The Ancient Ports of Myos Hormos and Berenike and the Indian Ocean Trade: A Braudelian Perspective

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Braudel's most famous work pursued two somewhat contradictory arguments. First, it conceived of *la méditerranée* as a geographical region bound by the distinct features of its climate, links to the sea, and topography. To Braudel, these predicaments of geography affected everything from when to harvest grapes or slaughter pigs (in December), to when to launch ships (never in winter), to when to send war expeditions (in summer):[1] "The calendar was commander-in-chief."[2] Yet Braudel also argued that "the Mediterranean has no unity but that created by the movements of men, the relationships they imply, and the routes they follow."[3] That second point animates his elastic boundaries of *La Méditerranée:* its boundaries encompassed not only the inland sea and its coastal regions, but a larger area that expanded and contracted with the "movements of men."[4]

Within the social sciences, Braudel's interpretative method unites a soft "geographical/environmental determinism" with "possibilism," the notion that every environment opens a range of

1 In this paper, I have relied on the 1972 English translation of the 1966 edition of *La Méditerranée et le monde méditerranéen à l'époque de Philippe II.* See Fernand Braudel, *The Mediterranean and the Mediterranean World in the Age of Philip II*, trans. Siân Reynolds (Harper Collins, 1972), 1: 231–75. I would like to thank the conference organizers for their kind invitation to share my work. Thank you also to Martin Lewis, whose recommendations greatly improved this essay.

2 Braudel, *The Mediterranean*, 1: 254.

3 Braudel, *The Mediterranean*, 1: 276.

4 In Braudel's thinking, the boundary between the Mediterranean and the rest of the world, or of the Mediterranean as a unified historical region in the sense of Plato's "frogs around the pond" analogy, is ever-fluctuating "on its continental and seaward sides," extending north to the Black Sea, east to the Red Sea and the Persian Gulf, and west to the Straits of Gibraltar and the Atlantic Ocean. Braudel, *The Mediterranean*, 1:419.

possibilities to human agents.[5] In *The Mediterranean*, "the concept of geographical space, all the permanent, slow-moving, or recurrent features of Mediterranean life," comes first.[6] As Braudel explains, the "slow-moving" aspects of reality form the constant structure of social life. The "movements of men," by contrast, are "the ephemeral" and dynamic aspects that —combined with everything slow-moving—define the "social history of groups, collective destinies, and general trends."[7] Braudel observes that in recovering the basic challenges of geography and climate, the historian can often rely on sources from various eras, including their own time.

This short paper employs Braudel's approach to explain the location of two ports on the Red Sea that were critical to the trade between the Roman Mediterranean and the Indian Ocean in the first century CE. Most scholarship on this ancient trade has followed a Braudelian perspective, though not always explicitly.[8] All scholars who study the trade confront the facts of climate and geography that enabled it. The seasonal monsoons and the ocean currents they created supplied the "slow-moving/permanent" conditions that enabled the trade in either direction (figure 1). In summer the Indian Ocean waters and winds move clockwise in a southwesterly direction. These conditions aided sailing voyages toward India. In winter, the monsoon winds and ocean water reversed their direction, traveling in a north-easterly direction, creating favorable conditions for sailing from ports in India to Arabia and Africa.[9] The strength of the monsoons and their predictable courses determined the timing of voyages. The peak months of summer (June through September) and winter (January through April) monsoon activity

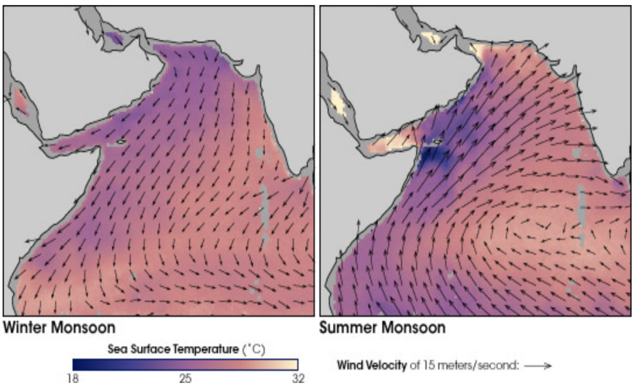

Figure 1: Sea surface temperature and direction and velocity of the winds over the Arabian Sea during the winter and the summer monsoons. Arrows indicate the direction and velocity of the winds. Maps by Robert Simmon. © Earth Observatory, NASA.

5 For this kind of soft geographical determinism (the role of the environment, seasonality, etc. on human decisions), see the enlightening study on the relationship between seasonality, labor, and reproduction by Brent Shaw, "The Seasonal Birthing Cycle of Roman Women," in *Debating Roman Demography*, ed. Walter Scheidel (Brill, 2000), 83–110. As Martin Lewis argues, Braudel's possibilistic orientation was indebted to Paul Vidal de la Blache (1845–1918) and Lucien Febvre (1878–1956), both of whom rejected the racist extremes of geographical determinism; see also Lewis's essay in the present collection. On environmental determinism more generally, see H. Ernste and C. Philo, "Determinism/Environmental Determinism," in *International Encyclopedia of Human Geography*, ed. Rob Kitchin and Nigel Thrift (Elsevier, 2009), available at https://www.sciencedirect.com/topics/social-sciences/geographical-determinism.

6 Braudel, *The Mediterranean*, 1: 353.

7 Braudel, *The Mediterranean*, 1:353.

8 For an excellent example of a Braudelian study, see Federico De Romanis, *The Indo-Roman Pepper Trade and the Muziris Papyrus* (Oxford University Press, 2020).

9 D. S. Pai, Arti Bandgar, Sunitha Devi, Madhuri Musale, M. R. Badwaik, A. P. Kundale, Sulochana Gadgil, M. Mohapatra, and M. Rajeevan, "Normal Dates of Onset/Progress and Withdrawal of Southwest Monsoon over India," *Mausam* 71, no. 4 (2021): 553–70. The onset of the seasons varies over the subcontinent. The summer and winter arrive at different times on the subcontinent. On the dates, see figure 2.

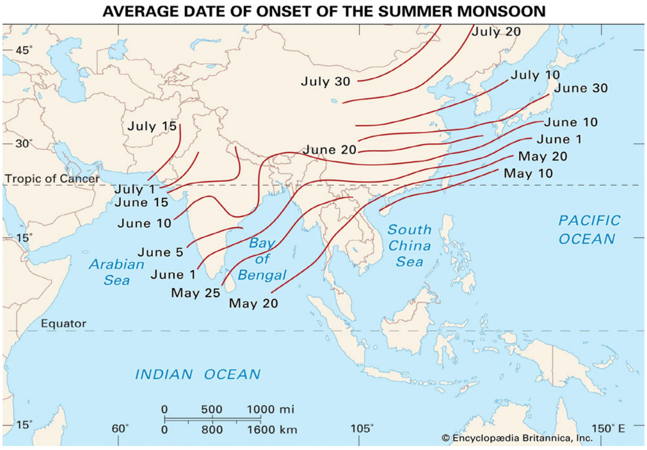

Figure 2: Average date of onset of the summer monsoon. © Encyclopaedia Britannica.

Figure 3: Google Earth Map of the Indo-Roman Trade. Map: Jack Harvey.

are preceded and followed by transitional periods of milder monsoon activity.[10] Altogether these are the "slow-moving" factors that determined the "ephemeral" undertaking of transoceanic trade voyages. The same basic monsoon patterns continue to this day, offering the opportunity to test various aspects of the journeys' challenges, such as the winds' velocity and their impact on the maritime routes (figures 2 and 3).

In their efforts to bridge the Indian Ocean and the Mediterranean, ships traveled either via the Red Sea or the Persian Gulf (see figure 3). Each route required that cargo be partly transported over land. The routes and the ports changed over time.[11] At the height of the trade, in the first century BCE/CE, the route via the Red Sea and the Sahara was preferred as were direct vs. multistage sea voyages.[12] The ports on the Indian subcontinent that were critical to the trade were Barbarikon (a seaport near modern Karachi, Pakistan) and Barygaza (a river port, Bharuch, India) on the northwestern coast, plus Muziris/Nelkynda (two ports on the Malabar coast of India) on the southwest coast.[13] The three yellow lines in figure 3 connect the island of Socotra by the Gulf of Aden with Barbarikon, Barygaza, and Muzuris, in that order, from north to south. Two Red Sea ports, 230 nautical miles apart, were key to the trade in the Mediterranean basin: Myos Hormos and Berenike (figure 4).[14] The anonymous author of the *Periplus of the Erythraean Sea,* which describes ports, cities,

10 Lionel Casson, "Appendix 3," in *The Periplus Maris Erythraei: Text with Introduction, Translation, and Commentary* (Princeton University Press, 1989), 283–84, provides a useful table of these monsoonal winds and the transitional periods between them.

11 For a summary, see De Romanis, *Indo-Roman Pepper Trade*, 34–76.

12 De Romanis, *Indo-Roman Pepper Trade,* 61.

13 Casson, *Periplus*, 39 (Barbarikon), 41–44 (Barygaza), Muzuris/Nelkynda (54–56), 75, 77–79, and 83–85.

14 Myos Hormos: Strabo, *Geography* 2.5.12, Loeb Classical Library, vol. 49, 454–55; Berenike: Pliny, *Natural History* 6.26; both: *Periplus,* 50–51. These sites have been identified and excavated. For Myos Hormos, see David Peacock and Lucy Blue, *Myos Hormos—Quseir al-Qadim: Roman and Islamic Ports on the Red Sea*, 2 vols. (Archaeopress, 2006–11); Lucy Blue, "Port of Myos Hormos and Its Relations to Indo-Roman Trade," in *The Eastern Desert of Egypt During the Greco-Roman Period: Archaeological Reports*, ed. Jean-Pierre Brun et al. (Collège de France, 2018), https://doi.org/10.4000/books.cdf.5235. For Berenike, see, among others, Steven

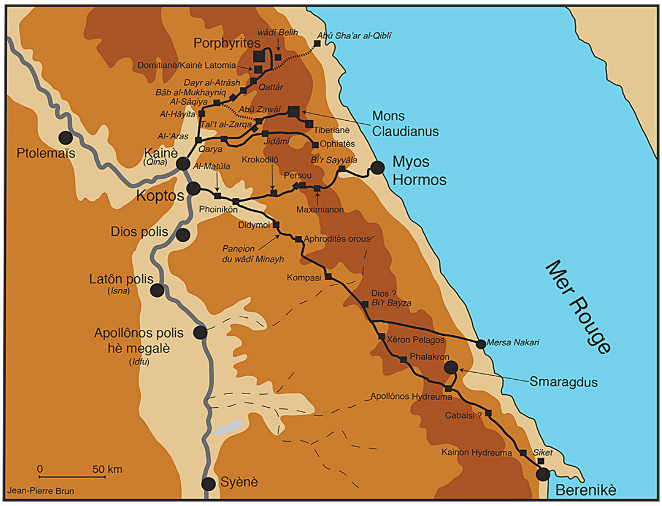

Figure 4: Map of the routes to Myos Hormos and Berenike at the end of the first century CE. © Drawing J.-P. Brun. Copied from Blue 2018.

navigation, and trade from Koptos to South Asia, mentions both.[15] In contrast, Pliny's *Natural History* (77 CE, based on early 50s CE data) omits Myos Hormos and assumes that trade ships to India departed from Berenike alone.[16] Regardless of which port ancient authors emphasized, transportation receipts confirm both emporia were operational and connected by traders as early as 6 CE.[17]

From Alexandria, export goods (especially gold and silver) were transported on the Nile to Koptos, then overland to either Myos Hormos (six to seven days) or Berenike (twelve days) (see figure 4).[18] The desert crossing was dangerous and resource-draining. It required water for thousands of people and animals, protection from thieves, and overnight stations. After its conquest of Egypt in 30 BCE, the Roman state provided essential infrastructure for the desert crossings: wells, armed guards, roads, and forts.[19] This investment was offset by a 25 percent import tax on all Indian Ocean imports.[20]

Yet the expense and difficulty of maintaining and protecting the desert roads to Myos Hormos and Berenike remain puzzling. First, neither port had the natural resources necessary for the thriving of humans and the animals they employed. Timber, water, and foodstuffs all had

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E. Sidebotham, "Archaeological Evidence for Ships and Harbor Facilities at Berenike (Red Sea Coast), Egypt," *Memoirs of the American Academy in Rome*, supp. vol. 6 (2008); and Sidebotham, *Berenike and the Ancient Maritime Spice Route* (University of California Press, 2011).

15 The date of the *Periplus* is debatable. For a first-century date (40–70 CE), see Casson, *Periplus Maris Erythraei*, 50–51.

16 Pliny, *Natural History* 6.26, online at Perseus Digital Library, https://www.perseus.tufts.edu. Unless indicated otherwise, references to India relate to pre-1947 India, that is, present-day South Asia.

17 On the discrepancies between the written sources (Strabo) and archaeological evidence, see Sidebotham, *Berenike and the Ancient Maritime Spice Route*, 18, 184.

18 Red Sea coordinates: 22°N 38°E; 12°40′N 43°30′E and 12°29′N 43°20′E. The Red Sea is 2,250 km (1,398 miles) long and 355 km (221 miles) across at its widest point. Myos Hormos: 26.15°N; see Pleiades, https://pleiades.stoa.org/places/786069. Berenike: 23.91°N; see Pleiades, https://pleiades.stoa.org/places/785986?searchterm=berenike. See also Polish Centre of Mediterranean Archaeology, "Berenike," https://pcma.uw.edu.pl/en/2019/04/17/berenike-2/. For the trade, see, among others: Federico De Romanis and André Tchernia, eds., *Crossings: Early Mediterranean Contacts with India* (Manohar, 1997); De Romanis, *Indo-Roman Pepper Trade*; Kasper Grønlund Evers, *Worlds Apart Trading Together: The Organisation of Long-Distance Trade between Rome and India in Antiquity* (Archaeopress, 2017); Roberta Tomber, *Indo-Roman Trade: From Pots to Pepper* (Duckworth, 2008); Rājan Gurukkal, *Rethinking Classical Indo-Roman Trade: Political Economy of Eastern Mediterranean Exchange Relations* (Oxford University Press, 2016).

19 Most recently, see De Romanis, *Indo-Roman Pepper Trade*, 31–58; for the Roman state, Matthew P. Fitzpatrick, "Provincializing Rome: The Indian Ocean Trade Network and Roman Imperialism," *Journal of World History* 22, no. 1 (2011): 27–54.

20 For the import tax, see De Romanis, *Indo-Roman Pepper Trade*, 277–97.

to be imported.[21] Berenike, for instance, drew potable water from fortified wells with their own garrisons located 7–8.5 km (4.3–5.3 miles) outside the city.[22] Second, at 230 nautical miles apart, the two ports were relatively close to each other. Myos Hormos held a clear advantage for overland transport, being only six to seven days from Koptos, that is, half the twelve-day journey to Berenike (figure 4). Given these advantages, why establish a port at Berenike?

Scholars attribute the need for two nearby Red Sea ports to environmental challenges in the northern Red Sea, particularly the relentless and dangerous winds noted by both ancient and modern authors.[23] Some researchers suggest one port served an "auxiliary" role as a weather haven.[24] Berenike's protected bay would have offered safe anchorage to heavy ships.[25] When founded in the third century BCE, its harbor was deep enough for elephant-carrying ships.[26] In the mid-second century, the 650-ton *Hermapollon*, carrying pepper, aromatics, and ivory from Muzuris in southern India, likely anchored there (Muziris is identified with Pattanam, a village near the town of Kodungallur in Kerala, India).[27] Despite these challenges, both ports were essential—trading companies maintained agents at each.[28]

The two harbors offered an imperfect solution, as evidenced by efforts to relocate the trade north, closer to Alexandria. A canal—precursor to the Suez Canal linking the Nile with the Red Sea, constructed and/or dredged at the time of Trajan (98–117 CE) —addressed the logistical challenges of desert crossings.[29] Yet the canal's existence did not eliminate reliance on either port. Mariners depended on Berenike for 800 years before silting forced its abandonment in the

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21 Sidebotham, *Berenike*, 18, 11–12, 102–24 (for the water supply).

22 Sidebotham, *Berenike*, 18, 11.

23 On the southward "creep" of Red Sea ports due to the northerly winds, see William Facey, "The Red Sea: The Wind Regime and Location of Ports," in *Trade and Travel in the Red Sea Region*, ed. Paul Lunde and Alexandra Porter (Archaeopress, 2004), 7. Facey is more optimistic about the ability of mariners to sail in the north of the Red Sea. For the winds, see also Federico De Romanis, *Indo-Roman Pepper*, 32–35.

24 Tomber considers the roles of Nechesia (Marsa Nakari), between Myos Hormos and Berenike, and Clysma (near ancient Suez) in the trade; see Tomber, *Indo-Roman Trade*, 64–65. See also Sidebotham, *Berenike*, 18, 186.

25 De Romanis, *Indo-Roman Pepper Trade*, 53–54; Sidebotham, *Berenike*, 18, 50–53 (on the relationship between heavy ships, northerly winds, and Berenike); Anna M. Kotarba-Morley, "Port Town and Its Harbours: Sedimentary Proxies for Landscape and Seascape Reconstruction of the Greco-Roman Site of Berenike Troglodytica on the Red Sea Coast of Egypt," *Polish Archaeology in the Mediterranean* 26, no. 2 (2018): 63–66 (a very useful overview of the site).

26 On the deep draft of the elephant-bearing ships, see Sidebotham, *Berenike*, 18, 50. Due to silting, the port later accommodated heavy-tonnage vessels. On this, see Kotarba-Morley, "Port Town and Its Harbours," 61–92.

27 On this ship and its cargo, see De Romanis, *Indo-Roman Pepper Trade*. For the text of the papyrus (P. Vindobonensis G 40882), commonly known as the Muzuris papyrus, detailing the cargo of pepper, malabatron, ivory, and others, see also https://papyri.info/ddbdp/sb;18;13167. Evers, *Worlds Apart*, 32, 99–108 (critiques De Romanis's estimate and lowers it to fifty to eighty tons, which is also the number estimated in previous scholarship). Berenike's harbor size contracted in the later centuries of its existence. See the multifaceted research of Kotarba-Morley, "Port Town and its Harbours," 83–84.

28 Casson, *Periplus*, 94–97. This conclusion is based on the "Archive of Nicanor," sixty-four receipts (scratched on *ostraca*) from Koptos, concerning the activities of a family transportation business (6 CE to 62 CE). On the archive, see Kai Ruffing, "Nicanor, Archive of," in *Brill's New Pauly Online* (Brill, 2016–2024). The entry contains key studies. Also see Tomber, *Indo-Roman Trade*, 63–64.

29 For the Trajan canal, see De Romanis, *Indo-Roman Pepper Trade*. It was operative only for parts of the year.

500s.[30] Myos Hormos endured until the third century CE, but, unlike Berenike, it would be reinhabited in the medieval period.[31]

Recent oceanographic scholarship can help deepen the environmental explanations for the two seemingly redundant ports. Studies of the Red Sea wind patterns reveal seafaring challenges that necessitated using both ports despite their inhospitable conditions. In Braudel's terms, seasonal wind regimes illuminate how the movements of men took precedence over their comfort: why one set of environmental challenges was chosen over another.

Much like the Indian Ocean, the Red Sea both enabled and hindered connection through its predictable ocean currents and winds. The Red Sea is 2,250 km (1,398 miles) long with a maximum width of 355 km (221 miles) and covers a surface area of roughly 458,620 km².[32] It has two distinct seasonal wind patterns dependent on the monsoons as well as the topography and the climatological conditions over the landmasses on either side. The Arabian subcontinent to the north and Africa to the south are arid deserts. These elements of climate and topography interact to produce seasonal patterns.

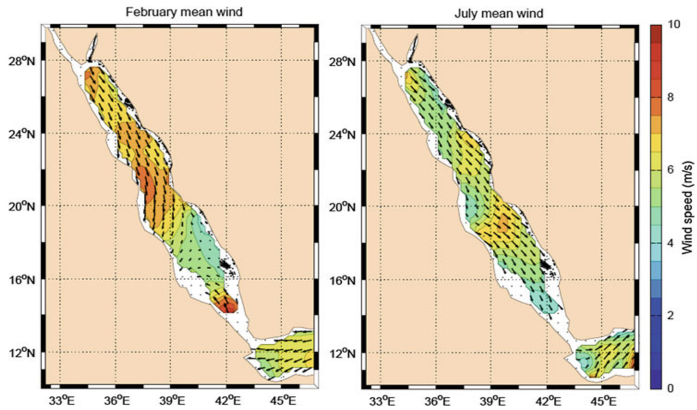

Figure 5: Climatological monthly mean surface winds for February (left) and July (right), at the two extremes of the annual cycle of surface winds in the Red Sea. The colored contours indicate wind speed, and the vectors depict the direction and relative speed. The climatological means are based on data from the QuikSCAT satellite scatterometer from September 1999 to October 2009 (Risien and Chelton 2008). Copied from Bower and Farrar 2015.

Over the northern Red Sea (north of 19–20° N) the surface winds are directed southeast all year (figure 5).[33] The summer, or southwest, monsoon determines the direction of the winds in the southern Red Sea (south of 19–20° N). During winter the winds in the southern Red Sea change direction from northwesterly to southeasterly. That switch facilitates the movement of returning ships through the southern Red Sea. The area where these oppositely directed air currents meet in the southern Red Sea is known as the Red Sea Convergence Zone (RSCZ).[34] That zone is the site of an annual meteorological phenomenon that would have

30 Sidebotham, *Berenike*, 18, 279–80; Kotarba-Morley, "Port Town and its Harbours," 89.

31 Lucy Blue, "Myos Hormos/Quṣeir al-Qadīm: A Roman and Islamic Port on the Red Sea Coast of Egypt—A Maritime Perspective," *Proceedings of the Seminar for Arabian Studies* 32 (2002): 139.

32 Najeeb M. A. Rasul, Ian C. F. Stewart, and Zohair A. Nawab, "Introduction to the Red Sea: Its Origin, Structure, and Environment," in *The Red Sea: The Formation, Morphology, Oceanography, and Environment of a Young Ocean Basin*, ed. Najeeb M. A. Rasul and Ian C. F. Stewart (Springer, 2015), 1.

33 Houshuo Jiang, J. Thomas Farrar, Robert C. Beardsley, Ru Chen, and Changseng Chen, "Zonal Surface Wind Jets Across the Red Sea Due to Mountain Gap Forcing Along Both Sides of the Red Sea," *Geophysical Research Letters* 36 (2009): L19605, doi:10.1029/2009GL040008.

34 Amy S. Bower and J. Thomas Farrar, "Air-Sea Interaction and Horizontal Circulation in the Red Sea," in *The Red Sea*, ed. Najeeb M. A. Rasul and Ian C. F. Stewart (2015), 330. For the RSCZ, see D. E. Pedgley, "The Red Sea Convergence Zone," *Weather* 21, no. 10 (1966): 350–58.

posed its own challenges to wind-propelled vessels. Winds within the zone are lighter (<4 miles/second) but unpredictable.[35] The RSCZ zone oscillates, moving every five days.[36] During 41 percent of the winter days it is between 18° N and 21° N. [37]

Beyond seasonal winds, the Red Sea experiences episodic but intense mountain gap winds caused by deep rifts in the mountains flanking the Red Sea (figure 6).[38] These mountain chains create a funnel-like formation that generally channels winds along the Red Sea axis.[39] Nevertheless, powerful mountain gap winds manage to overcome this effect and cross the Red Sea at high velocity. These dust-bringing jets occur every ten to twenty days, can last several days, and reach speeds up to 15 miles/second, blanketing up to 40 percent of the Red Sea.[40] In summer, they blow eastwardly, from Africa, causing storms that are most severe around the Tokar Gap. In winter (October–January), the gap winds descend from the Arabian subcontinent as cold, westward moving, dry, jet-like gales that can last for several days.

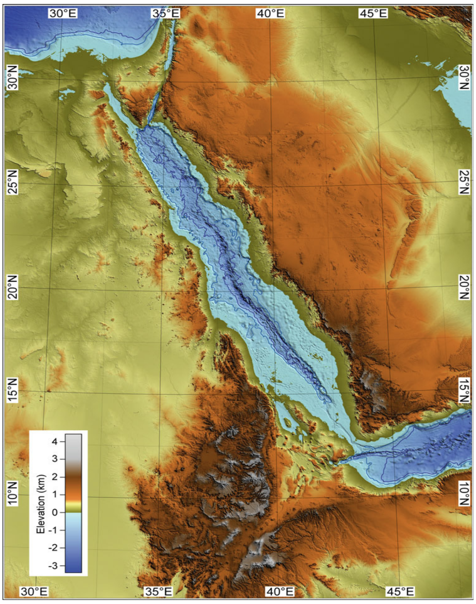

Figure 6: Topographic and bathymetric map of the Red Sea region. Bathymetriccontours are at 500 m interval. © Marco Ligi. Copied from Rasul, Stewart, and Nawab 2015, figure 2.

During the ten-year (2000–2010) Seawinds/QuikSCAT satellite mission, NASA measured fifth to seventy westward wind events north of 21.5° N.[41] Events south of 21.5° N were more numerous (between seventy and one hundred), longer lasting, and faster. In winter, the strongest winds occur in the northern end (at around 26–28° N) and the southern end (at 14–15° N) of the Red Sea basin.[42] Two northern Red Sea areas are prone to mountain gap wind jets: between 23° N and 24° N (three to four western wind jets annually) and between 25.5° N and 26.5° N (five to six events).[43] In winter, especially December and January, sailing north (beyond 26–28° N) was perilous, and sailing south (around 14–15° N, just north of the Bab-el-Mandeb Strait) was even

35 Bower and Farrar, "Air-Sea Interaction," 330.

36 Pedgley, "Red Sea Convergence Zone," 353–57.

37 Viviane V. Menezes, J. Thomas Farrar, and Amy S. Bower, "Evaporative Implications of Dry-Air Outbreaks over the Northern Red Sea," *Journal of Geophysical Research: Atmospheres* 124, no. 9 (2019).

38 Bower and Farrar, "Air-Sea Interaction," 330.

39 Pedgley, "Red Sea Convergence Zone," 353; Bower and Farrar, "Air-Sea Interaction," 329.

40 The speed at the eastern shore is 15 m/s; winds reach the western shore at 8–10 m/s at two places of greater impact. See Menezes, Farrar, and Bower, "Evaporative Implications"; Bower and Farrar, "Air-Sea Interaction," figure 2, 331–32; Jiang et al., "Zonal Surface Wind Jets," 2–6.

41 Viviane V. Menezes, J. Thomas Farrar, and Amy S. Bower, "Westward Mountain-Gap Wind Jets of the Northern Red Sea as Seen by QuikSCAT," *Journal of Physical Oceanography* 48, no. 3 (2018): 681–698. Here I follow Menezes' definition of western wind as in the 215°–280° range. On it, see Menezes, Farrar, and Bower, "Westward Mountain-Gap," 684.

42 Bower and Farrar, "Air-Sea Interaction."

43 Menezes, Farrar, and Bower, "Westward Mountain-Gap," 696; Menezes, Farrar, and Bower, "Evaporative Implications," 4838.

more dangerous.[44] Additionally, the northern Red Sea in winter experiences once or twice a year strong (≥ 8.5 m/s) north (*shamal*) winds, associated with dust storms lasting from twenty-four hours to five days.[45]

These environmental conditions have implications for the locations of the ancient Red Sea ports in the Mediterranean-Indian Ocean trade as well as for the ephemeral movements of men. They can be taken as a proxy for what ancient city founders and mariners considered when choosing the site of ports or when to sail the seas. That kind of knowledge cannot be reconstructed through the available textual sources alone. It parallels the expertise of the pilot who steered Vasco da Gama's ship from Melinde/Malindi, Kenya, to Calicut/Kozhikode, India, in 1498. That transoceanic crossing took twenty or twenty-two days (August 6 to August 26/28). The return journey, taken without the benefit of expert knowledge and against the monsoonal winds, took more than one hundred days.[46] The pilots who led ships from Egypt to India in the first centuries CE, like Vasco da Gama's anonymous pilot, presumably knew what to avoid and when to sail.

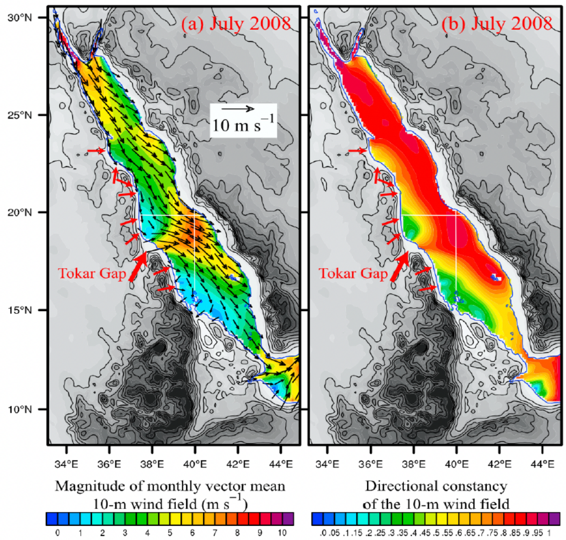

Figure 7: Monthly means of 10-m surface winds over the Red Sea from hourly WRF model output. (a) July 2008 monthly vector mean 10-m surface wind vector field overlapped with its magnitude (color contours). (b) July 2008 monthly mean 10-m wind directional constancy (color contours), defined as the ratio of the magnitude of the monthly mean 10-m wind vector to the monthly mean 10-m wind speed. The red (blue) arrows in figures la-lb (figures lc-ld) indicate the locations of mountain gaps along the western (eastern) coast of the Red Sea. The wind vectors are shown for ~30 percent of the grid points. Copied from Jiang, Farrar, Beardsley, Chen, and Chen 2009, figure 1.

First, they must have known that the month of July was particularly perilous for ships sailing in the southern Red Sea. To avoid the gales streaming through the Tokar Gap they must have left earlier (figures 7 and 8). Since strong easterly winds through the Tokar Gap (10 m/s and more) are a daily occurrence between mid-June and mid-September, ships would have had to depart from Myos Hormos/Berenike earlier than mid-June, possibly in May to mid-June, when they could take advantage of the southeasterly winds that dominate the southern Red Sea in the summer months. That timing,

44 The RSCZ causes more southerly winter events. For measurements, see Menezes, Farrar, and Bower, "Evaporative Implications," 4839. On the wind conditions in the south, see Pedgley, "Red Sea Convergence Zone," 356–57.

45 Menezes, Farrar, and Bower, "Evaporative Implications," 4843–44.

46 Gaspar Corrêa and Henry E. J. Stanley, *The Three Voyages of Vasco Da Gama, and His Viceroyalty, From the Lendas da India of Gaspar Correa, Accompanied by Original Documents, Translated from the Portuguese, with Notes and an Introduction by Henry E. J. Stanley* (B. Franklin, 1963), 109 (Melinde), 129 (advice when to cross the Indian Ocean), 137–38 (pilot's instruments and expertise), 144–45 (reached India in twenty days), 225–53 (return journey).

Figure 8: An enormous cloud of dust blankets the Red Sea on July 26, 2005. The winds blow from the east. Note the jet-like stream of dust flowing through the Tokar Gap (first third of the image, bottom to top, to the left). Image taken by MODIS (Moderate Resolution Imaging Spectroradiometer) on NASA's Terra satellite. Credit: https://earthobservatory.nasa.gov/images/15043/dust-storm-over-the-red-sea.

however, contradicts Pliny, who asserts that ships from Egypt to India set sail "before the raising of the Dog-star (Sirius) or else immediately after."[47] In the first century BCE/CE, Sirius rose around mid-July. Pliny's departure time would expose the vessels to gales through the Tokar Gap. In my view, Pliny likely confused the departure from Egypt with the onset of Indian Ocean crossings from the Gulf of Aden. *Periplus*'s author confirms this indirectly. He writes that "those who sail with the Indian [winds] leave around July," without noting the departure point.[48] Elsewhere, however, he specifies that direct voyages commenced from the Gulf of Aden (from Kane, Eudaimon Arabia, or the Promontory of Spices), implying that his earlier note about departure considered that area and not Alexandria or the Red Sea ports as the starting points.[49] The *Periplus* therefore provides evidence for a July departure for India, but only after the ships have traveled through the Red Sea. Additionally, the *Periplus* describes the west-to-east crossing as "hard going but favorable and shorter."[50] Such a characterization matches the climatic conditions. By July the southwestern monsoon winds in the Indian Ocean have peaked, making sailing bumpier but faster. As Casson demonstrates, a July departure would also position India-bound ships to reach the rain-drenched and wind-blasted subcontinent at favorable times for anchoring.[51]

Second, the pilots were likewise aware of the weather conditions affecting voyages from the subcontinent to the Gulf of Aden and then through the Red Sea to Myos Hormos or to Berenike. Pliny (6.106) gives the return season as December–January. Those months are the peak of winter wind activity in the Bab-el-Mandeb strait, the Tokar Gap, and gap winds in the northern Red Sea. In October, a transitional month, winds were variable and likewise imperfect for navigation (as Vasco da Gama discovered). Pliny's statement likely refers to the optimal period for crossing the Indian Ocean. If so, ships that sailed from India toward the Gulf of Aden in December–January would arrive at the Bab-el-Mandeb strait circa January–February. Optimal sailing conditions in the Red Sea were in February–March, when the winds in the southern Red Sea still pushed the sails north and those in the Arabian Sea blew toward the Mediterranean.[52] According to this logic, the timetable for voyages from ports in the Gulf of Aden to ports in South Asia was likely

47 Pliny, *Natural History*, 6.104. According to the IMCCE Sirius Calculator, in the year 26 BCE (the year of 120 ships sailing from Myos Hormos) the heliacal rising of Sirius occurred on July 30 BCE, while the summer of that year began on June 25. See https://promenade.imcce.fr/en/pages6/724.html.

48 Casson, *Periplus* 18.56, 85.

49 Casson, *Periplus* 19.57, 87 (with 15).

50 Casson, *Periplus* 13.39, 75.

51 Casson, "Appendix 3," in *Periplus*, 289.

52 Compare with De Romanis, *Indo-Roman Pepper Trade*, 67, and Casson, "Appendix 3," 287–91.

as follows: July–August for east/outbound journeys and December–February for the westbound ones. Sailing from Myos Hormos/Berenike toward the Gulf of Aden likely occurred in May–June, while the return journey through Bab-el-Mandeb to Myos Hormos/Berenike likely took place in February–March.

Third, considering that in winter the winds made the southern and the northern tips of the Red Sea unnavigable, Myos Hormos, situated at 26.15° N, is just at the southern boundary of the northern unnavigable zone (beyond 26–28° N). The choice of the site therefore depended not simply on its proximity to the Nile but also on the northernmost navigability of the Red Sea in winter. Still, it is located within one zone of intense westerly gap winds (between 25.5° N and 26.5° N). Berenike lies at 23.91° N, just at the northern boundary of the other zone for westerly gap winds (between 23° N and 24° N) (figure 9).[53] There's an important difference between these ports' ability to handle dust-rich storms.

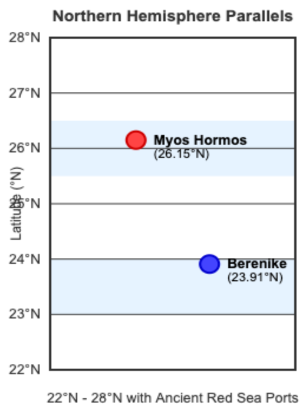

Figure 9: Locations of Myos Hormos and Berenike with respect to winter westerly gap winds in the Red Sea.

Recently collected data allows us to observe the effect of the westerly jets with a greater precision (figure 9).[54] Although both Myos Hormos and Berenike are in the path of the sand-blasting jets, Berenike's harbor would have weathered them better because the Ras Benas peninsula, which juts into the Red Sea and curves southward, effectively blocks the direct impact. Note the green dot of calm in figure 10. The measurements indicate that at the site of Berenike's harbor the wind's velocity had decreased from ca. 8 s/m to 5–6 s/m.

The goal of ships headed to either Myos Hormos or Berenike would have been to get to one of these ports before or after the onset of the winter westerly gales. It may be hypothesized that even if a ship got caught in such a gap-wind storm, Berenike's harbor would have provided a haven. No account mentions Berenike's harbor capacity, but it was the safer and deeper harbor.[55] Kotarba-Morley estimates that at Berenike, given its size before the silting, at its peak, 85 to 105 medium-size to large vessels (25 m x 7 m; 250–350 tons) could have been accommodated at one time.[56] That capacity would not have fit all the 120 ships of unknown size that the geographer Strabo states "were sailing from Myos Hormos to India" in

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53 For slight variations of this position for Berenike, see 23.54° N, https://latitude.to/satellite-map/eg/egypt/51033/berenice-troglodytica.

54 Direct measurements for the Red Sea are hard to come by. Most of the work on the Red Sea is based on models. See, for instance, Sarantis S. Sofianos and William E. Johns, "An Oceanic General Circulation Model (OGCM) Investigation of the Red Sea Circulation, 1. Exchange between the Red Sea and the Indian Ocean," *Journal of Geophysical Research: Oceans* 107, no. C11 (2002); Sarantis S. Sofianos and William E. Johns, "An Oceanic General Circulation Model (OGCM) Investigation of the Red Sea Circulation, 2. Three-Dimensional Circulation in the Red Sea," *Journal of Geophysical Research: Oceans* 108, no. C3 (2003); Stoitchko Kalenderski and Georgiy Stenchikov, "High-Resolution Regional Modeling of Summertime Transport and Impact of African Dust over the Red Sea and Arabian Peninsula," *Journal of Geophysical Research: Atmospheres* 121, no. 11 (2016). Surface winds are considered those up to 10 m from the surface. For the measurements for that day, see Jiang et al., "Zonal Surface Wind Jets," 4, and figure 3; Bower and Farrar, "Air-Sea Interaction," 330–31.

55 For the size of the harbor at Myos Hormos and its location, see David Peacock, "The Site of Myos Hormos: A View from Space," *Journal of Roman Archaeology* 6 (1993): 226–32.

56 Kotarba-Morley, "Port Town and its Harbors," 87–88.

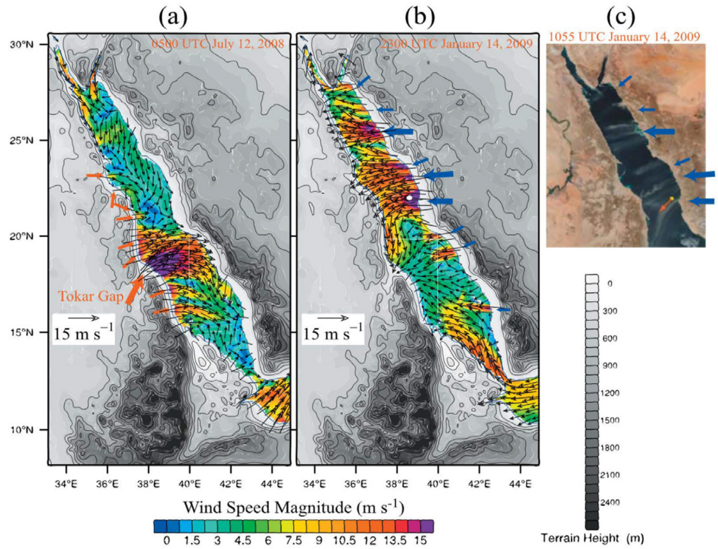

Figure 10: (c)-(d) Same as figure 5 la-lb but for January 2009. The red (blue) arrows in figures la-lb (figures lc-ld) indicate the locations of mountain gaps along the western (eastern) coast of the Red Sea. The wind vectors are shown for ~30 percent of the grid points. Copied from Jiang, Farrar, Beardsley, Chen, and Chen 2009, figure 1. Berenike is just below 25° N. Note the southeast horn-like shape of the Ras Benas peninsula.

26 BCE.[57] Therefore, anchorage at the ports called for advance planning. Perhaps the imperial authority responsible for the customs, maintenance of the wells, the forts, and the protection of caravans also managed the traffic of ships, ensuring they had safe anchorage in winter.[58] If most trading ventures with India in the first century operated like the *Hermapollon* and relied on loans, the loan givers would have kept records of those loans and would have monitored the arrival of ships. Those loans would have been one form of record keeping that whoever oversaw managing the ports may have had access to. If my hypothesis is correct, then Berenike would have served as an overflow harbor, not simply the port for larger ships, as hypothesized.[59] When a ship arrived at Berenike, a decision was made whether it could continue to Myos Hormos. Factors in making that decision included the weather conditions, the ships already at that port and their tonnage, and the time of their arrival.

Finally, let me offer a more minor point related to this hypothesis. The tight de facto connection between the ports may have engendered notional linkages, in which the name of one port stood for both. When Strabo speaks of Myos Hormos as a port of origin for all ships sailing to India, or when Pliny refers to Berenike in the same way, omitting Myos Hormos, both authors may have done so as a shortcut. Both ports harbored the same ships.

57 Strabo, *Geography*, trans. Horace Leonard Jones, Loeb Classical Library 49 (Harvard University Press, 1917), 2.5.12 (pp. 454–55).

58 For the forts, see Jean-Pierre Brun, "Chronology of the Forts of the Routes to Myos Hormos and Berenike During the Graeco-Roman Period," in *The Eastern Desert of Egypt*. For the taxation, see De Romanis, *Indo-Roman Pepper Trade*, 123–35. For the role of the state, see Fitzpatrick, "Provincializing Rome."

59 De Romanis argues for greater specialization; see De Romanis, *Indo-Roman Pepper Trade*, 46–54. That is not to be excluded. Yet the model I propose calls for greater flexibility.

To return to Braudel. Not all historical questions call for a Braudelian perspective. In this case, however, seeking to measure more precisely the "slow-moving" factors of the Indian Ocean monsoon's wind patterns has led—I hope—to a better understanding of the "ephemeral movements" of men: the rationale for constructing two closely aligned ports on the Red Sea as well as the timing of direct Mediterranean-Indian Ocean voyages. The narrow window for direct transoceanic voyages proposed here as well as the great risks and expense involved in sailing the seas, including the use of two linked harbors, could throw fresh insights on other aspects of the "ephemeral," such as the size of ships necessary to make the trade profitable, the volume of that trade based on the number and tonnage of ships, the involvement of the Roman state, the capital needed to make the trade profitable, and its size vis-à-vis other economic enterprises.[60] $\boxed{\text{A}}$

[60] I will be addressing some of these in a future publication.