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TRANSFER OF NAUTICAL KNOWLEDGE FROM THE U.S.A. TO EUROPE IN THE NINETEENTH-CENTURY: THE CASE OF THE SUMNER LINE OF POSITION AND ITS INTRODUCTION INTO SPAIN

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ABSTRACT

Modern celestial navigation has its foundations on the graphic method for fixing the ship's position, discovered in 1837 by the Captain of the U.S. Merchant Marine, Thomas H. Sumner. After being published, in 1843, this method was quickly adopted by U. S. navigators, thanks to Matthew F. Maury, at the time in charge of the Hydrographic Service in Washington. In Europe, on the contrary, the spread of Sumner's method was uneven. In order to analyse its introduction in Spain, an examination of Spanish specialised journals and texts, published during the nineteenth century, has been carried out. The results, shown in this work in chronological order, have been interpreted in the light of the complex political situation which shaped the progress of science and technology in the nineteenth-century Spain.

Key words: Maritime History, Nautical Astronomy, Sumner Line of Position.

1. INTRODUCTION

For many centuries navigation was conditioned by the difficulty of obtaining the geographical coordinates (i.e., latitude and longitude) which define a ship's position at sea. Long ago it was discovered how to determine the latitude, with sufficient precision, by observing stars close to the pole or the Sun at noon. However, reckoning the longitude at sea was considered to be "the limit God had set on human intelligence" (Martínez Hidalgo, 1946, p.75), and this problem did not have a practical solution until the final decades of the eighteenth-century. The method of lunar distances and the chronometer, which eventually allowed navigators to determine this precious coordinate, had been proposed some centuries before. However, for this method to be practicable further progress would have to be made in astronomy, mathematics and precision instrument making.

This quest for a method of reckoning the longitude, together with the age of the great discoveries, has been the dominant interest of maritime historiography of this period. However, other significant events, which were no less important for the progress of navigation, took place during the nineteenth-century. Certainly, the most important technical innovation was the advent of steam powered vessels, which achieved an extraordinary expansion during this century. The success of the new propulsion system brought about the transformation of the whole shipping industry, including position finding: with faster ships it was necessary to determine their position more often.

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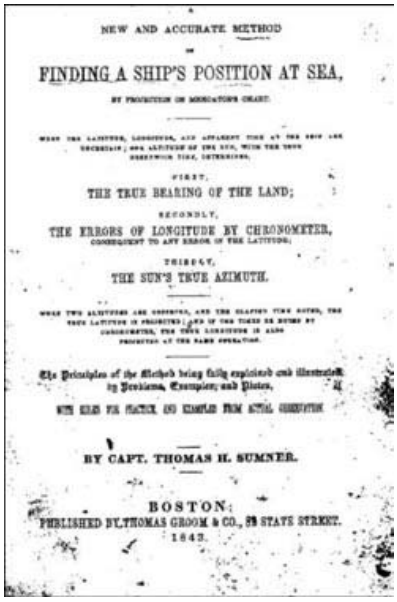
Once the longitude problem was solved, astronomical observations were made specifically for finding latitude (meridian passage) or longitude (prime vertical passage or lunar distances). Although theoretically possible, it was not common practice among navigators to determine both geographical coordinates simultaneously, mainly because of the complex and laborious calculations required. Undoubtedly, the most significant advance in this field during the nineteenth-century was the so-called "new astronomical navigation". The beginning of this is marked by the line of position discovered in 1837, and published in Boston in 1843, by the Captain of the U.S. Merchant Marine, Thomas H. Sumner (1807-1876). For the first time, a simple method for fixing the ship's position was made available to navigators, allowing the nineteenth-century to be considered (see Figure 1)"a golden era of astronomical navigation" (Cotter, 1968, p. 165).

Figure 1. Title page of Sumner's book.


NEW AND ACCURATE METHOD

FINDING A SHIP'S POSITION AT SEA,

THE TRUE BEARING OF THE LAND;

THE ERRORS OF LONGITUDE BY CHRONOMETER,

THE SUN'S TRUE AZIMUTH.

BY CAPT. THOMAS H. SUMNER.

BOSTON:
PUBLISHED BY THOMAS GROOM & CO., 98 STATE STREET.
1843.

2. BIOGRAPHICAL SKETCH

Born in Boston on 20th March 1807, in the bosom of a well-off family, Thomas Hubbard Sumner1 entered Harvard at the age of fifteen. There, he studied mathematics and astronomy with Professor John Farrar, and graduated in 1826. Shortly afterwards, when he was nineteen years old, he got married but that marriage lasted only three years. In 1829, after the divorce, he enlisted as a common sailor on a ship engaged in the China trade. After eight years, Sumner had risen to the rank of Captain and become Master of his own vessel. In 1834, he had married Selina Malcom, and they had six children between 1835 and 1848.

With the publication of his work, in 1843, Sumner's career reached its climax, declining soon afterwards as a consequence of an early mental illness. He died on 9th March 1876, after being confined to an asylum for the last 26 years of his life.

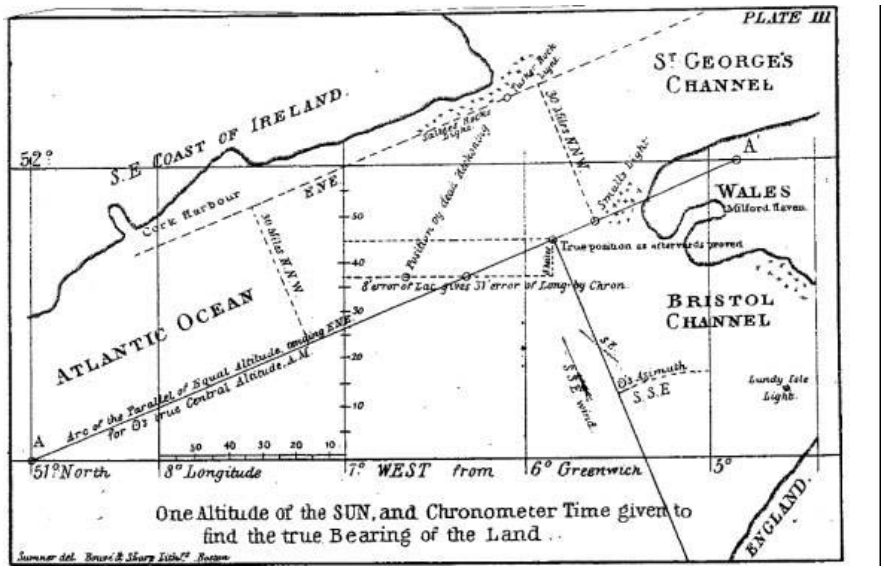
3. THE DISCOVERY OF THE LINE OF POSITION BY THOMAS H. SUMNER

Sumner describes in his book the dramatic conditions in which the discovery took place on 17th December 1837, when he was on board his vessel the *Cabot*2, sailing from Charleston (South Carolina) bound for Greenock (Scotland). After passing the Azores, the wind prevailed from the Southward; no observation was made, after passing longitude 21° W, until near land, on 17th December, within 40 miles, by dead reckoning, of Tusker light; at about 10 a. m. an altitude of the sun was observed, and the chronometer time noted. But, having run so far without any observation, it was plain that the latitude by dead reckoning was liable to error, and could not be entirely relied on.

Using, however, this Latitude, in finding the Longitude by Chronometer, it was found to put the ship 15' of Longitude, E. from her position by dead reckoning; which in Latitude 52° N. is 9 nautical miles; this seemed to agree tolerably well with the dead reckoning; but feeling doubtful of the Latitude, the observation was tried 10' further N, finding this place the ship E. N. E. 27 *nautical* miles, of the former position, it was tried again with a Latitude 20' N. of the dead reckoning; this also placed the ship still further E. N. E., and still 27 *nautical miles* further; these three positions were then seen to lie in the direction of *Small's light*. It then once appeared, that the observed altitude must have happened at *all the three* points, and at *Small's light*, and at the ship, at the *same instant of time*; and it followed, that Small's light must bear E. N. E., if the Chronometer was right. Having been convinced of this truth, the ship was kept on her course, E. N. E., the wind being still S. E., and in less than one hour, Small's light was made bearing E. N. E. ½ E., and close aboard. (Sumner, 1843, pp. 37–38)

Sumner had deduced that with a single altitude of a celestial body it was possible to obtain the line of position of the observer, represented by a straight line on the Mercator's chart. (Fig.2).

Figure 2. Chartwork for the discovery of the Sumner line of position. Source: Sumner, 1843, Plate III.



At that time, it was known that the places on the Earth's surface from which the same celestial body is observed with the same altitude, at the same instant, are all situated on a circumference whose centre is the terrestrial projection of the body and its spherical radius is equal to the zenith distance-- the complement of the altitude of the observed body. Sumner (1843, pp. 10-11) designated these circumferences "parallels of equal altitude", and showed that, in practice, a small portion of them can be represented by a straight line on the chart.

The usefulness of a single observation was most probably the main advantage of the method which also allowed, for the first time, a practical and simultaneous determination of latitude and longitude. With two altitudes and the indication of the chronometer of the instant the observations were made, the ship's position was fixed by means of the analytical calculation of four longitudes -to the reach of all navigators at the time- and a simple graphic design on the chart.

4. ACCEPTANCE, PROPAGATION AND IMPROVEMENT OF SUMNER'S METHOD

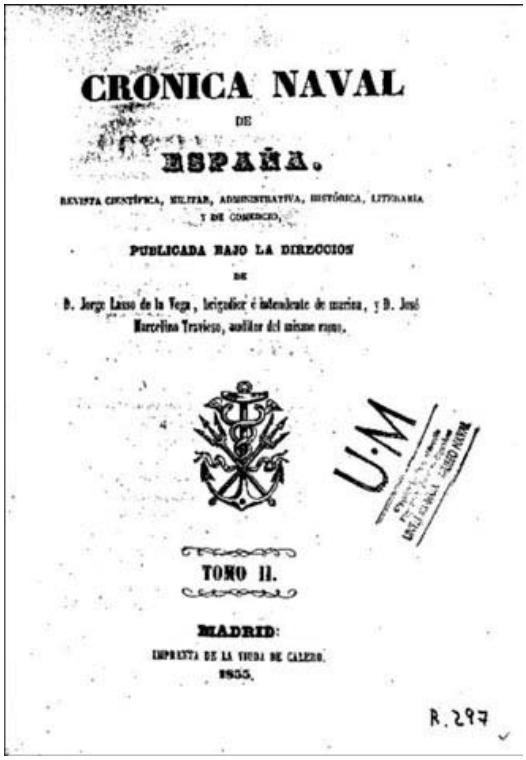
Before publishing his work, Sumner submitted the manuscript for approval to Benjamin O. Pierce, Professor of mathematics at Harvard, and also to the Bostonian *Naval Library and Institute* and to J. Surgis, Captain of the U. S. Revenue Cutter *Hamilton*. The three resulting reports precede the text of the first edition of Sumners' book, under the title "Recommendations". With such guarantees the method was quickly adopted by U. S. navigators. Its use became generalised thanks to Matthew F. Maury (1806-1873), at the time in charge of the Hydrographic Service in Washington, who, in October 1843, wrote to Sumner: "Your method can be considered as the beginning of a new age for the practice of navigation. Orders have been given so that all of our ships be provided with your book"3.

In Europe, however, the spread of Sumner's method was uneven. García Franco (1947, II, pp. 135-136) reports how the new method reached Britain through the *Nautical Magazine* in 1844. It arrived in France in 1847 by means of an article published by the sailor Barther [sic] in *Annales Maritimes*; and in Germany thanks to Henry A. Tobiesen, who in 1855 translated Sumner's work into German. In Spain, according to García Franco, it was 'diffused' in 1865 [sic] by lieutenant Montojo, although Quijano had already used the procedure and referred to it in 1857. Arroyo (1989, pp. 143-145) presents the introduction of the Sumner line into Spain in the very same way as García Franco.

When trying to check on this chronology, it was found that Williams (1994, pp. 113-114) confirms the fact that in 1844 the well-known essayist H. Raper reviewed Sumner's book in the *Nautical Magazine*. Likewise, in the French case, Duval (1955, p. 396) confirms that M. Barthet, a resident of the U.S.A., sent an article explaining the new method to be inserted in the *Annales Maritimes et Coloniales*4. As far as Germany is concerned, Gelcich (1893, p. 40) mentions that the third edition of Sumner's book was translated by Henry A. Tobiesen and published in Hamburg in 1855.

As for the Spanish case, however, a review of specialised journals of the period has shown not only that the learned paper on the Sumner line written by Montojo was published in 1864, but also that almost one decade earlier, in 1855, J. J. Navarro had published translated extracts from the first edition of Sumner's book in the second volume of the magazine *Crónica Naval de España.*(See Figure 3).

Figure 3. Cover of the second volume of the Crónica naval de España (1855), in which the article on the Sumner line by J. J. Navarro was published.


CRÓNICA NAVAL
DE
ESPAÑA.
REVISTA CIENTÍFICA, MILITAR, ADMINISTRATIVA, HISTÓRICA, LITERARIA
Y DE COMERCIO,
PUBLICADA BAJO LA DIRECCION
DE
D. Jorge Lasso de la Vega, brigadier é intendente de marina, y D. José
Marcelino Travieso, auditor del mismo rango.
U·M
TOMO II.
MADRID:
IMPRENTA DE LA VIUDA DE CALERO.
1855.
R. 297

In order to know the actual way in which the "new astronomical navigation" was introduced into Spain, a methodical and meticulous examination of Spanish specialised journals5 and texts6, published later than 1843, has been carried out. The results are shown later on, as the possibilities of interpretation increase when they are looked at in the light of the political situation which shaped the progress of science and technology in the nineteenth-century Spain.

Sumner's method proved useful and efficient at sea. Its importance for navigation fostered its rapid propagation, attracting the attention of sailors and scientists. A short time later, the initial method was improved and the general theory of celestial position lines was developed. In this process, the contribution of the French Navy officer A. L. A. Marcq Saint-Hilaire (1832-1889) stands out. In 1875, Marcq presented the line of position which bears his name through an article published in the *Revue Maritime et Coloniale*. Known as the "altitude difference" or "intercept method", St. Hilaire's line of position has become the basis of present-day celestial navigation.

5. CULTURAL IDIOSYNCRASY IN NINETEENTH CENTURY SPAIN, WITH A PARTICULAR REFERENCE TO NAVIGATION

As López Piñero (1992, p. 13) and Sánchez Ron (1999, p. 36), *inter alia*, claim, the modernisation of scientific and technical activity began in Spain with the *novator* movement of the last third of the seventeenth century. During the eighteenth century, it was promoted by the illustrated governments of the new Bourbon dynasty, reaching its highest point during the reign of Carlos III (1759-1788). So, at the beginning of the nineteenth century, the position of Spain in this respect was excellent, but science soon ceased to occupy a prominent place, mainly due to the internal political situation.

According to Vernet (1975, p. 231), the Peninsular War (1808-1814) meant the collapse of the feverish development of science. According to López Piñero (1992, p. 14) extended up to 1833; indeed, he qualifies the interval between 1808 and 1833 as a "period of catastrophe". In spite of the liberal interruption (1820-1823), absolutism presided the reign of Fernando VII (1814-1820 and 1823-1833) and caused the extinction or lethargy of nearly all scientific institutions. With the main scientists having been persecuted or exiled, the Inquisition was re-established and freedom of the press was suppressed. López Piñero (1992, p. 15) claims that the only Spanish scientific contributions were due to some exiles who were able to work in contact with the new European tendencies.

However, the fact that in Spain, during the first third of the nineteenth century, there was not an active, organised, scientific community, does not imply that there were no isolated researchers within the different scientific branches. With regard to navigation, for instance, as Peset *et al.* (1978, pp. 39-40) assert, there were some Spanish naval officers working individually under the protection of the Navy, who enjoyed worldwide recognition as scientists. However, their contribution to the progress of mathematics or physics was limited as they were obliged to devote all their efforts to pedagogic and technical matters. In addition to the cases of J. Mendoza y Ríos (1763-1816) and G. Ciscar (1760-1829), mentioned by Peset *et al.*, the one of J. Sánchez Cerquero (1784-1850) can be included. Director of the San Fernando Observatory from 1825, Cerquero made important contributions to the fields of mathematics, astronomy and navigation (Ibáñez, 2001).

In spite of the above exceptions, it can be said, as Menéndez y Pelayo (1888, p. 130) claimed, that for Spanish literature and science, the 19th century did not actually start until 1834. As a matter of fact, the cultural scene improved in Isabelline Spain (1833-1868) as a consequence of the end of absolutism. Although this period did not lack political swings, and consequently discontinuity in scientific policy, recovery was possible to a great extent as a result of the lesser control of the edition and circulation of scientific publications, including specialised journals. It should also be mentioned that during this period important educational reforms were undertaken and some scientific institutions established, factors that undoubtedly helped to smooth the way.

The extreme liberalism which characterised the revolutionary period (1868-1874), extended also to the academic world, and it definitely had an influence on the recovery

that scientific activity experienced during the Restoration (1874-1902). Although its level undoubtedly increased during this period, this does not mean that science was promoted by the official political and cultural ideology; rather, it was just consented (Tuñón de Lara, 1982, II, pp. 32-33).

The difficult circumstances that Spanish science suffered during the nineteenth century have been summarised by R. Taton (1995, p. 628): "In the Iberian Peninsula, badly damaged by the Napoleonic wars, in spite of some attempts of liberal reformation, the political situation remained unfavourable for the free progress of science".

From 1833, the different scientific and technical disciplines started to develop again but, according to Vernet (1975, p. 213), at an unequal rate, so that all of them reached maturity during the second half of the century. This proved true as far as navigation is concerned. In the first place, from 1833 the production of nautical works showed a quantitative increase, as well as a growth in the number of translations, signs of a new, more permissive, order. In spite of certain fluctuations, this tendency was consolidated during the second half of the century (Ibáñez, 2002, pp. 290-298). As for nautical journalism, it too was promoted, starting from the reign of Isabel II. *España Marítima*, published between 1839 and 1840, is credited with being the first Spanish marine journal. Its short life was a common characteristic shared by most publications that followed, chiefly due to the lack of subscriptions (Ibáñez, *et al.*, 2003, pp. 506-507). In the educational field, the reorganisation of civil nautical studies did not take place until 1850, and the syllabus implemented then remained in force until the second decade of the twentieth century (Arroyo, 1989, pp. 128-131).

6. THE INTRODUCTION IN SPAIN OF THE SUMNER LINE: A CHRONOLOGY7

1855: As mentioned above, José J. Navarro published a translation consisting of extracts from the first edition of Sumner's work in the journal *Crónica Naval de España*. However, it does not appear that this article served to disseminate the new navigation widely in Spain. In Pujazón's words, "the diffuseness and lack of method with which it was written caused it to be little read by our seamen" (Pujazón, 1865, p. 73), but it was more probably a consequence of the limited circulation of this publication (Ibáñez, *et al.*, 2003, p. 508).

Even though it may be written without a didactic approach, this 71-page translation is clearly organized in four sections. The first is devoted to the practice of the method which is structured in the classic problem style. The second refers to the advantages of the method. Its fundamentals are explained in the third part, and finally, in the fourth section, the extension of the method to the observation of celestial bodies other than the Sun is shown.

1857: In his work *El compañero del Almanaque Náutico*, Anselmo T. Quijano included ten appendixes, among which, the eighth stands out with the title: *Método de proyección para determinar la situación del buque en la mar* (Quijano, 1857, pp. 36-37).

According to Lasso de la Vega (1857, p. 552), it is "an abstract of the third edition of the American work by Captain Thomas Sumner". It is a meritorious work as, in only two pages, Quijano offers the essence of the usefulness of the method, not only for position finding–by means of two observations, simultaneous or not– but also for determining the compass error or for using the line of position obtained in coastal navigation –when there is only one observation available. He does not solve any examples since what he considers an "advantageous method" requires "a calculation so simple that no navigator ignores its resolution" (Quijano, 1857, p. 37). Finally, he praises and recommends the method, emphasising that "thanks to this clever, though as yet slightly used method, I have safely navigated twice through what is perhaps most reef-sown sea on the globe, the China Sea" (Quijano, 1857, p. 37).

1864: As mentioned earlier, José Saturnino Montojo inserted the same article on Sumner's work in two journals, namely: *El Departamento* and *Anuario de la Dirección de Hidrografía* (see Figure 4), each of which had an off-print (Llabrés Bernal, 1959, p. 50). His intention seems to have been to popularise among Spanish navigators the use of a method that, in his opinion, made it possible "to determine a good fix with two isolated altitudes and little numeric labour", and whose accuracy had already been confirmed by "the practice of many of our naval officers as well as merchant marine captains who have used it and use it daily" (Montojo, 1864, p. 30). In less than thirty pages, Montojo offers in a clear and simple way the essence of Sumner's method, explaining first the principles on which it is based, and then practical instructions to obtain the fix, including just one example as he considers the process "so simple and short in its calculations, which are frequently used by anyone who navigates" (Montojo, 1864, p. 61).

Figure 4. First page of the article by Montojo inserted in El departamento in 1864.

Núm. 2. Lunes 29 de Febrero de 1864. Año I.

EL DEPARTAMENTO.

REVISTA CIENTÍFICA DE MARINA.

Nuevo método de situarse en la mar, del capitan de la marina mercante de los Estados-Unidos Thomas H. Sumner. Escrito con arreglo á los conocimientos generales de nuestra marina militar y mercante por el teniente de navío de la Armada, D. José Saturnino Montojo.

Introduccion.

Durante muchos años ha ocupado á los náuticos con preferencia á cualquier otro, el problema de determinar la longitud en la mar como el de más dificultad é importancia; hoy la perfeccion de los relojes que salen de las acreditadas fábricas de Losada, Johannsen y otros artistas no ménos hábiles, permite obtener con toda seguridad esta coordenada siempre que se conozca igualmente la hora á bordo.

La determinacion de esta hora exige el cálculo de un horario de un astro cualquiera por medio de su declinacion y altura, y la latitud del observador.

El primero de estos elementos se obtiene con gran exactitud en el almanaque náutico que se publica en el Observatorio de Marina de San Fernando cualquiera que sea el astro; no así su altura ni la latitud del observador que están siempre sujetas á errores más ó ménos considerables y que en la mayor parte de las circunstancias influyen considerablemente en la determinacion de la hora á bordo.

Sabido es de todo el que navega que, para que estos errores sean los menores posibles, hay que observar al astro en el momento en que corta al vertical primario, circunstancia que no siempre puede llenarse.

Resulta, pues, que para obtener un buen punto en la mar con los métodos que hasta hoy se conocen, es me-

1864: Francisco Fernández Fontecha (1835-1886) published his addition to the *Tratado de Pilotage* by Gabriel Ciscar. In this case, what stands out is the absence of any reference to Sumner's line.

This fact is specially relevant as this work was formally declared a textbook for Spanish Nautical Schools8. It is very significant that 21 years after the publication of Sumner's book, Spanish seamen still did not have any knowledge of such a useful method when they finished their formal school training.

1865: Cecilio Pujazón (1833-1891) published in *El Departamento*, some reflections on Montojo's paper with the aim of correcting some conceptual errors he had detected and which, at the same time, he removed from Sumner's invention.

1873: Antonio Terry (1838-1900) published his *Manual del navegante* (Fig.5), a work dedicated to professionals, that was also used as a textbook in some Spanish Nautical Schools (Ricart, 1877, p. 228). In a small volume, the author compiled the most necessary elements to obtain the position at sea. This was the first book that included the Sumner line of position to which Terry devoted seven pages (Terry, 1873, pp. 177-183). He gave practical rules for obtaining the fix illustrated with an example, and concluded by reporting other utilities of the method. There were further reprints of this work (1875, 1897 and 1900), which in 1875 was recommended by the Ministry of the Marine to the officers of both navies (military and merchant)9.

Figure 5. Title page of the Manual del navegante (1873) by Antonio Terry


MANUAL

DEL NAVEGANTE

D. ANTONIO TERRY Y RIVAS,

BARCELONA.

1873.

1875: The two volumes of the *Curso de astronomía náutica y navegación* by Francisco Fernández Fontecha, were published. Just like the previous work by the same author, this one has the added value of having been used as an official textbook (Ibáñez, 1997). A 9-page chapter is devoted to Sumner's method (Fernández Fontecha, 1875, II, pp. 304-313), following the same structure (explanation, practical rules, example …) as Terry's *Manual*, on which Fontecha most probably was based.

1877: The method developed by the French navy officer Marcq Saint-Hilare was introduced in Spain through the magazine *Anuario de la Dirección de Hidrografía*.

1879: During the years that J. Ricart supported the *Revista Marítima*, he inserted several articles in it. In the one titled: "Método de Sumner. Determinación numérica del punto de intersección de los paralelos de alturas iguales", he discussed a method due to J. Galí for obtaining analytically the intersection point of the Sumner lines, although Ricart advocated the use of the graphic procedure. The main interest of this work lies in the fact that it proves that the "new navigation" had taken root: there were not only numerous scientists but also modest sailors who, even with a limited mathematical knowledge, undertook the study of the new methods, trying to improve the accuracy of the results obtained.

1880: The second edition of the *Curso de astronomía náutica y navegación* by Fernández Fontecha was published. This 1880 edition (there were further editions of this work in 1891, 1897, 1904 and 1906), which was the last one published in the author's lifetime, was structured in three volumes but no other significant change was made.

1883: Ramón Estrada (1852-1927) published a thorough study of St. Hilaire's method in the *Revista General de Marina*.

1883: Miguel González Aveño (1848-) in his *Compendio de navegación astronómica* devoted the 6th chapter to the simultaneous finding of the ship's position by the observation of two celestial bodies' altitudes (González Aveño, 1883, pp. 163-193). This chapter was divided into two articles: the first one on the graphic methods which provide an approximate solution; and the second one on the accurate solution by means of mathematical calculations. The Sumner line is dealt with in the first article in a four-page section describing the method in a general way. Aveño concluded that the procedure is simply a conditional method which, as it offers no absolute guarantee of safety, cannot be accepted with confidence in complicated situations.

In 1876, González Aveño had been appointed as a teacher of "Cosmography, Piloting and Manoeuvring" at the Nautical School of Valencia (AGMEC). His work is, among those considered, the first one published after the intercept method of St. Hilaire became known in Spain. González mentioned it in a foot note, and these few lines are enough to realise not only that he did not quite understand it, but also his disdain towards a method he considered to be only an approximate solution.

1885: Ramón Estrada published his *Lecciones de Navegación* which was meant to be, according to its title page, a textbook at the Floating Naval School. Estrada's work stands out as the first of the essays analyzed that does not deal with the Sumner line in an isolated way. He included it within the general theory of the new navigation methods (Estrada, 1885, pp. 661-711), in which he paid major attention to St. Hilaire's line of position.

1888: Antonio Perea, in his generic *Guía práctica del oficial de marina* devotes only 16 pages to "Astronomy and Navigation" (Perea, 1888, pp. 354-369), setting forth in the last 4 pages the way of fixing the ship's position by Sumner's method.

1895: The last decade of the nineteenth century was characterised by the publication of several articles and monographs10 about the new navigation. Among them, special mention should be made of the *Nueva navegación astronómica en los buques rápidos* by José Ricart. He established the principles on which the new methods started by Sumner are based, pointing out that Sumner's "lucky inspiration" caused "a true revolution in the methods for finding the geographical position of the ship at sea" (Ricart, 1895, p. 19). Nevertheless, Ricart treated the Sumner line from a historical perspective and even used the concept of St. Hilaire's method in explaining Sumner's, in order to facilitate its comprehension.

7. CONCLUSION

The Sumner line of position is credited with being the major achievement that took place during the nineteenth century in the field of astronomical navigation. Once its usefulness at sea had been demonstrated, the method was improved and the general theory of celestial position lines was developed, so Sumner's discovery became a landmark in the progress of this field.

First adopted by the U.S. fleet, the method spread–although at different rates–among the sailors of all nations, because of its interest for the practice of navigation, and fostered by the international character of the profession.

In Spain, during the nineteenth century, the development of navigation –like that of the rest of the scientific and technical disciplines– was, to a great extent, the reflection of the political instability which characterised the period. As a consequence, the diffusion of the methods of the new navigation was delayed.

Indeed, although news of Sumner's method was first given by Navarro in the review *Crónica Naval de España* in 1855, the new navigation method was not set forth until 1864, when Montojo published his work on this subject in two journals (*El Departamento* and *Anuario de la Dirección de Hidrografía*), both with off-prints, in which the author admitted that the procedure was already commonly used by many Spanish navigators. The first book that deals with the Sumner line was the *Manual del navegante* by Terry, published in 1873. In 1877, St. Hilaire's intercept method was made known in Spain thanks to an article inserted in the journal *Anuario de la Dirección de Hidrografía*; and, in 1885, Estrada was the first author to include it in a textbook.

Thus, it can be concluded that, after its utilisation at sea, the Sumner line (1843) made known in Spain through nautical journals (1855/1864), to be finally included, with a marked delay, in handbooks and treatises on navigation (1873/1875).

On the other hand, the late introduction of the Sumner line contrasts with the early diffusion of St. Hilaire's method (1877), and this fact shortened in Spain the useful lifetime of Sumner's method.

As for the way in which the Sumner line is explained, it can be observed how, in the lapse of 40 years, it is first considered in an isolated manner, then it becomes assimilated within the general theory of celestial lines of position, to finally become history.

Likewise, it is worth noting that in the sphere of training, the new generations of merchant marine officers were deprived of the benefits of celestial lines of position because there was no reference to them in the textbooks used in the Spanish Nautical Schools, until the publication of the works of Terry (1873) and Fontecha (1875).

It must be underlined that the originality of Sumner's method was questioned in Spain. Indeed, the only merit conceded to it by some authors11 was that it required shorter and simpler calculations than methods presented previously. And some other authors, such as Miguel González Aveño12, as late as 40 years after the publication of Sumner's discovery, even considered it to be a conditional method on which navigators could not rely. Antonio Terry13 saw certain analogies between the Sumner line and an original method explained in 1803 by the Spaniard Gabriel Ciscar (1760-1829)14. Terry's comment was soon distorted in a highly chauvinistic style: "Permit us to claim for Spain the honour and the glory of having introduced the use of graphic methods, since commandant Terry says [...] it was Gabriel Ciscar who, many years earlier and in his *Arte de Pilotaje*, invented the method which would later be known as Sumner's" (Anonymous, 1895, p. 386).

At present, however, the importance of Sumner's discovery is widely recognised. It is worth mentioning the homage paid to Sumner by the Spanish essayist Luis de Ribera (1867-1936) who pointed out: "Illustrious scientists later developed Sumner's coarse discovery; but that does not lessen his glory which at one time would have been sufficient to write his name with golden letters on Small's Light" (Ribera, 1935, p. 549).

REFERENCES

Anonymous (1895) La nueva navegación. *Revista de Navegación y Comercio*, VII, 385-388.

Arroyo Ruiz-Zorrilla, R. (1989) *Apunte para una historia de la enseñanza de la náutica en España*. Madrid: Ministerio de Transportes, Turismo y Comunicaciones.

Barreda y de Miranda, J. A. (1897) *Nuevos procedimientos de navegación astronómica*. El Ferrol: Imprenta de *El Correo Gallego.*

Brandenburg, A. and Hugon, P. (1965) Ce que fut le corps des professeurs d'hydrographie. *Navigation. Revue Technique de Navigation Maritime, Aérienne* et Spatiale, XIII (52), 452-461.

Ciscar, G. (1803) *Curso de estudios elementales de Marina*, 4 vols. Madrid: Imprenta Real.

Cotter, C. H. (1968). *A history of nautical astronomy*. London-Sidney-Toronto: Hollis & Carter.

Duval, R. C. (1955) Contribution a l'histoire de la droîte de hauteur. *Navigation. Revue Technique de Navigation Maritime, Aérienne et Spatiale*, III (11), 300-310; III (12), 395-410.

Duval, R. C. (1961) Le navire «Cabot», Capitaine Thomas H. Sumner. *Navigation. Revue technique de navigation maritime, aérienne et spatiale*, 10, 194-197.

Estrada, R. (1883) Cálculo de la situación en la mar por el procedimiento del punto aproximado. Arreglado para las tablas de Mendoza. *Revista General de Marina*, XII, 81-91.

Estrada, R. (1885) *Lecciones de navegación precedidas de unas ligeras nociones de astronomía y seguidas de unas tablas para facilitar los cálculos matemáticos*. Madrid: Sucesores de Rivadeneyra.

Fernández Fontecha, F. (1864) *Adición al tratado elemental de pilotaje escrito de orden de SM por D. Gabriel Ciscar…* Cádiz: Imprenta y Litografía de la *Revista Médica*.

Fernández Fontecha, F. (1875) *Curso de astronomía náutica y navegación,* 2 vols. Cádiz: Imp. de la *Revista Médica.*

García Franco, F. (1947) *Historia del arte y ciencia de navegar. Desenvolvimiento histórico de los cuatro términos de la navegación*, 2 vols. Madrid: Instituto Histórico de Marina.

Gelcich, E. (1889) *Estudios sobre el desenvolvimiento histórico de la navegación*. Valencia: Lib. de Pascual Aguilar.

Gelcich, E. (1893) Situación del buque. Manera de determinarla por los métodos de la nueva navegación astronómica. *Revista General de Marina*, XXXIII, 38-63 and 223-247.

González Aveño, M. (1883) *Compendio de navegación astronómica.* Valencia: Imprenta de Nicasio Rius.

González Aveño, M. (1904) *Resolución breve, clara y exacta de los problemas más usuales en la práctica de la navegación.* Valencia: Imprenta de Manuel Alufre.

Ibáñez (2002) *La difusión de conocimientos náuticos en la España decimonónica: la navegación astronómica en los textos de náutica españoles del siglo XIX*. Leioa: Servicio Editorial de la Universidad del País Vasco.

Ibáñez, I. (1997) Un libro de texto dedicado a las enseñanzas náuticas: el *Curso de astronomía náutica y navegación* (1875) de Francisco Fernández Fontecha (1834-1886). In: Fraga, X. A. ed. *Ciencias, Educación e Historia. Actas do V Simposio de Historia e Ensino das Ciencias (Vigo, setembro 1995)*. A Coruña: Publicacións do Seminario de Estudos Galegos, 271-276.

Ibáñez, I. (2001) José Sánchez Cerquero (1784-1850) y el problema de Douwes. Noticia sobre sus *Reflexiones sobre el método de hallar la latitud en la mar por medio de dos alturas del Sol observadas fuera del meridiano* (1823). *Revista de Historia Naval*, XIX (73), 105-114.

Ibáñez, I., Llombart, J. and Iglesias, M. A. (2003) Nautical journalism in Nineteenth century Sapain. In: *Conference Proceedings. 3rd International Congress on Maritime Technological Innovations and Research. Bilbao, 6, 7 and 8 november 2002*. Leioa: Servicio Editorial Universidad del País Vasco, 505-518.

J. J. N. [José Joaquín Navarro] (1855) Método para determinar la situación de un buque en la mar en latitud y longitud, por medio de proyecciones sobre la carta esférica. *Crónica Naval de* España, II, 307-331, 424-446, 545-567.

Lasso de la Vega, J. (1857) Bibliografía. Noticia de las materias y aplicaciones más notables que contiene "El compañero del Nuevo Almanaque Náutico", obra recientemente publicada, original del alférez de navío graduado D. Anselmo Teodoro de Quijano. *Crónica Naval de España*, V, 548-556.

Llabrés Bernal, J. (1959) *Aportación de los españoles al conocimiento de la ciencia náutica 1801-1950*. Palma de Mallorca: Imprenta Lulio.

López Piñero, J. M. (1992) Introducción. In: López Piñero, J. M. ed. *La ciencia española en el siglo XIX*. Madrid: Marcial Pons, 11-18.

Marcq Saint-Hilaire (1875) Calcul du point observé. *Revue Maritime et Coloniale*, XLVI, 341-376, 714-742.

Marcq Saint-Hilaire (1877) Cálculo para la determinación del punto de la nave. *Anuario de la Dirección de Hidrografía*, XV, 314-400.

Martínez-Hidalgo, J. M. (1946) *Historia de la aguja náutica*. Barcelona: Gustavo Gili.

Menéndez y Pelayo, M. (1888) *La ciencia española (polémicas, proyectos y bibliografía)*, 3ª ed., Tomo III. Madrid: Imp. de A. Pérez Dubrull.

Montojo, J. S. (1864) Nuevo método de situarse en la mar del capitan de la marina mercante de los Estados Unidos Thomas H. Sumner. Escrito con arreglo a los conocimientos generales de nuestra marina militar y mercante. *El Departamento*, I, 29-36, 61-68, 93-100, 125-133.

Perea, A. (1888) *Guía práctica del oficial de marina*. Cádiz: Imprenta de la *Revista Médica*.

Peset, J. L., Garma, S. and Pérez Garzón, J. S. (1978) *Ciencias y enseñanza en la revolución burguesa*. Madrid: Siglo XXI de España.

Pujazón, C. (1865) Reflexiones sobre la memoria del teniente de navío, D. José Montojo, titulada "Nuevo método de situarse en la mar del capitan de la marina mercante de los Estados Unidos Thomas H. Sumner". *El Departamento. Revista Científica de Marina*, *II*, 73-80, 97-104, 121-128, 145-150.

Quijano, A. T. (1857) *El compañero del Almanaque Náutico*. Cádiz: Imp., Lib. y Lit. de la *Revista Médica*.

Ribera y Uruburu, L. de and Ribera y Egea, J. L. de (1935) *Tratado de navegación*, 4th. ed. Madrid: Imprenta del Ministerio de Marina.

Ricart y Giralt (1879) Método de Sumner. Determinación numérica del punto de intersección de los paralelos de alturas iguales. *Revista Marítima*, III, 413-416.

Ricart y Giralt, J. (1877) La longitud. *Revista Marítima*, I, 227-230.

Ricart y Giralt, J. (1895) *Nueva navegación astronómica en los buques rápidos*. Barcelona: Tip. *L'Avenç*.

Richardson, R. S. (1946) Captain Thomas Hubbard Sumner 1807-1876. *Navigation. Journal of the Institute of Navigation*, 1 , 35-40.

Sánchez Ron, J. M. (1999) *Cincel, martillo y piedra. Historia de la ciencia en España (siglos XIX y XX)*. Madrid: Taurus.

Smiley, C. H. (1961) Un navire appelé «Cabot» commandé par le Capitaine Thomas Hubbard Sumner. *Navigation. Revue technique de navigation maritime, aérienne et spatiale*, 10, 198-199.

Taton, R. *et al*. (1995) *La science contemporaine. 1. Le XIX^e siècle*. Paris: Quadrigue, Presses Universitaires de France.

Terry y Rivas, A. (1873) *Manual del Navegante. Redactado con presencia de los mejores autores modernos*. Barcelona: Imp. y Tip. de C. Verdaguer y c^a.

Terry y Rivas, A. (1894) Situación del buque por los medios más rápidos y sencillos de la nueva navegación astronómica. *Revista de Navegación y Comercio*, VI, 1-2, 33-35, 99-102, 118-122 and 175-176

Tuñón de Lara, M. (1982) *La España del siglo XIX*, 12 ed., 2 vols. Barcelona: Ed. Laia.

Vernet, J. (1975) *Historia de la ciencia española*. Madrid: Instituto de España, Cátedra "Alfonso X el Sabio".

Williams, J. E. D. (1994) *From sails to satellites. The origin and development of navigational science*. Oxford-N. York-Melbourne: Oxford University Press.

NOTES

1 Biographical sketch taken from Richardson, 1946.

2 A small sailing ship of scarce 400 tonnes and 35 m. in length, built in Duxbury (Massachusetts) in 1832. See, e.g.: Duval, 1961, or Smiley, 1961.

3 As quoted in Gelcich, 1889, p. 217.

4 Nevertheless, Brandenburg and Hugon (1965, p. 460) assert that A. Fasci claimed to have been the first one talking in France about the lines of position of the new astronomical navigation.

5 The reviews: ⋆ *Anuario de la Dirección de Hidrografía* (Madrid), reviewed from 1863 to 1880; ⋆ *Crónica Naval de España* (Madrid), reviewed from 1855 to 1860; ⋆ *El Departamento* (San Fernando), reviewed from 1864 to 1865; ⋆ *Revista General de Marina* (Madrid), reviewed from 1877 to 1900; ⋆ *Revista Marítima* (Barcelona), reviewed from 1877 to 1881.

6 The reviewed books have been selected from the catalogue by Llabrés Bernal (1959).

7 The technical aspects of Sumner's method are not the main concern of this article. Therefore, it has been deliberately avoided to provide, when not necessary, a thorough description of the contents of the works listed below.
8 By Real Orden of 5th november 1864.
9 By Real Orden of 20th march 1875.
10 Apart from the one quoted here, some others can be mentioned, e.g.: Gelcich (1893) or Barreda (1897).
11 See, e.g.: Pujazón (1865, p. 74) or Terry (1873, p. 178).
12 See González Aveño (1883, p. 169). The author's position in this matter did not change eventually as he showed in: González Aveño, 1904, p. IV.
13 This author manifested it several times. See, e.g.: Terry, 1894, p. 1.
14 Ciscar (1803, vol. 4, pp. 144-145) explained how to determine the longitude at the time of obtaining the latitude by the so-called "problem of Douwes". Using two altitudes of a celestial body, fixing the point required the use of four supposed latitudes and the calculation of four hour angles (two for each observation). The analogies between Ciscar's method and that of Sumner lies in the fact that both allowed the simultaneous obtention of the two geographical coordinates and the analogy of the elements to be analitically calculated.

APPENDICE: TRANSFERENCIA DE CONOCIMIENTOS NÁUTICOS DE LOS EEUU A EUROPA EN EL SIGLO DIECIMUEVE. EL CASO DE LA RECTA DE ALTURA SUMNERY SU INTRODUCCIÓN EN ESPAÑA.

Al estudiar el progreso de la náutica en el siglo XIX, se encuentra un descubrimiento trascendental que marca el inicio de lo que la mayoría de autores coinciden en denominar "nueva navegación astronómica". El Capitán de la Marina Mercante de los Estados Unidos, Thomas H. Sumner (1807-1876), descubrió casualmente, en 1837, un procedimiento con el que, por primera vez, podían obtenerse simultáneamente las dos coordenadas geográficas (latitud y longitud) de la situación del buque, de forma sencilla y breve. Sumner dió a conocer su método en Boston, en 1843, con la publicación del folleto titulado *A new and accurate method of finding a ship's position at sea, by projection on Mercator's chart*.

El método de Sumner se propagó de forma desigual. Su uso se generalizó inmediatamente entre los marinos norteamericanos, gracias a Matthew F. Maury (1806-1873), por entonces director del Servicio Hidrográfico de Washington, quien, en octubre de 1843, escribió a Sumner: "Vuestro método puede considerarse como el principio de una nueva era en la navegación práctica. Se han dado órdenes para que todo buque de la marina se provea de vuestro folleto".

Según reseña García Franco, el nuevo método fue conocido en Europa por medio del *Nautical Magazine*, en 1844; por un artículo que en 1847 publicó en Francia el marino Barther, en *Annales Maritimes*, y por el alemán Henry A. Tobiesen, que lo tradujo a este idioma en 1855. En España, continúa García Franco, fue difundido, en 1865, por el entonces teniente de navío Montojo, aunque Quijano lo había ya utilizado, y dado noticias sobre el mismo en 1857. En línea con este autor, Arroyo presenta de forma idéntica la introducción en España del método de Sumner.

Sin embargo, examinando revistas de la época, encontramos que el trabajo de J. S. Montojo, había sido insertado en *El Departamento* y en el *Anuario de la Dirección de Hidrografía*, en el año 1864, así como que casi una década antes, en 1855, *Crónica Naval de España* había publicado la traducción que hizo J. J. Navarro de la primera edición de la obra de Sumner.

Esto despertó nuestro interés por conocer la forma en que el comienzo de la nueva navegación astronómica se extendió en España. Con este fin, se han examinado, en orden cronológico, los artículos publicados en: *Anuario de la Dirección de Hidrografía*, *Crónica Naval de España*, *El Departamento*, *Revista General de Marina*, y *Revista Marítima*; así como las obras de autores españoles, representativas de la segunda mitad del siglo XIX, seleccionadas a partir del catálogo de Llabrés Bernal (1959).

El descubrimiento de Sumner supuso el inicio de los modernos métodos geométrico-analíticos para el cálculo de la situación del buque, por medio de los cuales, con la ayuda de un cronómetro de confianza y la altura de un astro, tomada en cualquier instante, se obtiene una línea de posición que se traza como una recta en la carta mercatoriana. Con dos alturas, se obtienen dos rectas cuya intersección determina el punto donde se encuentra el buque. Esto satisfizo los deseos de los marinos, necesitados de una solución sencilla y breve para la determinación simultánea de la latitud y la longitud, sin tener que observar en momentos determinados.

Aunque inicialmente la originalidad del método de Sumner fue muy discutida, la importancia del mismo propició su rápida propagación, despertando el interés de marinos e investigadores. En corto espacio de tiempo, el procedimiento inicial fue perfeccionado, desarrollándose la teoría general de las líneas de posición de altura. En este proceso, destaca la intervención de Marcq Saint-Hilaire, quien en 1875 dio a conocer la recta de altura que lleva su nombre, habiendo llegado su método hasta nuestros días como el más indicado.

En el caso de nuestro país, la tardía introducción del trabajo de Sumner (1855), contrasta con la rápida difusión de la tangente Marcq (1877), lo que hizo que la vigencia de la secante Sumner fuera especialmente breve.

Asimismo, es particularmente curioso que en 1864, asumido como el año de la difusión general del procedimiento de Sumner en España, llevada a cabo por J.S. Montojo, fuera ya de uso común entre muchos de nuestros marinos, como el propio autor reconoce.

También destaca el hecho de que en el ámbito docente las nuevas generaciones de marinos mercantes fueran privadas de los beneficios del método por no hablar de él los textos utilizados en las Escuelas de Náutica, hasta la publicación de los trabajos de Terry (1873) y Fernández Fontecha (1875). En este sentido, sorprende que, tan tardíamente como 1883, un profesor de pilotaje, como lo era González Aveño, se mostrara poco partidario de los nuevos métodos, por considerarlos poco fiables.

Como resumen final del análisis cronológico efectuado, constatamos que, tras ser utilizada en la mar, la recta de altura de Sumner fue difundida a través de revistas marítimas, para, finalmente, ser incluida en manuales y tratados con notable retraso. En cuanto a la forma en que el procedimiento es expuesto, se observa cómo, en el transcurso de cuarenta años, pasa de ser contemplado de forma aislada, a ser difuminado en la teoría general de las rectas de altura, para, por último, convertirse en historia.