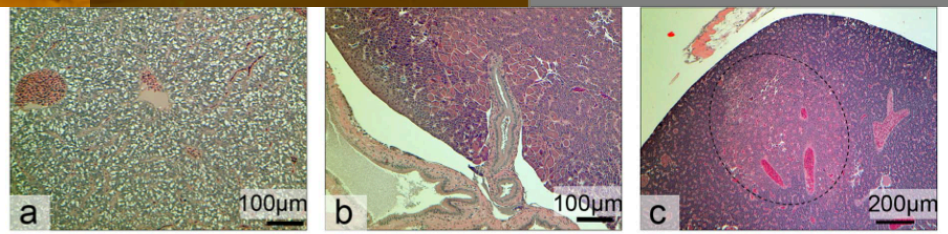
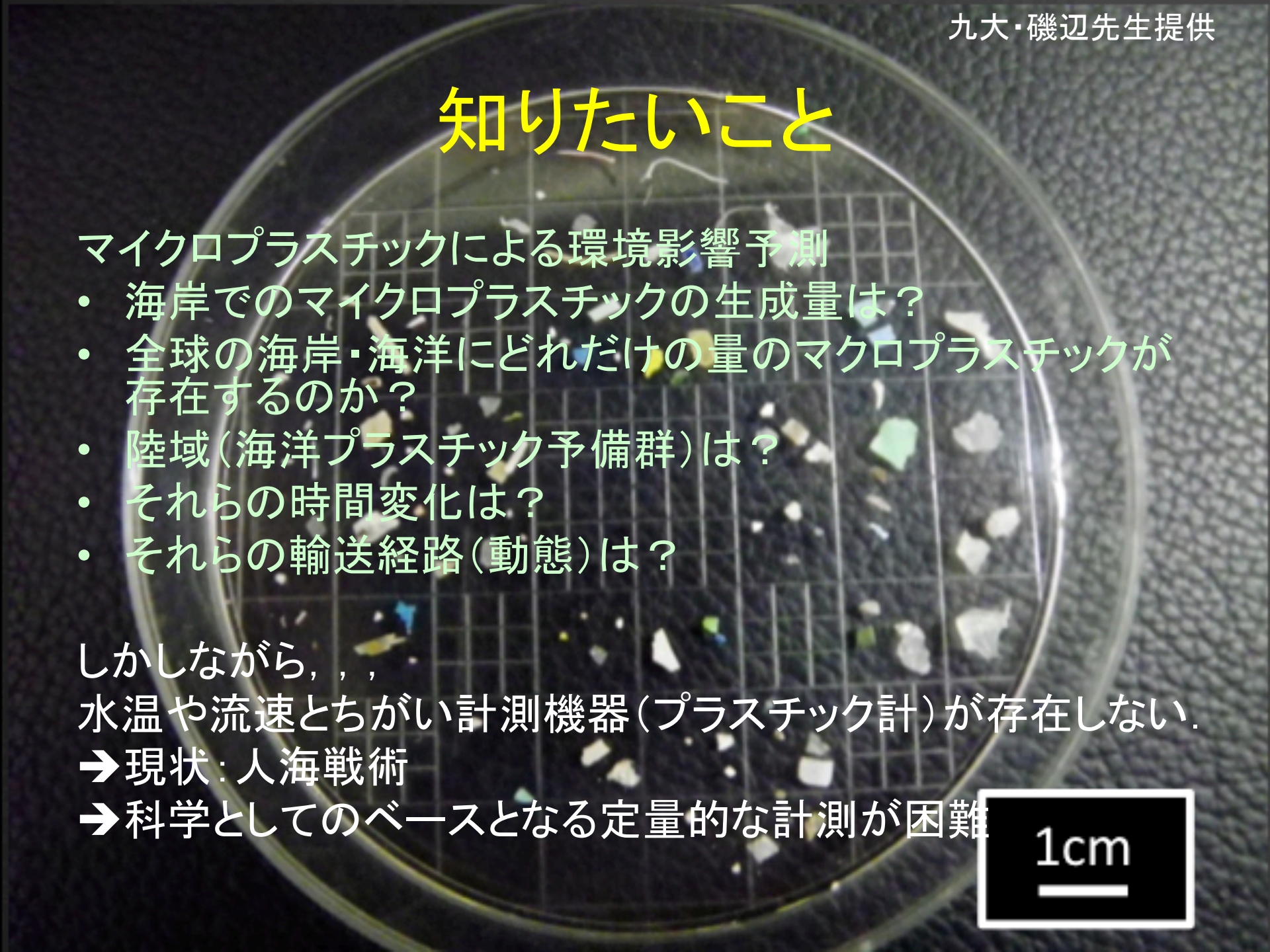


Figure 4 | Liver Histopathology in medaka sampled after 2 months. Micrographs show livers that are glycogen-rich from the control treatment (a) and glycogen-depleted from the virgin-plastic (b) and the pristine-plastic treatment (c). An eosinophilic focus of cellular alteration, a precursor to a tumour, was observed in one female from the virgin-plastic treatment (highlighted in panel b). Hepatocytes, approximately twice as large as the basophilic (blue coloration) glycogen-depleted hepatocytes. The progression of neoplastic hepatocytes is evidence by the presence of [illegible] adenoma in one female from the virgin-plastic treatment (encircled in panel c).

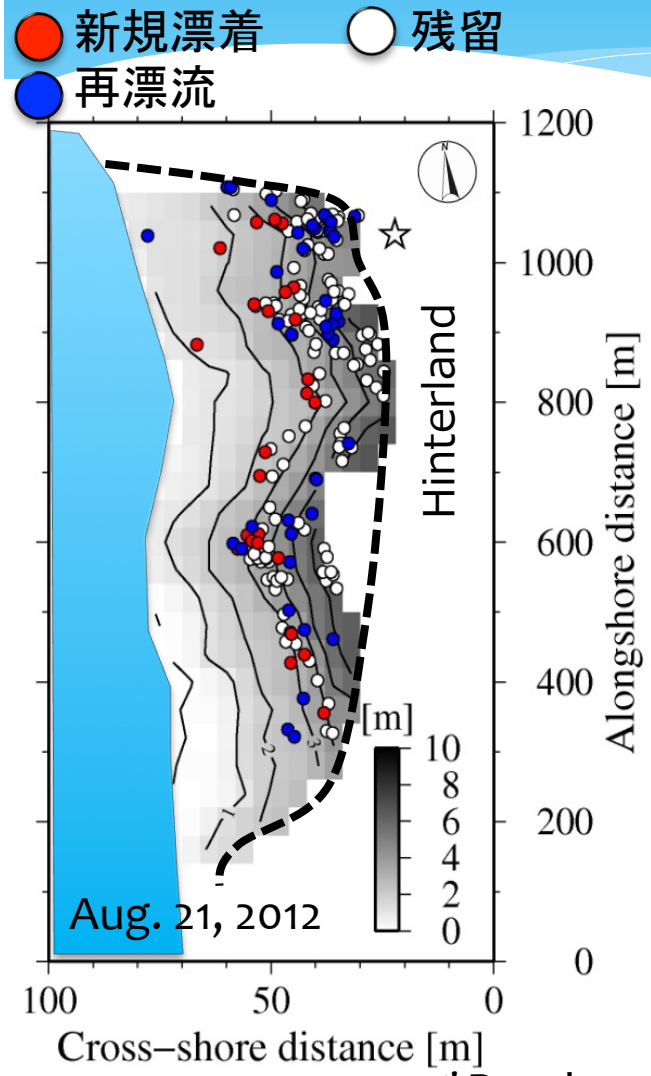
マイクロプラスチックスを摂食したメダカに発現した肝障害
Rocheman et al., (*Sci. Rep.* 2013)

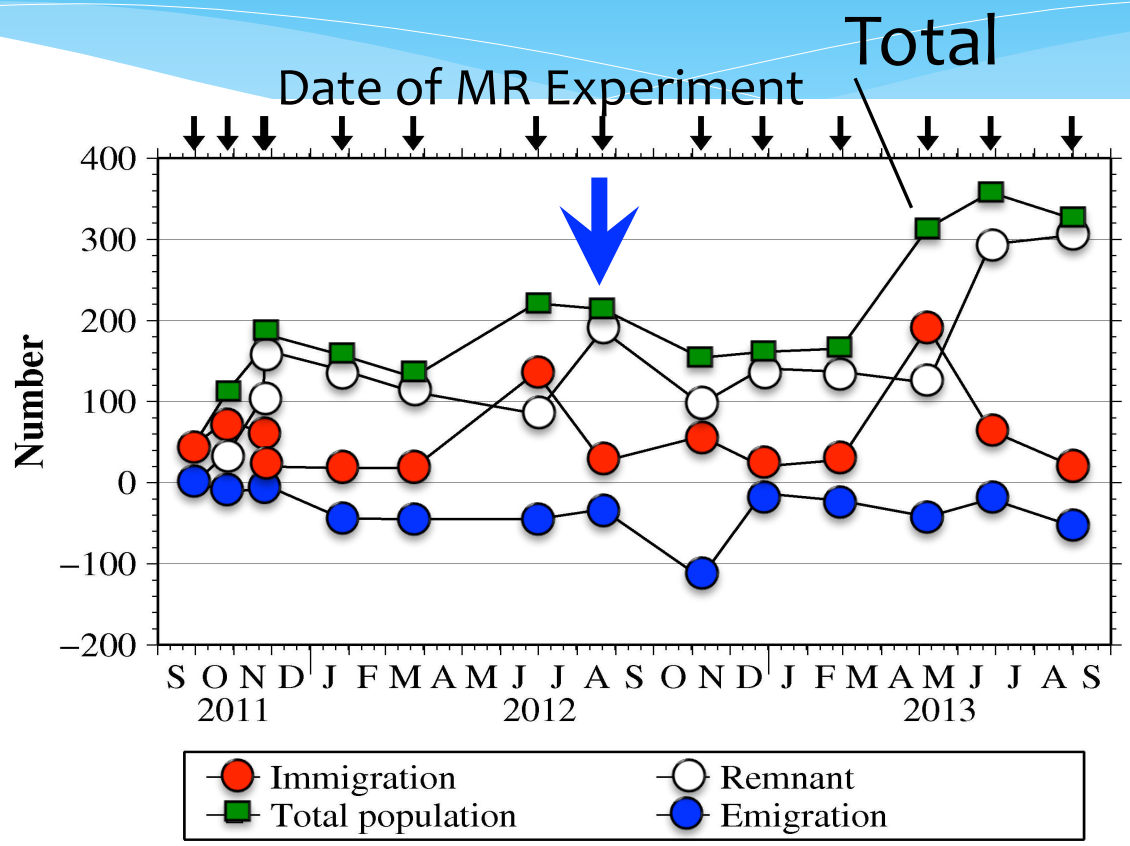

九大・磯辺先生提供
知りたいこと
マイクロプラスチックによる環境影響予測
• 海岸でのマイクロプラスチックの生成量は？
• 全球の海岸・海洋にどれだけの量のマクロプラスチックが存在するのか？
• 陸域（海洋プラスチック予備群）は？
• それらの時間変化は？
• それらの輸送経路（動態）は？
しかしながら，，，
水温や流速とちがい計測機器（プラスチック計）が存在しない．
➔現状：人海戦術
➔科学としてのベースとなる定量的な計測が困難
1cm

海岸におけるマクロプラスチックの振る舞い
漁業用フロートを例として

Iriomote Island

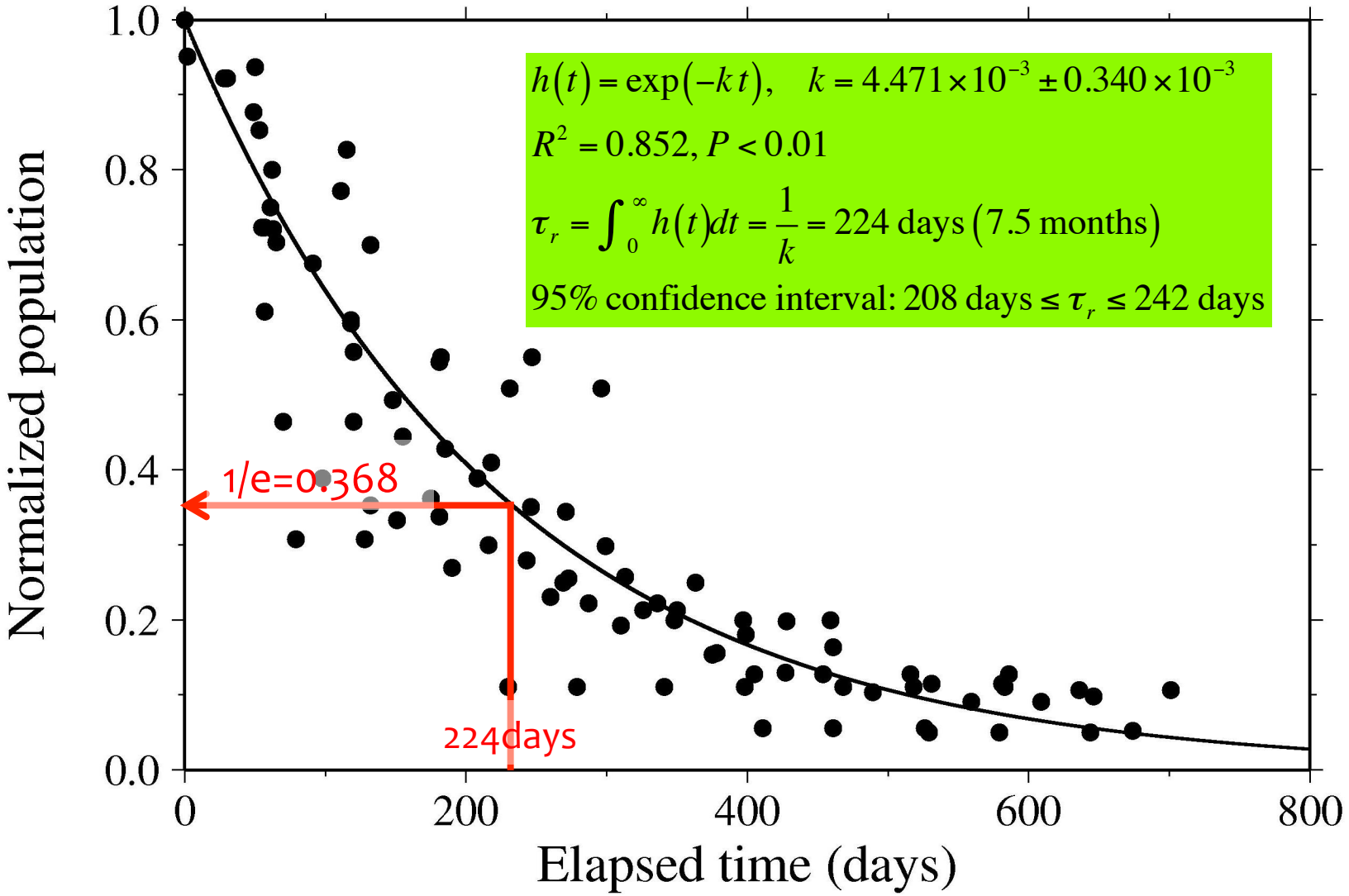
Time series of Immigrant, Remnant, Emigrant and Total



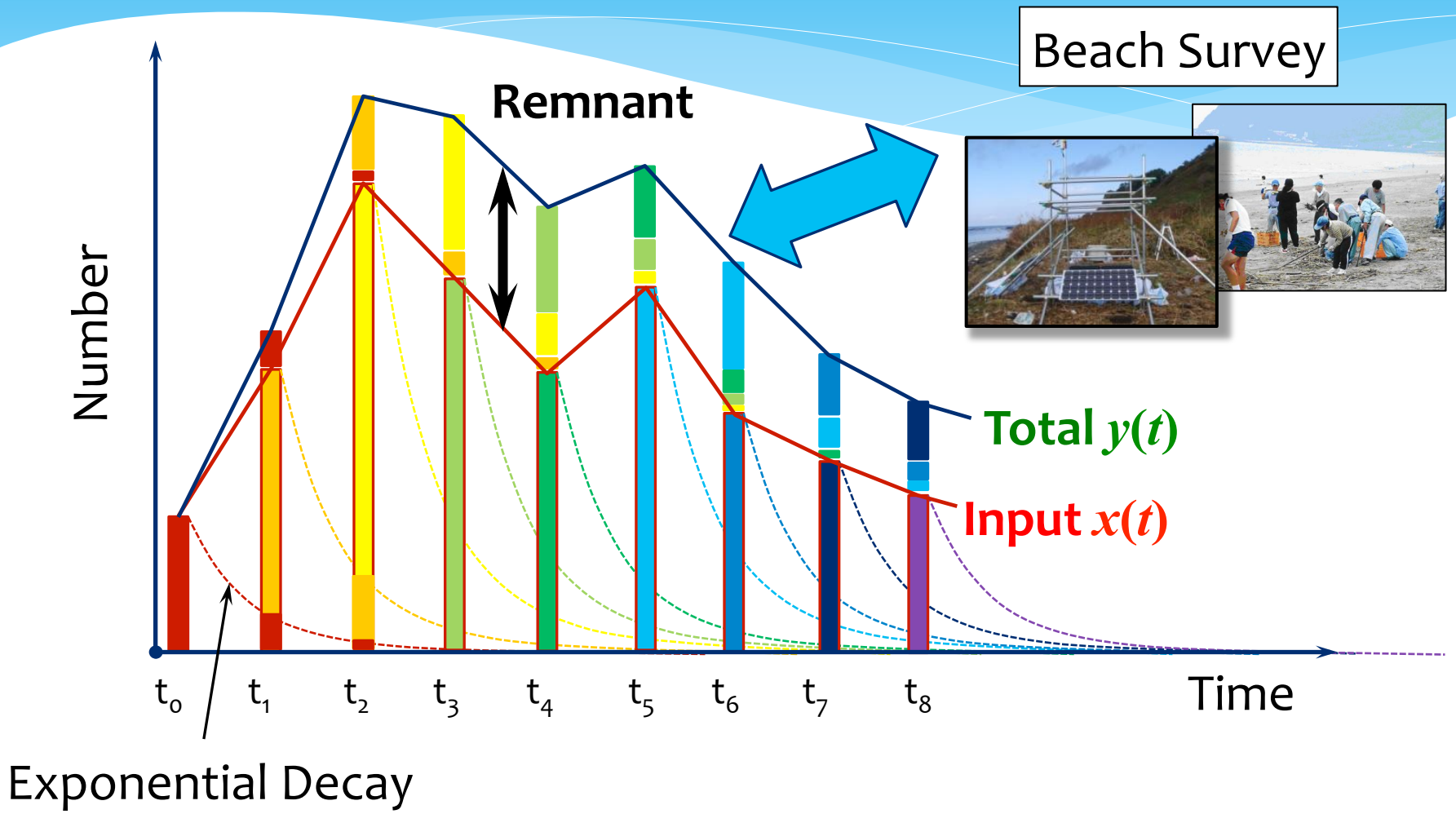


*Beach surveys measure the total population, but not the immigration.

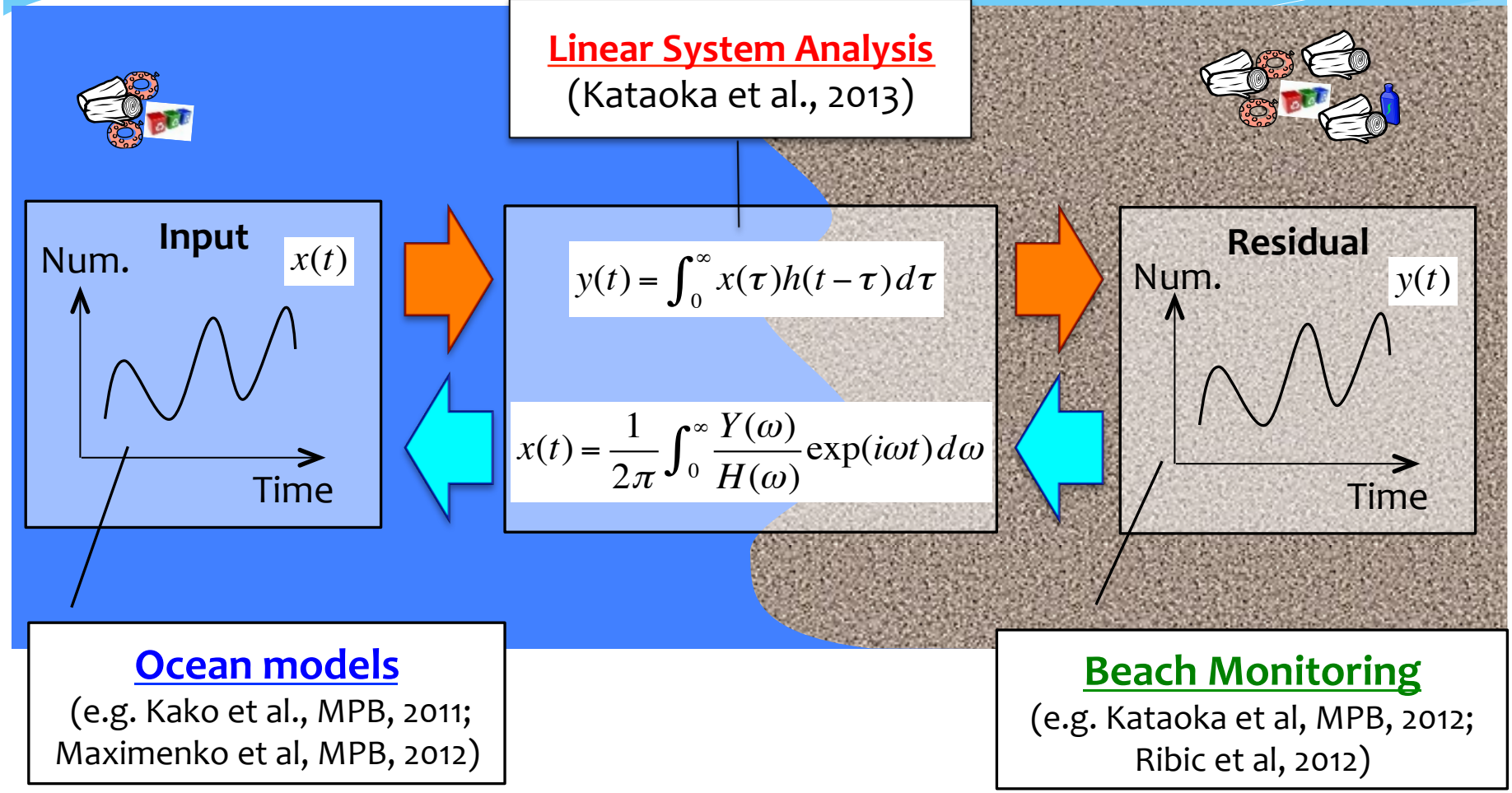
Residence Time on Wadahama Beach



Relation between Immigrant, Remnant and Total



Linear System Analysis
➔Mediator between Ocean Models and Beach Monitoring



マクロプラスチックの海岸での動態を探る上でキーとなる項目

* 滞留時間の把握＝個々のプラスチックの追跡
* 存在量の時系列の計測

時間分解能 ≪ 滞留時間

空間分解能：5mm～

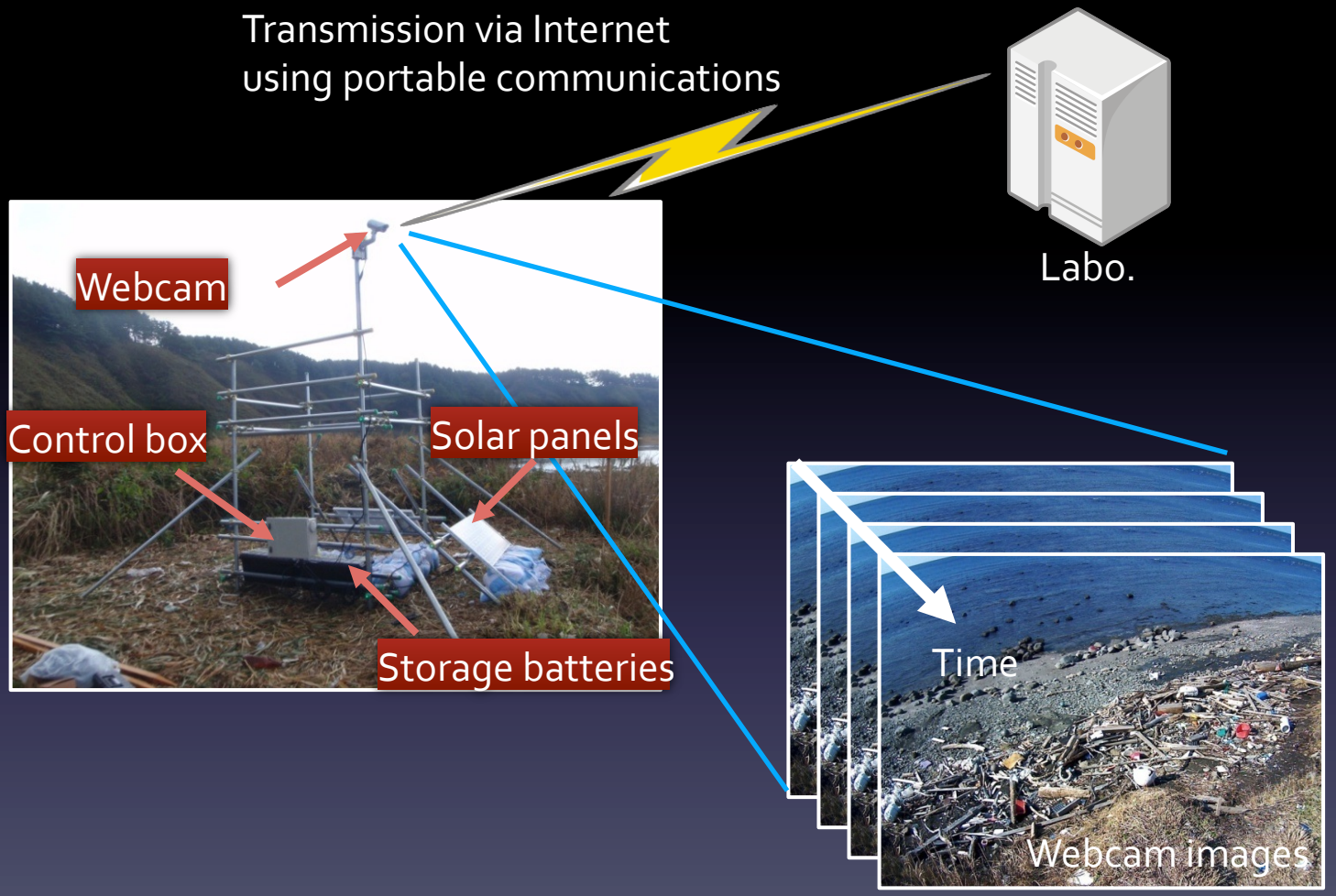
Purpose

（国総研　片岡研究官提供）

- To sequentially measure quantity of beach litter at four sites around East China and Japan Seas

Webcam monitoring system

（国総研　片岡研究官提供）



- System is operated every two hours for 7:00-15:00 (i.e., five time).
- Five images are taken every operating time by webcam.
- Daily number of images is 25 (i.e., 5 (times)× 5 (images)=25).

Webcam images at four sites

（国総研　片岡研究官提供）

Webcam images at Tobishima (Dec. 2010)

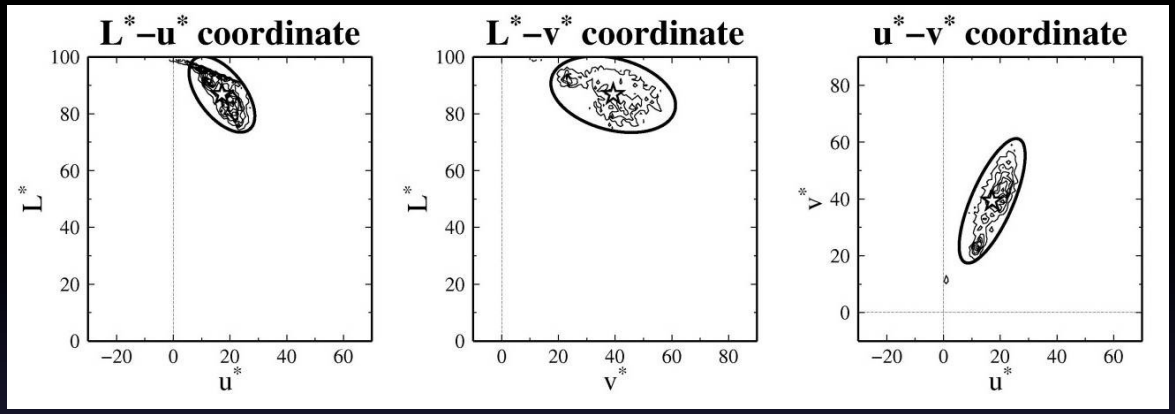
（国総研　片岡研究官提供）

Quantity of macro-plastic litter is calculated using these webcam images.

Step1: Generation of CRs

（国総研　片岡研究官提供）

Color distribution of plastic litter "C" in the CIELUV color space

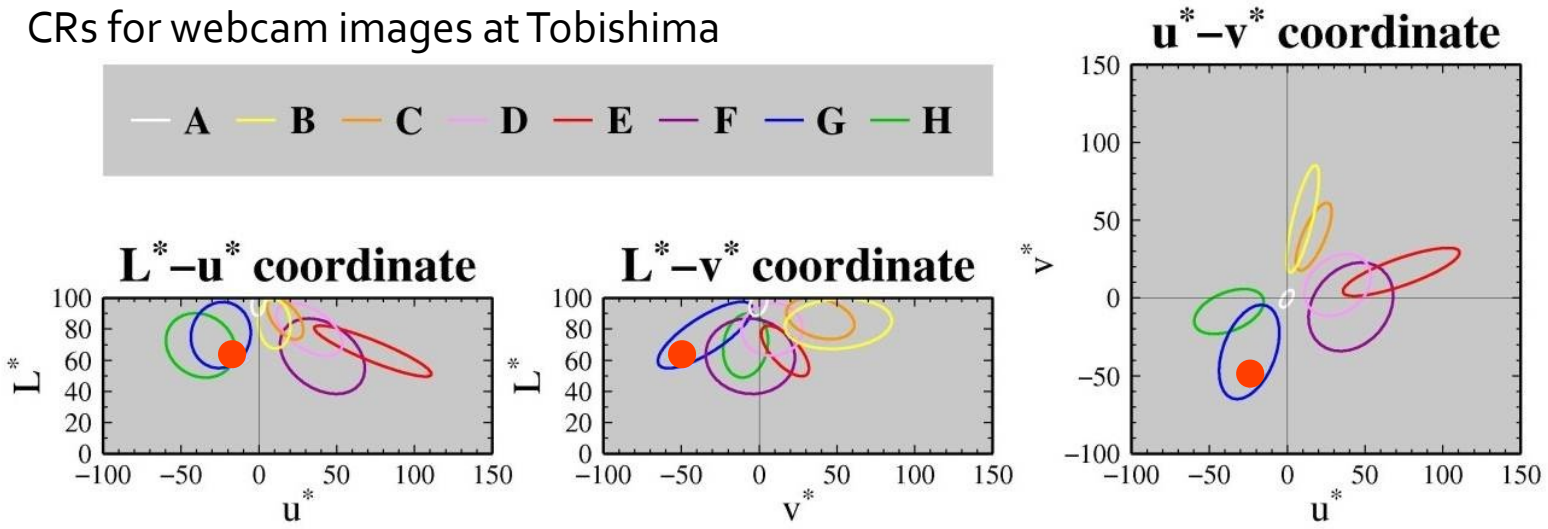


Blue plastic

Three ellipses form the ellipsoid body

CRs: Ellipsoid body in the CIELUV color space

CRs for webcam images at Tobishima



Step 2: Detection of plastic pixels

（国総研　片岡研究官提供）

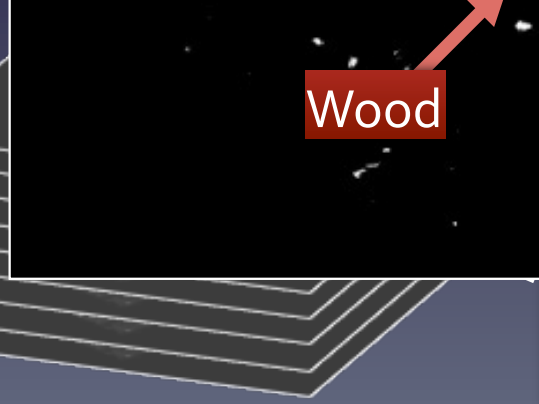
【Detection of plastic litter using a single image】

Plastic li

But othe

Plastic debris ➔ white

Using photos for three days



75 images
(3 days)

Wood

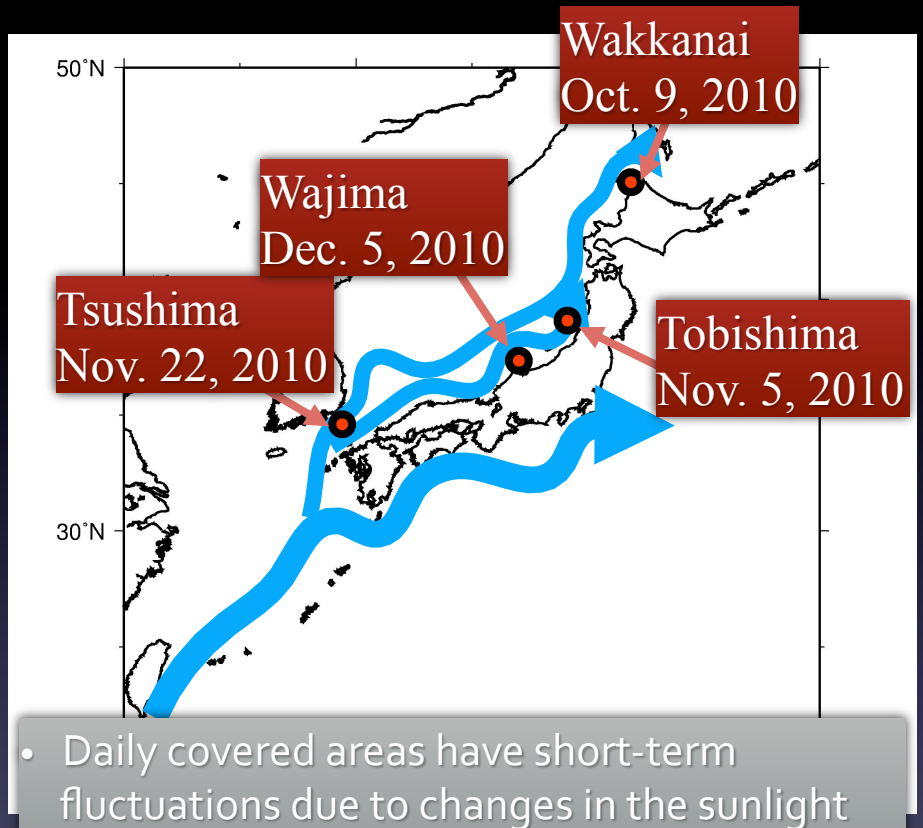
Plastic debris

detected

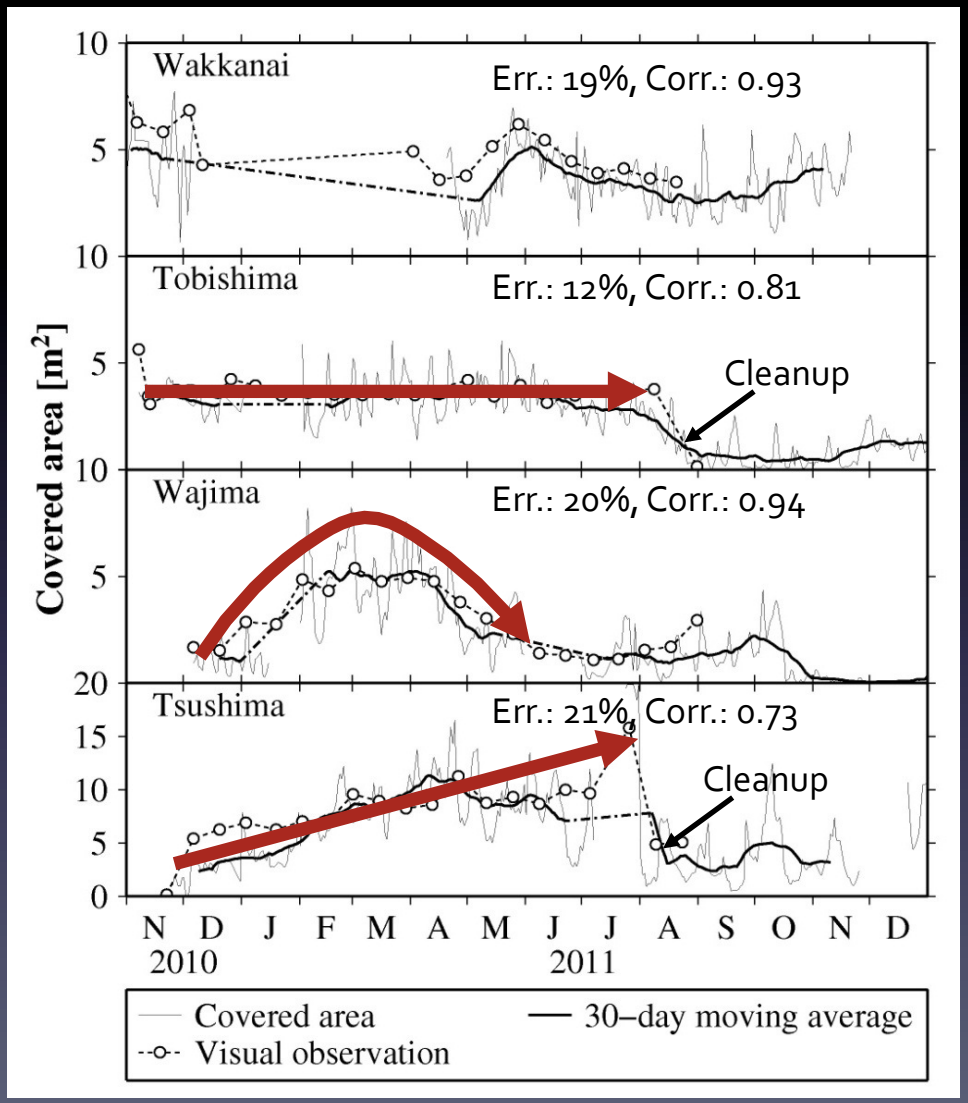
plastic pixel

Time series at four sites

（国総研　片岡研究官提供）

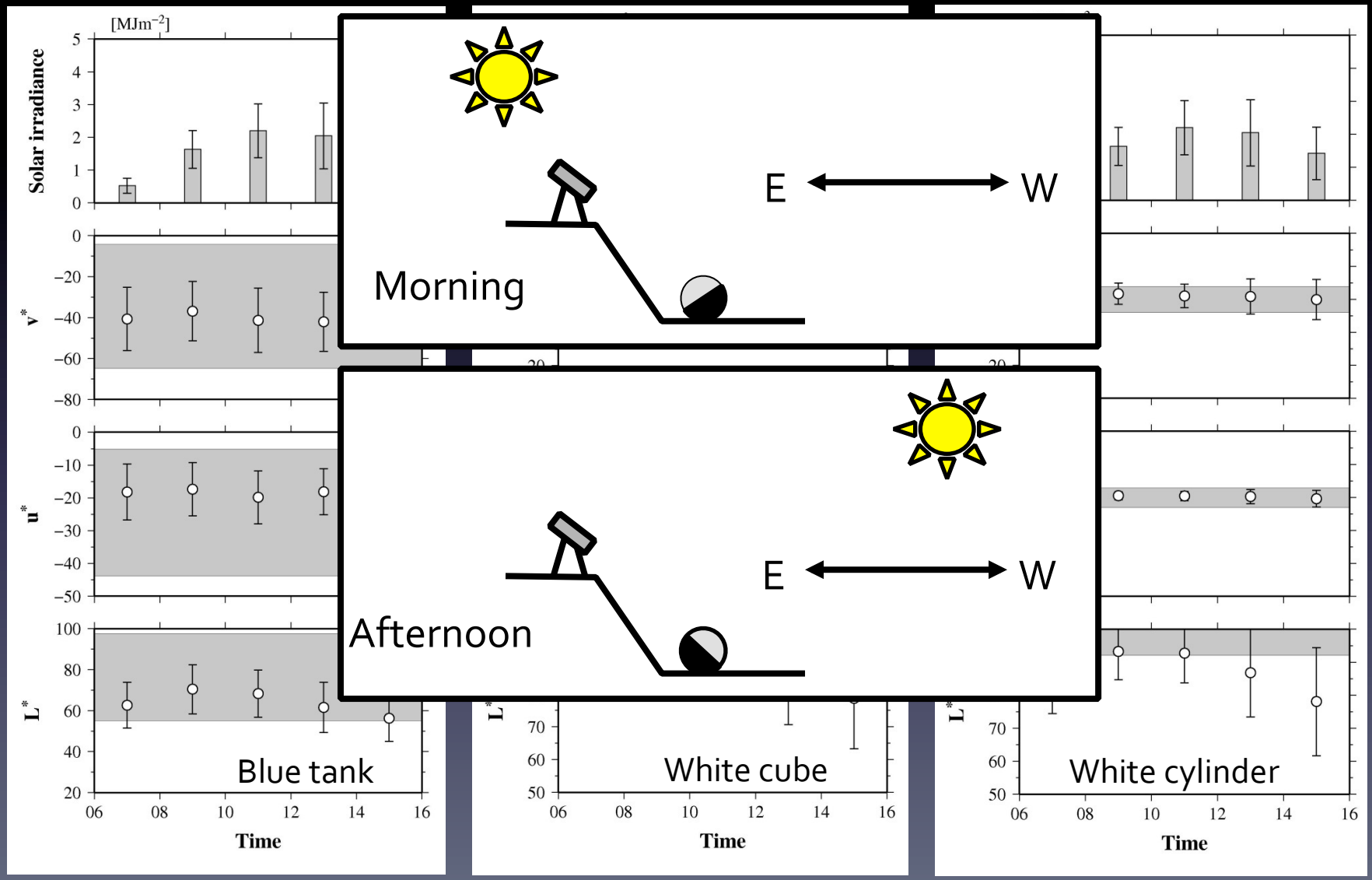


- Daily covered areas have short-term fluctuations due to changes in the sunlight condition (e.g., amount of sunlight).
- To remove the short-term fluctuations, 30-day moving average of daily covered area is calculated.



Monthly variability of litter color (side plane)

（国総研　片岡研究官提供）



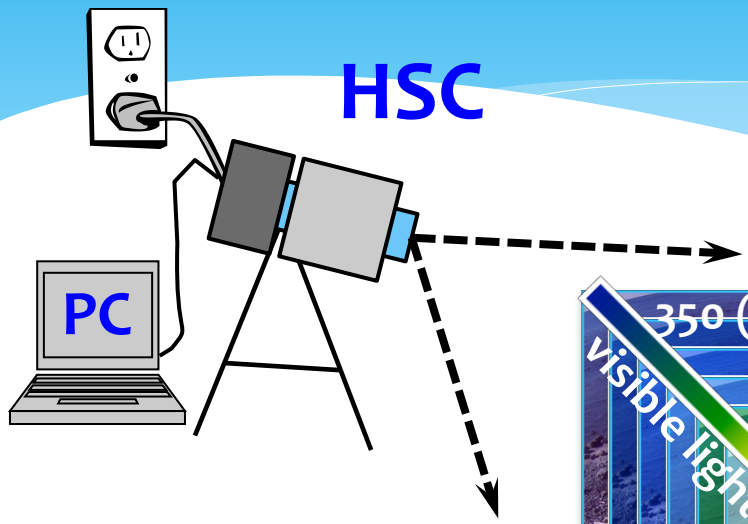
We use its COLOR and/or SHAPE to identify anthropogenic debris

Similar COLOR ➔ COLOR-based System N.A.
➔Hyperspectral Camera O?

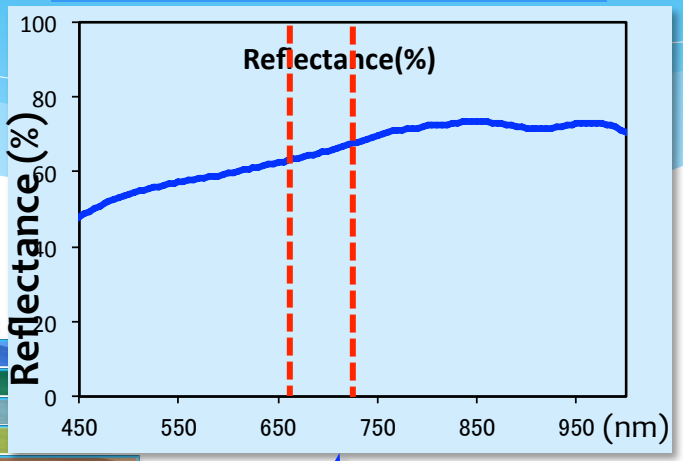
White pieces of Shell, Coral, Plastic, etc.

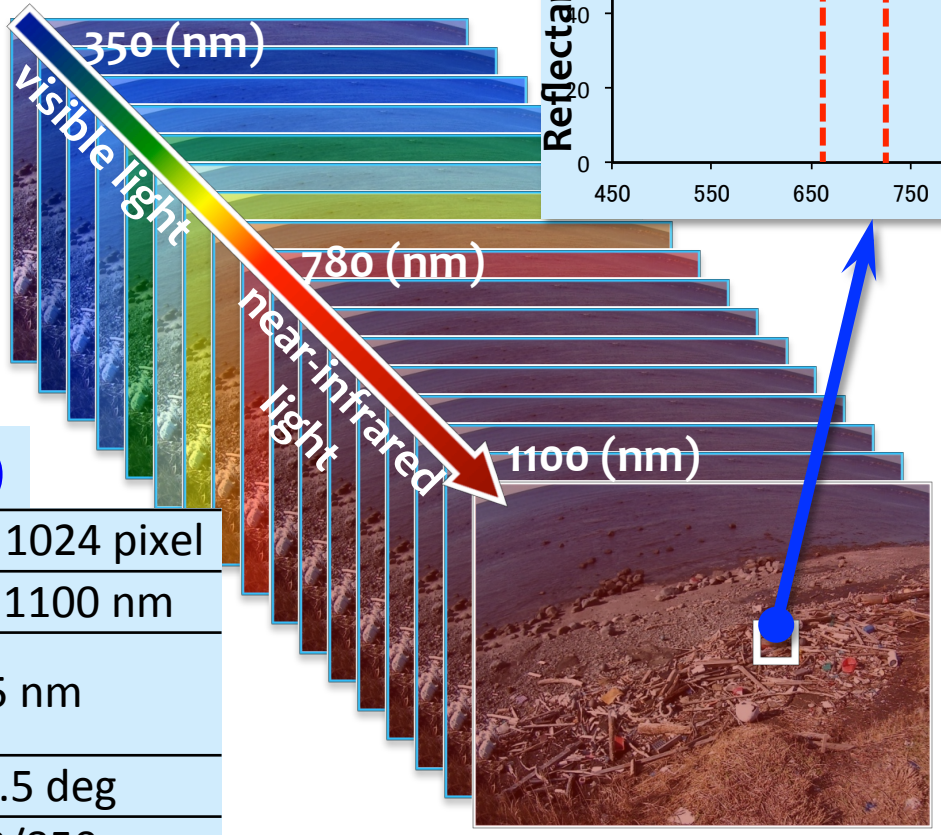
White Shellfish clinging to White Styrofoam Buoy

What is a Hyperspectral Camera?



NDVI←Ch. 63 and Ch. 76.

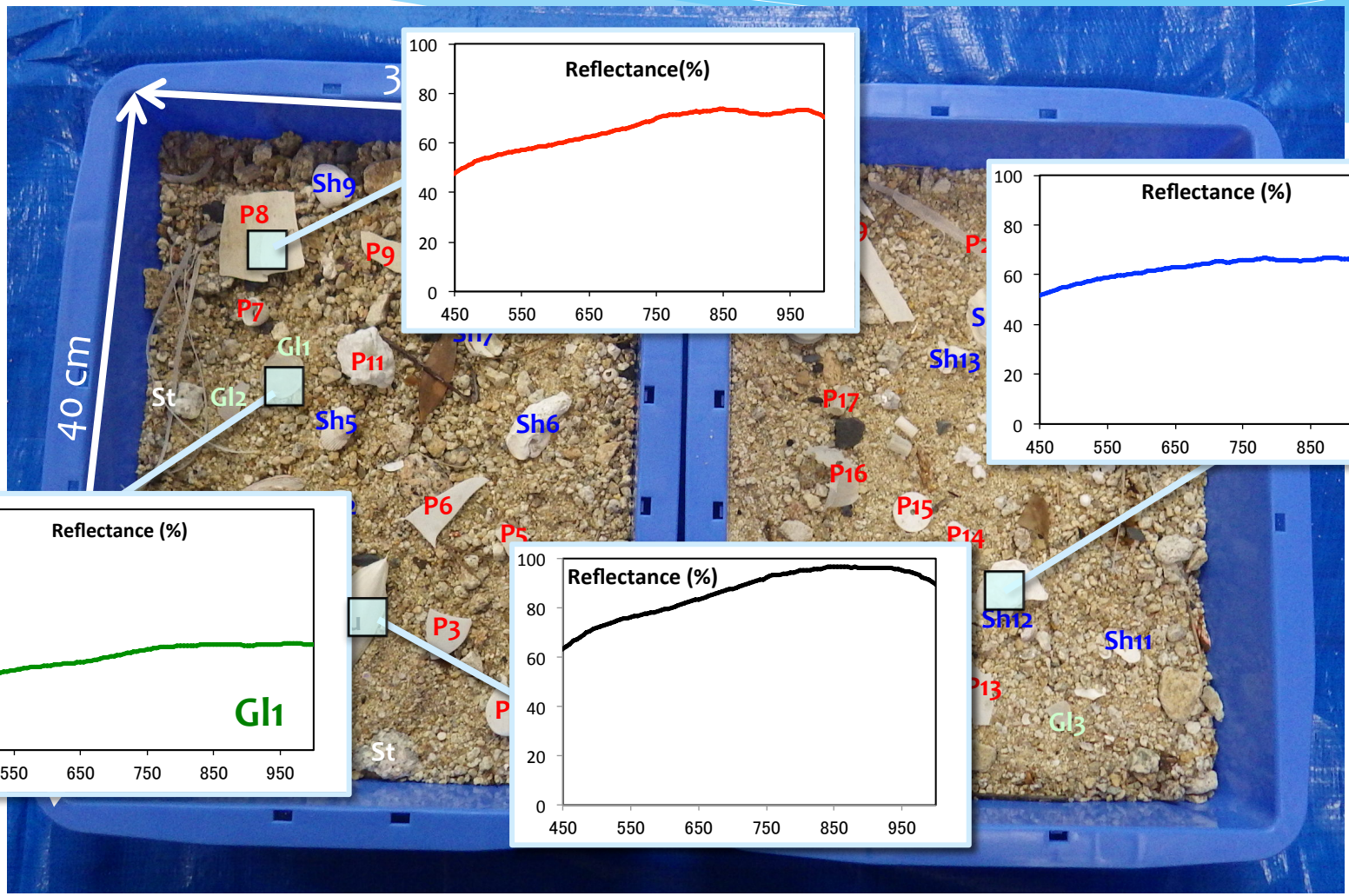




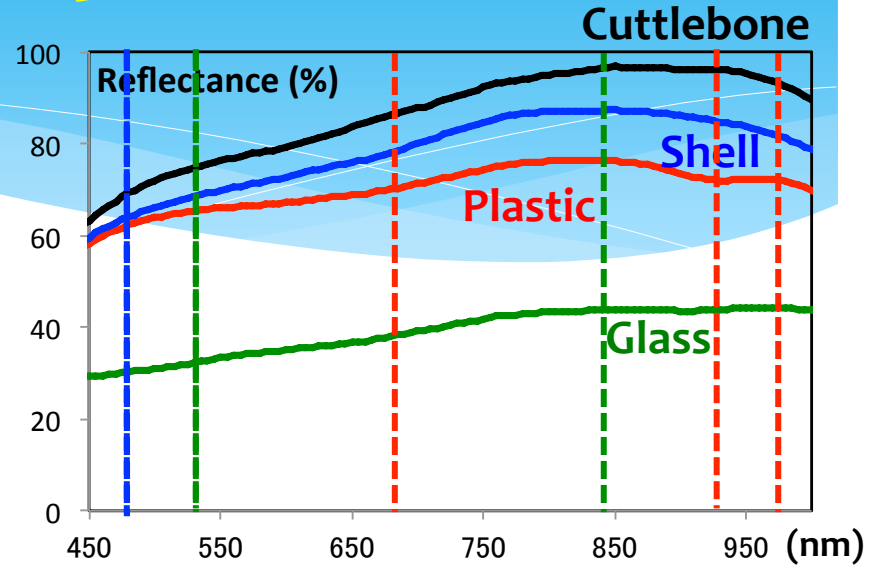
NH-7 (EBA JAPAN Co. Ltd.)	
Image Resolution	1280 × 1024 pixel
Wavelength Range	350 - 1100 nm
Wavelength sampling interval	5 nm
Viewing angle	22.5 deg
Weight	750/850 g

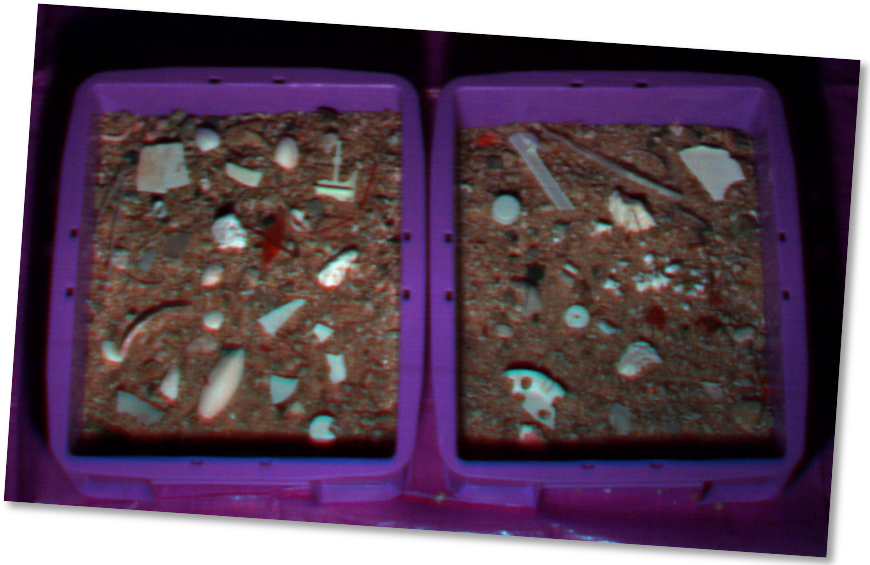
Tiny Beach in Plastic Case

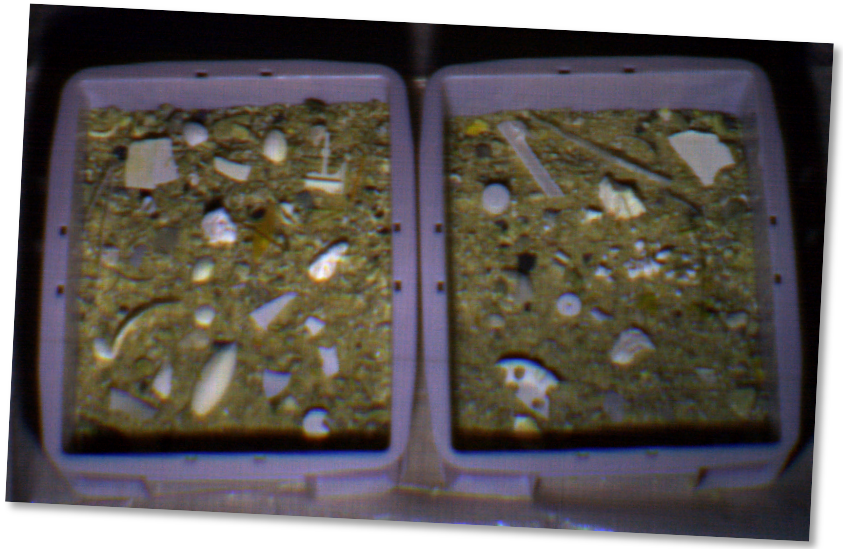
Plastic (21), Shell (14), Glass (3), Cuttlebone (1)



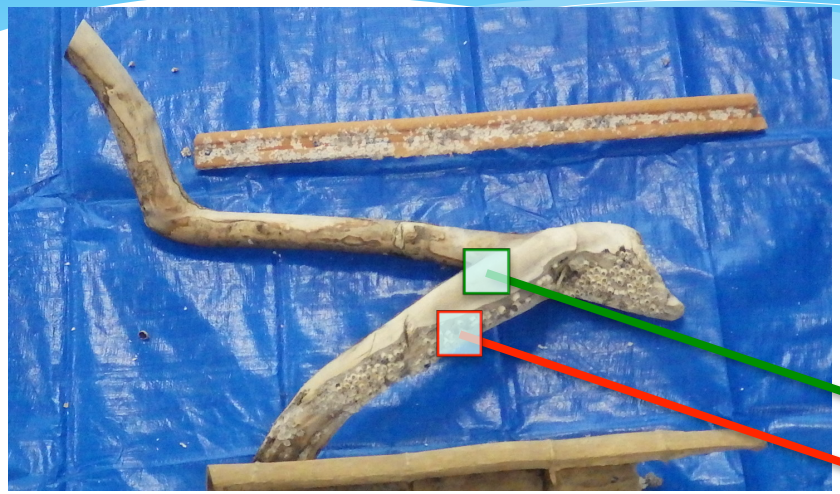
Looking the Beach through various combinations of 3-channel

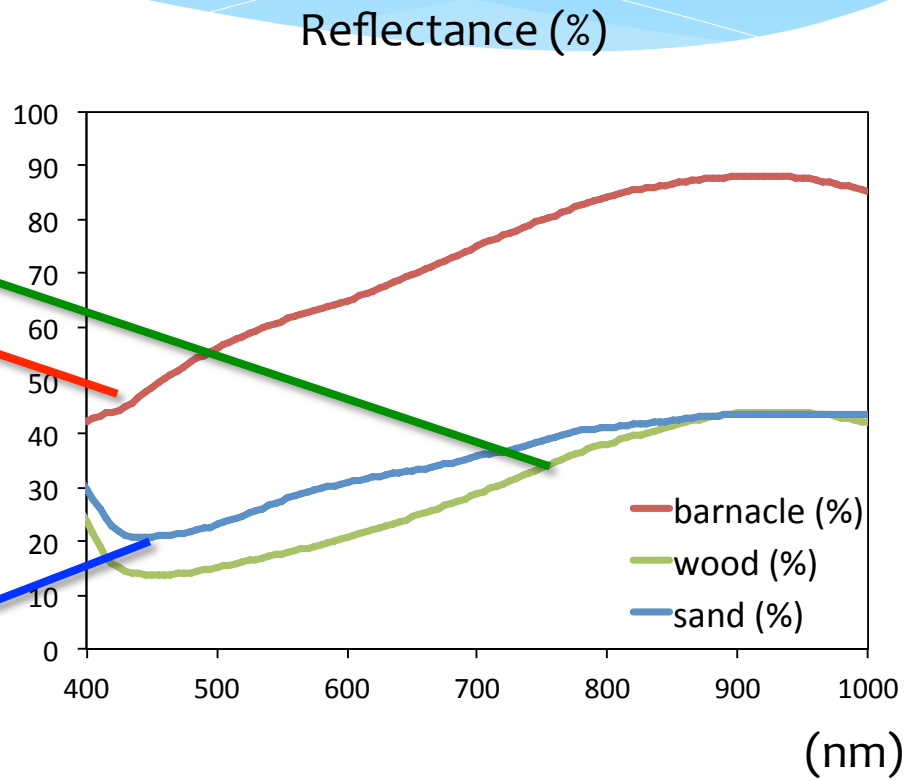






Barnacles, Sand and Wood





マクロプラスチックの海岸での動態を探る上でキーとなる項目

＊ 滞留時間の把握＝個々のプラスチックの追跡

＊ 存在量の時系列の計測

時間分解能 ≪ 滞留時間（あるいはイベント観測）

空間分解能：5㎜～

（もしくは粗い空間分解能でも

プラスチック量を計算できる技術）

白色系漂着物の識別

透明な漂着物の認識