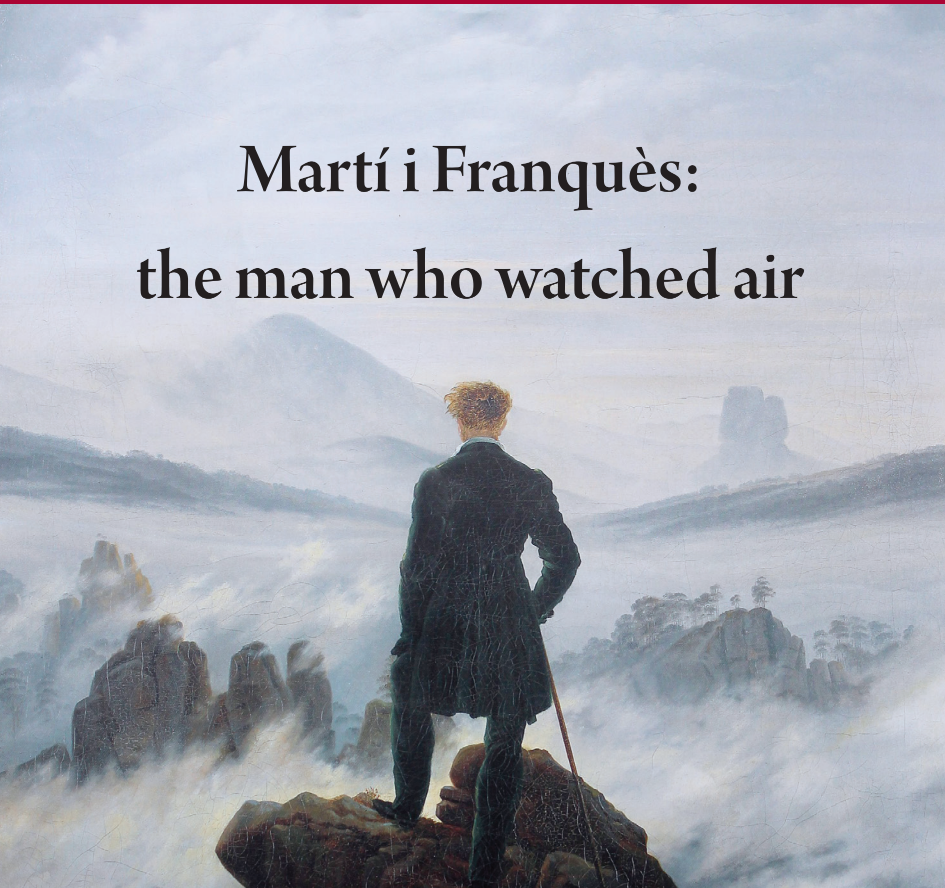
Universitat Rovira i Virgili

Martí i Franquès: the man who watched air



[publicacions] urv

Published by:

Publicacions de la Universitat Rovira i Virgili
Av. Catalunya, 35 · 43002 Tarragona
Tel. 977 558 474
www.publicacionsurv.cat
publicacions@urv.cat

Arola Editors
Polígon Francolí, parcel·la 3, nau 5 · 43006 Tarragona
Tel. 977 553 707 · Fax 977 542 721
www.arolaeditors.com
arola@arolaeditors.com

Legal Deposit: T-468-2013

Summary

PRESENTATION / 5

MARTÍ I FRANQUÈS, THE MAN WHO WATCHED AIR / 7

Two revolutions / 12

A stroll through Marti's findings / 16

Marti's success / 23

Method, intuition and contacts / 26

What remains to be done / 30

References / 32

Presentation

Another year has gone by and, once again, on the occasion of Saint George's day, we invite you to read a book to celebrate the festival of the book and the rose.

This time we have selected a text that not only combines science and arts but also deals with one of the most important figures ever to have come out of this land: Antoni de Martí i Franquès. Josep Grau, the author of the book, describes one of the most interesting moments in the history of science, the turn of the 18th century into the 19th, and he does so by constructing a narrative that describes the significant features of Martí's life with such attention to detail that it brings to our mind's eye the historical time at which the Altafulla-born chemist went about his work. He makes us feel his passion for the scientific method, which led him, among other things, to review all the studies that had inaccurately measured the composition of air and determine the correct amount. With basic but well-defined descriptions, he paints a meaningful picture of the landscape in which the figure of Martí i Franquès stands out for his steadfastness and rigour.

The man who watched air – as he is so poetically defined by the author – represents like few others the scientific spirit that is such a characteristic of the daily life of the university. This is why the programme of grants for students who are about to initiate their research work at the URV is called after him: he is a model for all those people these days who are prepared to strive to unravel the problems that define the limits and the scope of current science.

I would like to finish by thanking the author for accepting to synthesise the text *La química de l'aire* (*The Chemistry of Air*), which he wrote in conjunction with Dr. Josep Bonet to commemorate the international year of chemistry in 2011.

I wish you a very happy Saint George's day!

Francesc Xavier Grau Vidal
Rector

Martí i Franquès, the man who watched air

Antoni Martí i Franquès laid down his pen, got up from his desk and leant out of the open window. It was spring and a pleasant breeze was blowing. Although he spent most of the year at his home in Tarragona, he still liked to come to Altafulla when he needed to concentrate. From the window of the office in his house, which was near the castle, there was a view of the sea and a few boats quietly floating there. One of them belonged to Martí and was sailing out of the port of Tarragona loaded with goods. But this was not what he was looking at. The window also looked out onto the terraces of other houses, the fields between the village and the sea, and the track along which the farmers toiled to and fro from their crops. Some of these men worked on their land that was spread all over the Camp de Tarragona. But this was not what Martí was looking at either. On the balcony of the house opposite, a woman who had been hanging out the washing had hidden when she saw that Martí was looking. A lot of the people from the village held him in the highest regard, not just because of the fortune he had amassed but also because of the reputation his research projects had earned him as an eccentric. I have even heard, years after he died, people referring to him as "that man who made calendars". When the woman hid, she almost dropped a sheet into the street. But Martí did not even see this. Martí was watching something that was much closer, something that was right in front of his eyes. Martí was trying to watch the air.

But the air cannot be watched: even if we use binoculars or a magnifying glass all we see is what there is behind it. Air is invisible, and pointing out this fact can help us to understand the men who, at the end of the 18th century, focused their attention on this fluid. Antoni de Martí i Franquès (1750-1832) was one of these men. If we wish to understand the problem that these chemists faced, we must try to forget some of the notions that we have about chemistry. When contemporary chemists find a composition, we tend to think that they have been able to look much further than we have: they have used powerful electron microscopes, or complex equipment that requires a sample to be inserted and produces a list of the matter it is made up of. This could not be more different from how 18th-century chemists worked: the composition of air was discovered using two glass jars and a bucket of water. Martí's laboratory contained jars, flasks and little else. But before asking ourselves how the 18th-century chemists did it, we have to ask ourselves a simpler question: how did they even begin to suspect that air was made up of different parts? If you just stop to think about this for a moment, you will realise that this is by no means a trivial question. It is the type of sophisticated thought that required a considerable amount of time to become fully formed, and was the result of the accumulation of many different experiments and fortuitous findings. It is, in fact, one of the keys to the chemical revolution, one of the most studied and most controversial periods in the history of science. Martí i Franquès worked at that time and shared the doubts of the age.

Martí returned to his desk and went through the periodicals that had just arrived. They were scientific journals sent directly from France. In one package there were three issues of the *Journal de Physique, de Chimie et des Arts*, published in Paris, and in another there was a botanical treatise written in German. He had managed to get hold of them thanks to a friend of his, a priest, who knew someone who often had to cross the border with France and who was a good friend of a book seller in Perpignan. Every few months, when he had accumulated a few journals, the book seller would send Martí a package. If you ever get the chance to take a look at Martí i Franquès's collection of letters, you will realise the trouble he took to be up to date with the latest scientific advances. Science was changing rapidly and Martí invested a considerable amount of time and money to construct a network of contacts abroad who kept him in touch with all the new ideas. The knowledge to be found on Martí's shelves was not divided into different disciplines. He taught himself from scratch botany, biology, geology, physics and, in particular, the emerging discipline of chemistry.

Two revolutions

The chemical revolution is the period in the history of science that provides the backdrop to Martí i Franquès's life. The period was referred to as a revolution because of the enormous number of changes that took place. It occurred in parallel to the French Revolution, but decapitated theories not monarchs. The chemical revolution can be explained in two very different ways, in both of which Martí i Franquès plays a role. I like them both but everyone is free to choose the one they prefer.

The first explanation is the one that gives the period its name: the revolution of the revolutionaries, the revolution of the men who had the privilege of giving a name to the period of history in which they lived. In 1777, Antoine Lavoisier, the 'father of modern chemistry' wrote that "the importance of the end in view prompted me to undertake all this work, which seemed to me destined to bring about a revolution in physics and chemistry." He was referring to a project that had only just begun and which was being undertaken by the Académie des Sciences, a whole series of key experiments that would put an end to the phlogiston theory and lead to a new understanding of matter.

The old phlogiston theory provided an explanation for processes of combustion. Phlogiston is the incorporeal, invisible and odourless substance that is released when something burns.

When any substance is heated sufficiently, it divides into phlogiston, which is absorbed by air, and calx, which is what remains and is regarded as the true substance. It is a theory that is highly sensitive to our understanding of nature and our daily experience of seeing logs burn. The theory is essentially an explanation of this daily experience.

However, the experiments carried out by Priestly and Lavoisier on the decomposition of mercury oxide into mercury and oxygen, and the decomposition of water into hydrogen and oxygen, in conjunction with the discovery of new gases raised doubts about this simple model. These findings led to a new theory of combustion and acidity and, in the long run, required substances to be called by different names. Through a whole series of lectures, personal contacts and, above all, the journal *Annales de Chimie*, Lavoisier managed to popularise his new chemical system. Paris became the epicentre of the movement, the point from which were fired all the arrows aimed at the natural philosophers on the periphery. The classical stories of the chemical revolution, the epic stories, say that Paris spoke and thought while the world listened and agreed. It has subsequently been shown that this was not quite the case and, as we shall see, the periphery also had its say and did in fact make a contribution.

Alongside the story of the groundbreaking discoveries is the second story: the silent revolution: This is the story of the processes by which ideas were transmitted, the story of teaching and learning. It is fascinating to see how the leading discoveries of the age were understood and reinterpreted by individuals from different professions and with a wide variety of education and interests. Let us look at the example of oxygen, a term invented by Lavoisier that means 'begetter of acids'. At the Royal College of Surgery of Barcelona, founded in 1760, reports were read on the possible therapeutic uses of this 'new air', and even on the possibility of treating patients with aerostatic balloons such as the ones that the Montgolfier brothers had flown in Paris in the spring of 1783. In the archives of the Royal Academy of Sciences and Arts of Barcelona (founded in 1764) we find that the new chemistry represented hope for a wide range of industries, from textiles to the military. This second story is the one that tells of the local experts who became communicators and promoters of the new chemistry, a story that was made up of the sum total of numerous small contributions.

Lavoisier completely refuted the phlogiston theory in 1783 in *Réflexions sur le phlogistique,* a work in which he explained his experiments with mercury oxide. In 1787, the theory was explicitly rejected in Spain, and the man who did it was Martí i Franquès. At the Royal Academy of Arts and Sciences of Barcelona, he read the following

> The wise Englishman [Priestley] still does not want to relinquish his opinion that phlogiston exists, but this opinion is now clearly untenable if it is accepted that water can be decomposed.

Just a few years on, then, there is evidence that the new theories were being understood in the peninsula. There were various mechanisms that enabled information to flow from one place to another. First, the written word was fundamental and much of the chemical revolution was due to the free circulation of books. However, the Spain of the time was fearful of the political instability in France, the church had a considerable influence over the country's institutions, the king was afraid he might be put to the sword, the Inquisition was still alive and kicking, the *Index librorum prohibitorum* was still enforced and the borders were closed to French publications. Scientific journals could only be obtained in one of two ways: you either had plentiful funds and reliable contacts abroad, which was the rather exceptional case of Martí i Franquès, or you had the support and protection of an academic Institution. Catalonia, which in the middle of the 18th century was still suffering from the ordeal of the War of Succession, the Nova Planta Decree and the closure of the University of Barcelona, only had the University of Cervera, where a young Martí i Franquès began his studies of philosophy, which he was soon to abandon. Chemistry, then, was transmitted by such institutions as the Royal Academy of Sciences and Arts of Barcelona, the Royal College of Surgery of Barcelona or the courses paid for by the Board of Trade of Barcelona. Through these institutions and their equivalents in other countries, the new chemical system was reinforced and implemented internationally. It would be naïve to assume that all the men interested in chemistry simply learned – as if they were following a distance course – from the teachings of the French savants. Learning is never a passive process, and new knowledge is often accompanied by a creative response, particularly when the concepts find new applications, new contexts in which to be explained, new nuances to the explanation. The fact is that a considerable amount of information flowed from the periphery to the centre, and some objects, practices and ideas emerged from the receptor nuclei. The work done by Martí i Franquès – like a hand raised in the middle of a lecture – is one of the contributions made from the periphery.

A stroll through Marti's findings

We left Martí in his office, looking through some journals that had just been sent from France. Glancing at the index of articles, one of them attracts his attention. Somewhere in Switzerland, someone has measured the concentration of oxygen in the air at the top of a mountain. Martí flicks quickly through the pages until he finds the article in question, and then impatiently scans the text in search of a value. When he finds it, he gives a satisfied smile: according to the Swiss scientist, air is purer at the peak than at the foot of the mountain, and the concentration of oxygen is always between 20% and 25%. Another error, another mistaken value. With a half smile, Martí pulled a sheaf of bound paper from a drawer and noted down the details of this finding. For some time he had been paying attention to all publications that made any mention of the concentration of oxygen in the atmosphere. And for some time he had noticed that there were never two values that were the same.

But why was there any need to measure the amount of oxygen? Martí i Franquès had closely followed all the developments in this area: Priestly had been the first to isolate pure oxygen ("dephlogisticated air") and he made a fundamental observation: he found that mice survived for longer in oxygen than in atmospheric air. Thus emerged the concept of the "breathability of air": that is to say, the capacity of air to sustain life (also known as the "goodness of air" or even the "salubrity of air"). It was a Florentian, Felice Fontana, who in 1775 took up Priestley's challenge and standardised his experiment by creating a method for measuring breathability. Another Italian, Marsilio Landriani from Milan, named the invention the eudiometer, from the Greek word eudios, which means clean or pure – a combination of eu- ('good') and -dios ('celestial') – plus the favourite suffix of the Enlightenment: -meter ('measure'). Thanks to the fact that it now had a name – eudiometer – and a description – by Fontana – eudiometry soon became popular throughout Europe because it was one of the most accessible practices to enthusiasts who wanted to dabble in chemistry. For years, scientists had worked on the assumption that the concentration of oxygen – or vital air – was highly variable and, therefore, in many of the measures published experimental error Is mistaken for real variations. Martí recognised this problem and decided to find a solution to it.

Martí presented his experimental results on 12 May 1790 in *Memoria sobre los varios métodos de medir la cantidad de ayre vital de la atmosfera (Report on the various methods for measuring the amount of vital air in the atmosphere)*. Although the scientific style of the 18th century tends to be somewhat ungainly, I do not believe that anyone else could explain his finding as clearly as he does. For this reason, in this section, I shall try to use his words as often as I can. The first thing that Martí did was something that nobody had tried to do before (at least not systematically and thoroughly): he compared all the different types of eudiometers, seeking their strong and weak points and discounting the ones that did not work. He immediately discounted the nitrous air used by Fontana and tests based on hydrogen, phosphorus and iron filings. This beginning forcefully conveys the tone of the study: right from the start it is clear to the reader that Martí is aiming to produce the definitive study of the problem, an irrefutable solution. First he discounts nitrous air:

> It is proven, then, that the eudiometric test carried out with nitrous air is imperfect because it uses matter that is fluid and elastic.

He goes on to discount hydrogen:

> The second test of which I must speak, and which relies on the combustion of inflammable air, [...] is also subject to the same imperfection.

And then phosphorus:

> Although phosphorus [...] is a solid material it may also suffer from the same drawback.

At first he seems to be satisfied with iron filings with sulphur: "At first I used to employ this test and the liver of sulphur test, thinking, like all other physicists that they were equally good." But he also ended up by discounting it and he was finally left with only one option: liver of sulphur.

Understanding how the liver of sulphur test works is quite straightforward because it requires no knowledge of chemistry. Liver of sulphur (which we know today as *potassium pyrosulphate*) has the capacity to consume oxygen. So, if we place the sulphur in contact with a mixture that contains the two components of the atmosphere – nitrogen and oxygen – and we shake it for a while, we shall soon have only nitrogen. If we look at the difference in volume, we will know how much oxygen has been lost. Martí explains it in the following terms:

> To shorten the operation, I obtained some glass flasks of different capacities that had narrow necks and emery stoppers; I filled one of them with liver of sulphur; then, as quickly as I could I introduced a portion of atmospheric air; after corking, it was shaken for a short period of time and, on subsequent inspection, I found that it had disappeared completely.

It could not be more straightforward. Martí repeated this experiment hundreds of times, until he was convinced that the result would never change. Even so, having repeated the experiment in the laboratories of the Department of Chemical Engineering at the URV, I must say that one needs a good deal of practice. Martí says "shaken for a short period of time", but the correct value can only be guaranteed if the mixtures are shaken for a good 20 minutes. I suspect that Martí's servants had their work cut out shaking calcium sulphates because, as the good experimentalist that he was, he repeated his test In all the conditions imaginable. He took samples of air on humid days and dry days; on windy days and calm days; near reservoirs, the sea and the woods, and also at home. He even took measurements in a theatre full of people to find out whether stuffy atmospheres affected the concentration of oxygen. In his words:

> At times I have taken samples of air in the middle of churches in the city of Barcelona when they have been full of people and, on examination, I have found them to be as pure as the air outside [...] On 4 November 1788 I had the opportunity to

> test the air in the new theatre where the very first performance in its history was taking place.

Finally, after taking hundreds of repeated measures, Martí reached four well-defined conclusions. They had never been formulated before and they are still valid today. They are a large part of his legacy and it is worth transcribing them in full:

> These results have been repeated so often and on so many days that not only does their uniformity prove the accuracy of the method but also that my observations on the southern coastline of this principality show that
>
> 1. On no occasion has wind caused the respective amounts of vital air and nitrogen, of which the elastic fluid of our atmosphere consists, to vary by as much as one per cent. I have always found that of 100 parts, 79 were the latter and 21 the former. In no case were there 22 parts of nitrogen.
>
> 2. On no occasion has any difference been caused by the humidity or the dryness of the atmosphere, by the degree of stuffiness, or by calm or rainy weather. It is certainly true that, in the same atmospheric space, those aeriform fluids that contain the greatest amount of dissolved water impregnated with other heterogeneous bodies will not be found in such quantities as those fluids that are more lacking in foreign matter, but the number 21 of the vital part that has been found so often in both cases indicates that the elements of which its elastic portion is constituted are invariable.

> 3º The amount of the two components is also constant on days that Réaumur's thermometer marks freezing point and when It marks 24 degrees of heat.
>
> 4º Neither have I observed any variation when the mercury of the barometer is very low or when it Is above 28 inches.

The highest praise of his results is this: they are correct. The concentration of oxygen in air is always 21%, never 22%. That is to say, the debate on whether the 'purity' of air varies with the weather or the seasons has come to its definitive end. The value that Martí determined – 21% – is still valid today. However, his work was not exceptional for its remarkable accuracy nor because Martí was a man who was quite isolated from any active scientific community – which in itself was a considerable personal challenge – but because it clearly and concisely solved a scientific problem that had been left unsolved. He used tools that already existed to tackle questions that had already been raised, but it was Martí who formulated the problem and rigorously sought a solution.

Martí's success

How Martí i Franquès was received abroad is probably best reflected by the publication of his reports in journals in Spain, England, France and Germany between 1794 and 1801. Nevertheless, to date we are still unaware of the effect these articles had after they had been published. How had the readers reacted? Had they flicked through the pages as if the values they contained were of little import or had they taken their time to read them closely? We now know that dozens of publications had recognised the value of Martí i Franquès's work. As early as 1803, the book A System of Theoretical and Practical Chemistry, published in London by Frederick Accum, described Martí i Franquès's eudiometer under the title "Martís eudiometer" after the eudiometers of Priestley and Scheele. Likewise, the book A Brief Retrospect of the Eighteenth Century, published in New York in 1803, shows that Martí's research did not take long to cross the Atlantic. It describes Martí's eudiometer as being superior to Scheele's, which was too slow, but "this drawback was eliminated by Martí i Franquès, who improved on the degree of precision of Scheele's eudiometer." A book on chemical instrumentation published in London in 1813 was even more eloquent: "Martí perfected Scheele's eudiometer." In France he was mentioned, albeit less warmly, and his name was often misspelled or he was said to be English. The *Histoire philosophique* *des progrés de la physique* (1813) describes Martí i Franquès in the following terms:

> McCarthy: physicien anglais. Il fait servir les sulfures alcalins à la construction d'un eudiomètre.

Another volume that provides its own, original analysis of the history of chemistry is a collection of studies printed in Washington in 1866, 34 years after Martí's death, and published by the House of Representatives of the United States. In a section entitled Warming and Ventilating the Capitol, there Is a brief chronology of the eudiometer called Chronological View of Eudiometric Experiments. The chronology is very clear and it Is worth transcribing a whole fragment (note that the author refers to Martí as De Marty).

> 1774 Scheele states that air must contain two types of fluid; a quarter of pure or dephlogisticated air and the rest of fixed air.
>
> 1775 Because of the errors of the nitrous-oxide eudiometer, these researchers [Fontana and Landriani] concluded that the amount of oxygen was variable, and that this could cause good or ill health.
>
> 1778 Saussure carried out some eudiometric experiments in the southern Alps with a nitrous oxide eudiometer, and he drew the mistaken conclusion that the concentration of oxygen varies between valleys and mountains.

1790 On the basis of experiments carried out in Catalonia with calcium sulphate, De Marty states that the proportion of oxygen in the atmosphere is constant.
1799 Berthollet recommends the phosphorus eudiometer.
1801 Experiments by Davy in England confirm De Marty's results.

The chronology continues until 1852, but the author makes no further mention of any refinement in the percentage of oxygen in the atmosphere. He believes that Martí's experiment in 1790 is the definitive one and in this simplified history there is no place for other experimentalists who may have refined or repeated his measurements. Martí´s report effectively put an end to the debate initiated by the discovery of oxygen and popularised (and complicated) by the Italian eudiometrists.

In the land of his birth, his experiments were received differently. Martí i Franquès was not the last person to pronounce on vital air in Barcelona. In the same room in which he had read his results, other scientists gave their opinions about oxygen. It is revealing that in the ten years following Martí's presentation, none of them used his values. This, I fear, was the beginning of the oblivion into which Martí would gradually fall over the next two hundred years.

Method, intuition and contacts

His research into air was the most successful of all Martí's endeavours but by no means the only one. Throughout his life he initiated other projects, of different scopes and depths. I would like to briefly describe three examples, which I believe reveal the keys to the personality of Martí i Franquès.

The first example is his research into the sex of plants. The sexual reproduction of plants has been one of the longest-lasting debates in the history of science. In 1729, after centuries of uncertainty, the Swede Carl von Linné proved the existence of pistils and stamens, the basis of his theory of plant reproduction. The debate seemed to be over, but Linné's system prompted all sorts of reactions. His strongest adversary, Lazzaro Spallanzani, responded in 1785 with a whole range of experiments which raised doubts about the sexual theory. Spallanzani claimed that hemp and spinach, totally isolated in different pots, had reproduced without pollination.

Martí i Franquès, a follower of Linné's theories, was convinced that Spallanzani's results were impossible, that they had been caused by an experimental error, so he decided to repeat the experiments and solve the dilemma. Note that for this same reason he had decided to take measurements of atmospheric air himself: the suspicion that the values he had read were due to errors and that he could rectify them. Martí's experimental approach was an example of scientific work. He devised various assays to test different variables: he planted many pots for this purpose, some of which with just a few plants; he exposed them to different points of the compass and different amounts of sun; he discounted environmental factors and repeated the experiments with different species. His results, which were reported in *Experimentos y observaciones sobre los sexos y fecundación de las plantas* in 1791, confirmed Linné's theory and discredited Spallanzani's criticism. Although the study was not translated, the library of the Royal Academy of London and scientists such as the leading botanist Joseph Banks quickly acquired copies of Martí's work in Spanish. Martí was a methodical scientist, an experimentalist: this was the first and most important of his virtues.

The second example is a paragraph from his study on the composition of atmospheric air. It is a paragraph that can quite easily go unnoticed because it wanders off the main topic, but it is perhaps my favourite. It so happened that, when oxygen was being removed by liver of sulphur, Martí observed that the liver was "eating up" more air than he expected. Of course, because the only tool he had available were his eyes, he could not possibly know what was happening in the jar. But his intuition told him that this extra air that was absorbed was not reacting but was dissolving in the liquid. He explains it like this:

> At first I found this unexpected variety in the residue of the air quite perplexing; but on reflection, it seemed to me that the difference […] could only be due to the fact that the liver of sulphur was to some extent impregnated with hydrogen and, like other liquid substances, must contain or receive a certain amount of it, not combined but interposed. Indeed, the following experiments cleared up any doubts I may have had.

The key phrase is "not combined but interposed". That is to say, Martí accepted that gases can react with the liquid or dissolve in it without reacting. How did he know? How did he manage to draw up this hypothesis? We should bear in mind that the theory of solubility was not formulated by William Henry until 1803, years after Martí's study. Martí, however, already suspected that substances could combine or "interpose". This was the only explanation possible for the phenomenon that he was observing. Martí trusted in his experiments and, above all, he had a second and vital virtue: an enormous intuition.

Finally, the third example is how Martí helped to measure the world. Until 1800, the world had not been measured. And not only had it never been measured but there was no way in which this measure could be expressed. Every region and every city had their own way of measuring and weighing. After the French Revolution, the wise men of the Enlightenment proposed a universal system of measurement: the metric system. As a base for this system they chose something that all human beings have in common: the Earth. In 1792, a scientific expedition set out from Paris with the objective of measuring the distance between the North Pole and the equator. This distance divided by 10,000,000 was what they decided to call the metre, from the Greek metron, which means measure. The South expedition, led by the astronomer Pierre Méchain, measured the distance between Paris and Barcelona.

The mission was of considerable international importance, and many people helped the scientists during the process of climbing up bell towers and mountains so that they could perform their triangulations. In Tarragona, the French expedition was assisted and advised by Martí i Franquès, who gave them his hospitality and allowed them to set up their scientific equipment on his land. The measurements were made from the mountain of Tamarit to the lighthouse of the port of Tarragona, which was being constructed at the time. Martí also played host to the scientists Francesc Aragó (born in Perpignan) and Jean-Baptiste Biot from the second expedition of the Science Academy of Paris. The latter, who recovered from an illness in Martí's house, went on to write a letter in which he expressed his admiration for the experiments that Martí had shown him.

The reason these natural philosophers trusted in Martí was that he had always strived to keep up a network of contacts around Europe. Martí worked hard to be well communicated with others and, without this third virtue, his method and intuition may not have been so successful.

What remains to be done

Without exception, all the books and articles that have been written about Martí i Franquès contain a paragraph lamenting the oblivion into which this great scientist has fallen, demanding that justice be done and expressing hope that he will soon be more widely recognised. I sometimes doubt that this is ever going to happen: icons, great figures, are fashioned slowly, after centuries of having praise heaped on them. I may, however, be mistaken, and perhaps we are now at the beginning of a period during which Martí i Franquès will gradually acquire the prestige he deserves. However, I do not wish to finish this text with a lament. I would like to do something a little different and finish with a list of all the things that remain to be done.

When I started to research the figure of Marti I thought that there was not a great deal new left to say about him. I could not have been more wrong. Although the laboratory notebooks from his eudiometric research have been lost, it is still possible to consult hundreds of pages of experimental values taken between 1816 and 1826 but which nobody knows anything about. If someone plucks up sufficient courage and is patient, these notes could still be analysed. There is also an extensive collection of letters, classified by his first biographer, Antoni Quintana. Is there anything in this collection that provides information about Martí's later experiments? Is there something important that Quintana did not notice? Who are the characters that are mentioned? Nobody knows. Martí is said to have travelled around Europe. Who did he see, who did he meet, what did he learn? These are all questions about Martí the scientist, but there may be many aspects of Martí the citizen, businessman and politician that interact with science and which have yet to be clarified.

There are, then, many questions still unanswered. The mission of the history of science is not to ensure that justice is done, to add another figure to the list of the heroes of science, nor does it have the power to do so. However, it does have the mission and the power to provide tools so that old texts can be read in a new light and our gaze renewed. This is the modest aim of this book: to reveal the impact, rigour and detail of Martí's studies so that they can be read anew.

References

GRAU, Josep; BONET, Josep (ed.) (2011). *La química de l'aire*. Tarragona: Publicacions URV.

QUINTANA, Antoni (1935). "Estudi biogràfic i documental". In: *Antoni de Martí i Franquès: memòries originals, estudi biogràfic i documental.* Barcelona: Nebots de López Robert, p. 61-309.

NIETO-GALAN, Agustí (1996). "Martí i Franquès, Carbonell i Bravo, i els usos de la nova química a la Catalunya il·lustrada". In: NIETO-GALAN, Agustí *et alii* (ed.) *A. L. Lavoisier i els orígens de la química moderna 200 anys després*. Barcelona: Institut d'Estudis Catalans, p. 159-184.

BERNAT, Pasqual (2011). "Correcting Lazzaro Spallanzani. The Antoni Martí Franquès contribution to the knowledge of sexual reproduction of plants (18th century)". In: ROCA ROSELL, A. (ed.) (2012). *The Circulation of Science and Technology: Proceedings of the 4th International Conference of ESHS, Barcelona, 18-20 of November 2010*. Barcelona: SCHT-IEC.

BERTOMEU SÁNCHEZ J. R.; GARCÍA BELMAR, A. (2006). *La revolución química: entre la historia y la memoria.* València: Universitat de València.

Universitat Rovira i Virgili

ANTONI DE MARTÍ I FRANQUÈS laid down his pen, got up from his desk and leant out of the open window. It was spring and a pleasant breeze was blowing. Although he spent most of the year at his home in Tarragona, he still liked to come to Altafulla when he needed to concentrate. From the window of the office in his house, which was near the castle, there was a view of the sea and a few boats quietly floating there. One of them belonged to Martí and was sailing out of the port of Tarragona loaded with goods. But this was not what he was looking at. The window also looked out onto the terraces of other houses, the fields between the village and the sea, and the track along which the farmers toiled to and fro from their crops. Some of these men worked on their land that was spread all over the Camp de Tarragona. But this was not what Martí was looking at either.

Cover illustration: Caspar David Friedrich, *Wanderer above the Sea of Fog*, Oil-on-canvas, 98,5 x 75 cm. Hamburger Kunsthalle, Hamburg (1817).

[publicacions] urv