Exploring the World's Oceans with Tara







In this talk, I will address the following:

What is Tara?

How did we get to sail on the Tara?

What science does the Tara promote?

Present a few scientific results from recent expeditions.

Tara: a 36m schooner

1989 - 1996: "Antarctica" (Jean Louis Etienne)

• Repeat Nansen's historic 3-year Arctic drift in the Fram (1893-1896).

1996 - 2001: "Seamaster" (Sir Peter Blake)
Raise awareness of human impacts on the oceans



A family affair



agnès b.





Tara is actually the Tara V



Agnis b. Etienne Bourgois

2003- present: the Tara Expeditions foundation for marine research

 Finance long-term scientific research concerning the impact of global warming on ecosystems.

• Increase general awareness about environmental issues.

• Diffuse scientific data for educational and policy purposes.

10 years of tara, 10 expeditions



How did UMaine get involved with Tara?









TARA Oceans

A three year expedition:

- To explore plankton and coral reef ecosystems in relation to environmental conditions
- To popularize Science
- To educate



Scientific plan: characterize planktonic ecosystems in the World's Oceans

- 3 years of sampling throughout all the oceans (~500 stations + continuos data acquisition)
- Sample all microscopic life '<u>end to end</u>' (from viruses to fish larvae), by size classes
- Sampling of ecosystems down to 2,000m
- Multidisciplinary approach from oceanography to genomics
- Modern instrumentation (high throughput genomics and fast imaging methods)

Planned Tara Oceans route

- Scientific considerations
- Seasons: Northern-Southern hemispheres
- In-line with prevailing winds



Inspired by:

Venter's global ocean sampling expedition (2003-2010):







H.M.S. CHALLENGER PREPARING TO SOUND, 1872.



1872-76, 362 'stations'



Some facts about Tara

- Aluminum hull ice strengthen
- 36m long x 10m wide
- Draught: 1.50 3.50m
- Weight: 120 tons
- Sail area: 400m²
- Propulsion: 2 x 350 HP
- Watermaker: 300 litres/hour
- Fuel tanks: 40,000 litres
- Water tank: 6,000 litres
- 3 kW wind generator power system
- Communication: Satellite/radio
- Oceanography: 3,000 m winch
- Autonomy: 5,000 nautical miles
- Number of berths: 14

Challenge: what could we (@Umaine) do to contribute? Who would fund it?

Answer: NASA products need validation. Database currently biased.



What can we do, that nobody else does?



- Lamp 1
- 1 mm aperture 2
- 3 Lenses
- IR Filter 4 Filter wheel 5
- 9 Singlet lens 10

7

8

- Signal detector 11
- 6 Beam splitter

Flow tube

Reference detector

6 mm quartz pressure window

System for acquisition and processing of particulate absorption/attenuation



Acquisition and processing of particulate absorption:



Slade et al., 2010, JTECH



Simultaneous scattering and T correction based on shape of $a_w(T)$.

Generated three additional products:

- 1. [Chl_a]
- 2. Size index (from c_p)
- 3. Particulate Organic Carbon from c_p

Partnering with French colleagues, sampling was enhanced with: backscattering, attenuation, Fchl, Fcdom on rosette, added a radiometer buoy, and sampling for HPLC.



Technical support, the true heroes:







TARA OCEANS: Challenges

- Funding how do we get on (boat is leaving 9/2009)
- Use an appropriate data and sample tracking system



High quality logistics (permits, handling and shipping of samples)



 computing and conceptual tools to organize the data and do modeling



Septembre 2009, Lorient, Bretagne

It takes a village!

PLANNING A SAMPLING LEG (SHORE SUPPORT)



Chiefscientist

Revised plan



UMaine personnel chief-scientists on 3/33 legs +2/6 in following Polar Circle.

MAP OF TARA OCEANS POLAR CIRCLE

Added responsibilities:

Scientific steering committee

Responsible for imaging and cytometry (with Laval)

Umaine personnel on every leg

Added equipment:

- Flowcytobot
- CPR
- ALFA
- Ultrapath
- pH
- PCO₂





Virtual tour of the Tara as it during the Polar Circle expedition

Photo: Clare Kines, Arctic Bay, Nunavut

How is data collected on Tara?

- I. Rosette:
- Physical variables: temperature, salinity, pressure, light level.
- Optical variables: scattering, attenuation. Biological variables: imaging camera, chlorophyll.

Chemical variables: nitrate, oxygen, DOM.

Bottles to collect water ->

Biological variables: Virus, bacteria, pigments Chemical variables: Carbonates, nutrients, O¹⁸

II. Nets (of variables mesh size):Biological variables: protists, phytoplankton,zooplankton (for '-omics' and imaging)

Spatial scales: 1km² Temporal scales: week/days Vertical scales: surface to 1000m at O(1m)



Come on board with Todd the copepod







Anna Deniaud

For Lino (near Disco Island, Greenland):





100.0 µm 001080

100.0 µm, 001243





Data and Samples Collected: On Board and on Land



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TARA Oceans

Tara_SAMPLING_PLAN_A_48h_20100826.pdf

DCM

PREPARATION

DOUBLE_20µm_DCM

PUMP_DCM

PUMP_DCM

PREPARATION

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BACT-VIRUS

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DCM



DATA Locations where we have particulate absorption (95,000) and attenuation (72,000) 1km²-averaged spectra.







Tara data: where does it fit?

Ecology



Ecosystem models

Presence/absence Prey/Predator/symbiosis

Environment Physics/chemistry

Biogeochemistry









TARA OCEANS: Some results Massive DNA sequencing @ Genoscope: Sampled > 1,000,000,000 ribosomal DNA sequences extracted form all eukaryotic samples, representing >1,000 planktonic communities.

Sequenced >100,000,000 bacterial genes, >50% new to science.

80 meta-genomes sequences - whole samples (virus <-> fish larvae)- notable: reached saturation.





Comparison with remote sensing



IOP variance - within satellite pixel variability





TARA MÉDITERRANÉE 2014 Focus: plastic pollution

TRAJET ALLER TRAJET RETOUR AIRES MARINES PROTÉGEES SITES NATURA 2000 EN MER AIRES MARINES PROTÉGEES EN PROJET





Fashion







Art



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TARA

Exhibitions



Chasing the ice edge





Anna Deniaud

Tara is at the table with the most influential international organizations







Summary:

I. In science, social skills are just as important as the three R's.

II. Private funding allows more flexibility than public in the execution of your work. There is an added 'cost': need to educate non- specialists in the importance of your work.

III. Oceanography has lost its use of sail in research. Time to rethink.



The next adventure (2016-2018):



Tara Pacific (coral)