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Guest Editorial

Caspian–Black Sea–Mediterranean corridors during last 30 ky: Sea level change and human adaptive strategies: Proceedings of IGCP 521, 481 – INQUA 501 Sixth and Seventh Plenary Meetings and field trips

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Caspian Sea
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The Fifth Special Volume of the *Quaternary International* journal is dedicated to the memory of Prof. Dr. Evgeny Larchenkov (1946–2012), a Co-Coordinator of the Working Group 6 "Structural Geology and Active Tectonics." Evgeny was Head of the Department of Physical and Marine Geology at Odessa I. I. Mechnikov National University and Academician of the Ukrainian Engineering Academy of Sciences. He was a high ranking specialist in structural geology, had a forceful personality, was a fine leader, and impressed all as an honest and energetic person with a great sense of humor. His scientific interests were related to the study of historic and genetic conditions of oil and gas development as well as the petroleum potential of the rift sedimentary basins of the Eastern European and Siberian platforms, and the passive continental margins of South America, western Africa, and the western and southern parts of Australia. Within the IGCP 521-INQUA 501 frameworks, he worked on evaluating the role of active tectonics on sea-level change and coastal processes in the Black Sea, the Marmara Gateways, the Aegean Sea, and northern Turkey.

The Fifth Special Volume of the *Quaternary International* journal includes ten contributions to the projects IGCP 521 "Black Sea-Mediterranean Corridor during last 30 ky: Sea level change and human adaptation" (2005–2010) and INQUA 501 "Caspian–Black Sea–Mediterranean Corridor during the last 30 ky: Sea level change and human adaptive strategies" (2005–2011). Most of the papers were discussed at the Sixth and Seventh Plenary Meeting in 2010 and 2011.

Both projects focus on the evolution of the coastal zone, where a rich sedimentary and archaeological archive provides a superb opportunity to study spatial and temporal interactions between human adaptation and environmental change. The main goal of both projects was to bring relevant research groups together to obtain cross-disciplinary and cross-regional correlation of geological, archaeological, and historical records within various settings of the Caspian–Black Sea–Mediterranean Corridor [the "Corridor"] and thereby evaluate the influence of sea-level change and coastline migration on human adaptive strategies during the last 30 ky.

To reach the main goal and objectives, the IGCP 521 – INQUA 501 projects incorporated five dimensions, each addressed by integrating existing data and testing of hypotheses: 1. The geological dimension examined the sedimentary record of vertical sea-level fluctuations and lateral coastline change caused by external (climate change, active tectonics) and internal (mainly coastal sedimentary budget) forces. 2. The paleoenvironmental dimension integrated paleontology, palynology, and sedimentology in order to add new features to the portrait of past landscapes. 3. The archaeological dimension investigated cultural remains. 4. The mathematical dimension dealt with GIS-based mathematical modeling of the human dynamics underlying past/future sea-level change in the "Corridor" that can be meaningfully compared with global sea-level fluctuations. 5. The Geo-information dimension grasps the "big picture" of geological and archaeological events in the "Corridor" over the past 30,000 years. The structure of the project encouraged shared responsibilities to foster effective and efficient management of project activities. The Headquarters and twelve Regional Working Groups (WG) were headed by Regional Coordinators who distributed the tasks among the participants, monitored progress, and submitted their data for integration to the Correlation Committee. As of today, most of abovementioned objectives have been fulfilled (Yanko-Hombach, 2011).

WG1 "Paleontology and Biostratigraphy" established several reference collections of Quaternary benthic foraminifera and mollusks from the Black Sea, Sea of Azov, and Eastern Mediterranean. These collections will allow us to improve the stratigraphic scale for the last 30 ky and to provide correlation of various geological settings within the "Corridor." The collections are stored at the Paleontological Museum of Odessa I. I. Mechnikov National University, Odessa, Ukraine, Institute of Geography of the Russian Academy of Science, Moscow, Russia, and Moscow State University named after M.V. Lomonosov.

WG2 "Palynology" has collaborated with the BIOME 6000 team (the Global Palaeovegetation Mapping subprogram) under the international program IGBP (International Geophysical-Biophysical Program) at Bristol University, and with members of IGCP 480 to compile existing pollen data sets for about 100 sites in the Caspian–Black Sea–Mediterranean Corridor, and to employ a student who will make biomization models for these data at selected time intervals over the past ca. 20,000 years. Through inter-laboratory exchange of technology and students, we have also established a system of standardized marine palynology preparation methods and taxonomy for study of the Black Sea corridor sediments and the palynomorphs to allow future interpretations to be based on

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the same types of assemblages using updated nomenclature. Over the past 5 years, WG2 has produced more than 15 papers on regional palynology in scientific journals (e.g., Mudie et al., 2007, 2010, 2011, 2014; Cordova et al., 2009; Yanko-Hombach et al., 2014), and Carlos Cordova has published one book, *Millennial Landscape Change in Jordan: Geoarchaeology and Cultural Ecology* (Cordova, 2007). The group developed a research protocol for the Eastern Mediterranean-Black Sea-Caspian Biomes (EMBSeCBIO) and created a pollen and dinoflagellate WG3 "Geophysics and Sequence Stratigraphy" (Team of Prof. Aksu) contributed new high-resolution data from the southwestern Black Sea that show (1) the reconnection of the Mediterranean and Black Seas before 8.6 ka BP, (2) the absence of catastrophic flooding at any time during the Holocene, and (3) the presence of brackish to slightly saline water in the Black Sea during the Holocene (Flood et al., 2008; Hiscott et al., 2007a, b; 2009). The Team of Dr. Lericolais proposed that the level of the Black Sea was linked to regional climate modifications rather than to global eustatic changes. During the LGM, the Black Sea was an enclosed lake, its surface −120 m below present sea level. Deglaciation raised the lake level to −30 m, and then again to −100 m between 11 and 8.5 ka BP followed by rapid transgression starting just after 8.5 ka BP (Lericolais et al., 2007, 2011).

WG4 "Sedimentology and Mineralogy" developed a high-resolution geological model of sedimentation on the NW Black Sea shelf (Larchenkov and Kadurin, 2011) that reveals significant periodicities of sedimentation related to sea-level change and hydrodynamic activity (Konikov, 2007; Martin and Yanko-Hombach, 2011).

WG5 "Geochemistry" developed a new approach to investigating amino acid racemization and AMS radiocarbon dating of Holocene Black Sea core sediments that aimed to utilize the amino acid racemization (AAR) geochronological technique to date a number of shells in Holocene cores from the Black Sea, and explore the possible extent of time-averaging in Black Sea sediments (Nicholas et al., 2011).

WG6 "Structural Geology and Active Tectonics" evaluated the role of active tectonics on sea-level change and coastal processes in the Black Sea, the Marmara Gateway, the Aegean Sea, northern Turkey, and the northwestern part of the Black Sea (Koral, 2007; Yilmaz, 2007).

WG7 "Geomorphology" developed the Black Sea level curve in radiocarbon and calendar time scales for the last 12 kyr (Balabanov, 2007a, b, 2009). While some authors (Martin and Yanko-Hombach, 2011) agreed that despite its possible drawbacks, the synoptic curve of Balabanov appears to reflect relatively subtle eustatic sea-level change related to hemispheric—and perhaps even global—climatic phenomena, some others (Brückner et al., 2010) have insisted that tectonic signals often override the eustatic ones, and as such, establishing a local sea-level curve is the only reliable option.

WG8 "Paleoceanography and Paleoclimatology" described paleoceanographic evolution in terms of paleotemperature, paleosalinities, paleoproductivity, circulation patterns, and efficiency of the Manych (Chepalyga, 2007; Svitoch et al., 2010) and Marmara Gateways (Hiscott et al., 2007a) for given time intervals. They also traced the evolution of water masses in space and time, identified their possible sources, and reconstructed vegetation and climate dynamics in the "Corridor" since the LGM (Cordova et al., 2009).

WG9 "Archaeology" developed an interdisciplinary model of ecological crisis dynamics for the NW Black Sea coast and adaptive reaction of ancient people to changeable environmental conditions at the Late Pleistocene–Holocene boundary, provided quantitative assessment of the impact of environmental changes on the spread of early farming in the northern Black Sea area, and investigated the Lower Volga in order to reconstruct Late Pleistocene and Holocene paleoenvironment and geochronology of Mesolithic-Early Neolithic settlements (Dolukhanov et al., 2009a, b). The group also provided in-depth study of transmigrations as a mechanism of living space exploration in the Northwestern Black Sea region at the Pleistocene-Holocene boundary (Smyntyna, 2007; Stanko, 2007; Yanko-Hombach et al., 2011a, b), investigated the interrelation between sea-level change and human adaptive strategies (Dolukhanov and Shilik, 2007; Yanko-Hombach et al., 2007a), and studied the cultural sequences, the emergence of food-producing village economies in SE Europe, and the collection of various rocks that have been used in the prehistory of the Southern Marmara (Özdoğan, 2007).

WG10 "Radiocarbon Chronology" established a data set on radiocarbon assays obtained in eastern (Balabanov, 2007b, 2009) and western laboratories (Yanko-Hombach, 2007).

WG11 "GIS-aided Mathematical Modeling" developed several mathematical models of: (1) the Late Pleistocene and Holocene transgressions of the Black Sea (Esin et al., 2010) that describe the process by which the Black Sea basin filled with freshwater flowed into it. The model takes into consideration the temporal changes of freshwater balance, rate of uplift of the strait's bottom, and geometry of the strait channel. This model is self-sufficient, explains all processes from the melting of the glaciers by physical laws and does not demand the application of any additional hypotheses (contact person Dr. N. Esin ovos_oos@mail.ru); (2) the extreme Black Sea and Caspian Sea levels of the past 21,000 years with general circulation models (Kislov and Toropov, 2011); and (3) the transition from the Mesolithic to the Neolithic, from about 7000 to 4000 BC in Europe (Davison et al., 2006).

WG12 "Geoinformation System" created the interactive website http://black.sealevel.ca. Its GIS-aided Web-database and science informatics permit the creation of a "big picture" of the influence of climate, sea-level change, and coastline migration on human adaptive strategies in the "Corridor" (Wallace, 2010).

The outcome of the projects is present in three books (Yanko-Hombach et al., 2007b; Dolukhanov et al., 2009b; Buynevich et al., 2011), seven peer-reviewed volumes of extended abstracts (Yanko-Hombach et al., 2005a, 2006a, 2007c; Gilbert and Yanko-Hombach, 2008, 2009, 2010, 2011), seven field trip guides (Yanko-Hombach et al., 2005b, 2006b, 2007d; Poenaru and Briecag, 2008; Helvaci et al., 2009; Sakellariou and Lukosis, 2010; Smyntyna et al., 2011), five (including present one) special volumes of Quaternary International (Yanko-Hombach and Yilmaz, 2007; Yanko-Hombach and Smyntyna, 2009; Yanko-Hombach et al., 2010, 2012; Yanko-Hombach, 2014) and few hundreds of articles in various journals and chapters in books (for example, Yanko-Hombach et al., 2011a).

The Field Trips carried out after the Plenary Meetings have allowed participants to visit under the guidance of local experts many relevant sites in the "Corridor" that would otherwise have been very difficult to see, and discuss important scientific issues about these sites with colleagues. The meetings and field trips were carried out in Istanbul, Turkey (2005), Odessa, Ukraine (2006, 2011), Gelendzik, Russia–Kerch, Ukraine (2007), Varna, Bulgaria–Bucharest, Romania (2008), Çanakkale–Izmir, Turkey (2009), and Rhodes, Greece (2010) (Fig. 1).

All together, they covered the coastal zone of the western and northern Black Sea from Varna to Gelendzhik (Yanko-Hombach and Smyntyna, 2009; Yanko-Hombach et al., 2010, 2012), the Marmara Sea (Yanko-Hombach and Yilmaz, 2007) and part of the Eastern Mediterranean (Helvaci et al., 2009; Sakellariou and Lukosis, 2010) as a single geographic unit bypassing language and political boundaries and encouraging East–West dialogue.

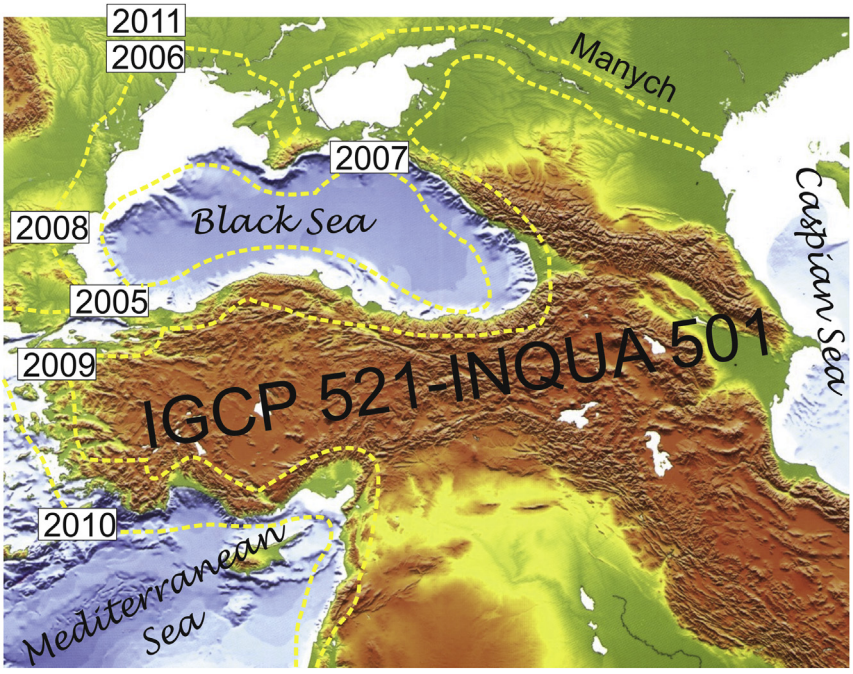

Fig. 1. The Caspian–Black Sea–Mediterranean Corridor and location of the IGCP 521-INQUA 501 Plenary Meetings and Field Trips: 2005 – Istanbul (Turkey); 2006, 2011 – Odessa (Ukraine); 2007 – Gelendzhik (Russia)-Kerch (Ukraine); 2008 – Bucharest – Tulcea (Romania)-Varna (Bulgaria); 2009 –Izmir-Çanakkale, (Turkey); 2010 – Rhodes (Greece).

The Sixth (last meeting of IGCP 521) and the Seventh (last meeting of INQUA 501) Plenary Meetings and Field Trips were focused on finalizing both projects. Special attention was paid to the following matters. (1) Linear and non-linear geological processes and concepts through correlative studies of a wide range of sites through the "Corridor" that are needed to achieve a better understanding of the influence of global climate change and/or active tectonics on regional sea-level fluctuations, coastline evolution, transformations from lacustrine to marine environments, eco- and sedimentary systems (including the deposition of sapropels), as well as prehistory and history of the adaptation of Anatomically Modern Humans; (2) Correlation of sea-level changes between the Black, Mediterranean, and Caspian Seas; (3) Improvement of standards in research methods, techniques (e.g., quantitative modeling of environmental crises with detailed identification of the factors involved and their behavior), and protocols; (4) Delineation of the main areas of natural risk (e.g., erosion, flooding) required for proper environmental management; and (4) Elaboration of a complete database on bibliography, radiocarbon assays, archaeological sites, and artifacts linked to sea-level changes.

The Sixth Plenary Meeting and Field Trip was held on the island of Rhodes, Greece, from September 27 to October 5, 2010. The meeting was organized by the Hellenic Centre for Marine Research at the Hydrobiological Station of Rhodes and the Avalon Institute of Applied Science, Canada. The President of the conference was Prof. Dr. Valentina Yanko-Hombach. The Chairman of the Organizing Committee was Dr. Dimitris Sakellariou.

The meeting and field trip were focused on the Eastern Mediterranean Region. This region is an important part of the "Corridor," having played a crucial role in the sequence of events related to water exchange between the Black and Mediterranean Seas across the Marmara Sea during the transition from the last glacial to the present-day interglacial. During the field trips, participants observed the coastal sediments of northeastern Rhodes that were deposited within active tectonic settings; such sediments provided an excellent opportunity to investigate the relative roles played by climate and tectonics in sedimentary processes. They were also able to examine uplifted coastlines, marine terraces, and active faults, as well as a rich archaeological archive of prehistoric and historic materials lasting into the Classical, Hellenistic, Roman, and medieval periods in Rhodes.

One hundred eighty-one scientists from four continents and 16 countries contributed to the conference; 57% of them were from developing countries (Fig. 2). Their peer-reviewed contributions are assembled in a 235-page volume that contains 81 extended abstracts (Gilbert and Yanko-Hombach, 2010).

The Seventh Plenary Meeting and Field Trip was organized jointly by the Odessa I. I. Mechnikov National University, Ukraine, and the Avalon Institute of Applied Science, Canada, on 21–28 August 2011. The President of the conference was Prof. Dr. Olena Smyntyna. The Executive Director was Prof. Dr. Valentina Yanko-Hombach.

The Field Trips of 2011 represented a logical continuation of the Field Trips of 2006 that were conducted during the Second Plenary Meeting of IGCP 521-INQUA 501 in Odessa, August 20–28, 2006. In 2006, the field trips concentrated on the study of geological outcrops and archaeological sites located in the Dniester-Pivdennyi Bug region (Fig. 3), while in 2011 they were focused on the Lower Dniester and Ukrainian part of the Lower Danube region (Fig. 4).

One hundred twenty five scientists from two continents and thirteen countries contributed to the conference; 61% of them were from developing countries (Fig. 5). Their peer-reviewed contributions are assembled in a 204-page volume that contains 56 extended abstracts (Gilbert and Yanko-Hombach, 2011).

The papers in this Special Volume geographically cover whole "Corridor" from the Eastern Mediterranean (Drinia et al., Triantaphyllou) to the Sea of Marmara (Taviani et al.), the Black Sea (Brieciag and Ion, Esin and Esin, Tyuleneva et al., Yanko-Hombach et al.) and the Caspian Sea (Kislov et al., Tudrun et al., Yanina). Timewise they cover diapason from LGM to present. All of them use paleontological (benthic foraminifera, ostracoda, coccolithophores,

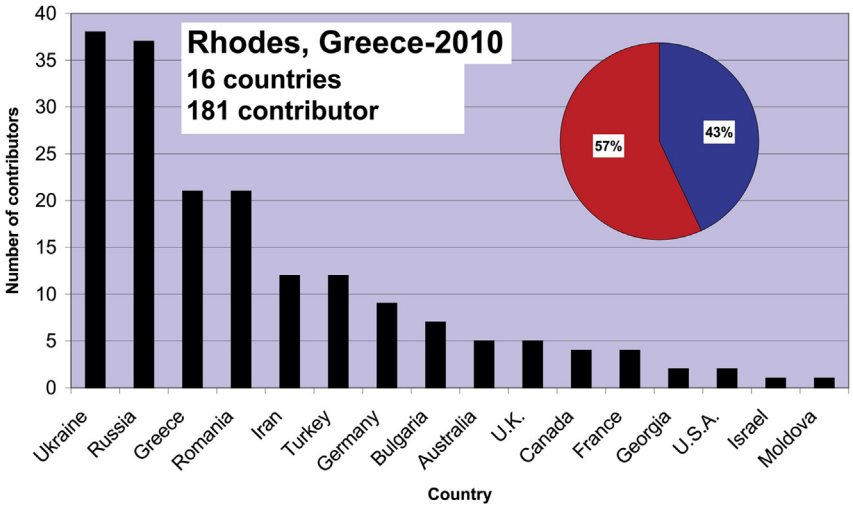

Fig. 2. Number of countries and contributors to the 2010 Sixth Plenary Meeting Volume of Extended Abstracts (Gilbert and Yanko-Hombach, 2010).

mollusks) and sedimentological records to effect paleogeographic reconstructions.

1. Mediterranean Sea

The paper by Drinia et al. focuses on the late Quaternary paleogeographic reconstructions of semi-isolated North Evoikos Gulf located in the central part of the Aegean Sea. Based on the study of benthic foraminifera in six gravity cores (up to 250 cm long) recovered in different physiographic settings, the late Pleistocene–Holocene paleoenvironmental reconstructions are performed. In the late Pleistocene, two main domains are recognized. In the first one, succession of the foraminifera is mainly controlled by the ongoing sea-level rise while in the second one, by a high flux of organic matter discharged into the basin by enhanced river runoff. The latter provokes seasonal pulses of organic matter and, related to it, seasonal dysoxia. In the Holocene, fully marine conditions existed from the very beginning with a short lacustrine phase taking place in the proximal part only due to a damming of the northern entrance to the gulf. The final conclusion is that paleoceanographic evolution of the gulf has been primarily driven by climatic (eustatic) processes and accurately depicts local conditions, while tectonic processes played no role.

The paper by Triantaphyllou deals with paleoceanographic and paleoclimatic reconstructions of the northeastern Mediterranean (Aegean and northern Levantine Seas, Greece). The research is based on the study of coccolithophore assemblages from four cores (up to 670 cm long) recovered at water depths of 496–2211 m. All cores contain a dark colored mud unit that corresponds to sapropel S1 and consists of two discrete intervals separated by a lighter colored interval representing the S1 interruption. Based on the study, an increased stratification of the water column is identified

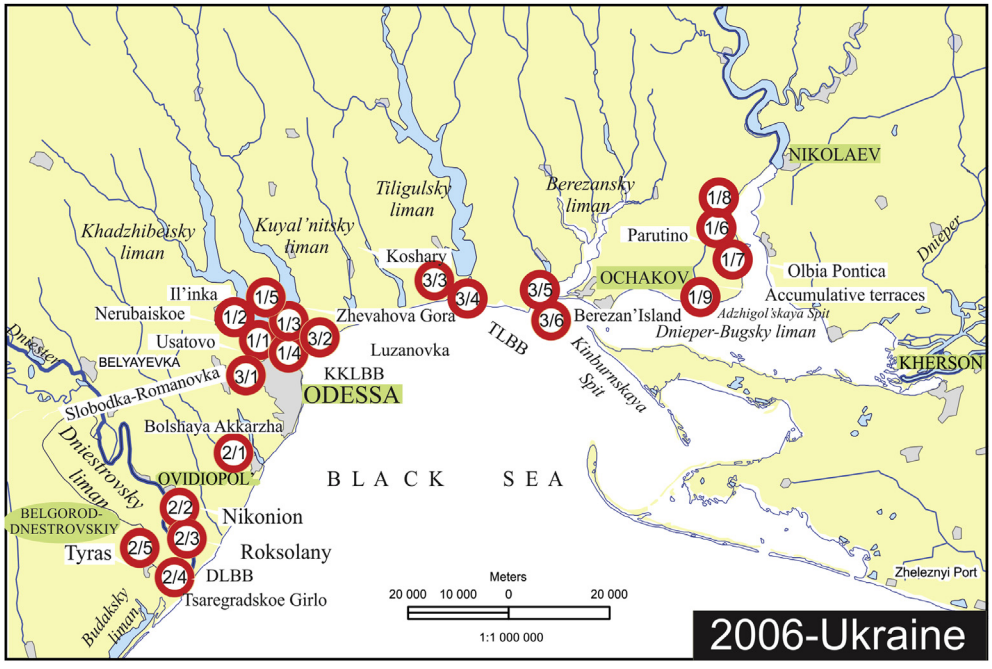

Fig. 3. Sketch of the 2006 Field Tip sites marked by circles with numbers (Yanko-Hombach and Smyntyna, 2009).

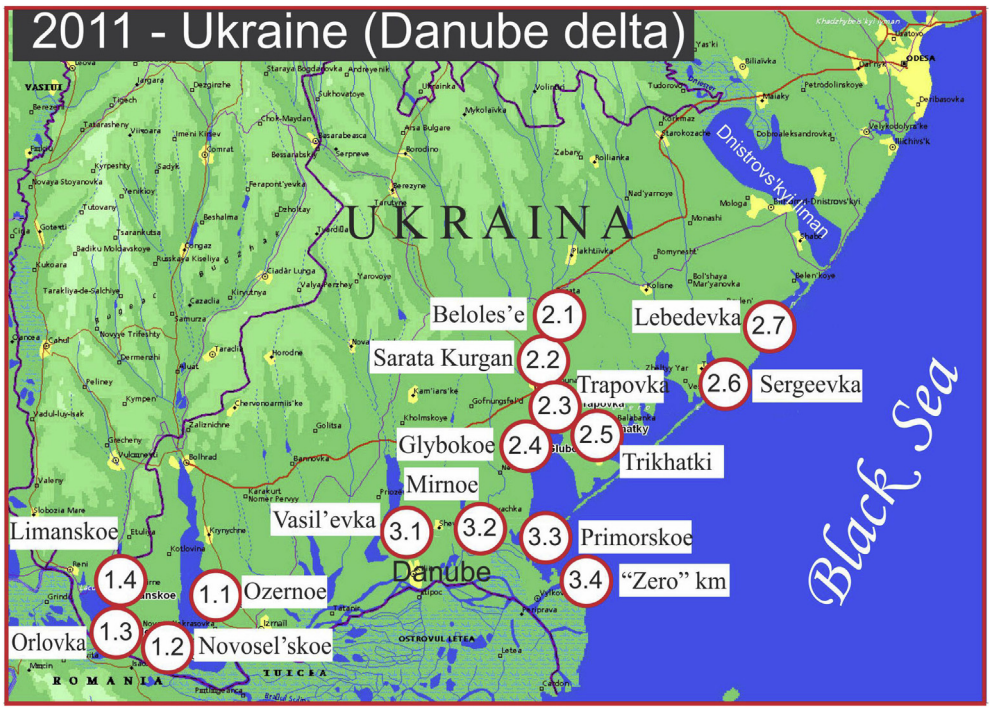

Fig. 4. Sketch of the 2011 Field Tip sites marked by circles with numbers (Smyntyna et al., 2011).

and linked to the significant freshening of the North Aegean surface waters by input and influx of the Black Sea water after ~9.0 ka BP (S1a depositional interval). A series of cooling events detected towards the end of sapropelic conditions (~7.2 ka BP) mostly in the North Aegean site, may be linked to outbursts of cold northerly air masses and relevant pulses in the deep-intermediate water ventilation that caused the enhancement of surface marine productivity and the temporary cessation of S1 at ~8.0 ka BP. In contrast, in the SE Aegean and the northern Levantine Sea, the water column remains still warm and stratified, influenced by moderate freshwater input, for at least one more millennium.

2. Sea of Marmara

The paper by M. Taviani et al. is devoted to the water exchange between the Late Neoeuxinian lake and the Marmara Sea around 16 ka BP (uncalibrated) based on the Pontocaspian bivalves and gastropods in the sediment column of the shallow-silled (ca. 50 m) Gulf of Gemlik, Sea of Marmara. The age of the fauna is consistent with known episodes of Caspian overflow into the Black Sea Basin (Early Khvalynian flood). This proves the valuable discovery that the Neoeuxinian basin extended south of the Bosporus in the latest Pleistocene. This also provides some insight into the origin of the modern Black Sea Pontocaspian mollusks.

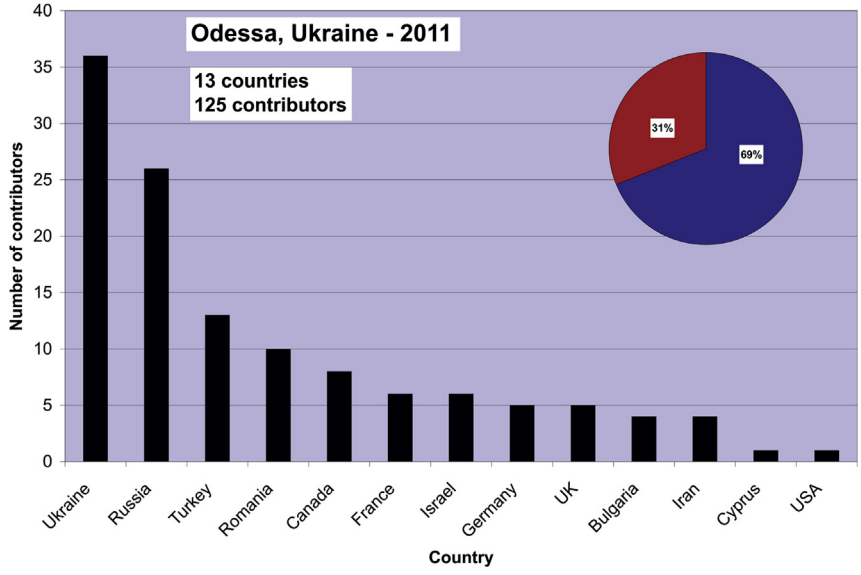

Fig. 5. Number of countries and contributors to the 2011 Sixth Plenary Meeting Volume of Extended Abstracts (Gilbert and Yanko-Hombach, 2011).

3. Black Sea

The paper by Briceag and Ion discusses ostracod and foraminiferal assemblages in order to find out which environmental parameters are mostly responsible for their distribution on the Romanian shelf of the Black Sea. Based on the study of two cores (30 cm long) recovered at water depths of 17.8 m and 78 m, the authors conclude that spatial and taxonomic distribution of both groups of microorganisms is controlled by hydrodynamic conditions, bathymetry, salinity, and nutrient input.

The paper by Esin and Esin deals with the mathematical modeling of the Black Sea level change for the last 20 ky. It is based on the equations of viscous incompressible fluid motion according to Navier–Stokes, Sen-Venans, and the equation of water balance in the sea. A method of eustatic curve calculation of sea-level change on the local curves and division of local curves into eustatic and tectonic components is proposed. The mechanism of two transgressions of the Black Sea during this time period is explained. The impossibility of Black Sea fluctuations of many meters in the Holocene is demonstrated. Calculation of eustatic changes in Mediterranean Sea level and vertical motions of some sections of its coast during the Holocene is also presented. It is shown, that in the Holocene, the Black Sea level repeated the changes of World ocean level.

The paper by Tyuleneva et al. deals with reconstructions of coastline position for the Holocene on the Northwestern Black Sea shelf. It is based on the study of subsurface geology, relief features, lithological composition and distribution of bottom sediments, molluscan complexes and paleofacies analyses. On the basis of the analyzed data, the authors suggest that the Holocene transgression invaded paleo-river valleys. Comparison of the various positions of the coastline and its facies changes through time enable one to conclude that the Holocene transgression followed a progressively oscillatory course.

The paper by Yanko-Hombach et al. is based on a multidisciplinary study of geological material recovered from different shelf areas of the basin that refines the chronology of the marine transgression and clarifies conflicting interpretations of the water level and salinity of the Neoeuxinian Lake prior to the initial inflow and transgression of Mediterranean water in the early Holocene. The combined data set of sedimentological characteristics and microfossil data establish that the Holocene marine transgression was of a gradual, progressive nature in the early Holocene. The level of the Late Neoeuxinan Lake prior to the early Holocene Mediterranean transgression stood around −40 m bsl, the lake was brackish but not fresh, and by 8.9 ka BP, the Black Sea shelf was already submerged by the Mediterranean transgression. An increase in salinity took place over 3600 years, with the rate of the marine water incursion being estimated on the order of 0.05 cm–1.7 cm y^{-1}.

4. Caspian Sea

The paper by Kislov et al. is devoted to the current status and paleostages of the Caspian Sea as a potential evaluation tool for climate model simulations. It describes the temporal behavior of the Caspian Sea and the relationship between sea level and climate based on the links between sea-level variations and water budget. It shows that decadal-scale oscillations in the level of the Caspian Sea were generated primarily by variations in Volga River runoff. Therefore, despite the fact that the image of the Caspian Sea within the climate models is rather simplified, the Caspian Sea level changes can be used to assess the ability of climate models to reproduce the water budget over the East European Plain. The proxy database comprises a number of detailed maps of the Caspian Sea plotting the main regression and transgression stages together with information about sea-level positions during the last 30 ka. Comparison between observed or reconstructed Caspian Sea level positions is calculated based on simulation experiments using the CMIP5/PMIP3 protocol. The modeled data are verified based on how well the models can simulate: (a) the observed decadal-scale CS level dynamics during the 20th century; (b) the Derbentian regression, transition to the New Caspian (5th phase) highstand, and slight lowering of the Caspian Sea level at the end of the 19th century.

The paper by Yanina, "The Ponto-Caspian Region: Environmental consequences of climate change during the Late Pleistocene," provides information on the evolution of the Caspian and Pontian (Black Sea) basins based on a multidisciplinary study of a large amount of geological and paleontological (mollusks) material from coastal stratotypes and drillholes. It is shown that during glacial intervals, transgressions in the Caspian and Pontian basins occurred synchronously with lake levels not exceeding those of the present day. Maximum level of the Caspian and Pontian transgressions was controlled by the Manych sill height and the Bosporus sill depth, respectively. During interglacial periods, transgressions in the Caspian basin also occurred in the Caspian Sea and the Black Sea basins. In the Caspian, these depended mainly on the interglacial endothermal (cool and moist) phases, while marine transgressions of the Pontian basin correlated with the interglacial transgressions of the World Ocean. Lake-level change in the Caspian, and Caspian-type transgressions of the Pont, were asynchronous with eustatic sea-level change.

Acknowledgments

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