

Weather and climate notes on the Adriatic up to the middle of the 19th century

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The paper deals with weather and climate descriptions originating before the establishment of the meteorological station network. The oldest of them stem from as long ago as the second and the first century B.C. They may be found in local and foreign almanacs, reports, letters, newspapers and books. In the first part of the paper records of weather are ordered chronologically. These are casual notes, accounts of somehow peculiar weather events, and even regular, almost daily weather notes written through many years in the 18th century in Makarska. The second segment presents reports on common weather characteristics, i.e. climate attributes. These are mostly wind accounts, particularly of Bura (Bora), but there are also a few climatographies.

Keywords: old meteorological notes, weather, climate, the Adriatic

Introduction

Many centuries before the introduction of systematic meteorological observations, prompted by various events people made notes on weather or climate, registering, of course, only what they could see or otherwise sense without the aid of instruments. The first such known documents for the Adriatic region (Figure 1) are older than two thousand years, and are still being discovered in various locations – this account must therefore not be considered as final. In this review we shall arrange them into two groups: the first one refers to a fully defined and known short period, so it depicts weather, and the second refers generally to weather attributes *i.e.* to the climate.

Records of weather

As we shall later see, records of weather on a specific day or month may be found primarily in monastery, parish and other annals, in preserved let-



Figure 1. Map of the Adriatic

ters from prominent individuals, and recently in the press too. These are often more or less accidental notes within reports of battles, earthquakes and some other extraordinary events, or descriptions of some rare or unpleasant weather phenomenon. Almost proper meteorological journals were found too. Such notes may be interesting due to their age, author or the historic context they arose from, and some of them present a base for the study of climate instability.

In the text on the Alexandria war,¹ which is supposed to be written by *Hirtius*, the associate to Gaius Iulius Caesar, military ventures in the Adria about 50 B. C. are also cited, and weather circumstances, particularly chills and wind, are occasionally specified. This *Hirtius* report is mentioned in several articles in Croatian. We shall portray it here in greater detail to facilitate proper understanding of his notes on the weather.

1 C. I. Caesar, 1906: Libri III de bello civili cum libris incertorum auctorum de bello Alexandrino Africo Hispaniensi. E Typographeo Clarendoniano, Oxonii.

Chapter 43 of the text discusses the stay of Gabinius, Caesar's army leader, in the Illyricum. When Gabinius arrived there during the winter and rough season of the year, he could not use boats because gales prevented sea travel. During the worst of gales and in spite of shortages he prepared to conquer fortified towns:²

... Gabinius ut in Illyricum venit hiberno tempore anni ac difficili ... neque navibus intercluso mari tempestatibus commeatus supportari poterat; ...Ita cum durissimis tempestatibus propter inopiam castella aut oppida expugnare cogeretur ...

Gabinius was overcome by the barbarians (this is known to have happened in the year 48 B. C.) and he had to retreat to Salona where he died from illness a few months later. Pompei's legate Octavius then hoped to conquer the whole province. The main event which is described in the next four chapters of the same document is the battle at Tauris (Šćedro, a little island between Hvar and Korčula) in the year 47 B. C. In each chapter one information on the weather conditions may be found.

Chapter 44. On getting the news from Illyricum, Caesar's general Vatinius in Brundisi (Brindisi) started preparations for a military campaign to expel Octavius from the east Adriatic. Although severely ill he mastered his disease and the difficulties arising from winter and from hasty preparations through enthusiasm.³

... tamen virtute vicit incommodum naturae difficultatesque et hiemis et subitae praeparationis.

He sent a letter to Ahaia requesting support in boats, but as it did not arrive he rigged the ships he had, embarked the army and set off for Illyricum. He met the Octavius army at Epidauros (Cavtat).

Chapter 45. Octavius immediately retreated to the island of Tauris where he intended to affront and defeat the inadequately equipped enemy. Vatinius started to pursue him, but did not know where he will find him. When he approached Tauris, his ships dispersed because the gale was fierce and nobody suspected the enemy there,⁴

Cum propius Tauridem accessisset distensis suis navibus, quod et tempestas erat turbulenta et nulla suspicio hostis, ...

he spotted a battleship. Other Octavius ships left the harbour and both fleets aligned for battle.

Chapter 46. In the furious close range battle in a small area of the sea the Vatinius were dominant. Among others they sank the Octavius ship too. He

2 Caesar o.c. 44.

3 Caesar o.c. 44.

4 Caesar o.c. 45.

swam wounded, by his own, to his cruiser ship and sailed away in a huge storm, when night halted the battle:⁵

... cum proelium nox dirimeret, tempestate magna velis profugit.

A few of his ships, saved by chance from destruction, followed him.

Chapter 47. Vatinius stopped on Tauris, rested, repaired his and the captured ships, and after the third day rushed to the island of Issa (Vis) where he hoped to catch Octavius. However there he found out that the latter had left for the Greek provinces, with some smaller boats in favorable winds:⁶

...comperitque ipsum Octavium parvis paucisque navigiis vento secundo regionem Graeciae petisse ...

From there he sailed to Sicily and then to Africa. In this way Vatinius had, in short time, taken the province back, expelled the hostile navy from the Adriatic and returned to Brindisi a victor, preserving the army and the ships.

All this leads to conclusion that an Adriatic cyclone caused a storm on the day when the two fleets, Caesar's and Pompei's, were fighting for the domination of the Adriatic Sea in the well known battle of Tauris. We are lead to conclude so by the ferocity and the duration of the storm – it was raging before and still after the great battle – which is also consistent with the season of the year in which the event occurred. Admittedly, it is not known how long Vatinius prepared in Brundisi, but if he did not reach Tauris in winter it must have happened in early spring, and in that season there are yet no thunderstorms (called »nevere«) which belong to the warm half of a year and which are rather short-lived and frequently weaker too. In principle, severe storms develop in a cyclone. Behind it follows the wind from the northern quadrant, regardless whether the cyclone moved to the Ionian Sea (in winter) or to the continent (in spring), and this was favorable for Octavius to leave the Adriatic. Other data on weather during the battle of Tauris which may be found, some even in quotation marks, fit this picture, but they could not be found in the Latin original.⁷

We must also mention the storm which in autumn of the year 60 tossed the boat conveying the apostle Paul from Caesarea to the magistrate in Rome. They have been at sea for fourteen days, finally beaching at an island where the passengers spent three winter months.⁸ Opinions which located

5 Caesar o.c. 46.

6 Caesar o.c. 47

7 see M.Kozličić, 1983: Pomorska bitka kod Taurisa. Dubrovački horizonti 23, 38–41; M. Kozličić, 1990: Historijska geografija istočnog Jadrana u starom vijeku. Književni krug, Split, 417 pp. and the end of chapter 46 of Alexandria war translated by T. Smerdel quoted by M. Nikolanci, 1974: Pomorska bitka kod Taurisa, Prilozi povijesti otoka Hvara IV, 5–15.

8 Kršćanska sadašnjost, 1990: Biblija. (Ed. J. Kaštelan, B. Duda.) Zagreb, 368 pp., Djela apostolska 27, 28.

the stranding on the island of Mljet, are rejected in favor of Malta. Differing explanations of that journey result from the ambiguous geographical names. According to the Apostle volumes the wind hauled the boat through the Adriatic, but at that time the name was used for the Adriatic Sea as well as the seas all the way to Africa between Crete and Sicily. Furthermore, Malta as well as Mljet had the Latin name Melita then.

In Hennig's Catalog⁹ the winter of 441/442 has been noted as severe and snow-rich, particularly in the Illyricum (according to F. Schnurer, Chronik der Seuchen, Tübingen 1842).

The winter of 859/60 was very cold. Parts of the sea at the northern Adriatic rim were frozen so that carts could pass over them. Hennig¹⁰ reports this on the basis of the Fulda monastery chronicles and many similar sources, Italian among others. Hildebrandsson¹¹ and Köppen¹² mention the same winter.

In the year 1177 political and ecclesiastic matters have induced the pope Alexander III to decide on sailing from the small town of Vieste on the tip of the Monte Gargano peninsula to Venice and visit Zadar on that occasion. At the beginning rough weather delayed the departure of the ships, and then forced them to stop at the islands of Palagruža and Vis. The political and churchly circumstances, the voyage itself, and the popes visit to Croatian lands were depicted by Oreb¹³ using original documents and folk tradition. The following weather report for the Adriatic from February 9th to March 17th, 1177 is based on his paper:

The pope waited in the small town of Vieste thirty days for the storm to calm down and the favorable south wind to start blowing, enabling him to sail to the east coast of the Adriatic and alongside it to Zadar:¹⁴

Ceterum cum valida maris tempestas issum iam per XXX dies contra propositum suum ibidem detinuisset invitum, ecce subito auster diu desideratus advenit, et statim naute ad tranfretandum eundem pontificem alacriter invitarunt

writes the pope's escort and author of his biography, cardinal Boson. The weather suddenly turned for better in the night before March 9th so the ships

9 R. Hennig, 1904: Katalog bemerkenswerter Witterungsereignisse. Abhandlungen des Koenigl. Preuss. Met. Inst, II/4, 93 pp.

10 Hennig o.c.

11 H. Hildebrandsson, 1881: Beitrag zur Verzeichung der strengen Winter Europas. Zeitschrift für Meteorologie 14, 345.

12 W. Köppen, 1881: Über mehrjährige Perioden der Witterung, IV. Die strengen Winter Europas... Zeitschrift für Meteorologie 14, 183–187.

13 M. Oreb, 1993–1994: Papa Aleksandar III. na Visu. Adrias, Zbornik Zavoda za znanstveni i umjetnički rad HAZU u Splitu, 4–5/ 81–120.

14 Oreb o.c. 88

sailed directly before morning. But about noon Bura arose, and the southerly wind calmed down completely. Instantaneously the sea was severely agitated:¹⁵

Sed circa meridiem superveniente bora, prorsus extinctus est auster, et illico facta est in mari turbatio maxima.

Pope's life was endangered. Ten boats arrived to Palagruža with great efforts of the rowing crew, where they anchored sheltered from Bura, yet two freight boats could not master the wind but returned with one ship to Vieste. Citizens of Komiza who fished at Palagruža prepared a generous supper for the unexpected and dear guests. However, the Bura calmed down and when the travelers fell asleep the south wind started blowing again. According to Boson it animated the sailors to pull out:¹⁶

Post modicum vero spatium, cum iam quiescerent omnes, ex insperato desiderabilis auster nautis adrisit, et eos ad agendum non mediocriter animavit.

So they hoisted all the sails in a mood of common joy and departed while it was still dark. They landed at Vis on March 10th close to the noon. The truth is probably that the vessels had to sail away from the windward side of the island even though the night was dark and the sailors and oarsmen were sleepy, so that the winds and waves – if rising – would not smash them against the rocks of Palagruža. That is why they stopped at Vis to rest, contrary to their travel plans. The pope stayed on Vis for the whole next day too. In the meantime the fishermen of Vis sailed, down a weak Jugo (Scirocco), to Split to inform the archbishop Raineri of the pope's arrival. The archbishop and the town authorities set out early in the morning on the 11th carrying much food and presents towards Vis, where they arrived, sailing near to the wind, in about ten hours, *i.e.* at approximately three o'clock in the afternoon. During a strong Jugo that journey would not be possible at all. The departure of the pope and the archbishop from Vis come about in the night to March 12th, to enable them to reach Šibenik archipelago by day, because it requires watchful passage between the numerous islands and rocks. They sailed through there in optimal circumstances, with Jugo in the stern, yet they did not reach Zadar the same night but only on Sunday the 13th before sunrise, during strong Bura. According to the chronicles of the Modruš bishop Šime Kožičić – Benjo, native of Zadar (16th century), the whole town assembled in the harbour to meet the pope, even though strong Bura was blowing, praying for an apostolic blessing, which he donated to the citizens of Zadar numerous times:¹⁷

15 Oreb o.c. 88.

16 Oreb o.c. 88.

17 Oreb o.c. 117.

Venienti tota civitas in portum effusa, licet ventus aquilonaris esset validus, obviam processit, deprecantes omnes Apostolicam benedictionem Jaderinis pluries elargitam.

When the Bura diminished on March 17th, the pope sailed off to Venice, and the Split archbishop returned to Split.

We could deliberate on the pressure and wind system patterns during pope's wait in Vieste and the voyage through the Adriatic in the following way (Figure 2):

Cyclonic activity in the Tyrrhenian and Ionian Seas with high pressure in the Middle Europe up to the Dinarides may last for several weeks in January and February. During such circumstances the weather is unstable and windy in Apulia, but certainly without winds from the southern quadrant in the Adriatic. With the spring lengthening of the day the continent begins to warm up and the shallow winter high above it disappears. In this way a pas-

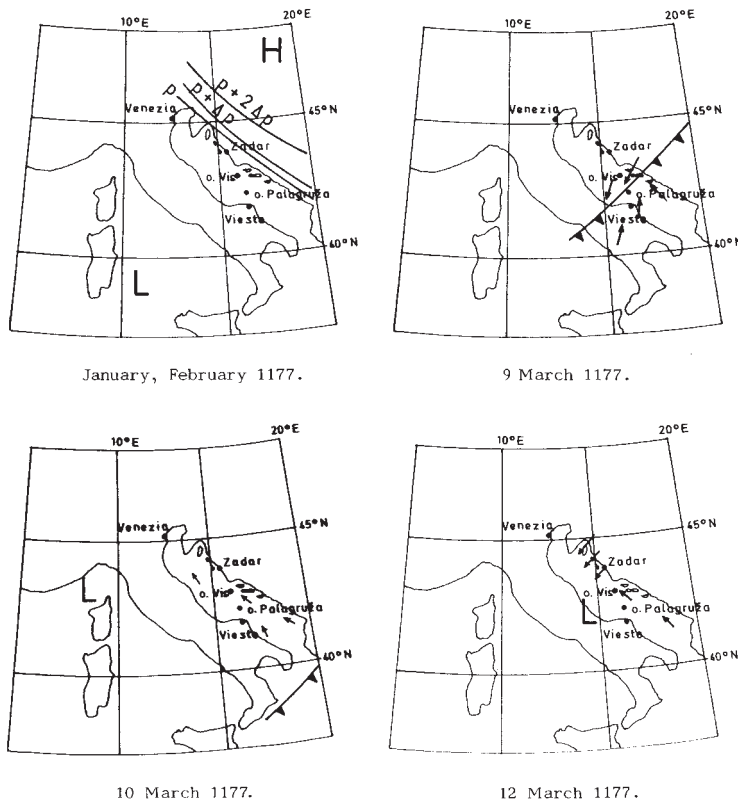


Figure 2. Supposed locations of atmospheric fronts and pressure systems during the pope's visit to Croatia in 1177.

sage is created for the western drift above Europe. In that current a well-marked and fast cold front may have passed to the east, also crossing over the Adriatic on March 9th, causing initially the south wind and immediately after that a short lived Bura. The cold air behind the front induced cyclogenesis in the Genoa Bay and hence the veering of the wind to Jugo again in the night of March 10th. It was not strong during the days of 10th and 11th, implying that the cyclone remained in the Gulf of Genoa for two days and then moved to the Adriatic Sea. Sometime before the evening of March 12th, in front of Ravni Kotari (middle of Dalmatian coast), the ships have transferred from the domain of Jugo on the leading edge of the cyclone into the region of Bura behind its center and that prevented their entrance into Zadar still by the night. Since the wind still lasted for a few days in Zadar – where due to the low relief the probability of Bura is lower then elsewhere on the coast – it is appropriate to deduce that the pressure gradient favorable to Bura was comparatively large. The cyclone has meanwhile pulled away. As it was already middle of March, it is more likely to have moved eastward or north-eastward to the continent, then along the Adriatic to the Ionian Sea.

In the winter of 1210/11 there was an abundance of snow in Austria; the river Po and parts of the north Adriatic were frozen to such a degree as to bear heavy carriages.¹⁸ The same winter is mentioned by Köppen¹⁹ and Kratochwill.²⁰

The Adriatic and the river Po were frozen again in the winter of 1234.²¹ The winter was very cold in many parts of Europe.²²

In the chronicles of European cities and monasteries the winter 1322/23 is recorded as unusually severe. This winter was also quoted by Köppen,²³ Kratochwill²⁴ and Knoch.²⁵

The nobleman of Zadar *Pavao Pavlović* has recorded in his annals some meteorological phenomena and events too.²⁶

One of these is the great hail in the night of February 23rd 1402, just before the first slumber. The grains were as large as big hazelnuts, and some as

18 Hennig o.c. according to Wenger, Unglückschronik, Bern 1888.

19 Köppen o.c.

20 F. Kratochwill, 1940: Über kalte und strenge Winter in Mitteleuropa. Meteorologische Zeitschrift 73, 420–424.

21 Hennig o.c. according to Wenger, Unglückschronik, Bern 1888.

22 Hildebrandsson o.c., Köppen o.c., Kratochwill o.c.

23 Köppen o.c.

24 Kratochwill o.c.

25 K. Knoch, 1929: Heisse Sommer und strenge Winter im 14. bis 17. Jahrhundert in Norddeutschland. Zeitschrift für angewandte Meteorologie 8, 221–224.

26 F. Šišić, 1904: Ljetopis Pavla Pavlovića patricija zadarskoga. Vjestnik kr. hrvatsko-slavonsko-dalmatinskog zemaljskog arkiva, VI, 37–43.

smaller walnuts. In the same night a live child, aged about three months, was brought to St. Martins church in the surroundings of Zadar, born without arms and legs. A few days earlier a comet could be seen in the sky:²⁷

1402. Die iovis 23. mensis februarii de nocte ante primum somnum, fuit in Jadra grando maxima, ita quod fuerunt grana magnitudinis unius magnae avelanae et quasi unius parvae nucis et eadem nocte fuit portata una creatura unius infantis vivi circa trium mensium apud ecclesiam Sancti Martini ante Jadram, ... ; et paucis diebus ante haec visus fuit cometa in coelo.

Another phenomenon was the sun halo described as follows: On Sunday May 11th 1404 in the third hour a sign appeared in the sky, the sun could be seen circled by a closed arch. Outside the circle the moon was foremost and inside the circle a star followed:²⁸

1404. Die dominico 11. mensis madii apparuit hora tertiarum signum in coelo, apparuit enim sol circulatus arcu foederis, quem extra circulum anteedebat luna et inter circulum sequebatur stella una.

According to the Pavlović records the winter of 1404/1405 was very cold and long. He notes that already in the spring of 1404 very few swallows arrived to our provinces, they hatched their young only once and not twice as usual, and left over the seas many days earlier than customary. In the same year not one small bird appeared, like the sparrows or similar, and all the summer the dangerous flies which bred out of proportion persisted, as well as very few fleas. The next winter great droughts prevailed and water would hardly accumulate in the cisterns. From the day of St. Lucia in the month of December for almost a hundred days, north winds continued, with very severe and unusual chills, deep snows and huge ice on the mountain slopes as well as at the seaside, so that many ports and shores were frozen rather wide on our islands and also in the region:²⁹

...venti septentrionales a festo Sanctae Luciae de mense decembris quasi per dies centum cum asperrimis frigoribus et insuetis continuo vigerunt profundissimae nives, glacies grossissimae et latae in montibus et apud maritima, ita ut multi portus et littora satis large congelata fuerunt per insulas nostras et iuxta civitatem, ...

The fishermen and the hunters found dead small fish and small frogs with dried toes or legs from the cold and great ice. Soon after that, at the end of March, some kind of fog descended in those parts:³⁰

... et inde circa finem mensis martii proxime sequentis, cecidit quaedam caligo in partibus istis, ...

27 Šišić o.c.

28 Šišić o.c.

29 Šišić o.c.

30 Šišić o.c.

Immediately, almost on the same day, many people of both sexes fell ill with major cough, headache and fever. The disease spread. Finally, there were more than a thousand ailing in the district so there was no house without a patient, and in some of them almost everybody lay in bed. However only few people died from that disease, and those who succumbed were mostly very old. Additionally, let us mention that Kratochwill³¹ recorded the quoted winter as a cold one.

Hennig notes that the winter of 1490 was very harsh and the Adriatic Sea froze in the region of Venice. It is not evident from where this information originates:³²

1490. Sehr strenger Winter; das Adriatische Meer bei Venedig zugefrozen.

Köppen writes of the same winter.³³

The chronicles from 1571 describe how in that summer on Assumption Day a sudden and mighty storm saved the city of Korčula from Algerian pirates. The citizens of Korčula could not have resisted them if the wind and waves did not smash the pirate galleys against the rocks and sunk them.³⁴

In the year 1594 the Adriatic has again been frozen near Venice.³⁵ The harshness of that winter was confirmed by Köppen.³⁶

It has also been recorded how the Uskoks of Senj fared well in their clashes with Turks and Venetians during February of 1598 in the region from Primošten to Krk, because they knew how to use the Bura and Jugo which raged in turn in those days. The enemy soldiers and ships definitely were not competent to fight in those winds. This is reported by Klaić³⁷ according to the paper: Minucio Minuci, *Historia degli Uscochi scritta da ... arcivescovo di Zara. Co i progressi di quella gente sino all'a(nno) 1602.*

According to many old chronicles the winter of 1607/08 was unusually severe. The cold was hard even in Spain, and high snow was recorded in Padova:³⁸

Ungemein strenger Winter, »Der grosse Winter« genannt, in ganz Europa und ebenso in Nordamerika, wo die europäische Kolonie Sagadahoc daran zu Grunde geht, neben 763 und 1740 der härteste, der je vorgekommen ist; Beginn in Europa am 21. Dezember (n.St.), Höhepunkt am 20. Januar; alle

31 Kratochwill o.c.

32 Hennig o.c.

33 Köppen o.c.

34 M. Sijerković, 1993: *Hrvatski vremenari. Školske novine*, Zagreb, 138 pp., p. 18–19.

35 Hennig o.c. according to S. Lancelloti: *L'Hoggidi ovvero il Mondo non peggiore, ne piu calamitoso del passato. Venezia 1630.*

36 Köppen o.c.

37 V. Klaić, 1973: *Povijest Hrvata*, V. Matica hrvatska, Zagreb, 741 pp., p.551.

38 Hennig o.c.

Flüsse zugefrozen, selbst die Themse derartig, dass man auf dem Eise Boote zimmert; auch die Ostsee und der Bodensee zugefrozen; noch in Padua ungewöhnlich hohe Schneedecke; auch Spanien arg betroffen; selbst dem König Heinrich IV. ist eines Morgens beim Erwachen der Bart gefrozen; der Wein gefriert in den Fässern; noch nach Pfingsten (15. Mai a. St.) laufen die Knaben bei Danzig auf den gefrorenen Gräben Schlittschuh.

The winter is cited by Köppen,³⁹ Knoch⁴⁰ and Kratochwill.⁴¹

In the Dižmar journal which was kept by canons in Vrbnik on the island of Krk, three extraordinary cold spells were recorded. At the end of January 1616 high snow fell all over the islands and the ice persisted for 10 days so the cattle was afflicted:⁴²

...1616 jenvara dan 21 pade velik snig po vsuda i na otoci bi veliki požled i dura dan 10. Živina zlo stojaše.

In the end of February and at the beginning of March of 1620 it was so cold that wine froze in the chalice during a mass service as well as in the barrels:⁴³

1620. To leto bi prestup i to leto se učini fortuna od bure na dan S.tog Matija. I učini se tolika stid zač ta stid dura veliko vrime. To isto leto biše perva sreda na dan 4. marča. I takova stid biše da parvi četartak korizmi ja pop Matii Sparožić služeč misu od kuventa i smarznu se S.ta karv u kaleži i vsim ostalim redovnikom ki služahu ta dan. I potli se smarzivaše vsaki dan. Posahnuše ...i vino u bačvah se smarzivaše.

In February of the next year the weather was windy and very cold too. Wine froze in barrels again, the trees were frost-bitten, and the cattle could not find fodder because everything was frozen:⁴⁴

1621 na dan 26 pervara (febrara) dignu se fortuna od bure. Učini se tolika stid da se vino u bačvah smarzivaše. I mnogo drivja pozebnu. I dura ta stid dan ... Živina zlo staše zač se vse kali bihu smarznuli da na njih ne imijahu jist i ne mogahu se pred veliku stidi pomoć. Vsi od Boga pomoći čekasmo ki nam vazda pomozu Amen. I ja to teško zapisah zač ne mogah od zimi.

Kratochwill⁴⁵ noted both of these last winters, and Hildebrandsson,⁴⁶ Köppen⁴⁷ and Knoch⁴⁸ noted the second one.

39 Köppen o.c.

40 Knoch o.c.

41 Kratochwill o.c.

42 A. Gilić, 1948: Bilješke o vremenu u XVII. stoljeću. Hidrometeorološki glasnik I/2, 128.

43 Gilić o.c.

44 Gilić o.c.

45 Kratochwill o.c.

46 Hildebrandsson o.c.

47 Köppen o.c.

48 Knoch o.c.

Along with reports on earthquakes, weather descriptions are frequently found because many considered that the two phenomena may be causally related. Consequently, reporters of the strong Dubrovnik earthquake of 1667. registered that it occurred in fine weather.⁴⁹ The Franciscan Vid Andrijaš described the event extensively ten days after the quake to Diodon Boždarić (Bosdari) in Ancona, and the latter printed the letter in the same year to motivate the Italians to help Dubrovnik »... I write to you ... that on Ash Wednesday, April 6th 1667, in fair weather, clear skies and weak south wind, while the community was ready for holy communion ... and the priests were busy with confessions, ... exactly at 14 hours (note: 9 o'clock according to today's count) a tremor arose ... so fierce, that ... the quake ... demolished and destroyed ... whole of Dubrovnik and surroundings ... only a few houses remaining and these are damaged too ... On that gloomy day all the fires were burning ... to prepare what was required for a meal and for the holy days. So the fire caught the wood of the collapsed houses, and the north wind stirred it up and amplified it so that finally it destroyed everything ... the remaining buildings, property and the people buried alive.« The Dutch consul Jakob van Damm on his way to Smirna stayed in Dubrovnik through the earthquake and notes in an extensive report to his government that the earthquake came about in the finest weather.

In the period from 1662 to 1686 the friar *Pavao Šilobadović* kept the annals of the Franciscan monastery in Makarska. In spite of hard times, when murders, robberies and plundering in the region of the Turkish border were more significant than bad or fair weather, in this 24 years he made also 11 notes on weather. They concern exceptional events like late snow on the Biokovo mountain, long lasting cold with Bura and snow on the ground, drought, fog, spout, strong Bura and Garbin (south-west wind):⁵⁰

1662. ... Ovoga godišća bi suša šest mjeseci, to est: sarpnja, ilinščaka, gospoinščaka, rujna, listopada i studenoga. ...

1678, mjeseca januvara na 22. – Udari garbin koga nisu zapamtili starci 80 godišća učini ruinu od brodova da ne more niko u Dalmaciji znati ni u Istriji takoga garbina.

In the year 1709 the winter was very cold. It is pointed out in many parish and town chronicles in Europe.⁵¹ The chronicler Gojak from Makarska recorded it as such in later years.

After a pause, the monastery annals in Makarska continued in the 18th century They were attended to by fra *Nikola Gojak* from 1712 to 1772. Among other, he zealously entered weather data. From the fifties almost

49 M. Kišpatić, 1891: Potresi u Hrvatskoj. Rad JAZU 107, 81–164, p.32, 33, 35.

50 J. A. Soldo (ed.), 1993: Makarski ljetopisi 17. i 18. stoljeća. Književni krug, Split, 373 pp.

51 Hennig o.c., Köppen o.c., Kratochwill o.c.

every change of the weather is recorded. His notes provide certain notions on the climate which are scarce even today. These relate to some characteristics of weather types which were not yet subject to systematic research.⁵² Gojak's notes are much more extensive than those from Šilobadović, as is shown by the following examples:⁵³

Paka na 5. gjenara 1755. učini bura nevelika pak učini snig a na Vodokarsće bi bura i snig i sve se smarze i bi velika studen i led ali brez vode zlo i tako slidi vas misec led veliki da se i more smarze i vode žive i vino i rakija niti je ovaki led bijo nego li del 1709.

1758/59. ... Paka od Božića tako lipa vrimenta da ne mogu lipša, brez vitra, brez dažda nego li sve lipo i vedro, a vidi ćemo za koliko će ovo durati! I ovo vrime slidi sve od Božića, samo na 7. denara bi malo dažda a na 8. malo bure pak ništa nego li lipo. Paka 21. malo bure, paka na 2. febrara malo bure, paka lipo vrime. Ovo je čudo priko čuda koje će se moći pripovidati za veće godišta tko bude živ.

Na 15. aprila 1764, što bi Domenica di Palma dođe daž i jaka krupa. Na 16. ovoga lipo, na 17. sirocho. Na 18. daž paka snig do po planine i učini bura velika i slidi na 19. i bi studeno. Slidi na 20, na 21, na 22, na 23. i bi studeno. Glad žestoki po svemu svitu. Slidi bura i na 24. i bi studeno. I ništa se ne zna da je proliće. S(lava) Bogu!

The first example concerns the great cold in the January of 1755, when the sea, running waters, wine and spirits froze. Also in Italy the weather was very cold and dry.⁵⁴ This cold was also evidenced by other authors.⁵⁵

The next chronicler in Makarska was fra *Petar Antulović*, from 1773 to 1780. He primarily recorded weather manifestations which caused great damage or which were beneficial to agriculture.⁵⁶

Gennero 1775. Na 2. ovoga miseca priko noći poče odit snig, ter je slidio i sutradan vazdan, da se nije nigdi ustavio, i bilo ga je dosta i ovda i po skolji, sve do mora, a iza Stina mnogo veće, ter se nije diga da je mnogo vrimenta prošlo; i ne samo da je biho velik snig, da je bila velika i žestoka studen. – Ove iste mećave i leda pomelo je mnoge na mnogo mista; koje je zateklo u putu, uteć nisu mogli, a mećava velika, i tako valjalo je da poginu, kako su i poginuli. Od ovizi jest jedan soldat Konjić, koji je odio iz Sinja, da će u Klis, a mećava prisnaži sve to veće, pak ga najposli pomete u putu. Također jedan čovik s Prugova koji je gonio vino, da će k svojoj kući, ali kuće svoje ne vidi, niti će vidit nikada, zašto poginu na putu od velike mećave. I mnogi drugi u

52 B. Penzar, I. Penzar, 1997: Bilješke iz 17. i 18. stoljeća o vremenu u Makarskoj. Manuscript.

53 Soldo o.c.

54 Hennig o.c. according to G. Toaldo: Della vera influenza degli astri, delle stagioni e mutazioni di tempo, saggio meteorologico, Padova 1770.

55 Hildebrandsson o.c., Köppen o.c., Kratochwill o.c.

56 Soldo o.c.

različiti misti, ali ji ovde ne pišem, nego samo da je u ovo vreme žestoka mećava bila.

Settembre 1776. Na 7. ovoga pade ništo malo rose, ali na 9. i 10. bilo je dažda dobri i ovo je sve došlo s neverom, ter je bilo i krupe malo s daždem, ali nije nikakve štete učinilo, već kiše pade dosta. Ali je sila krupe bilo po Planini u isto vreme kad je ovda daž bio, ter krupa ubi naše dvoje jarenja koje su bili na Planini; ali ne bi ni tu štete, istom kad su ostali zdravi vinogradi od krupe. Bog je tako hotio, da se je sve prosulo po Planini, a ispod stina nije ništa, već lip, zdrav i ugodan daž, koji je mnogo dobra učinio svuda, a navlastito u Primorju, zašto tako pomože grožđu, da ga je bilo dosta, ter nisu ljudi imali u što vina livati, ...

In the annals of fra *Andrija Ivičević*, from 1781 to 1794, all the notes are short, and accordingly so are those on the weather:⁵⁷

Febraro 1790. Febrar bijo je vas suh brez kiše, ali burovit i mnogo žita ozebe.

Decembre 1793. Na parvi ovoga nađe snig do sela i za 7 danah bih veoma studeno; ali posli omekša vreme i počеше šiloci brez dažda i slidiše do 20. istoga.

The annals from Makarska contain records of intense winds of various directions, particularly on the strong and stormy Bura, on sudden gales, spouts and tornadoes, drought, fog, frost, rain, snow, hail and snow pellets, great heats and colds. Two aurorae were noted, a few comets, multitude of earthquakes and one brontide.

In the year 1775 the physician *Xav. Grazianus* from Rijeka wrote in his paper *De usu mercurii*, referring to a multitude of earthquakes currently occurring in Rijeka, that it could not be observed that the earthquakes diminished along with any change in weather.⁵⁸ Nevertheless, in later years along with earthquake reports, interesting weather descriptions may be found, and we shall refer to some of them.

So *Ivan Lovrić* described vividly, yet perhaps not entirely dependably, in 1776 the wind and cloud movement shortly before the earthquake of November 28th 1769 in Sinj:⁵⁹ »... it came about, that on November 28th of the same year (1769) such an earthquake occurred, like only a few that can be remembered in Dalmatia. ... Preceding that day Bura suddenly developed in the evening, and the struggle of clouds, darker than coal, showed some magnitude of electric matter in the air. In the same night, several times, lightning was observed in clear skies ... But as the next day broke, the rage of the winds rose higher and higher, and equally the struggle of the clouds intensi-

57 Soldo o.c.

58 Kišpatić o.c., p. 47.

59 I. Lovrić, 1948: Bilješke o Putu po Dalmaciji opata Alberta Fortisa. (Transl. by M. Kombol.) Izdavački zavod JAZU, Zagreb, 229 pp., p.151–152

fied, making them turn bewildered, some due to the first and some due to the second wind. On the ground the Bura blew with its highest might, and towards noon, when the earthquake was felt, it amplified still more...«

In the winter of 1788/89 the Adriatic and Black Sea were frozen:⁶⁰

24. November bis 14. Januar ausserordentlich strenger Frost und ungeheuer viel Schnee in ganz Europa: schon am 17. November in Mitteleuropa bis zu -20° R,... auch die erste Hälfte des Januar in Italien, Spanien und Portugal sehr kalt; das Adriatische und das Schwarze Meer völlig zugefroren. ... 27. bis 30. Dezember: in Rom bei sehr kaltem Winde häufige Schneefälle, selbst in Neapel noch Schnee.

That winter is also specified by Köppen⁶¹ and Kratochwill.⁶²

On January 4th 1802 during a very bad weather the region of Trieste, Rijeka and Bakar was hit by an earthquake. The event was well described by the Trieste correspondent of the Parisian daily *Gazzete Nationale* dated January 16th:⁶³ »After a forceful wind that lasted a few days it started to rain in the evening of the 3rd. Rain, hail and snow followed one another all the way to midnight; around two o'clock horrible thunder roared. That storm was accompanied by sea surging, which did not happen for a number of years back. Large parts of the city were flooded, the water invaded basement stockrooms and caused immense damage. The storm settled down at seven o'clock in the morning with such a fierce impact of the earthquake that the people do not recall to have ever suffered similar.« From this one and from other newspaper reports on this earthquake one may conclude that the storm probably traveled along the Adriatic Sea (in Ljubljana at the time of the quake the lightning only lit the horizon) along the cyclone path Vd common for that part of the year.

For the earthquake of March 22nd 1844. Kišpatić submits two reports from Dalmatian Zora, which reference the weather on that morning in Split, where strong Jugo blew:⁶⁴

... silna trešnja ... koja je oko 5 sekunda trajala. ... Štete nije bilo nikakve ... Za trešnje puhao je silan jugoistočnjak, tako da se je more dimilo; poslije trešnje se je vjetar malo stišao, pa opet objačao.

and in Poljica, where some snow accompanied the same wind:⁶⁵

60 Hennig o.c. according to many old chronicles.

61 Köppen o.c.

62 Kratochwill o.c.

63 P. Albin, I. Cčić, G. Morelli, I. Sović and M. Živčić, 1994: A preliminary investigation of the January 4th, 1802 earthquake, Materials of the CEC Project »Review of Historical Seismicity in Europe«, vol. 2, Milano, 205–214.

64 Kišpatić o.c.

65 Kišpatić o.c.

Na dan trešnje padao je snijeg do 9 sati u jutro. Kad se je iza toga provedrilo, navali njeka zapara i u to se zemlja jako potresla tako da su se krovovi rušili ...

In some reports on earthquakes or brontides from the beginning of the 19th century along with the weather description there exist numeric data on temperature and air pressure. We shall not consider them here.

At the end of this review it is appropriate to mention that in the first half of the 19th century parson Randić of Crikvenica kept some kind of meteorological journal for many years. Sadly, his records have been lost.

Records of climate

Records which pertain to general and characteristic weather features may be found in historic, geographic and natural history books, navigation manuals, natural history discourses, travel accounts, etc. These are often accounts of winds, short or detailed surveys of climate, and sometimes descriptions of some peculiar meteorological phenomenon. Among the winds, Bura is mostly quoted because of its exceptional strength and particular properties.

Skimno (about 200 B. C.), geographer from the island of Hio, is the author of a partially salvaged work in verse *Periegesis* (Continental travel records). From the time when the paper was for the first time credited to him, and not to some other author, the term Pseudo Skimno remained until today in the professional papers, but Skimno from Hio is used too. In the section concerning the Adriatic Sea he states that the climate there is mild, humid and rainy with frequent summer storms.⁶⁶

Another Greek geographer, *Strabon* (Amasia in Asia Minor, 64 B. C. –Rome, 19 A. D.) in the seventh book, chapter 5 of his *Geography*, in which he collected the antic knowledge of the then known regions, describes Panonia and Illyricum. In item 10 there is a general review of the Illyric coast, which he describes as being well exposed (to sun) like the Italian coast and has equally fertile soil. Therefore olive tree plantations and rich vineyards could be found everywhere, except in a few entirely arid locations. In contrast to that the area above the coast is mountainous and cold. Snow is frequent there, particularly in the northern part, making the vine grapes rare on the slopes as well as in the valleys.⁶⁷

66 J. Lucius, 1986: De regno Dalmatiae et Croatiae. (Ed. B. Kuntić-Makvić.) Biblioteka Latina et Graeca VII, Zagreb, 471 pp., 138.

67 Strabon, 1873: Géographie. (Trad. nouvelle par Amédée Tardieu.) Hachette, Paris, 238 pp., 50.

Plinius Secundus from Como by Milano (23–79) in the second book of his *Natural history* denotes some cave in Dalmatia as the source of the wind. He itemizes different causes of wind which is nothing other than flow of air:⁶⁸

...quoniam ventus non aliud intelligatur quam fluxus aëris.

These are: evaporation from the earth, water evaporated into the air, the sun etc. Wind may also stem from rivers and calm seas or rise from dry land. Curved and dense mountain peaks, passes and ravines divide the air which reflects there unequally producing the wind similarly to the formation of echoes. Furthermore, from a cave with a large and steep orifice, as found in Dalmatia, emerges a stormy whirlwind, even if the day is calm, when some light object is thrown into the cave. Its name is Senta:⁶⁹

Jam quidam et specus, qualis in Dalmatiae ora, vasto in praeceps hiatu, in quem dejecto levi pondere, quamvis tranquillo die, turbini similis emicat procella. Nomen loco est Senta.

As there is no known place of such a name on the Adriatic coast, and Senj is renowned for Bura, it would not be surprising if in the original manuscript the name was Senia and if the *i* was falsely read as *t* at some time. The error could be transmitted to all subsequent editions of *Natural History*. Kozličić is of a similar opinion.⁷⁰

Procopius from Caesarea (6th century) notes in his work *De bello Gothico* that in Dalmatia a bad and very severe wind howls. When it is blowing, all the roads are empty because everybody stays at home. The charge of that wind lifts a horseman with his horse, spins and throws him down:⁷¹

In Dalmatia vero, quae contra hanc urbam (Beneventum) in adversa continente sita est, malus ac vehementissimus bacchatur: qui quoties flare coeperit, in via neminem reperire est: ac omnes se domi tenent. Is enim est venti impetus, ut equitem cum equo in sublime rapiat, ac diu per auras circumactum, quoquaque sors tulerit, proiciens enecat.

Italian *Filip de Diversis* whose life is not well known, was a school teacher in the service of the Dubrovnik municipality from 1434 to 1441. From his description of Dubrovnik in Latin titled *Situs aedificiorum, politiae et laudabilium consuetudinum inelytae civitatis Ragusii ad ipsius Senatus descriptio* some transcriptions have been salvaged.⁷² The subject of the second chapter is the location of Dubrovnik with regard to the air and abundance of

68 C. Plinius Secundus, 1841: *Historia mundi libri XXXVII*, vol. primum. (Ed. M. Domenichi.) J. Antonelli, Venetiis, 261 pp., lib.II, XLIV.

69 Plinius o.c. lib. II, XLIV, 44.

70 Kozličić 1990, o.c. p. 262.

71 S. Brusina, 1889: *Primorska »bura« u šestom stoljeću po Isusu*. Glasnik hrvatskoga naravoslovnoga društva 4, 231.

72 I. Božić, 1973: *Filip de Diversis i njegovo djelo*. Dubrovnik 3, 11–80.

water. There he gave probably the oldest, and of course very brief, account of two weather types on the Dalmatian coast. »... If it ... is considered rationally and calmly, it must be acknowledged that the air in Dubrovnik is good and that water is present in abundance. In order to certify the first statement, we note that pest is considered here a rare disease... In the town there are many

people aged sixty, seventy and eighty years, some live to be ninety and even hundred with phenomenally clear mind, physically strong for their age and rosy in their cheeks. All this could not be without the beneficial influence of the air. It can therefore be readily confirmed that in Dubrovnik the climate is good and mild. However, speaking of climate, winds have to be taken into account. It is said that the region where fresher winds blow is healthier. In Dubrovnik two opposing winds prevail: Jugo and Bura. The first wind is warm and adverse for health, the second is very cold and healthy. Here Bura is an enemy to Jugo and disperses it with all the might. Bura blows and rages here so vigorously that the windows have to be secured with iron bolts and double shutters. Bura completely clears the air in Dubrovnik.«

In the first Croatian textbook on navigation skills – a manuscript of the Dubrovnik citizen *Benedikt Kotruljević* (1416–1469) from the year 1464 – which is today kept at the Yale university – winds are analyzed too (Figure 3). The third chapter of the third book considers varying winds. It is written there that according to Seneca in the Adriatic Euro and Euro Austro blow more frequently than other winds:⁷³

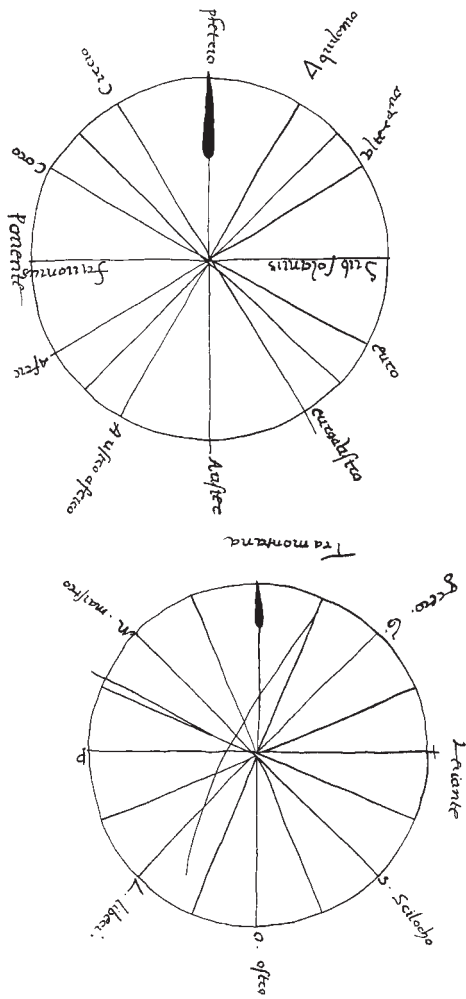


Figure 3. Wind roses by Kotruljević from 1464.

73 B. de Cotrullis, 1646: De navigatione libri IV. Manuscript, lib. III, cap. III.

Come narra Seneca in libro de naturalib' questionibus, ch' in gallia Trahe Circio piu ch nesciun altro: In germania occidentale Favonio. Iusta li monti ch sse chiamano alpi Septentrione et in mare adriatico Euro et Euro Austro.

This concerns the south-eastern wind. Namely, the two cited winds are located on one and the other side of the south-eastern direction (which does not have any wind of its own according to the wind rose described by Kotru-ljević), and their azimuths differ from that direction by approximately 11 degrees in the Adriatic region.

Paladius Fuscus (Padova 1450 – Kopar 1520) spent more than forty years in Šibenik, Trogir, Zadar and Kopar as a teacher of grammar, rhetorics and classic languages. His work *On the location of the Illyric coast* was first published posthumously in 1540 in Venice. In the first book of that opus, after describing the climate and fertility of the Illyricum according to Strabon, he adds that on the coast the environment is so mild as to exclude any excessive warmth in the summer because pleasant winds blow. In the winter moreover no cold is perceived, except when the north-easterly wind blows:⁷⁴

Sed ad oram redeo, in qua ea est aeris temperies, ut per aestatem ventis leniter flantibus, nullus ingens calor; per hyemem vero nullum frigus, nisi spiret aquilo, sentiatur.

He accepted from antic writers the notion that winds emanate from caves and applied it to the Senj Bura calling it a mighty wind which blows daily from the caves in the background of Senj:⁷⁵

A tergo autem Seniae sunt quidam specus unde nullo non die vehemens ventus perflat, quem loci peculiarem Boream Senensem nuncupant.

According to Bazala the first paper concerning the influence of Adriatic climate to human health was written by *Alojzije Gjurašević* – Aloysius Georgirius (Dubrovnik 1520 – Bologna 1565), physician in Dubrovnik and then professor of medicine and astrology in Bologna. The manuscript *De ratione medendi eos qui sub climate Ragusae nati sunt* has been lost in Dubrovnik during the earthquake in 1667.⁷⁶ In another manuscript by the same author some Croatian wind names are included.⁷⁷ The subject is beyond the scope of this paper.

74 P. Fuscus, 1990: De situ orae Illyrici. (ed. B. Kuntić-Makvić.) Bibliotheka Latina et Graeca XIX, Zagreb, 149 pp., p. 86.

75 Fuscus o.c., 88.

76 V. Bazala, 1978: Pregled hrvatske znanstvene baštine. Matica hrvatska, Zagreb, 495 pp., p.27, 214.

77 R. Almagia, 1934: Un trattato cosmografico di autore Ragusino del secolo XVI («Cosmographiae commentaria» di Luigi Georgireo). Archivio storico per la Dalmazia, a. IX, vol.XVI, fasc.96, 575–584.

In the scientific meteorological paper by *Nikola Vitov Gučetić* from Dubrovnik (1549–1610) – *Nicolo Vito di Gozze, Discorsi ... sopra le Metheore d'Aristotele* (Venice, 1584) the Aristotle's ideas on wind origin are applied to the two particular microclimates of caves in the vicinity of Dubrovnik. The wind blowing from the cave Vjetrenica in Popovo Polje is explained as a warm and dry evaporation from the ground stimulated by sunshine. The non-existence of wind from another cave, Šipun, is considered as a consequence of a well in the cave and wetness of the place which makes the dry evaporation impossible.⁷⁸

The Italian trader named *Giovanni*, born in Fermo in 1558 lived for many years in Rijeka and wrote around 1621 a detailed paper *Uscocci di Segna* in form of a dialogue in which Antonio asks, and Giovanni describes and defends the Senj Uskoks. It is written there how the north wind torments the Senj, Vinodol and Bakar region.⁷⁹ The army can not reach Senj from the sea because of the restricted harbour and danger of Bura (*il vento boria*) in the Senj Channel which blows frequently even in summer.⁸⁰ The locals can induce it by burning straw in some caves above Sv. Juraj whereupon a frightening wind starts from the smoke filled space. Giovanni himself sojourned in Senj when it was very dangerous to exit from the houses because the roofs were lifted by the wind and thrown to the road. In Rijeka he observed in the middle of summer how the wind, in form of a storm exits the Bakar Bay, raising the sea water, dispersing it and converting it to dense fog, which clouded the island of Krk, the surrounding parts being clear all the time. Some have told him that in the night, while blowing with full force, they saw flames coming from the Bakar Bay:⁸¹

Sopra il monte di san Giorgio nell' luogo detto Spodgoria vi sono alcune caverne, che accendendovi il fuoco dentro con paglia o altro, pur che facci fumo grande, e per qualche segreto naturale o patto sotto empiendo quell' luogo lo fa con isdegno mandar fuori venti orribili, a quanto piu cresce il fumo, tanto piu cresce il vento – dove per quei canali la fortuna crudele. E mi sono ritrovato a Segna quando soffiava questi venti non potero uscire di casane io ne altri, se non con gran pericolo rispetti lo scoprimento de tetti, che cascono nelle strade. A Fiume poi nel mezzo dell'estate ho visto per la bocca di Bucheri uscir tal fortunale del sudetto vento, e a lavar l'acqua di sul mare, e talmente butarla e ridurla in folta nebbia, che l'isola di Veglia, non sendo piu lonatana che 12 miglia, non si vedere; e tutto il resto era sereno. Et alcuni mi hanno detto haver visto di notte fiamme di fuoci uscir di detta bocca, quando soffia con impeto grande.

78 Ž. Dadić, 1994: Hrvati i egzaktne znanosti u osvitu novovjekovlja. Naprijed, Zagreb, 340 pp., p.37–39.

79 F. Rački, 1877: Prilog za poviest hrvatskih uskoka. Starine JAZU, IX, 172–256., p. 232.

80 Rački o.c., 176.

81 Rački o.c., 176.

It is hard to believe into such an artificial provocation of Bura. However a physical mechanism may be imagined which would rise the air warmed by fire, and suck in the surrounding air. If in doing so, due to favorable terrain, cold air from the Lika plateau is drawn to the coastal side, a so called siphon could be activated, proceeding in spilling over the cold air from the inner regions to the sea *i.e.* the Bura. Smoke, of course has no influence in such a process.

Giovanni perceives also the Senj's climate influence on the descendants of the newcomers. He writes that the Uskoks from Bosnia are by nature slow for running and life activities, but by mixing with domestic Senj population and through the influence of the climate they became swift. He saw one with his own eyes who was so fast, he caught a running hare, furthermore not on even grounds but in the mountain:⁸²

... i Bossinesi sono piu gravi nel corso e nella agilita della vita, ma mescolata con quella razza di Segna, et ili clima li fa piu agili nel correre. E vi diro cosa che va ne riderete: io ho visto talun di loro tanto veloce nel corso che hanno pigliato una lepre a corsa, non dico nella pianura ma al monte.

Ivan Lučić – Joannes Lucius (Trogir 1604 – Rome 1679), author of the first Croatian history book *De Regno Dalmatiae et Croatiae, libri sex* (Amsterdam 1666, Frankfurt 1667, Amsterdam 1668), wrote two paragraphs interesting for meteorology in the first book of that opus. In the first one a change of wind is pointed out in the vicinity of the Cape Ploče, formerly Cape Diomedes. Lučić, who lived a long time nearby Trogir, describes that region, dangerous to navigators of that time, in detail and explains the movement of the sea around it. He then makes mention of winds and writes that at the very point of the cape not only waters collide, but – even more strange – very frequently also the opposing winds blow simultaneously from here and there. Then the boats which arrived with full sails suddenly remain windless and find themselves exposed to whirlpools. If the south wind appears, it is almost incredible how high the waves beat the rock and how deep whirlpools originate near it:⁸³

...in extremo Promontorii angulo sitam ... ubi invicem pugnant non solum aqae, verum quod mirabilius est, saepe saepius venti contrarii hinc inde ad Syrtim usque, simul perveniunt, naves vero plenis velis, ex contrariis partibus illuc delatae, vento repente destitutae, vorticibus aquarum exponuntur, et si Auster superveniat, incredibile pene est, quam ingentes undae Syrtim verberent, immanesque vortices prope eam oriantur; ...

Even three centuries later the local population knows that Jugo may reach as far as Cape Ploče at the same time when to the north of it Bura reigns.

82 Rački o.c., 191.

83 Lucius o.c., 200.

The occurrence is mentioned by an excellent expert for weather in the broader region around Split, Marki.⁸⁴ This change of wind direction in the vicinity of Cape Ploče should be attributed to cyclones which after crossing the Apenine peninsula somewhere in the middle, and then also the Adriatic Sea, continue onward on land to the north-east. If we look along that path, the cyclone – when in the Adriatic region – causes Jugo on its right side, Bura on the left, and in between, where the atmospheric pressure is the lowest, the wind is weak.

In another paragraph the Etesian wind is specified as being a permanent summer wind blowing even at night, accelerating the navigation from Istra to Vis and further along the Adriatic Sea towards Otrant. (The term Etesian has been kept also by modern meteorologists. In the Croatian translation of that paragraph the name of the wind has been translated with »northern winds« which does not correspond in direction because it is a north-westerly wind. The mistake in translation came about because the Etesian winds in Greece blow from the north.):⁸⁵

Ideo sicuti Scylax praeternavigationem regionis Liburnorum duorum dierum ponit, ita eandem ab Istriae Promontorio, extra Liburnicas Insulas, recto tramite Issam versus, metitum dignoscitur; cum tempore aestivo flantibus aethesiis, bidui spatio eadem Insulae praeternavigentur; ad quarum extremas cum nautae perveniant, si aethesiae noctu quoque spirent, ut solent, Issam, Pharumve (!) versus iter prosequantur; ...

In the famous and extensive publication *Glory of the Carniolan duchy* printed in 1689 by the Slovene nobleman and polyhistor Valvasor (1641–1693) notes on weather in Croatia may be found too.

Describing the climate⁸⁶ Valvasor writes that in the Karst district which incorporates the Kastav area and Histerreich (interior, northern part of Istra) the sun in summer scorches intensely and heats powerfully. In that season thunderstorms are common, particularly on the Učka Mt. and in the Kastav area. Each year there are many sheep killed by thunderbolts and many others are wounded so they succumb.⁸⁷ The winter is short. In February Istra is all in blossom, while around Ljubljana still snow and ice prevail. In the Kastav area and Istra snow is rare, and the ground does not freeze. When snow does fall it will not stay for one, two or three days but melts rapidly. But there are very cold and biting winds which seem to cut through the heart. The description of that wind is rather detailed. It is an easterner

84 E. Marki, 1950: Vrijeme. Pomorsko brodarski savez Jugoslavije, Split, 175 pp., 117.

85 Lucius o.c., 204.

86 J. W. von Valvasor, 1877–1879: Die Ehre des Herzogtums Krain. (2^{te} unveränderte Auflage) Rudolfswerth, Teil I:696 pp, II: 836 pp, III: 730 pp, IV: 610 pp; III, 306–309.

87 Valvasor o.c., III, 321.

which blasts and shoves with such a might that man or cattle can not withstand it when it blows its anger with full force from bloated cheeks. Sometimes it lasts for five or more consecutive days. When it develops intensely, everybody who does not choose to be thrown to the ground or moved from the spot by force, must stay at home. The wind even shifts the loosened stones, and screeches so that it hurts the ears:⁸⁸

...auf dem Karst ... raset er über die Masse starck, bevorab im Winter, da der Ost-Wind mit solcher Gewalt sauset und stürmt, dass weder Mensch noch Vieh davor fortzukommen eine Möglichkeit findet, wann er mit gantzer Macht ansetzt, und recht mit vollen Backen seinen Streit ausbläset. Solches währet bissweilen zwei, drei, vier oder fünff Tage und noch wol länger nacheinander. ...derjenige welchen er nicht zu Boden stossen oder von der Stelle hinweg reisen soll, wann er recht ausgelassen ist, daheim bleiben muss. Er macht nicht nur die Baum-Blätter, sondern auch Sand und lossgerissene Steine flüchtig, und pfeift so starck, dass Einem die Ohren davon wehe thun.

Let us mention here Valvasors description of the Senj Bura which he does not define by name or by direction. He writes that it is not desirable to leave the houses in Senj when very strong winds rage there in winter. They drive sea waves which foam and lift them so high the water frequently smashes even above the tower within the city walls:⁸⁹

Zur Winters-Zeit gibt es allhier überaus starcke und so heftig tobende Winde, dass man vor selbigen nicht wol aus den Häusern gehen kann. Diese treiben die zu solcher Zeit schäumende Meereswellen so hoch auf, dass sie auch über den kurtz zuvor besagten Sabbae Thurn öftters zusammen schlagen.

However the air in Senj is very good and healthy causing very old people to be found there. As an example Valvasor points out the sergeant's father who died in his 124th year of life.⁹⁰

Rijeka too, is in no need of good, healthy air and cool, clear water. Life is good in that city because all that is required for food and drink is very cheap. The snow never stays on the ground and the only discomfort is the northerly wind which is usually strong:⁹¹

Sonnst ist auch in dieser Stadt sehr gut und wol zu leben; weil man Alles, was die Speise und Tranck betrifft, sehr wolfeil daselbst haben kann, dabenebenst auch an guter gesunder Luft und eisskalten Wassern sich nicht der geringste Mangel findet. Der Schnee bleibet hier niemals ligen, unerachtet ein sehr starcker Wind von Norden her zu wehen pflegt. (Meo tempore. Nota mea.)

88 Valvasor o.c., III, 307.

89 Valvasor o.c., XII, 79.

90 Valvasor o.c., XII, 89.

91 Valvasor o.c., XX, 104.

It is obvious that the author dwelt in Senj and Rijeka and learned himself what he is describing.

He probably also observed for himself the Saint Elmos's fire in Tinjan (Antinjana) which he describes as natural but still astonishing luminescence which manifests itself on the city tower, chimneys and particularly the cross of the church tower, during nightly lightning and thunder, and according to which the locals forecast, from experience, a harmless storm without hail or shower:⁹²

Wunders-würdig (obschon natürlich) sind diejenigen Lichtlein, welche sich bei instehendem nächtlichen Blitzen und Donnern auf dem Stadt-Thor, ingleichen auch zu Zeiten, wiewohl selten, auf hohen Caminen oder Rauchfängen, am allermeisten aber auf dem Pfarr-Kirch-Thurn und dessen aufgestecktem Kreuz zeigen, und denen Einwohnern aus oft wiederholter Erfahrung ein unschädliches, von Hagel und Schauer befreites Gewitter prophezeien.

The famous Dubrovnik citizen *Ruder Josip Bošković* (Figure 4) in his scientific discourse on tornadoes in Rome, *Sopra il turbine* (Figure 5), writes



Figure 4. Ruder Josip Bošković

SOPRA
IL TURBINE

Che la notte tra gli XI. e XII. Giugno del MDCCLXIX
danneggiò una gran parte di ROMA

DISSERTAZIONE

DEI

P. RUGGIERO GIUSEPPE BOSCHOVICH
DELLA COMPAGNIA DI GESÙ

DEDICATA A SUA EMINENZA

IL SIGNOR CARDINALE

SILVIO VALENTI

SEGRETARIO DI STATO,
E CAMERLENGO DI SANTA CHIESA.



IN ROMA MDCCLXIX.

APPRESSO NICCOLÒ, E MARCO PAGLIARINI.
CON LICENZA DE' SUPERIORI.



Figure 5. R. G. Boschovich, *Sopra il turbine* ...
– the title page

⁹² Valvasor o.c., XI, 19.

also about water spouts in the Adriatic region. He states that the physicists usually call them sea tubes, and in the Adriatic, where they are frequent, they are known as *šijuni* (scioni in orig.), or elsewhere by the Greek term of *sifoni*. He observed them himself repeatedly as a boy before he left for Italy, so he describes here three such cases. During a storm which arrived from the south-southwest, out of the open sea to the land as a horrible thunderstorm with rain and hail, he counted as much as 13 spouts, which is rare indeed, although often two or three could be observed and rarely even four at the same time.⁹³

Questi turbini sono oggi comunamente chiamati da' Fisici Trombe di mare. Nell' Adriatico, dove sono i medesimi frequentissimi, si chiamano comunamente Scioni, nome, che in qualche parte dello Stato Veneto si da a que' cannelli vuoti, che servono per travasare i liquori, e altrove si chiamano dal nome Greco Sifoni. Io da fanciullo prima di venire in Italia nelle vicinanze di Ragusa moltissimi ne ho veduti in alto mare, a mi sovienne, che trovandomi un giorno in compagnia di molti a vederle uno assai piu grosso dell' ordinario in una grande distanza, fu preso un Cannocchiale per contemplarlo; ma toltane l'acqua del mare, che sotto immediatamente a quella Tromba si alzava, come si e detto, non si vide altro, che come una gran striscia di nuvola in forma di una smisurata colonna. Uno un giorno peraltro assai piccolo ne vidi dare Terra e mi passo vicinissimo alzando in aria con un movimento assai violento un vortice spaventoso di polvere, a di arena. Un altro giorno, che da alto mare con una furia spaventosa di Ostro, e Lebbeccio venne a terra un fierissimo temporale di lampi, tuoni, e pioggia, e grandine precipitosa, io dall' eminenza di una collina, che domina la Citta, e il mare, prima di ritirarmi al coperto nel vicin casino, dove co' miei solevo passare l' autunno, fermatomi alquanto a contemplare quello spaventoso spettacolo, molti fra' densi nuvoloni forieri di quell' orore ne vidi di questi turbini qua, e la dispersi per l' Adriatico, e benche allora fossi in eta ancor troppo tenera, pure ne conservo nell' animo vivamente impressa l' imagine, e ho ferma idea di averne contati tredici nel tempo istesso, cosa veramente rara in que' maris benche per alrro (sic!) assai sovente accada vederne due, o tre, e non di rado ancora quattro in un medesimo tempo.

The well known and appreciated work *Illyricum sacrum* published by the Italian jesuit *Daniele Farlati* (1690–1773) contains in addition to church history also some other data, among others an illustration of climate. In the first book it is the climate of Dalmatia. Its pleasantness and mildness are emphasized: the summer is not too dry due to rain in time(!), not too hot due to etesian winds, and in winter the aquilo (wind) from the north does not last fiercely over land or over the sea (!).⁹⁴

93 R. G. Boschovich, 1749: Sopra il turbine che la notte tra gli XI e XII Giugno del MDCCXLIX danneggiò una gran parte di Roma. Niccolo, e Marco Pagliarini, Roma, 224 pp., p. 44–45.

94 D. Farlati, 1751: *Illyrici sacri tomus primus*. S. Coleti, Venetiis, 780 pp., 165.

Nec vero ab Sole aestivo nimis torrida est, aut fervida; quippe tempestivi imbres, atque Aetisiae sic aestum temperant, ut non solum non incommode, sed etiam jucunde habitetur. Per hyemem vero, nisi Aquilo ab Septemtrione vehementior orae marique incuberit, vere quasi perpetuo floret nitetque, cum frigorum vim Sol meridianus obtundat.

The air is particularly clear and transparent in the mountains and hills. The region is mostly curative, only in some locations like the swamps by the Neretva and Bojana estuaries, perilous diseases develop, especially in summer, due to the fog produced by evaporation from flooded acreage and the lukewarm waters.

Alberto Fortis (1741 Padova – 1803 Bologna) in his renowned work *Viaggio in Dalmazia* published in 1774 writes in numerous places about the weather and climate. In the chapter on the seaside of Biokovo⁹⁵ he notes, among others, numerous proper and interesting weather observations learned by the local abbot Grubišić. »Before the northerner starts to blow, if there is fog on Biokovo, it lifts high shattered in a thousand ways; the inwards of the mountain hums and then howls powerfully ... If there is no fog on Biokovo, the northerner is announced by clouds, evenly stretched across that portion of the sky, and an unusual sharpness of the air ... The wind descends from the top to the sea as a powerful and abrupt surge ... If that wind blows steadily, it is believed to ... be favorable when the grapevine is pestered with downy mildew. But it is most pestilent because it brings death of cold to the sheep and goats when it catches them in the mountain pastures. ... When it gets furious it rips, breaks and tears plants, dries and pulverizes the soil and then takes it up into the air ... The seamen dare not sail in the night through the channel between the coast and the islands of Brač and Hvar in fear of the momentary intensity of that wind which swoops from the mountains or bursts from the Vrulja valley. ... – Jugo (south-easterner) and Maestral (north-westerner) also alternate in the reign of Primorje ... High waters forecast Jugo, as low ones exceptionally forecast the nearing of northern winds ... Sporadic Jugo by Easter (!) does not bring rain but warmth ... this dry Jugo is harmful because it dries the plant shoots. To the people Jugo does not bring any other disease but fatigue and depression, so they are gloomy, but in compensation they get an abundant catch of fish ... and specifically when it frequently carries rain, also a good harvest of crops in the mountain. When the Maestral calms down for a day, it is a sign of Jugo on the next day. ... The south-western winds (Garbin) are somewhat rare here in comparison to northerners, Maestral and Jugo. ... Snow and ice do not last long in Primorje and also not on the top of Biokovo. ... The cold is never very severe in

95 A. Fortis, 1984: Put po Dalmaciji. (ed. Josip Bratulić, transl. M. Maras.) Globus/ Zagreb, 303 pp., p. 219–221

these seaside regions, if not carried by the northerner; without it January there is like our (Italian) April. Almost all of the summer is exceedingly hot...«

In that part of the text there are statements and forecast rules of dubious value, so we do not present them here. Among them is the one that Bura originates in mountain caves, which reminds of the ancient Plinius text quoted earlier.

Fortis writes that the climate of Rab does not belong to the most fortunate, but he probably saw only the part of the island principally exposed to Bura:⁹⁶ »... the cold part of a year is horrible here, because fierce northern winds blow, which every so often turn intermediate seasons into winter. Salty fog raised by horrible waves roaring between Rab hills and the opposing mountains in the narrow Morlac channel, singes all the plant and crop sprouts if it falls on the island carried by wind... If these adversities are ignored the air on Rab is healthy...«

He went too far in his description of the Pag island too:⁹⁷ »The winter is fearfully cold, and the summer shockingly hot. The stormy sea rages while beating against the rocky coast of the island opposite to the mountain; on that side the tops and the slopes of the hills are barren due to wind, so that they hold no forest, no pasture, no soil, except in few locations; only tough bare rock, desolate and uninhabitable, covers almost all the area. The air is generally hazy due to the salty mist which rises from the clashing of the waves in the narrow Morlac channel amidst the steep and bare rocks...The inhabitants of the town can not leave the houses while the wind rages, and the roofs have to be weighted all around with heavy stones.. (They say that) ... in winter ... the island ... is wholly covered in snow and permanently exposed to the chilly northerner. I was there in summer and consider it equal to the hottest regions of the world.«

However the description of the Senj Bura by Fortis is very vivid and true:⁹⁸ »The wind which arrives from the barren mountains blows so hard in that narrow dell that sometimes in winter a man can not leave the house without hazard, and out of town it is even worse. It often happens that the wind lifts children or weaker individuals and throws them against a wall, even when they do not walk across the square where no reasonable person appears in such weather, but through the narrow and swerving streets; and when acute need forces someone to go to the harbour where the ships rest, although crawling on his arms and legs, sometimes he rolls like a straw in the might of the wind. In the Senj market the wind frequently topples horses

96 Fortis o.c., 259.

97 Fortis o.c., 266.

98 Fortis o.c., 274.

laden with salt, lifts the roofs of the houses even though they are covered with very heavy stones.«

Ivan Lovrić from Sinj (around 1754–1777) in the work *Osservazioni sopra diversi pezzi del Viaggio in Dalmazia del signore abate Alberto Fortis coll'aggiunta della vita di Socivicza* (Venice 1776) rightly refutes Fortis's reference to the duration of Bura under Biokovo and to its generation in caves. Additionally he notes that the Morlac belief how rain on St. George's predicts an ample harvest, is not confirmed in practice. He concluded that part of text with an excellent observation how it is an usual mistake of people which are hardened in some belief, to perceive only what they find fitting.⁹⁹

The French hydrographer *Charles Francois Beautemps-Beaupré* (1766–1854) in the description of the eastern side of the Adriatic Sea with regard to sailboat navigation, refers frequently to local winds. He considers Bura (borea) most dangerous to navigation because of its unparalleled severity and gustiness. Although Bura is the strongest close to the east coast of the Adriatic Sea, navigation along that coast is still recommended, because it offers numerous refuges where anchoring in wind shelters is possible. Jugo causes high agitation of the sea and lowers visibility. Rain arrives with that wind. Good shelter from it may also be found in some places along the east coast. The northerner and the north-wester are even less dangerous, and the winds from the west and east-southeast are considered harmless.¹⁰⁰

Dragutin Seljan (1810–1848), the priest and the prefect in the nobleman convent of Zagreb, published the *Geography of the Illyrian province* in 1843, in which description of the climate in Istra and Dalmatia can be found. He points out the abrupt and huge transition in climate experienced by one moving away from the coast, which is also manifested only a few miles from the coast in the change of flora. He also refers to flowers and vegetables which are grown in seaside in the middle of winter:¹⁰¹

Podnebje Istrie i otokah njezinih sluti već na bližinu toploga i umilnoga talianskoga zraka; različito cvětje ovdě se i u prosincu za klobukom zaděnuto nosi. Zima traje kratko vrěme, jer prolětje već koncem sěčnja počimlje. Sněg, koi u zimi padne, netraje dugo, nego ga berzo nestane. – Dalmacia, što se podnebja tiče, najtoplia je strana austrijanskoga carstva. Lěto je tamo jako suho i noći vruće, hladovite i ugodne (!); magla pako skorom se nikada nevidi. Najpriatnie je podnebje na otocih, ovi u obće blagi zrak uživaju i to bez svake skorom zime. I buduć pokrajina ova od sěvera k jugu veliko produženje imade, zato pamtiti trěba, da je zrak u sěvernoj strani hladnii nego u južnoj.

99 Lovrić o.c., 149–150.

100 M. Kozličić, 1995: Beautemps-Beaupré o Jadranu 1806. godine. Pomorski zbornik 33, Rijeka, 259–279

101 D. Seljan, 1843: Zemljopis pokrajina ilirskih, dio I. Tiskara Lj. Gaj, Zagreb, 256 pp., p. 59–60.

U obćem pako podnebjje Dalmacie veoma je blago na primorju i otocih, nu čim se čovĕk od mora udaljava i k turskoj granici približuje, i zrak surovii i hladnii biva. Na nĕkoliko miljah od mora prestaju već rastja južnim pokrajinam prirodna, kao n. p. masline, bademi, smokve, koje uzduž ĉĕloga dalmatinskoga pribrežja razkožno rastu. Jesen je krasna, a zima blizu mora i na otocih prijatna i mehka, k medji oštra i surova. Snĕg rĕdko kada u primorju i na otocih pada, i kad padne, berzo okopne. U srĕd zime lĕpi se ovdĕ tulipani, ruže, karanfĭci i. t. d. odgojiti mogu. Karfiolah se najviše i u najlĕpših ružah u sĕčnju i veljaĭi pojĕde, i već poĉetkom ožujka divjih špargah u izobilju imade. Pogdikoja godina prodje, da ni najmanje snĕga nepadne, nu to se samo od primorskih okolišah razumĕva.

Od velike su pako napasti stanovnikom polag mora: Bura i Široko zvani vĕtri. Bura, sĕverni i hladni vĕtar, krove višeputak s kuĉah sbaci; vĕtar ovi na drumu kod Gabrika višeputah tako silno duhati može, da silom svojom natovarena kola preverne, i ovako morski brodovi, da se od napasti njgove obrane, od obale u veliko se more otisnuti moraju. – Široko vĕtar, duše iz južnih stranah, ovi ako kiše nedonese, i isto se korenje od travah posuši, donese li pako kiše, onda je osobito u Dalmacii dobra lĕtina i ribaria. Nesnosnu ovu vrućinu u Dalmacii, koju ovaj južni vĕtar (tal. scirocco) još više umnožava, razblažuje opet maestral (!) (tal. maestro), drugi vĕtar, koi lĕti obĭčno oko



Figure 6. Frane Carrara

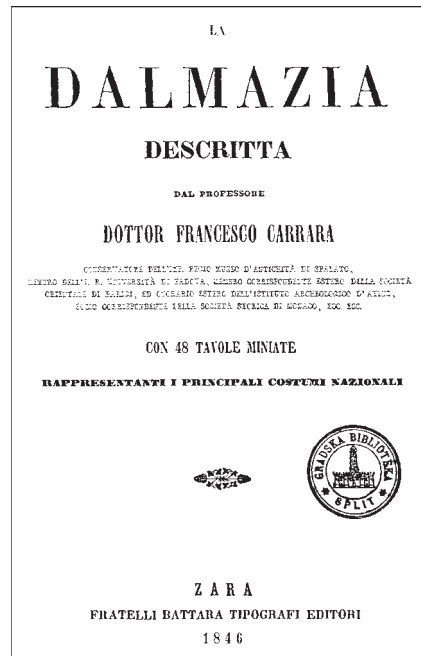


Figure 7. The title page of La Dalmazia descritta by Carrara

podne započinje i do zahoda sunca traje. Mnoga kiša kviri u Dalmacii vino, nu plodnosti maslinah jako je prijatna.

Only three years later the Split citizen *Frane Carrara* (1812–1850) (Figure 6), archaeologist, conservationist and historian, published in Zadar the *Description of Dalmatia* (Figure 7) in the Italian language. A comparison of these two documents shows clearly that Seljan's description is based on data from literature and Carraras on personal experience. In his chapter on climate¹⁰² we initially find a description of nature, particularly plants, as proof that the climate of the region is mild. The data on pressure and temperature measurements follow, which we shall skip here, and after that – on more than one page – depiction of weather according to seasons of the year with special regard to wind.

At the start he specifies that in Dalmatia thrive carob, box tree, laurel, fig, pomegranate, rosemary, mimosa, lavender, oleander; palms grow in the open, lemons and oranges are cultivated. Almonds flower in December there, broad-beans and peas are picked at Christmas, bats flutter in January, artichokes ripen in February, in March the ears form:¹⁰³

...Un paese ... ove in dicembre fioriscono i mandorli, si colgono fave e piselli a Natale, svolazzano in gennaio le nattole, maturano in febbraio i carcioffi, si formano delle spiche nel marzo, ...

There would be neither winter nor the cold if not for Bura. However, each year, even if the January and February are mild, in March three strong Buras turn up on the following dates: 7th, 17th and 27th. (!) (That belief of March Buras is present in some regions even today.) If the first three months are cold, April is cold too, writes Carrara. The snow falls rarely, and stays even less frequently, probably due mostly to the vicinity of the sea. Jugo is a mild, sometimes warm, usually rainy wind. In other stages of the winter the weather is unstable, but mild and pleasant:¹⁰⁴

Se non fosse il vento da bora, non avremmo alle coste ne freddo ne verno giammai. Ma ogni anno, se anche e mite il gennaio e il febbraio, nel marzo soffiano tre forti bore, cui un trito segna al sette, al diecisette e al ventisette. Se gennaio non genniza, dicono i popolani, se febbraio non febrizza, marzo genniza, febrizza, marziza. Ma se sono freddi que' primi tre mesi, e freddo pure l'aprile. La bora soffia d'ordinario nell' inverno con molta furia ... Cesata, vien meno anche il freddo; e la povera genta ... piu temono il vento che la pioggia. La neve cade assai rado e piu rado si apprende, forse meno perche non tocchiamo di molto la linea delle nevi, quanto per il prossimo mare. Lo scilocco ... e tiepido, talvolta caldo, d' ordinario piovoso. L' unico dei suoi in-

102 F. Carrara, 1846: *La Dalmazia descritta*. Fratelli Battara, Zara, 142 pp., p. 51–54.

103 Carrara o.c., 51.

104 Carrara o.c., 53.

comodi e, che quando in autunno o nel verno cominciano le piogge, non sanno ristare. Del resto nell' inverno il tempo e inconstante, ma mite e piacevole. Se gli stranieri lo conoscessero bene, avremmo, credo, molti ospiti e piu viaggiatori.

Transfer to summer is abrupt. Spring consists of nice winter days, and often it does not show up. The summer is dry, hot, but stable and wonderful. Regularly, every day from noon to night the Maestral is blowing and soothing the unbearable heat. The nights are clear, calm, very pleasant if the breath of Maestral or a land-breeze continues. The rains are few. Sudden storms are frequent, short but severe, called Neverini. Except for weather benefits, the summer brings also two unpleasant side effects, the skin rash called *calore – sudamina* – which disappears with the first fresh breeze as well as flies and mosquitoes, most bothersome during sleep. The first rain in August freshens the sea and the forest:¹⁰⁵

Rapido di troppo, e quasi senza distanza degli estremi, e il passaggio dall' inverno alla state. La nostra primavera e nelle belle giornate dell' inverno, e spesse fiate non e. L' estate comincia alla piu lunga col maggio: porta molata arsura e gran caldo, ma tempi stabili e deliziosi. Regolarmente spira il maestro ogni di da mezzogiorno a notte, e toglie all' insupportabilita del calore. Le notte sono serene, tranquille, amenissime se continua lo spiro da maestro, o una brezzolina da terra. Il venticello da terra ricrea, a modo di zeffiro, nelle prime ore del giorno, a giova alla salute ed al sonno. Rade sono le piogge, spessi ma brevi e talvolta ruinosi, i temporali, o, come li dicono, neverini. Due snotevoli convenienze oltre alla temperie porta la state: un' esantema alla cute, detto calore – sudamina –, che sparisce colle prime aure di fresco, i culici e le zanzare, infestissimi al sonno. Corso il luglio, il caldo non e piu tormentoso: prima pioggia d' agosto, rinfresca il mare e il bosco.

The autumn is long, pleasant, with spring breezes. This is the time for travel, stays in the country, bird hunts and the harvest, but often spoiled by long and intense rains and weather inconsistency:¹⁰⁶

L'autunno e lungho, ameno, con aure primaverili; e la stagione dei viaggi, delle villeggiature, dell' uccellazione e delle vendemmie. Spesso le piogge lunghe e dirotte, a la mobilita della temperie lo guastano.

The description of the climate ends in a statement that Bura is characteristic of the winter and Maestral of the summer. Jugo and the easterner are unpleasant in any season of the year. The main winds are Bura and Jugo:¹⁰⁷

105 Carrara o.c., 53–54.

106 Carrara o.c., 54.

107 Carrara o.c., 54.

La bora caratterizza per così dire l' inverno, il maestro la state: lo scillocco e il vento da levante sono incomodi in tutte le stagioni. Tra i più dominanti sono la bora e lo scillocco.

It is certainly interesting that nothing is written on the direction of Bura either where it is mentioned as a winter wind, or in the end where all the Italian wind names from 16 directions are listed »as they are called in Dalmatia and elsewhere«. Evidently the direction is not so significant for Bura, as are the other characteristics (even though these are not described in detail either) which makes that wind stand out among other winds.

The third description of Dalmatian climate has also been written in the first half of the 19th century, and issued eleven years after Carrara's in an extensive and manifold account on Dalmatia. Its author is a German *Franz Petter*, teacher of the German language and natural historian who came to Dubrovnik in 1823 and lived there and in Split for thirty years. That work of his was published with support from the Viennese Academy after his death.¹⁰⁸

His account of weather and climate also comprises what the author himself experienced and perceived. Unlike Carrara, who at times writes almost enthusiastically about climate, caring that his sentences sound gentle and balanced, Petter writes in more detail, more rationally and likes to endorse his assertions with, for example, Latin plant names and some numerical data, his own experiences or a humorous portrait of a social notion or behavior (for example why there are no stoves in Dalmatian houses and how the population endures the very cold days).

The change of weather during the year was illustrated in more details by Petter than by Carrara. Between the two equinoxes it is unstable, so after a warm day often a cold one follows. The fair weather starts in May as a rule. The skies are beautifully blue then, and in the night stars glitter in the canopy. The ground is freshened by strong dew which disappears as soon as the day breaks. The heat becomes frequently intolerable already in June. The nights are then also so warm as to impair sleep. The rain falls infrequently and than as a shower. In the description of the summer Petter, except for the rash resulting from heat and the mosquitoes, also cites the customs concerning bathing in the sea and the shortage of water. The desired rain finally falls at the end of August (according to popular saying between the two Marian holidays) and the temperature changes immediately so that the nights freshen up:¹⁰⁹

108 V. Klaić, 1878: *Prirodni zemljopis Hrvatske*. Matica hrvatska, Poučna knjižnica 1, Zagreb, 406 pp., p.11.

109 F. Petter, 1857: *Dalmatien in seinen verschiedenen Beziehungen*, I. J. Perthes, Gotha, 296 pp., p.49.

Wenn auch ein Nachsommer stattfindet, so schwitzt man nur mehr bei Tage, aber nicht mehr in der Nacht und damit ist schon viel gewonnen.

The autumn with its presents is the favorite season of the author. The winter is not harsh and often years pass before a snow flake may be seen at sea. There are few days when the water freezes and it lasts only as long as the Bura blows. The transfer from winter to spring and from spring to summer isn't noticed at all in some years:¹¹⁰

...und ich habe erlebt, wo man die Winterkleider nur abgelegt hat, um die Sommerkleider zu nehmen.

Already in March it is hot in the sun, but the air is cold in the shadow. There is no fog at sea. Thunder and hail are more frequent in winter than in other seasons. Spouts at sea may be seen in Dubrovnik every year.

Petter lists more winds than Carrara. Their illustration is detailed and is located in a separate chapter which initially shows that the wind determines the type of weather: If in the morning you see through the window which wind is blowing, at once you know if it will be cold or warm, humid or dry:¹¹¹

Die Winde spielen in allen Küstenländern eine bedeutende Rolle. Im deutschen Vaterlande habe ich mich nie um die Winde bekümmert; hier aber werfe ich Morgens beim Aufstehen sogleich einen Blick auf's Meer. Ist der Wasser Spiegel glatt, so herrscht vollkommen Windstille, ist er wenig bewegt, so ist der Wind schwach, erblickt man viele weisse Flecken auf der Oberfläche, so ist der Wind heftig, denn der Wind wühlt das Wasser so stark auf, dass er grosse Wellen wirft, die sich am Kamme kräuseln und vielen Schaum erzeugen. Aus der Richtung der Wellen lässt sich sogleich erkennen, aus welcher Himmelsgegend der Wind wehe. ... Weiss man, welcher Wind weht, so weiss man auch schon ob es kalt oder warm, feucht oder trocken sei. Man hört daher weit öfter fragen »Welchen Wind haben wir heute« als: »Welches Wetter ist heute.«

The description of Bura as the strongest wind along the coast is comprehensive. Petter presumes that on the mountain ridges which represent the frontier between differing flora and where Krš (rocky range) starts, the wind from Bosnia towards the sea becomes Bura. He cites its annual course, locations where it is particularly strong, damage it brings about, gustiness, weather appearance, clouds which pre-announce it, and there are some claims about its duration. Petter emphasizes what Carrara omitted to quote, *i.e.* that Bura is not designated in the seaman's wind rose, but that every wind from the direction ENE, NE or NNE is called by that name, when it exceeds a certain strength:¹¹²

110 Petter o.c., 50.

111 Petter o.c., 51.

112 Petter o.c., 51–52.

Es ist dies kein nach der Bussole der Seefahrer benannter Wind, sondern man bezeichnet mit diesen Namen jene Winde, welche von O.N.O., N.O. und N.N.O. wehen, sobald sie einen höheren Grad von Heftigkeit erreicht haben; sonst nennt man sie Borin.

Describing Jugo (Scirocco) he quotes its mode of blowing, the distribution during the year, the appearance of the sea and the weather, the adversities and benefits it brings. Without a special name, a Jugo without rain is cited too. Oštro (S wind) and Garbin (SW wind) almost always follow Jugo, but with rain added. Garbin forces the sea perpendicularly to the coast. If it is low, flooding and sand covering ensue, and if it is steep, the waves spectacularly break against it and engulf it in salt and water. Maestral is a summer wind. It gradually increases in the morning, lasts for a few hours with constant intensity, then it withers and stops with the setting of the sun. It eases the heat. It blows only in clear weather, and if it does not show, Jugo comes the next day. In the summer nights the weak and unsteady land-breeze blows, commonly as northwesterner (Burin) or easterner, persisting a few more hours after sunrise. Tramontana (N wind) never embraces the whole coast and does not last longer than half a day. There is less of it in summer than in winter. It brings cold and rain, not seldom with hail.

Petter, as well as Carrara, also cites some instrumental data of pressure and temperature, but he is conscious that these are too few and depend on many factors so that nothing reliable may be determined by these measurements.

The three quoted climatographies published in the middle of the 19th century encompass in a way the knowledge on the Adriatic weather and climate up to that time, acquired by own or the experience of others. Approximately at the same time when they were being printed, begins the foundation of the network of meteorological stations in that region. They were meant to systematically and regularly observe and measure atmospheric changes and so provide a qualitative basis for meteorology research in the future.

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References

- Albini P., I. Cecić, G. Morelli, I. Sović and M. Živčić (1994): A preliminary investigation of the January 4th, 1802 earthquake, Materials of the CEC Project »Review of Hystorical Seismicity in Europe«, **2**, Milano, 205–214.
- Almagia R. (1934): Un trattato cosmografico di autore Ragusino del secolo XVI (»Cosmographiae commentaria« di Luigi Georgireo). Archivio storico per la Dalmazia, a. IX, vol. XVI, fase. 96, 575–584.

- Bazala V. (1978): Pregled hrvatske znanstvene baštine,. Matica hrvatska, Zagreb, 495 pp.
- Boschovich R. G. (1749): Sopra il turbine che la notte tra gli XI e XII Giugno del MDCCXLIX danneggio una gran parte di Roma . Niccolo, e Marco Pagliarini, Roma, 224 pp.
- Božić I. (1973): Filip de Diversis i njegovo djelo. Dubrovnik 3, 11–80.
- Brusina S. (1889): Primorska »bura« u šestom stoljeću po Isusu. Glasnik hrvatskoga naravoslovnoga društva 4, 231.
- Caesar C. I. (1906): Libri III de bello civili cum libris incertorum auctorum de bello Alexandrino Africo Hispaniensi. E Typographeo Clarendoniano, Oxonii.
- Carrara F. (1846): La Dalmazia descritta. Fratelli Battara, Zara, 142 pp.
- de Cotrullis B. (1646): De navigatione libri IV. Manuscript.
- Dadić Ž. (1994): Hrvati i egzaktne znanosti u osvitu novovjekovlja. Naprijed, Zagreb, 340 pp.
- Farlati D. (1751): Illyrici sacri tomus primus. S. Coleti, Venetiis, 780 pp.
- Fortis A. (1984): Put po Dalmaciji. (ed. Josip Bratulić, transl. M. Maras.) Globus/ Zagreb, 303 pp.
- Fuscus P. (1990): De situ orae Illyrici. (ed. B. Kuntić-Makvić.) Biblioteka Latina et Graeca XIX, Zagreb, 149 pp.
- Gilić A. (1948): Bilješke o vremenu u XVII. stoljeću. Hidrometeorološki glasnik I/2, 128.
- Hennig R. (1904): Katalog bemerkenswerter Witterungsereignisse. Abhandlungen des Koenigl. Preuss. Met. Inst, II/4, 93 pp.
- Hildebrandsson H. (1881): Beitrag zur Verzeichung der strengen Winter Europas. Zeitschrift für Meteorologie 14, 345.
- Kišpatić M. (1891): Potresi u Hrvatskoj. Rad JAZU 107, 81–164.
- Klaić V. (1878): Prirodni zemljopis Hrvatske. Matica hrvatska, Poučna knjižnica 1, Zagreb, 406 pp.
- Klaić V. (1973): Povijest Hrvata, V. Matica hrvatska, Zagreb, 741 pp.
- Knoch K. (1929): Heisse Sommer und strenge Winter im 14. bis 17. Jahrhundert in Norddeutschland. Zeitschrift für angewandte Meteorologie 8, 221–224.
- Köppen W. (1881): Über mehrjährige Perioden der Witterung, IV. Die strengen Winter Europas... Zeitschrift für Meteorologie 14, 183–187.
- Kozličić M. (1983): Pomorska bitka kod Taurisa. Dubrovački horizonti 23, 38–41.
- Kozličić M. (1990): Historijska geografija istočnog Jadrana u starom vijeku. Književni krug, Split, 417 pp.
- Kozličić M. (1995): Beutemps-Beaupré o Jadranu 1806. godine. Pomorski zbornik 33, Rijeka, 259–279.
- Kratochwill F. (1940): Über kalte und strenge Winter in Mitteleuropa. Meteorologische Zeitschrift 73, 420–424.
- Kršćanska sadašnjost (1990): Biblija. (Ed. J. Kaštelan, B. Duda.) Zagreb, 368 pp.
- Lovrić I. (1948): Bilješke o Putu po Dalmaciji opata Alberta Fortisa. (Transl. by M. Kombol.) Izdavački zavod JAZU, Zagreb, 229 pp.
- Lucius J. (1986): De regno Dalmatiae et Croatiae. (Ed. B. Kuntić-Makvić.) Biblioteka Latina et Graeca VII, Zagreb, 471 pp.
- Marki E. (1950): Vrijeme. Pomorsko brodarski savez Jugoslavije, Split, 175 pp.
- Nikolanci M. (1974): Pomorska bitka kod Taurisa. Prilozi povijesti otoka Hvara IV, 5–15.
- Oreb M. (1993–1994): Papa Aleksandar III. na Visu. Adrias, Zbornik Zavoda za znanstveni i umjetnički rad HAZU u Splitu, 4–5, 81–120.
- Penzar B., I. Penzar (1997): Bilješke iz 17. i 18. stoljeća o vremenu u Makarskoj. Manuscript.
- Petter F. (1857): Dalmatien in seinen verschiedenen Beziehungen, I. J. Perthes, Gotha, 296 pp.
- Plinius Secundus C. (1841): Historia mundi libri XXXVII, vol. primum. (Ed. M. Domenichi.) J. Antonelli, Venetiis, 261 pp.
- Rački F. (1877): Prilog za poviest hrvatskih uskoka. Starine JAZU, IX, 172– 256.
- Seljan D. (1843): Zemljopis pokrajinah ilirskih, dio I. Tiskara Lj. Gaj, Zagreb, 256 pp.

- Sijerković M. (1993): Hrvatski vremenari. Školske novine, Zagreb, 138 pp.
- Soldo J. A. (ed.) (1993): Makarski ljetopisi 17. i 18. stoljeća. Književni krug, Split, 373 pp.
- Strabon (1873): Géographie. (Trad. nouvelle par Amédée Tardieu.) Hachette, Paris, 238 pp.
- Šišić F. (1904): Ljetopis Pavla Pavlovića patricija zadarskoga. Vjestnik kr. hrvatsko-slavonsko-dalmatinskog zemaljskog arkiva, VI, 37–43.
- von Valvasor J. W. (1877–1879): Die Ehre des Herzogtums Krain. (2^{te} unveränderte Auflage) Rudolfswerth, Teil I: 696 pp, II: 836 pp, III: 730 pp, IV: 610 pp.

SAŽETAK

**Zapisi o vremenu i klimi na Jadranu do sredine
19. stoljeća***Ivan Penzar i Branka Penzar*

Rad se odnosi na kvalitativne zapise nastale prije osnutka mreže meteoroloških postaja, od kojih najstariji potječu još iz drugog i prvog stoljeća prije Krista. Nalaze se u različitim domaćim i stranim ljetopisima, kronikama, izvještajima, pismima, knjigama i novinama. U prvom dijelu članka kronološki su poredani zapisi o vremenu. To su usputne bilješke, prikazi po nečemu osobitih meteoroloških događaja, a čak i dugogodišnje gotovo redovito praćenje vremena u Makarskoj u 18. stoljeću. U drugom dijelu prikazani su zapisi o općim značajkama vremena, tj. o obilježjima klime. To su većinom prikazi vjetrova, osobito bure, a ima i nekoliko klimatografija.

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