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Palagruža - The Island of Diomedes - and Notes on Ancient Greek Navigation in the Adriatic

Branko Kirigin, Alan Johnston, Marko Vučetić and Zvonimir Lušić

The small archipelago of Palagruža is the omphalos *of the Adriatic Sea. The recent discovery of some 13,000 sherds of Greek fine pottery (late 6th - 2nd/1st century BC), some with graffiti that confirm the existence of Diomedes cult, enables discussion on ancient navigation up and down and across the Adriatic. Analysing other archaeological data, ancient written sources, the winds and currents, meteorological data collected in the last 100 years from north, central and south Adriatic, and the capabilities of boats and sailors, we offer a preliminary picture of how the ancient Greeks navigated in this part of the Mediterranean. Documents from the Medieval period and local traditional weather lore of fishermen support our assumption that long-distance trade with cargo ships was possible only from May to October.*

Keywords: Adriatic, Diomedes, Greeks, meteorology, navigation, Palagruža, sailing season, trade, traditional weather lore

Introduction

To ancient mariners who sailed the open sea, the most important thing was to find and recognize landmarks: islands, capes, promontories and hills. Since the Adriatic is a narrow sea, finding land was not so difficult, but it was very difficult to approach it and to land. One had to be a very skilful sailor, with good knowledge of coasts, rocks, reefs, winds, and currents, and of signs that can help in predicting weather conditions. That knowledge could not have been acquired without regular connections among Adriatic communities throughout prehistory and history, before the invention of navigation instruments such as the compass, barometer, sextant, radar, and the GPS.

The inspiration for this paper came through excavations on the island of Palagruža, situated almost in the centre of the Adriatic Sea, and recently identified as the Island(s) of Diomedes (Kirigin and Čače 1998) (Figure 1; see also Figures 2, 5 and 7). After providing basic geographical data, we summarize the archaeological evidence from Palagruža and present results of recent research on ancient navigation and weather conditions in the Adriatic, as well as the weather lore of fishermen from the island of Vis (Appendix 1), in order to propose a reconstruction of open sea navigation in the Adriatic during the Archaic and Classical Periods. We know that goods and people moved around the Adriatic by boats, but it has never been practically explained how these boats were navigated.

The Adriatic

The Adriatic is the nearest sea to Central Europe. Total length of its coastline is 3737km, but the eastern coastline, including the Albanian coast, is almost twice as long (2390km) as the Italian coastline. If one includes the coastlines of over a thousand islands, islets and rocks that face the east Adriatic mainland (a total of 4001km), the eastern coastline is five times longer than the western one, which is only 1249km long (see Figure 7)![1] The east coast is characterized by high, rugged mountains, while the west coast is flat, except for the promontories of Gargano and Conero. Fertile soil is as rare in the east as rocks are in the west. The west coast has very few safe natural harbours and faces even fewer islands, while the east coast offers many places of shelter, except for the low and marshy Albanian coast, some 400km long in a straight line, which has only two safe anchorages, at Vlora Bay (ancient Oricum) and Durres (ancient Epidamnos/Dyrrhachion). Distance from Venice to Otranto Straits is 423NM (783km). The Adriatic is at its widest between Bari and Dubrovnik (some 114NM), where it also reaches its greatest depth (1228m). It is narrowest between the mouth of Po River and Rovinj in Istria (some 47NM), where it is only 35m deep (anon. 1956, 322-325; Thompson and Thompson 2000; Duplančić Leder *et al.* 2004).

At the time when the Greeks started sailing towards the northern Adriatic, the sea level would have been some 2-3m lower then today (van Andel 1989; 1990; Morton 2001, 5-8). Some of the islands would have been connected to the mainland or to other islands. Parts of the north Dalmatian coastline and the islands facing it between Zadar and Šibenik may have been shaped differently, while some of the submerged rocks would have been exposed. Nothing

[1] Land distances are expressed in kilometers (km), while sea distances are expressed in nautical miles (NM); 1Nm = 1.852km.

Figure 1. View of Velo Palagruža from Molo Palagruža. 1 Zolo, 2 Salamandrija, 3 Lighthouse.

fundamental has changed, however, that would signal different navigation problems.

Palagruža

Palagruža is a small archipelago situated between the Gargano Peninsula and the Dalmatian islands of Sušac, Lastovo and Vis (see Figures 5 and 7). It consists of two larger islands, Velo (Great) and Molo (Little), separated by a channel about 200m wide, as well as two large rocks and some 20 small rocks and shoals, ending with the islet of Galijula (Figure 2).

Velo Palagruža is about 1350m long, 300m wide and 87m high. Its southern side consists of steep cliffs overlooking at their centre a pebble beach, Zolo (Figure 1). The northern slope offers seven hectares of thin arable soil. Near the western end there is another small pebble beach, Storo vloka, the only place aside from Zolo where one can land.

Due to many rocks and shoals, strong currents (up to 6 knots)[2], and variable winds, landing on Palagruža is not easy, as attested by many shipwrecks dating from 4th/2nd century BC to the present times (Orlić 1988; Radić 1988; 1990; Radić Rossi 2002; Miholjak 2007). Safe landing is possible only when the sea is calm, which usually occurs from May to October, when westerly and northerly winds are blowing (see Figure 6). Even then, one has to be a skilful mariner to anchor safely in front of the Zolo beach. Until recently, fishing boats were beached regularly, but that was not an option for longer vessels. Landing a small merchant boat, e.g. an ancient *lembos* that could hold 20 tons of cargo, was out of the question, since one would not have been able to put it back to sea. Fishermen from Komiža on the island of Vis would first unload their boat – which could carry up to 4 tons – and then pull it out. Otherwise it was too heavy to beach without a winch.

For landing on Palagruža, one either has to swim, or to row to the beach in a small boat (a tender), as is still done today. Casson (1995, figures 144, 146 and 154) provides illustrations of such tenders of Roman date (see also Pekáry [1999]). One cannot land on Zolo if the south wind (the *jugo*) is blowing, and if *jugo* is strong, one cannot land in Storo vloka either, because the island is small, and the sea gets rough all around it. With due care one can anchor in front of Zolo when winds are blowing from W, NW, N and NE, but with those winds it is impossible to land at Storo

[2] 1 knot = 1 nautical mile per hour

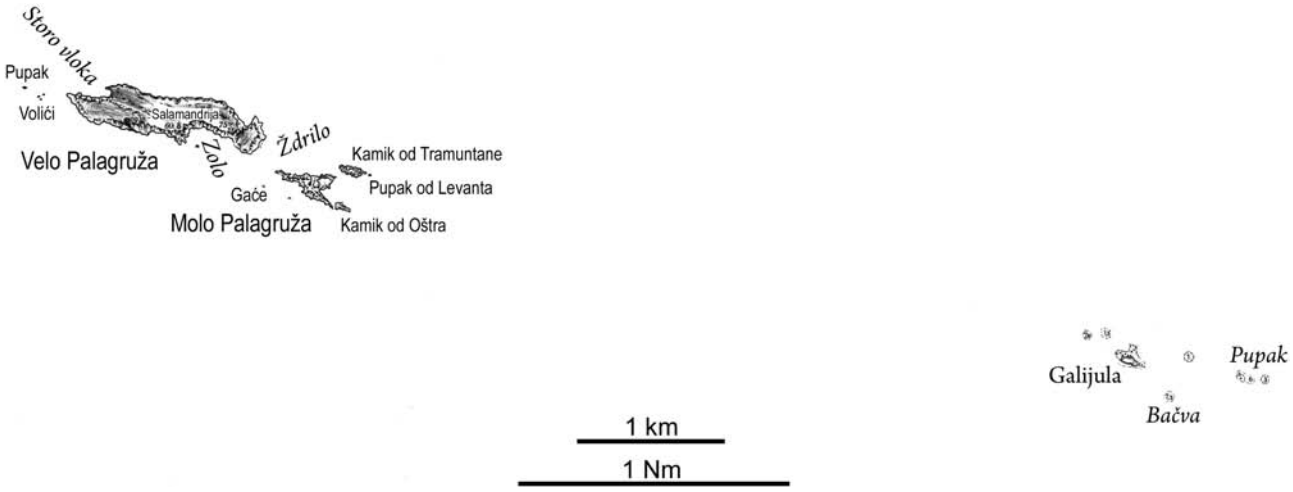

Figure 2. Map of Velo Palagruža, Molo Palagruža and Galijula with surrounding rocks and shoals.

vloka. Palagruža has strong winds every second day on the average, and severe gales every seventh to tenth day (Vučetić and Vučetić 2002, 43).

After Thira (Santorini), Palagruža has the lowest rainfall in the northern Mediterranean, with an average of 290.3mm per year (Milković 1996). The island does not have a fresh water source. In order to be able to live on Palagruža, one has to build a large cistern, as the Romans did. Seven hectares of arable land is sufficient to support a small community.[3] Fish is not a problem and there is food for goats; even grapes have been grown here, an endemic sort known as *Palagružonka*. The average humidity on the island is high (75%), often causing fog or mist and providing sufficient amounts of dew for a diverse bush vegetation (there are no trees). Palagruža has the lowest air pressure in the Adriatic, which means that winds often change their direction at random, up to three times a day (Pandžić and Sijerković 1996, 301).

One cannot spot Palagruža from the sea level, in good weather conditions, from a distance greater than *c.* 25NM. Palagruža therefore is not visible if one is sailing past Gargano, or past Vis or Lastovo; it becomes visible only half a mile south of Sušac! During windless, hot summer days, when evaporation is high, Palagruža can be seen only from a mile or two away.

Recent excavations have shown that the island has played an important role in maritime communications starting back as early as 8000 years before the present (Forenbaher 1999). Palagruža was also considered important during the Middle Ages, when pilot maps (*portolans*) often show it much bigger than in reality (Duplančić 1996). In 1875, Austrian authorities built there the biggest and strongest lighthouse in the Adriatic, which remains in service.

The Early Neolithic and Late Copper Age / Early Bronze Age finds from Palagruža have been well presented by Forenbaher (1999) and Kaser and Forenbaher (1999) (see also Forenbaher in this volume). It is interesting to note that Palagruža did not yield any finds from the period between the Early Bronze Age and the 6th century BC. Mycenaean pottery has not been recovered, though it is attested at several sites in south and north Adriatic, especially during the LH IIIc period (Vagnetti 1999, map on p. 161; Gaffney *et al.* 2002).

Local Adriatic Iron Age finds also are absent. The island may have been uninhabited and the local polities may have had no interest in controlling it. It seems that native navigators did not stop at Palagruža, nor did they build a shrine on the island, unlike the Messapians, who honoured their deities in cave shrines along the west Adriatic coast [Pagliara 1991, 503-526]). Palagruža was not an attractive place to live, but it was an important landmark for Iron Age sailors, who could cross the Adriatic (80NM from Gargano to Issa) in a day.

Evidence of trans-Adriatic contacts in the 1st Millennium BC

That the products of the Apulians (Daunians, Peucetians and Messapians) did cross the Adriatic is attested by their matt-painted pottery, which can be found at many sites in Dalmatia, Liburnia, and Histria, starting from the 9th century BC onwards (De Juliis 1977, map C; Petrić 1993; Kirigin 2006, 11, 21; Barbarić 2006, 58). Only a single 5/4th century BC fragment of such pottery has been found on Palagruža. Early Iron Age artefacts and people from the East Adriatic coast also crossed the Adriatic and reached the Italian coast (Batović 1976; 1987, 349, 379; Peroni 1976; Katičić 1976; Benac 1988; Guidi and Piperno 1993,

[3] During the Middle Ages, the Hvar commune rented Palagruža for planting grain (Mardešić 1993, 67 and note 82; Kovačić 1997, 41). The 7 hectares of arable soil could have produced some 3500 kg of wheat or, due to low rainfall, barley. This could have supported some 15 persons for a year.

446-448, 509: Bouzek 1997, 224-227). While we do not have a clear idea about trade or exchange patterns, maritime connections among Adriatic communities were evident before the Greeks showed interest in this region in the 6th century BC. We may note that the early Greek finds from Otranto and up the Salento coast, together with the late 7th century BC Greek colonies on the Albanian coast (Epidamnos and Apollonia), show that the Greeks were familiar in sailing the '*stoma tou Adriou kolpou*' (D'Andria 1990; Wilkes and Fisher-Hansen 2004), the most difficult part of the Adriatic.

Local communities of the Archaic and Classical periods on central Dalmatian islands reached a degree of pre-eminence based on control of agricultural land, and through their proximity to trade routes (Gaffney *et al.* 2002). Although arable land and other resources were relatively scarce (except maybe fish), the islands certainly played an important role in the Iron Age Adriatic. The few examples of Archaic and Classical Greek fine pottery (Corinthian and Attic) from east Adriatic coastal and island sites (Kirigin and Čače 1998, 77, note 62) indicate trade (contacts) on a much smaller scale than on the opposite side of the Adriatic. One fragment of such pottery, datable 490-470 BC, was found recently on the hillfort of Rat on the island of Brač. It has a graffito under the foot with a Greek letter M and belongs to Johnston's trademark type 13B (Johnston 2006, 81-2); the same letter is on a lekythos base from the former Hirschmann collection, attributed to the Eucharides painter, indicating that the Rat vase might have arrived by the same route as the vases of this painter found in Italy and Sicily. An Attic kylix and skyphos sherds have also been found on this site during survey in 1994 (Barbarić 2006, 58-59). Several late Archaic sherds have been found at the Kaštil on the island of Lastovo (see Della Casa *et al.* in this volume). One sherd of a South Italian red-figured vase (c. 350 BC) was found within the medieval walls of Dubrovnik (Menalo 2004, 255, 268 figure 7). Recently, several black-figured and red-figured Attic sherds have been found at Nin in north Dalmatia (unpublished). Altogether there are very few examples of figured pottery from Dalmatia, Kvarner, and Istria, coming from not more then ten sites along the Croatian coast and islands. On the west Adriatic coast there are some 35 sites with black-figured vases while on the entire east coast there are about nine; likewise, there are some 84 sites with red-figured vases on the west coast and about 17 on the east coast (D'Ercole 2006, figures 5 and 6).

If we are to believe Filippo Giudice's distribution and quantification of 4034 Attic figured vases of the 6th and the 5th century BC around the Adriatic, almost 99% of them were found on the Italian side, with the greatest concentration at Spina, Bologna and Adria (Guidice 2004). It is hard to believe that things will ever change dramatically, especially for the Archaic and Early Classical periods. To some extent, this situation may be a consequence of relatively few recent excavations on the Croatian side of the Adriatic. There is a strong possibility, however, that the Illyrians did not appreciate Attic painted pottery, or could not afford it. The economic potential of Dalmatia cannot be compared with the fertile richness of the Italian coast, and even the ancient sources mention that the Illyrians were envious of that land (Antoninus Liberalis 37).

Table 1. Number of potsherds recoverd during excavations in 1996 and 2002-2007 form layer 4050, south slope of Salamandrija (Palagruža).

Square	P	Gfw	Rfw	G/Rfw	Ccw	Amph	Tiles	Me/Mo	Total
V-6	382	341	73	231	89	6	83	0	**1205**
V-7	301	1300	274	498	396	57	252	0	**3078**
V-8	22	503	68	-	223	17	16	0	**849**
Z-6	621	1351	315	347	746	75	343	0	**3798**
Z-7	73	1969	864	426	624	41	522	1	**4520**
Z-8	57	1644	628	571	1105	96	789	1	**4891**
A-8	4	86	35	50	66	5	11	0	**257**
B-8	25	453	171	88	401	27	157	0	**1322**
A-9	16	200	88	58	166	49	107	0	**684**
B-9	9	107	42	128	66	16	229	0	**597**
Z-9	12	24	18	12	14	0	20	0	**100**
Total	**1522**	**7978**	**2576**	**2409**	**3896**	**389**	**2529**	**2**	**21301**
%	**7.15**	**37.45**	**12.09**	**11.31**	**18.29**	**1.83**	**11.87**	**0.01**	**100.00**

P = prehistoric, **Gfw** = Greek fine ware, **Rfw** = Roman fine ware, **G/Rfw** = Greek and/or Roman fine ware, **Ccw** = Greek and Roman cooking coarse ware, **Amph** = amphorae, **Me/Mo** = medieval and modern

Greek and Hellenistic pottery from Palagruža

As a result of the recent excavations on Palagruža, we can now add more Attic pots to Guidice's list. Although the vast pottery assemblage from Palagruža has not been studied in detail (Table 1), it seems that Attic pottery is more dominant in the late 6th/5th century BC than in the 4th century BC. Some of the Attic figured pottery (some 20 sherds) has been published (Kirigin and Čače 1998; Kirigin 2003; Kirigin *et al.* 2004; 2005; 2006; in press), while the majority consists of black gloss sherds.

The Attic figured pottery on Palagruža seems to correspond well with the situation in Puglia (Semeraro 1997, 377-388; Mannino 2004, 355), Adria (Wiel-Marin 2005), Numana (Fabrini 1984), and Spina (Berti and Guzzo 1993; Sassatelli 2000; Nilsson 1999; Giudice 2007). On the other hand, Palagruža has not yielded any figured sherds attributable to the workshops of Magna Grecia, which are so common in Puglia, and also at Issa and Pharos in Dalmatia. Fragments of Gnathia ware (some of them with graffiti) and other local Hellenistic Adriatic styles are common on Palagruža, while Early Roman fine wares ('thin walled' and Arretine) are less frequent. Most of the fine wares on Palagruža are drinking vessels (kylikes, skyphoi and bowls), while cooking pottery is relatively scarce (Miše 2006). This suggests that wine was offered to Diomedes, the legendary Greek hero of the Trojan war, together with coins, gems, rings, fibulae, dice, as well as a few lamps and terracottas.

Several late 6th century BC black-figured sherds and graffiti indicate that the shrine of Diomedes was founded on Palagruža around that date. Which of the Greeks were visiting it? Judging by the pottery, the sanctuary founders were neither the Corinthians, nor the Eastern Greeks, whose fine wares appear on both shores of the Adriatic, but not on Palagruža. The Greek Archaic and Classical pottery found here all seems to be Attic. Graffiti inscribed on potsherds provide further indications.

Graffiti

Out of more than 200 fragments with graffti (most of them dedications), for our purposes here we point out just a few.

Aside from the famous text with the name of DIOMEDES (Figure 3: 1) (Kirigin and Čače 1998, 64, 85, #3, 94, figure 4, 108, Pl. 1:3) that has inspired our excavations all these years, a kylix base with two lines: *...unadr/...aiai* (Figure 3: 2) (Kirigin and Čače 1998, 79. Pl. 1:1) may mention another dedicatee. The ending *-aiai* could be supplemented *Athenaiai* but the statistical likelihood of this reading is not strong. A fine and early dedication is preserved on two non-joining fragments of an Attic red-figured eye-cup of *c.* 520-500, with the text in Ionic script (Figure 3: 3a, 3b) (Kirigin *et al.* 2005, 257, figure 6: 3a, 3b).

About ten texts mention material relevant to navigation. The longest text from Palagruža is cut on a large black skyphos of perhaps 450-425 BC. We have the beginnings of three lines and part of a fourth in much larger lettering, the dedication to Diomedes (Figure 3: 4) (Kirigin 2003, 271-374, figure 11 left). The dedicator's name, which appears in line 2 (apparently, Perraios), is occasionally found in central and northern Greece. In line 3 there is clear reference to *soteria*, 'safety', a common word in sailors' prayers and thanks, here perhaps 'but may you give him a safe passage home'.

Another key word probably appears on a late Archaic or early Classical black-glazed scrap, with]UPLO[, that could well be *euploia*, referring to a good voyage, or less likely to Aphrodite Euploia, a well-known seafarers' cult (Figure 3: 5) (Kirigin *et al.* 2005, 257, figure 6: 4).

More common is the dedicatory formula that refers to the joint dedication of a ship's crew, 'X and his fellow sailors', *sunnautai*. All these texts are very fragmentary unfortunately, though one is an early example of the formula, *c.* 500 BC.

The origins of the sailors can be discerned in the Ionic text mentioned above, some graffiti probably in the script of Aegina (see below) and a couple of texts in which the specific *polis* of the dedicator may be mentioned. One is cut beneath the black-figured frieze of a cup of perhaps the later 6th century BC,]ENOXI[(Figure 3: 6) (Kirigin 2003, 271-374, figure 11, right); the reading could be ANETHEK]EN O XI[OS, a dedication by a Chian at a date close to 493/2 BC, when the island of Chios (in eastern part of central Aegean) was devastated by the Persians. The other,]AMIOST[, is likely to refer to a man from the more southerly island of Samos (Figure 3: 7) (unpublished).

The only complete graffito reads: SOLEIOS ANETHEKE. This is indeed very interesting, as it must be the same man, Soleios, who is known at Adria by an owner's inscription, SOLEIO EMI, on an Attic cup of similar date, *c.* 500 BC. The script is almost certainly Aeginetan (Figure 3: 8) (Kirigin *et al.* in press).

Even though the texts are so fragmentary, we see that Greek seamen were making offerings to Diomedes, and that before the Hellenistic period these pots are Attic. This also clearly shows that many of the seamen were literate; they could therefore well have had some written 'pilot book' of the Adriatic on board.

History of the sanctuary

It is impossible to answer the question of how often the sanctuary was visited. Much damage has been done by the Late Roman fortification, the mid 19th century church of St. Michael, several cisterns and water collecting pavements, the two Italian military installations, and erosion. Judging by the fact that only one of the recovered Greek graffiti

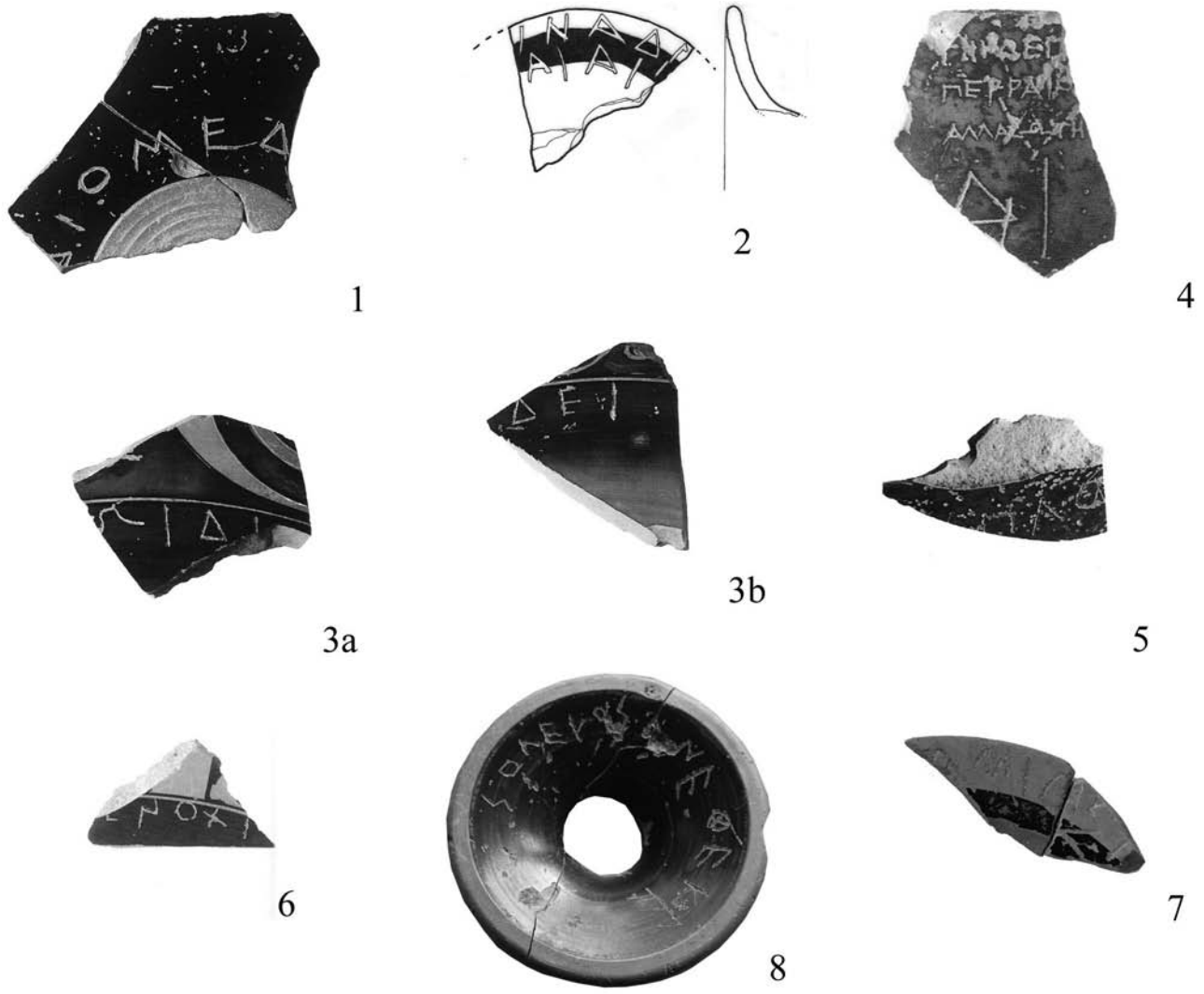

Figure 3. Graffiti from Palagruža (not to scale).

is complete, well over a half of the pottery assemblage is missing. We cannot estimate from the available evidence how many landings were made during each sailing season, or within a decade. At the moment, we can only say that the sanctuary existed through the Greek and Early Roman period (late 6th century BC – 1st/2nd century AD).

The ancient written sources that mention sanctuaries of Diomedes in the Adriatic do not locate Diomedes' Island(s) with the precision provided for the other sanctuaries. This adds to the mystery of the sanctuary on Palagruža, and might indicate that only the seafarers knew its location, rather than the geographers and scholars who wrote about it, or it might be because it was far away from any coasts. Indeed, before our work on Palagruža, the Tremiti were considered to be the islands of Diomedes (Braccesi 1979, 15, note 12; Kirigin and Čače 1998, 75, with bibliography; D'Ercole 2002, 23-24).

The Greeks established the sanctuary on Palagruža despite the island's many dangers. It could not have been sited at the beach, as it would have been destroyed by the *scirocco* which sometimes creates waves higher than 8m (Britvić *et al.* 1996, 269). It stood on Salamandrija, which is reached from Zolo by a steep 60-metre climb (Figure 1). From this height one could see much farther than from the sea level. In exceptional visibility conditions one can see Mount Maiella (2793m) in Italy, 200km away, and Mount Orjen (1895m) in Montenegro, 220km away, not to mention the islands and coastal mountains of Dalmatia, Gargano, and Tremiti. This was important not just for orientation, but also for predicting the weather conditions.

Diomedes' birds

When Diomedes died (or was killed), Zeus transformed his friends into birds. The ancient sources tell us that:

> *'These birds live like in a town. Before dawn they soak the place with their wings and again sprinkle it wetly, and then they go hunting, leaving the prey*

in a heap, and together they distribute it among themselves' (*scholia ad* Lycophron 594).

'At once the Illyrians suddenly attacked and killed the Dorians on the island, at the moment when they were offering funeral sacrifice. According to the decision of Zeus, the bodies of the Hellenes disappeared and their souls were transformed into birds. And even now when a Hellenic ship puts to shore, the birds come to it, while from an Illyrian one they all fly off and disappear from the island' (Antoninus Liberalis 37).

'[These birds] annoy the visiting barbarians with their cries, and only to the Greeks do they show deference. Every day they clean [the sanctuary] with full throats and wet wings, and from this arose the story that these are friends of Diomedes, who have transformed themselves into the appearance of birds' (Pliny *Nat. His.* x, 126-127).

'On the island of Diomedes, which lies in the Adriatic, it is said that there is a sanctuary of Diomedes, beautiful and holy, and that surrounding the sanctuary sit birds, big in growth, and having large and hard beaks. And it is said that when the Hellenes go ashore at that place, they remain calm, but if any of the barbarians that live nearby come, they fly out and precipitate from the air headlong and wound or kill them with their beaks' (Aristotle, *Mir. Ausc.* 385b. p.8).

Morton (2001, 225, note 135) notes that '*the hostility of the birds in this passage is a reflection of the natural tendency to protect nesting sites*'. On Palagruža seagulls protect their eggs and youngsters from late April to early July. It is interesting to note that all birds mentioned by the ancient sources are migratory birds[4]. Only the endemic Illyrian swifts live permanently on Palagruža, while Cory's shearwater[5] and Eleonora's falcon are among the few birds that stay there for longer periods. Even the seagulls, which are the most common birds on Palagruža, come to the island in November and leave in July. The time of seasonal bird migrations roughly corresponds to the opening and closing of the sailing season in antiquity.

Limits of navigation

Descriptions of the Adriatic coast by Pseudo-Skylax and other ancient writers are helpful since they describe the geography, the inhabitants, and the distances between settlements along the coast and islands. They do not provide practical instructions on how to reach them by sea, nor do they mention landmarks, sea depths, anchorages, sheltered places, or fresh water supply. They are not pilots for sailors (Medas 2004, 109-135), but taking them as such, scholars have come to the erroneous conclusion that navigation proceeded only along the coast, during daytime, and with a following wind.

Scholars working in the east Adriatic presumed until recently that ancient navigators hugged the coasts and travelled during daytime (Kozličić 1996, 39-40, 43; Ničetić 2000; Kozličić and Faričić 2004, 38). Although Braccesi (1979, 16, note 15) notes that open sea navigation was not an '*ostacolo insormontabile*', the opinion is still voiced that the Greeks avoided the Adriatic as much in summer as in winter (Morton 2001, 121, 128, 234, 242). Recent research has demonstrated what already was known from ancient literary sources, namely that Greek merchant ships with square sails could sail up to 80° towards the wind (Pomey 1997, 32-37; Medas 2004, 183-206), at night (Braudel 2001, 214; Davis 2001, 136-185; Morton 2001, 261-265; Bilić 2004, 2005; Medas 2004, 155-181), and for days on the open sea (Davis 2001; Morton 2001, 206-228).

Sailing with the side wind was crucial for transadriatic navigation. Otherwise it would have been almost impossible to sail, for instance, from Issa (Vis) to Salona (Solin), as the winds that blow in that direction are extremely rare and stormy. The same applies to the passage from Ancona to Zadar. While sailing against the wind (tacking), the speed of ships would have been about 1 knot, maximum 2.5 knots (Casson 1995, 281-296). During the presumed sailing season (May to October), the prevailing winds in the Adriatic come from the NW (see Figure 6). Thus it was a much longer trip from Kerkyra to Spina than *vice-versa*. Sailing from Kerkyra to Spina along the east coast, with the favourable current and the unfavourable prevailing winds, ships could have maintained an average speed of 1.5 knots, thus making 36NM per 24 hours. On the way back they could have sailed at an average speed of 3-4 knots, making 72 to 96NM in 24 hours.

Night sailing in the Adriatic

Strabo (iii: 2, 5) and Arathus (*Phaen*. 37-44, 728; Davis 2001, 170) are explicit about the Greeks sailing at night. For orientation they used the Ursa Minor constellation, an art that they learned from the Phoenicians (Aubet 2001, 168-170). There are no references to night sailing in the Adriatic, which posed many specific problems, but it does not mean that it was impossible.

One of the main rules of night sailing is to avoid sailing near the coasts. In the northern hemisphere, the simplest orientation is by Polaris (the Polar Star), the star that remains in the same place for a stationary observer. Since

[4] They are described by ancient writers as: 'Similar to swans' (*Scholia* ad Lycophron 592 and 594), 'similar to moorhens' (Pliny *Nat. His*. x, 126-127), 'similar in form to bald coots, and in size to swans' (Isidorus of Seville, *Etymologia sive origines*, xii, 7, 28-29), 'Diomedes birds' (Julius Sotinus), or just as 'birds' (Strabo ii, 5, 20.123; Antoninus Liberalis 37), or as 'big in growth and having large and hard beaks' (Aristotle *Mir. Ausc*. 385b. p. 8).

[5] *Calonectris diomedea,* known in Croatian as *Kaukal, Galeb kaukavac* or *Veliki zovoj*; we do not know how the reference to Diomedes in its scientific name came about.

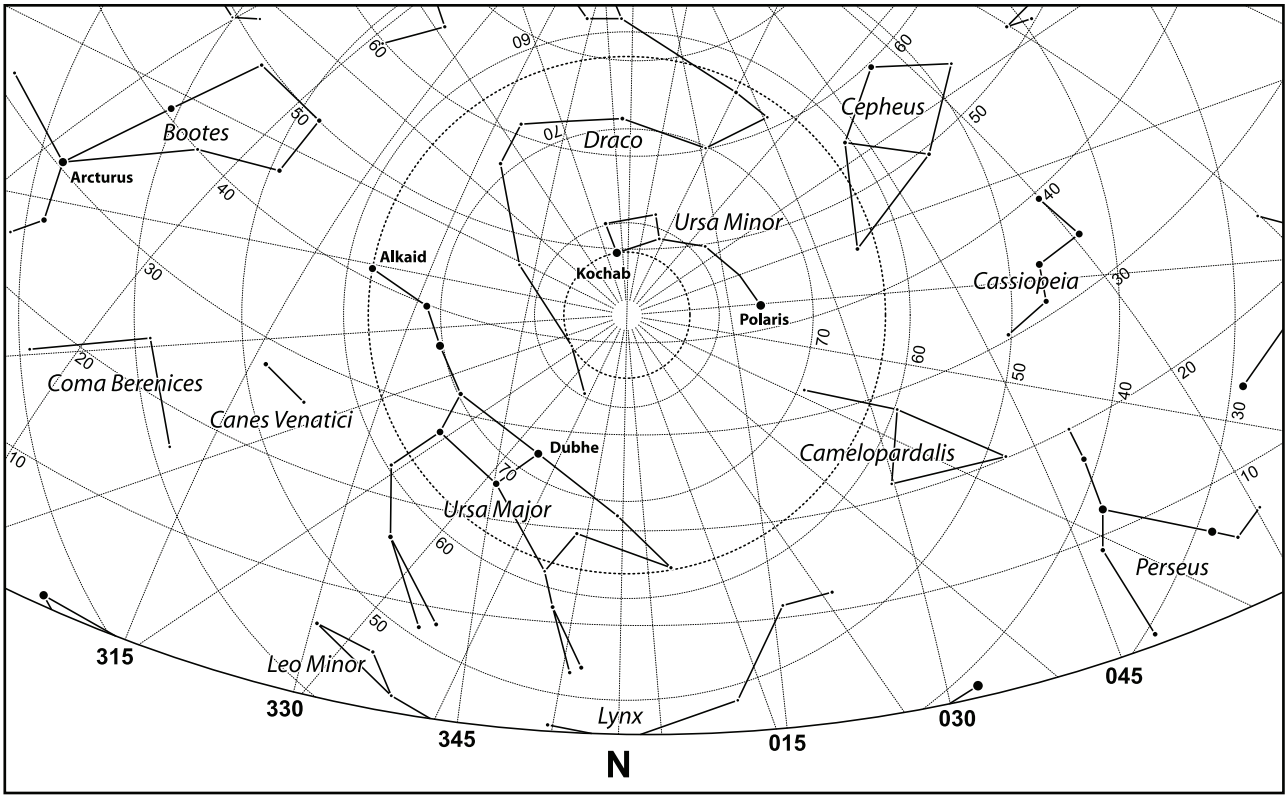

Figure 4. Sky on July 1st 500 BC, Central Adriatic. Source: www.stellarium.org (with modifications by Lušić).

Polaris is near the celestial pole, its altitude approximately equals the latitude of the observer, and its azimuth is very close to north.

In the ancient times, however, Polaris was not the Polar Star. In the first millennium BC, none of the stars were very near the Celestial pole, the nearest one being Kochab in the constellation Ursa Minor (Figure 4). The easily recognizable main constellations (e.g., Ursa Minor, Ursa Major, Orion) probably were the main guides. These constellations would have been ideal for an observer in the Adriatic: they were easy to find, and they were circumpolar, i.e., always above the horizon.

Ancient seamen also knew how to obtain latitude by observing the upper and lower meridian passages, i.e., by identifying positions of destinations according to meridian passage of celestial bodies (Davis 2001, 175; Ničetić 2000, 83; Bowditch 2002). While this method is valuable on long courses heading east or west, is less useful in the Adriatic, a relatively narrow sea that extends in a NW-SE direction.

A voyage from the Straits of Otranto to the northwestern Adriatic ports and *vice-versa* may have been accomplished as follows:

> Set out at night, on a course heading towards the open (safe) sea. Keep heading towards the open sea in order to avoid arrival at a destination (e.g., port, anchorage, narrow passage, shallow waters) before daylight.
>
> During daylight, base your position on observation of terrestrial objects and the Sun. During nighttime, keep your direction according to the celestial bodies and constellations.
>
> For night orientation, use Ursa Major or Ursa Minor, especially Kochab.
>
> Additional orientation is possible at the time of rising, setting, and meridian passage of celestial bodies, but these vary with the season and the observer's position.

During summer months, when daylight is much longer then night, not much sailing would have taken place in darkness (12 - 36NM). The journey was even safer when moonlight provided good visibility. Night breezes coming from the mainland (locally known as *burin* or *ternin*) provided additional help.

How many ships?

Why did the Greeks go to Spina and Adria? It is generally considered that they went for cereals, metals, amber, horses, salt, dried meat and slaves (Braccesi 1979, 135, 152-157; Sassatelli 1993, 211-213; 2000; Raviola 1999, 59-62; Menichetti 2000). The most favourable time to purchase grain would have been in early summer, after the harvest.

It has been estimated that Athens normally imported from

11,500 to 23,000 tons of grain each year,[6] which could have been brought to Piraeus in between 92 and 192 ships (Garnsey 1988, 90-91, 143). Greek cargo ships ranged from 20 to 330 tons burden. Ships '*of 5,000 talents (130 tons) were at least of average size*', although '*freighters of 350-500 tons, though considerably large, were not out of the ordinary*' (Casson 1995, 183-184).[7] Recent underwater excavations have confirmed that, by the 5th century BC, there were Greek merchant ships of 126 tons burden (Hadjidaki 1996), but the majority of known wrecks of the period are substantially smaller, 10 to 18-metre vessels (Hadjidaki 1996, 588-90; Panvini 2001, 19).

The principle Athenian suppliers of grain were the Propontis (the Sea of Marmara) region, Crimea in the Black Sea (Bosporan kingdom), Egypt, Sicily and the *Alto Adriatico,* though no ancient literary source mentions grain trade between the last and Athens. It would be interesting to compare the timing of harvest seasons in Egypt, Sicily, and the Black Sea, since different harvest seasons would have allowed successive shipments of grain to be brought to Athens by the same ships. If these four regions were indeed the principal suppliers of grain for Athens, then about 48 *sitegoi* of 120 tons burden (a fourth of the total of 192 ships) might have arrived at Spina each year between late June and early September. Even fewer ships would have sufficed if some of them were larger, although draught would have limited the size of vessels that could enter the ports in the laguna. The low-lying coast must have been provided by a man-made monument signalling the entrance to the ports. We do not know how the grain was kept dry while on board.

More ships may have arrived at Spina if they were smaller, if there was a bad harvest in Greece, or if a conflict situation arose between Athens and the states that controlled the grain export and ports of trade in Egypt, Sicily, the Propontis and the Black Sea (Raviola 1999, 54). There is some support for this in the fact that not a single ancient shipwreck in the Adriatic dates from the Archaic and Early Classical periods, while most of them are Late Hellenistic and Roman (Parker 1992; Jurišić 2000; Auriemma 2004, vol. 2, 289-233).

One should note that the route Piraeus – Spina *via* Cape Malea (c. 900NM) is the longest of all the routes in question (Table 2). In view of this, we might surmise that grain may not have been the only product, or even the main one, that the Greeks were looking for at Spina. It may have been something that could not be obtained at other ports, something more valuable, or something that they could trade with. What was given in exchange to the Etruscans, the Veneti, and the inhabitants of Central Europe? Obviously, not only pottery; wine and olive oil may have been of prime interest, and perhaps also marble, spices and cloth.

[6] This amount has been disputed (Garnsey 1988 101-6; Hansen 2006, 78, 90-1); on Demosthenes' much discussed figure of 400,000 it would have been c.13,000 metric tons. If one posits a mean boat tonnage of 120 tons (see Whitby 1998, 124) this would amount to around 110 ship loads.

[7] Information comes from inscriptions dated to the 4th/3rd century BC

Table 2. Approximate sea distances from Piraeus to various grain-supplying regions.

Route	Distance (NM)
Piraeus – Spina *via* Cape Malea	900
Piraeus – Spina *via* Corinth (Diolkos)	715
Piraeus – Propontis	480
Piraeus – Crimea	750
Piraeus – Alexandria	520
Piraeus – Syracuse *via* Cape Malea	500
Piraeus – Syracuse *via* Corfu	780

Greek ships may have been travelling to the north Adriatic in convoys, as was the case in the Black Sea (Herodotus vii. 147; Theophrastus, *FGH* 115 F 292 and 230; Philochorus, *FGH* 328 F 162). Sailing in a group is much safer, as ships can help each other if in trouble. Athenian trade with the Adriatic in the late 5th century BC is demonstrated by Lysias (xxxii, 25), perhaps we can see an underlying view that it was risky due to maritime hazards, but potentially lucrative (Raviola 1999, 50). We may conclude that the Greeks were primarily interested in reaching the ports of Adria and Spina.

Sailing season in antiquity

Long-distance sailing in antiquity was generally done during the warmer part of the year, especially when trade ships were in question (Morton 2001, 255, 261; Medas 2004, 34-40). Ancient literary sources mention that the best season was from the end of June to the end of September (Hesiod, *Op.*, 663-684), optimally from May 27th to September 14th, with two interim periods from March 10th to May 27th and from September 14th to November 10th (Vegetius, *The Art of War*, iv, 39).

In the Adriatic, the summer weather is marked by steady and moderate northwesterly winds, favourable currents, clear sky and dry air. In winter, the north Adriatic is often foggy, while the east coast has regular *bura* wind which at times, and without notice, can reach hurricane force (up to 200km/h). *Bura* rarely reaches the opposite Italian coast at such a strength. Days are short, the sky is often cloudy, visibility is low, and there are sudden changes of strong winds. During winter and much of spring and autumn, the west coast (especially, the low-lying marshy lagoons) is often covered by fog and mist. Frequent rain and high oscillation of tides, especially in north Adriatic (up to 1.8m at Venice), as well as the springtime river floods in the *Alto Adriatico,* further complicate navigation (anon. 1999, B-26; Thompson and Thompson 2000).

In winter, sailing may have been done only during daylight (no more than eight hours a day), ideally making 40NM

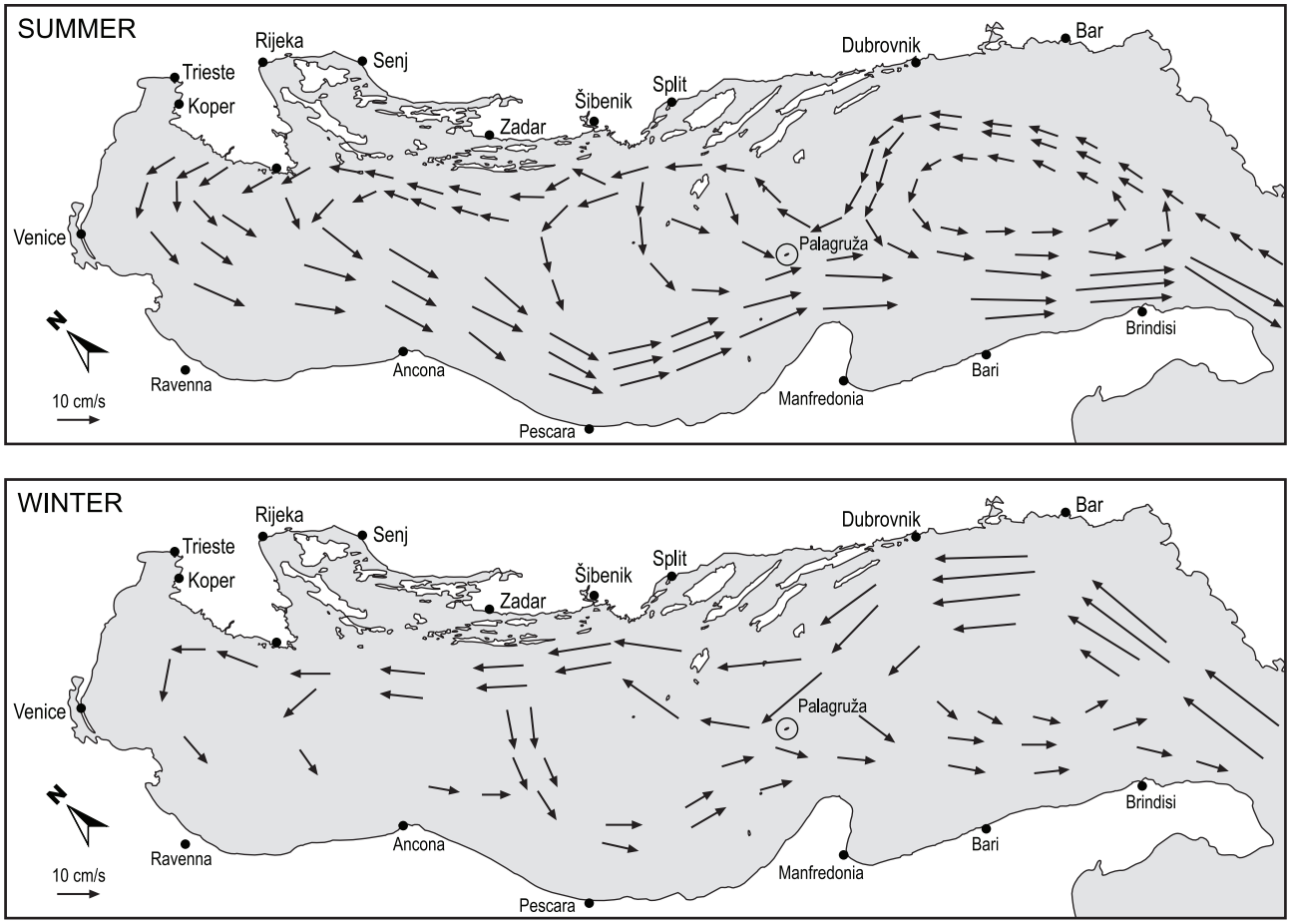

Figure 5. Surface currents in the Adriatic, summer (above) and winter (below) (after anon. 1999, B11).

under favourable winds. It seems, therefore, that long distance navigation would have been impracticable from November to May, especially with a comparatively valuable cargo, since risks would have been too high.

Sailing the Adriatic

A recent pilot book (anon. 1953) recommends that vessels navigating from Otranto towards the north-west should follow the Italian coast at the distance of 10-20NM to have favourable winds from E-ESE and SW. Following this advice one will encounter Palagruža. The intention is to avoid the current that flows towards Otranto along the west coast, and to make use of the slow current that goes up the Adriatic, with its main flow far from the coast in the south Adriatic, heading towards the Palagruža sill (Figure 5). This observation can be matched with verses 481-486 of Dionysius Periegetes (end of 2nd century AD): '*And when your boat enters the Adriatic being in her left course, you will see immediately the island of mighty Diomedes near the land of the Japyges.*..' The ingoing current is strongest in winter and almost non-existent in summer, while the outgoing current along the Italian coast is stronger in summer (anon. 1956, 537). The main ingoing flow changes direction west of the Istrian Peninsula and joins the main outgoing flow in the vicinity of Pesaro and Ancona. Aside from the main counterclockwise currents, in the central Adriatic there are significant deviation flows between the two coasts, in summer especially towards Gargano, but without any regularity (Figure 5).

As Pomey (1997) has noted, the principle of moving against the wind was explained by Aristotle, (*Mech.* 851 b) in the 4th century BC. Pliny (*Nat. Hist*., ii, 128) comments that

> *'...omnes venti vicibus suis spirant, maiore ex parte autem ut contraries desinenti incipiat, cum proximi cadentibus surgunt, a laevo latere in dextrum ut sol ambient. De ratione eorum menstrual quarta maxime luna decernit. Isdem autem ventis in contrarium navigator prolatis pedibus, ut noctu plerumque adversa vela concurrant' (ed. C. Mayhoff)*

('...almost all winds blow in their turn, so that when one ceases its opposite springs up. When winds which are continuous succeed each other, they go from left to right, in the direction of the sun. The fourth day of the moon generally determines their direction for the whole of the monthly period. We are able to sail in opposite directions by means of the same wind, if we have the sails properly set;

hence it frequently happens that, in the night, vessels going in different directions run against each other')

Pomey states that the practice of tacking was more in use near the coast, especially when passing some promontory, going into calm waters, or leaving port. While that may be true, tacking was also possible on open sea, where winds are more stable than near the coast, promontories, or among islands (Marki 1950, 14; Morton 2001, 128). '*By tacking... ships could make continuous progress against the wind'* (Casson 1951, 137f), '*...even if at a prohibitively slow rate for the completion of long-distance voyages in a reasonable time*' (Morton 2001, 270-271).

So, if Greek merchant ships sailed during summer from Kerkyra to the north Adriatic in order to fetch grain, it would have suited them best if the *scirocco* were blowing. That wind rarely occurs in summer, however, when the *maeštral* (mistral) and etesian winds are dominant, which would have forced the mariners to tack in order to reach the north Adriatic.

Weather conditions in the Adriatic

It is generally accepted that the physical environment, weather conditions and climate has not changed much since antiquity in the Mediterranean (Morton 2001, 5-8, with bibliography). This encourages us to produce a May-October weather chart for the North, Central and South Adriatic based on observations made by meteorological stations (Figure 6).[8]

When the winter air pressure distribution is established over Eurasia and the Mediterranean, winter begins in the Adriatic. Low pressure prevails over the Mediterranean, one of its centres being around Palagruža (the Palagruža minimum), while high pressure prevails over the mainland (the Alps and Siberia). With this pattern established, cyclonic activities commence that involve interchanges between *bura* (a cold, dry and gusty wind) and *jugo* (a warm, wet and uniform wind) (Makjanić 1978).

The prevailing summer weather, from about the beginning of May until the end of September (Vučetić and Vučetić 2002), gradually returns with the change in the air pressure pattern. The Azores anticyclone spreads over the Mediterranean, in some years influencing areas far inland. High pressure prevails over the sea, which is relatively cool near land, and low pressure prevails in the Balkans. Pressure tends to diminish eastward from the centre of the Azores anticyclone, towards the low pressure zone above Arabia, Persia and Afghanistan (the Karachi depression). This pressure distribution causes typical etesian weather of the Mediterranean and the Adriatic; the latter is incorporated in a sub-tropical area of high pressure, with sunny, hot and dry summers (Vučetić 2004a, 2004b). On the seasonal wind rose (Figure 6: Palagruža), north-west is the dominant component, with north some way behind; wind force can reach 10 Beaufort (Bf). Such strength is more often reached by the less frequent southerlies and south-easterlies. The strongest wind recorded on Palagruža between 1949 and 2006 (11 Bf) came from the SW, an extremely rare direction.

Summer cyclones that bring rain and natural disasters pass to the north of the Adriatic. Before summer is fully established (from May until the first half of June), and when it is breaking (during the second half of August and early September), weaker cyclones and associated frontal systems (especially, cold fronts) can occur in the Adriatic. They bring fast-moving, brief, but violent storms, locally called *nevera*. Sometimes in these situations local tornados can occur (water spout or *tromba marina*). The north Adriatic sees more frequent and stronger summer *neveras* than the south Adriatic. In some years, frequent weak cyclones bring relatively cool conditions and rain to the north Adriatic. These weather disturbances mainly decay near Cape Ploča (the ancient *promunturium Diomedis*), situated in the central part of east Adriatic near Rogoznica. In central and south Adriatic they cause a lowering of air humidity and the appearance of *bura*, or a relatively strong NW wind known as *maeštral*.

Monthly (May to October) wind roses for Pula, Palagruža and Otranto (Figure 6) clearly show differences in wind directions among the three areas of the Adriatic.

When to sail?

The most favourable months for sailing the Adriatic Sea from Otranto to Spina (SE-NW) are May and June. In both months, but especially in May, there are fewer NW winds (etesians) than in July and August. There are also fewer ESE–SSE winds (*jugo*), especially in June, than in September and October. In the north Adriatic, the NNE-ENE winds (*bura*) are not so frequent in late spring as in early autumn. The most favourable time to sail up the Adriatic is from the second half of May to the first half of June. For this analysis, we assume that a favourable wind for sailing is from 2 Bf (1.6-3.3 m/s) to 4 Bf (5.5-7.9 m/s), or exceptionally 5 Bf in the case of gradually increasing wind towards the end of the day, enabling safe entry into harbour. During May and June Palagruža has, on average, two consecutive days of *jugo* with a mean strength of 3 Bf (mainly 2-4 Bf, exceptionally 5 Bf); the maximum recorded is five such days. Data from meteorological stations closer to the east Adriatic coast (Lastovo, Hvar and Pula) provide an average of three such days with a maximum of 6 to 8 days. This coincides with the situation already observed by Makjanić (1978) in the central Adriatic, where the maximum likelihood of *scirocco* stronger than 4 Bf is near the coast, between Split and the mouth of Neretva River.

[8] As there are no meteorological measurements from the Otranto area, the wind regime assessment in the mid-Otranto for point j = 40.2° and l = 19.0° was determined by re-analysis of the period 1996-2001, using the numerical ALADIN/HR model for a limited area. We are grateful for this data to Stjepan Ivatek-Šahdan.

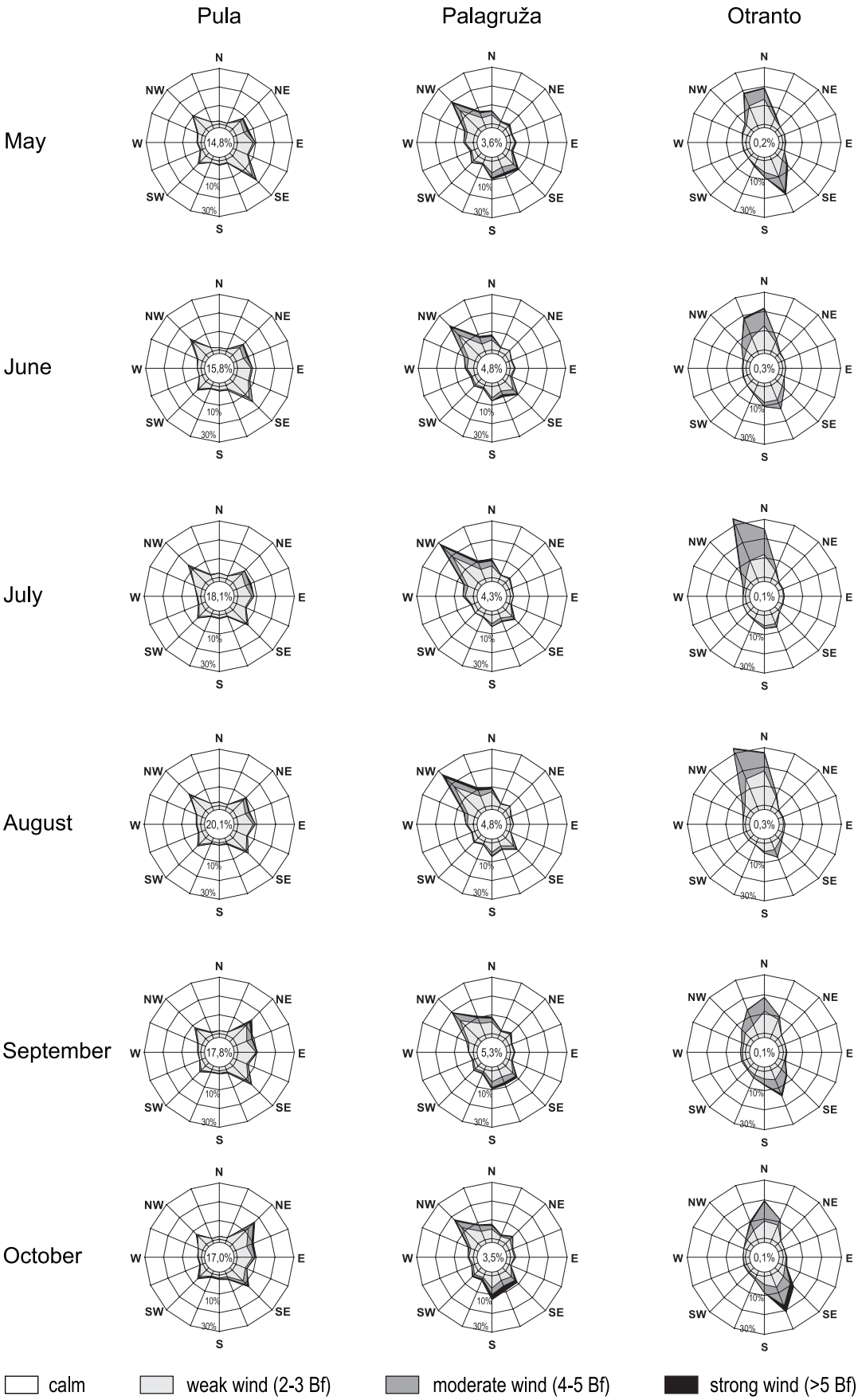

Figure 6. May to October wind roses for Pula, Palagruža and Otranto.

Figure 7. Sailing routes in the Adriatic (source: Electronic Chart Display and Information System, modified by Lušić).

Table 3. Duration of journeys from Kerkyra to Spina and back.

From Kerkyra to Spina:				
Route	Distance (NM)	Sailing duration* (days)	Average speed** (knots)	Notes
# 1	480	12.5	1.6	two breaks (Gargano and Ancona)
# 2	480	7.4	2.7	one break (Vis or Lastovo)
# 2a	490	7.6	2.7	non-stop
# 2b	540	10.7	2.1	two breaks (Gargano and Ancona)
From Spina to Kerkyra:				
Route	Distance (NM)	Sailing duration* (days)	Average speed** (knots)	Notes
# 3	470	5.9	3.3	4.9 days with 4 knots

*Time spent in ports not included in sailing duration
**Speed estimated as per average currents and prevailing favourable winds

For navigation in the opposite direction, from Spina to Otranto, the most favourable winds are in July and August (Figure 6), but strong and frequent northwesterlies can cause trouble in July. August is more favourable, especially since the winds from ESE-SSE are much less frequent, and there are no gales or strong winds. Navigation in October is not recommended because of strong and severe *jugo* and, in north Adriatic, similarly severe *bura* or *tramuntana* (Figure 6).

Having in mind the seaworthiness of ancient trading ships (Morton 2001, 271-275), the weather data strongly suggest that long-distance sailing on open sea was not possible in the Adriatic during the colder part of the year (Morton 2001, 121, 258-261) (Appendix 2).

Which route to take?

Did the Greek merchant ships reach Adria and Spina by sailing along the east or the west coast of the Adriatic? If they have been following one of the coasts during Archaic and Classical periods (before colonisation of central Dalmatian islands), why would they have made a significant detour to Palagruža? We might think that Palagruža was on the way from Kerkyra to Spina or Adria, or vice versa, but as the presented weather patterns and navigation skills suggest, that was not always the case. Records of two medieval voyages illustrate the unpredictability of sailing the Adriatic (Appendix 2).

Palagruža is almost exactly half way along the *c.* 480NM long open sea route from Corfu to Adria or Spina (Figures 5 and 7). It would have taken four to five days of constant sailing to reach Palagruža from Corfu (275NM) under favourable conditions, propelled by the south wind (*jugo*), or much longer if tacking against westerly winds was necessary, or if ships were becalmed. The *jugo*, however, is common in winter, and especially in April, when it may blow incessantly for 20 days, know as '*pasijunsko jugo*' (thus the local fishermen's proverb, '*Aprile dolce dormire*', meaning that it is better to sleep in April then to go to the sea). During summer, *jugo* blows only for a day or two at a time.

Figure 7 and Table 3 display possible sailing routes from Kerkyra to Spina and back. If the Athenians, or whoever carried cargo from Athens, wanted to reach Adria, Spina, Numana or Ancona, they would have used the open sea route, which is much easier to navigate than the coastal routes, and is shorter by more than 100NM than the east Adriatic route. Navigation in the Adriatic presumed knowledge of weather conditions and distances that had to be obtained from the locals, or use of some kind of 'pilot'. The east coast is dangerous due to its many islands and rocks (Duplančić Leder *et al.* 2004), sudden changes of winds (anon. 1999), not to mention pirates and local navies.[9]

For those sailing north, the west coast has a relatively strong current (1-1.5 knots) going in the opposite direction. It also has very few safe anchorages (D'Ercole 2002), coastal waters are shallow, and many inflowing rivers confound the sea currents, making coastal navigation difficult (anon. 1999, B-I; Thompson and Thompson 2000, 2-7, 354-355).

If the Greeks were carrying grain from Adria or Spina to Corfu (and then further on), there was no need for them to sail along the coasts. The distance from Spina to Palagruža is *c.* 220NM. With the current that goes down the west coast at an average speed of 1-1.5 knots, and with a following *maeštral* (the prevailing NW daytime wind in summer, blowing approximately from 10 AM to 5 PM) and the etesian at night, the ship could sail at 5 knots, ideally making some 120NM in 24 hours. Palagruža could have been reached in 44 hours, or in two days. If the captain left Spina very early in the morning, after two days of sailing he would have arrived at Palagruža during the night. That, however, is not an ideal time to anchor at Palagruža, since landing is possible only in daytime.

Conclusion

This is merely a prologue to the creation of a reasonably reliable picture of navigation in the 1st millenium BC Adriatic[10]. It would be important to learn more about traditional navigation of sailors and fishermen from the Italian coast, as well as from both sides of the Otranto Straits, the crucial and difficult part of the Adriatic. Our basic argument is that, in ancient times, long-distance voyages were very difficult and dangerous in the Adriatic between November and May. Data that we offer in Appendices 1 and 2 make this explicit. We also hope that we have provided convincing arguments in support of night sailing and tacking when sailing against the wind.

Due to the currents, the winds, and the available methods of daytime and nighttime orientation, the optimal NW course of an ancient ship would have been an open sea route in the south Adriatic, close enough to the east coast to be within sight of the high coastal mountains of Montenegro and Dalmatia. In the area of Palagruža, one would have turned westward to Gargano, from where one would have followed the west coast northward.

For the SE course, the optimal route follows the west coast at an appropriate distance, crossing to the east coast in the Otranto area. The critical point on this route is around Palagruža, which thus becomes a very important landmark on both routes, and also marks the most dangerous part of the voyage. That was the main reason why Greek seamen

[9] Livy (x, 2,4) describes the late 4th century BC open sea voyage of Cleonymus of Sparta from Otranto to Padua (northwest of Venice) stressing that the left side of the Adriatic coast is without ports, and that on the right side are the Illyrians, Liburnians and Histrians, savage peoples ill-famed for piracy.

[10] Only two generations ago we could have observed how wooden trading ships under sail (from 20 to 100 tons) fared in the Adriatic. That is no longer possible, and the experience of seamen from those times has largely been lost.

gave such a important role to the island and named it the Island(s) of Diomedes.

The question remains how did Attic pottery reach the numerous sites along the Italian coast where it can be found. A conjectural answer is that several distribution centres (*emporia*) existed at places like Otranto, Brindisi, Ancona and Spina. From there, local cabotage traders would have travelled to sell or exchange pottery for other goods.

Appendix 1. Traditional weather lore of fishermen from Komiža (the island of Vis)

At least from the 16th century AD onwards, fishermen from Komiža on the island of Vis were harvesting the rich fisheries around Palagruža with more than 70 boats, each with five crew members. To reach Palagruža they had to sail or to row continuously for up to 13 hours. In summer they fished for sardines, for 20 days each month on moonless nights, while in winter they fished for lobsters. These fishermen have accumulated a fascinating knowledge of open sea navigation in the Adriatic that was carried out without any navigation instruments.

Thanks to the work of Joško Božanić (1996) we have at our disposal an extraordinary body of knowledge related to seafaring, fishing, and predicting weather conditions around Vis and Palagruža, i. e., in central Adriatic. That knowledge has been recorded in a local dialect known as Čakavian, a mixture of pre-Slavic (Latin) and Slavic (Croatian) languages that is still spoken on the east Adriatic coast, and especially on the islands (Moguš 1977, 77; Magner and Jutronić 2006, XVII-XVIII).

One of the last traditional fishermen from Komiža was the late Ivan Vitaljić Gusla. This appendix contains translations of some of his observations that Božanić has recorded in the local dialect of Komiža.

> *'The experience of weather forecasting here on our islands is as old as the sail, the oar and the boat. Ever since man began to fight the sea, from the moment he put his boat afloat, he had to find the answer in the sky; will his boat be broken by the sea, or will he be able to navigate?' (Božanić 1996, 21).*

Gusla would say that one had to be on the open sea in order to make a reliable forecast, and to watch where the stars were positioned. If a star was at the tail of the young crescent moon, the weather would change. If meteors (which he also called stars) were flying from *tramuntana* (N-NW) towards *oštar* (S), winds would blow from N to W. If meteors were flying from *levanat* (E) towards *pulenat* (W), strong *jugo* or *gregolevanat* would blow. At night, when the moon is up, wind will blow from the side where the moon is open. A *kolobor* (a ring around the moon), *oci di kapra* (a dull circle around the moon) and *suncenjok* (a pale reddish circle on cloudy sky) foreboded bad weather (Božanić 1996, 23-24). If *suncenjok* was to a side of the sun, the wind would blow from that direction. If it was to the side of *tramuntana,* strong *bura* would blow soon. If it was on the side of *oštar* (S) in the morning, strong *jugo* would start blowing (Božanić 1996, 79).

Every experienced fisherman should know how to distinguish 16 winds (Božanić 1996, 9)! The English pilot book of the Adriatic knows of six (Thompson and Thompson 2000, 3-5), while the Croatian one distinguishes nine (anon. 1999, B19-B24). One also had to know the currents, and what the seagulls were talking about. '*I could be at sea in winter, in absolute calm, but could not take my nets out due to currents that were strong like rivers*'. The currents are at their strongest at full moon and at new moon (Božanić, 1996, 24, 49, 52).

> *'For fishermen, the moon provides best signs for weather forecasting. There are four points of the moon, one every week, and at each point one can expect weather to change'* (Božanić 1996, 58-59, 69-70).

> *'If it was windy while the moon was up, the wind will blow stronger when the moon disappears'* (Božanić 1996, 9).

The proverb '*Rosso di sera, bel tempo si spera*' (Red sunset, good weather is expected) is well known. '*Rosso di matina, tempora cattiva*' signifies that bad weather will come if the sky was red before sunrise on the eastern horizon.

> *'If clouds are covering the hills from Makarska to Zadar,* jugo *will blow, but if long clouds (called* lignje*, i.e. calamari) appear above those hills or above the western Adriatic,* bura *will blow'* (Božanić 1996, 9).

> *'If clouds 2-3 fingers thick (a fog bank) sit on the horizon from* oštar *(S) to* pulenat *(W) – which is called* kaloda *– the weather will not change within next 24 hours (good weather will continue). If* kaloda *rises, and clouds begin moving from W to E,* jugo *will soon blow'* (Božanić 1996, 49-50).

> *'If rainbow appears at dusk on the side of* pulenat *(W), good weather is expected, but if in the morning one sees a rainbow to the east* (levanat)*, bad weather is coming'* (Božanić 1996, 9)

When in summer one sees Mount Maiella, it is 90% certain that the south wind will blow. When one sees lightning above Maiella in winter (starting from October), *bura* or *gregolevante* will blow within 24 hours (Božanić 1996, 56-57).

According to a proverb, it is more likely that three experienced persons will make the same mistake than that

the three *buras* of March will fail to blow. According to another proverb, March sank eight brothers and made the ninth one smart; he never navigated until the month was over (Božanić 1996, 18).

Yet another proverb, '*Quatro aprilanti, quaranta duranti*' means that whatever the weather is like on April 4th, it will remain the same for the next 40 days. April is the month of *jugo*, sometimes blowing ceaselessly for twenty days, known as *reposol* or *pasijunsko jugo* (Božanić 1996, 20-22).

In May, '*...if the weather does not reflect the season (is not stable), May harvests the sea and the land*', meaning that strong and persistent *jugo* called '*mažor*' is doing much damage, since May is known for the richest sardine catches (Božanić 1996, 23-25, 57-58)

June, July and August usually are stable, but not always; if thick white clouds are not moving towards the south, the weather will not be stable. *Maeštral* is the most favourable summer wind, but there is a proverb that says '*Maestro d'inverno – diavolo d'inferno*'.

High tides start in October and culminate in January, indicating bad and unpredictable weather. '*It has always been said that weather is like it is; it is not a question of seasons*' (Božanić 1996, 29-30).

When fog descended on a calm sea and visibility was bad, fishermen from Komiža would throw fish into the sea, inviting seagulls to come and take them, and fly away towards land. But if *bura* was about to start blowing, seagulls would not leave the land. They would fly close together some 200m high above the islands, and would cry. That was a sign that strong wind would start blowing within the next ten hours (Božanić 1996, 21). Fishermen from the town of Hvar noted that if a seagull stands still on rocks with its beak pointing in a certain direction, wind should be expected from that quarter (Vučetić and Vučetić 2002, 31).

Fishermen used the 'sky clock' for keeping time during the night. They knew when specific constellations would emerge above the eastern horizon. First, Peter's Great Cross would appear, then Peter's Small Cross, followed by the Pleiades (*Vlašići*), Orion (*Šćopi*), the Gemini (*Gvardiule*), the *Rošćapnica* (we have not yet identified its astronomical name), and finally, just before dawn, *Pizdukalo* (the morning star). The main star for orientation was *Tramuntona,* i.e. the North Star (Božanić 1983, 99).

Appendix 2. Two medieval documents regarding Adriatic navigation

The following two well-documented medieval voyages illustrate the unpredictability of sailing the Adriatic.

From the late 14th century AD we have the evidence from the diary of Ogiera, a French feudal lord, who travelled as a pilgrim from Venice to Jerusalem and back. He left Venice on August 30th and arrived to Pula on the 31st. He left Pula on September 1st and arrived to Corfu five days later, on September 6th. We do not know when he entered the Adriatic on his way back, but we know that he landed on the island that he calls La Monte (Koločep near Dubrovnik?). He continued from there towards Venezia on May 9th, '*… and being always on the sea and never landing at any place*' he arrived on May 23rd, two weeks later (Kozličić 1997, 259-260)!

In the year AD 1177, Pope Alexander III waited from February 9th to March 9th in Vieste on Gargano Peninsula for a favourable wind to set sail for Venice via Palagruža and Zadar. His ships finally left Vieste at night, but the scirocco stopped and *bura* started to blow around noon, when the 13 galleys and 5000 people were near Palagruža, It was impossible to sail, so they started rowing. Three of the galleys eventually returned to Vieste, while the rest proceeded with great hazard, struggling with the wind, waves and currents, and anchored in late afternoon (or at night) on the south side of Palagruža. The Pope, exhausted by fasting and the rough sea voyage, had a very big meal *(copiose hilariterque cenavit)*, although it was the first day of Lent. Scirocco started blowing again sometime around midnight, allowing them to leave Palagruža. The next day around noon they arrived at the island of Vis and from there proceeded to Zadar. The Pope spent four days at Zadar and around three days in Istria, and continued to Venice, where he arrived on March 24th (Oreb 1993-1994). It took him 14 days to reach Venice from Vieste, seven of which he spent at sea.

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