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Ballast water research in France : Current status

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♦ **Abstract :**

Due to important economic activities along the French coastline, the introduction of noxious organisms into French coastal waters, particularly by ship ballast water, may have serious consequences.

After preliminary studies of ship movements in Charente Maritime, several samplings of ballast water and sediment were made. Samples were taken in five major harbours in France, along the Atlantic, Channel and Mediterranean coastlines. The main task of this first assessment was the research for exotic and possibly noxious phytoplancton. *Clostridium* and *Vibrio* bacteria were also tested for. The results are presented and discussed, with plans for further work.

♦ **Introduction :**

Risk assessment of the introduction of unwanted or noxious species along French coasts by ship deballasting is now a matter of concern for the French authorities.

A previous study in La Rochelle harbour (Charente Maritime) indicated that a high percentage of arriving ships came from areas known for toxic algal blooms. Subsequent work has therefore been carried out concentrating on these ships arriving in French ports.

The main points to be stressed were tests for the presence of :

- 1° Known toxic phytoplancton cells,
- 2° *Vibrio* and *Clotridium* pathogenic bacteria.

This is a completely new research subject in France and requires the development of methods comparable with the same kind of work already done elsewhere in the world.

♦ **Assessment of deballasting activity in the main French Harbours** :

The diversity of harbours, of goods loaded or unloaded and of type, size and age of ships, makes it a hard task to estimate the amount of water deballasted in French harbours or in the close coastal areas.
Ballast water management is slightly different on a large container carrier, for example, coming into Le Havre from Anvers to complete loading before crossing the Atlantic Ocean and on a small bulk carrier arriving on ballast in La Rochelle or Rouen, from North Africa, for loading corn, wheat or fertilisers.

The following table gives an idea of the amount of ballast water released in French waters, estimating ballast capacity as 40 % of the loaded freight capacity.

Main Harbours	**Loaded freight (T) (1998 or 1999)**	**Cargo**	**Estimation of BW released (MT)**
Dunkerque	7.950.954	Cereals (1,6 MT) , oil and gas , diverse	3
Le Havre	14.718.345	Containers, fresh and frozen food.	6
Rouen	15.190.286	Cereals (8,8 MT), food, gas, ore	6
Nantes-St Nazaire	6.137.194	Oil and gas, cereals, wood, cars	2.5
La Pallice + Rochefort	3.055.356	Cereals, fertilisers, meat	1.2
Bordeaux	3.197.412	Cereal (1,9 MT), oil, paper, containers, Clinker and cement.	1.3
Bayonne	2.500.000	Corn (1 MT), sulphur, chemical, products, wood.	1
Sète	580.000	Liquid or solid bulk, various	0.2
Marse	1.620.400	Fresh food, containers	0.65
Total	**54.949.947**		**22**

- **Methods:**

Sampling :

Due to the short notice and the limited funds in this first study, the sampling was restricted to five ports and five ships in each.

Among the habours of Dunkerque, Le Havre, Nantes-St Nazaire, La Rochelle-Pallice and Marseille-Fos, samples were taken from 29 ships:

RoRo	:	4
Container carriers	:	7
Bulk carriers	:	16
Gas Tanker	:	1
Ore ship (OBO)	:	1

The ships had come from :

North Africa	:	5
Middle East	:	2
Africa	:	4
North America	:	3
Caribbean	:	2
South America	:	2
Spain	:	5
South East Asia	:	2
North of Europe	:	2
Unknown	:	1

The main problem for such sampling in French waters is the lack of ballast water management regulations. Therefore we could only rely on the goodwill of the captains and accept what was offered, i.e. the possibility of taking one or two litres of water rather than filtering several cubic meters as described in Mc Donald (1995) or Gollash et al (1995).

We therefore devised a sampling kit with two small bilge pumps (one suction pump and one immersed, used depending on the situation), connected to a motorbike battery, enabling us to pump 6 to 12 litres at a depth of up to 6m. This system was used 4 times.

The other sampling methods were :

- Tap on the ballast (pumping system), usually on the pump, in the engine room.
- Outflow on the side of the hull : 1
- Overflow on the deck : 2
- Entering inside the ballast chambers : 2
- In the filtering system before the ballast pump : 1

♦ **Analysis :**

Phytoplancton :

The 1 litre sample was preserved with formalin (2 ml/l) and iodine (2,5 ml /l). The subsamples were put in 10 ml trays and checked under an inverted microscope after several hours settling.

♦ **Bacteria :**

The *Vibrio* and *Clostridium* germs were tested for as these are the most worrying genera. They are relatively easy to culture on EPSA (Alkaline salted peptone water). This was done for 18 hours at 41°C, isolation was then performed on TCBS (Thiosulfate, Citrate, Bilesaccahrose) for 18 hours at 37°C, and, after oxydase testing, the genera were determined with an API 2O E system.

For the *Clostridium*, a TSN (Tryptone-Sulfite Neomycin) medium was used, for 24 hours at 37°C.

When necessary, a further serotype determination could be done at the Institut Pasteur (Paris).

♦ **Results :**

The results already available are shown in table II.

Bacteria :

Clostridium perfringens, the most commonly isolated of the genera, responsible for gastro-intestinal tract infections, was found in 50 % of the samples, whatever the origin of the ballast water. The number of colony units was particularly high in the sediments.

The *Vibrio* taxa detected included serious pathogens but not *Vibrio parahemoliticus*. This last species, common in estuarine and coastal water, is frequently responsible for collective toxi-infections associated with seafood consummation.

The other genera (*Pseudomonas*, *Aeromonas*, *Schewanella*) are known as « opportunists », noxious for people with lowered immune defences.

Phytoplancton :

Of the18 samples already examined, 8 contained genera, such as *Dinophysis*, or *Pseudonitzchia*, known to contain toxin-producing species (most *Pseudonitzchia* were *seriata sp.*). Most of these were not recognised as toxic, but there is a strong possibility of finding species producing toxins which are noxious to the marine fauna present in French waters. In the present case these come from NW Spain.

In addition we also found an undetermined dinaflogellate cyst in ballast water from Fort de France (West Indies).

♦ **Discussion** :

The sampling campaign is the first useful French study on ballast water quality to our knowledge. Despite the limited scale, some consistent results were produced considering the small number of ships sampled.

The main problem regarding sampling was heterogeneity. It was only possible in two cases to go inside a ballast, and thus obtain both water and sediment samples.
Most of the samples were taken in the engine room, from a tap or checking valve of the pumping system, with a pump running. Under these circumstances, very high pressures can be developed in some parts of the pump body, i.e., very difficult conditions for the survival of living cells...
In spite of this, we found a lot of bacteria, some of them still alive several hours after sampling, before we made the fixations. Fortunately, we didn't found *Vibrio cholerae* strains, but the survival of such strains under these conditions remains a reasonable possibility.

However, we detected the presence (and survival) of *Heterosigma carterae* in high numbers (62 400 cells/litre) in ballast water from Bilbao, well known as an area with frequent toxic algal blooms. This water was released at La Rochelle-Pallice, close to the main European oyster farming area. This gives an idea of the threat presented by deballasting activity in sensitive areas.

♦ **Conclusion** :

Although conducted on a limited scale, this sampling campaign revealed some worrying facts (as have previous foreign studies). Toxic phytoplancton cells and pathogenic bacteria were found surviving in the ballasts of ships arriving on French coasts.

This study in itself, not to speak of numerous international assessment and research programs, underlines the urgent need for consistent applied research programs in France, particularly in two directions :

- Provide scientific evidence and technical tools to the French authorities, leading to strict regulation of deballasting activity along French coasts.

- Find appropriate techniques for ballast water treatment, aboard ships and also ashore.

One of the first moves (on the European scale to start with) could be the setting up of a toxic phytoplancton alert monitoring network. This would help the different port authorities to efficiently manage the ballasting/deballasting activity of the ships loading and unloading in European waters.

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TABLEAU II : RESULTS

Type	Length (m)	Last Port	Sampling method	Salinity (g / l)	Possibility Toxic phytoplancton	Chostridium Perfingens (UFC /100ml)	Vibrios and other (occurrence)
RoRo	90	Casablanca	DB, tap on pump	37.7	Dinophysis, Pseudonitzchia	100	
RoRo	90	Casablanca	DB, tap on pump	36.6		0	
C.C.	110	Izmir	N° 1 ballast hold, SK	26.6		0	
RoRo	95	Algeria	Out flow on hull	36.7		0	
C.C	244	South East Africa	DB, tap on pump			0	
RoRo	112	Alexandria (Egypt)	DB, tap on pump			400	Vibrios
Bulk C	115	Brazil	Forepeak, SK	15.8		300	Vibrios fluvialis
Gas T.	287	Nigeria	Aft peak, tap on pump	24.3		0	
O.B.O	243	Baltimore	DB under sloptank	31.9	Pseudonitzchia, Dinophysis	0	
Bulk C.	168	Halifax (Canada)	DB, tap on pump	36		100	
Bulk C.	95	Santander	SB, SK	29.1		0	Schewanella putrefasciens
Bulk C.	88	Spain	Forepeak S.K.	32.4	Dinophysis, Pseudonitzchia	200	
C.C	290	Boston	DB, tap on pump	14.7		50	
Bulk C.	93	Algeria	DB, tap on pump	28.5	Pseudonitzchia (1800/l)	25	
Bulk C.	148	Scezin (Poland)	DB tap on pump	26.9		25	
C.C.	162	Anvers	S.B, overflow	16.6		0	
C.C.	260		DB, tap on pump	30.7		0	
C.C.	211	Caribbean	DB, tap on pump	29.2		25	
C.C	215	Caribbean	DB, tap on pump	34.	Dinoflogellate cysts	130.000 (sediment)	Vibrio Parahaemoliticus
Bulk C.	104	?	DB , tap on pump	34.		0	
Bulk C.	176	Africa	N°1 Ballast hold (inside)	35.6		700	
Bulk C.	197	Scezin (Poland)	DB, tap on pump	11.9		0	Vibrio fluvialis
Bulk C.	93	Bejaia (Algeria)	DB, tap on pump	30.		0	Pseudonomas-Aeromonas
Bulk C.	123	Spain	SB, tap on pump	32.9	Dinophisys	50	Pseudomonas
Bulk C.	218	Paranagua (Br).	SB starboard (inside)	33.9		200(water)750 (sediment)	
Bulk C.	170	China	SB starboard, S.K.	35.5		0	
Bulk C.	96	Seville Spain	DB pump filter	1.1		50	Pseudonamas
Bulk C.	82	Bilbao (Spain)	SB starboard, overflow	25.5	Heterosigma carterae	900	
Bulk C.	176	Dakar	DB tap on pump	33.7		0	

CC : Container Carrier
Bulk C : Bulk carrier
S.B. : Side Ballast
Gas T : Gas Tanker
SK : Sampling kit.
OBO : Ore But Oil carrier
DB : Double bottom