The *Sarmiento de Gamboa* in the Malaspina Project

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▸The Itinerary of the *Sarmiento de Gamboa*

The *Sarmiento de Gamboa* left Gran Canaria on January 27 2011 for the Dominican Republic, on a route similar to the one Christopher Columbus had followed over five hundred years earlier, to carry out the oceanographic campaign at latitude 24.5° north in the waters of the Atlantic. Previously, the *Sarmiento de Gamboa* had departed from the city of Vigo on its course to Gran Canaria with a group of researchers and journalists: the former told the latter about the tasks they would carry out during the oceanographic campaign, their importance and their details. A few miles from Gran Canaria, when everything augured that they would arrive in less than five hours, a fierce storm broke out that caused a delay of twelve hours in their reaching the island. It was not exactly a very promising start to the fifty-day crossing we were about to make, and yet everything turned out well.

For several weeks Gran Canaria had been preparing for the arrival of the *Sarmiento de Gamboa* with talks at the Museo de la Ciencia, delivered by Andrés Galera, Javier Arístegui and Santiago Hernández León. These talks, and the information we sent to the media via the press office of the Universidad de Las Palmas de Gran Canaria, had created an atmosphere of great expectation o that the arrival of the ship would be a success, which is what occurred. Over four thousand people contacted the Museo de la Ciencia, organiser of the visit to the ship, to get to know it. Besides visiting the vessel, the public was able to enjoy the Malaspina Expedition, whose curator, Sandra Rebock, travelled expressly to Gran Canaria to present it.

After a press conference attended by the President of the CSIC, the Dean of the Universidad de Las Palmas de Gran Canaria, the Director of the Instituto Español de Oceanografía and the campaign's head scientist, at which the details were explained of the Malaspina Expedition in general and our voyage in particular, we departed from Gran Canaria at three in the afternoon and headed for the first station, located 13 miles from Morocco, in waters 100 metres deep.

The first station in any oceanographic campaign is of crucial importance, since here we carry out what in theory we all know. The process of collecting physical, chemical and biological data must be conducted with exactitude, ensuring that there is no delay in sampling, since this would have an adverse effect on the development of the campaign. At eight o'clock in the morning the first station was sampled in the presence of all the expedition scientists. The success was total, a foretaste of the magnificent development of the campaign.

After this first station, subsequent stations were sampled one after the other from the ocean surface downwards, occasionally to depths of up to 6,000 metres, without any major mishaps. The weather was on our side at all times; indeed, during the fifty days of the campaign rough seas made it impossible for us to work on two nights only, a circumstance practically unheard-of on such a long campaign. The bad weather we experienced on the crossing from Vigo to Gran Canaria did not recur during the expedition.

For over forty days we saw no sign of land, only sea and the occasional ship on the horizon. On the 43rd day Esther, first officer of the *Sarmiento de Gamboa*, sighted land and made the announcement over the loudspeakers. 'Land!', we exclaimed, like the crew of the caravel *Pinta* when Columbus's lookout Rodrigo de Triana saw land. Furthermore, it was one of the Bahamas islands, like the one that was sighted for the first time in the New World.

Having seen the Bahamas, we proceeded to sample the current of Florida, which flows between this North American peninsula, from which it gets its name, and the Bahamas archipelago. It is a very fast current, ten times faster than any of the currents we had measured hitherto. Indeed, so fast is it that the cable that joins the instruments we cast into the ocean to the ship slanted at a spectacular angle. None of us had ever measured such a fast current before.

Once we had concluded sampling at the last oceanographic station, number 167! – never had so many stations been sampled at latitude 24.5° north –, we began our five-day voyage to Santo Domingo.

At nightfall, after sailing for fifty days, we reached Santo Domingo, where we were welcomed by Arturo Castellón, head of ships of the *Unidad Tecnológica Marina* of the CSIC. We chatted with him while customs formalities were gone through and finally were able to disembark from the *Sarmiento de Gamboa*. Walking on dry land is a strange sensation after so many days at sea. We headed for the colonial area, which is truly grandiose: the Parque de Colón, the Alcázar de Colón and the Cathedral of Santa María la Menor are three magnificent examples of what may be visited. And as you stroll through its streets, suddenly and unexpectedly you come across other, equally impressive monuments.

Our welcome in Santo Domingo, which has so many historical and cultural links with Spain, was extraordinary. Organised by the Centro Cultural de España in Santo Domingo, a series of events were held attended by a great many journalists and people interested in our research.

The day after our arrival, a press conference was held aboard the *Sarmiento de Gamboa*, in which Juan José de Damborenea, Associate Vice-President of Áreas Científico Técnicas of the CSIC, who had travelled expressly to Santo Domingo, and the chief scientists of the oceanographic campaign which had just been completed, explained the Malaspina Expedition.

In the afternoon of the following day a conference was organised in which those responsible for the Malaspina project explained its different facets and those of the latitude 24.5° north campaign. The conference was so well attended and the questions and comments so interesting that we were truly satisfied.

We also met and conversed with Diego Bermejo, the Spanish Ambassador, who received us with great hospitality.

▸The importance of the 24.5° north parallel

During the 1980s and 1990s an international project was developed called the WOCE (World Ocean Circulation Experiment), in which transoceanic sections were made in all the world's oceans. The main aim of these campaigns was to determine the relationship between the ocean and climate. The Spanish contribution to the project, led by Gregorio Parrilla of the Instituto Español de Oceanografía, was the execution and analysis of the 24.5° section latitude north in 1992, the same which, nineteen years later, we have carried out.

Once the WOCE project had been completed and the importance of the ocean in the configuration of the terrestrial climate acknowledged, a number of these oceanographic sections located at key points for the study of climate have been repeated on several occasions. The section 24.5° latitude north in the Atlantic is the one that has been repeated most often, due to the fact that it is the most important when it comes to determining possible climate change. And this for several reasons.

In the first place, the Atlantic behaves differently from the other oceans, the Pacific and the Indian, as regards heat flow. While in the other oceans heat flow is directed from the Equator to the Poles, in the Atlantic this flow heads north in all latitudes. Furthermore, it is at 24.5° north that this heat flow is maximum.

This explains why European winters are more benign than North American ones, which is easily verifiable if we compare the atmospheric temperatures of two cities on the same latitude, one in Europe and the other in America: for instance, Lisbon and New York. Lisbon has an average winter temperature 8° C higher than that of New York. From this we readily deduce that if there were any variation in this heat transport, there would be a variation in the climate of Europe.

In the second place, such variation, if it occurred, would have major repercussions on not only the climate of Europe but also that of the rest of the world, since in the North Atlantic, in the near vicinity of Norway, Greenland and the Sea of Labrador, there is an area of deep water that links all the world's oceanic circulations together in what is known as the Global Conveyor Belt (GCB), a concept introduced by Broecker in 1987. Any variation in this heat flow or associated transport of mass would also cause a variation in the formation of deep water masses and, consequently, in the GCB and global oceanic circulation.

The main aim of our campaign, therefore, was to determine whether or not any variation has occurred in the heat flow that carries oceanic masses northwards. To achieve this, we compared our measurements with those conducted previously in 1957, 1981, 1992, 1998 and 2004. However, our campaign also set out to determine whether any variations had occurred in other oceanographic parameters, such as temperature, salinity, oxygen, pH and carbon dioxide, among others. We were able to analyse some of these parameters directly aboard the *Sarmiento de Gamboa*, which is equipped with laboratories similar to those at research centres on land. Others, however, are being analysed at the research centres and the results will be known over the next few months.

▶ Life on board

Throughout the entire fifty-day voyage, work continued round the clock aboard the BO *Sarmiento de Gamboa* in shifts from 8 to 12, 12 to 4 and 4 to 8, both day and night. All the scientists on board were assigned to one or another of these shifts, except for the head scientist, who had to be permanently available to solve unexpected problems as they arose.

From the outsider's point of view, an oceanographic campaign might seem to be a very monotonous affair: we get up, have breakfast or lunch (depending on the shift), go to the lab to conduct experiments, have dinner and go to bed. But not everything is like this. Although we spend most time in the lab, there is also time for a little recreation. After lunch, a group of scientists take a rest, movie included, while others, in the evening or at night, get together to play cards, dice or darts. The *Sarmiento de Gamboa* has a container split into two, which is filled with water during fine weather to serve as a swimming pool. Sunday is a special day: for breakfast there are croissants or *churros** with hot chocolate. Many scientists, even though they may have been assigned a later shift, get up at breakfast time so as not to miss this treat. At lunchtime, weather permitting a barbecue is organised on deck. These are ways to break the routine, as well as telling us what day of the week it is.

On every oceanographic campaign a practical joke is played on one or other of the newcomers. On this occasion the victim was María, the journalist who accompanied us on board. There is a sensor called the XBT, which is shaped like a cannonball. The joke consisted of persuading her that it really was a cannonball and, consequently, it had to be cast with utmost precaution into the sea. We asked her if she wanted to be the one to cast the campaign's first XBT; naturally, we told her she had to be extremely careful so as not to suffer from burns, as many of us allegedly had. Without hesitating for a moment, she replied that she would be delighted, although she was very scared. At eight in the morning we began preparations, even though casting time was not until twelve: she had to put on fireproof overalls, a special mask and thick gloves. For four hours she sat with the XBT in her lap, from time to time being told 'keep it still, otherwise it might explode'. The captain, who was in on the joke, told her over the loudspeakers that it was time to cast the ball since there were no ships in the near vicinity, warning her to watch out for the recoil. A sailor even came with an extinguisher in case casting the XBT caused a fire. The XBT is completely harmless, of course, so after it had been cast the joke came to an end with tumultuous applause on the part of the scientists and crew for María and her heroic feat.

One of the greatest adversities that may occur on an oceanographic campaign is when a sampling instrument ceases to function. Sampling may last from four to five hours, so if the breakdown is not discovered until the end the result may be disastrous. In such cases, you have two options: either proceed to the next station, with the drawback that you have no data collected by this instrument from the previous one, or else repeat the sample, with all the loss of time this involves. This happened to us at station 25 of the 167 we sampled. We decided to repeat the operation, since the data the faulty instrument would have provided were of great importance to the objectives of our campaign.

So we repeating the sampling and waited the regulation five hours for it to finish and for us to process the findings. Then one of those wonderful things occurred that happen so rarely in the world of science: we obtained a result nobody expected and nobody had described before. When we compared this with the previous sampling, we discovered a time variability in the temperature and salinity values of the entire water column. Our calculations were repeated several times by different scientists in order to make sure that we had made no mistake in our operations. There was no mistake. The news began to spread through the *Sarmiento de Gamboa*: 'There's a time variation in temperature and salinity!'. 'Check and see if the same thing occurs with the oxygen dissolved in the seawater', we asked our colleagues who measured oxygen. 'Oxygen shows the same variability', they replied. Excitement was growing. 'Check that it's also in the Ph' (which measures the ocean's acidity). 'It's there, too', they said. Sampling repeated by way of routine, due to the failure of an instrument, had given us a result that nobody expected.

Another of the memorable episodes was the achievement of records on the ship. The Mid-Atlantic dorsal goes down to depths of over 6,500 metres, depths that the *Sarmiento de Gamboa*'s oceanographic instruments had never reached.

GENERAL CHARACTERISTICS OF THE *SARMIENTO DE GAMBOA*

1. Propulsion and steering system
- 1.1 **Propeller engine:** 2 x 1,200 Kw. GENERAL ELECTRIC electric motors (CC) in tandem with fixed pitch propeller.
- 1.2 **Generator engine:** 3 x 1,400 Kw. WARTSILA (CA) diesel-electric generators with automatic power control system.
- 1.3 **Bow thruster:** combined 590 Kw tunnel/azimuthal.
- 1.4 **Stern bow thruster:** 350 Kw tunnel.
- 1.5 **Rudder:** Becker type.
- 1.6 **Dynamic positioning:** class 1 Konsberg DP.

2. Gantries, winches and loading elements.
- 2.1 **Main:** stern.
- 2.2 **Articulated CTD arm-crane:** starboard (uner the hangar).
- 2.3 **Lateral gantry:** Corer/Plankton starboard.
- 2.4 **Main gantries:** Port (12 Tm - 16 m)
- 2.5 **Auxiliary gantries:** bow and stern.
- 2.6 **PESCAS winch:** two + 1 (double) drum network.
- 2.7 **CTD winch.** With data transmission (8,000 m Coax. 11 mm Ø).
- 2.8 **CORER winch** (8,000 m 16mm Ø).
- 2.9 **PLANKTON winch** (6,000 m Coax. 6 mm Ø).
- 2.10 **REDES ELECT winch.** With data transmission (7,000 m Coax. 14 mm Ø).
- 2.11 **MULTIPURPOSE winches.** Two movable.
- 2.12 **NETWORK SOUNDER winch.** With data transmission.

3. Sound equipment
- 3.1 Ecosonda Biológica EK60. Installed on the retractable keels, they are used in biomass sound estimates (five frequencies).
- 3.2 Ecosondas MUTIHAZ. Produces 3D plans in aguas profundas and shallow.
- 3.3 Correntímetro Doppler (ADCP (two frequencies) for surrent measurements.
- 3.4 Ecosonda PARAMÉTRICA, with penetration in the top layer of subsoil sediments.
- 3.5 POSEIDONEA submarine positioning.

4. Communications
- 4.1 **Via satellite communications:** 2 Fleet 77+1 Fleet 33.
- 4.2 **GMDSS.** Maritime safety communication system.
- 4.3 **VSAT:** satellite broadband, which makes data transmission via the Internat possible.

5. Laboratories
- 5.1 **Work area on main deck:** 325 m².
- 5.2 **Main laboratory:** 94.3 m².
- 5.3 **Thermoregulated laboratory:** 19.5 m².
- 5.4 **Analysis laboratory:** 28 m².
- 5.5 **Chemical laboratory:** 21 m².
- 5.6 **Fish dissection laboratory:** 26 m².
- 5.7 **Electronic equipment:** 35 m².
- 5.8 **Processing room:** 32 m².
- 5.9 **CTD hangar / wet line: 55 m².**
- 5.10 **Refrigerators / Freezers:** 49.8 m².

Neither would we go down so far, since our instruments could descend no further than 6,000 metros; but neither had the oceanographic instruments of the *Sarmiento de Gamboa* ever reached this depth.

We began to break records by 10-metre intervals at consecutive stations. We began with 5,881 metres at station 46, the first record; then 5,894 metres at station 48, another record; 5,909 metres at station 49, another; and finally 5,915 metres at station 50, the last record! This is the maximum depth ever reached by *Sarmiento de Gamboa* instruments, and I suspect that this particular record will be hard to break. So on our campaign the *Sarmiento de Gamboa* has attained two new records: fifty days of non-stop sailing and the maximum depth to which its instruments have been lowered.

▶ The BO *Sarmiento de Gamboa*

Technical specifications

Length: 70.5 m	Gross tonnage: 2,758 tons
Beam: 15.5 m	Draught: 4.9 m
Height: 7.9 m	Top speed: 14 knots

The BO *Sarmiento de Gamboa* has placed Spain among the world's leading countries in the sphere of oceanographic research, and the quality of its equipment places it in a privileged position among the world's best oceanographic ships. In July it will have been in service for four years, and during this time the *Sarmiento de Gamboa* has given ample evidence of its qualities, for none of the tasks assigned to it have ever been suspended.

The *Sarmiento de Gamboa* is defined as a multipurpose oceanographic ship, and its geographical range of work encompasses all the seas and oceans of the world (except the polar regions). Furthermore, as we learn from its definition, the principal characteristic of the vessel is that it is *multipurpose*. This means that it is not restricted to one specific type of research; on the contrary, it may be configured to suit the campaign to be conducted, that is, we may endow the ship with the form needed to cover the following five areas:

1. Oceanography.
2. Hydrography.
3. Geophysics. Seismics. Two LMF25/138-207 compressors with G cannons. SERCEL company Gun II.
4. ROV Victor 6000 submarine. Work capacity down to 6,000 metres.
5. Fishery sampling.

In order to carry this out, we have a very spacious, uncluttered deck with highly adaptable flooring on which we may place the machinery needed for any kind of operation. In other words, and by way of an example, in the space of only a few days we may transform the ship from a trawler to a seismic vessel.

To these characteristics we must add the ship's fixed elements, thanks to which it is able to cover a wide range of oceanographic research.

We have capacity for 26 technicians and researchers and 17 crew members, accommodated in cabins, either single or for two, and the vessels has sufficient autonomy to remain at sea without the need for new supplies for a period of over fifty days, as was evidenced during the Malaspina Expedition.

The *Sarmiento de Gamboa* is extremely manoeuvrable and emits very little noise into the sea, two essential characteristics for any oceanographic ship. It is equipped with diesel-electric propulsion, which makes a high degree of control possible on the platform, added to a bow thruster and a stern thruster. All this is computer controlled by a dynamic positioning (DP) system, thanks to which the ship may move with a degree of precision of under one metre and speed variations of a tenth of a knot, thereby satisfying any demand on the part of researchers. Furthermore, this propulsion system is perfect when it comes to minimising noise emission, optimising sound measurements.

We have two platforms for the sound transducers, which gives them great versatility since they are separated from the hull. This way we avoid noise and bubbles that would otherwise hinder signal reception. These platforms are the gondola, located below the hull at the prow, and the retractable keels.

The Malaspina Expedition 2010 and Scientific Communication

Sandra Rebok

The Malaspina 2010 campaign is not only a circumnavigation project of great interest to the scientific community but also a fascinating expedition for the public in general. A round-the-world mission on two oceanographic ships, the *Hespérides* and the *Sarmiento de Gamboa*, with stopovers at cities so far from Spain as Rio de Janeiro, Perth, Sydney, Auckland, Honolulu, Panama and Cartagena de Indias, or Santo Domingo in the case of the latter vessel, the project is conceived to appeal to interested citizens and, in this way, allow them to share in this major scientific adventure.

On the other hand, this initiative constitutes a great opportunity to make a project carried out from Spain visible to society on an international scale. A centuries-long tradition of travel accounts describing the exploration of remote regions of our planet, some of these publications mere scientific treatises while others are descriptions of the customs of other peoples, with interesting outlooks on a world unknown to us, is evidence of the fact that this theme has always been of interest to society. It is the combination of the yearning to discover the world, curiosity for the unknown, purely scientific interest and passion for adventure that fosters this inclination and explains the success of these scientific publications and travellers' accounts, both in the past and in the present day.

In the case of this particular expedition, we have exploited all the instruments at our disposal in the modern world to reach citizens and involve them in this project. And this does not mean simply publishing scientific results on the one hand and descriptions based on personal impressions on the other, as has been usual practice hitherto in expeditionary voyages. Today we have an infinite number of possibilities by which to create a nexus with society, not only when the expedition has come to its conclusion but also from the very first moments of its preparation and, subsequently, as it is in progress, and in real time.

Given its multidisciplinary nature, which embraces such a wide range of fields of knowledge as the humanities, biology and biomedicine, natural resources, the agrarian sciences, physical technologies, material technology, food technology and chemical technology, as well as the involvement of qualified people from different professions (the military, computer experts, engineers and journalists), this project requires tight coordination and constant communication between everybody involved so that they may work together with their sights set on a common objective, which helps foster a new culture of scientific cooperation.

Furthermore, we must bear in mind that the great challenges to twenty-first-century science are interdisciplinary and, therefore, must be addressed from several academic disciplines. Science cannot be detached from its social environment; on the contrary, it must establish links with society, bring the general public closer to the science developed in the different research centres, and inform people about the challenges to be faced and the achievements obtained so that society may contribute to the advance of knowledge. Efforts to foment rapprochement and openness must be directed towards a very wide audience, that is, they must contemplate different age groups, degrees of previous knowledge and different educational levels in the target population.

This constitutes a major challenge to our circumnavigation project, since it pursues very important objectives that affect society and, consequently, must be transmitted via a wide variety of media: one such objective is assessing the impact of global change on the ocean, in or-