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CHANGES IN THE LEVEL OF MAGNETIC DECLINATION IN THE ADRIATIC FROM 1806 TO 1995 – A CONTRIBUTION TO THE HISTORY OF ADRIATIC SEAFARING

PROMJENE RAZINE MAGNETSKE DEKLINACIJE NA JADRANU 1806 - 1995. GODINE - PRILOG POVIJESTI JADRANSKOG POMORSTVA

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ABSTRACT

The paper analyzes changes in magnetic declination in the Adriatic Sea from the first measurements in 1806 to the latest isogonic charts from 1995. The basis of analysis are data provided by the Adriatic pilot books as literature that mariners used as an indispensable instrument in sailing that has not been properly evaluated in the scientific research so far. It is emphasized the the magnetic declination was relevant primarily to overseas ferries, and was less important in coastal navigation, usually along the archipelagos of the eastern Adriatic maritime zone as terrestrial navigation was used in sailing in this belt with over a thousand islands and islets.

Keywords: Adriatic, magnetic declination, changes, 1806-1995, Adriatic pilot books, coastal navigation, overseas ferries, magnetic compass compensation, maritime history.

SAŽETAK

U radu se analiziraju promjene magnetske deklinacije na Jadranskom moru od prve izmjere 1806. do najnovijih karata izogona iz 1995. godine. Temelj analize su podatci koje donose peljari Jadrana, kao literatura koja je pomorcima bila nezamjenjivo pomagalo u plovidbi, a u dosadašnjim znanstvenim istraživanjima nije dovoljno korištena. Ističe se da se magnetska deklinacija prvenstveno odnosila na prekomorske trajekte, a za obalnu plovidbu, najčešće uz otočne nizove akvatorija istočnog Jadrana nije bila od prevelike važnosti jer se tim pojasom, s preko tisuću otoka i otočića, redovito plovilo uz pomoć terestričke nacigacije.

Ključne riječi: Jadran, magnetska deklinacija, promjene, 1806.-1995., peljari Jadrana, obalna plovidba, prekomorski trajekti, kompenzacija magnetskog kompasa, povijest pomorstva.

1 INTRODUCTION

Changes in increase or decrease of the magnetic field influence (magnetic declination) of the Earth have been its millennial constant trait. If the magnetic declination reaches high values, and the mariner is not aware of this, or he is aware but he did not perform quality compensation of magnetic compass on his ship, the sailing can become far more complex, particularly on overseas ferries, when one can rely only on compass in cloudy weather, even to the point that destination port cannot be reached during daylight hours. Voyages of these overseas ferries are possible within a day sail in the Adriatic from late spring to early autumn, when daylight exceeds 12 hours, if a storm is not underway (Kozličić, 2000a). In sailing along the eastern Adriatic coast (coastal navigation), which was a common millennial sailing route for ships going in and out of the Adriatic (Kojić, 1967; Kozličić, 2012; Kozličić and Rotunno, 2017), compass is not of crucial importance. To reach the destination, it is sufficient to use terrestrial navigation and have good knowledge of island groups of this maritime zone and general geographic knowledge about the coast of the mainland and islands, and to follow the coastline of the islands and mainland at the distance of not over five nautical miles (about 9,3 km), i.e. in the normal visibility area (Kozličić and Uglešić, 2015). In other words knowledge of magnetic declination in the Adriatic is particularly important primarily on the overseas ferries: Poreč or Rovinj - Venezia, Pula - Ancona, Veli rat on the island of Dugi otok - Ancona or Ravenna, Split region - Gargano, Dubrovnik - Bari or north Corfu - Otranto, including possibility of sailing in the opposite direction.[1] General knowledge about oscillations of the magnetic field elements "have not been measured systematically in the area of the Adriatic Sea" is the first constatation stressed by Gržetić (1999: 25) in the latest edition of the *Eastern Adriatic Pilot Book*. However after taking a closer look at the earlier pilot books, that have been mariners' principal support in sailing for centuries, alongside instruments used for determining position, we get a completely different picture. It is exactly what this paper deals with.

2 OVERVIEW OF INFORMATION ON MAGNETIC DECLINATION IN THE ADRIATIC PILOT BOOKS, AS THE BASIC HISTORICAL SOURCE ON THIS COMPONENT OF EARTH'S MAGNETISM

According to the latest research magnetic declination as a phenomenon has been known from the 8th century AD and it changes with location on Earth and over time (Dadić, 1982: 200). Already Christopher Columbus on his voyage to America in 1492 noticed such deviations of the magnetic compass (Prodanović, 2003: 187-188). Later authors explored this phenomenon (Brkić, Bašić and Vrbanac, 2003; M. Solarić and N. Solarić, 2008), but not in the Adriatic where rulers often changed (Venetian Republic, Austrian Empire, Ottoman Empire), so that nautical charts and pilot books contained no such information until the beginning of the 19th century (Kozličić, 2013; Kozličić, Mlinarić and Andrić, 2015; Kozličić and Uglešić, 2015;

[1] On many aspects of these sailings in the Adriatic in the last three millennia more in: Kozličić (1990, 2000a, 2000b, 2006); Kozličić and Bratanić (2006), Kozličić and Duplančić Leder (2003), Kozličić and Faričić (2004), Kozličić, Mlinarić and Andrić (2015), Kozličić and Rotunno (2017), Kozličić and Uglešić (2015).

Muljačić, 1971). Spreading of the French power in the northern Adriatic and in the nearby peri-Adriatic areas, and in continuation to the periphery of the south-eastern part of this sea, will initiate many geographical and other research with an aim of valorization of newly conquered areas with institutional improvement (forming of the first cartographic institutions which will eventually grow into the Military Geographical Institute in Milan), within Napoleon's imperial policy in south-eastern Europe. Furthermore Napoleon hired the most respected hydrographer at the time, *father of the world hydrography*, Charles François Beautemps-Beaupré, who in his campaigns 1806 and 1808-1809 made the first geomagnetic measurements of the value of magnetic declination as well as the measurements of parts of the eastern Adriatic coast (Kozličić, 2006; Kozličić and Duplančić, 2003). In that regard the Adriatic was deemed as the most quality sailing transport corridor connecting Europe with Asia and Africa, as it had been for centuries (Kojić, 1967; Kozličić, 1990; Idem, 2000a; Idem, 2000b; Idem, 2006; Kozličić and Bratanić, 2006; Kozličić and Faričić 2004).

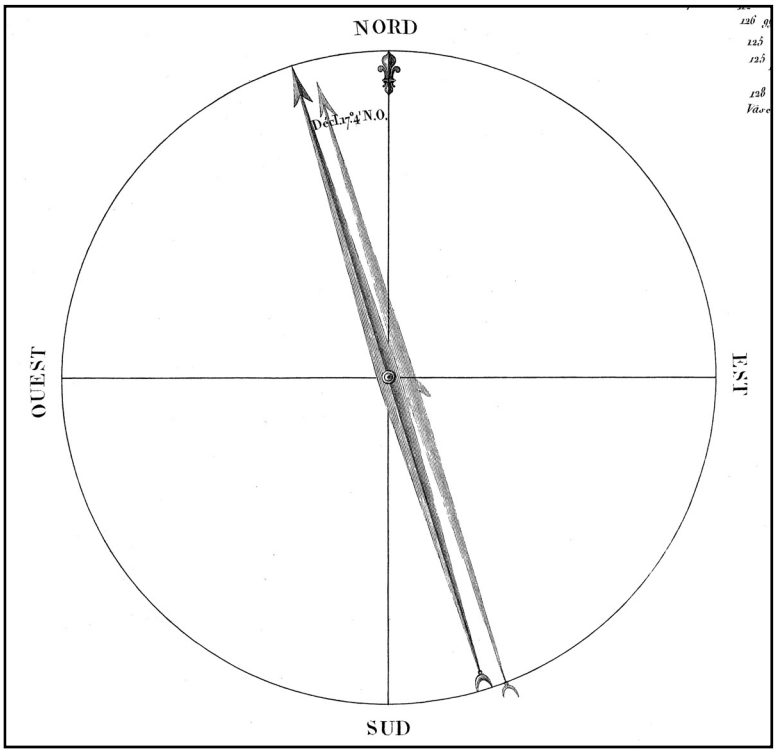
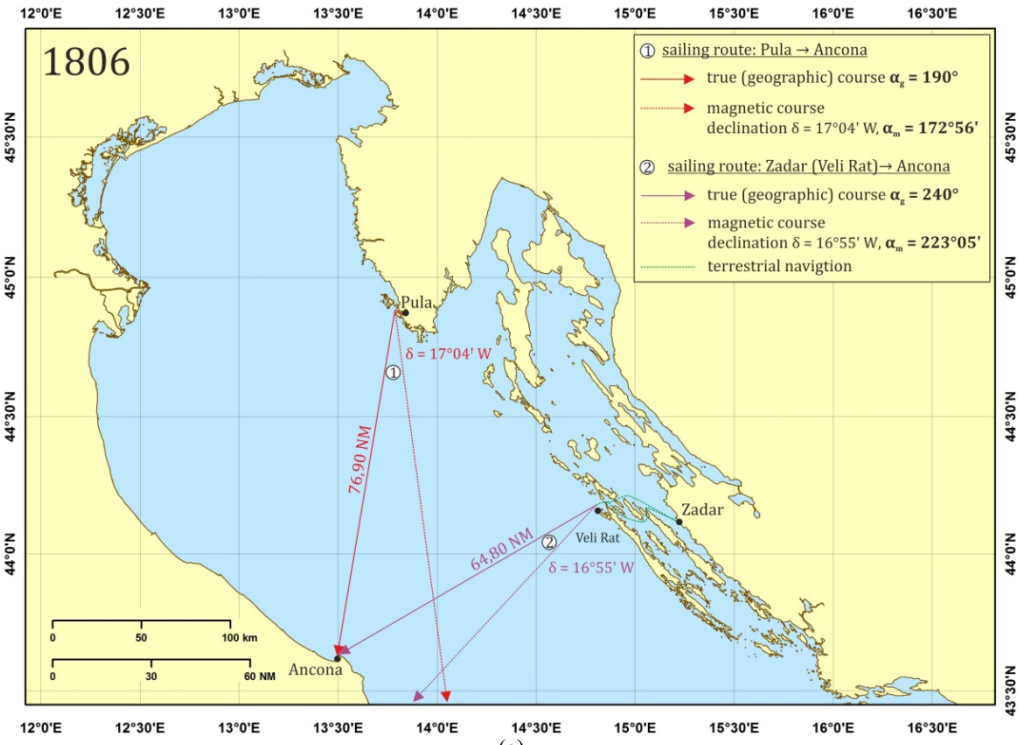
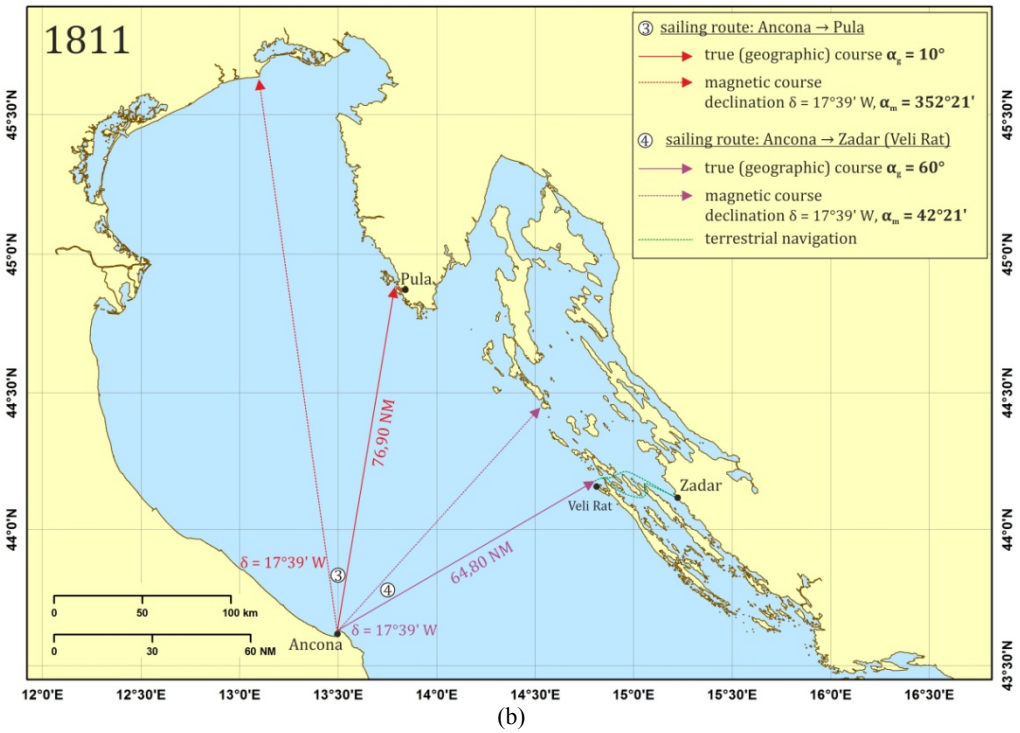


Figure 1. Value of magnetic declination near Pula on Beautemps-Beaupré's map published in 1821 (Kozličić, 2006)



(a)



(b)

Figure 2 (a) and (b). If a mariner did not know the value of magnetic declination while sailing on both overseas ferries he would not end up in his port of destination but far away from it

Beautemps-Beaupré's measurements determined relatively high values of this component of Earth's magnetism. This hydrographer stated, on the basis of his research, that one should sail in the Adriatic with compasses with corrected declination of the magnetic needle (Beautemps-Beaupré, 1849a: 35; Idem, 1849b: 6). Accordingly, the author emphasizes, we are always aligned with the right meridian when we denote the heading of the ship, coast spreading direction, direction of the wind etc. To show that in practice, Beautemps-Beaupré presented values of magnetic declination for all more important ports, in the description of the 1806 campaign (Beautemps-Beaupré, 1849a: 38, 41-43, 50, 55, 70-71; Idem, 1849b: 9, 12-14, 21, 26, 37, 41-42). Text of the "Report" referring to the campaign from 1808-1809 provides no such data, but they are represented in his charts for both campaigns (Figure 1) (Kozličić, 2006).

In order to demonstrate practically what it meant to the mariners, a simulation was made on modern maps of Mercator projection for the overseas ferries Pula – Ancona and Veli rat on the island of Dugi otok – Ancona (Figure 2a) and vice versa (Figure 2b), [2] with an assumption that a mariner knew nothing of such influence on his magnetic compass.

New scientific research was undertaken when the Military Geographical Institute started operating in Milan in 1815 (in the meantime French administration was replaced by the Austrian in northern Italy, but also on the entire eastern Adriatic coast, approximately to Bar, the rest was governed by the Ottoman Empire) (Faričić and Mirošević, 2017). This will result in making and publishing the work *Carta di cabottaggio del mare Adriatico* (Carta, 1822-1824; Faričić and Mirošević, 2017; Kozličić, 2013) between 1822 and 1824, on 22 pages in folio format, in 1 : 175.000 scale, bringing forth not only exceptionally valuable nautical charts but also, for the first time, values of magnetic declination (Figure 3).

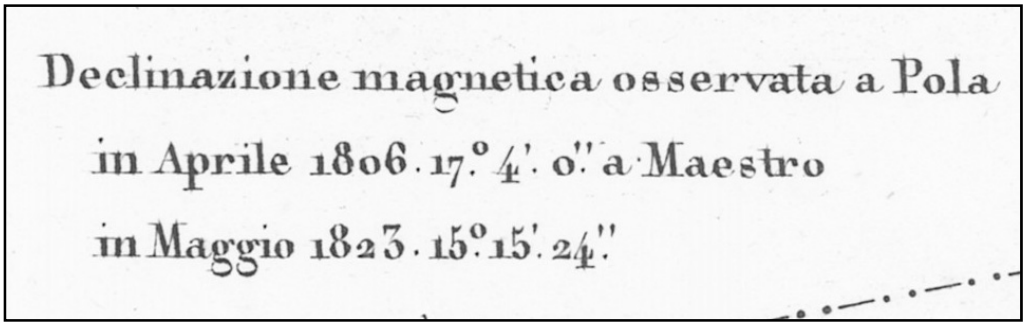


Figure 3. Magnetic declination near Pula (Carta, 1822-1824: segment from Foglio III.)

The first quality pilot book of the Adriatic was published in 1830 in which values of magnetic declination for the most important navigation points of the Adriatic were listed in tables for the first time (Marieni, 1830: 579-580) (Table 1), so that the mariners had two most important sources for sailing in the Adriatic: quality maps and sailing manual of equal quality (Kozličić, 2013).

[2] Both maps were made by Tome Marelić, MA, student at the postgraduate doctoral study program "The Adriatic – a link between the continents" of the University of Zadar in accordance with the author's instructions.

Table 1.
West magnetic declination in the Adriatic 1806–1823 according to the data of captain Giacomo Marieni [3]

No.	Place of measurement	Date of measurement	Value	Measurer
		A. Eastern Adriatic		
1.	Trieste	15.09.1812.	17^0 44'	I. Prina
2.	Piran	15.07.1806.	17^0 10'	C.-F. Beautemps-Beaupré
3.	Piran	15.08.1819.	16^0 05'	H. Smyth
4.	Luka Mirna	15.07.1806.	17^0 10'	C.-F. Beautemps-Beaupré
5.	Poreč	15.07.1806.	17^0 10'	C.-F. Beautemps-Beaupré
6.	Poreč	15.08.1819.	16^0 00'	H. Smyth
7.	Pula	15.04.1806.	17^0 04'	C.-F. Beautemps-Beaupré
8.	Pula	15.08.1819.	15^0 00'	H. Smyth
9.	Pula	15.03.1823.	15^0 15'	H. Smyth
10.	Rijeka	15.08.1819.	15^0 20'	H. Smyth
11.	Rab	15.07.1821.	17^0 50'	G. Marieni
12.	Mali Lošinj	15.08.1819.	14^0 13'	H. Smyth
13.	Vir	15.07.1821.	16^0 41'	G. Marieni
14.	Zadar	15.07.1806.	16^0 55'	C.-F. Beautemps-Beaupré
15.	Zadar	15.08.1819.	14^0 13'	H. Smyth
16.	Zadar	15.03.1823.	14^0 43'	H. Smyth
17.	Ist	15.07.1821.	15^0 47'	G. Marieni
18.	Kornat	15.06.1821.	16^0 25'	G. Marieni
19.	Murter	15.07.1818.	15^0 30'	G. Marieni
20.	Zmajan	15.07.1818.	16^0 50'	G. Marieni
21.	Zlarin	15.09.1806.	16^0 16'	C.-F. Beautemps-Beaupré
22.	Zlarin	15.07.1818.	15^0 18'	G. Marieni
23.	Žirje	15.07.1818.	14^0 56'	G. Marieni
24.	Žirje	15.07.1819.	14^0 19'	H. Smyth
25.	Žirje	15.06.1821.	16^0 12'	G. Marieni
26.	Rogoznica	15.09.1806.	16^0 04'	C.-F. Beautemps-Beaupré
27.	Rogoznica	15.07.1819.	14^0 30'	H. Smyth
28.	Šolta	15.07.1818.	16^0 00'	G. Marieni
29.	Split	15.09.1806.	16^0 38'	C.-F. Beautemps-Beaupré
30.	Split	15.07.1818.	16^0 36'	G. Marieni
31.	Split	15.07.1819.	14^0 15'	H. Smyth
32.	Omiš	15.07.1818.	15^0 56'	G. Marieni
33.	Brač	15.07.1818.	16^0 18'	G. Marieni
34.	Hvar	15.07.1819.	14^0 05'	H. Smyth
35.	Vis	15.07.1819.	14^0 00'	H. Smyth
36.	Makarska	15.08.1818.	16^0 42'	G. Marieni
37.	Korčula	15.08.1818.	16^0 07'	G. Marieni
38.	Pelješac	15.08.1818.	16^0 01'	G. Marieni
39.	Pelješac	15.08.1819.	14^0 00'	H. Smyth

[3] Marieni (1830: 579-580) used abbreviations instead of complete names of hydrographers who measured magnetic declination; in this table they are written in full form: B. = Charles François Beautemps-Beaupré, French hydrographer; M. = Giacomo Marieni, Italian mariner; Pö. = Pöltl, commander of the Austrian corvette "Velox"; Pr. = Ignazio Prina, Italian hydrographer; S. = Henry Smyth, British navy captain. A work by Smyth (1854: 362-369) was particularly helpful in that regard.

No.	Place of measurement	Date of measurement	Value	Measurer
40.	Lastovo	15.08.1818.	16^0 15'	G. Marieni
41.	Palagruža	15.09.1819.	15^0 10'	H. Smyth
42.	Mljet	15.07.1819.	15^0 00'	H. Smyth
43.	Dubrovnik	15.09.1809.	15^0 48'	C.-F. Beautemps-Beaupré
44.	Dubrovnik	15.06.1819.	16^0 00'	H. Smyth
45.	Dubrovnik	15.04.1820.	15^0 22'	G. Marieni
46.	Mali Molunat	15.09.1809.	16^0 01'	C.-F. Beautemps-Beaupré
47.	Kotor	15.04.1809.	15^0 33'	C.-F. Beautemps-Beaupré
48.	Kotor	15.06.1818.	14^0 25'	H. Smyth
49.	Kotor	15.09.1821.	16^0 17'	G. Marieni
50.	Durrës	15.09.1818.	15^0 58'	H. Smyth
51.	Vlöre	15.07.1818.	14^0 00'	H. Smyth
52.	Vlöre	15.06.1823.	13^0 56'	H. Smyth
53.	Kerkyra	15.06.1818.	14^0 33'	H. Smyth
54.	Paxi, SE Kerkyra	15.06.1819.	16^0 54'	Pöltl
		B. Western Adriatic		
1.	Malamocco	15.09.1819.	17^0 50'	H. Smyth
2.	Goro	15.09.1819.	18^0 10'	H. Smyth
3.	Primaro	15.03.1810.	17^0 30'	I. Prina
4.	Rimini	15.07.1810.	17^0 10'	I. Prina
5.	Ancona	15.11.1811.	17^0 39'	G. Marieni
6.	Fano	15.12.1811.	17^0 50'	G. Marieni
7.	Porto di Civitanova	15.11.1811.	17^0 21'	G. Marieni
8.	Grottamare	15.10.1811.	17^0 45'	G. Marieni
9.	Tremiti	15.09.1819.	15^0 00'	H. Smyth
10.	Manfredonia	15.09.1819.	14^0 55'	H. Smyth
11.	Brindisi	15.04.1823.	14^0 35'	H. Smyth

Identical information is provided in the new edition of this pilot book some 15 years later (Marieni, 1845: 527-528), as new measurements were not made in the meantime, but only in the middle of the century (Kreil, 1855; Idem, 1862). These data are accompanied by isogonic chart (Figure 4), as well as the list of values of magnetic declination for the most important ports (Kreil, 1855: 43-44, 46; Idem, 1862: 42-43, 47).

Later on, over the course of about hundred years, new measurements were made and registered in new editions of pilot books (Botrić, 1952; Idem, 1953; Handbuch, 1930; Makarović, 1964; Idem, 1973; Idem, 1982; Opis, 1934; Portolano, 1940; Idem, 1949; Segelhanbuch, 1893; Idem, 1906; Idem, 1906: Supplement 3 from 1913). Since quality of production of magnetic compasses has been significantly improved in the meantime, including the compensation of the compass (M. Solarić and N. Solarić, 2009), sailing on the overseas ferries in the Adriatic was much safer. On the basis of all the aforementioned, including the Marieni's data (Marieni, 1830; Idem, 1845), we made a convenient table (Table 2) encompassing all measurements from 1806 to 1950. It is interesting that last individual information were published for 1950, and only the charts of isogonic lines afterwards, which is understandable as the values of magnetic declination have become exceptionally low.

Table 2.
West magnetic declination in the Adriatic from 1806 to 1950 *

E Adriatic

No.	Place of measurement	1806.	1809.	1810.	1811.	1812.	1818.	1819.	1820.	1821.
01.	Trieste	-	-	-	-	17^0 44,0'	-	-	-	-
02.	Piran	17^0 10,0'	-	-	-	-	-	16^0 05,0'	-	17^0 10,0'
03.	Umag	17^0 10,0'	-	-	-	-	-	-	-	17^0 10,0'
04.	Novigrad	17^0 10,0'	-	-	-	-	-	-	-	17^0 10,0'
05.	Poreč	17^0 10,0'	-	-	-	-	-	16^0 00,0'	-	-
06.	Rovinj	-	-	-	-	-	-	-	-	-
07.	Pula	17^0 04,0'	-	-	-	-	-	15^0 00,0'	-	-
08.	Kamenjak	-	-	-	-	-	-	-	-	-
09.	Medulin	-	-	-	-	-	-	-	-	-
10.	Labin (Rabac)	-	-	-	-	-	-	-	-	-
11.	Rijeka	-	-	-	-	-	-	15^0 20,0'	-	-
12.	Sušak									
13.	Malinska	-	-	-	-	-	-	-	-	-
14.	Rab	-	-	-	-	-	-	-	-	17^0 50,0'
15.	Senj	-	-	-	-	-	-	-	-	-
16.	Lošinj	-	-	-	-	-	-	-	-	-
17.	Mali Lošinj	-	-	-	-	-	-	14^0 13,0'	-	-
18.	Veli Lošinj	-	-	-	-	-	-	-	-	-
19.	Orjule, SE Lošinj	-	-	-	-	-	-	-	-	-
20.	Veli rat, NW Dugi otok	-	-	-	-	-	-	-	-	-
21.	Vir	-	-	-	-	-	-	-	-	16^0 41,0'
22.	Zadar	16^0 55,0'	-	-	-	-	-	14^0 13,0'	-	-
23.	Ist	-	-	-	-	-	-	-	-	15^0 47,0'
24.	Kornat	-	-	-	-	-	-	-	-	16^0 25,0'
25.	Murter	-	-	-	-	-	15^0 30,0'	-	-	-
26.	Zmajan	-	-	-	-	-	16^0 50,0'	-	-	-
27.	Zlarin	16^0 16,0'	-	-	-	-	15^0 18,0'	-	-	-
28.	Šibenik	-	-	-	-	-	-	-	-	-
29.	Žirje	-	-	-	-	-	14^0 56,0'	14^0 19,0'	-	16^0 12,0'
30.	Rogoznica	16^0 04,0'	-	-	-	-	-	14^0 30,0'	-	-
31.	Šolta		-	-	-	-	16^0 00,0'		-	-
32.	Split	16^0 38,0'	-	-	-	-	16^0 36,0'	14^0 15,0'	-	-
33.	Omiš	-	-	-	-	-	15^0 56,0'	-	-	-
34.	Brač	-	-	-	-	-	16^0 18,0'	-	-	-
35.	Hvar	-	-	-	-	-	-	14^0 05,0'	-	-
36.	Jabuka	-	-	-	-	-	-	-	-	-
37.	Vis	-	-	-	-	-	-	14^0 00,0'	-	-
38.	Makarska	-	-	-	-	-	16^0 42,0'	-	-	-
39.	Ploče	-	-	-	-	-	-	-	-	-
40.	Opuzen	-	-	-	-	-	-	-	-	-
41.	Korčula	-	-	-	-	-	16^0 07,0'	-	-	-
42.	Trpanj	-	-	-	-	-	-	-	-	-
43.	Pelješac	-	-	-	-	-	16^0 01,0'	14^0 00,0'	-	-

No.	Place of measurement	1823.	1850.	1870.	1890.	1904.	1928.	1940.	1950.
01.	Trieste	-	14^0 28,2'	12^0 18,0'	10^0 27,6'	09^0 12,4'	5^0 50,0'	4^0 08,0'	02^0 21,0'
02.	Piran	-	-	-	10^0 31,2'	09^0 16,0'	5^0 52,0'	4^0 12,0'	02^0 23,0'
03.	Umag	-	-	-	-	-	5^0 50,0'	-	-
04.	Novigrad	-	-	-	-	-	-	-	-
05.	Poreč	-	14^0 38,5'	12^0 20,0'	10^0 31,9'	09^0 16,7'	5^0 53,0'	4^0 09,0'	02^0 24,0'
06.	Rovinj	-	-	-	10^0 26,3'	09^0 11,1'	5^0 47,0'	3^0 58,0'	02^0 27,0'
07.	Pula	15^0 15,0'	14^0 12,4'	12^0 05,0'	10^0 16,6'	09^0 04,0'	5^0 37,0'	3^0 57,0'	02^0 17,0'
08.	Kamenjak	-	-	12^0 03,0'	-	-	-	-	-
09.	Medulin	-	-	-	10^0 16,1'	09^0 02,3'	5^0 37,0'	3^0 52,0'	02^0 17,0'
10.	Labin (Rabac)	-	-	-	10^0 16,4'	09^0 01,2'	5^0 53,0'	3^0 53,0'	02^0 33,0'
11.	Rijeka	-	14^0 17,7'	11^0 49,0'	10^0 07,7'	08^0 52,5'	-	3^0 52,0'	02^0 04,0'
12.	Sušak						5^0 23,0'	-	
13.	Malinska	-	-	-	10^0 09,2'	08^0 54,0'	5^0 32,0'	3^0 45,0'	02^0 02,0'
14.	Rab	-	-	-	-	-	-	-	-
15.	Senj	-	-	11^0 50,0'	-	-	-	-	-
16.	Lošinj	-	-	11^0 52,0'	-	-	-	-	-
17.	Mali Lošinj	-	14^0 05,9'	-	09^0 56,7'	08^0 42,9'	5^0 18,0'	3^0 48,0'	01^0 58,0'
18.	Veli Lošinj	-	-	-	-	-	-	-	01^0 49,0'
19.	Orjule, SE Lošinj	-	-	11^0 44,0'	-	-	-	-	-
20.	Veli rat, NW Dugi otok	-	-	11^0 51,0'	-	-	-	-	-
21.	Vir	-	-	-	-	-	-	-	-
22.	Zadar	14^0 43,0'	13^0 48,9'	11^0 58,0'	10^0 00,8'	08^0 47,0'	5^0 27,0'	3^0 45,0'	02^0 07,0'
23.	Ist	-	-	-	-	-	-	-	-
24.	Kornat	-	-	-	-	-	-	-	-
25.	Murter	-	-	-	-	-	-	-	-
26.	Zmajan	-	-	-	-	-	-	-	-
27.	Zlarin	-	-	-	-	-	-	-	-
28.	Šibenik	-	13^0 37,1'	11^0 31,0'	09^0 47,3'	08^0 34,9'	5^0 10,0'	3^0 27,0'	01^0 43,0'
29.	Žirje	-	-	11^0 26,0'	-	-	-	-	-
30.	Rogoznica	-	-	-	-	-	-	-	-
31.	Šolta	-	-	-	-	-	-	-	-
32.	Split	-	13^0 24,7'	11^0 21,0'	09^0 31,9'	08^0 19,5'	4^0 54,0'	3^0 12,0'	01^0 37,0'
33.	Omiš	-	-	-	-	-	-	-	-
34.	Brač	-	-	-	-	-	-	-	-
35.	Hvar	-	13^0 10,7'	10^0 57,0'	09^0 19,8'	08^0 07,4'	4^0 42,0'	3^0 00,0'	01^0 28,0'
36.	Jabuka	-	-	09^0 37,0'	-	-	-	-	-
37.	Vis	-	13^0 01,2'	10^0 51,0'	09^0 03,1'	07^0 50,7'	4^0 34,0'	3^0 00,0'	01^0 20,0'
38.	Makarska	-	-	-	09^0 16,1'	08^0 03,7'	4^0 39,0'	3^0 02,0'	01^0 22,0'
39.	Ploče	-	-	-	-	-	-	-	01^0 17,0'
40.	Opuzen	-	-	-	09^0 02,8'	07^0 50,4'	4^0 25,0'	2^0 44,0'	01^0 11,0'
41.	Korčula	-	12^0 50,9'	10^0 40,0'	08^0 59,9'	07^0 48,9'	4^0 22,0'	2^0 45,0'	01^0 17,0'
42.	Trpanj	-	-	-	09^0 03,2'	07^0 50,8'	4^0 27,0'	2^0 47,0'	01^0 13,0'
43.	Pelješac	-	-	-	-	-	-	-	-

No.	Place of measurement	1806.	1809.	1810.	1811.	1812.	1818.	1819.	1820.	1821.
44.	Ston Veli	-	-	-	-	-	-	-	-	-
45.	Lastovo	-	-	-	-	-	16^0 15,0'	-	-	-
46.	Palagruža	-	-	-	-	-	-	15^0 10,0'	-	-
47.	Mljet	-	-	-	-	-	-	15^0 00,0'	-	-
48.	Gruž	-	-	-	-	-	-	-	-	-
49.	Dubrovnik	-	15^0 48,0'	-	-	-	-	16^0 00,0'	15^0 22,0'	-
50.	Mali Molunat	-	16^0 01,0'	-	-	-	-	-	-	-
51.	Herceg Novi	-	-	-	-	-	-	-	-	-
52.	Tivat	-	-	-	-	-	-	-	-	-
53.	Meljine, E Herceg Novi	-	-	-	-	-	-	-	-	-
54.	Kotor	-	15^0 33,0'	-	-	-	14^0 25,0'	-	-	16^0 17,0'
55.	Bar	-	-	-	-	-	-	-	-	-
56.	Durrës	-	-	-	-	-	15^0 58,0'	-	-	-
57.	Vlöre	-	-	-	-	-	14^0 00,0'	-	-	-
58.	Kerkyra	-	-	-	-	-	14^0 33,0'	-	-	-
59.	Paxi, SE Kerkyra	-	-	-	-	-	-	16^0 54,0'	-	-
60.	Prevesa	-	-	-	-	-	-	-	-	-

No.	Place of measurement	1823.	1850.	1870.	1890.	1904.	1928.	1940.	1950.
44.	Ston Veli	-	-	-	09^0 02,6'	07^0 51,6'	4^0 18,0'	2^0 42,0'	01^0 12,0'
45.	Lastovo	-	12^0 51,1'	10^0 32,0'	08^0 53,7'	07^0 42,7'	4^0 15,0'	2^0 42,0'	01^0 09,0'
46.	Palagruža	-	-	11^0 04,0'	-	-	-	-	-
47.	Mljet	-	-	-	08^0 53,8'	07^0 42,8'	4^0 16,0'	2^0 32,0'	01^0 12,0'
48.	Gruž	-	12^0 19,2'	10^0 10,0'	08^0 43,8'	07^0 32,8'	-	2^0 25,0'	-
49.	Dubrovnik	-	12^0 17,8'	10^0 06,0'	-	-	4^0 06,0'	-	00^0 57,0'
50.	Mali Molunat	-	-	-	-	-	-	-	-
51.	Herceg Novi	-	-	-	08^0 33,1'	07^0 22,1'	3^0 56,0'	2^0 14,0'	00^0 52,0'
52.	Tivat	-	-	-	08^0 29,3'	07^0 18,3'	3^0 53,0'	2^0 12,0'	00^0 43,0'
53.	Meljine, E Herceg Novi	-	12^0 21,0'	10^0 10,0'	-	-	-	-	-
54.	Kotor	-	12^0 03,2'	09^0 57,0'	-	-	-	-	-
55.	Bar	-	12^0 06,1'	09^0 46,0'	08^0 19,1'	07^0 08,1'	3^0 39,0'	2^0 05,0'	00^0 47,0'
56.	Durrës	-	11^0 48,7'	09^0 35,0'	08^0 09,9'	07^0 00,3'	3^0 33,0'	2^0 00,0'	00^0 41,0'
57.	Vlöre	13^0 56,0'	11^0 43,4'	09^0 36,0'	08^0 08,5'	07^0 00,3'	3^0 33,0'	2^0 03,0'	00^0 41,0'
58.	Kerkyra	-	11^0 36,2'	09^0 23,0'	08^0 00,1'	06^0 53,3'	3^0 17,0'	1^0 48,0'	00^0 25,0'
59.	Paxi, SE Kerkyra	-	-	-	-	-	-	-	-
60.	Prevesa	-	-	09^0 05,0'	-	-	-	-	-

W Adriatic

No.	Place of measurement	1806.	1809.	1810.	1811.	1812.	1818.	1819.	1820.	1821.
01.	Venecija	-	-	-	-	-	-	-	-	-
02.	Malamocco	-	-	-	-	-	-	17^0 50,0'	-	-
03.	Goro	-	-	-	-	-	-	18^0 10,0'	-	-
04.	Primaro	-	-	17^0 30,0'	-	-	-	-	-	-
05.	Ravenna	-	-	-	-	-	-	-	-	-
06.	Rimini	-	-	17^0 10,0'	-	-	-	-	-	-
07.	Ancona	-	-	-	17^0 39,0'	-	-	-	-	-
08.	Fano	-	-	-	17^0 50,0'	-	-	-	-	-
09.	Porto di Civitanova	-	-	-	17^0 21,0'	-	-	-	-	-
10.	Grottamare	-	-	-	17^0 45,0'	-	-	-	-	-
11.	Pescara	-	-	-	-	-	-	-	-	-
12.	Tremiti	-	-	-	-	-	-	15^0 00,0'	-	-
13.	Manfredonia	-	-	-	-	-	-	14^0 55,0'	-	-
14.	Molfetta	-	-	-	-	-	-	-	-	-
15.	Brindisi	-	-	-	-	-	-	-	-	-
16.	Otranto	-	-	-	-	-	-	-	-	-
17.	Santa Maria di Leuca	-	-	-	-	-	-	-	-	-

No.	Place of measurement	1823.	1850.	1870.	1890.	1904.	1928.	1940.	1950.
01.	Venecija	-	15^0 01,1'	12^0 50,0'	10^0 59,8'	09^0 44,6'	-	4^0 32,0'	03^0 08,0'
02.	Malamocco	-	-	-	-	-	-	-	-
03.	Goro	-	-	-	-	-	-	-	-
04.	Primaro	-	-	-	-	-	-	-	-
05.	Ravenna	-	-	-	11^0 01,4'	09^0 47,6'	-	4^0 42,0'	03^0 18,0'
06.	Rimini	-	-	-	-	-	-	-	-
07.	Ancona	-	14^0 08,4'	11^0 55,0'	10^0 17,6'	09^0 05,2'	-	4^0 00,0'	02^0 36,0'
08.	Fano	-	-	-	-	-	-	-	-
09.	Porto di Civitanova	-	-	-	-	-	-	-	-
10.	Grottamare	-	-	-	-	-	-	-	-
11.	Pescara	-	-	-	10^0 05,0'	08^0 54,0'	-	3^0 55,0'	02^0 31,0'
12.	Tremiti	-	-	-	-	-	-	3^0 30,0'	02^0 06,0'
13.	Manfredonia	-	-	-	09^0 26,0'	08^0 16,4'	-	3^0 15,0'	01^0 51,0'
14.	Molfetta	-	12^0 50,6'	10^0 44,0'	09^0 09,7'	08^0 00,1'	-	2^0 53,0'	01^0 29,0'
15.	Brindisi	14^0 35,0'	12^0 16,2'	10^0 06,0'	08^0 37,4'	07^0 29,2'	-	2^0 27,0'	01^0 03,0'
16.	Otranto	-	-	-	-	-	-	2^0 18,0'	00^0 54,0'
17.	Santa Maria di Leuca	-	-	-	-	-	-	2^0 23,0'	00^0 59,0'

**** Source of information:***
1806. = Beautemps-Beaupre, 1849a: 38, 41-43, 50, 55, 70-71; Idem, 1849b: 9, 12-14, 21, 26, 37, 41-42; Marieni, 1830: 579-580; Idem, 1845: 527-528; **1809.-1823.** = Marieni, 1830: 579-580; Idem, 1845: 527-528; **1850.** = Kreil, 1955: 44-45; Idem, 1862: 42-43; **1870.** = Marieni, 1845: Dopuna - No. 3; **1890.** = Segelhandbuch, 1893: 32; **1904.** = Segelhandbuch, 1906: 30; **1928.** = Opis, 1934: 50; **1940.** = Portolano, 1940: 27; Idem, 1949: 30; **1950.** = Botrić, 1952: 42; Idem, 1953: 37.

Figure 4. Isogonic lines in the Adriatic and peri-Adriatic region in the year 1855 (Kreil, 1862: 95)

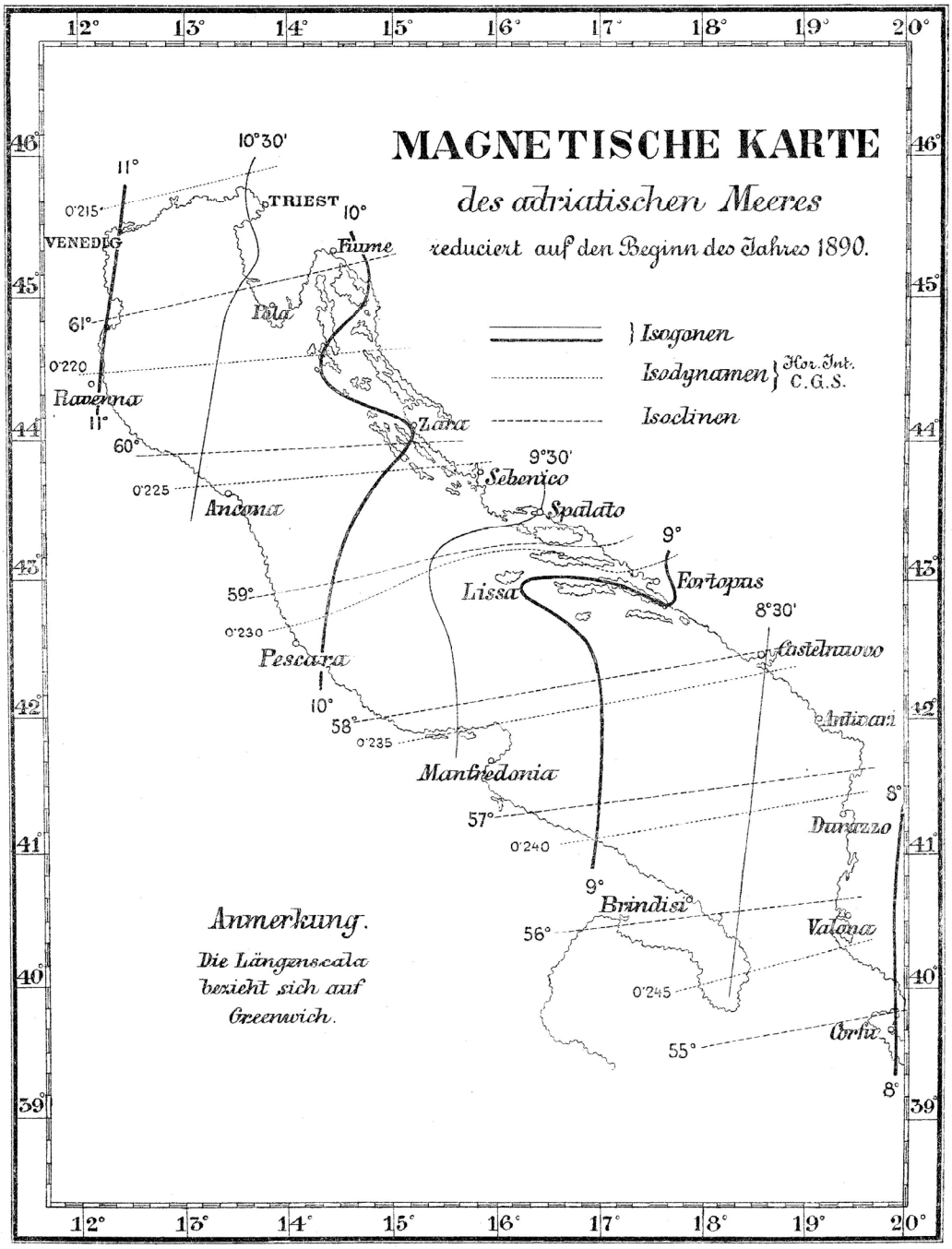


Figure 5. Isogonic lines in the Adriatic in the year 1890 (Segelhandbuch, 1893: 33)

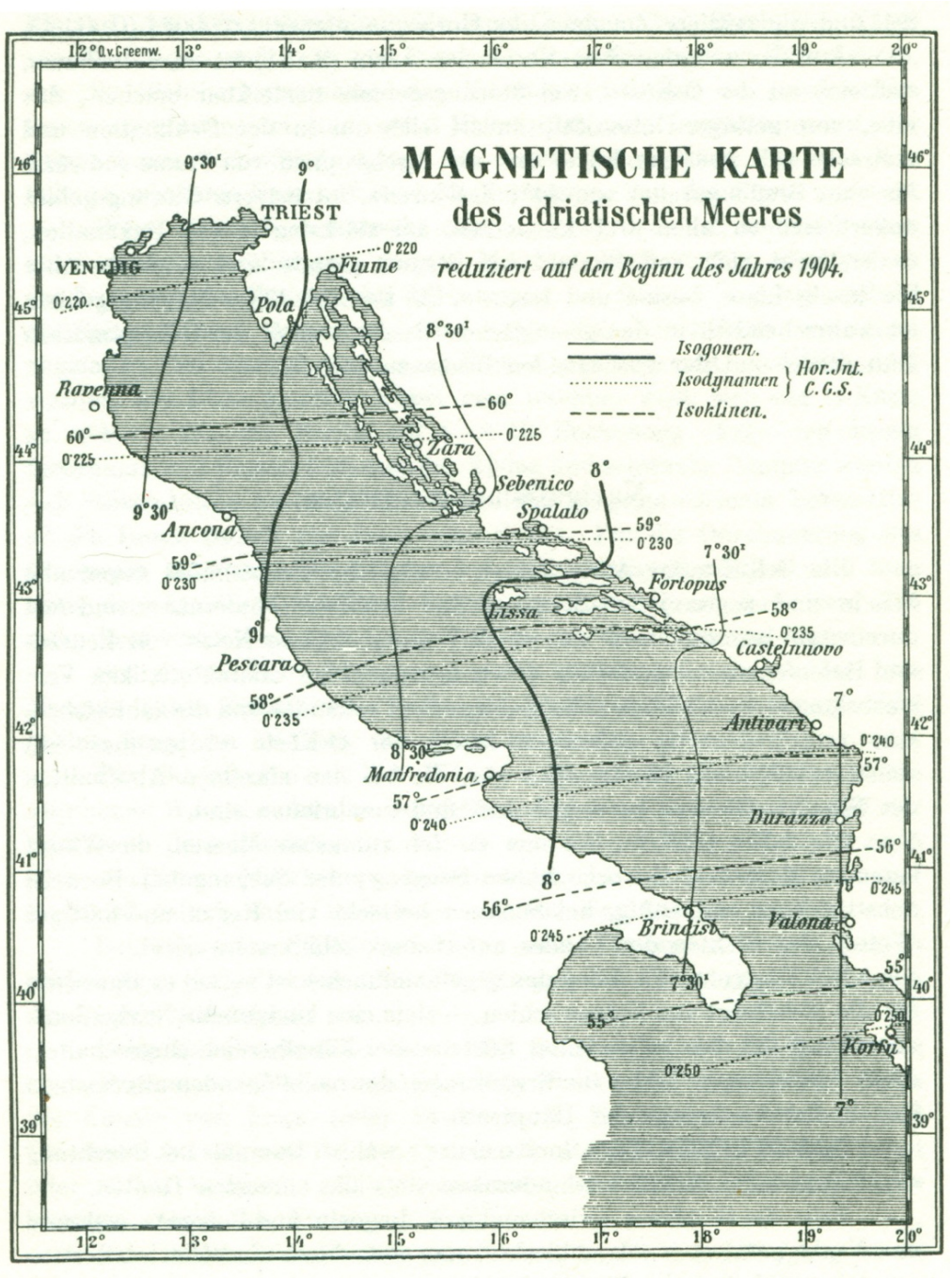


Figure 6. Isogonic lines in the Adriatic in the year 1904 (Segelhandbuch, 1906: 31)

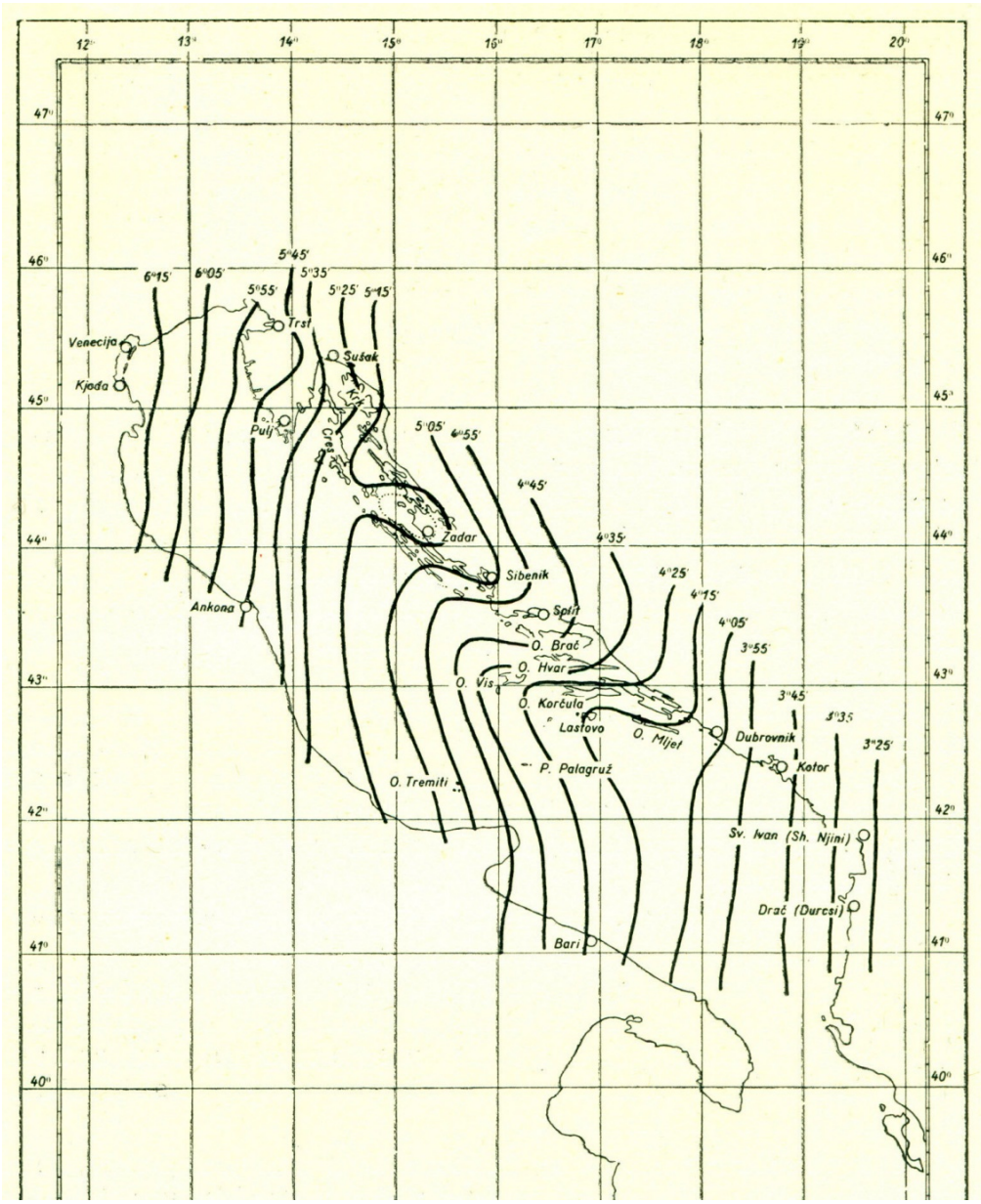


Figure 7. Isogonic lines in the Adriatic in the year 1928 (Opis, 1934: 51)

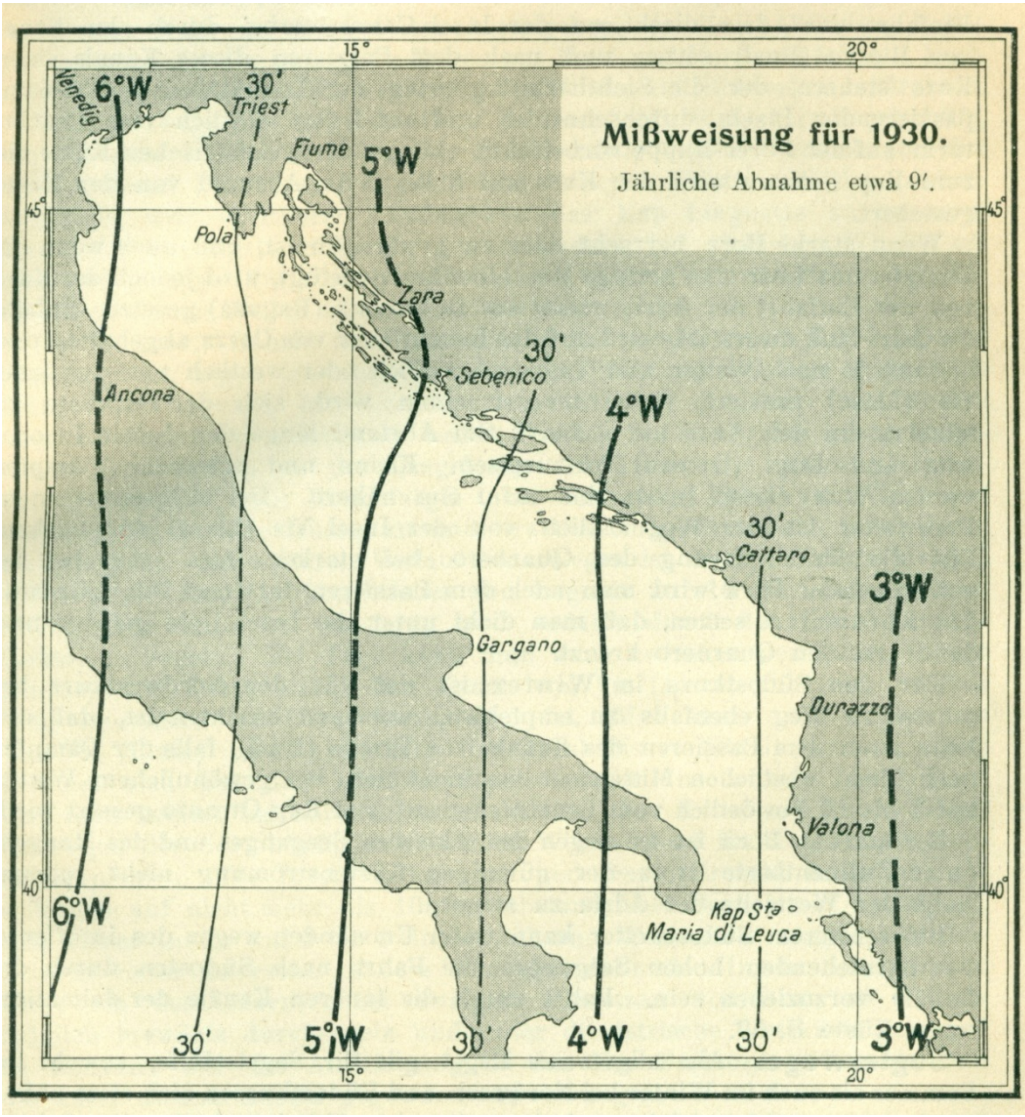


Figure 8. Isogonic lines in the Adriatic in the year 1930 (Handbuch, 1934: 47)

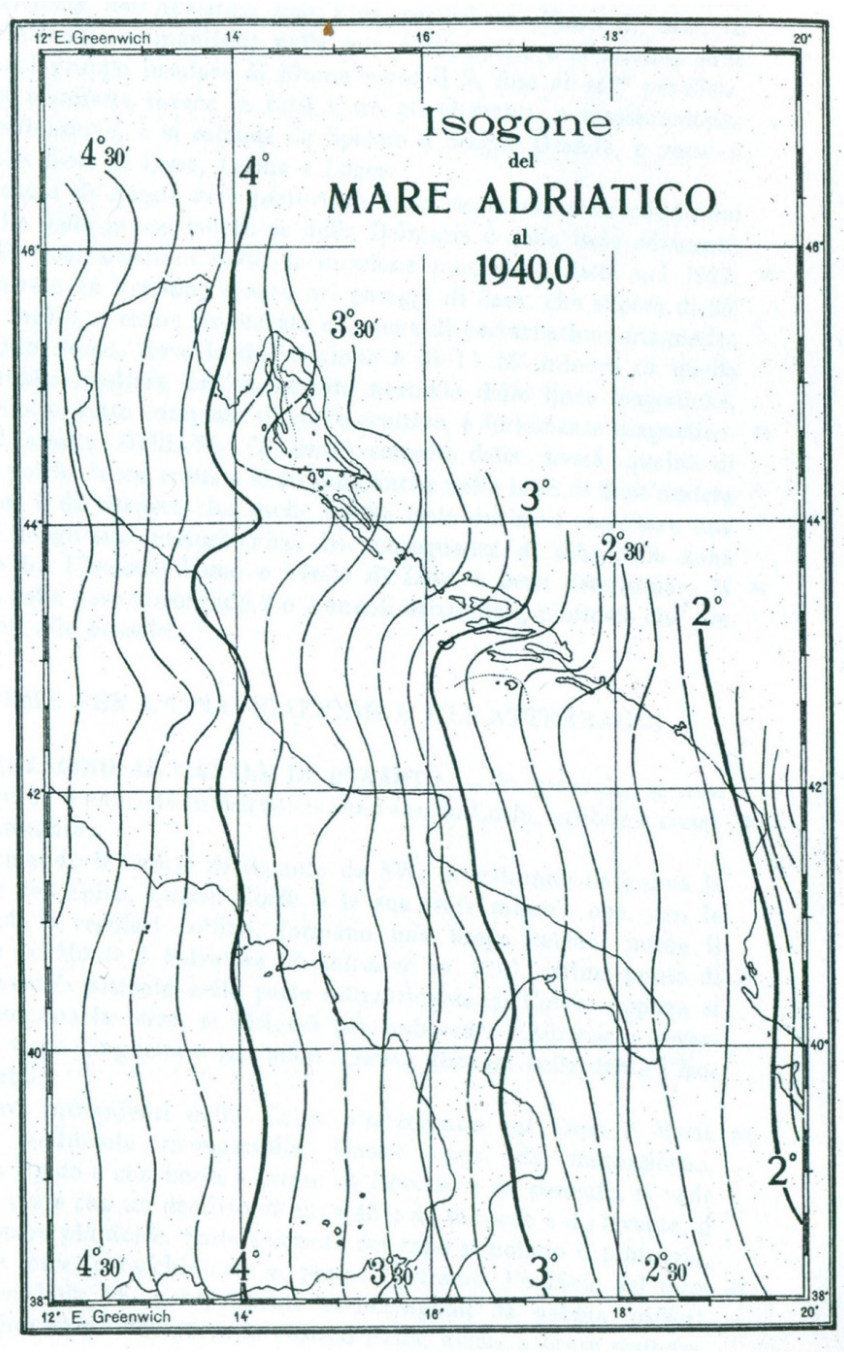


Figure 9. Isogonic lines in the Adriatic in the year 1940 (Portolano, 1940: 33)

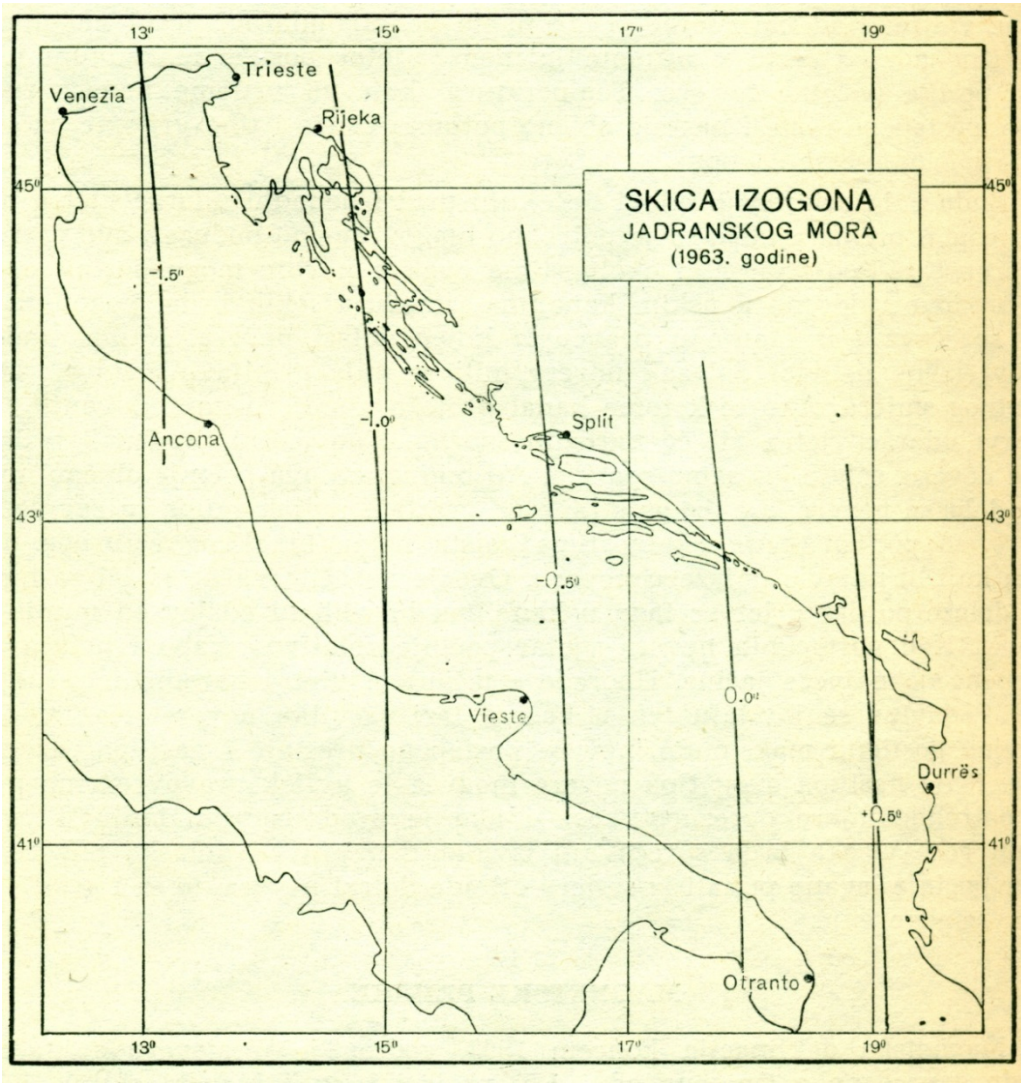


Figure 10. Isogonic lines in the Adriatic in the year 1963 (Makarović, 1964: 16)

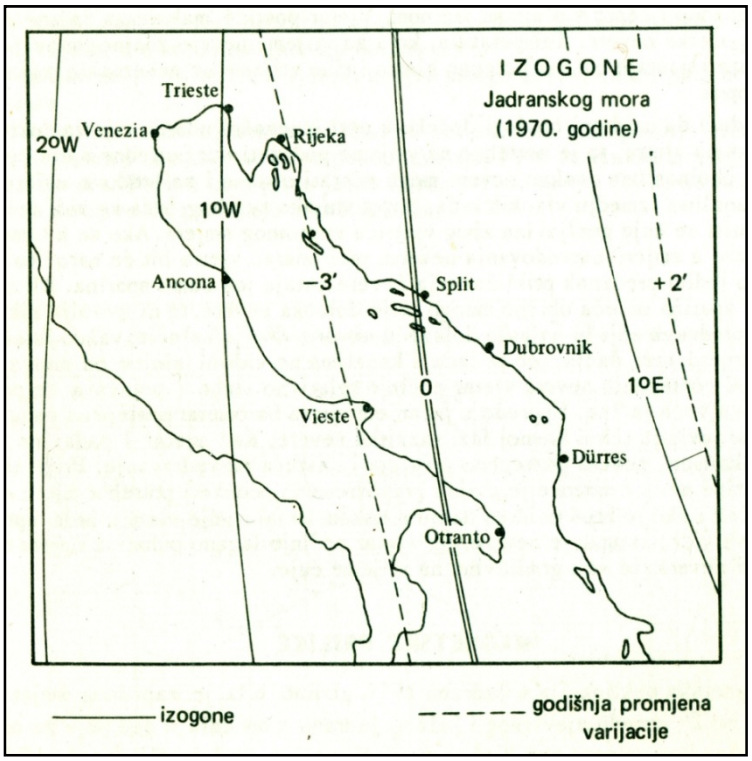


Figure 11. Isogonic lines in the Adriatic in the year 1970 (Makarović, 1983: 16)

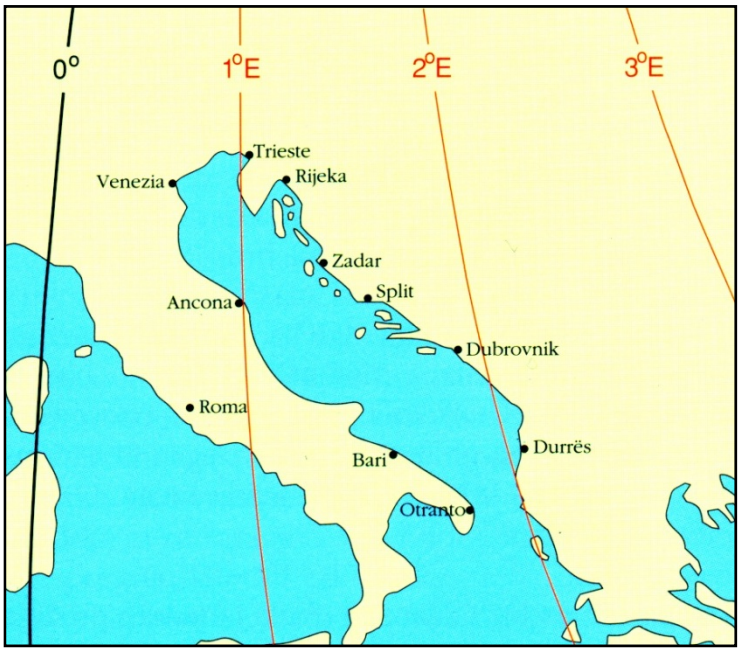


Figure 12. Isogonic lines in the Adriatic in the year 1995 (Gržetić, 1999: 25)

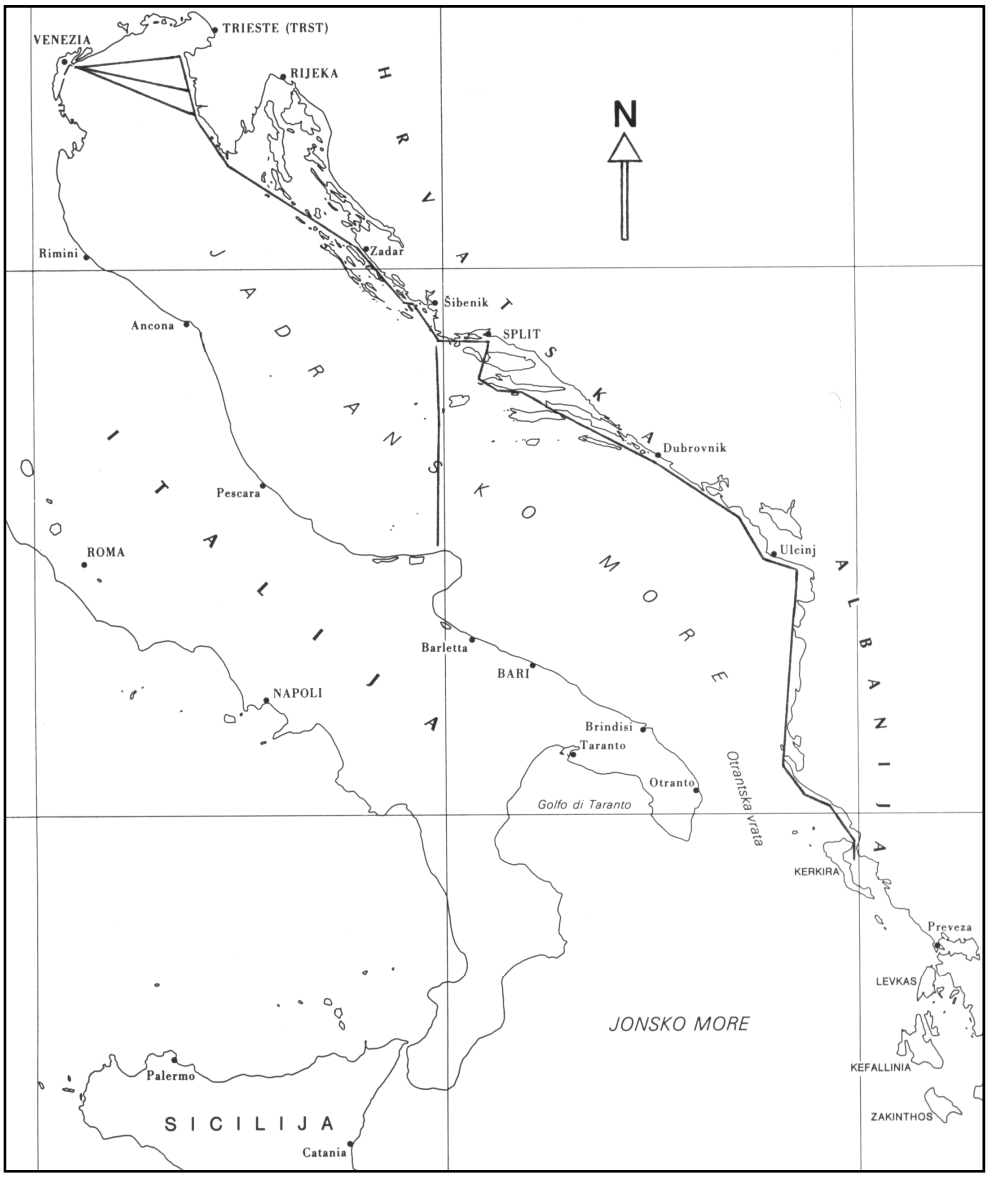


Figure 13. Coastal sailing routes used for millennia and the most heavily traveled overseas sailing routes (Kozličić, 2000a)

3 CONCLUDING REMARKS

For thousands of years the most frequent merchant sailing route from SE to NW and vice versa had been along the eastern Adriatic coast, in a protective belt of over a thousand islands and islets, with densely distributed lighthouses as reference points (Jurčić, 1988). Further on, from the Strait of Otranto, ships most often sailed along the coast, in the Mediterranean and neighbouring seas. Most frequently the sailing season lasted from the second half of spring to the end of the first half of autumn, when climate was milder, which was exceptionally important in the time of wooden sailing ships due to their relatively limited level of construction quality (they could hardly cope with big waves). Even in that period overseas expeditions in the Adriatic were undertaken, at first only with astronomical instruments, and later also compass. However knoweldge of magnetic declination was not widespread because mariners knew, owing to the legacy of their fathers and grandfathers, that if the compass did not show direction exact enough (because of magnetic declination), heading should be changed for ten or more degrees towards west or east. Therefore deaths because of this element of Earth's magnetism were rare (Figure 13).

The situation changed significantly from 1806 when measurements of the magnetic declination became regular. The data were published in the Adriatic pilot books and on nautical charts (Figures 4 - 12), essential tools without which no ship of medium to high carrying capacity did not engage in any kind of sailing. In that regard the situation was improved in financial terms as the period of the 19th to 21st century represents the time when nautical charts and pilot books were much cheaper in comparison with the period before the invention of printing. Finally from the end of the 19th century system of compensation of the magnetic compass has been finally elaborated which could not completely eliminate the influence of magnetic declination but it reduced it to an acceptable level. Testing sites for compensation were used for that purpose in the Fažana Channel in front of Pula (during Austo-Hungarian rule) and eastern part of the Kaštela Bay near Split (period of two Yugoslavias).

Furthermore, magnetic declination has started to reduce gradually, from about 17^0 west in 1806 to 0^0 in 1970, when isogonic line with that value was in the middle of the Adriatic: NW of it was still west and SE of it east magnetic declination (Figure 10). In 1995 this zero value will move so much to the west that it will leave the Adriatic maritime zone, where medium value of magnetic declination will be about $1,5^0$ east (Figure 11). However anomaly in the isogonic lines from Mljet to the north of the Zadar archipelago will still remain as a result of volcanic activity in the depth of the Earth's crust under the islands around Palagruža (visible on all isogonic charts).

Finally in the last half century, after a massive replacement of magnetic compasses with gyro compasses, and most recently with introduction of satellite navigation, and change of most frequent sailing routes, particularly for big ships (Lakoš, 1985), magnetic declination will have minor importance in terms of ship safety, even on those ships made of ferromagnetic materials that also carry cargo of identical materials which strongly affected ship's magnetism.

In that sense this paper is primarily focused on presentation of changes of the position and intensity of isogonic lines of the magnetic declination from east to west, concerning the Adriatic, with simultaneous emphasis on completely neglected segment of historical sources,

relevant for precise understanding of changes of magnetic declination in the same maritime zone.

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PROMJENE RAZINE MAGNETSKE DEKLINACIJE NA JADRANU 1806 - 1995. GODINE - PRILOG POVIJESTI JADRANSKOG POMORSTVA

OSNOVNE INFORMACIJE O ČLANKU:
POGLEDATI STRANICU 5

1 UVOD

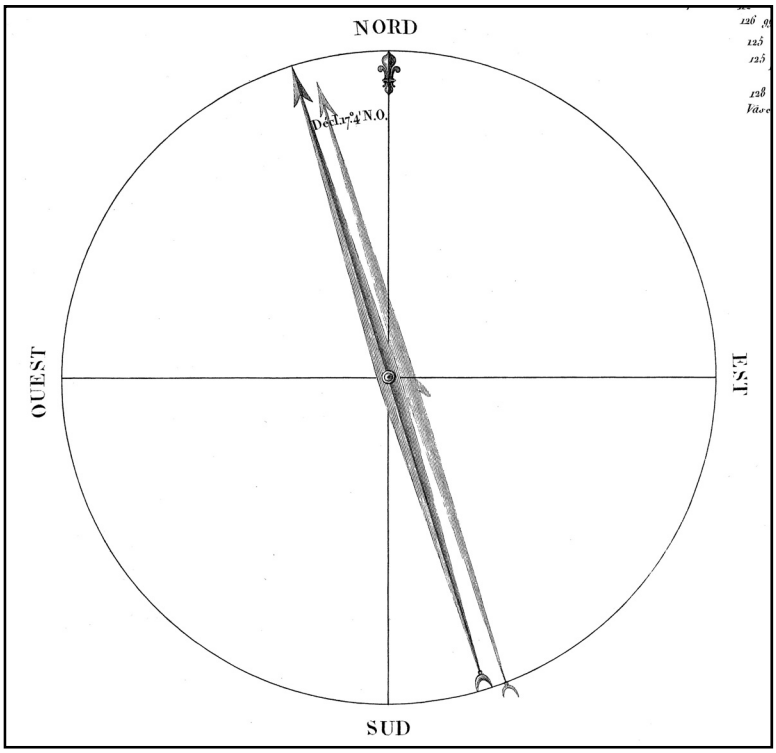
Promjene u povišenju ili sniženju utjecaja magnetskog polja (magnetske deklinacije) Zemlje njezina su tisućljetna konstanta. Ako je magnetska deklinacija prilično visokih vrijednosti, a pomorcu to nije poznato, ili zna ih ali nije izvršio kvalitetnu kompenzaciju magnetskog kompasa na vlastitu brodu, plovidbu, posebno u prekomorskim trajektima, kada se za oblačna dana može pouzdati jedino u kompas, može bitno usložniti, čak dotle da se za danjeg svjetla ne dosegne ciljana luka uplovljenja. Na Jadranu su ti prekomorski trajekti, od kasnog proljeća do rane jeseni, kada je dnevna svjetlost 12 i više sati, mogući unutar jednog dana plovidbe, pod uvjetom da ne vlada orkansko nevrijeme (Kozličić, 2000a). U providbi uz istočnu obalu Jadrana (obalna plovidba), što je ustaljeni tisućljetni plovidbeni put brodova u i iz Jadrana (Kojić, 1967; Kozličić, 2012; Kozličić i Rotunno, 2017), kompas pomorcu najčešće i nije presudno potreban. Uz dobro poznavanje arhipelaških nizova toga akvatorija i općeg geografskog znanja o obali kopna i otoka, prateći obalnu liniju otoka i kopna na daljini ne većoj od pet nautičkih milja (oko 9,3 km), tj. u području uobičajene vidljivosti (Kozličić i Uglešić, 2015), dosegnut će željeni cilj uz pomoć terestričke navigacije. Drugim riječima, znanje o magnetskoj deklinaciji na Jadranu posebno dolazi do izražaja prvenstveno u prekomorskim trajektima: Poreč ili Rovinj - Venezia, Pula - Ancona, Veli rat na Dugom otoku - Ancona ili Ravenna, Splitsko područje - Gargano, Dubrovnik - Bari ili sjever Krfa - Otranto, uključujući i plovidbe u suprotnom smjeru.[1] Općenita znanja o kolebanju elemenata magnetskog polja "na području Jadranskog mora nisu sustavno mjereni" prva je konstatacija koju ističe Gržetić (1999: 25) u najnovijem izdanju *Peljara istočnog Jadrana*. Međutim, boljim uvidom u raniju peljarsku literaturu, a ona je pomorcima stoljećima bila temelj za plovidbu, uz instrumentarij za određivanje pozicije, dobije se potpuno druga slika. Tome je posvećen ovaj tekst.

[1] O brojnim aspektima tih plovidbi Jadranom u zadnja tri tisućljeća više u: Kozličić (1990, 2000a, 2000b, 2006); Kozličić i Bratanić (2006), Kozličić i Duplančić Leder (2003), Kozličić i Faričić (2004), Kozličić, Mlinarić i Andrić (2015), Kozličić i Rotunno (2017), Kozličić i Uglešić (2015).

2 SLIJED PODATAKA O MAGNETSKOJ DEKLINACIJI U PELJARIMA JADRANA, KAO TEMELJNOM POVIJESNOM IZVORU O TOJ KOMPONENTI MAGNETIZMA ZEMLJE

Prema novijim istraživanjima magnetska deklinacija je kao pojava poznata još od 8. stoljeća nove ere te ona nije jednaka na svim točkama Zemlje ali ni u svim razdobljima (Dadić, 1982: 200). Već Kristof Kolumbo za svojeg putovanja prema Americi 1492. primjećuje takva odstupanja magnetskog kompasa (Prodanović, 2003: 187-188). Kasniji autori istražuju taj fenomen (Brkić, Bašić i Vrbanac, 2003; M. Solarić i N. Solarić, 2008), ali ne i na Jadranu, koji je bio pod različitim vlastima (Mletačka Republika, Austrijska Carevina, Osmansko Carstvo), pa su pomorske karte i peljari (plovidbeni priručnici) bez takvih podataka do početka 19. stoljeća (Kozličić, 2013; Kozličić, Mlinarić i Andrić., 2015; Kozličić i Uglešić, 2015; Muljačić, 1971). Širenje francuske vlasti na sjeveru Jadrana i tamošnjih prijadranskih prostora, a u nastavku do kraja jugoistočnog dijela tog mora, u sklopu Napoleonove imperijalne politika na jugoistoku Europe, inicirat će se brojna geografska i druga istraživanju u cilju valorizacije novoosvojenim područja, uz institucionalno unapređenje (formiranje prvih kartografskih institucija iz kojih će vremenom izrasti Vojnogeografski institut u Milanu). K tome, Napoleon angažira onodobnog najuglednijeg hidrografa, *oca svjetske hidrografije*, Charlesa Françoisa Beutemps-Beaupréa, koji u svojim kampanjama 1806. i 1808-1809. uz izmjeru dijelova istočne obale Jadrana, po prvi puta vrši i geomagnetska mjerenja vrijednosti magnetske deklinacije (Kozličić, 2006; Kozličić i Duplančić, 2003). Pritom se Jadran, kao i stoljećima ranije, vrednuje kao najkvalitetniji morski prometni koridor za vezu Europe s Azijom i Afrikom (Kojić, 1967; Kozličić, 1990; Idem, 2000a; Idem, 2000b; Idem, 2006; Kozličić i Bratanić, 2006; Kozličić i Faričić 2004).

Beautemps-Beaupréove izmjere utvrđuju relativno visoke vrijednosti te komponentne Zemljina magnetizma. U Jadranu se, tvrdi taj hidrograf na temelju svojih istraživanja 1806., treba ploviti s kompasima ispravljene deklinacije magnetske igle (Beautemps-Beaupré, 1849a: 35; Idem, 1849b: 6). Prema tome, ističe on, kad označavamo pravac broda, pružanje obale, smjer odakle puše vjetar itd., uvijek se ravnamo prema pravom meridijanu. Da bi to i praktično pokazao Beautemps-Beaupré za sve važnije luke, u opisu kampanje 1806., donosi vrijednost magnetske deklinacije (Beautemps-Beaupré, 1849a: 38, 41-43, 50, 55, 70-71; Idem, 1849b: 9, 12-14, 21, 26, 37, 41-42). Tekst "Izvješća" koje se odnosi na kampanju 1808 - 1809. nema takvih podataka, ali su zato oni zastupljeni na njegovim kartama za obje kampanje (Slika 1) (Kozličić, 2006).

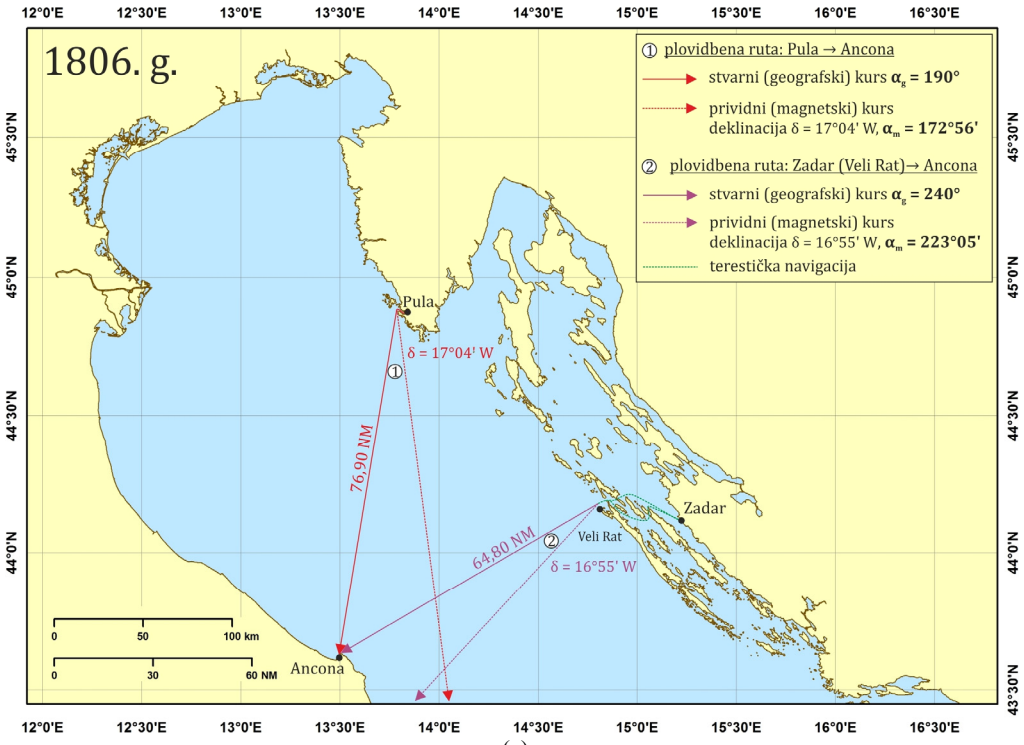


Slika 1. Vrijednost magnetske deklinacije kod Pule na Beautemps-Beaupréovoj karti izdanoj 1821. godine (Kozličić, 2006).

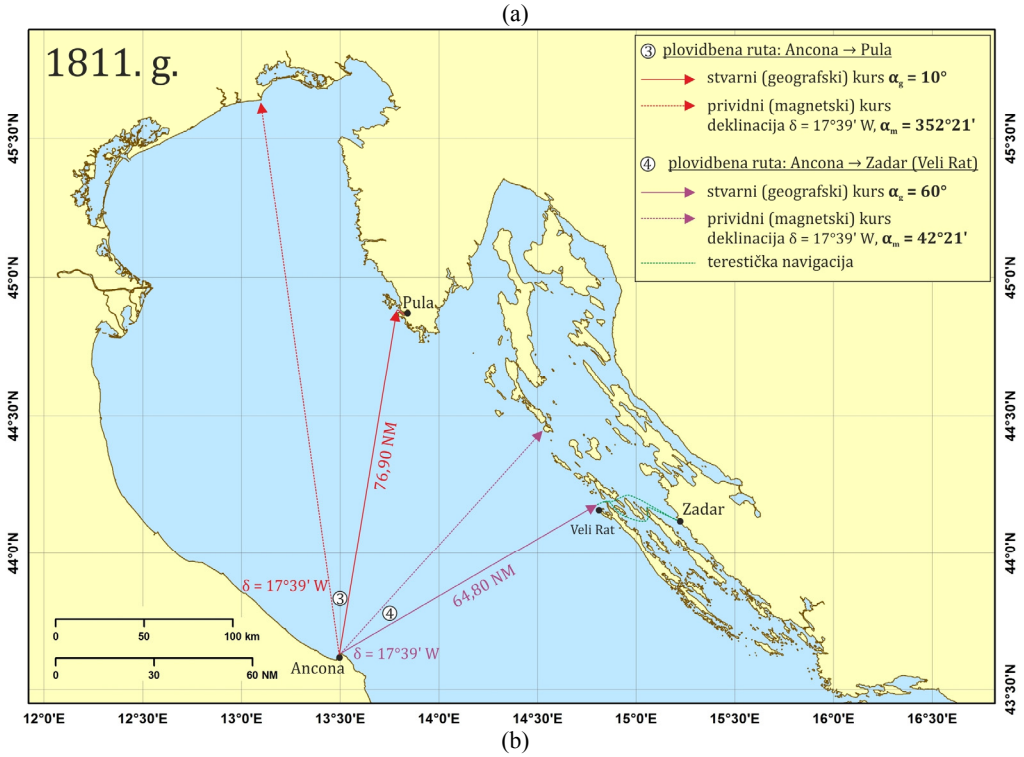
Kako bi se vrlo praktično pokazalo što bi to pomorcima značilo izradilo se simulaciju na modernim kartama Mercatorove projekcije za prekomorske trajekte Pula - Ancona i Veli rat na Dugom otoku - Ancona (Slika 2a), i obratno (Slika 2b),[2] uz pretpostavku da pomorac uopće nije upoznat s takvim djelovanjem na njegov magnetski kompas.

Kako od 1815. u Milanu počinje djelovati Vojnogeografski institut (u međuvremenu je francusku smijenila austrijska vlast na sjeveru Italije, ali i cjelini istočne obale Jadrana do približno Bara; dalje je bilo područje pod upravom Osmanskog Carstva), poduzimaju se nova znanstvena istraživanja (Faričić i Mirošević, 2017). To će između 1822. i 1824. rezultirati izradom i tiskom djela *Carta di cabottaggio del mare Adriatico* koja na 22 lista folio formata u mjerilu 1 : 175.000 (Carta, 1822-1824; Faričić i Mirošević, 2017; Kozličić, 2013), donosi ne samo izvanredno vrijedne pomorske karte, već po prvi put na njima i vrijednosti magnetske deklinacije (Slika 3).

[2] Prema uputama autora obje karte je oblikovao Tome Marelić, MA, student poslijediplomskog doktorskog studija "Jadran - poveznica među kontinentima" Sveučilišta u Zadru.

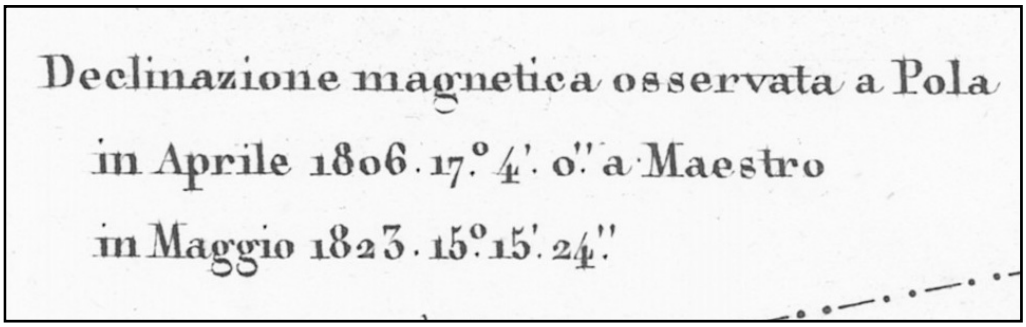


(a)



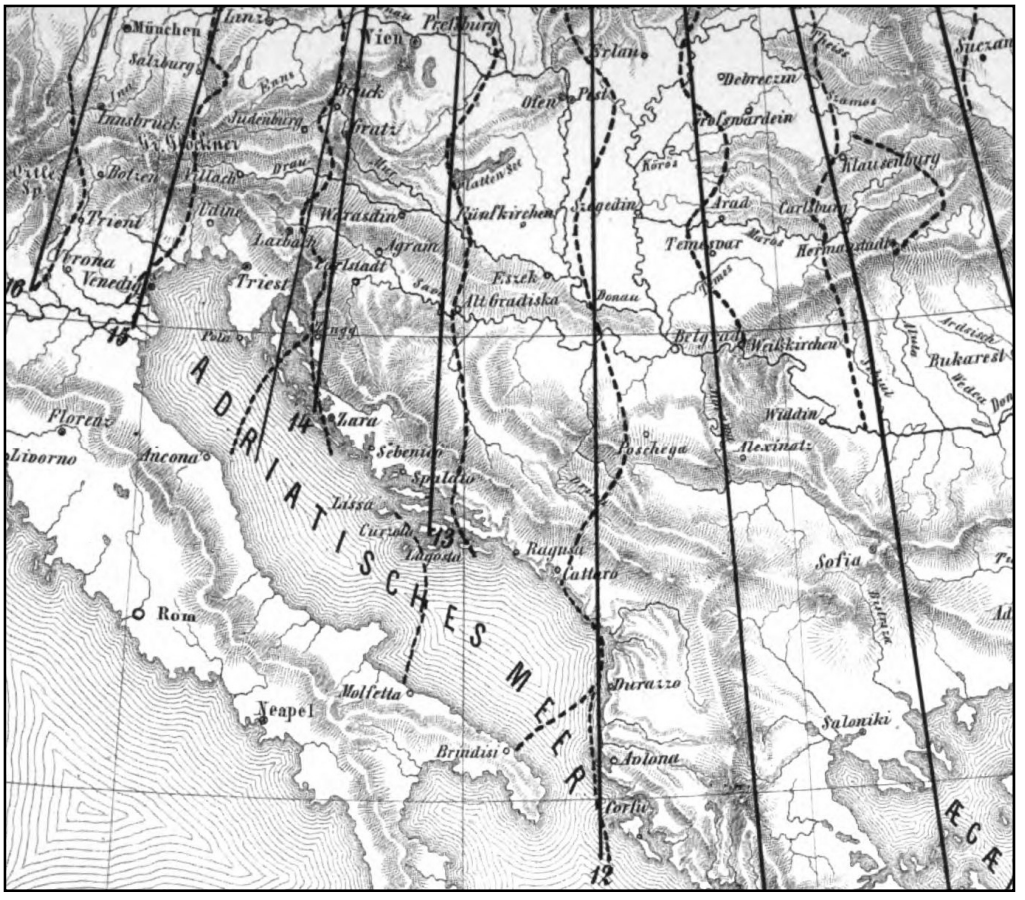
(b)

Slika 2 (a) i (b). Ukoliko pomorac nije upoznat s vrijednošću magnetske deklinacije ploveći na oba prekomorska trajekta ne bi, uz uporabu magnetskog kompasa, završio u ciljanoj luci, već daleko od nje



Slika 3. Magnetska deklinacija kod Pule (Carta, 1822-1824: isječak s Foglio III.)

Nekoliko godina kasnije to će slijediti i prvi kvalitetom pravi peljar Jadrana iz 1830. u kojem su po prvi put tabelarno navedene vrijednosti magnetske deklinacije za najvažnije plovidbene točke Jadrana (Marieni, 1830: 579-580) (Tablica 1), pa će pomorci za plovidbu Jadranom imati dva najvažnija izvora: kvalitetne karte i jednako kvalitetni plovidbeni priručnik (Kozličić, 2013).



Slika 4. Izogone užeg jadranskog i prijadranskog prostora 1855. godine (Kreil, 1862: 95)

Tablica 1.
Zapadna magnetska deklinacija na Jadranu 1806 - 1823. prema podacima kapetana Giacoma Marienija[3]

Red. br.	Mjesto mjerenja	Datum mjerenja	Vrijednost	Mjeritelj
		A. Istočni dio Jadrana		
1.	Trieste	15.09.1812.	17^0 44'	I. Prina
2.	Piran	15.07.1806.	17^0 10'	C.-F. Beautemps-Beaupré
3.	Piran	15.08.1819.	16^0 05'	H. Smyth
4.	Luka Mirna	15.07.1806.	17^0 10'	C.-F. Beautemps-Beaupré
5.	Poreč	15.07.1806.	17^0 10'	C.-F. Beautemps-Beaupré
6.	Poreč	15.08.1819.	16^0 00'	H. Smyth
7.	Pula	15.04.1806.	17^0 04'	C.-F. Beautemps-Beaupré
8.	Pula	15.08.1819.	15^0 00'	H. Smyth
9.	Pula	15.03.1823.	15^0 15'	H. Smyth
10.	Rijeka	15.08.1819.	15^0 20'	H. Smyth
11.	Rab	15.07.1821.	17^0 50'	G. Marieni
12.	Mali Lošinj	15.08.1819.	14^0 13'	H. Smyth
13.	Vir	15.07.1821.	16^0 41'	G. Marieni
14.	Zadar	15.07.1806.	16^0 55'	C.-F. Beautemps-Beaupré
15.	Zadar	15.08.1819.	14^0 13'	H. Smyth
16.	Zadar	15.03.1823.	14^0 43'	H. Smyth
17.	Ist	15.07.1821.	15^0 47'	G. Marieni
18.	Kornat	15.06.1821.	16^0 25'	G. Marieni
19.	Murter	15.07.1818.	15^0 30'	G. Marieni
20.	Zmajan	15.07.1818.	16^0 50'	G. Marieni
21.	Zlarin	15.09.1806.	16^0 16'	C.-F. Beautemps-Beaupré
22.	Zlarin	15.07.1818.	15^0 18'	G. Marieni
23.	Žirje	15.07.1818.	14^0 56'	G. Marieni
24.	Žirje	15.07.1819.	14^0 19'	H. Smyth
25.	Žirje	15.06.1821.	16^0 12'	G. Marieni
26.	Rogoznica	15.09.1806.	16^0 04'	C.-F. Beautemps-Beaupré
27.	Rogoznica	15.07.1819.	14^0 30'	H. Smyth
28.	Šolta	15.07.1818.	16^0 00'	G. Marieni
29.	Split	15.09.1806.	16^0 38'	C.-F. Beautemps-Beaupré
30.	Split	15.07.1818.	16^0 36'	G. Marieni
31.	Split	15.07.1819.	14^0 15'	H. Smyth
32.	Omiš	15.07.1818.	15^0 56'	G. Marieni
33.	Brač	15.07.1818.	16^0 18'	G. Marieni
34.	Hvar	15.07.1819.	14^0 05'	H. Smyth
35.	Vis	15.07.1819.	14^0 00'	H. Smyth
36.	Makarska	15.08.1818.	16^0 42'	G. Marieni
37.	Korčula	15.08.1818.	16^0 07'	G. Marieni
38.	Pelješac	15.08.1818.	16^0 01'	G. Marieni
39.	Pelješac	15.08.1819.	14^0 00'	H. Smyth
40.	Lastovo	15.08.1818.	16^0 15'	G. Marieni

[3] Marieni (1830: 579-580) umjesto cjelovitih imena hidrografa koji su mjerili magnetsku deklinaciju ima kratice. One su u ovoj tablici razriješene i to: B. = Charles François Beautemps-Beaupré, francuski hidrograf; M. = Giacomo Marieni, talijanski pomorac; Pö. = Pöltl, zapovjednik austrijske korvete "Velox"; Pr. = Ignazio Prina, talijanski hidrograf; S. = Henry Smyth, britanski pomorski kapetan. Pritom je od osobite pomoći bilo djelo Smyth (1854: 362-369).

Red. br.	Mjesto mjerenja	Datum mjerenja	Vrijednost	Mjeritelj
41.	Palagruža	15.09.1819.	15^0 10'	H. Smyth
42.	Mljet	15.07.1819.	15^0 00'	H. Smyth
43.	Dubrovnik	15.09.1809.	15^0 48'	C.-F. Beautemps-Beaupré
44.	Dubrovnik	15.06.1819.	16^0 00'	H. Smyth
45.	Dubrovnik	15.04.1820.	15^0 22'	G. Marieni
46.	Mali Molunat	15.09.1809.	16^0 01'	C.-F. Beautemps-Beaupré
47.	Kotor	15.04.1809.	15^0 33'	C.-F. Beautemps-Beaupré
48.	Kotor	15.06.1818.	14^0 25'	H. Smyth
49.	Kotor	15.09.1821.	16^0 17'	G. Marieni
50.	Durrës	15.09.1818.	15^0 58'	H. Smyth
51.	Vlöre	15.07.1818.	14^0 00'	H. Smyth
52.	Vlöre	15.06.1823.	13^0 56'	H. Smyth
53.	Kerkyra	15.06.1818.	14^0 33'	H. Smyth
54.	Paxi, SE Kerkyra	15.06.1819.	16^0 54'	Pöltl
		B. Zapadni dio Jadrana		
1.	Malamocco	15.09.1819.	17^0 50'	H. Smyth
2.	Goro	15.09.1819.	18^0 10'	H. Smyth
3.	Primaro	15.03.1810.	17^0 30'	I. Prina
4.	Rimini	15.07.1810.	17^0 10'	I. Prina
5.	Ancona	15.11.1811.	17^0 39'	G. Marieni
6.	Fano	15.12.1811.	17^0 50'	G. Marieni
7.	Porto di Civitanova	15.11.1811.	17^0 21'	G. Marieni
8.	Grottamare	15.10.1811.	17^0 45'	G. Marieni
9.	Tremiti	15.09.1819.	15^0 00'	H. Smyth
10.	Manfredonia	15.09.1819.	14^0 55'	H. Smyth
11.	Brindisi	15.04.1823.	14^0 35'	H. Smyth

Iste podatke donosi se i u novom izdanju toga peljara petnaestak godina kasnije (Marieni, 1845: 527-528), jer se u međuvremenu nije vršilo nova mjerenja. Njih se vrši tek polovicom stoljeća (Kreil, 1855; Idem, 1862). Naravno, uz njih se donosi karta izogona (Slika 4) te popis vrijednosti magnetske deklinacije za najvažnije luke (Kreil, 1855: 43-44, 46; Idem, 1862: 42-43, 47).

U nastavku, kroz stotinjak godina, vršit će se uvijek nove izmjerene koje će registrirati nova izdanja peljara (Botrić, 1952; Idem, 1953; Handbuch, 1930; Makarović, 1964; Idem, 1973; Idem, 1982; Opis, 1934; Portolano, 1940; Idem, 1949; Segelhanbuch, 1893; Idem, 1906; Idem, 1906: Dopuna 3 iz 1913.). Kako je u međuvremenu bitno uznapredovala kvaliteta u izradi magnetskih kompasa a s njom i kompenzacija tog kompasa (M. Solarić and N. Solarić, 2009), sigurnost plovidbe na prekomorskim trajektima Jadrana bitno će se povisiti. Na temelju svega istaknutog, uključujući i Marienijeve podatke (Marieni, 1830; Idem, 1845), izradilo se vrlo preglednu Tablicu 2, obuhvativši sve izmjere od 1806. do 1950. godine. Pritom je zanimljivo da se zadnje pojedinačne podatke objavilo za 1950., a nakon toga samo karte izogona, što je razumljivo utoliko što su vrijednosti magnetske deklinacije postale iznimno niske.

Tablica 2.
Zapadna magnetska deklinacija na Jadranu 1806.-1950. godine*

E Jadran

No.	Mjesto mjerenja	1806.	1809.	1810.	1811.	1812.	1818.	1819.	1820.	1821.
01.	Trieste	-	-	-	-	17^0 44,0'	-	-	-	-
02.	Piran	17^0 10,0'	-	-	-	-	-	16^0 05,0'	-	17^0 10,0'
03.	Umag	17^0 10,0'	-	-	-	-	-	-	-	17^0 10,0'
04.	Novigrad	17^0 10,0'	-	-	-	-	-	-	-	17^0 10,0'
05.	Poreč	17^0 10,0'	-	-	-	-	-	16^0 00,0'	-	-
06.	Rovinj	-	-	-	-	-	-	-	-	-
07.	Pula	17^0 04,0'	-	-	-	-	-	15^0 00,0'	-	-
08.	Kamenjak	-	-	-	-	-	-	-	-	-
09.	Medulin	-	-	-	-	-	-	-	-	-
10.	Labin (Rabac)	-	-	-	-	-	-	-	-	-
11.	Rijeka	-	-	-	-	-	-	15^0 20,0'	-	-
12.	Sušak									
13.	Malinska	-	-	-	-	-	-	-	-	-
14.	Rab	-	-	-	-	-	-	-	-	17^0 50,0'
15.	Senj	-	-	-	-	-	-	-	-	-
16.	Lošinj	-	-	-	-	-	-	-	-	-
17.	Mali Lošinj	-	-	-	-	-	-	14^0 13,0'	-	-
18.	Veli Lošinj	-	-	-	-	-	-	-	-	-
19.	Orjule, SE Lošinj	-	-	-	-	-	-	-	-	-
20.	Veli rat, NW Dugi otok	-	-	-	-	-	-	-	-	-
21.	Vir	-	-	-	-	-	-	-	-	16^0 41,0'
22.	Zadar	16^0 55,0'	-	-	-	-	-	14^0 13,0'	-	-
23.	Ist	-	-	-	-	-	-	-	-	15^0 47,0'
24.	Kornat	-	-	-	-	-	-	-	-	16^0 25,0'
25.	Murter	-	-	-	-	-	15^0 30,0'	-	-	-
26.	Zmajan	-	-	-	-	-	16^0 50,0'	-	-	-
27.	Zlarin	16^0 16,0'	-	-	-	-	15^0 18,0'	-	-	-
28.	Šibenik	-	-	-	-	-	-	-	-	-
29.	Žirje	-	-	-	-	-	14^0 56,0'	14^0 19,0'	-	16^0 12,0'
30.	Rogoznica	16^0 04,0'	-	-	-	-	-	14^0 30,0'	-	-
31.	Šolta		-	-	-	-	16^0 00,0'		-	-
32.	Split	16^0 38,0'	-	-	-	-	16^0 36,0'	14^0 15,0'	-	-
33.	Omiš	-	-	-	-	-	15^0 56,0'	-	-	-
34.	Brač	-	-	-	-	-	16^0 18,0'	-	-	-
35.	Hvar	-	-	-	-	-	-	14^0 05,0'	-	-
36.	Jabuka	-	-	-	-	-	-	-	-	-
37.	Vis	-	-	-	-	-	-	14^0 00,0'	-	-
38.	Makarska	-	-	-	-	-	16^0 42,0'	-	-	-
39.	Ploče	-	-	-	-	-	-	-	-	-
40.	Opuzen	-	-	-	-	-	-	-	-	-
41.	Korčula	-	-	-	-	-	16^0 07,0'	-	-	-
42.	Trpanj	-	-	-	-	-	-	-	-	-
43.	Pelješac	-	-	-	-	-	16^0 01,0'	14^0 00,0'	-	-

No.	Mjesto mjerenja	1823.	1850.	1870.	1890.	1904.	1928.	1940.	1950.
01.	Trieste	-	14^0 28,2'	12^0 18,0'	10^0 27,6'	09^0 12,4'	5^0 50,0'	4^0 08,0'	02^0 21,0'
02.	Piran	-	-	-	10^0 31,2'	09^0 16,0'	5^0 52,0'	4^0 12,0'	02^0 23,0'
03.	Umag	-	-	-	-	-	5^0 50,0'	-	-
04.	Novigrad	-	-	-	-	-	-	-	-
05.	Poreč	-	14^0 38,5'	12^0 20,0'	10^0 31,9'	09^0 16,7'	5^0 53,0'	4^0 09,0'	02^0 24,0'
06.	Rovinj	-	-	-	10^0 26,3'	09^0 11,1'	5^0 47,0'	3^0 58,0'	02^0 27,0'
07.	Pula	15^0 15,0'	14^0 12,4'	12^0 05,0'	10^0 16,6'	09^0 04,0'	5^0 37,0'	3^0 57,0'	02^0 17,0'
08.	Kamenjak	-	-	12^0 03,0'	-	-	-	-	-
09.	Medulin	-	-	-	10^0 16,1'	09^0 02,3'	5^0 37,0'	3^0 52,0'	02^0 17,0'
10.	Labin (Rabac)	-	-	-	10^0 16,4'	09^0 01,2'	5^0 53,0'	3^0 53,0'	02^0 33,0'
11.	Rijeka	-	14^0 17,7'	11^0 49,0'	10^0 07,7'	08^0 52,5'	-	3^0 52,0'	02^0 04,0'
12.	Sušak						5^0 23,0'	-	
13.	Malinska	-	-	-	10^0 09,2'	08^0 54,0'	5^0 32,0'	3^0 45,0'	02^0 02,0'
14.	Rab	-	-	-	-	-	-	-	-
15.	Senj	-	-	11^0 50,0'	-	-	-	-	-
16.	Lošinj	-	-	11^0 52,0'	-	-	-	-	-
17.	Mali Lošinj	-	14^0 05,9'	-	09^0 56,7'	08^0 42,9'	5^0 18,0'	3^0 48,0'	01^0 58,0'
18.	Veli Lošinj	-	-	-	-	-	-	-	01^0 49,0'
19.	Orjule, SE Lošinj	-	-	11^0 44,0'	-	-	-	-	-
20.	Veli rat, NW Dugi otok	-	-	11^0 51,0'	-	-	-	-	-
21.	Vir	-	-	-	-	-	-	-	-
22.	Zadar	14^0 43,0'	13^0 48,9'	11^0 58,0'	10^0 00,8'	08^0 47,0'	5^0 27,0'	3^0 45,0'	02^0 07,0'
23.	Ist	-	-	-	-	-	-	-	-
24.	Kornat	-	-	-	-	-	-	-	-
25.	Murter	-	-	-	-	-	-	-	-
26.	Zmajan	-	-	-	-	-	-	-	-
27.	Zlarin	-	-	-	-	-	-	-	-
28.	Šibenik	-	13^0 37,1'	11^0 31,0'	09^0 47,3'	08^0 34,9'	5^0 10,0'	3^0 27,0'	01^0 43,0'
29.	Žirje	-	-	11^0 26,0'	-	-	-	-	-
30.	Rogoznica	-	-	-	-	-	-	-	-
31.	Šolta	-	-	-	-	-	-	-	-
32.	Split	-	13^0 24,7'	11^0 21,0'	09^0 31,9'	08^0 19,5'	4^0 54,0'	3^0 12,0'	01^0 37,0'
33.	Omiš	-	-	-	-	-	-	-	-
34.	Brač	-	-	-	-	-	-	-	-
35.	Hvar	-	13^0 10,7'	10^0 57,0'	09^0 19,8'	08^0 07,4'	4^0 42,0'	3^0 00,0'	01^0 28,0'
36.	Jabuka	-	-	09^0 37,0'	-	-	-	-	-
37.	Vis	-	13^0 01,2'	10^0 51,0'	09^0 03,1'	07^0 50,7'	4^0 34,0'	3^0 00,0'	01^0 20,0'
38.	Makarska	-	-	-	09^0 16,1'	08^0 03,7'	4^0 39,0'	3^0 02,0'	01^0 22,0'
39.	Ploče	-	-	-	-	-	-	-	01^0 17,0'
40.	Opuzen	-	-	-	09^0 02,8'	07^0 50,4'	4^0 25,0'	2^0 44,0'	01^0 11,0'
41.	Korčula	-	12^0 50,9'	10^0 40,0'	08^0 59,9'	07^0 48,9'	4^0 22,0'	2^0 45,0'	01^0 17,0'
42.	Trpanj	-	-	-	09^0 03,2'	07^0 50,8'	4^0 27,0'	2^0 47,0'	01^0 13,0'
43.	Pelješac	-	-	-	-	-	-	-	-

No.	Mjesto mjerenja	1806.	1809.	1810.	1811.	1812.	1818.	1819.	1820.	1821.
44.	Ston Veli	-	-	-	-	-	-	-	-	-
45.	Lastovo	-	-	-	-	-	16^0 15,0'	-	-	-
46.	Palagruža	-	-	-	-	-	-	15^0 10,0'	-	-
47.	Mljet	-	-	-	-	-	-	15^0 00,0'	-	-
48.	Gruž	-	-	-	-	-	-	-	-	-
49.	Dubrovnik	-	15^0 48,0'	-	-	-	-	16^0 00,0'	15^0 22,0'	-
50.	Mali Molunat	-	16^0 01,0'	-	-	-	-	-	-	-
51.	Herceg Novi	-	-	-	-	-	-	-	-	-
52.	Tivat	-	-	-	-	-	-	-	-	-
53.	Meljine, E Herceg Novi	-	-	-	-	-	-	-	-	-
54.	Kotor	-	15^0 33,0'	-	-	-	14^0 25,0'	-	-	16^0 17,0'
55.	Bar	-	-	-	-	-	-	-	-	-
56.	Durrës	-	-	-	-	-	15^0 58,0'	-	-	-
57.	Vlöre	-	-	-	-	-	14^0 00,0'	-	-	-
58.	Kerkyra	-	-	-	-	-	14^0 33,0'	-	-	-
59.	Paxi, SE Kerkyra	-	-	-	-	-	-	16^0 54,0'	-	-
60.	Prevesa	-	-	-	-	-	-	-	-	-

No.	Mjesto mjerenja	1823.	1850.	1870.	1890.	1904.	1928.	1940.	1950.
44.	Ston Veli	-	-	-	09^0 02,6'	07^0 51,6'	4^0 18,0'	2^0 42,0'	01^0 12,0'
45.	Lastovo	-	12^0 51,1'	10^0 32,0'	08^0 53,7'	07^0 42,7'	4^0 15,0'	2^0 42,0'	01^0 09,0'
46.	Palagruža	-	-	11^0 04,0'	-	-	-	-	-
47.	Mljet	-	-	-	08^0 53,8'	07^0 42,8'	4^0 16,0'	2^0 32,0'	01^0 12,0'
48.	Gruž	-	12^0 19,2'	10^0 10,0'	08^0 43,8'	07^0 32,8'	-	2^0 25,0'	-
49.	Dubrovnik	-	12^0 17,8'	10^0 06,0'	-	-	4^0 06,0'	-	00^0 57,0'
50.	Mali Molunat	-	-	-	-	-	-	-	-
51.	Herceg Novi	-	-	-	08^0 33,1'	07^0 22,1'	3^0 56,0'	2^0 14,0'	00^0 52,0'
52.	Tivat	-	-	-	08^0 29,3'	07^0 18,3'	3^0 53,0'	2^0 12,0'	00^0 43,0'
53.	Meljine, E Herceg Novi	-	12^0 21,0'	10^0 10,0'	-	-	-	-	-
54.	Kotor	-	12^0 03,2'	09^0 57,0'	-	-	-	-	-
55.	Bar	-	12^0 06,1'	09^0 46,0'	08^0 19,1'	07^0 08,1'	3^0 39,0'	2^0 05,0'	00^0 47,0'
56.	Durrës	-	11^0 48,7'	09^0 35,0'	08^0 09,9'	07^0 00,3'	3^0 33,0'	2^0 00,0'	00^0 41,0'
57.	Vlöre	13^0 56,0'	11^0 43,4'	09^0 36,0'	08^0 08,5'	07^0 00,3'	3^0 33,0'	2^0 03,0'	00^0 41,0'
58.	Kerkyra	-	11^0 36,2'	09^0 23,0'	08^0 00,1'	06^0 53,3'	3^0 17,0'	1^0 48,0'	00^0 25,0'
59.	Paxi, SE Kerkyra	-	-	-	-	-	-	-	-
60.	Prevesa	-	-	09^0 05,0'	-	-	-	-	-

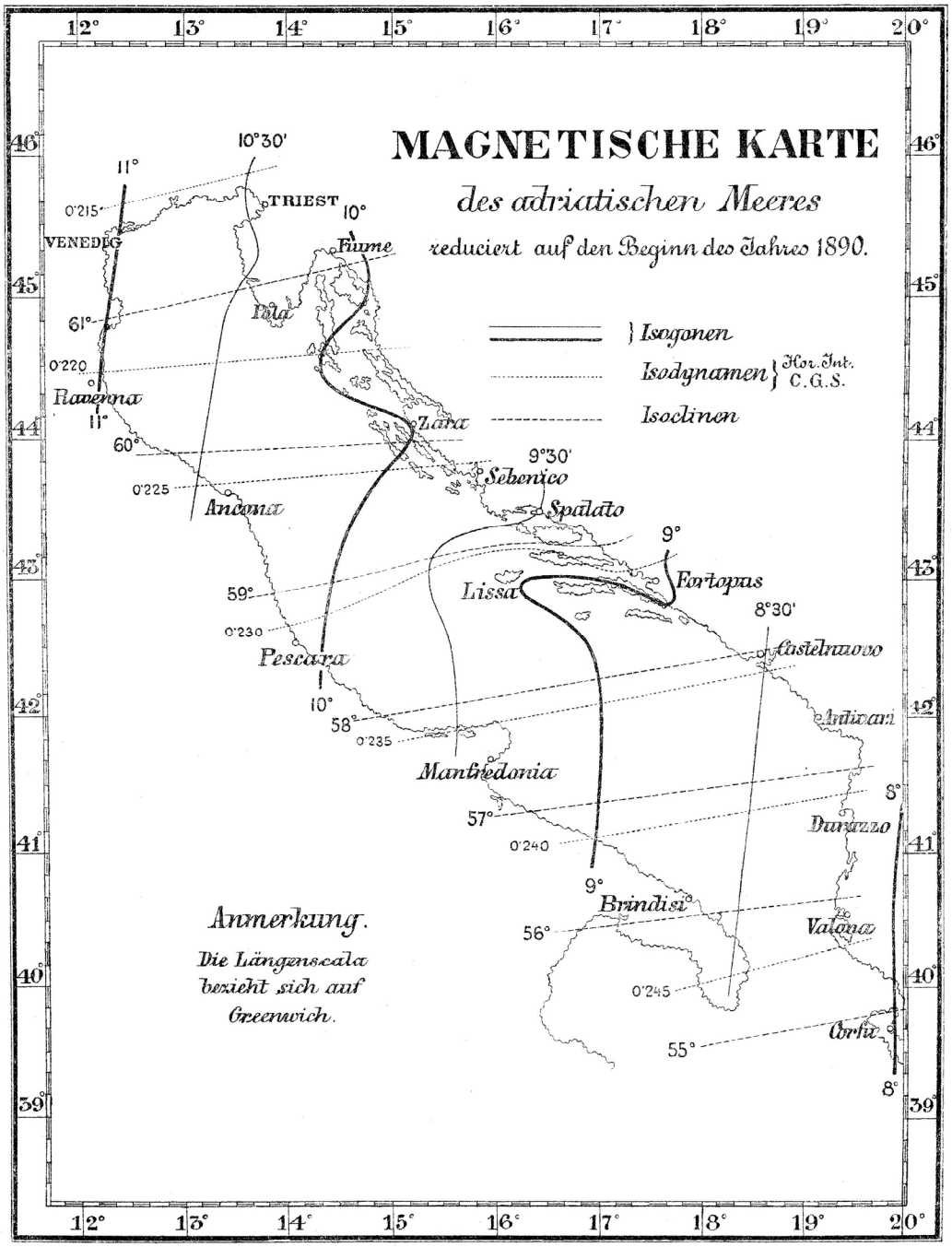
W Jadran

No.	Mjesto mjerenja	1806.	1809.	1810.	1811.	1812.	1818.	1819.	1820.	1821.
01.	Venecija	-	-	-	-	-	-	-	-	-
02.	Malamocco	-	-	-	-	-	-	17^0 50,0'	-	-
03.	Goro	-	-	-	-	-	-	18^0 10,0'	-	-
04.	Primaro	-	-	17^0 30,0'	-	-	-	-	-	-
05.	Ravenna	-	-	-	-	-	-	-	-	-
06.	Rimini	-	-	17^0 10,0'	-	-	-	-	-	-
07.	Ancona	-	-	-	17^0 39,0'	-	-	-	-	-
08.	Fano	-	-	-	17^0 50,0'	-	-	-	-	-
09.	Porto di Civitanova	-	-	-	17^0 21,0'	-	-	-	-	-
10.	Grottamare	-	-	-	17^0 45,0'	-	-	-	-	-
11.	Pescara	-	-	-	-	-	-	-	-	-
12.	Tremiti	-	-	-	-	-	-	15^0 00,0'	-	-
13.	Manfredonia	-	-	-	-	-	-	14^0 55,0'	-	-
14.	Molfetta	-	-	-	-	-	-	-	-	-
15.	Brindisi	-	-	-	-	-	-	-	-	-
16.	Otranto	-	-	-	-	-	-	-	-	-
17.	Santa Maria di Leuca	-	-	-	-	-	-	-	-	-

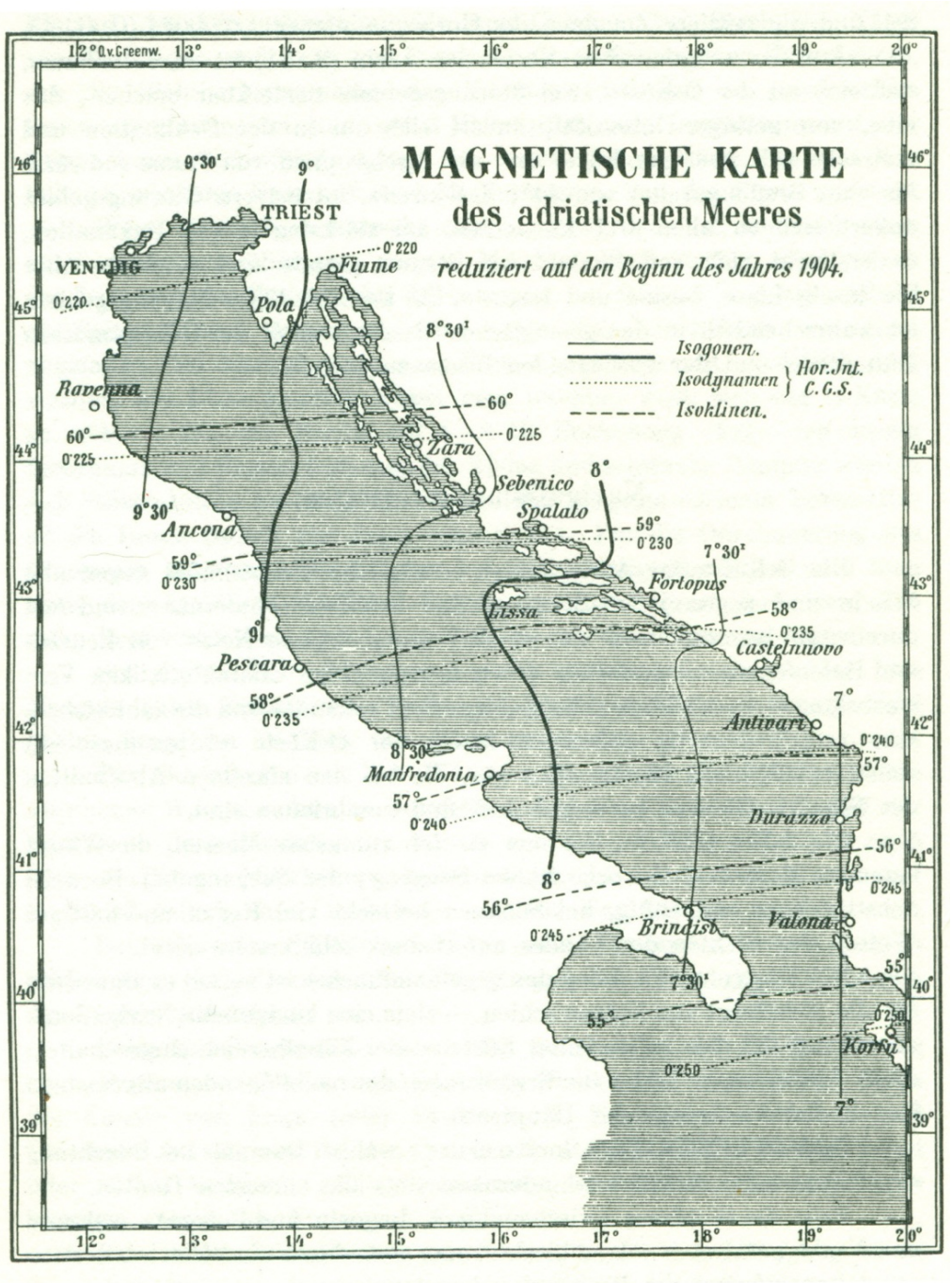
No.	Mjesto mjerenja	1823.	1850.	1870.	1890.	1904.	1928.	1940.	1950.
01.	Venecija	-	15^0 01,1'	12^0 50,0'	10^0 59,8'	09^0 44,6'	-	4^0 32,0'	03^0 08,0'
02.	Malamocco	-	-	-	-	-	-	-	-
03.	Goro	-	-	-	-	-	-	-	-
04.	Primaro	-	-	-	-	-	-	-	-
05.	Ravenna	-	-	-	11^0 01,4'	09^0 47,6'	-	4^0 42,0'	03^0 18,0'
06.	Rimini	-	-	-	-	-	-	-	-
07.	Ancona	-	14^0 08,4'	11^0 55,0'	10^0 17,6'	09^0 05,2'	-	4^0 00,0'	02^0 36,0'
08.	Fano	-	-	-	-	-	-	-	-
09.	Porto di Civitanova	-	-	-	-	-	-	-	-
10.	Grottamare	-	-	-	-	-	-	-	-
11.	Pescara	-	-	-	10^0 05,0'	08^0 54,0'	-	3^0 55,0'	02^0 31,0'
12.	Tremiti	-	-	-	-	-	-	3^0 30,0'	02^0 06,0'
13.	Manfredonia	-	-	-	09^0 26,0'	08^0 16,4'	-	3^0 15,0'	01^0 51,0'
14.	Molfetta	-	12^0 50,6'	10^0 44,0'	09^0 09,7'	08^0 00,1'	-	2^0 53,0'	01^0 29,0'
15.	Brindisi	14^0 35,0'	12^0 16,2'	10^0 06,0'	08^0 37,4'	07^0 29,2'	-	2^0 27,0'	01^0 03,0'
16.	Otranto	-	-	-	-	-	-	2^0 18,0'	00^0 54,0'
17.	Santa Maria di Leuca	-	-	-	-	-	-	2^0 23,0'	00^0 59,0'

Izvor podataka

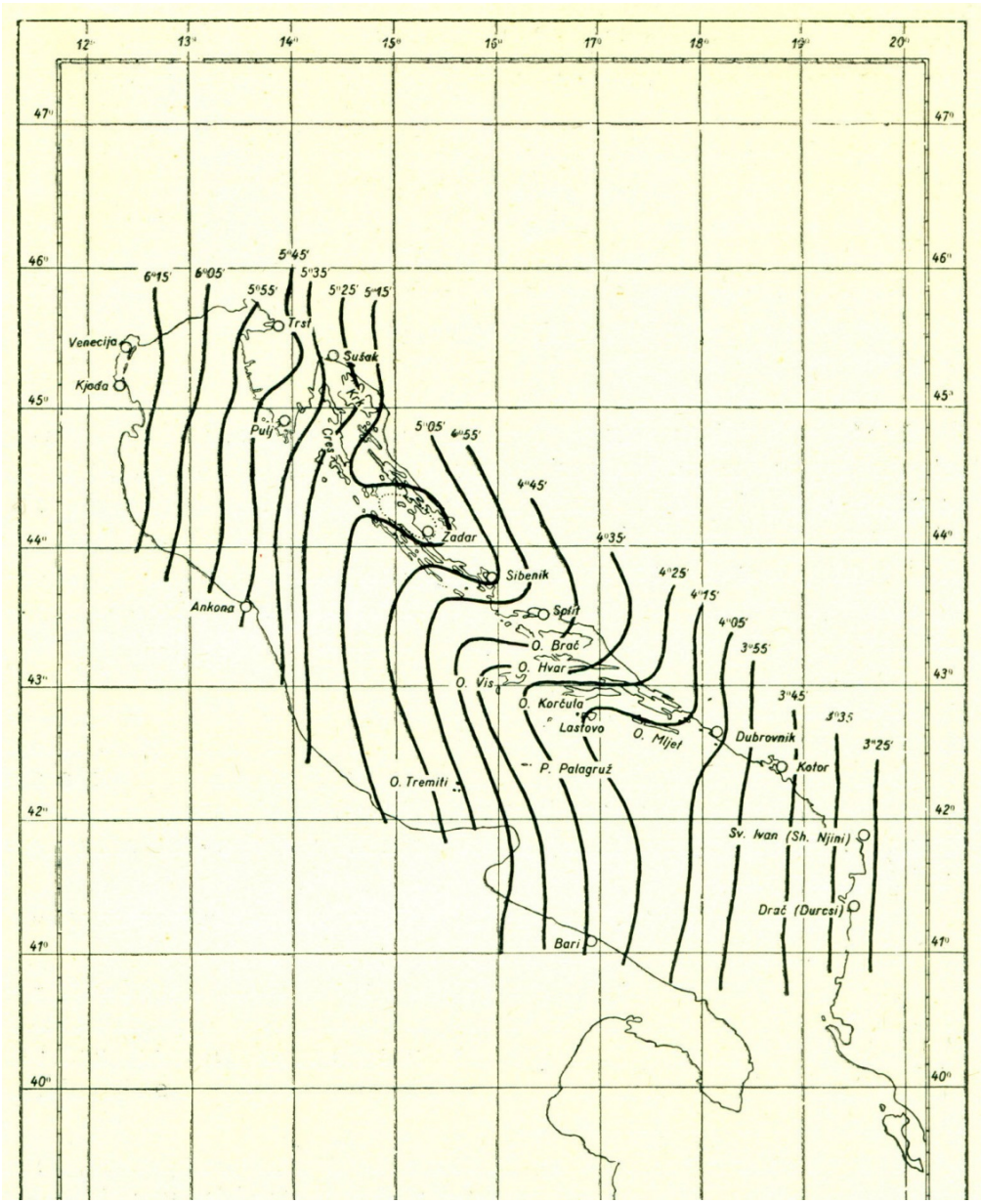
1806. = Beautemps-Beaupre, 1849a: 38, 41-43, 50, 55, 70-71; Idem, 1849b: 9, 12-14, 21, 26, 37, 41-42; Marieni, 1830: 579-580; Idem, 1845: 527-528; **1809.-1823.** = Marieni, 1830: 579-580; Idem, 1845: 527-528; **1850.** = Kreil, 1955: 44-45; Idem, 1862: 42-43; **1870.** = Marieni, 1845: Dopuna - No. 3; **1890.** = Segelhandbuch, 1893: 32; **1904.** = Segelhandbuch, 1906: 30; **1928.** = Opis, 1934: 50; **1940.** = Portolano, 1940: 27; Idem, 1949: 30; **1950.** = Botrić, 1952: 42; Idem, 1953: 37.



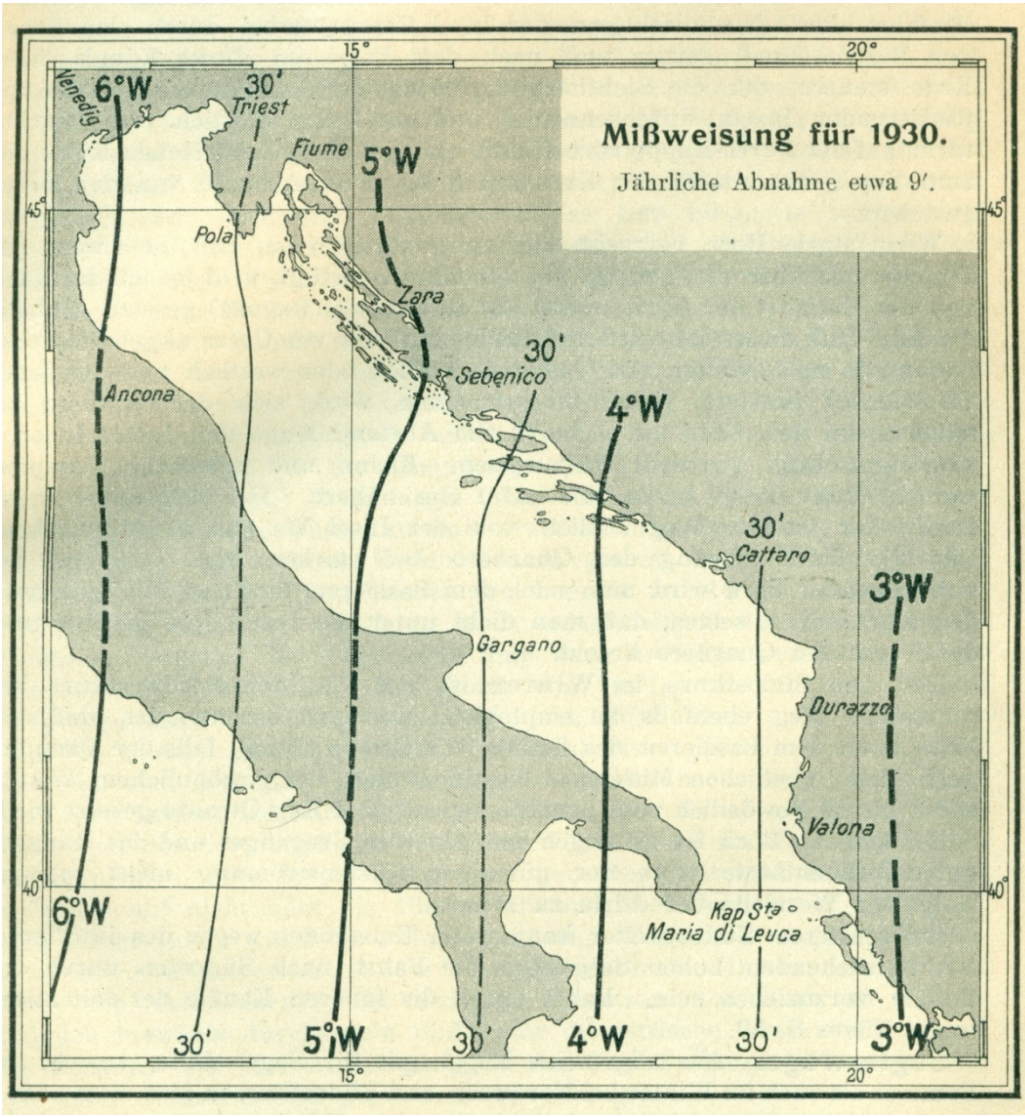
Slika 5. Izogone na Jadranu 1890. godine (Segelhandbuch, 1893: 33)



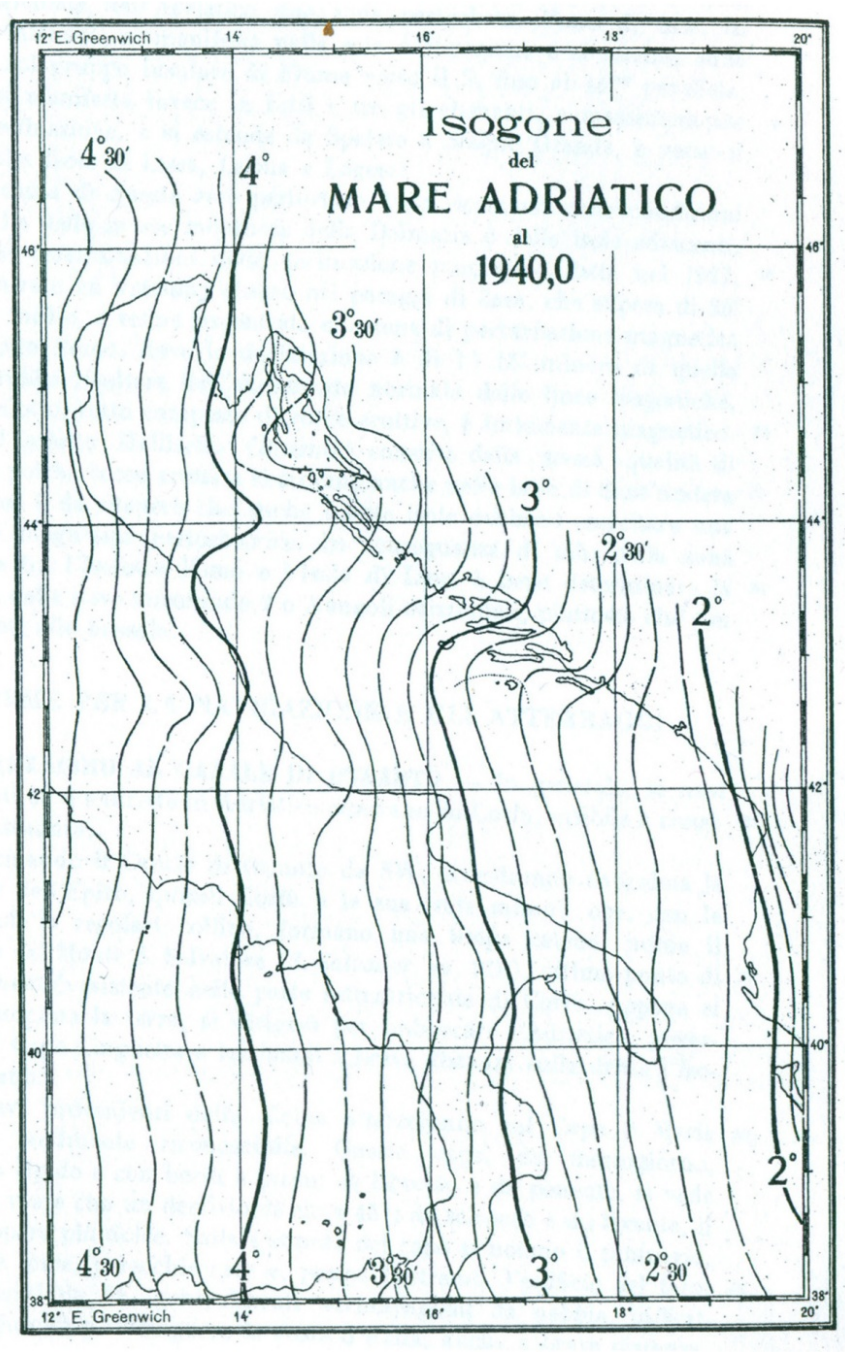
Slika 6. Izogone na Jadranu 1904. godine (Segelhandbuch, 1906: 31)



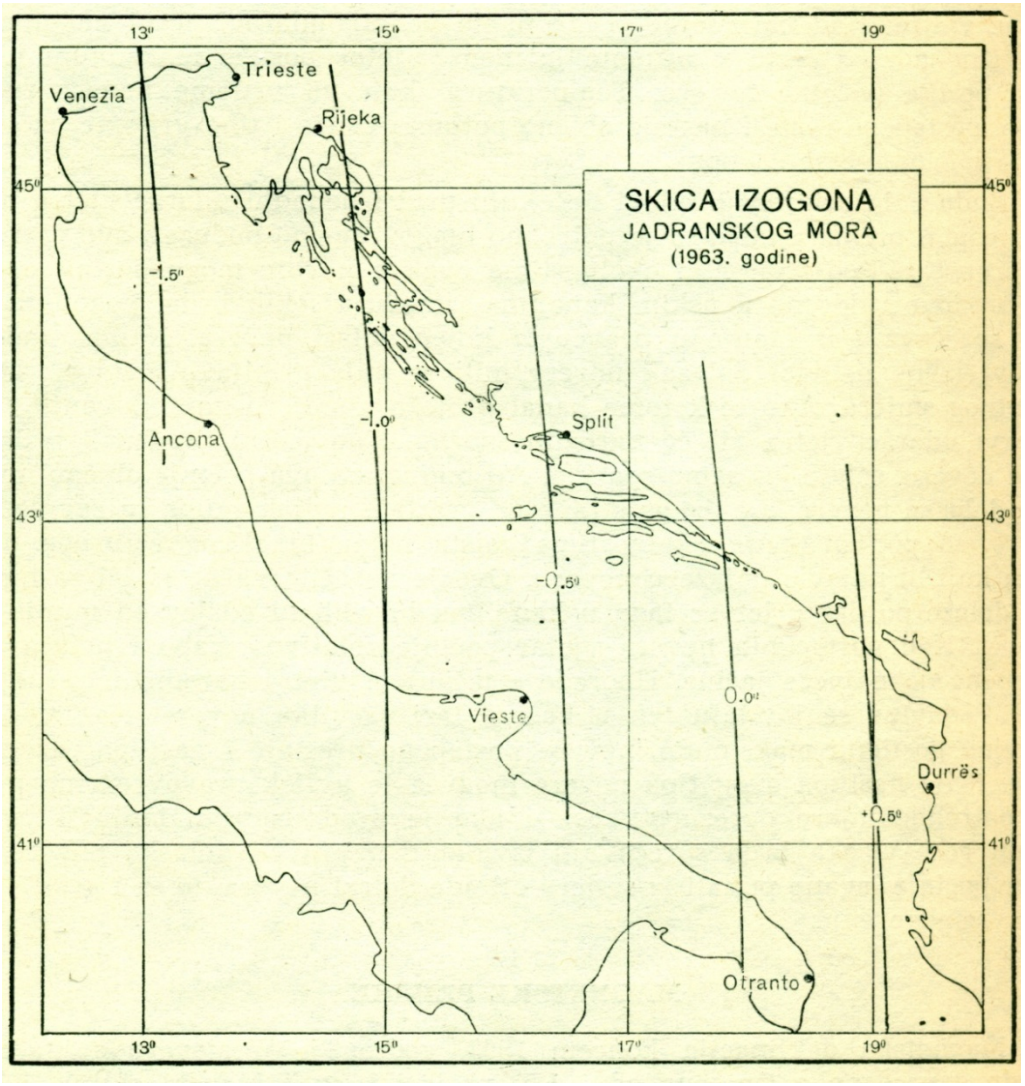
Slika 7. Izogone na Jadranu 1928. godine (Opis, 1934: 51)



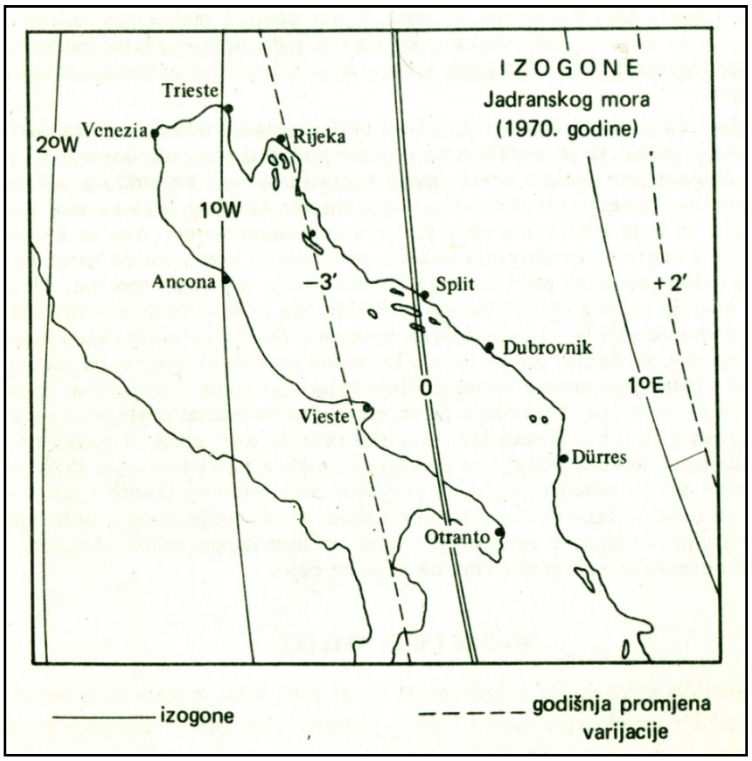
Slika 8. Izogone na Jadranu 1930. godine (Handbuch, 1934: 47)



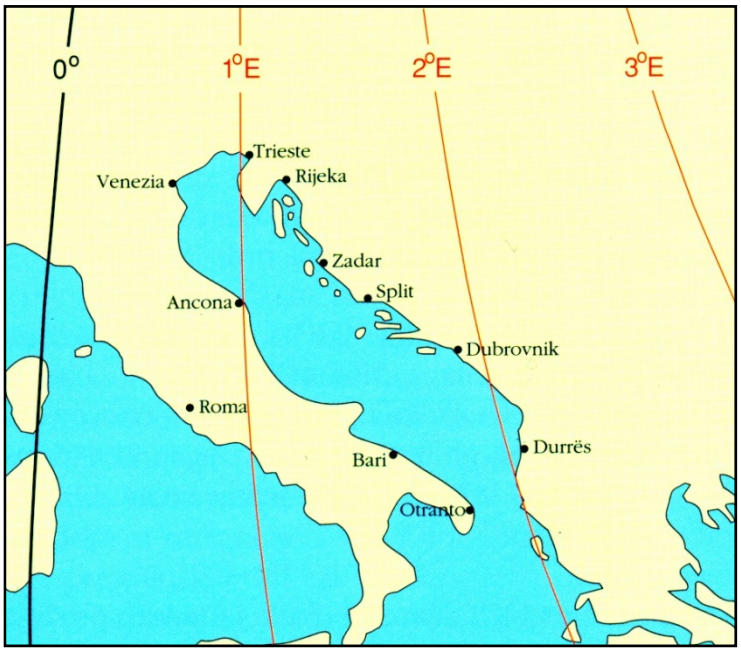
Slika 9. Izogone na Jadranu godine 1940.0 (Portolano, 1940: 33)



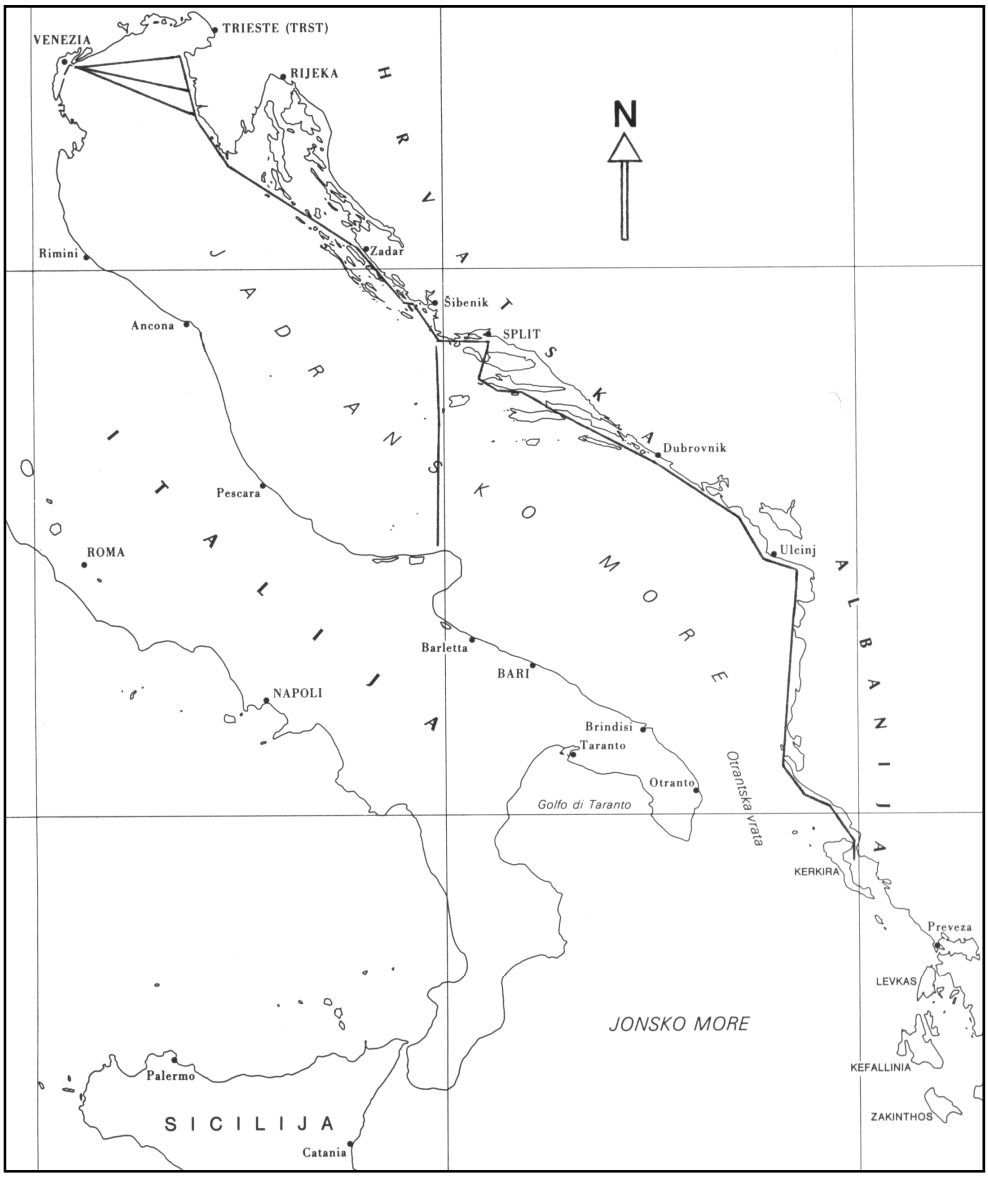
Slika 10. Izogone na Jadranu godine 1963.0 (Makarović, 1964: 16)



Slika 11. Izogone na Jadranu godine 1970.0 (Makarović, 1983: 16)



Slika 12. Izogone na Jadranu godine 1995.0 (Gržetić, 1999: 25)



Slika 13. Milenijski ustaljene dužobalne i najčešće prekomorske plovidbene rute Jadranom (Kozličić, 2000a)

3 ZAKLJUČNA RAZMATRANJA

Tisućama godina najčešća trgovačka plovidbena ruta od SE prema NW i obratno bila je uz istočnu obalu Jadrana, u zaštitničkom pojasu preko tisuću otoka i otočića, uz oslonac na iznimno gustu mrežu svjetionika (Jurčić, 1988). Dalje se, od Otranskih vrata, opet najčešće prateći obalu, plovilo po Sredozemlju i okolnim morima. Najčešće je plovidbena sezona bila od druge polovice proljeća do kraja prve polovice jeseni, kada su klimatske prilike bitno umjerenije, što je posebno bilo važno u eri drvenih jedrenjaka, zbog njihove relativno ograničene razine konstrukcijske kvalitete (iznimna osjetljivost na visoke valove). I tada su se poduzimale prekomorske plovidbe unutar Jadrana, u početku uz pomoć priručnih astronomskih instrumenata, a kasnije i kompasa. Ipak, svijet o magnetskoj deklinaciji nije bila raširena, jer ako kompas zbog njezina utjecaja nije pokazivao dovoljno točan smjer, iskustveno se, kao naslijeđe od očeva i djedova, znalo da za desetak ili više stupnjeva treba više okrenuti kurs prema zapadu ili istoku. Pogibelji zbog tog elementa magnetizma Zemlje nisu stoga bile česte (Slika 13).

Situacija se bitno mijenja od 1806. pa dalje kada izmjere magnetske deklinacije postaju ustaljene. Podaci se objavljuju u peljarima Jadrana i na pomorskim kartama (Slike 4-12), dakle onim pomagalima bez kojih se ni jedan brod od srednje pa prema višoj nosivosti nije ni pokušavao upustiti u plovidbu. U tom smislu situacija je bila bitno i financijski olakšana, jer 19-21. stoljeće vrijeme je masovne uporabe tiska, čime su pomorske karte i peljari postali bitno jeftiniji u odnosu na vrijeme prije izuma tiska. Konačno, od kraja 19. stoljeća do kraja je razrađen sustav kompenzacije magnetskog kompasa, koji naravno nije mogao u cjelini otkloniti utjecaj magnetske deklinacije, ali ga je svodio na prihvatljivu mjeru. Za to su služili poligoni za kompenzaciju u Fažanskom kanalu pred Pulom (doba austro-ugarske vlasti) i istočni dio Kaštelanskog zaljeva kod Splita (vrijeme dviju Jugoslavija).

K tome, i magnetska deklinacija se počela postupno smanjivati, od oko 170 zapadno 1806. do 00 1970. godine, kada se izogona s tom vrijednošću nalazila po sredini Jadrana: NW od nje i dalje je bila zapadna, a SE od nje istočna magnetska deklinacija (Slika 10). Godine 1995. ta nulta vrijednost pomaknut će se toliko na zapad da će izići iz okvira akvatorija Jadrana, na kojem će srednja vrijednost magnetske deklinacije biti oko 1,50 istočno (Slika 11).

Konačno, u zadnjih pola stoljeća, masovnom zamjenom magnetskih sa žiro-kompasima, a u najnovije vrijeme uvođenjem satelitske navigacije, ali i promjenom najčešćih plovidbenih pravaca, osobito za velike brodove Lakoš (1985), magnetska deklinacija u smislu sigurnosti brodova, postat će minorna. Čak i kod onih brodova izgrađenih od feromagnetskih materijala koju uz to prevoze teret također izrađen od istih materijala, čime se bitno utjecalo na brodski magnetizam.

U tom smislu ovaj rad ponajprije je usmjeren na prikaz promjerenja položaja i intenziteta izogona magnetske deklinacije od istoka prema zapadu, kada se radi o Jadranu, uz istovremeno isticanje potpuno zanemarenog dijela historijskih izvora, relevantnih za precizno razumijevanje mijena magnetske deklinacije na istom tom akvatoriju.

LITERATURA I IZVORI

Pogledati literaturu na stranici 26

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