

ON THE HISTORY OF THE NAUTICAL MILE.

by
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The unit of measurement for distances at sea, namely the nautical mile, is nowadays identical with a minute of the meridian on land. It is well known that, owing to the compression of the earth, the true length of a minute of latitude varies a little with the latitude; yet logs must be constructed for a determined value of the metre. This log value should therefore be a mean value of the terrestrial meridian, suitable for practical use. As this mean value is not everywhere calculated on the same basis, it follows that the nautical mile nowadays expresses a slightly different value in different countries. But it is defined as a "minute-mile" and is used as such. This has not, however, always been the case.

We propose now to give a succinct summary of the unit of measurement of sea distances which has been used in the course of time. To guide us in this task, we have used among other things an article which appeared in the *Annalen der Hydrographie* of 1913: *Zur Geschichte der Seemeile*, by H. WAGNER.

The unit of distance at sea, in olden days, was not in any way allied to the minute of the meridian on the earth. In the XV century much use was made of the Spanish *Leguas*, of which $17 \frac{1}{2}$ went to the degree of the terrestrial great circle. At that time it was very doubtful what was the real length of the degree, for there was only the vaguest knowledge of the size of the globe. Christopher COLUMBUS had taken the degree to be $56 \frac{2}{3}$ Roman miles (about 84 km.). Consequently, his calculation of the length of the degree was too small by 32 %. It is only within recent times that, by measuring arcs of meridians, so much progress has been made in our knowledge of the dimensions of the earth that, having determined the order of magnitude that the unit of distance must have, it has been possible to know how many metres or feet it must contain.

Various contemporary nautical authors have proclaimed erroneously that the "mile" of olden times was the same as our present mile.

The order of magnitude of the nautical mile was fixed long before its absolute length. In 1715, the English nautical author Henry WILSON wrote, "that it is indisputable that the length of a knot on the log-line must be the 120th part of a mile, because half a minute (a 30-second sand-glass) is the 120th part of an hour; but the difficulties arise from the divergency of opinion on the number of yards contained in a degree of the great circle on the earth." When collating the determinations of the dimensions of the earth which were available at that time, WILSON proposed to fix the length of the knot at 48 ft. 7 in. or 51 feet, as against 42 feet, the length used till then in England. Another English author, NORWOOD, had recognised the falsity of the latter value as early as 1636.

Pierre BOUGUER, who took part in the expedition sent out to measure an arc of the meridian in Peru, about 1750, wrote as follows: "The Italians use miles, which count as 1,000 geometrical or double paces, each of 5 feet; and they suppose that 60 of these miles make one degree. This method of counting distances is very convenient... but it is therefore necessary to modify its length, and increase it by approximately one-seventh. In fact, 1,000 geometrical paces or 5,000 Royal feet only come to $833 \frac{1}{3}$ toises; instead of which the mile must be given 950 toises to make it equal to our thirds-of-a-league or to the minutes of arc of the meridians or of the equator which we take to be equal."

Here are the miles which have been used since the beginning of the XIV century for the measurement of distances at sea:

One of about 1,230 metres ;
One of about 1,500 " ;
One of about 1,850 " .

Besides these, there have been three "great" nautical miles in use; they were linked to the two last small miles by a fixed ratio. They are:

The Spanish *Legua Maritima* equal to $4 \times 1,480$ m. Of these, $17 \frac{1}{2}$ were taken to the degree, making the latter about 105 km., while it is actually 111 km. The French *Lieu Marin* and the British *Sea League*, equal to about $3 \times 1,500$ m.; the degree contained 20 of them and was consequently about 90 km. The Dutch-German *mile* (of about 5,500 m.), of which 15 were counted to the degree, thus making the degree 82.5 km. These miles were based on the size of the degree; also, when it became evident that the earth was bigger than had been previously supposed, the length of the mile was modified as well. The Dutch-German mile was altered from 5,500 to 7,400 m.; the Anglo-French mile from about 4,500 to 5,500.

The small nautical miles:

(1) *The Mediterranean mile.* — The longest-established nautical mile in the Mediterranean seems to have been of about 1,230 m., or $\frac{5}{6}$ of the Roman mile. It was used in the charts of the portolans of the middle ages and was probably of Greek origin.

(2) *The Roman nautical mile.* — It is more than probable that the coasts of the Atlantic Ocean on the Italian charts of the middle ages were surveyed with a mile of the same order of magnitude as the Roman mile, or mile of a thousand paces. At the time of the great discoveries it seems to have been in general use. Christopher COLUMBUS' logs state that he used that mile. It was of about 1,480 m., and $56 \frac{2}{3}$ went to the degree. This mile continued to be used in the Mediterranean nearly up to the end of the XVIII century, during which period people started counting 75 to the degree. (Which is nearer the truth).

At the start of the period of the great discoveries, there was so much uncertainty about the dimensions of the earth that the differences of opinion reached 50%. The length accepted for the degree varied from $56 \frac{2}{3}$ to $87 \frac{1}{2}$ Roman miles. Most of the Southern-European navigators, however, only used the following measurements:

$$\begin{aligned} 1^\circ &= 70 \text{ migli (or, as 4 migli = 1 legua),} \\ 1^\circ &= 17 \frac{1}{2} \text{ Spanish leguas.} \end{aligned}$$

Only the Portuguese counted with $1^\circ = 16 \frac{2}{3}$ legoa.

Nowhere among the navigators does one find at that time that the degree is divided into 60 miglia, as many historians have claimed. The cosmographers started from the XV century to count with the degree of 60 (Italian) miliaria. The Italians had been using this mile continuously and for some time as a land measure. In an edition of Ptolemy published at Ulm in 1482, the degree of 60 miliaria is found appearing on the chart of Southern Asia. The author Nicolaus GERMANUS had already drawn the chart for an edition of Ptolemy in 1466, and it is quite possible that this German was the creator of the degree of 60 miles. WAGNER merely sees in that a better adaptation to the framework of the chart of what Ptolemy accepted, i. e. 62 Roman miles. The result was a convenient division of the degree into whole miles. Thus was born, without anyone realising it, the mile of one minute. At a period when so much uncertainty prevailed with regard to the dimensions of the earth, there was no great error in assuming the degree to be of 60 Roman miles instead of $62 \frac{1}{2}$ (of about 1,480 m.). By way of reminder we may recall that ERATOSTHENES, at Alexandria, when trying about 275 B.C. to measure the size of the earth, found the latter's circumference to be 250,000 stadia, which he rounded off to 252,000 "so that there should be exactly 700 stadia to the degree."

It follows from the above that the cosmographers of about 1500 depicted the earth as smaller than it is; in fact they counted the degree as 60 miles of about 1,480 m., making it about 89 km.

The Italian navigators held a different opinion, since they fixed the degree at 70 miles of the same length as above. Pedro DE MEDINA, in the book *Arte de Navegar* (Seville, 1545), mentions no other miles but these. On the chart of the Moluccas of 1598, the legend gives for the three scales of miles of the chart, $1^\circ = 17 \frac{1}{2}$ Spanish leguas = 70 Italian miles = 15 German miles.

This explains why the circumference of the earth accepted by the navigators of the period was too small by 7%, since $70 \times 1,480$ m. = 103.6 km. This mile remained in

force in the Mediterranean for many centuries later. When it became possible to take the exact size of the earth into account, the mile was not lengthened, but the number of miles to the degree was increased from 70 to 75, making the degree 111 km.

The old British nautical mile of 5,000 feet. — In the course of the XVI century, the scales of miles of charts began more and more to be provided with legends, or else several scales of miles were given alongside one another on the same chart. But, from the fact that these miles were referred to the terrestrial degree, as on the chart of Southern Asia which we have already mentioned, it was not possible to deduce the absolute length of these miles. Even in treatises on navigation nothing can be found in the chapter on the terrestrial globe on the subject of the size of the mile or the degree. It was discussed in a very vague manner in the chapter on the log. From the introduction of the log, at the end of the XVI century, the ratio between the measure of time and linear measure had been fixed so as to determine the speed of the ship. It was BOURNE who first talked of the log in his *Regiment of the Sea*, London, 1574. The time of the log was half a minute. J. COLLINS wrote in 1659 that "our English mile or Italian mile by which we reckon at sea contains 1,000 paces, each pace being 5 feet and each foot 12 inches." It seems that this mile agreed with the Roman mile. In a treatise of 1683 (*Practical Navigation* by J. SELLER) it is noted that the degree has been calculated as 60 of these miles,... "60 such miles make a degree, so that a degree should contain 300,000 of our feet, and one mile (or minute) 5,000 feet..." But this false calculation was sufficiently refuted by NORWOOD and other authors. As early as 1639 it had been shown, as a result of NORWOOD's calculation of the size of the earth, that it would be correct to increase the length of the knot proportionally. The nautical author COLLINS thought that the degree should be at least 360,000 feet, and that it would be correct to increase the length of the knot from 42 feet to 50 feet. It is known that in 1636 the mile used in England was this mile of 5,000 feet. It thus corresponded to what is now known as the London Mile.

The English nautical mile. — The true nautical mile may be considered to date from 1636. In 1637 there appeared in London the little booklet, *The Sea-man's Practise*, containing a *Fundamental Probleme in Navigation, experimentally verified*. The preface of this work is by NORWOOD, and the latter shows that the mile of 5,000 feet is too short. NORWOOD, who had himself measured an arc of the meridian, wrote in his book, *Reader of the Mathematicks*, in the chapter on the log ("Dividing the Logline and reckoning the Ship's Way"), "It appears, not only from this experiment, [i. e. from the measurement of the arc of a meridian] but even by all other, that there is a greater number of feet contained in a Degree than the common opinion, that a thousand of Paces make a mile."

In NORWOOD's opinion, there were several reasons for this misunderstanding relative to the length of the mile. First, the fault inherent in the chart plates. On these, in fact, the parallels were the same length as the equator, i. e. the minute of latitude did not increase. If, as is the custom nowadays, the degree on the equator is given a length of 60 miles, i. e. $10^\circ = 600$ miles, on the 35th degree of latitude the 10° of longitude will not be more than 490 miles. But if, owing to the projection, this distance of 10° is counted at this higher latitude also as 600 miles, the false result is obtained that one mile equals 5,000 feet. This misunderstanding had, on the other hand, the advantage for navigators of not risking being taken unawares by the presence of land after navigating a certain distance by the log. This distance had already been rendered passably uncertain by ignorance of the currents, of the magnetic variation, etc. In consequence, even if navigators had noticed that the mile was too small, it is certain that all the circumstances that influence dead reckoning by the log would have set them at ease with regard to this smallness. NORWOOD proposed, after his measurement of the arc of the meridian, to fix the mile at 6,120 feet, and later at 6,000 feet, observing that "the Ship's Way is commonly more than by the Log-line appears to be, and every man desires to have his reckoning something before his ship, that he fall not in with a Place unexpected."

Little by little, this mile was introduced into practice, but it was not until the first half of the XVIII century that it was called the nautical mile. It is quoted for the first time in a treatise of 1730. Meanwhile, the distance between the knots of the log remained unchanged, but the time of the log was altered from 30 to 24 seconds.

