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THE PALAEOENVIRONMENTAL CHANGES IN THE ERA OF GREEK COLONIZATION OF THE NORTHERN BLACK SEA COAST AND THE DEVELOPMENT OF GREEK SETTLEMENTS OF THE LOWER DNIESTER MICROREGION. PRELIMINARY RESEARCH

ABSTRACT The Greek colonization of the Black Sea resulted in the creation of many new settlement points placed on the entire coastline of the sea basin. One of the aspects to be recognized, both when studying the beginnings of Greek colonization in the Black Sea and in relation to the later development of the Pontic poleis, are the palaeoenvironmental conditions. It is beyond discussion that certain aspects of the natural environment, such as the topography and coastal features, influenced the choice of colonization directions, the place where the colonies were established and the development of the settlement network supporting new poleis (chora). Recognition of the palaeoenvironmental features is also significant for studying contemporary archaeological sites, influencing their characteristics created by researchers excavating particular Greek centres. The reconstruction of the northern Black Sea paleoenvironment during the Greek colonization was determined by the hypothesis of sea level fluctuation, covering the entire Black Sea basin, as part of Phanagorian Regression and Nymphaeum Transgression. These processes were to reduce sea waters in the range from 2 to 15 m below the present level of the sea and then raise them again (ca 2-3 m). However, the new research and methodology proposed in the last decade undermine the validity of such a broad approach to paleo-natural phenomena, which allegedly covered the entire Black Sea coast. The results obtained for selected areas on the eastern and western parts of the northern coast of the Black Sea call into question the theory of Phanagorian Regression. The article aims to present the problem of the reconstruction of the natural environment features of the Lower Dniester area during the formation and development of the Greek colonies in this area in the light of new achievements in the reconstruction of palaeoenvironmental features of the northern Black Sea coast.

Key words: Greek colonisation, northern Black Sea coast, Nikonion, palaeoenvironment features

ABSTRAKT Grecka kolonizacja Morza Czarnego zaowocowała powstaniem wielu nowych punktów osadniczych położonych na całej linii brzegowej basenu morskiego. Jednym z aspektów, które należy rozpoznać, zarówno przy badaniu początków greckiej kolonizacji na Morzu Czarnym, jak iw odniesieniu do późniejszego rozwoju poleis pontyjskich, są warunki paleośrodowiskowe. Wydaje się nie podlegać dyskusji, że pewne aspekty środowiska przyrodniczego, takie jak ukształtowanie terenu i cechy wybrzeża, miały wpływ na wybór kierunków kolonizacji, miejsca powstania kolonii oraz rozwoju sieci osadniczej wspierającej nowe poleis (chora). Rozpoznanie cech paleośrodowiskowych ma również znaczenie dla badania współczesnych stanowisk archeologicznych, wpływając na ich charakterystykę kreowaną przez badaczy prowadzących wykopaliska w poszczególnych ośrodkach greckich. Rekonstrukcję paleośrodowiska na obszarze północnego wybrzeża Morza Czarnego objętego kolonizacją grecką wypracowali badacze zakładający wahania poziomu morza, obejmujące cały basen Morza Czarnego, w ramach procesów związanych z Regresją Fanagoryjską i Transgresją Nimfajońską. Procesy te zakładały obniżenie wód morskich w zakresie od 2 do 15 m od współczesnego poziomu morza, a następnie ponowne ich podniesienie (o około 2-3 m). Jednak nowe badania i metodologia zaproponowana w ostatniej dekadzie podważają zasadność tak szerokiego podejścia do zjawisk paleonaturalnych, które rzekomo obejmowałyby całe wybrzeże Morza Czarnego. Wyniki uzyskane dla wybranych obszarów na wschodniej i zachodniej części północnego wybrzeża Morza Czarnego stawiają pod znakiem zapytania teorię Regresji Fanagoryjskiej. Celem artykułu jest przedstawienie problemu rekonstrukcji cech środowiska przyrodniczego obszaru dolnego Dniestru w okresie formowania się i rozwoju kolonii greckich na tym obszarze w świetle nowych osiągnięć w zakresie rekonstrukcji cech paleośrodowiskowych północnego wybrzeże Morza Czarnego.

Introduction

The Greek colonisation of the Black Sea, which began in the middle of the 7th century BC, resulted in the emergence of many new settlement points – cities, trading posts and rural (agricultural) centres across the coast. As the researchers exploring this issue have already noticed, the situation of the colonists settled in the territories by the Black Sea was radically different from the conditions that Greeks encountered when establishing new cities in the western Mediterranean.[1] While the first Greeks in the West of the Mediterranean See followed the sea routes and trade networks established already in the Bronze Age, those who sailed to the Black Sea entered a world almost unknown. The geographical and climatic conditions were significantly different in both regions, with a mostly hilly and fertile landscape in the West compared to flat open steppes in the Northeast. Despite all these differences, which shaped the process of colonization in various ways, the effect was similar – both in the Mediterranean and the Black Sea, a network of cities scattered on the sea coasts arose in a way that allowed their inhabitants to communicate and cooperate on different levels. One of the aspects that should be recognised, both when examining the beginnings of Greek colonisation in the Black Sea and the subsequent development of Pontic poleis, are the conditions of the palaeoenvironment, which had a substantial impact on the directions and dynamic of the colonisation process, the choice of the place for a new polis and the development of the settlement network supporting new city (chora). The reconstruction of the palaeoenvironment in the area of the northern Black Sea coast covered by Greek colonization was influenced by the views of researchers assuming periodic fluctuations in the sea level covering the entire Black Sea basin as part of the Phanagorian regression and the Nymphaeum Transgression. This phenomenon was supposed to lower the sea level by 2 to 15 meters below the present, and the later exceeding caused the sea level to rise. These phenomena explained the submerged parts of cities recorded at archaeological sites, especially ports, and the destruction of some settlement structures.

The concepts concerning the image of the Lower Dniester region palaeoenvironment in relation to the development of Greek settlements (Tyras and Nikonion) were also developed in the main stream of interpretation pointing out the Phanagorian Nymphaeum Regression and the subsequent Transgression as decisive factors that influenced the present state of preservation of archaeological sites (Tyras and Nikonion).

All phenomena recorded through the archaeological research in the Black Sea were interpreted in the context of this concept. However, the research conducted in the last decades and new methodology proposed in this process undermine the legitimacy of such a broad approach to the palaeonatural phenomena which supposedly covered the entire Black Sea coast. The results obtained for selected areas on the eastern and western ends of the northern coast put into question the theory of Phanagorian Regression indicating other factors like local tectonic movements and the morphodynamics of the lake shores, which attests the flooding of the harbours as well as the residential parts of Greek cities on the northern coast of the Black Sea. At the same time the attention was paid to look at the phenomena of the palaeoenvironment recognised in the Black Sea area from a broader perspective of the recorded processes (or lack thereof) in the Mediterranean Basin.

The Lower Dniester region in the ancient Greek colonisation period

Nikonion is one of the five Greek poleis in the so-called northwest Pontic zone (Fig. 1). The remaining sites included in this group are Histria, Borysthenes and Olbia.[2]

As archaeological sources indicate, the process of colonisation of this part of the Black Sea coast began in the third quarter of the 7th century BC.[3] Histria and Borysthenes were established in the northwest section of the coast due to the first (oldest) colonisation phase. About Histria, historical records indicate the beginning of the third quarter of the 7th century BC or the end of the 7th century BC,[4] when the polis was founded.[5] However, in light of the available archaeological sources, the Greek settlement in this area can be referred to as the last quarter of the 7th century BC.[6] Borysthenes, the ancient name of Berezan island, which was a peninsula in a time of colonisation, was founded according to Eusebius in

[1] Guggisberg 2022: 1-4.

[2] Gajdukevich 1955: 10; Shelov 1967: 219-224; Brashinskij 1970: 133-137.

[3] Koshelenko, Kuznecov 1992: 11.

[4] Ps.Scym. 768-770.

[5] Eusebius, 95b, 657.

[6] Dimitriu, Coja 1958: 69-92.

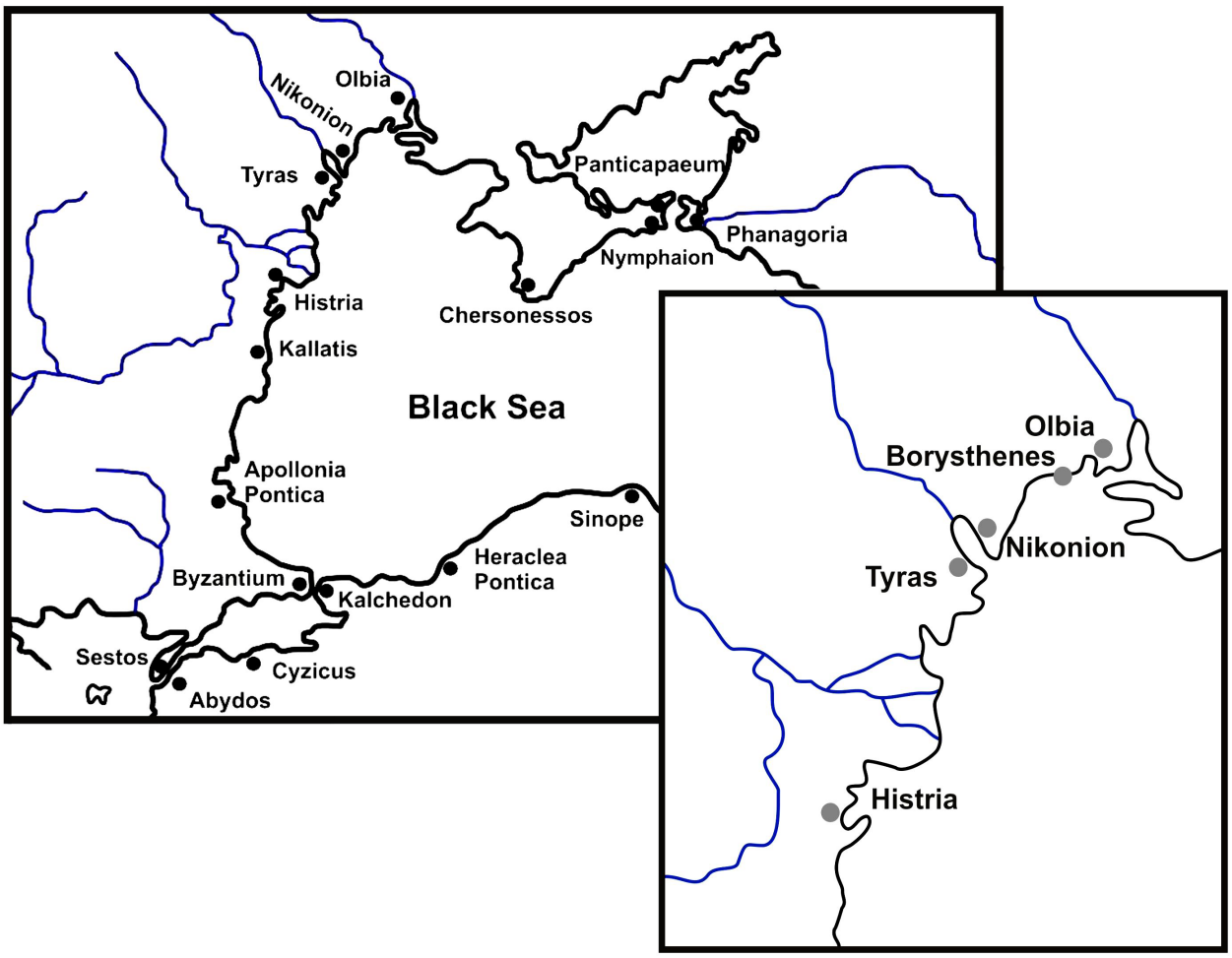

Fig. 1. Greek Colonies in the Black Sea

447/646 BC. The review of of the archaeological evidence has shown thet the foundation date must be in fact lowered by some 30 years.[7] The archaeological site of Olbia is situated at the confluence of the Dniepr-Boh and Berzan-Sosnitsa limans.[8] In the light of historical and, above all, archaeological sources, the foundation of Olbia dates back to the first[9] or the second quarter of the 6th century BC.[10] After the founding of Olbia in the region, another phase of colonization of the North Pontic coast takes place, including the basin of the Lower Dniester. As a result of this process, Tyras and Nikonion were founded. Apart from the two sites that show the most extended settlement continuity, nearly 40 other settlement points of a Greek character have been identified in this region.[11]

Written sources on Greek colonies in the Dniester basin are random and imprecise, often mutually exclusive. The first historical account of the Black Sea Northwest region comes from the texts of Herodotus. Concerning the Dniester basin, he does not mention any Greek cities known from other sources. He only says that at the mouth of the Tyras River lived Hellenes, calling themselves Tyrites.[12] The name Nikonion appears for the first time in the Pseudo-Skylaksa periplus, where three Greek cities are enumerated: Tyras, Nikonion and Ofiusa. The information about poleis Nikonion, Tyras and Ofiusa can also be found in Pseudo-Skymnos periplus.[13] The existence of a city with this name is also confirmed in Strabo's account.[14] Strabo also mentions the Neoptolemus Tower and the village of Hermonassos,[15] which were supposed to be situated at the mouth of the

[7] Soloviev 2004: 17.
[8] Kryzhitskiy 1997: 101.
[9] Vinogradov 1989: 36-38.
[10] Kryzhitskiy et al. 2003: 398.
[11] Sekerskaja 2007: 471.
[12] Herodotus IV, 51.
[13] Ps.Scym. 798-803.
[14] Strabo VII, 3, 16.
[15] Strabo VII, 3.

Tyras River, as the Dniester was called in ancient times.[16] In the Pseudo-Arriana periplus, there is information that on the bank of the Tyras River, there is a city of the same name. Pliny also describes the river Tyras, stating that on its shore, there is a city bearing the same name as the river, which was previously called Ofius.[17] In the poetry by Valerius Flaccus, "Argonauts", which is modelled on the work of Apollonius of Rhodes, there is also mention of Tyras and the city Ofiusa. Pomponius Mela writes about the River Tyras and the city of the same name located on its shores. On the other hand, Ptolemy distinguishes between both cities, giving the location of Nikonion as the third polis, the village of Hermonassos and the city of Phiska, unknown from other sources. In one of the latest sources – the account of Stefan Byzantine from the 6th century AD – only Tyras was mentioned as a city lying on the bank of the Dniester. At the same time, the author placed Nikonion on the shores of the Danube. There are two views in the literature regarding the chronology of Nikonion foundation. One suggests that polis was founded in the mid-6th century BC.[18] The second assumes that the city was established in the last decades of the 6th century BC.[19] Some researchers also assume that Tyras itself was previously called Ofiusa.[20] As in the case of most of the other polis at the Black Sea shore Miletus is pointing out as Nikonion mother city but the strong influence of Histria in early period of cities existence, manifested by Histrian coins among archaeological finds of Nikonion, suggests that the new colony was founded by or with the support the inhabitants of this very polis.[21]

The co-called Phanagorian Regression

The changes recorded in sea level in the Black Sea basin during the late Holocene by archaeological and geological sources have attracted the attention of both the scholars interested on the region's geography in the last century and the renewed research efforts in the recent decade. The Phanagorian regression was first proposed by Fedorov in 1959 and then the theory was developed by him in 1977.[22] In his works he proposed the Black Sea level fluctuation curve, which presents the Phanagorian Regression recorded in the 1st millennium BC. According to his assumptions, the sea level in this period was 2 m lower than today. After underwater archaeological research conducted in 1959-1960 by V.D. Blavatsky[23] in the area surrounding ancient Phanagoria, Fedorov's assumptions obtained new kinds of data confirming the hypothesis. According to this concept, large changes in sea level were assumed in the cycle of re- and transgression, with a minimum sea level of 5-6 m below the current position in the middle of the first millennium BC. The theory was based on archaeological and palaeogeographic research carried out around Greek colonies over the Cimmerian Bosphorus, in particular in already mentioned Phanagoria, where the presence of a large number of submerged relics dating back to the classical period was revealed. Since then, most of the research on the evolution of the late Holocene relative sea level (RSL) in the Black Sea assumed a high level at the beginning of the second millennium BC and then a significant decline in the first half of the first millennium between 5 and 10 m, and even 15 m below the today's sea level.[24] The Phanagorian regression theory is important for settlement studies as it covers the era of Greek colonization of the northern Black Sea coast, which led to the creation of many port facilities and commercial outlets throughout Crimea (Pantikapaion, Pheodosia, Nymphaion, Chersonessos), the Black Sea and the coast of the Azov Sea (Phanagoria, Gorgippia, Olbia, Berezan). The fact that some of these cities' former harbours are now submerged is a clear sign that the sea level was lower in ancient times than it is today.[25]

As a consequence of this research the scholars assumed a sequence of changes in the Black Sea level that was to occur in the entire sea basin, these fluctuations roughly correlated with a specific historical period.[26]

- Dzhemetinian Transgression (3800-2600 BP) – Archaic Period

[16] Ochotnikov 2006: 86, fig. 11.

[17] Pliny, NH, IV, 83.

[18] Sinitsyn 1966: 53; Sekerskaya 1976: 95; 1989: 3, 22; Bruyako 1993: 61, 76; 1999: 14; Vinogradov 1999: 54.

[19] Okhotnikov 1990: 66; 1997: 28; Samoylova 2000: 83-84; Sekerskaja 2001: 126.

[20] Zubar, Son 2007: 50.

[21] Vinogradov 1999: 70.

[22] Fedorov 1959; 1977.

[23] Blavatsky 1961: 277-280.

[24] Blagovolin, Shcheglov 1969: 45-58; Balabanov, Izmailov 1988: 54-62; Ivanov, Schmuratko 1983; Shilik, 1997; Balabanov 2007: 711-730; Izmailov et al., 1989: 61-69; Svitoch 1999: 94-101; Svitoch et al. 2000: 594-603; Selivanov 2003.

[25] Brückner et al. 2010: 170.

[26] Buynevich 2017: 52.

- Phanagorian Regression (2600-2000 BP) – Classical and Hellenistic periods
- Nymphaean Transgression (2000-700 PB) – Roman and Late Antiquity period

The ancient sea level in the Black Sea – the archaeological data overview

The ancient Greeks' intensive settlement of the Black Sea coastlines has left abundant archaeological evidence along its entire coast, including harbours. As it was mentioned earlier, it has been recognized that some archaeological structures can provide interesting information on the direction and amplitude of changes in RSL since ancient times. Over the past decades many authors have studied the use of archaeological markers to investigate sea-level change ratios.[27] These arguments are very often raised concerning the northern shores of the Black Sea.

On the Bulgarian Black Sea coast a series of sunken harbour facilities – Karantinata, Galata, Apollonia Pontica[28] and parts of residential quarters – Bizone, Mesambria are known.[29] Based on archaeological data of Bulgarian sea shore scholars assumed that RSL was around 4 m below present in the 6th century BC, rising to the present mean sea level around the 6th century AD.[30]

The submerged ruins of Histria residential district discovered during excavations carried out in the 1950s in the central part of Lake Istria were interpreted as having been built on an island that supposedly existed there in the ancient times.[31] The settlement situation reconstructed in this way was associated with the Phanagorian Regression, or sinking of the settlement relics due to a recent (contemporary) rise of the sea level. It led to the interpretation that they were created in the regressive phase, contemporary with the date of the first colonisation. What is more, the submergrd of some structures that were built on sea sands, as well as the formation of Lake Sinoe, were associated with a marine transgression phase that is locally called "the Histrian transgression".[32] A range of new archaeological and geological evidence suggests otherwise – that Histria was originally built at an open coast location with a morphological configuration suited to high-capacity marine navigation and port activities.[33] This issue so as the assumptions about the palaeoenvironment of the Dniester Liman area where Tyras and Nikonion are localised will be discussed in the further part of the article.

Researchers dealing with the shaping of the coastal area at the mouth of the South Boh and the Dnieper, taking as the basis of their research the assumption of the widespread lowering of the sea level in connection with the Phanagorian regression, indicated that the modern island of Berezan during the Greek colonization was a peninsula that created favourable conditions for the establishment of the first colony, initiating the presence of the Greeks in the area. Subsequent changes and the Nymphaeum Transgression resulted in the area becoming an island.[34] The conducted underwater research is to confirm that some relics of ancient settlements are currently submerged.[35]

Ancient Olbia was a subject of several underwater archaeological campaigns[36] which results were widely used in understanding RSL changes since antiquity[37]. The two defensive structures are located 2.0-2.3 m below present and have been constrained to the 5th to 3rd centuries BC.[38] Remnants of a defensive wall along the palaeoliman coastline allow the eastern border of the lower city to be delineated. At depths of 2.2-3.1 m two amphora fields have been elucidated: the first (southern) field yielded material from the 4th century BC, while the second, 50-60 m north of the former zone, contains ceramic material from the end of the 6th to 4th centuries AD.[39] Underwater research at Olbia has shown that cultural layers in the outer part of the lower city presently lie 2.5-3.3 m below MSL. These remains broadly attest

[27] Flemming 1969; Stiros 1998: 731-741; Sivan et al. 2001: 101-117, 2004: 315-330; Auriemma, Solinas 2009: 134-146; Anzidei et al. 2011: 5-12, 2013: 158-167; Evelpidou et al. 2012: 259-277; Mourtzas 2012: 3-18; Morhange, Marriner 2015: 146-156.

[28] Dimitrov, Orachev 1982: 1-11.

[29] Ognenova-Marinova 1975: 43-48; 1980: 26-29; Preshlenov 2008; 2016: 305-307.

[30] Ognenova-Marinova 1975: 43-48; Toncheva 1964,1970: 10-15; Dimitrov, Orachev 1982: 6; Preshlenov 2008: 305-307; Peev 2014: 180, 2016: 18-22.

[31] Parvan 1915: 253-270; 1916: 18-20; Lambrino 1938: 11-21; Zirra, Alexandrescu 1957: 22-31.

[32] Bleahu 1962: 45-56; Fedorov 1977: 25-32; Vespremeanu 2005; Hanganu 2012: 7.

[33] Vespremeanu-Stroe et al. 2013: 246.

[34] Shilik 1975: 51-91.

[35] Nazarov 1997: 131-136; 2003; Ievlev 2014: 51, ris. 9.

[36] Kryzhitskiy, Shilik 1972: 396-397; Pydyn 2008: 135-141; Vakhoneyev 2013: 27-33.

[37] Kozlovskaya 26-65; Porotov 2007: 30.

[38] Kryzhitskyi 1984: 36-65; Nazarov 1985: 53-54.

[39] Leipunskaya 1984: 65-88.

to a mid-1st millennium BC sea level at 5.0-4.5 m below present. Ceramics indicate that the lower city continued to function until the 3rd century AD, and indirectly testifies to moderate RSL changes between the end of the 1st millennium BC and the first half of the 1st millennium AD.[40] The analysis of the sources of archaeological research of the Olbia and Odessa Bay area shows an extensive port network. The possible remains of ancient jetties have been found underwater near the site of Staraya Bogdanovka and Kozyrka, the traces of a reportedly ancient pier made out of stone blocks have been detected near the site of Ochakovskoe.[41] The topography of the Sofievka site also suggests that the ancient settlement there consisted of an upper fortified one (Sofievka 2/Grubokaya Pristan) and the lower one with the harbour (Sovievka I).[42] It is also suggested that in antiquity, Tiligil'skiy, Kuialnitsky I Khadzhibeyskii Limans had access to the sea and were a part of the cabotage sea-route network.[43]

Considering the north-eastern part of the Black Sea coast the ancient city of Kerkinitida, located on the south-western shoreline of Crimea, on a low-lying promontory that closes the northern boundary of Kalamite bay, despite a dearth of data referring to the palaeotopographies of the ancient city, there are several indicators that point to a low RSL position during the Late Bronze to Early Medieval times. It is primarily attested to by flooding of the low part of the stratigraphic sequence at 1.7-1.8 m below present.[44]

In the case of Chersonesos, hydroacoustic and underwater archaeological research[45] has revealed numerous archaeological structures at a depth of 3 to 3.5 m, including port structures (moles, jetties and quays). They made it possible to locate the ancient coastline, which is now 3.5-5.0 m below the MSL. Further archaeological research of this ancient polis has revealed the other traces of historical RSL change.[46]

Research on the coastal area of Classical Nymphaeum has elucidated cultural remains at 6.5 m below present. Stone remains were found over a wide area down to depths of 1 to 4.5 m and attest to a drowned ancient coast. These constructions have been dated to the 4th to 3rd centuries BC on the basis of ceramics.[47]

As some scholars postulate the archaeological data of RSL changes in the Gulf of Taman during the past 3000 to 4000 years are complemented by the study of sediment archives at various sites (Fouache et al., 2004, 2005). In the outer part of the Gulf of Taman, fossil sand barriers lie 2-4 m below present. This transgressive sequence reflects the onshore movement of sand tracts covering up the underlying lagoonal facies. Radiocarbon dates from the base of the barrier yielded an age of 2450 ± 70 years BP (ca. 339 cal. BC-50 cal. AD). It was said that the drowned barrier system represents one of the many examples of the Phanagorian transgression during the second half of the 1st millennium BC, when relative sea level lay 5 to 5.5 m below present.

The palaeoenvironment of the northern Black Sea coast in the light of recent studies

Another approach, developed in recent decades, is based on interdisciplinary research and examines some cases of geoarchaeological situations in the Taman Peninsula and the Danube Delta (Histria). In accordance with the methode introduced for these areas, developed by researchers who successfully applied them into research process of the eastern Mediterranean coast,[48] the scholars reject the idea of one-time, significant for the whole Black Sea basin changes in the sea level occurring in the late Holocene known as a Phanagorian Regression.

In order to establish a more realistic and reliable sea level curve in the Holocene a new research and fields works were conducted in the Taman Peninsula[49] and southern Danube delta.[50] As a result of the conducted analyses, a sea level curves were obtained which fits the indicated individual solutions for the areas, as well as the type 2 arch for the Mediterranean Sea.[51] In the case of Taman Peninsula the research method gave the opportunity to recreate the locally applicable sea level curves: one for the Kuban delta plain, the other for the Golubitskaya sand dam and the third for

[40] Porotov 2007: 30-31.

[41] Ievlev 1991: 311-318.

[42] Shilik 1997: 115-129; Porotov 2007: 31; Kozlovskaya 2017: 30-31.

[43] Kozlovskaya 2017: 35.

[44] Kutaitsov 1988: 5-16; Shcheglov 1978: 29-42.

[45] Zolotarev, Iones 1979: 19-22; Zolotarev 2004: 55-67.

[46] Blagovolin, Shcheglov 1969: 49-58.

[47] Scholl, Zinko: 1999; Zinko: 2003; Porotov 2007: 31.

[48] Brückner, Vött, Schriever, Handl. 2005: 95-106.

[49] Brückner et al. 2010: 160-179.

[50] Vespremeanu-Stroe et al. 2013: 245-256.

[51] Brückner et al. 2010: 161.

the Semebratnee. The same applies to the curves from the sand spit (the Anapa Spit and the Burgaz Spit) and the Taman Bay. In addition, as researchers point out nowadays, also referring to earlier achievements in this field, due to local tectonic movements, synchronous coastlines in different coastal regions of the Black Sea vary considerably in height. This alone demonstrates that it is impossible to create a uniform (coherent) Holocene sea level curve for the entire Black Sea. In many areas, the local tectonic signal is superior to the glacial-eustatic signal – at least throughout the last 7500 years.[52]

Histria is located in the Razelme-Sinoe lagoon system on the southernmost beach-ridge unit of the Danube delta. The Vadu-Istros area is at the end of a littoral cell, and so is strongly affected by sedimentary deposition, as it acts as a trap for the sediments. The area has seen significant geomorphological transformations in the context of general sea-level changes. It is defined by beach-ridge plains such as Chituc and Saele, on which the archaeological site is located, coastal barriers (Lupilor), and shallow lakes – Sinoe to the east, Istria and Nuntași to the west. Part of the settlement system lies on rocky deposits of green slate, while the rest of the site area is covered by sea sands. In contrast to the evolutionary models developed for the deltaic lobes formed to the north of the Sf. Gheorghe tectonic fault line,[53] which are widely accepted by most scientists,[54] there is no consensus among researchers regarding the southern areas where the system of sandy barriers and lagoons was formed. However, it should be emphasised that in this case, archaeological finds do provide reliable chronological data allowing for the reconstruction of the palaeolandscape of the coast.[55] Nonetheless, the nature of the processes that have transformed the ancient bay into a mosaic of coastal plains, beach ridges and lakes was a subject of discussion.[56] Based on the results of the interdisciplinary research, the obtained new chronological indicators (OSL) and archaeological evidence, the hypothesis was confirmed that the ancient city was founded on a coastal complex in the shape of a peninsula, consisting of a rocky promontory located opposite a sandy plain. As a result, the colony was established both on the rocky ground, where the city centre was built, and on the adjacent sandy plots, where residential districts were created.[57] The new data, especially the OSL ages, which show the same chronology (1300-700 BP) for Young Saele and Chituc,[58] oppose previous theories that suggest the formation of the Chituc beach-ridge plain caused the transformation of the former Sinoe gulf into a lake.[59] Most probably, the lake formation is related to the intense local subsidence caused by tectonic fault lines that coincide with its straight coastlines.[60]

As it was mentioned before, considering changes in the landscape of Histria, most researchers refer to eustatic sea level changes,[61] and only a few researchers point to the effects of tectonic movements or the morphodynamics of the lake shores,[62] indicating these processes as the primary factors that influenced the emerging palaeolandscape of Histria. As a result of new set research, a new model of evolution of this region's coast is being proposed. The conducted palaeoenvironmental reconstruction suggests that the relative sea level recorded in the delta of the southern Danube displayed a fluid tendency throughout the recent four millennia, ranging from 0 to 2 m from the current level, with a relative stable position of about 0.7 m during 3000-1000 BP, encompassing the entire period of the city functioning.[63] Based on the new approach regarding the reconstruction of the palaeoenvironment, a location of the ancient port of the city has been proposed.[64]

The stated results of geoarchaeological research obtain from several archaeological sites spread on the northern Black Sea shore do not confirm eustatic oscillations, but rather widespread hydroisostatic and neotectonic effects of the Black

[52] Brückner et al. 2010: 168; Fouache et al. 2011: 170-171.

[53] Ianovici et al., 1968; Sandulescu, 1984.

[54] Panin, 2003; Giosan et al., 2006.

[55] Bleahu 1962; Cotet 1966; Stefan, 1987; Canarache 1956; Pippidi 1983; Alexandrescu 1978; Pippidi 1983; Avram et al. 2004; Höckmann et al. 1997.

[56] Bleahu 1962: 45-56; Cotet 1966: 337-352; Alexandrescu 1978: 331-342; Pippidi 1983: 14-37; Panin, 1983: 175-184; 1989: 25-36; 2003: 249-255; Canarache 1956: 289-315; Giosan et al. 2006: 757-760.

[57] Zirra, Alexandrescu 1957: 22-31; Alexandrescu 1978: 331-342; Vespremeanu-Stroe et al. 2013: 250-251, fig. 2.

[58] Hanganu 2012: 69-70; Preoteasa et al. 2013: 569; Vespremeanu-Stroe et al. 2017: 545.

[59] Bleahu, 1963; Coteț, 1966; Panin et al., 1983; Panin, 2003.

[60] Vespremeanu-Stroe et al. 2013: 255.

[61] Bleahu 1962: 45-56.

[62] Canarache 1956: 289-315; Giosan et al. 2006: 757-760.

[63] Vespremeanu-Stroe et al. 2013: 255.

[64] Bivolaru et al. 2021: 311, fig. 9, 10.

Sea.[65] Moreover the level of the sea was also certainly influenced by a sudden rise of 50-90 m during its reconnection to the Mediterranean Sea after being temporarily isolated from the world ocean.[66] The oceanographic research conducted currently in the area of the Black Sea indicates that since the reconnection of the Black Sea to the Mediterranean Sea (i.e. no later than 7500 BP), both bodies of water have remained in equilibrium.[67] This fact, as well as arguments from fields such as archaeology, history, hydrodynamics etc., put the existence of the Phanagorian Regression in question. Especially because none of the sea level curves determined for the Aegean Sea does not show a comparable cycle of regresssion/transgression of several metres in the 1st millennium BC.[68]

The recorded exchange of water between the two seas through the Bosporus and Dardanelles Straits is very intense. Another argument against the Phanagorian Regression is that any large difference in water levels between the Black Sea and the Aegean Sea (Mediterranean) would equalise in just a few years and would certainly not become a fact conditioning the development of settlement during the following centuries. Even in this worst-case scenario, the water deficit would be balanced within 12.2 years. In the best case, the maximum total values of 512 km^3/year were enough to restore equilibrium in only 4.6 years.[69] According to Tolmazin, the mean value of the total river outflow directed into the Black Sea basin is 350 km^3/year. In this case, the deficit would cease to exist in 6.8 years.[70]

Taking into account the shallow shelves of the Sea of Azov and the larger areas of the northern coast of the Black Sea, a vertical drop of the sea level measuring several metres would cause the coastline to be displaced by several kilometres.[71] Ancient writers would have noticed such an event that would affect all the coasts, and especially coastal settlements. However, there is no confirmation of such an event in archaeological sources. On the other hand, it should be emphasised that the factual state that emerges through archaeological evidence confirms that during the Greek colonisation all coastal settlements were established near – not a few kilometres from – the current coast. In this case, a very good example is the Olbia with a very well-developed settlement network of the city (Fig. 2.1, 2), which grows significantly between the archaic and classical periods. As the lists of archaeological sites and their locations show, new points of Greek activity were located on the bank of the liman.[72] When studying the settlement network's development, it is impossible to state the relocation of the sites. The fact that they are currently located on the modern shore suggests that the change in the water level of the river's liman, although it certainly did not take place in the time if the settlements existence, or did not take on significant (from the settlers' point of view) values.
The fact that parts of certain ancient settlements are now submerged may rather indicates a later subsidence and/or a general rise in sea level since their establishment, which is also known from the Mediterranean basin. What also should be mention, as noticed by the researchers studying the formation of the Taman Peninsula, the primary geomorphological features in this area are recent and relict erosion cliffs (up to 50 m tall). They are formed in unconsolidated neogenic bedrock that erodes easily. In the case of the ancient city of Hermonassos,[73] it was calculated that the seaside cliff receded up to 20 m inland in the last century. Assuming these values as a point of reference for further calculations, during the last 2-3 millennia, some areas of the coast occupied by Greek colonies might have experienced an erosion of a few hundred metres of land. Erosion processes recorded in various sections of the Black Sea[74] also may be one of the reasons why some archaeological sites are currently located underwater.

[65] Giosan at al. 2006: 757-760; Filipova-Matinova 2007: 453-482; Protov 2007: 29-36; Brückner et al. 2010: 160-179; Fouache et al. 2011: 162-164; Vespremeanu-Stroe et al. 2013: 245-256.

[66] Ryan et al. 1997: 119-126; Major et al., 2002: 75-106, 184-187; Giosan et al., 2006: 757-760.

[67] Pirazzoli, Pluet 1991: 58; Ryan et al. 2003: 525-554; Brückner et al. 2010: 168; Fouache et al. 2011: 172-174; Vespremeanu-Stroe et al. 2013: 250.

[68] Brückner et al., 2006: 63-83, Kraft et al., 2007: 121-149; Fouache et al. 2011: 170.

[69] Konikov 2007: 405-436; Fouache et al. 2011: 170.

[70] Tolmazin 1985: 217-276.

[71] Nikonov et al. 1997: 818-822; Polonic et all. 1999: 300-301; Brückner et al. 2010: 174; Dikarov 2011: 9-10; Fouache et al. 2011: 171-172.

[72] Kryzhitskiy 1997b: 68-69; Kryzhitskiy at al. 1989: 21, 98, ris. 3, 35; Kryzhickiy et al. 1990.

[73] Sudarev, Chevelov 2010: 220-223.

[74] Kos'yan, Kuklev, Khanukaev, Kochergin 2012: 246-250.

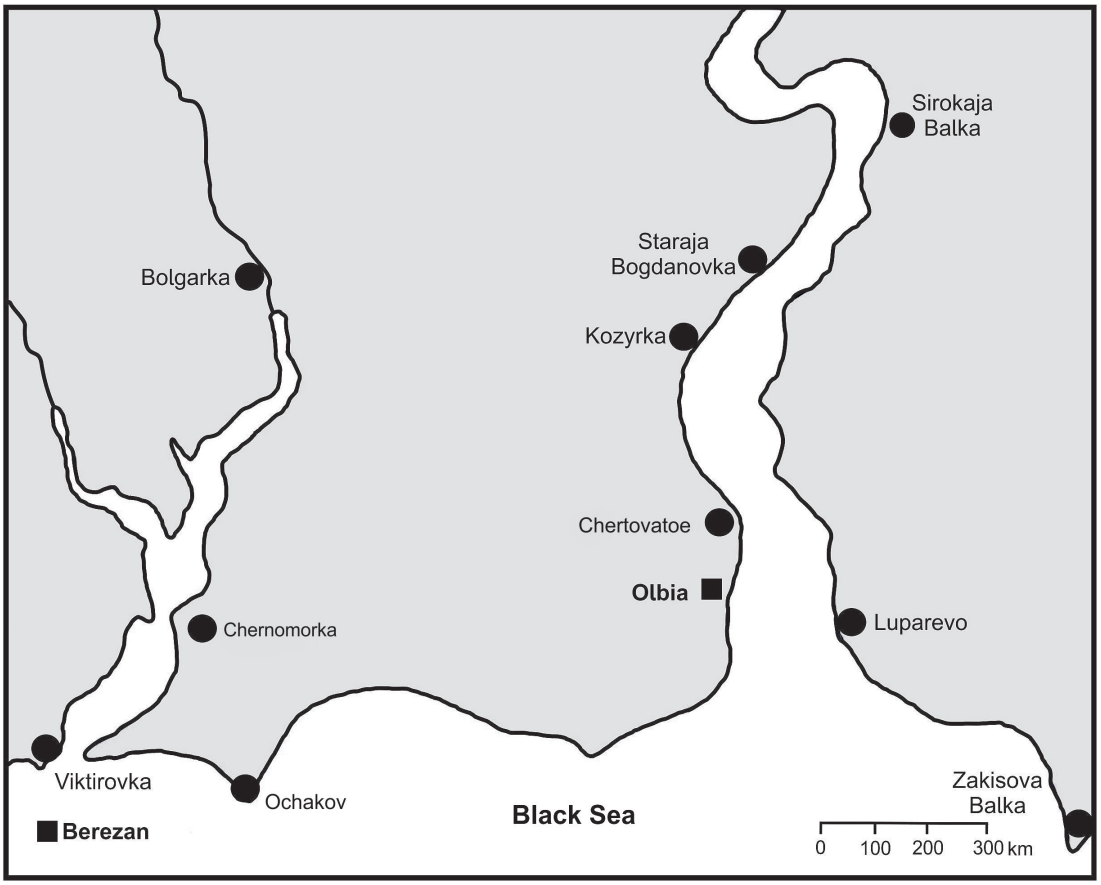

Fig. 2.1. The development of Olbian chora in Archaic period (after Kryzhitskiy at al. 1989)

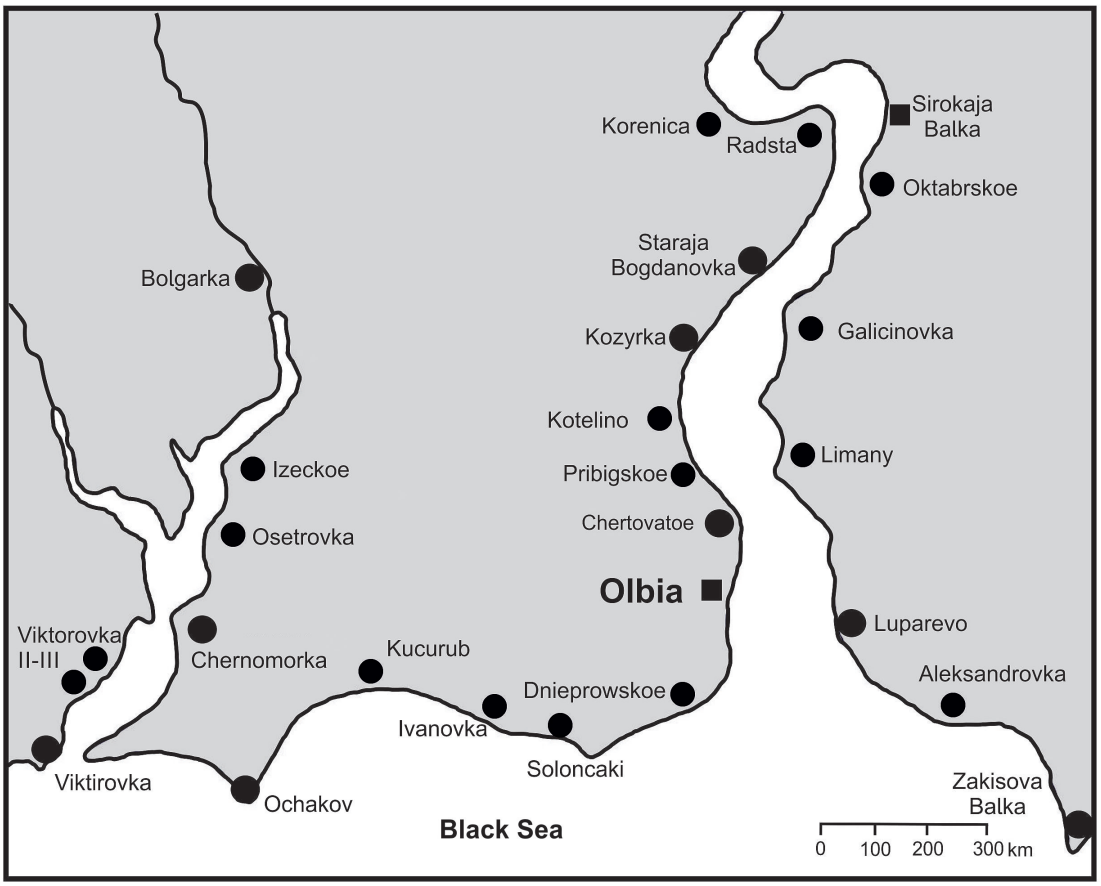

Fig. 2.2. The development of Olbian chora in Classical period (after Kryzhitskiy at al. 1989)

Fig. 3. Nikonion – the topography of archaeological site (Google Earth access: 18.09.2022)

The Dniester Liman palaeoenvironment situation

The remains of the ancient city of Tyras are located in the modern town of Belgorod-Dniester in the Odessa region. They focus on the headland washed by the waters of the Dniester estuary, where the medieval fortress of Akerman is also located. The latter partially overlaps with the ancient city. The coasts of the Dniester and Budak estuaries and the adjacent areas are known in the historical literature as the Lower Dniester. At the beginning of the research, the palaeoenvironmental conditions around and at the time of the ancient Greeks' presence, the researchers assumed that the sea level in antiquity was much lower (5-8 m) than today. According to this period, the estuaries of the Dniester and Budak did not exist, and the Dniester had two arms flowing into the sea. Between them was a low island named the Tyragetae Island after the Thracian tribe inhabiting this territory.[75] Due to the sharp rise of the Black Sea level as a result of the Nymphaeum Transgression in the first centuries of our era, the land was flooded with the waters of the Dniester estuary, so to this day only a part – the central part of the ancient city – can be explored by archaeological research.[76] A northwester part of the ancient Tyras is now covered by the Middle Ages fortress and modern city Belgorod Dniestrovsky, A part of the ancient city that is the Lower City and the port were destroyed by natural erosion of the coast of the estuary. The underwater research carried out in the 1960s did not bring precise results, and the prospection focused on assessing the morphology of the liman bottom.[77] Because of this, is not possible to determine the accurate area of the ancient city. The area of surviving part of the ancient Tyras does not exceed 8-9 ha and the prospective area might occupy no more than 22 ha.[78]

Nikonion is located on the eastern shore the of the Dniester Liman at a distance of about 300 m to the north-west from the contemporary village of Roksolany. The site is located on a small hill, the western part of which is an almost vertical cliff falling into the waters of the liman. The plateau on which the relics of the ancient city are located slopes down in the south-western direction, the northern peak of the hill is reaches an elevation of about 52 metres above the contemporary water level of the liman, and the southern part has an elevation of 39-40 metres above the Dniester Liman water level. The contemporary area of the plateau is 3.8 ha.

[75] Ptol. 3.5.25; Pliny 5.12.26; Samoylova 2007: 435.

[76] Ecin, Sabiun 1975: 205; Fedorov 1963: 29; Shilik 1975: 54; Samoylova 1988: 8.

[77] Kryzhitskiy, Shilik 1972: 396-397.

[78] Kryzhitskiy 1997: 61-62; Samoylova 2007: 435.

Fig. 4.1. Nikonion – the topography of the archaeological site – the northern border of the archaeological site (phot. E. Kozłowska)

Fig. 4.2. Nikonion – the topography of the archaeological site – the southern border of the archaeological site (phot. E. Barańska)

Fig. 4.3. Nikonion – the topography of the archaeological site – the western border of the archaeological site (phot. E. Barańska)

On the northern side, the hill is delimited by a deep, steep gully jutting into the land in the eastern direction (Fig. 4.1); from the south, the site is delimited by a shallow gully with a flat bottom and gently inclined slopes (Fig. 4.2); from the west, the site ends with a cliff falling into the waters of the liman (Fig. 4.3); from the east, the boundary of the site is a linearly elongated, open, shallow relief depression, extending along the north-south line.[79]

The earliest Nikonion plan was made by a group of military hydrographers and topographers supervised by Captain Mangarani in 1830. In the mid-nineteenth century, the Nikonion plan was prepared by A.I. Uvarov.[80] The map of Uvarov shows that the coastline differs significantly from today's, especially in the vicinity of the settlement. The southwestern part of the settlement obtrudes to the west, but the map scale does not allow for the location of details.[81]

Historical reports and observations of the results of archaeological research carried out at the site indicate that the western end of the plateau is not a natural border of the ancient city. Even before the commencement of regular archaeological research, archaeological relics were discovered in the coastal part of the hillside, referred to as the archaeological layer appearing in the profile of the hill, interpreted as a trace of the lower terrace of the city, exposed and destroyed as a result of landslides into the waters of the Dniester Liman.[82] Such erosion processes were reported in relation to the areas of the plateau already at the beginning of the 20th century by V.I. Goshkievich, who visited the site several times. In 1904, he noted significant damage to the slope of the hill bordering the liman.[83] After the destruction of the lower terrace of the settlement in 1910, Goshkevich made a plane of the upper terrace of the city. On that map, the already destroyed lower terrace of the plateau was marked as a shoal located at the map at opposite the plateau with an ancient settlement.[84]

Erosion action is also visible on the current wall of the hill. In addition, slow erosion and destruction of the western part of the site are confirmed by archaeological research. The architectural structures uncovered in the south-western part of the hill between 1957-1959 and 1969-1977,

[79] Sinitsyn 1966: 11; Brujako, Dzigovskij, Sekerskaya 2008: 8.
[80] Uvarov 1815.
[81] Sekerskaya 2008: 474.
[82] Brujako, Dzigovskij, Sekerskaya 2008: 8.
[83] Goshkevich 1909: 176.
[84] Sekerskaya 2008: 474.

Fig. 5.1. Nikonion. The effects of the erosion process observed at the archaeological site (phot. J. Barańska)

Fig. 5.2. Nikonion. The effects of the erosion process observed at the archaeological site (phot. J. Barańska)

as well as in the western and south-western part between 1980-2007 reveal architectural structures such as the structures of houses, which were destroyed as they reached the current border of the upper terrace of the hill.[85] This destruction, secondary to the architectural structure, prevents a complete spatial reconstruction of the buildings. Exposed structures break off on the western shore, implying that the recorded spatial system is not the human-planned end of the city. A very good example of such a situation is an architectural ensemble oriented along the east-west direction with reviling walls of houses and the alleged floor of the room or inner courtyard (which have not been fully uncovered), discovered in 2000-2005 excavations by a Ukrainian-Polish expedition.[86] The construction terminates abruptly at its western end, which is related to the destruction of the western shore of the site.

In the case of Nikonion, the port of the city or the bay convenient for the establishment of such a port has not yet been discovered by the researchers. In the 1960s and 1990s, underwater research in liman waters bordering the site was carried out, as a result of which stone structures located at the bottom of the liman were recorded at a distance of several metres from the shore. In 1962, under the direction of V.D. Blavatski, underwater research was carried out in a part of the Dniester Liman, corresponding to the south-western part of the site (at the level of squares 28-29 at the site). The conducted research revealed that at a distance of 75-100 m from the shore and at a depth of 1-1.2 m, there are stone structures related to the functioning of the lower, unpreserved terrace of the city or port.[87] In 1995, archaeologists from the Nicolaus Copernicus University in Toruń made another attempt at underwater research. However, due to the high siltation of the liman waters, the research did not bring unambiguous results.[88]

The aforementioned phenomena and the state of preservation of the site indicate its slow degradation associated with erosion processes affecting the western slope of the hill. Similar phenomena are also observed at other Black Sea sites, e.g. in the area of the Taman peninsula. The induced destructive processes may be associated with

[85] Sinitsyn 1966: 14-15, 20-40, ris. 2-5; Bruyako, Sekerskaya 1999: 4-5, phot. 3, 5.

[86] Sekerskaya 2002: 12-13, phot. 5, 7.

[87] Sekerskaya 1989: 18.

[88] Zaginailo, Sekerskaya 1997: 18.

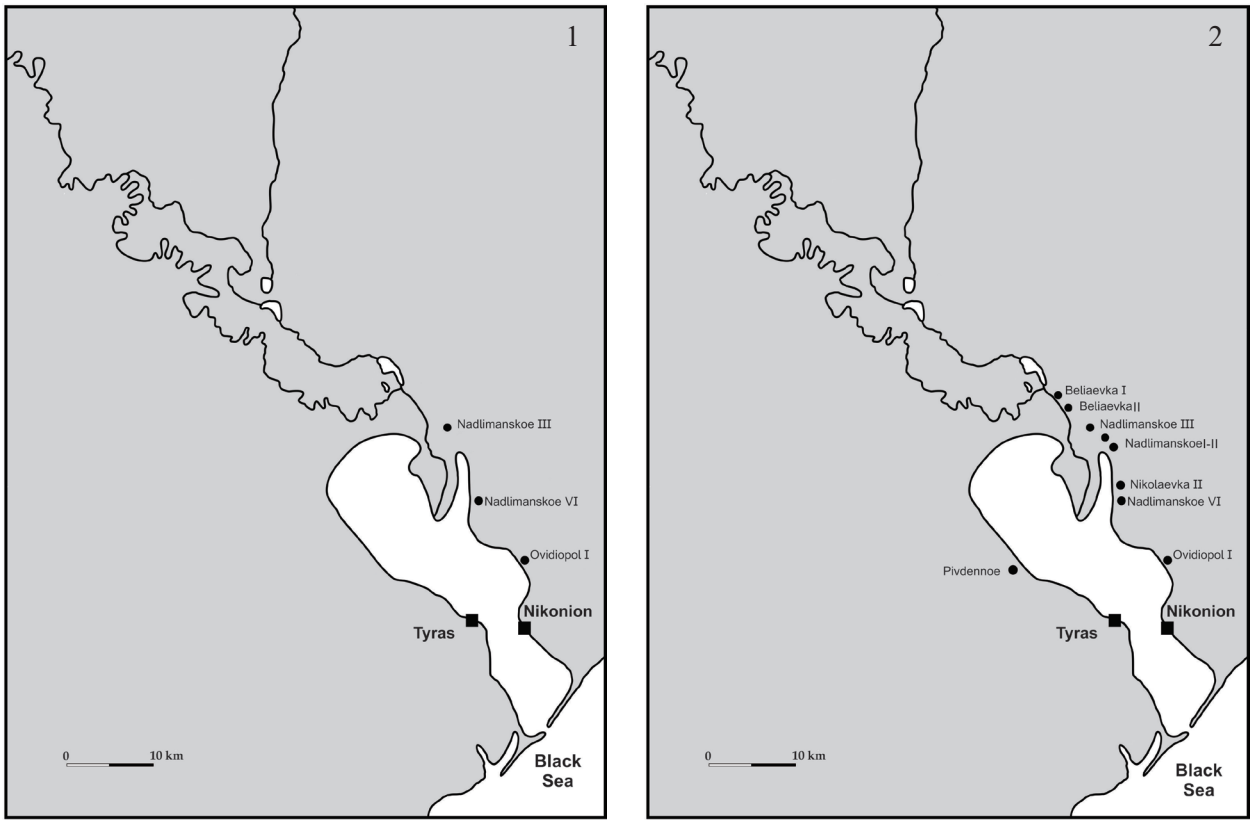

Fig. 6. The development of Nikonion chora: 1 – Archaic, 2 – Classical period (after Ochotnikov 2006)

fluctuations in the water level of the liman, which is also observed today at the base of the cliff on which the site is located (Fig. 5.1, 2).

The variability of the water level of the liman is also indicated by the partial destruction of Tyras in a result of rising water level at the mouth of the Dniester.[89] The current state of knowledge is based on hypothetical assumptions resulting from the analysis of archaeological and historical sources and contemporary observations of landscape and geological conditions recorded at the site. At this stage, these observations cannot be combined with any of the known theories concerning the palaeoenvironment of the northern coast of the Black Sea. This issue certainly requires further interdisciplinary research on both banks of the liman on which ancient cities are located. This postulate becomes more important when one considers that the archaeological sites recorded in the upper liman, interpreted as rural settlements constituting the Nikonion chora (Fig. 6), can also serve as an argument for further geoarchaeological research. In the 6th century BC, the Nikonion chora had a small extent (sites: Ovidiopol I, Nadlimanskoe III and VI) reaching about 30 km in a straight line from the site. The sites are located on the liman coast, which ensured easy transport by water. In the next stage of city development, the chora polis developed (sites: Ovidiopol I, Nadlimanskoe VI, II, I-II, III, Nikolaevaka II, Beliaevka I, II), reaching areas located within a radius of about 50 km of the site in the northern direction. Some of the archaeological sites are currently located inland and are not directly connected to the liman shore, which changes direction (in relation to the development of the settlement network) near the Nikolaevka II site and becomes shallower. Further settlement points such as Nadlimanskoe I-II, III, Belaevka II, I, are the most closely connected to the Turunchuk River (although they are still far away from the very bank of the river).[90]

At most sites, systematic archaeological research was not carried out. It is therefore difficult to ascertain their settlement extent and spatial layout. However, assuming that one of the basic determinants of the location of rural settlements was the ease of maintaining a transport connection and communication with the city (in this

[89] Shilik 1975: 54; Samoylova 1988: 8.

[90] Ochotnikov 1995: 120-124; Okhotnikov 1990; 1997:13-17; 2006: 81-98; Dzis-Raiko 2012.

case, Nikonion) in the easiest way as cabotage shipping,[91] one can assume the working hypothesis that modern archaeological sites determine the original layout of watercourses – the river/liman in the ancient period when this area was exploited by the Greeks. With this assumption, it would be advisable to postulate a higher level of the liman waters inland, which may also suggest a higher water level at the mouth of the liman waters to the sea. However, under this assumption, the coastline corresponding to the period of establishing / expanding Greek colonies in this area would be at a different (higher?) Level than today, which may be contradicted by the results of preliminary underwater research suggesting the existence of architectural relics of both cities now under water, the argument is particularly important with regard to Tyras. Perhaps the shoreline change at this point occurred later, and the phenomenon's scale is local. In the case of Nikonion, changes in the water level of the liman during the functioning of the already developed urban center or later, after the disappearance of settlement, could affect the progressive processes of water erosion, which led to the destruction of the waterfront and even a landslide. The lack of ancient historical or epigraphic sources recording such an event during the functioning of the city, in the light of the generally scarce source database in this regard concerning the city, does not raise any objections. Nevertheless, the recorded archaeological, geological and geographical phenomena indicate the need for detailed research that will consider this microregion's specificity. In such studies, when interpreting the obtained materials, the neotectonic activity of the area should be taken into account,[92] and the issue should be considered in the context of changes in the characteristics of the palaeoenvironment in the periods preceding the settlement's development of the Dniester liman during the Greek colonization.[93]

All in all, on the basis of the landscape and archaeological features observed today, the situation of the palaeoenvironment in the Dniester Liman basin indicates a complex system of dependencies that can be understood only through undertaking comprehensive interdisciplinary research combining the results of geological, archaeological and historical analyses. The undertaken research may shed new light not only on the settlement situation of the Nikonion complex and the city chora, but also allow for a better recognition of the palaeoenvironment of the neighbouring city of Tyras and provide an opportunity to locate other ancient Greek settlement points in this area such as the tower of Neoptolemus and the Hermonassos village, which are mentioned in the sources.

Conclusions

The importance of coastal areas lies not only in their access to the sea, but also in their navigable connections to the mainland. Therefore, coastal regions played a key role not only in the process of colonisation itself, but also in the further settlement of areas inland (chora), and in the development of contacts with nomadic steppe cultures of the Scythians and the Sarmatians. Despite continuous research and the growing development of interdisciplinary geoarchaeological analyses of areas covered by Greek interference, the correlation and integral interpretation of the collected geological and archaeological data is still a challenging enterprise.

As already noted, the researchers emphasise the relationship between Histria, Borysthenes, Olbia, Tyras and Nikonion, especially in the first phase of colony development on the northern Black Sea coast. These relationships and their changes are postulated based on the analysis of available archaeological sources and research on the development of individual Greek centres. A question may be asked whether the reconstruction of the palaeoenvironmental conditions for each of these ancient city can be significant in this approach. It seems so, especially when we consider that the colonisation of this area was a process that spread over time, and the cities were not established in one act. The colonisation timeline of this territory may reflect the process of area recognition and, consequently, the development of the settlement network. In this context, it seems not without significance that the reconstruction of the palaeoenvironment of the Black Sea shore, may allow for a better assessment of navigation conditions prevailing in the Black Sea. Consequently, research in this direction may bring new concepts and a better understanding of the situation of Greek colonists establishing their cities in an area that was

[91] Ochotnikov 2006: 81-98. An indirect proof of such a picture of the communication system is the content of ostrakon found in Nikonion: Awianowicz 2011: 237-239; Awianowicz, Rakoczy: 1-5; Głuszek 2016: 19-30.

[92] Fouache, Protov, Müller, Gorlov 2004: 47-58; Chekunov 2009: 495-508; Brückner et al., 2010: 162, fig. 1.

[93] Larchenkov, Kadurin 2011: 83-85, fig. 10; Marret, Bredley, Tarasov, Ivanova, Zenina, Murdmaa 2019: 648-661.

disproportionately less known by them than the Mediterranean coasts.

Interdisciplinary research conducted in recent decades to identify the environment of selected areas of the northern Black Sea coast in places where there has been intensive and long-term development of Greek colonies indicates that such research should consider each area's local specificity. It seems impossible to use one schematic scenario for the entire Black Sea coast – Phanagoria Regression, Nymphaion Transgression.

Taking as a starting point the undisputed fact that the coastline was different from the contemporary one, the detailed reconstruction of the palaeoenvironment gives a new research perspective that seems to be important in many aspects of research on the phenomenon of the appearance of the Greeks on the Black Sea (colonization) and the further development of already independent centres which have developed their network of communication, political, economic and social connections. However, to use the potential of such research, it is necessary to identify other critical areas for the northern coast of Pontus and increase the source base for further analysis and synthesis.

At the present stage of research in the Dniester Liman microregion, it can be assumed, which was already postulated in the literature based on a general comment about the state of preservation of archaeological sites, that the original range and size of Greek cities located in this area, especially Nikonion, is not known today. Therefore, it seems that attempts to reconstruct the palaeoenvironment in relation to this area may be significant, especially since, in this case, we are dealing with colonies that were established in the lower floodplain of the river delta. It can be assumed that this fact has implications that may be reflected in the reconstruction of the palaeoenvironment of this area. Recognition of environmental conditions seems essential for the contemporary assessment of archaeological sites located off the coast of liman, such as Tyras and Nikonion; it may shed light and set new research directions focusing on the recognition of individual settlement systems linking each of the polis with its agricultural base. The results of such studies also seem attractive from the point of view of the interpretation of historical sources that provide information about the functioning of Greek centres in this region. The problems in this subject are caused, on the one hand, by the fact that the mentions in the ancient written sources are very terse and are limited to listing the cities that were supposed to exist in this area. On the other hand, historical records, apart from those identified with Tyras and Nikonion today, mention names that elude researchers' interpretations based on the available archaeological material. Moreover, it should be remembered that not all points of Greek activity, such as the tower of Neoptolemus, have been interpreted from the point of view of archaeological data. In this case, attempts to recreate the coastline seem particularly important.

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