TARA OCEANS: oceans.taraexpeditions.org
ARTWORK BY MARA G. HASELTINE: calamara.com

LINK to ROCK-U-MENTARY VIDEO:

Departure: September 2009 from Lorient (France).
Return: November 2012 in Europe.
Duration: 2.5 years with about sixty stops.
Distance travelled by Tara: 150 000 km.
Fields of study: biodiversity and climate: ocean relations / functioning of marine ecosystems / life’s origin and evolution.
On board manipulations per 24 hours: 20 scientific experiments.
Tara occupants: an international team of 14 people, including 1 captain, 4 crew members and 5 scientists.
Average stay on board: 3 months for the crew, 1 month for the scientists.
The course of a day: 16 hours of navigation and 8 hours of stationary sampling.
Oceans travelled: Arctic, Atlantic, Pacific, Indian Oceans and many seas.
Visited ports of call and countries: About 60 ports of call in 50 countries (Barcelona, Bombay, Cape Town, Rio, Sydney, Artic, NewYork etc…)
For detailed description of route go to the website for TARA OCEANS.
Fields of study: biodiversity and climate: ocean relations / functioning of marine ecosystems / life’s origin and evolution.
On board manipulations per 24 hours: 20 scientific experiments.
For a detailed description of routes and ports of call go to:
call:http://oceans.taraexpeditions.org/
Participating institutions: 50 laboratories in 15 countries.
Conceived and sailed by visionary explorers, Tara is a unique ship for scientific discovery and adventure.

Dockyard: SFCN at Villeneuve La Garenne
Architects: Bouvet and Petit
Former owners: Jean-Louis Etienne and Sir Peter Blake
Flag: French (French international registry)
Classification: Bureau Veritas – 1 3/3 (E)
Length: 36 metres
Width: 10 metres
Draught: 1.50 metres – 3.50 metres
Weight: 120 tons
Hull Material: Aluminium
Masts: 2, each 27 metres
Sail area: 400 square metres
Propulsion: 2 x 350 HP
Power: 2 x 22 kW and 1 x 40 kW
(“Environmental Protection Agency II Standard”)
Watermaker: 300 litres/hour
Fuel tanks: 40,000 litres
Water tank: 6,000 litres
Soiled tank: 7,000 litres
Number of berths: 14
Autonomy: 5,000 nautical miles
3 kW windgenerator power system
Means of communication: Eutelsat, Fleet Broad Band, Radio HF, Standard C
Meteorology: Station Bathos II Météo France, thermo salinometer
Oceanography: 3,000 m oceanographic winch capstan
Science: Dedicated microscopy and IT, wet laboratory
Equipment: Diving compressor and equipment for 4 persons, two semirigid 30 and 40 HP
Heating: 150 mm polyurethane isolation, central heating
Garbage treatment: 1 crusher and 1 compactor of garbage
Home port: Lorient
Crew Members on Voyage:

Captain: Herve BOURMAUD
Chief Mate: Alain GIESE
Chief Engineer: Loic VALETTE
Deck officer: Baptiste REGNIER
Cook: Helene SANTENER
Journalist: Vincent HILAIRE
Artist: Mara HASELTINE

Scientists:

Chief scientist: Chris BOWLER
Deck engineer 1: Marc PICHERAL
Deck engineer 2: Franck PREJGER
Optical engineer: Antoine TRILLER
Protist sampling: Celine DIMIER
Bacteria/Virus sampling: Pamela LABBE-IBANEZ
Chilean observer: Marcela CORNEJO
**Tara Oceans: Overview**

The purpose of this expedition is to create vital open source knowledge about the effect as well as the function of plankton on our planet in particular plankton's role in regulating the atmosphere of the planet. The results of this project will have outstanding implications for our understanding of early life evolution, global biogeochemical cycles and spatio-temporal evolution of the earth's climate. The data collected will be interpreted during and after the expedition. The most important outcome for the future is that this will open the possibility to build models integrating the evolution of pelagic ecosystems with environmental changes.

It is now unequivocal that global warming is occurring at a rate 100 times greater than documented in geological studies. The major part (>50%) of global primary biomass production occurs in the upper 200 m surface water layer of the oceans (the photic zone) and this also drives most of the global elemental cycling involved in climate regulation.

Key actors in these elemental cycling processes are thought to be plankton protists, which produce oxygen and recycle carbon dioxide. However, protists are embedded in a network of plankton organisms that range from viruses to fish larvae and the complex, dynamic food webs that these organisms form remain largely un-investigated.

Tara Oceans will analyze plankton ecosystems in relation to physicochemical conditions throughout the world’s oceans, assessing their adaptation to and feedback on a rapidly changing earth system. Large scale genomics and metagenomics projects coupled to newly developed high-resolution and high-throughput imaging methods will allow quantitative studies of plankton ecosystems and identification of the plankton composition within these ecosystems. Integrative bio-informatics analyses of the imaging, genomes, physicochemical and climate data generated in the project, will be used to assess plankton biodiversity and activity in the diverse ocean ecosystems sampled. All of the data generated through the project will go to form an open-source multidimensional bio-oceanographic database that will allow generating predictive models of the spatio-temporal evolution of plankton ecosystems.

From a purely scientific point of view, this approach should allow us to establish how ecosystems of “small” organisms in the world’s oceans are structured. We will learn which viruses, bacteria, protists and small metazoan organisms live together in given marine environments. Since the ocean is an open system, one could think that all organisms are everywhere. Obviously this is not the case because when a given organism migrates into an unfavorable environment, it dies.

This approach should tell us a lot about the mechanisms of evolution. In particular, the classical idea of survival of the fittest could be examined. For instance, how viruses and their hosts co-evolve under different physico-chemical pressure is unknown. The
Tara Oceans expedition will provide a unique opportunity to better understand such questions.

We clearly need complex modeling, based on bioinformatics analyses of DNA and RNA sequences obtained from organisms collected during the voyage, combined to morphological analyses of these same organisms. We will also study plankton populations and communities dynamics in relation to their physico-chemical environments. Thus, we will learn much about how ecosystems change and adapt in response to climate change. Since they are at the base of the oceanic food chain, we may be able to predict how marine ecosystems will affect the climate by producing more or less oxygen and absorbing more or less CO2.

**Importance of Oceanic Protists:**

Given the proposed sequencing effort, this study will provide the most complete census of oceanic protists ever undertaken. Protists constitute the largest biodiversity gap in eukaryotes. Protists are also known – especially from the fossil record - to react rapidly to global climate change. Many populations of marine protists have extreme turnover rates and build complex nano- and micro- (in)organic skeletal structures, which generate some of the largest fluxes of biological material on earth. Their impact on global geochemical cycles and climate is extremely important. Very little is known about the way protists will react to increasing levels of CO2. We will investigate how changes in protist communities and biodiversity will affect primary productivity and carbon flux.

For the first time, these basic questions will be addressed at the level of the entire protistan community, establishing solid foundations for future research in this underexplored field critical for predicting the co-evolution of climate and biota. Furthermore, the hundreds of thousands of marine protists still to be discovered represent a phenomenal repertoire of unknown genes, metabolic pathways, and nano material. Protists have large genomes often much larger than the human genome. This genetic biodiversity predates and exceeds the relatively smaller gene repertoire of plants and animals. Recent sequencing of oceanic metagenomes has revealed a huge unsuspected diversity of microbial species and genes of prokaryotes and viruses. Eukaryotes have not yet been included in these analyses despite their closer relationship to us.

**Functional Genomics of Diatoms:**
The Leg of the Voyage that our Chief Scientist on board was Dr. Chris Bowler, NRS/Ecole Normale Supérieure, Paris, France whose work is described below. On our leg of the voyage we will be studying the "functional genomics of diatoms".

What are Diatoms?

Diatoms are one of the most important components of marine phytoplankton and are the main players in the biological carbon pump (sequestration of CO2 from the atmosphere to the ocean depths). During the Tara Oceans expedition, the SeaFlow cytometer will continuously monitor diatom concentrations in surface waters. In addition, water samples will be collected that are enriched in diatoms, both from surface waters and from the Deep Chlorophyll Maximum (DCM) zone. We will use these for microscopy observations, both onboard using live samples, and on land using fixed samples, in order to characterize diatom populations at the species level.

To facilitate species identification we will use the fluorescent dye FITC-silane, which specifically labels the silicified cell walls of diatoms. Cells from water samples will be collected on filters and DNA and RNA will be extracted. DNA and rRNA will be sequenced in order to quantify species abundance at the molecular level, and mRNA will be sequenced to reveal gene expression profiles in different oceanic contexts.

Key outcomes expected are a global evaluation of diatom communities and diatom gene expression profiles in a range of different oceanic contexts. The results will provide a basis for understanding how diatoms will be affected by climate change-induced phenomena in the future.

Laboratories involved are the ENS in Paris, Stazione Zoologica in Naples, University of Washington Seattle, EMBL in Heidelberg, Genoscope in Evry, in Cambridge, and the Station Biologique in Roscoff.
My Background:
For the past 12 years I have been exploring the explosion of information that has occurred since the advent of computerized bioinformatics. Scientific data is the backbone of my art practice. Many of the structures I have utilized for my artwork come directly from computerized data gleaned from electron microscopes via x-ray crystallography. (X-ray crystallography is the three dimensional portrayal of minute submolecular matter through the refraction of light off of their crystalline structures.) I am developing a protocol with the 3D imaging scientist Dr Emmanuel G. Reynaud Stokes Lecturer School of Biology & Environmental Science University College Dublin (UCD) from Tara Oceans to convert the data I collect into three dimensional works of art, I plan to translate the data I collect of the coast of Chile and use it as armatures for my sculptures. This procedure could be used for water bodies worldwide and am going to Ireland this June to study microscopy at the University of Dublin.
This is not the first time I will be collaborating with marine biologists, for the past five years I have been studying and working in the field of reef restoration. My art has revolved around the creation of environmentally friendly reefs structures or sculptures as Eco-habitats for the past five years. In 2006 I became an active member of the Global Coral Reef Alliance and studied with the late German Architect Wolf Hilbritz and Marine Biologist Dr. Goreau reef restoration in Indonesia and became an active member of the Global Coral Reef Alliance. When I came back to New York I collaborated with marine biologists and ecologists and built the first solar powered oyster reef in New York City in 2006-7 in College Point Queens. I have been teaching a hybrid design and sustainable reef restoration class at the New School for Eugene Lang and Parson's students for the past three years. The class entitled "The Art of Urban Oyster Restoration” has conducted numerous experiments and is currently
collaborating with the NY/NJ Baykeeper on a citywide program to restore oysters to New York's Harbors.

I am also a founding member of "The Green Salon" devoted to environmental solutions where I worked on two major symposiums and think-tank around water solutions one entitled the "The Blue Salon" at the Swedish Embassy 'House of Sweden' Washington DC in 2007 as well one this past spring in conjunction with the New York Academy of Sciences on "Sustainable Water Solutions" here in New York.

**Artistic Mission on Board:**

I am devoted to the cause of teaching people about how their planet's atmosphere functions it hope that they may preserve it better. In particular, I think it is important to start with the Oceans and their waters. Most of our body is composed of water making us "water based" life forms. Taking care of water is the same as taking care of our own bodies as it is our vital life force that connects us to each other and our planet.

As a science based artist and environmentalist my mission on board Tara Oceans was to collect data and research the science of the unique and vital ecology of plankton. I am delighted that the leg of the voyage was off the coast of Chile as it is well known that the sea there is rich in diatoms some of the most beautiful forms on the face of the earth, their delicate forms and skeletons are barely touched by the heavy hand of gravity making them hover in the brink between human perception and life so small it is not visible to the naked human eye but can only be discerned through microscopes, with endless formations as different and delicate as three dimensional snowflakes.

With ocean acidification and global warming occurring our planets' plankton is in jeopardy which making my role as an artist and educator both timely and necessary. My work will act as a catalyst for creating public awareness around the importance of understanding and preserving plankton with my primary source data being the plankton that I helped collect in Chilean waters using the actual data collected by Tara Oceans scientists as examples. The reasons why it is important for the public to learn about this vital part of ocean ecology are innumerable but heading the list is that plankton plays a crucial role in the way that our atmosphere functions. For example, it is a little known fact that plankton protists produce up to 50 percent of the oxygen on the planet and that plankton is a major source of carbon sequestration.
Tara Ocean’s Impact on My Art Work:

Tara Oceans is now in the process of discovering and categorizing untold endangered forms of oceanic life. I like to think of this work as following in the footsteps of the nineteenth Century German Scientist and artist Ernst Haeckel who not only discovered, named and described thousands of new species, mapped a genealogical tree relating all life forms, and coined many terms in biology, including anthropogeny, ecology, phylum, phylogeny, and the kingdom Protista but also brought them into the public through his magnificent illustrations. The work that has particularity influences me and countless others are his book Unstformen der Nature, "Artforms of Nature" which includes over 100 detailed, multicolor illustrations of animals and sea creatures.

Haeckle’s illistrations from the turn of the century of radiolarians

My hope is that scientists and artists will use the work that I produce from participating in this voyage as source material for centuries to Come.
A reef design I created based on a radiolarian skeleton
I arrived after more than fifteen hours of travel in Puerto Monte Chile, a small coastal town located at the tip of South America. From a cursory glance the stands by the road next to the sea are all very touristic with most of the plastic merchandise they sell coming directly from main land China. The most authentic merchandise the stands sell seems to be large bundles of wool accompanied by thick sweaters made from alpaca and sheep’s wool. I arrived in time for the last week of their tourist season and the weather is fair about 70 degrees F. The Puerto Monte is named after the mountains that surround its small bay the pinnacle of which is a snow capped volcano named of all things “Puerto Monte” which resembles in its near perfect symmetry Mt Fuji. There is a local market at the far north end of town, which boasts a bustling trade of fresh fruits, vegetables and all sorts of amazing fish. Because of the rich currents flowing up from the South, which create large-scale plankton blooms, Chile’s Coast boasts the largest natural fishery in the world. (One of our Chilean postdoc’s looked on with mirth as I attempted to consume a strange mussel-like mollusc which was either naturally red or turned red from the smoking/preserving progress it went through called ‘Purin.” With its name omomoniapelia sounding a bit like ‘putrid’” and its chewy texture and bitter strange bitter taste, it more than surprised me. When I spat it out unable to stomach a swallow I was met by peels of laughter from the other Chileans on the boat. Apparently the men in Pamela’s family (one of our Chilean Postdoc’s) are able to eat the stuff while the females detest it. I had the vague sense that “Purin” has a direct stake in Chilean male virility….

Pamela Labbe-Ibanaz
Later that same day….

When I arrived at the port even farther north of the market on a winding road at the base of the mountains Tara was nestled in with a lot of other fishing boats. On first glance as I practically somersaulted down the pier it was much smaller and more weather worn than I had expected from the glossy images I had so longingly looked at. When I arrived the crew from the Antarctic was still on board, the Tara “A” list having just viewed the snowy Antarctic with its whales and glaciers. Among the people there from the last leg were Etienne Bourgois, Tara’s visionary leader, Eric Karsenti, scientific director and mastermind of the 3 year long expedition, Christian Sardet the genius 2-D imager from Villefranche and a hilarious French journalist in leather pants who apparently freelances for National Geographic. Because it would be the only time their crew and ours would be together I made sure to get plenty of photographs with the Explorer’s Club Flag. After which “foies gras” and wine was served in the homely wooden mess. Needless to say I ate no “foies gras” but drank several glasses of delicious cool white wine. Alcohol is not permitted while at sea during the voyage so it was a special occasion indeed. It was wonderful to be on the boat and to meet the crew. Everybody was a bit weather worn and quite jolly. We had dinner at a seaside restaurant. I had small pieces of abalone, which was quite meaty and juicy. I thought it was delicious.

2.19.2011 Stuck at Port

Chris Bowler, Me, Antoine Thriller on deck
We did not set sail today as planned, because the ships’ winch was broken. This is really too bad because it means we cannot collect from deep water so unless we get it fixed we are stuck collecting surface plankton samples. Chris Bowler (English, but working in Paris) our Chief Scientist for this leg told me maybe we will be able to drop a few bottles down fairly deep if necessary. On-board there is also a rosette hand crafted by one of the Engineers on board. The problem with the rosette is that most of the line has been used for the anchor and we only have 250 meters left and it is not stable at all. As a result it will depend on the weather if we can use the rosette. Our Captain Hervé Bourmaud that it is predicted said we should have fair weather and smooth sailing with plenty of strong wind during our leg. (The Antarctic leg received mostly rain everyday) Before dinner our Chief Scientist Dr. Chris Bowler gave us a brief lecture on the dynamics and biology of plankton and how Tara is sequencing DNA, and creating three-dimensional images of plankton. One interesting thing of note that Chris mentioned is that the Tara Scientists are identifying all the different strains of plankton and then re-creating their ecosystems in silico, to understand which organisms are doing what and how. The reason for this is so that they can learn about how plankton communities function and evolve together.

Tomorrow we will set sail at 9:00 am!

2.19.2011 All about LECTURE: CHRIS BOWLER: CHIEF SCIENTIST ON CHILEAN LEG

Tara is a boat owned by Etienne Bourgois, the Director of ‘AgnesB.’ a famous French fashion house. Etienne has been the owner for the past 8 years and the boat is a sturdy schooner with a flat bottom especially made for ice so that it can drift on top of ice without being crushed by it. Eric Karsenti is the scientific mastermind of the 2.5 year long expedition, also a sailor, he convinced Etienne to use Tara for a 2.5 year worldwide expedition devoted to planktonic ecosystems, which will diagnose the health of the ocean at the turn of this century. There are many trials and tribulations on this voyage as Tara is a fairly small sailboat with a small crew. Amongst them are variable winds and adverse weather conditions,
changes in seasons from very hot to very cold, currents and pirates. As Tara is travelling around the world it stops in major ports and even some small ones. Tara’s mission while at port is to meet with local people and ambassadors and always to educate the world about the importance of plankton and its role in relationship to climate change. So far some of the places Tara has sailed are the Mediterranean, Indian Ocean, Rio de Janeiro, Neunes Ares, Chile, and most recently Antarctica next stop after our leg will be Easter Island. It is planning ongoing for the first time through the Northwest passage and will stop in Boston and New York in 2012 before she heads home to France.

While in the tropics Tara studied coral reef systems as well as planktonic ecosystems. Wherever Tara stops the crew educate children about the science of plankton through images and stories illustrating why plankton are important for the well being of our planet. They show microscopic images of many living things adrift in our oceans such as metazoans, protists, prokaryotes and viruses.

Plankton is the base of the oceans’ food chain; photosynthetic plankton creates half of the worlds’ oxygen. Yet it is grossly understudied mostly because of the difficulty to study open ocean systems.

Its main supporters are Veolia and Elecricite de France, the IUCN (International Union of Nature Conservancy) and UNEP (UN Environmental Program), the French national funding agency CNRS and the European Molecular Biology Laboratory (EMBL) in Heidelberg Germany.

2.20.2011 Humboldt Current

I am lucky to be on-board during this leg off the coast of Chile because water below the surface is rich in nutrients that plankton love. The water is part of the Humboldt Current that flows off the coast of Chile, mixing warmer sub-equatorial water flowing from the north with sub-Antarctic waters from the south. The mixing is patchy and creates pockets or holes which are chock full of the nutrients that plankton thrives on. These nutrients fertilize the water and feed massive plankton blooms especially the beautiful protists called diatoms, which have cell walls made of glass. Diatoms are especially numerous near the coast.

Note: Protists are unicellular organisms.
There are two ways in which plankton is fertilized:

A. From upwelling of deep water to the surface on continental shelves. This brings nitrate and other goodies.

B. From atmospheric dust. This brings iron from the deserts.

Science meeting by Dr. Chris Bowler Our Chief Scientist on the Expedition
2.20.2011

Major Points:

1. The Humboldt Current is a very interesting body of water that we are going to sample. It is very rich in plankton even though there is almost no oxygen below 100 or so feet down.

2. We will not use the rosette because of the broken winch. This is OK for most of what we want to study.

3. We will be doing a typical Tara sampling protocol at each station, but Marcela Cornejo, one of our Chilean scientists on-board, needs 2-3 litres of water for her experiments, in order to study how N2O & N15 gases get incorporated into ammonia.

4. Marcella needs to be the first scientist to sample because she is testing for dissolved Oxygen which is an extremely time sensitive experiment.

6. There are to be 3 proposed stations: Tuesday am, Thursday and Friday. Satellite data showing chlorophyll concentrations, sea surface temperature, and altimetry (the height of the sea) will guide us to the most interesting sites.

8. 200 miles from the coast in open ocean will be the first station. This area is likely to be quite poor in plankton because the Humboldt Current is not likely to have much of an influence there.

9. Our third station will be at a site of upwelling and so should be rich in plankton. The site we want to target is called UPW and was sampled on a previous cruise 5 years ago.

10. I will get to use 4 degrees take out bottle last min-make Laberine erasing
Today we left Puerto Monte and headed for the Open Ocean. Grey Dolphins with white bellies (note look up name) followed the ship as it passed through a very difficult channel with incredible views of surrounding volcanoes with snow capped peaks. Chris, Antoine Triller (the optical engineer on-board), and I took the flag on deck for the occasion. Vincent Hilaire, the cameraman, took pictures of us from the zodiac, which was surrounded with dolphins! (I found the dolphins a good luck or auspicious omen)

Later I took the calm seas as a good opportunity to watch Christian Sardet’s “Plankton Chronicles” It is incredible what is living in the depths. I also found it to have a great narrative tract. I was especially impressed with the part where the narrator talked about the fact that ocean acidification is eating away at the shells or exo-skeletons of some planktonic organisms. After lunch there was a science meeting in which Marc explained that he built the ship’s “rosette” from scratch and it was a much-needed piece of equipment and he did not think it was worth losing it. The issue, which I may have mentioned before, is the line was divided up for the anchor and also it is a bit too flimsy for the rosette. So the final decision was to wait until open water and only to do
the surface samples. We then went to the “dry” lab on board (the “wet” lab being on the ships deck) One thing I found of particular interest was the “flow meter” which is constantly sucking up seawater from underneath the ship into a machine, which processes the planktonic content of the water. One can tell if it is working properly if there is a small bubble inside the tube. (Marc then asked everyone if they were up at odd hours during the night to check the flow meter to see if the bubble was there)

I spent the rest of the afternoon trying not to get sea sick as we were experiencing decent sized waves, organizing my test tubes and adding 25 mill of 95 % ethanol to them. I also began preparing a special power point for Tara, “Entitled from the Nano to the Geo”, which I hope to show in two nights after dinner. It is of note that the water temp was 17 degrees Celsius near coast and now that we are in open water it is 11 degrees Celsius. It is also of note that we left the blue sky in Puerto Monte and as we travel into the open ocean the sky has become increasingly overcast. Antoine Triller, who is a neuro-biologist believes the ocean has its own neuron chemistry, which is similar to the neurochemistry of brain function. For example, when plankton that form giant planktonic blooms are infected by pathogens they could send off warning messages to their neighbours, like synapses firing off to create actions “stemming” from the brain. I love this theory it explains how on a global sense everything is interconnected as plankton effects the entire functioning of the planet. As I sail on this boat a tiny blip in the vast blue expanse of ocean I can’t help but think to myself what is the human role in the planets’ functioning. Could our complex network of communication become the consciousness for our planet? Can our species react to information the same way our cognitive functioning does and in essence become a functioning brain to save our species and our ailing biosphere. Does our global presence ever more tightly knit by breakthroughs in technology, which increase communications and travel, do to improve our common planet? Will we as a species function as a parasite destroying the world for ourselves and other species or will we serve a conscious nervous system to improve life for all, avoiding the pending environmental disaster? The mission of Tara Oceans is to diagnose the state of the world’s oceans and how they relate to our atmosphere in essence the information is for future generations. Perhaps what is the most important function of Tara is to communicate educate the world about the role of plankton in our atmosphere. This way of thinking is in congruence with Lovelocks “Gaia Hypothesis” which I abide by. To quote Lovelock…

“Still more important is the implication that the evolution of Homo sapiens, with his
technological inventiveness and his increasingly subtle communications network, has vastly increased Gaia’s range of perception. She is now through us awake and aware of herself. She has seen her fair face through the eyes of astronauts and the television cameras of orbiting spacecraft. Our sensations of wonder and pleasure, our capacity for conscious thought and speculation, our restless curiosity and drive are hers to share. This new interrelationship of Gaia with man is by no means fully established; we are not yet truly a collective species, corralled and tamed as an integral part of the biosphere, as we are individual creatures.”

-James Lovelock, "The Gaia Hypothesis" 1971

February 21st, 2011 Station One

We reached the first station today (Station 90 for Tara) and began a huge sampling procedure about 5:00pm. There was a surface net to catch plastic as well as other large-scale nets that were cast at the surface and down to a few hundred feet. Marcella, Celine Dimier (the biology engineer), Pamela Labbé, Chilean guest, Chris and the crew were all scrambling around. (At one point I saw a large black fin protruding from the water. I thought it was a dolphin at first but Marc and the rest of the crew thought it was a shark except for Vincent who thought the animal in question was most likely a Sunfish. Personally I think it was a shark just by the methodical steady course of the trajectory of its protruding fin.) Finally after the mad scramble died down and the scientists were done “Fishing” for plankton I was able to cast my 153 micron net for a full 10-15 min. When I first cast it the net just bobbed along the surface so I pulled it back up and kept it attached to the fishing line that I brought with me and just let it spool out. When I re-coiled the net back in, quite a haul, I was reminded of “Old Man and the Sea” by Ernest Hemingway. I was amazed! Even tough I spilled half my collection jar on deck my sample was teaming with life! Especially prevalent were tiny Medusas. In fact I also saw a ctenophore, or “gooseberry”, which was the exact specimen I was fabricating a week before while on land! I fixed my samples in 95 % ethanol, which will most likely not preserve the jellies well according to Frank Prijger, the second deck engineer. After dinner Chris surprised me with a fantastic gift of some of the “protists” that Celine had collected with a larger net 50 cm across as well as one with a smaller mesh especially designed to capture protists.
I took four 50 ml test tubes and filled them to about 25 ml. Frank graciously added about 1ml of formaldehyde, which he says was enough- the stuff is TOXIC! :}
Today started quietly with Frank giving me a lesson in ctenophores.

Detail of ctenophore sketch

February 21st, 2011 cont…

The reason that Station 90 was picked as far as I can tell is that the Humboldt Current, which travels from the north bringing with it an amazing amount of Nutrients, is not very strong there, which will make an interesting comparison for the next sampling stations which should be right in the heart of the current. But there are a lot of other factors as well, as Chris says, “this is an interesting body of water”, such as winds from the South. When the sub-Antarctic Currents meet the nutrient rich currents … BOOM! –PLANKTON SOUP
February 22nd, 2011 Giruses and Birthday in the Drylab

Today started off slowly with the ship travelling only at about four knots as we sailed toward the next station. Everyone is quietly working on their computers in the ships cabin and Pamela is busy with her tedious work of filtering what seems like an endless amount of water to isolate bacteria, viruses and giruses. Giruses are an amazing new form of life that are half virus-half bacteria that seem to live a parasitic existence inside other cells. She has been working around the clock with very little sleep to finish the job. Marcella is measuring nitrogen levels in the ocean to see how plankton blooms affect atmospheric gases like nitrous oxide… Basically, more photosynthetic plankton means more oxygen and less carbon dioxide. But she says we still don’t know how nitrous oxide is made and how it gets broken down, and so she is looking for bacteria that do it.

Later the same day…

Actually it is my Birthday today. I didn’t tell anyone on board because I did not want to be a bother. However being on this ship and collecting samples is one of the most rewarding things I have ever done. I can’t believe I made it through life without any major accidents and the curiosity of my youth still intact. The days onboard seem to float by but in real-time.

Drawing of Yemanja is an orisha

Yemanja is celebrated throughout Africa and Brazil originally of the Yoruba religion, who has become prominent in many Afro-American religions. Africans from what is now called Yorubaland brought Yemaya and a host of other deities/energy forces in nature with them when they were brought to the shores of the Americas as captives. She is the ocean, the essence of motherhood, and a protector of children. I this drawing made after a few hours on the bow of the ship screaming to the waves and wind.
This afternoon Antoine and I used the microscope to look at samples I collected yesterday at Station 90. Like Frank predicted, the sample that I preserved in 95% ethanol was pretty much decimated by the alcohol. The amazing thing though was that there was a comb jelly in one of my test tubes about half the size of a raisin.
I could not believe it since before I left I had started making these same creatures in glass. This was taken with my small net, which was just skimming the surface. The sample that Celine took that was fixed in formaldehyde did much better. Her net takes “bugs” (plankton) from 20 microns to 180 microns so her mesh size was much smaller and therefore particularly geared for taking protists like diatoms and radiolarians. We did not capture any specific diatoms or radiolarians that I recognized, but there were a lot of them. Some of the specimens still had color from their chlorophyll or from the zooanthyllae embedded in them. Some looked like fluted champagne glasses (these organisms are called tintinnids), while some looked like “critters” or tiny lobsters. These latter ones Celine said were juvenile copepods. There were also some juvenile jellies or medusas but Celine said these had not yet been fully formed.

Glass Fabrication of Ctenophores
At the second station I will try and use formaldehyde for my 145-micron sized net. The sun came out later in the day today and we are still sailing at the slow pace of four knots. Hervé says this is so we will reach the second station when the conditions have improved enough to be able to sample. At the moment the swells have gotten quite large (6 metres) with 30 knot winds, and the boat is positively swaying back and forth on either side. Every now and again some big waves crash into the boat. Note to self ask Frank if I can pour most of the ethanol out and replace with formaldehyde.
February 23rd, 2011 Science Meeting and Equipment on Board

1) Recording changes in the oceans due to climate change is important because the oceans generate half of the oxygen on the planet, oceanic plankton is a major pump to remove carbon dioxide from the atmosphere, and because plankton is the most fundamental link in the oceans food chain.

2) We have no consistent dataset to gauge the health of the world's oceans but the data collected by Tara will provide a data set for the beginning of the 21st century that can be used for centuries to come. The Tara Oceans expedition is providing this data for free.

3) The nutrient rich water brought by the Humboldt current off the coast of Chile is an incredible life support system for this part of the world, and so can be very sensitive to pollution. The Chilean aquaculture industry generates a lot of pollution and damages marine ecosystems. One effect is that they create toxic algal blooms which can poison fish and even humans sometimes.

4) Tara is also measuring microscopic plastic in surface waters. This is the first time anyone has done this on a worldwide scale.

5) A lot of the water near the coast of Chile is cold water coming from sub-Antarctic regions, whereas the warmer Humboldt current is below the surface.

6) The water gets warmer as you go West because the subantarctic waters have less influence but it is still cold.

7) The salinity of the water is affected by the Humboldt current but is also affected by rainfall and river runoff.

8) There is very little oxygen in this body of water below 50 metres. This is called the Oxygen Minimum Zone. There is not enough oxygen for life here and so it is amazing that the surface waters are so productive.

9) N2O is very high here at 11 or 12 max.

10) The third station is 92 for Tara.

11) UPW was sampled during a 2004 cruise and should be high in phytoplankton.
14) The large purple areas on the map indicate that nitrate is poor, so in these regions there are not many nutrients that can nourish life.

15) Tara is also measuring microscopic plastic in surface waters.

16) The nutrient rich water off the coast of Chile is very important for their fishing industry. It is also important further north, off Peru.

LECTURE: By Marc Picheral seen below on deck

Marc is the deck engineer on-board Tara who hails from Villefranche in Nice. The lecture began with Marc’s photographs from the Antarctic expedition leg before this, they are incredible. The rest of the lecture was based on the different kinds of equipment that Tara is equipped with that record in real-time what is being found in the ocean.

The instruments in the “dry lab” work 24/7 as Tara sails and are used to generate data that create model to teach us about different water masses worldwide. There are 3 main sensors, which detect temperature and salinity 1.5 meters below the ship. The temperature censor can detect minute changes in temperature up to a thousandth of a degree. There is also a “Spectral Absorption and Attenuation Meter” (ACS) that measures coloured and fluorescent particles in the water, many of which are living organisms. The flow cytometer uses light to produce images of what the plankton cells actually look like. In addition at each station many other instruments are used. The average time of a Station is 1.5-2.5 days. Plankton nets filter to generate samples for meta-genomics or imaging, three dimensional microscopy, and taxonomy. All the nets have sensors that relate the depth and volume of water filtered. There are nets that go to 100 meters, and for 500 meters there are nets called “Bongo” and “Regent” as well as a deep water net at 1000 meters. It is very important to be very precise. Depth recorders also have weights to help them stay down. Blue pressure increases with dive and night dive, which helps us know where and when to sample. The
multi-net is a stainless frame with five nets that can collect at different depths. The maximum depth for the Mult-net is 1200 meters, and by calculating the speed and area we can know the amount of water that passes through the net. The Manta Net does surface sampling of microscopic plastic particles. The peristaltic pump can pump down to a depth of 100 meters. A Tethered Spectral Radiometer Buoy or TSRB measures light from the sun and reflections of water that are indicative of assemblages of phytoplankton. To sample from depth and to measure fluorescence and other parameters like nutrient concentrations at the same time the Rosette is often used. The CTD Rosette is composed of ten water bottles, which are pre-programmed to collect water from different depths. There are different sets of sensors which test for: temperature, conductivity, oxygen, beam attenuation, fluorescence, CDOM, Back Scatter, Nitrates. The Rosette was made by Marc and is composed of handmade and store bought components, which can fit many sensors into a small frame. What is unique about the Rosette is the underwater vision Profiler (UVP) that profiles images of living organisms down to 1 millimeter in size, precisely in the ecological niche where the organism lives. This Meta data is being archived to be used for the next generations of humans on the Planet. So far, Tara’s rosette has made 187 profiles. There are three instruments on-board that can capture images of zooplankton. They are the Flow Cam, Zoo-Scan and the underwater profiler on the Rosette. The Flow Cam counts the size of everything that passes through it above 10 microns. This means any particle, whether zooplankton or phytoplankton, or other gets counted. The zooscan is a machine in Villefranche that is trained to identify different kinds of zooplankton.

After Marc’s lecture I was exhausted by the amount of equipment on such a small vessel it is really incredibly efficient.

February 24th, 2011 Geotherapy at Sea
Today so far has been the least eventful of all the days at sea. We are enroute from Station 90 to Station 91, which is about two straight days of sailing. The swells are really big and have been since yesterday afternoon. Last night I fell asleep almost instantly feeling safe inside Tara like Jonah inside the whale as the boat rocked and swayed to and fro. A large wave crashed into Pamela and Marcella’s room through their skylight soaking all of their clothing… With luck the swells will die down by morning and we will be able to collect specimens at 9am. I am going to divide the specimens half in 85 % ethanol and half in formaldehyde. Tonight I am giving a talk on my artwork after entitled “From the Nano to the Geo”.
The most nerve racking part of this for me is speaking slow enough so people who don’t understand English that well can understand me and fast enough so that I don’t go over my half an hour allotment. I am excited to explain to the scientists and crew the concept of Geotherapy by which embed in all my work which either teaches the public about science or actually becomes living sculpture as with my reef sculptures or bio-filtered aquarium. Result of panel discussion: May 17th 1991, Confrence at Universite Claude Bernard Lyons France. The term Geotherapy was coined at this conference by, Von Renssler Potter and Richard Grantham.

Declaration for Geotherapy and Bioethics:

- Accelerating Environmental Degredation threatens the habilbilty of the Biosphere. We believe that corrective action is possible and urgent.
- Our goal is long term survival in an acceptably maintained ecosystem
- We as human beings take full responsibility for our actions by not sacrificing natural resources for short term gains and by working to make the world a better living place
- This choice will influence our biological and cultural evolution; we cannot avoid it without grave consequences
- A global bioethic should further develop a guide and motivate geotherapy and our cultural evolution.
- A root problem is excessive demographic growth; the earth’s carrying capacity is being exceeded. With the present style patterns of development pollution of all kinds will increase as long as the population increases.
- We declare that scientists people* of all walks of life should adopt the aforementioned goals and participate in meeting at all levels to apply these principals.

*artists addition
I am also going to show the project I did of a solar powered amphibious reef. Based on the shape of a Ctenephore
The proposal I completed two days before departure entitled “Enchanted Star Sand” for Miyako Island for the first time tonight and I am looking forward to getting some feedback.

**February 24th, 2011 The Wave**

My Talk went last night and even I was impressed as for the first time on board I succumbed to seasickness and was violently ill directly before my presentation. Another important lesson that I relearned from surfing was that it is important never to turn your back on the ocean. After I got sick before my lecture I was trying to “catch” some air on deck near the cabin door where all our navigational equipment is. I was holding the puppy we have on board Chiloé and chatting with Hervé our Captain when suddenly he yelled “CLOSE THE DOOR” I turned around and saw a gigantic wave crash onto the deck. It looked as if it was in slow motion to me with giant finger-like tendrils coming straight at us. I shoved the puppy into Hervé’s arms and managed to close and lock the door in time the skylight in the main cabin was left open and reports have it that water came rushing in a few inches away from the lap top I am writing this on as well as a few other people’s computers. Everything on the table was soaked and tipsy turvy and I was happy I had been holding the small pup and he was not lost at see. Hervé explained that the largeness of the wave was due to a culmination of waves from the South Pacific when they join forces with the Humboldt current they join forces and VOILA! One Mungo-Hungo wave!!!! (This must have been the same kind of wave that soaked Pamela’s and Marcella’s cloths. Also another thing that I learned yesterday is that copepods are the most prevalent kind of zooplankton. Later that day…We could not sample today, which is quite a shame because it is the perfect place where the South Pacific Gyre meets the colder water of the Humboldt Current. This was because the waves were too high, maybe six meters. So instead for the first time we put up all the sails and turned off the generator. IMAGES until the generator was turned off I did not realize that it was creating so much white noise. I spent the afternoon imaging with Antoine in the dry lab. We were just a days sail away from Robinson Crusoe Island today. Unfortunately we couldn’t call in as it was not on our route.
February 25th, 2011 Collecting Samples

Last night the waves died down completely so we woke up to a lake like ocean, which is not great for sailing but perfect for sampling, which we did do at a site closer to the coast than we had been planning to do. I first used the 153 mesh net and caught many ctenophores and what looked like a lot of “Portuguese Man of War” larvae, which can be identified by the blue violet color spots they have on them. I then switched to my 20 mesh net to obtain the smaller “bugs”. As far as I can tell this worked perfectly. The ctenophores were huge almost one inch long in perfectly clear water. When I emptied the jar from the 20-micron mesh net it looked “dirty”, meaning it was teeming with life smaller than the eye can see.

After the petite dejeuner I was doing my chores for the day. Actually I was just finishing up taking out the trash and taking it upstairs to the deck when there was a commotion on deck. We were surrounded by a pod of twenty sperm whales travelling with their calves. At first I thought they were grey humpbacks but when I saw a very rectangular shaped head emerging from the water’s surface I could tell they were in fact Sperms. The Sperm whale I later read in the ships’ identification book are on average 60 feet or 18.4 meters and weigh 60 tons or 57000 kg and are the largest
toothed whale in the Oceans. It now all makes sense that these giant magical beasts would live in this nutrient rich water, which is teeming with life, and why in Melville’s ‘Moby Dick’ much of the books action where he battles with the Sperm whale takes place of the coast of Chile. The whales stayed with Tara for a good half an hour surrounding the boat on either side until they began swimming away towards the North West.

February 25th, 2011 Station 3
Today we did a third sampling station and everything went like clockwork. Only twelve miles off the coast it was chock full of life and everybody was at ease at his or her stations on deck. A far cry from the near panic of the first Station as people were just learning how the equipment operated. After sampling Antoine and I used the Flow Cam and the microscope the whole day to capture beautiful images. When Antoine got busy with the other equipment I went up to the bow of the ship my favorite spot and spent a lot of time staring at the waves. It’s the best place to feel the power of the oceans and for me the bigger the waves the better. I love riding the swell and staring at the seemingly endless blue horizon moving in front of me. Our last dinner was quite jolly and I admitted to everyone that I had started the trip quite nervous but had “fallen in love with everyone aboard”. I am in love with Tara and the Ocean. This love has only grown while aboard and has now all but consumed my being and my soul.
February 27th Valparaiso and Micro Plastics

Sometime late this afternoon I came on deck and saw the first glimpse of land I had seen for a week. I knew that morning we had only been twelve miles off the coast but still it came as quite a shock. We had reached our next port of call Valparaiso, Chile.

View of port In Valparaiso

Colonial style architecture in Valparaiso

Valparaíso known to sailors as city was known as “Little San Francisco” and “The Jewel of the Pacific.” The city very quaint with colorfully painted buildings stacked on top of each other on cliffs overlooking a bustling seaport with many colonial style buildings in the main square and scattered. Upon its hills. Valparaíso was once one of the most important ports in the world when in the second half on the 19th century the
Valparaiso’s port served as a required stopover for ships crossing between the Atlantic and Pacific oceans before the Panama Canal was formed no longer was Valparaiso the agricultural Picunches Indians, or the nomadic Changos Indians but became a magnet for European immigrants, Valparaiso mushroomed. Many refer to this period as during as Valparaiso’s golden age, (1848–1914), the city received large numbers of immigrants, primarily from Europe and newspapers in German, French and English could be found on every corner.

My first steps on land were odd to say the least as I accompanied Marcella and Pamela to go and get a local empanada at Marcella’s favorite place (she studied in Valparaiso as and undergraduate) I felt as if I was still at sea. The rocking sensation persisted for the greater part of an hour and was intensified when I went into small spaces like the bathroom of the restaurant. It also felt odd to be amongst civilians and I realized I could not wait to get back to the ship and the rest of the Tara Crew. The next few days were filled with sunshine and taking care of biasness we were joined by World Courier who collected all the samples and the new crew mostly composed of women began arriving. It was great to meet the new people. Since school was still in summer last session we did not immediately have students to visit the ship. But our second day in port there was a visit from the French Ambassador and other locale officials. There was also a press conference I did not attend, as they mainly wanted to focus on the work of the Chilean Graduate students.

Micro plastic collector in action
One person that I met during this transitional period was Melissa Duhaime an American woman, my first contact with a fellow American, studying at the Biosphere2 in Tuscan Arizona. Meeting her was incredible as she is not only nice and smart but also studying the exact one of the subjects I am most passionate about as an environmentalist, which is the effect of distinitrating plastic particles in the ocean. To this end she was sampling the plastics for the microbial effects of plastic found in Tara’s plastic collector on plastic and UV degraded plastic found on Tara with the idea that they could be tested in a in the man-made controlled ocean that exists in Biosphere2 environment. Melissa gave me her grant proposal that she was working on with conjunction with Tara Oceans and here are some of the major points as to why the study of micro plastics is important which is unlike chunks of plastics which are mostly float on the surface of the ocean or are contained in “The Great Pacific Garbage Patch”, an massive accumulation of plastic trash the plastic is mostly contained by tides and eddies within it. Micro plastics or UV degraded plastic is found throughout the water column only to settle in the ocean floor. As Melissa wrote, “These Microplastics vary, e.g., nano particles, beads, and resins derived from netting, ropes, packaging and floats…. This recently recognized global distribution and potential threat of Micro plastics to human and environmental health has led researchers to believe that “one of the most ubiquitous and long-°©-lasting recent changes to the surface of our planet is the accumulation and fragmentation of plastics” Barnes et al., 2009). Micro plastics are a huge threat to human and animal health as their toxicity increases upon ingestion. Melissa wants to study micro plastics and the communities of microbes that settle on them her.” hypothesis that differences in plastic type will correlate with different microbial community Compositions more strongly than with surrounding source water, or other variables.” What is so fascinating and terrifying about what Melissa is studying is that nobody knows the long term effect that plastic has on the planet because plastic is a relatively new substance it is vitally important that this is studied as she states, Microbial communities (bacteria, archaea, micro-°©-eukaryotes, and their viruses), in a biochemical sense, rule the world.” Future generations will note the time that we are now living in as “The Age of Plastic” etched in our geological history. I realize this is a depressing a depressing way to end the account of what I consider an epic journey however I found meeting Melissa to be completely inspiring because with out the science behind the plastics and their effects on living organisms there can be no solutions. The future of our species is intertwined with the health of our oceans.

Microplastic observations
Antarctica St. 85
approx. 49 W, 62 S
M. Duhaime
Plastic particles found on beach at Easter Island

The Future Is Up To Us