

REVIEW ARTICLE

Piri Reis – a pioneer of marine knowledge and marine science heritage in the seas of the Old World

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Abstract

A review is made of the developments leading from marine knowledge to marine science in the seas of the 'Old World'. Piri Reis, a technically well-equipped captain and chart maker of medieval times, was also a good observer of nature leading to important conclusions on the workings of nature. Like most other medieval figures, such contributions did not surface to gain recognition in the old world for many years, and often centuries. In particular, the efforts of Luigi Ferdinando Marsili, who actually initiated the methods of marine science that evolved into the basic science of modern oceanography, had his share of the ignorance from the establishment, but survived the centuries, as compared to Piri Reis who gave his life against bigotry, while his superior world map remained undiscovered until the beginning of the 20th century. A much overlooked set of observations reported by Piri Reis on tides is brought under light, and referenced with respect to the historical trend of development which was far behind his level.

Keywords: Piri Reis, civilization, oceanography, Turkish Straits, Black Sea, Bosphorus, Mediterranean, ecosystems

Early Developments in the 'Old World'

First civilizations including seafaring ones developed and spread across the Mediterranean, Black and Caspian Seas in the 'Old World' region, at the confluence of the European, Asian, African continents. Population increase in the old world created a search for remote natural resources and the development of trade by the ancient communities, eventually leading to the historical parade of competing states and long-lived empires in the region. Trade along the ancient inter-continental highway, the 'silk-road', linked remote civilizations of the Asian continent to the Mediterranean region, complemented by trade across the sea. These interactions were not always peaceful; trade and wars between duelling states were two sides of the same coin. The richness of the material

wealth and civilization of the eastern Mediterranean began to receive much attention from the west, striving to take control of trade routes in the middle ages.

Travel and conquests to discover and make use of the traditional cultural and material wealth of the east was on high demand in Christian Europe throughout the middle ages, starting with the pillage and plunder of the near east by the Crusades in the 11th to 13th centuries and motivated further by the eastern travels of Marco Polo in the 13th century. The conquest of İstanbul in 1453 made a major impact on west and its march on the east, in the search for alternative sea routes bypassing the Ottoman Empire, which controlled trade on the Silk Road. Christopher Columbus (Cristoforo Colombo) seeking India at sea with this motivation reached America in 1492, which made him equally perplexed as if he had reached India. Prior to his travel across the Atlantic, Columbus had become an expert on charting the wind and current systems of the Mediterranean Sea, travelling as far as the island of Chios in the Aegean Sea in 1474. He used this experience in the Mediterranean later to take advantage of the low latitude easterlies in the voyage forward, and of the mid-latitude westerlies on the way back.

In the middle ages, great advances were made in the activities at sea, when, in parallel with other emerging sea powers of the time, the Ottoman Empire, the most powerful state of the period (Seydi 2007), recognized the growing importance of the control of sea routes, along with its existing control of the Silk Road, which had been a main route of the eastern trade since three thousand years. In this effort, it also became a major naval power dominating the Mediterranean, despite the competition with its sometime trade partner and other times opponent Venice. Despite its superior power in the middle ages, the Ottoman Empire failed to take steps that would have ensured its success, for instance by introducing the printing press (1720) much later than Gutenberg (1450). In contrast, the number of books published in Europe about the Ottoman Empire during the 15th and 17th centuries was already more than two times those about the newly discovered America (Atkinsons 1935).

Interest in Europe to discover and seize the ancient lands and wealth of the near and middle east since the Crusades was followed by campaigns against the Eastern Roman (Byzantine) empire in the 15th century, and by the political and commercial competition between the Ottoman empire with the Habsburg empire and its ally Venetian Republic in the 16th and 17th centuries. The image of the 'invincible Turk', built in early medieval times in Europe was seriously tried but could not be totally shattered in Lepanto (1571). It was with these motives that a number of 'travellers' flooded the east in the middle ages and later centuries, to discover the lands and the people that seemed to dominate not only the east but also intersected with the trade routes. Among these discoverers was Marsili, later lending his expertise gained in İstanbul to the Habsburg during the second

siege of Vienna (1683) and the ‘Holy League’ of 1684 through the war of 1683-1697, leading to the treaty of Karlowitz (1699) that initiated the gradual demise of the Ottoman Empire in the next centuries. His monumental description of the military state of the Ottoman Empire (Marsigli 1732) was part of these basic discoveries to be used by its enemies.

From the 15th century onwards, a new type of literature emerged in the region: Isolario (island books) compiled during the many Mediterranean cruises, presenting information on distances between sites, maps and pictures of islands, castles and cities, folk costumes and customs (Harley and Woodward 1987). It was noteworthy that most of the sea voyages described in the Isolario essentially terminated in İstanbul (Constantinopolis).

The isolario of Gilles (1561), published almost a century after its writing, with a great number of its descriptions based on *Anaplous Bosporou* of Dionysios of Byzantium who lived in the 5th century, provided a detailed account of the Bosphorus Strait, drawing attention to the untouched natural beauty of İstanbul, seemingly unaffected by the burden of history.

Gilles (1561) also provided a detailed description of currents in the Bosphorus. Observations on surface currents flowing south from the Black Sea indicated that the currents in the southern reaches of the strait were intercepted by the protrusion of the Seraglio Point (Byzantium) and diverted them towards the Golden Horn (Keras), causing the entrapment of Bonito schools in this small estuary, which were then easily fished. In addition to the recirculation and eddies, the transient reversal in the current direction known as ‘Orkoz’ during southerly winds or ‘lodos’ created adverse conditions influencing pollution in the Bosphorus, as they do now, being primarily responsible for modern day ship accidents. The seasonal spawning migrations of some fish between the Black and the Mediterranean Seas were known to be adapted to the specific stratified, turbulent flows in the Bosphorus, and the fishing methods were also finely adapted to these environmental factors. The fish were so plentiful that ancient methods of fishing were efficiently used on the shores of the Bosphorus until recent times. For instance, simple nets lowered from the elevated wooden ‘dalyan’ structures, often inhabited by entire fishing families, as described in *Anaplous Bosporou* of Dionysios, or ‘ıǧrıp’ nets encircling fish schools and hauled by people at the coast were quite sufficient to catch plenty of fish at any time (Ertan 2010). These variability features, supporting the productive estuarine fishery that supplied the locally consumed fresh fish and the trade of salted fish, historically are known to be a major source of income for İstanbul since ancient times (Bursa 2010; Tekin 2010).

In addition to the recirculating currents south of Beşiktaş, leading fish into the Golden Horn, Gilles has noticed other areas of recirculating currents in the many bends and turns of the Bosphorus, referred to with their historical names.

These recirculating currents are well known today, near Çengelköy, Bebek-Akıntıburnu (the Devil's stream), Yeniköy, Çubuklu, Beykoz, Umuryeri and Büyükdere. Ships challenging the mainstream currents are often caught up with the rapid changes at these bends and narrows, resulting in the many ship accidents that occur in the strait.

Gilles noted the reversal of currents at depth. The drift towards the Black Sea of fishing nets submerged in the deeper waters of the Bosphorus experienced by fishermen operating in the Bosphorus was already well-known at the times and had been always well noted and was also on record much earlier, by Procopius in the 6th century (Deacon 1982; Gill 1982; Korfmann and Neumann 1993).

Old and New World Synthesis: Piri Reis (1465-1554)

Climbing to the post of Admiral in the career he started as a privateering young sailor and later as captain in the Ottoman Navy, Piri Reis (Ahmet Muhittin Piri, 1465-1554) is one of those served to make the Ottoman Empire a great sea power during its golden age, its influence reaching from the Mediterranean to the Indian Ocean. Yet, after running campaigns to capture key areas from the Portuguese and helping to build the power base of the empire in the Indian Ocean at age approaching 90, he refused to go for another campaign and was killed by beheading, on orders from the Ottoman governor of Egypt.

As an expert geographer and cartographer of his time as well as a great captain and Admiral of the Navy, Piri Reis made great contributions to the knowledge of the seas, recorded in exquisite maps (Figures 1 and 2) and books reporting his modest observations. “Kitab-ı Bahriye” or simply “Bahriye” (literally “knowledge of the seas”), the geography book written by Piri Reis in 1521 and presented as gift to Sultan Selim I in Egypt in 1524 follows the customary pattern of the Isolario but providing much more: a total of 290 maps of the many harbors, islands and other localities, describing currents and waves, sandbars and gates, anchoring areas in great detail, while also providing information on stellar navigation methods and referring to the voyages of Columbus and Vasco de Gama as his contemporaries and predecessors.

The Piri Reis map of the Old World (Figure 1) shows the Mediterranean, Black, Red, North and Baltic Seas with features very close to what would appear in a modern atlas. As an example of maps from “Bahriye”, Figure 2 displays the details about Venice.

His famous 1513 map of the new world, discovered in 1929 at the Topkapı Palace, depicts the land masses of Spain on Europe, Sahara region of Africa, north and south America, Antarctica and Greenland with astonishing accuracy for his time. The map also gives details of peoples and habitats of the lands, and even sea mammals at sea, inscribed on it.



Figure 1. Piri Reis map of the seas of the Old World

These notes speak of Indian Ocean and China Seas, implying that there was also a second part of the map that was unfinished or lost (Hagood 1996; Ülkekul 2009). A second map of the new world updated in 1528, of which only a small piece survives today, depicted details of Labrador, Newfoundland, Florida, central America with Cuba and some other Caribbean islands.



Figure 2. Map of Venice Lagoon from 'Kitab-ı Bahriye' of Piri Reis

According to what is reported in notes on the world map, the map was constructed from a synthesis of 20 other charts of Spanish, Portuguese, Arabic, Greek, Chinese and Indian origin, including some from Ptolemaic times and an original one by Columbus. It was an enormous feat at the time to put information together from various maps of different ages and projections despite making use of all the ancient and concurrent tools of mapmaking, with a grid

system found to be close to the modern Mercator system that took many years to be deciphered (Hapgood 1996) and still being discussed almost a century after discovery. As Piri Reis claims in his notes: “In this century there is no map like this one in anyone’s possession. By reducing all these maps to one scale this final form was arrived at. So that the present map of these our countries is considered correct and reliable by seamen”. He writes in his notes that some information on the map was obtained from Columbus: “And also Colombo was a great astronomer. The coasts and islands on this map are taken from Colombo’s map”. He also provides a clue to how some information may have been obtained through people formerly attached to Columbus, later associated with his uncle Kemal Reis, a former great captain with whom Piri Reis started up as seaman: “The late Gazi Kemal had a Spanish slave. The above-mentioned slave said to Kemal Reis, he had been three times to that land with Colombo” (Hapgood 1996).

The most prominent set of observations reported in Piri Reis' *Kitab-ı Bahriye*, is on tidal fluctuations of sea level and currents. Yet these observations are not sufficiently known, as public interest building on fanciful books, movies and TV shows have been focused on his much appreciated capacity as a great captain, navigator and chart maker, but not so much as geographer making careful use of observations as a prototype scientist. His observations of nature with scientific curiosity expressed much before the advent of modern science and the Galileo revolution of the next century have not been publicly much appreciated.

While his ship was anchored near the island of Djerba at the Gulf of Gabes, Tunisia, he made observations of the tidal motions, attempting to establish links between their cycles and the motions of the moon and the sun (Zaimeche 2002; Ülkekel 2009). It was established that the tidal currents increased in the first period of the moon and decreased in the second period. The 6 hourly ebb and flood flows of the semidiurnal tide and the higher/lower amplitudes during the spring/neap tides in relation to the respective positions of the moon and sun were clearly observed by Piri Reis, although interpretations based on a physical understanding yet had to wait for several centuries after him.

The main reason such clear observations could be made by Piri Reis at his anchor location was his unique position in the whole of the Mediterranean and Black Seas, where typically the tides are often too small. The Gulf of Gabes is an exception, because of the unique combination of geometry and topography, yielding local resonant behavior to create the largest tidal fluctuations in the whole Mediterranean (Figure 3). While the tidal range is typically less than 40-50 cm in the rest of the Mediterranean and about 10cm in the Black Sea, tidal ranges of up to 2m are common during spring tide (Figure 4) near the Djerba island of the Gulf of Gabes.

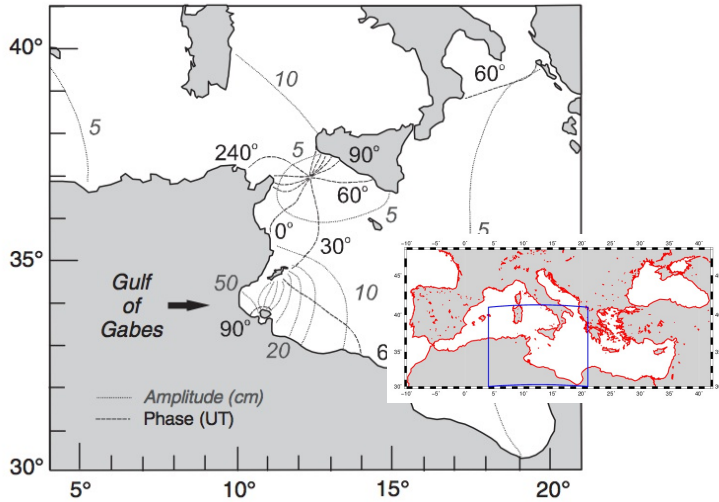


Figure 3. M2 tidal harmonic amplitudes (5cm intervals, dotted contours) and phases relative to UT (degree intervals, dashed contours) in the Strait of Sicily and Gulf of Gabes, Mediterranean Sea (square area shown in inset, after Sammari *et al.* 2006)

The history of tidal observations actually goes back to 325 BC when Pytheas from the Greek colony of Massalia (Marseilles) in his travel to the British Isles had the chance to observe large amplitude tidal oscillations there, suggesting for the first time a relation between spring tides and the phase of the moon. The Babylonian astronomer Seleucus of the Seleucid Empire of Mesopotamia in around 150 BC proposed that tides had something to do with the moon and the tidal range depended on location on earth and the position of the moon relative the sun. Because there was never a theory to explain tides in relation to gravitational fields of celestial bodies, these explanations appeared as flashes of conscience and faded away with time as more fanciful explanations took their place. Strabo, Pliny the Elder and Aristotle, all had inquired tidal motions based on their observations (Cartwright 1999).

In 1616 Galileo Galilei (1564-1642), who lived almost a century after Piri Reis revealed a tidal theory in which the effect of the moon is not even mentioned. His theory attributed tides to sloshing of water due to the earth's motion around the sun. In 1609 his contemporary Johannes Kepler (1571-1630) had correctly suggested that the gravitation of the moon caused the tides, based upon his knowledge of the ancient observations, but Galileo strongly rejected the idea, finding it useless.

In his *Principia*, published in 1687, Isaac Newton (1642-1727) was the first physicist to attribute tides to static forces of gravitational attraction by astronomical masses, creating what is called the equilibrium theory of tides.

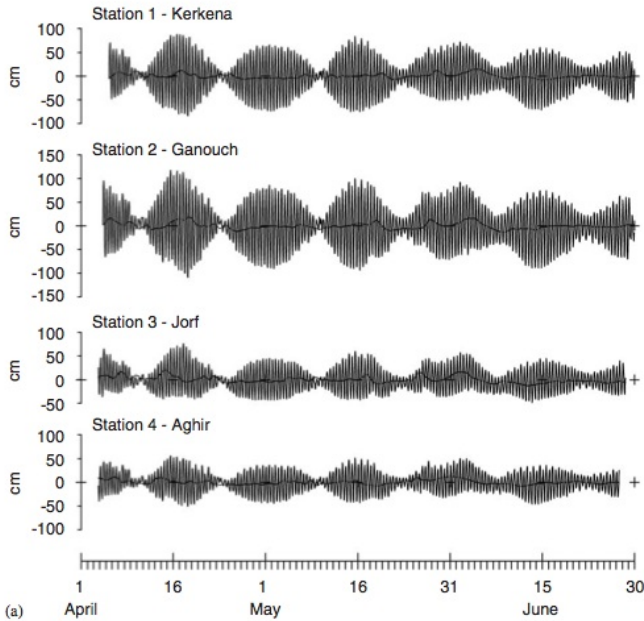


Figure 4. Sea level variability and tidal resonance in the Gulf of Gabes, Tunisia (after Sammari *et al.* 2006)

In 1778, almost two and a half centuries after the observations of Piri Reis, Pierre-Simon Laplace (1749-1827) developed the first dynamic theory of tides based on partial differential equations, which implicitly included tide generating forces (tidal potential) of the moon, sun and other astronomical components, as well as the effects of bottom geometry and inertial effects.

First in Ocean Science: Ferdinando Luigi Marsili (1658-1730)

In the year 1679, Luigi Ferdinando Marsili, an apprentice scientist of 21 years age, sailed to İstanbul, accompanying the newly assigned Venetian ambassador to the Ottoman capital. This journey of discovery in the years 1679-1680, based on a series of observations and measurements, Marsili (1681) laid the foundations of modern oceanography (Soffientino and Pilson 2005, see also accounts in papers by Pinardi and Özsoy in Öztürk 2010). His ultimate conclusion that ‘the sea can be measured’ (Pinardi 2009) came into effect at this age, but his basic theory of straits had to survive the following three centuries before it was recognized by modern science. Marsili made use of the “scientific method”, a Galilean heritage dating from only about 50 years earlier, in his study of the Bosphorus exchange flows. He based his conclusions on the sea water density measurements he had made along the ship’s route, as well as on other basic environmental observations, density and current measurements in

the Bosphorus, finally demonstrating his theory through the famous tank experiment carried out in Rome.

Rapid Development in the Last Century

The exchange currents flowing in opposite directions in the upper and lower layers of the Bosphorus Strait as explained for the first time by the scientific efforts of Marsili have since been verified by instrumental measurements, first carried out in 1918 and 1921, reported by Merz and Möller (1928) and Möller (1928), and interpreted by Defant (1961) in his pivotal book on physical oceanography.

Local development of marine science that would create first interests on marine science in Turkey had to wait until the 1930's till after the founding of the Turkish Republic in 1923 by the Anatolian Revolution that ended the Ottoman rule. Modern oceanographic research unfortunately had yet to wait until the 1980s, when for the first time, physical oceanographers of the Institute of Marine Sciences of the Middle East Technical University became involved in marine research, and helped create an active research agenda based on extensive measurements in the Turkish seas through national and international programs of research, even before some of the later well-built European Union marine research incentives were created in the region. The renewed interest in the surrounding countries resulted first in the Physical Oceanography of the Eastern Mediterranean (POEM) international collaborative program, followed later by a series of similar collaborative programs in the Black Sea, which immensely elevated the level of scientific understanding of the regional seas, which later achieved joining of the efforts with other fields of marine science.

During the earlier period of 1940-1970, few biologists, Ulyott and Pektaş among them, had some chances to have repeated measurements in the Bosphorus, with the limited means of the time, facing the task to rediscover and demonstrate what was already known about the exchange flows. These efforts as well as those later by Çeçen *et al.* (1981) and Bayazıt and Sümer (1982) acknowledged but failed to detect the outflow of the Mediterranean water into the Black Sea, because there was insufficient knowledge of the narrow canyon and northern sill topography leading into the Black Sea and insufficient sampling to locate its position. It was therefore argued whether the lower layer flow was continuous or perhaps intercepted during some time. Later work by Gunnerson and Özturgut (1974), Tolmazin (1985) and Latif *et al.* (1991) revealed more information that helped to permanently settle this question. The knowledge base on the Turkish Straits System existing at the time was reviewed by Ünlüata *et al.* (1990). Continued surveys with plenty of observations by oceanographers in the last few decades, including the development of models, better and more accurate measurements, and synergetic interpretation of results once again revealed fine details of the flow and the underlying physics (e.g. Ünlüata *et al.* 1990; Gregg *et al.* 1999; Özsoy *et al.* 2001; Gregg and Özsoy 2002; Sözer 2013).

Conclusions: Oceanography as Civilization

Today, the old world, centered on the Mediterranean region, is the common heritage of all peoples around. The shared civilization and culture of the Mediterranean (e.g. Braudel 1996) are integral parts of today's world, as well as the ancient world. Therefore it is necessary to assimilate all that is brought to us from previous civilizations, preserve the environment and to extend knowledge across the region whether it originates from the east or the west in order to peacefully share and protect this unique habitat rather than yield to greed, while advancing the science that would hopefully ensure the survival of the heritage. Oceanography, a modern science often claimed to have developed after the world wars, had precursors of development since the middle ages, not always given recognition in those times, but promising to be a pillar of civilization in the modern world.

As we have touched upon some features of the high energy environment of the Turkish Straits, a unique passage that connects and regulates contrasting ecosystems both on land and at sea, it is essential that we poise to think to do what science would dictate on the projected 'Canal İstanbul' craze of the 'new middle age' that potentially endangers these precious ecosystems, in direct contrast with international agreements such as the Montreaux, Barcelona and Bucharest Conventions, and as such cannot be allowed. Such drastic intervention coming out of a wild craze would threaten the environment that supports liveliness of the millions of people living on the already over-populated coasts and emerging mega-cities in the region. Danger of an imminent collapse of the ecosystems, which already has made a good headway in the last century and already defying a healthy understanding in the present age of anthropogenic climate change, can only be stopped by conscientious and strict efforts that soon will not possible to be considered as extreme.

Piri Reis - Eski Dünya Denizlerinde Deniz Bilgisinin ve Denizbilim Mirasının Öncüsü

Özet

'Eski dünya' denizlerinde deniz bilgisinden denizbilime doğru olan gelişme gözden geçirilmektedir. Piri Reis, ortaçağda teknik donanımlı bir kaptan ve haritacı olmasının yanında, doğanın işleyişini önemli çıkarımlarla saptayan iyi bir gözlemci olmuştur. Diğer birçok ortaçağ şahsiyetlerinde olduğu gibi, eski dünyada bu tür katkılar yıllar ve hatta yüzyıllar boyunca yeterince takdir görmemiş ve ortaya çıkamamıştır. Özellikle çağdaş temel bilime, oşinografiye doğru zamanla evrilecek olan öncül denizbilim yöntemlerini başlatan Luigi Ferdinando Marsili, mevcut düzenin dayattığı bu cehaletten payını alsa da yüzyıllara dayanabildi, ancak onunla karşılaştırıldığında üstün dünya haritası 20. yüzyılın başlarına kadar keşfedilmemiş kalan Piri Reis, yaşamını zorbalığa yitirmek zorunda kaldı. Piri Reis'in çoğu kez gözden kaçan gelgitler üzerine gözlemlerine dikkat çekilmekte ve çağında onun seviyesinin çok altında kalan tarihsel gelişim dizgesiyle ilişkili olarak değerlendirilmektedir.

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