TRANSGRESSIVE AND REGRESSIVE PHASES IN THE BLACK SEA HISTORY

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This paper deals with some questions about the biostratigraphy of the Black Sea based upon the ostracods and mollusks communities. The history of the Black Sea starts during the Upper Pontian and means the times of isolation, the endemic fauna, the ecological changes, the alternation between marine, almost freshwater and brackish water environments. The low salinity fossil fauna suggests a lowering of the water level within the Black Sea, and implicitly an isolation of the basin. The marine fossil fauna suggests an opening of the Bosporus strait and the possibility of correlation with Mediterranean sedimentation and its fauna. All the Black Sea events are correlated with those in the Dacian basin and the Caspian basin.

The Upper Pliocene and the Quaternary from the Black Sea area divided into nine biostratigraphical units. All of them are brackish water sequences and none completely fresh water or completely marine. This brackish water ecosystem was especially prolific in ostracod and mollusk species and distinct from recent species (few exceptions). Their potential for dispersal is today as good as in the past, interdicted by the salinity barrier. Some ostracod species are extremely euryhaline while others have very restricted salinity ranges.

CARAION (1967) and SORNIKOV (1968) described almost 130 ostracod species from the entire Pontic area including the Dnipr and the Dnister limans, the Razelm-Sinoe limans and the Azov Sea. Each of them is more or less a restricted and distinct biotope with different qualitative and quantitative ostracod communities structure. Only nine of them are relic species from early epoch and old times.

Generally, the benthic specific diversity varies along the depth gradient increasing from the coastal shallow bottoms to 100 m bottoms, where it reaches the highest values, then decreasing towards the shelf break. The maximum density of benthic organisms (crustaceans) is more 300,000 sps / m^2, in front of the mouths of the Dniester and the Dnipr. In the ostracods case, the maximum of densities is in front of the Danube mouths and in some littoral oligohaline lakes (other species, of course).

The fossil ostracods species are extremely abundant, many of them, with short longevity and large diversity in contradiction with the common aphorism "*speciation is rare and difficult event*" (ELDRIDGE and GOULD, 1972).

The Black Sea area had a complicate and not well known history, it being the last descent of the old Paratethys.

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The Upper Pontian is the time when the Black Sea area tends to become an isolated bioprovince with specific fauna and its own ecological particularities. It is the time when the Paratethys area fragmented into four more or less isolated basins: Pannonian, Dacian, Pontian and Caspian. Their history was different.

The Middle Pontian is the last (geological) time when the Paratethys area had a faunal unity and, most likely, an ecological unity. In the Pannonian basin, the last brackish water sequence belongs to the Middle Pontian, with *Congeria rhomboidea* and *Paraloxoconcha hodonica,* the common species for all basins. The next sequence is the lacustrine facies, the so-called Paludine beds (most likely coeval to the Romanian stage from the Dacian basin).

In the Dacian basin, the Dacian stage is the last brackish water sequence with a few common species to the eastern region. It is followed by lacustrine and oligohaline fauna (=Romanian). In this way, the Black Sea area is the single descent of the Paratethys kingdom resisting today over the geological time and events. Each relic basin has its own biostratigraphical units, although they had parallel histories.

The biostratigraphic units in this area are the Kuialnikyan, the Gurian, the Ceaudian, the Paleoeuxin, the Uzumlar, the Karangatian, the Neoeuxinian, the Old phase of the Black Sea and the New phase or Recent (since the historical time).

The Kuialnikyan is the last interval of time of the Kimmerian stage. It closed an epoch in the fauna evolution. Unfortunately, this fauna is known from the coastal, shallow water areas from Crim and Abkhazia (western Georgia) and therefore, could be interpreted as a regional effect of the continental influences. However, it represented a geological time materialized in a specific fauna community. At this time an exuberantly diversification of Tyrrhenocythere species (six species) took place, two new Bacunella species (*B. guriana* and *B. abchazica*) appeared, the new genus Advenocypris (with just one known species, *A. schneiderae,* but there are more). In plus, now appear some new bivalve species (*Dreissena rostriformis* and *D. polymorpha, Didacna multicristata, D. gurievi*), and at the same time become extinct the last Eccericardium and Pseudocatillus species (very abundant during the Kimmerian time).

The Gurian (or "Guria Beds") has a similar or lesser salinity. Now there are some specific mollusks, foraminifers and ostracods, which together, make a clear biostratigraphical outline of this interval of time.

Within this time, no more no less than eight new species of Digressodacna, two species of foraminifers (Elphidium) and seven ostracod species (*Candona (Caspiocypris) rectoides, C. (C.) duabiensis, Candona (Caspiolla) liventalina, Pontoniella* aff *sagittosa, Moesiella schemachiensis, Bacunella (Guriella) abstracta, Loxoconcha tschaudae)* appear.

The Ceaudian (or "Ceauda Beds" for other authors) can be separated by the anterior stage, according to some new apparition in the fauna constellation. In its

lower interval three new species of Digressodacna and four of Didacna (=Tshaudia) appear, beside the omnipresent *Dreissena polymorpha* and *Ammonia beccari*.

In the upper part of the Ceaudian appear other nine new species of Tshaudia subgenus allied with nine species of ostracods: *Pontoniella (?) tshaudae, Bacunella (?) liventali, Turkmenella pseudoabnormis, Euxinocythere vulgata, E. irinae, Loxoconcha gibboida, Tyrrhenocythere davidaschvili, T. iverica, T. grandis, Cytherois* sp., *Cytherura* sp.

Now appears a new and eccentric morphological pattern in this ostracods community, the genus Amplocypris (it is specific for the Pannonian-Pontian communities from the Pannonian bioprovince and its presence is an enigma)

In other words, during the Ceaudian time, the salinity fluctuated within large limits, suggesting connections with other areas and other communities of fauna.

After KOCHEGURA and ZUBAKOV (1977), the Ceaudian age is between 1.0 and 0.6 M. years.

The Paleo-Euxinic phase (stage or substage) characterized by Caspian influences (*Dreissena caspia, Didacna pontocspia, Monodacna pontica, Adacna plicata relicta*), implicitly suggests connections between the two bioprovinces.

The Uzumlar phase is well outlined as a biostratigraphic unit. Now appear for the first time a few mediterraneean immigrants (*Venus galina, Cardium edule*). It is continued and amplified during the Karangat interval of time (probably synchronous with the interglacial Riss-Würm). During this time in the Black Sea appear few nannoplancton species (*Gephyrocapsa carribbeanica*), Diatoms (Thalassiosira) (PERSIVAL, 1978, JOUSE and MUKHINA, 1978, *fide* HSU and GIOVANOLI, 1980) and a very rich marine community of ostracods (*Carinocythereis carinata, Pterigocythereis jonesii, Leptocythere multipunctata, Loxoconcha granulosa, Callistocythere macallena, Semicytherura* aff *acuticostata* and many others). Some of these species are surviving in recent community. Many others do not: two Semicytherura species, Sclerochilus, Cytheroma, Cytherois, Hemicyheria, Echinocythereis, the taxa unknown in post-Pliocene and recent Mediterranean community). However, it is seems to be the first opening of the Bosporus straits during the post-Pontian times and the first invasion of marine organisms into the Black Sea basin.

The Neoeuxinian is regressive. The Bosporus strait is closed, the salinity is low and the marine colonists become extinct. In exchange, Caspian fauna elements appear (almost 25 species more 50% of mollusks species). Dominant is *Cardium edule* Linne (very close to *Avicardium dombra* Andrusov, "index fossil" for the Apscheronian, another difficulty and another question).

The Old Black Sea phase is difficult to separate from the "New Black Sea" phase. At this time, the number of Mediterranean immigrants is greater. The three exclusive mollusk species *Mytilus galloprovincialis, Ostrea sublamellosa* and *Venus gallina* seem to be the first and single eudominant species penetrated in the new low saline basin.

The second marine waves from the Mediterrean Sea were during the Sourozhian episod (with *Callistocythere mediterranea, C. flavidofusca, C. diffusa, Bairdia raripila*) and the last one during the Viteazian episode (recent fauna).

All these events are differently correlated by geologists. Generally, the glacial phases are regarded as regressive, while the interglacial ones as transgressive. In plus, there are the eustatic oscillations which complicate interpretations.

The lowermost level of the sea was during the Lower Ceaudian (coeval with the Gunz glacial epoch and a direct effect of it) when the Black Sea level was –150 m than Recent level. During the Upper Ceauda (presumed to be synchronous with the Gunz-Mindel interglacial epoch), the level rose to +100 – 130 m above the recent level. The total water quantity was enormous and difficult to explain. Usually the glacial and interglacial play is blamed.

In Table 1 we present a synthesis of the knowledge accumulated by geologists up to now (from FEODOROV, 1978, HSU and GIOVANOLI, 1978, SCHERBAKOV *et al.*, 1979, PANIN and POPESCU, 2002).

Table 1

Years	Episods	Events	Level fluctuations
2500[1]	Dzemetinian	Nymphaean transgression	**+ 1 m**
4500	Kalamitian	Phanegorian regression	**– 3 – 5 m**
	Bugazian-Viteazian ("Old Black Sea")	postglacial transgression Mediteranean immigrants (Bosporus III)	
Starts to 6800			
8500	Upper Neo-Euxinian	between 15 and 18000 years the sea level lifts to actual level. The Pleistocene-Holocene boundary	
10200			
	Middle Neo-Euxinian	18000 maximum of regression.	**–100 – 120 m**
23000	Lower Neo-Euxinian	Caspian influences (?)	
72000	Sourozhian	transgression. The sea level to actual level. Bosporus II. The Danube flowing into the Pontic basin	
	post-Karangatian	regression The connections with the Aegean Sea and the Caspian Lake were interrupted	**– 60 – 80 m**
90000			
	Karangatian (= Riss-Würm)	transgression Bosporus I (in connection with the Mediterranean Sea and the Caspian Lake)	**+ 8 – 12 m**
100000	Upper Paleo-Euxinian (= Riss glacial)	regression. Caspian fauna (?)	**– 100 m**

Years	Episods	Events	Level fluctuations
	Middle Paleo-Euxinian (=Riss-Mindel)	transgression in connection with the Caspian Lake (=Bakunian episode)	+ 20 – 40 m
	Lower Paleo-Euxinian (= Mindel)	regression. The mammals from Tiraspol	
600000			
	Upper Ceaudian (=Mindel-Gunz)	transgression in connection with the Caspian Lake. Apscheronian fauna.	+ 100 – 130 m
	Lower Ceaudian (= Gunz glacial)	regression. The fossil mammals from Taman-Nogaysk	– 150 m
1000000.....			
	Gurian	transgression. In connection with the Caspian Lake (?)	
	Kuyalnikian	regression. Low brackish-water	
	Upper Kimmerian	transgression. Marine influences [2]	
	Middle Kimmerian	specific faunas and Caspian influences	
	Lower Kimmerian	start of isolation. Specific fauna, different from the Dacian basin	
	Upper Pontian	regression in the two basins from around the Black Sea (freshwater fauna in the Pannonian and Caspian basins)	
	Middle Pontian	maximum of transgression (including the Pannonian basin)	
	Lower Pontian	transgression. A new type of fauna	
	Upper Meotian [3]	regression in the Dacian and the Caspian basins	
	Lower Meotian	transgression (high salinity)	
	Upper Sarmatian	regression (in the Dacian basin: oligohaline water and even lacustrine levels during the uppermost Kersonian from the Subcarpatian region. All foraminifers become extinct.	
	Middle Sarmatian	transgression. Fauna unity for the whole Paratethys area. A great number of foraminifers, mollusks and ostracods new species.	
	Lower Sarmatian	regression. Cold climate (after plants).	
15–16000000			
	Upper Badenian ("Buituri" sequence)	the last marine species. Start of the regression and "great isolation" of the brackish-water ecosystem named Paratethys [4].	

Remarks:

[1] The years age for the Upper Quaternary episods and a parallel with the glacial and interglacial phases, after PANIN (1999). The schema, having become a standard one, uses, most often, a kind of DNA amprenta for identification of unknown species. Due to its uniqueness, inevitably it is almost "sacred", and immune to criticism.

[2] The problem of the "marine influences", is not yet very clear. Their source is undoubtedly the Mediterranean Sea and the Bosporus straits. This was open during the Neo-Euxinian (Bosporus III), during the Sourozhian (Bosporus II), the Karangatian (I) and during the Lower Akchiaghilian, sometime between the Kimmerian and the Kuyalnikian times. Three cores analysed showed at 520–550 m depth few marine species (*Cytheropteron* sp., two Xestoleberis species and *Cytherura* aff *limata*, see OLTEANU, 2003, pl. IV).

[3] The Sarmatian and the Meotian sediments (with their specific faunas) found up to now, in drillings from the Black Sea area. It is another great question for us.

[4] The biostratigraphy of the Pontus Euxinus sediments involves three kinds of arguments. The most important is the fossil fauna succession, its changes according to salinity fluctuations. From it derives another point, the connections with other marine, brackish or almost lacustrine basins and their influences upon the ecological components. The isolation of the sea (when? how long time ago?) and the relations between local fauna and the new marine opportunistic "conquerors" are some of the most important theoretical questions. Last but not least come the fluctuations of the sea level, the transgressions and the regressions over the Danube Delta area.

REFERENCES

CARAION, FRANCISCA, Fauna RSR, *Crustacea (Ostracoda), Fam. Cytheridae (Ostracode marine şi salmastre)*, 1–164, 43 text-fig. Ed. Academiei, Bucureşti, 1967.

FEDOROV, P.V., *Post-glacial transgression of the Black Sea,* Internat. Geology Rev., v. **14** (2): 160–164, New York, 1971.

HSU, K.J., *When the Black Sea Was Draind,* Scientific American, v. 238, n. 5: 52–64, New York, 1978.

HSU, K.J., GIOVANOLI, F. *Messinian Event in the Black Sea,* Palaeogeography, Palaeoclimatology, Palaeoecology, **29** (1979–1980): 75–93, Elsevier Sci. Publ. Co. Amsterdam, 1979.

IMNADZAE Z.A., *Necotorie dannie ob ostracodvoi faune Pliotenovih otlojenii Zapadnoi Gruzii,* Vopr. Geol. Gruzii, XXVII, pag. 286–293, pl. I–IV, Tbilisi, 1964.

IMNADZAE, Z.A., KARMISHINA, G.L., *Comparasion of the Pliocene Ostracoda complex in Northern and Eastern Black Sea region,* Voprosi Strat., v. **5**: 131–148, Leningrad, 1980.

MANDELSTAM, F.A., MARKOVA, L.P., ROSIYEVA, T.R., STEPANAITYS N.E., *Ostracodi Pliocenovih i Post-Pliocenovih otlojenii Turkmanistana*, Iz. Akad. Nauk. Turkmeniskoi SSR, 288 pag., XLVI pl., Ashabad, 1962.

OLTEANU, R., *Ostracods from DSDP 42 B*, In: Initial Rep. Deep Sea Drilling Project, XLII, **2**: 1017–1024, pl. I–IX, Washington, 1978.

OLTEANU, R., *Dacian Ostracods*, In: *Chronostratigraphie und Neostratotypen*, Pliozän, Dazien, p. 268–313, pl. I–XXXVI, Ed. Academiei, Bucureşti, 1995.

OLTEANU, R., *Orthogenesis and Orthoselection. The Leptocythere lineages (Ostracoda, Crustacea) in the brackish water biotopes of the Neogene*, Rev. Roum. Géologie, t. **42**: 141–153, pl. I–VI, Bucureşti, 1998.

OLTEANU, R., *Loxoconcha Genus (Ostracoda, Crustacea) within the Parathetys area*, Memoires Inst. Geol. Rom., vol. **36**: 1–46, pl. I–XXVI, Bucureşti, 2000.

OLTEANU, R., *Kimmerian Ostracods and the Ponto-Caspian bioprovince. A critical view*, Rev. Roum. Géologie, t. **45**: 195–204, pl. I–VI, Bucureşti, 2003.

PANIN, N., *The Danube Delta, Holocene, Ancient Time and Present Day Evolution*, Publication ASF, n. **29**: 1–63, Paris, 1999.

POPESCU, IRINA, *Analyse des processes sédimentaires récents dans l'évantail du Danube (Mer Noire)*, Thèse de doctorat, Univ. Bretagne Occ., Univ. de Bucharest, 2002.

SHORNIKOV, A.V., *Rodclass Ostracod ili rakuskovie raki Ostracoda Latreille, 1816*, In: Oprededitel fauni Cernogo i Azovskogo Morei, p. 163–217, pl. XLIV, Akad. Nauk. USSR, Kiev, 1969.

VEKUA, MZIA, LAURA, *Ostracodi Kimmeriskih i Kuialnikih otlojenii znacenie*, p. 1–127, pl. XX, Ed. Metzniereba, Tbilisi, 1975.

WINGUTH, C., WONG, H.K., PANIN, N., DINU, C., GEORGESCU, P., UNGUREANU, G., *Upper Quaternary sea-level changes in the northwestern Black Sea*, GeoEcoMarina, **2**: 103–113, Bucureşti, 1996.

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