C. R. Geoscience xxx (2016) xxx–xxx

Contents lists available at ScienceDirect

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History of sciences

French explorations of the Mediterranean Sea during the 17th and 18th centuries

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ARTICLE INFO

Article history:
Received 1st July 2016
Accepted after revision 11 July 2016
Available online xxx

Handled by Vincent Courtillot

Keywords:
Mediterranean Sea
Past French explorations
Geodesy
Astronomy

ABSTRACT

Many 17th- and 18th-century French astronomers and geophysicists made very valuable contributions to our knowledge of Mediterranean geography. Peiresc was the first, and after him came Chazelles, La Condamine, and Chabert. They were all meticulous geodesists, and, in order to carry out their work in sometimes hostile environments, intrepid travellers as well. This invited paper summarizes the 17th and 18th century expeditions and observations of these astronomers.

1. Introduction

1.1. History

The idea of locating with a drawing the various explored, known or even imagined places is actually a very old one. Without the aid of any accurate measurements, Babylonian maps already described rather small areas (Fig. 1).

The idea that the Earth is spherical is a very ancient one. Lunar eclipses cannot, after all, be understood in any other way. It seems that Anaximander tried to make a map of the World. Herodotus described the countries of the Near and Middle East, but without mapping them. Pythagoras was the first man to state unequivocally that the earth was spherical. Aristotle himself, after making daily observations, came to the same conclusion.

Erathostenes (276–174 BC) can be credited with the invention of geography, since he created the word for it. He noted that Alexandria and Swenett (now Aswan) are located on the same meridian. The simultaneous observations (at noon on the day of the summer solstice) of the projected shadows in both places allowed him to determine the angle under which the distance between the two locations could be seen from the Earth's centre. The calculation of that angular distance by Eratosthenes is only slightly different from today's one. Eratosthenes's map of the inhabited world (called the ecumene) was the accepted one for a very long time (unfortunately no copies survived).

Hipparchus (188–120 BC), the great Greek astronomer, in his critical treatise on Eratosthenes' geography, described astronomical methods for the determination of the latitude and longitude of geographical locations (by using the time of these observations). He pioneered the stereographic projection for extended mapping.

Strabo (57 BC–25 AD) made very important contributions as well. His *Geography* is indeed fascinating, and he left to posterity the contributions that Hipparchus had made to the understanding of latitude and longitude and also the expeditions of Pytheas of Massalia.

At that time, Alexandria was the scientific centre of the Mediterranean world. Ptolemy's (90–165) *Geography* was a continuation of Hipparchus' works. In particular, he

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http://dx.doi.org/10.1016/j.crte.2016.07.001

Fig. 1. Babylonian map of the World.

mapped areas that had already been explored (see Fig. 3), especially the Mediterranean, that he described as extending as far west as El Hierro Island (one of the Canary Islands).

The Greek and Alexandrian heritage was somewhat forgotten in the Middle Ages. For example, the maps produced in monasteries depicted the universe symbolically as a flat circle divided into four equal parts: in the top left section, one found Europe (Europa), in the lower left one, Africa, while Asia itself comprised the entirety of the right-hand side of the map. Major rivers (the Volga and Nile) and the Mediterranean Sea served as markers to separate the continents; Jerusalem, quite naturally, was to be in the centre (Fig. 2). Other more sophisticated but just as broadly outlined depictions were made of the world, as it was known at that time.

Ptolemy's maps (Fig. 3) were redone and improvements were made. At last in 1570, the Flemish cartographer Abraham Ortelius made a rather satisfactory map (Fig. 4) of as much of the world as had been explored up until his time. The way was now laid open for a detailed and precise cartography of the Earth (Lévy, 2004), and especially of the Mediterranean, which is the subject of this short historical note.

1.2. The principles of map-making

Making a map requires knowledge of the longitude and latitude of each city, each harbour, each islet... The question of determining latitude was not particularly difficult, as this could be done by observing the elevation of the polar star above the horizon. This made it possible to determine directly the latitude of any location, in comparison to a reference parallel circle that had been well-known for a long time, the Equator (the measure of the elevation of the polar star above the northern horizon allows one to measure directly the latitude of any location).

But determining longitude, however, presented severe difficulties (Raynaud-Nguyen, 1985). There was no meridian circle that could be used as an "origin (or reference) meridian", so one had to be chosen (that of some arbitrary location 'A', for example). To get the longitude of a place 'B' relative to 'A', the same astronomical phenomenon had to be noted at place A at the local time T_a, and at place B at the local time T_b; the difference (T_a–T_b) would give the longitude of B, and thereby the angular difference between the meridian circles could be measured. A simple method – and one already proposed by Hipparchus – was to use a lunar eclipse (Fig. 5), a phenomenon that occurs at the same time everywhere on Earth, wherever it can be observed.

Astronomers could, without too much trouble, measure a distance on the Earth (as a number of steps or wheel revolutions), both south to north and east to west, but what when at sea? Moreover, whether ashore or at sea, it was necessary to determine the difference in solar time of a specific astronomical phenomenon at place A from the solar time at which the same phenomenon could be observed at place B. Modern clocks can be carried around easily, but the gnomons of ancient times could not!

This technique did not, however, facilitate the making up of a geographical map, because units of length that can be easily inferred from a difference in latitude are not so easy to infer from a difference in longitude (length units being much larger for a low latitude than for a high latitude). The astronomer-geographer (for instance for France or the Mediterranean area) had to make a precise computation corresponding to a longitudinal difference at a given latitude. In order to draw maps of a larger latitudinal extent, it is necessary to project the sphere on a plane, an operation for which several well-known options do exist (not described here).

At the end of the 16th century, the invention of refracting, and then reflecting, telescopes enabled the viewer to get a much better view of dim and distant objects. This is why, in the early 17th century, Galileo's use of his refracting telescope (which he did not invent, but improved greatly) allowed him to discover in the sky hitherto unknown objects (Fig. 6). Other astronomers, especially in Germany, followed his lead.

Later on, improvements were made on these instruments: the use of telescopes installed on "quarters of circle" used in astronomy and geodesy, the invention of the micrometre, which increases the accuracy of angular measurements. One should also mention the improvements made by Huyghens (circa 1665) on the mechanism of clocks, the best of which (circa 1673) never varied by more than a second per day (Fig. 7). One should remember that in astronomy the accurate measurement of time is of equal importance as the accurate measurement of angles.

Please cite this article in press as: Dumont, S., French explorations of the Mediterranean Sea during the 17th and 18th centuries. C. R. Geoscience (2016), http://dx.doi.org/10.1016/j.crte.2016.07.001