The Principles of Arab Navigation edited by Anthony R. Constable and William Facey

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This attractively printed, copiously illustrated work consists of nine papers by six authors, all specialists in one or another aspect of Arabic maritime history or geographical literature. We have no written records of when the principles of Arabic navigation evolved because our earliest written sources are manuals by two Arab sea captains who lived in the late 15th and early 16th centuries of our era, namely, Ibn Mājid and Sulaymān al-Mahrī, the latter making heavy use of the writings of the former. These sources and later logbooks by Arab sea captains inform the contributions to this book.

In chapter 1, the first of four devoted to Arab stellar navigation, A. Constable lays out the basic principles and problems of maritime navigation, particularly as they relate to the early history of Arab sailing in the Indian Ocean. In the context of a clear introduction to maritime navigation in general, Constable introduces some of the basic features of Arab navigation such as the *iṣba'* (the visual angle subtended by the width of a finger held at arm's length) and *dhubbān* (the width of four *iṣba'*). It is, as he emphasizes, not possible to settle on any exact value for these angles in degrees and minutes; but, he says, 'it is usually agreed' that a full circle contains 224 *iṣba'*, which implies about $1\frac{3}{5}^\circ$ per *iṣba'*. He gives no source for this claim but it does mean that 7 *iṣba'* are exactly the angle between successive points on what he calls the Arab compass. This was a division of the horizon into 32 supposedly equal sectors originally defined by the rising-points (on the eastern horizon) and setting-points (on the western) of certain stars or asterisms. Thus, NE/NW were the directions of the rising/setting of Capella and SE/SW the corresponding directions for Orion's belt. The various ways in which ancient mariners could use the stars and asterisms of the night sky to find the fundamental direction, that of the pole star, even when that star was not visible, are well

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described and very impressive. One comes away from the chapter realizing that a thorough knowledge of the night sky was literally a matter of life and death for ancient mariners.

In chapter 2, Hasan Salih Shihab gives an illuminating discussion of a method used by 'the old navigators' (i.e., those living prior to the arrival of European methods) to determine what we would refer to as a change in longitude. (As with Constable's discussion in chapter 1, Shihab's exposition benefits from the excellent graphics accompanying the book.) Fundamental to the method for finding change in longitude was the *zām*, which originally meant a three-hour watch and later came to mean the distance sailed during that watch as well, so the distance sailed in a whole day of sailing was 8 *zām*. What distance this actually denoted was, however, highly variable. The distance (in *zām*) that one had to sail along a given *rhumb* (direction) to change the height of the celestial pole by one *iṣba'* (the fundamental unit of latitude) was known as the *tirfa* of that *rhumb*, and a sail of 8 *zām* was the *tirfa* for due north or south. Obviously, if one sailed any *rhumb* other than due north or south, it would require a longer sailing time to change the pole height by one *iṣba'*. In his writings, Sulaymān gives navigators, for each of the eight *rhumbs* from N to NE, the *tirfa* for that *rhumb*. (The values from N to NW are obviously identical.)

If one sailed a certain *rhumb* for a certain number of *tirfa*, one obviously departed, in an easterly or westerly direction, a certain distance from the north/south *rhumb* of one's origin. Sulaymān gives these distances, known as 'departures'. For example, for a compass setting of NE (or NW), the *tirfa* was 12 and the departure was 8, clearly reckoned on the basis of 'plane sailing'. Thus, if one had sailed one *tirfa* along a given *rhumb*, one could consult Sulaymān's book to find both the distance sailed and the departure east or west from one's original meridian. For example, one traditional value for the *tirfa* of ENE was 20 *zām* and, for the departure, 18 *zām*. (The values calculated by elementary trigonometry are, respectively, 20.91 and 19.31 *zām*.) However, each region and each tradition had its own set of *tirfa* and departure values for each *rhumb*, and these could, of necessity, be only approximate. On the assumption that these values are in fact part of a very long tradition, one wonders whether Ptolemy used such information in calculating longitudes in his *Geography*.

The repertoire of navigational techniques had expanded by the time of the mid-19th century, as Yacoub Yusuf al-Hijji informs us in his instructive chapter 3. At this time, the ancient techniques were still very much in use but a number of navigators had adopted the sextant and marine chronometer from the Europeans for voyages across the Indian Ocean and Arabian Sea, and they knew enough geometry to plot a course across these waters. The bulk of this chapter is an exposition of examples of computations from log books of Kuwaiti captains (*nakhodas*), computations involving the Pythagorean Theorem and the use of the cosine or tangent trigonometric functions. One is left wondering, however, where the multiplier '86' in the 'Rule of 86' for calculating one's bearing came from. And the same might be said for the divisor, 15, appearing in the rule for using numbers that the author calls 'star constants' to calculate departure from change of latitude. One is also left wondering, given the fact that Kuwait had no school to train captains in the new methods, how these men acquired the knowledge to use these functions. The author's suggestion that a few learned them from Indian or Omani navigators and then taught the methods to their friends who traveled with them on long sea voyages is, of course, possible—and even likely in some cases. It would have been interesting to know what impact trained navigators from such mercantile powers as Portugal, Holland, and Britain might have had in this change to modern methods.

In chapter 4, Eric Staples reports some of the lessons learned from the voyage that the ship *Jewel of Muscat* made in 2010 from Oman to Singapore. The ship, a square-rigged sewn vessel with no motor was built according to the archaeological evidence surviving from the ninth-century ship but the navigational methods were based on those of the 15th and 16th centuries. The goals were to document star-altitude measurements over the course of the trip and to experiment with different types of instruments used in those centuries and three different sorts of star-measurements.

The whole chapter is highly interesting and sheds much light on what actually happens when one uses the ancient techniques and instruments. Here it must suffice to quote the conclusion:

> It also became clear that although the Pole Star was the foundation of the star-altitude measuring system, other star combinations were taken far more often than originally assumed, due to the difficulty of Pole Star sightings. These star

> combinations, in particular the non-circumpolar combinations, do not often receive the recognition they deserve. [59]

Following these four chapters on the details of stellar navigation come five chapters devoted to special topics of a less technical nature. The first (chapter 5) is Paul Lunde's study of the maritime routes in Sulaymān al-Mahrī's *ʿUmdat al-mahrīya fī ḍabt al-ʿulūm al-bahriyya* (*Support for Grasping the Maritime Sciences*) and his *Al-manhāj al-Fākhir fī ʿilm al-bahr al-zākhir* (*The Splendid Program for the Science of the Overflowing Sea*). Lunde [63] stresses the gulf that existed between the world of such geographers as al-Idrisī, who was intent on reworking Ptolemy, and practical navigators such as Sulaymān. As evidence, he mentions that the latter knew perfectly well that the coast of Africa headed SW and did not turn to the east, as Ptolemy and, following him, al-Idrisī thought. He also cites the fact that the distances that Sulaymān gives for the routes from ports on the east coast of Africa to Javanese and Sumatran ports agree, to within a few degrees, with modern distances. This should not be too surprising, however, when one learns that 'There were well established Arab merchant colonies in South China even earlier [than AD 830]'. In addition to his informative text, along with its citations from Sulaymān's treatises giving details of deep-sea voyages, Lunde includes a good map of the voyages mentioned in the text, voyages as far south as Madagascar and as far east as Java and Taiwan. (Indeed, the book as a whole is copiously documented with maps—something this reader much appreciated.)

Following his treatment of maritime routes, the same author, in chapter 6, gives a detailed treatment of the times of the year that Sulaymān recommends for beginning various voyages. Knowledge of these times would be very important to any captain, since starting off at the wrong time in relation to the monsoons could mean a wait of several months in some port. Lunde points out that the specification of these times was complicated by the Hijri calendar, whose strictly lunar months in a year of 354/355 days fall out of phase with the seasons. For this reason, sailors on the Indian Ocean used the Yazdegird calendar of 365 days per year and an epoch of 18 June 632; but its lack of leap years caused the same problem in the long run as the Hijri calendar. For administrative reasons, the Caliph al-Muʿtadid tried in AD 825 to change the epoch to 11 June but again without adding any leap year; so the problem persisted. Finally, in AD 1079, the Seljuk sultan, Jalāl al-Dīn set

the beginning of the New Year (*nayrūz*) on 15 March and added a leap day. However, it seems that the piety of the sailors exceeded their allegiance to the Sultan and that they ignored the leap day, since the Muslim faith forbade intercalation. So any given calendar date still fell back relative to the seasons by 1 day every four years. Consequently, captains had to remember to set dates back by one day every four years. And, somehow, they managed it!

In chapter 7, al-Hijji offers a critical view of certain aspects of Alan Villiers' classic work on navigation, *Sons of Sindbad*. Al-Hijji himself credits Villiers' work with inspiring him to take up the subject, and puts his criticisms of Villiers' approach in the context of providing another perspective on a classic work. He makes a good point that Villiers' assessment of Arab navigational skills was based on his experience on one coastal trip taken in 1938–1939 on a ship named *The Triumph of Righteousness*. This ship sailed from Aden to a locale slightly south of Dar es-Salam and then back up along the south coast of the Arabian Peninsula and, finally, up the Persian Gulf to Kuwait. The captain of that boat, ʿAlī al-Nejdī, was skilled in coastal sailing and also did well in taking the ship across a small stretch of open ocean between Africa and the Yemen, something that Villiers ascribed to 'an act of God'. Moreover, it seems that there was a clash of personalities from the very beginning between Villiers and the young, strong-headed Kuwaiti captain. All of this left Villiers with the mistaken impression that by the 1930s the Arabs had lost the navigational skills of their forefathers; but al-Hijji offers convincing evidence that this was not the case.

In chapter 8, on Arab navigation in the Mediterranean, al-Hijji makes two points. The first is that, at least from the Middle Ages onwards, there was a common navigational practice among all the nations around the Mediterranean basin; and the other is that this tradition was navigation by coastal sailing with the aid of a *portolano* and portolan charts. The relative narrowness of the sea and the number of large islands made it possible to sail its entire length, even right down the center, without ever traversing more than 400 miles of open ocean. (And to traverse those stretches all one needed was the ability to sail along a latitude, i.e., to keep the altitude of the pole star relatively constant.) Most navigators did not in fact sail it right down the center but sailed 'from one landmark to another'. Such a practice drew scorn from the navigators of the Indian Ocean but Mediterranean navigators were not sailing that ocean. Their text of sailing directions and its visual rep-

resentation in a portolan chart sufficed for their needs. So it is paradoxical that a maritime chart was not used in the Indian Ocean, where we might have thought it would be most useful, but was used in a much smaller sea.

In chapter 9, 'Sailing on the Red Sea', William Facey makes the point that the Red Sea is essentially two seas. The lower part, from Bāb al-Mandam in the south to Jidda about halfway up the east coast, receives virtually all the attention in our principal sources, Ibn Mājid and al-Mahrī. But, as for the upper part,

> this maritime region seems to have been an alien zone; they probably never went there and, even if they did, as far as they were aware alien conditions prevailed and different rules applied. [102]

Among those 'alien conditions' was the constant wind direction from the north in the part of the sea north of Jiddah, making sailing in that direction difficult at best, for one had to rely on land breezes and surface currents (available mostly in July and August, if that). Facey also traces the effect of the advent of Islam on the development of ports on the Red Sea. The pilgrim traffic to Jiddah resulted in that city's becoming not only a 'tourist center' but 'a vital link in the Indian Ocean trade network'. Ports on the African side, which had been important in the Roman world, lost their status; and from the early 10th century onwards, the Indian Ocean ships unloaded cargo, even goods bound for Egypt, at Jiddah for transfer to coastal vessels that would take the goods farther up the Red Sea.

Two appendices, notes, a bibliography, and an index conclude a work which should be of interest to anyone interested in Arab navigation and the Indian Ocean trade. Although the bibliography records the treatment of Arabic navigation in volume 2 of Harley and Woodward's *History of Cartography* [1992], a reader interested in the topic may also want to consult the article 'Arabic Nautical Science' by H. Grosset-Grange [1996].

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