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The taxonomic diversity indices of benthic diatoms at two environmentally different estuaries of SW Crimea (Black Sea)

Petrov Alexey N., Nevrova Elena L.

Institute of Biology of the Southern Seas NASU, Sevastopol, Ukraine; alexpet-14@mail.ru

The study examined differences in the structure and taxonomic diversity of benthic diatom assemblages from 16 sampling stations of two sites of SW Crimea: estuaries of r. Chernaya (Inkerman - 6 stations) and r. Belbek (10 stations). The Belbek estuary is rather unpolluted open shore area northerly of Sevastopol bay mouth, whereas Inkerman is heavy polluted area (metals, PCBs, oil hydrocarbons) in the innermost part of the main Sevastopol bay. Duplicate samples were taken at every station by tube (surface area 16 cm²) from the upper layer (2-3 cm) of sandy/silty bottoms at 6-18 m depth. Samples were evaluated for abundance, species richness and taxonomic structure of benthic diatoms. Multivariate statistical routines (PRIMER v5) were employed to distinguish the stations grouping in relation to structural characteristics of assemblages (Clarke, Gorley, 2001). Taxonomic distinctness indices, AvTD (Δ^+ , the average path length through the taxonomic tree connecting every pair of species in the regional list) and variation in TDI (Δ^+) were calculated for each of station.

Deviation in diatoms taxonomic structure from the simulated expected mode calculated from the total Black Sea inventory was also assessed (Warwick, Clarke, 2001, 2005). The objective of the study was to compare the changes in quantitative development indices and taxonomic structure (aggregated into 7 higher hierarchical levels) of benthic diatom assemblages resulting from environmental heterogeneity and long-term pollution impact in the compared estuarine areas. At Belbek area 267 sp. & ssp. were found and 116 ones – at Inkerman. The total number of diatoms registered altogether for the both investigated areas is set to 269 sp. & ssp. Based on results of cluster and MDS analysis (using Bray-Curtis similarity coefficient for \sqrt{N} -transformed abundance matrix), 2 groups of stations were distinguished at 38% similarity level. First group consisted of Inkerman' stations (6), whereas second group of stations (10) corresponded to Belbek estuary area. Difference between these groups was statistically significant: the value of R-statistics was quite high (0.79) at 0.1% significance level (one way ANOSIM test). These results verify that the certain diatom taxocenotic complex is formed within each of the estuarine area and characterized by well-defined taxonomic structure. Among 21 most dominant species (61% of total taxocene abundance at Belbek and 92% – at Inkerman), 5 species are typically freshwater forms (15% of total abundance – at Belbek and 12% – at Inkerman). The most dominant 16 species in each of the estuaries are typically marine and brackish-water forms consisted of about 47% (in Belbek) and 79% (in Inkerman) of total density of diatom taxocene.

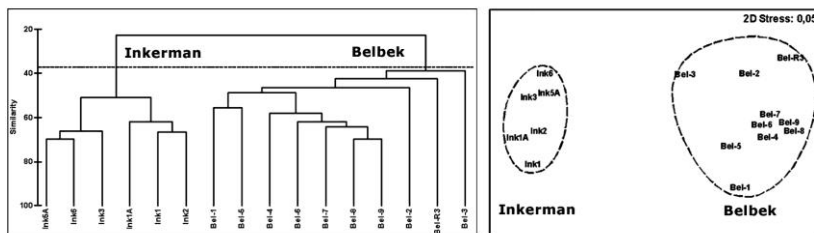


Fig. 1 Dendrogram and MDS plot of stations grouping based on similarity of diatom abundance and number of species at two estuaries.

The updated inventory of Black Sea benthic diatoms (877 sp. & ssp.) was aggregated into 7 ascending levels (from infraspecies to division) and applied for construction of 95% probability contours (ellipses), where distribution of Δ^+ and Λ^+ values were derived from 1000 simulated size-different siblists of diatom species. Position of samples on plot represented vertical evenness of the taxa distribution across the hierarchical phylogenetic tree (AvTD) and its horizontal variability (VarTD). Simultaneous assessment of these two components of diversity is important when habitat heterogeneity is likely to influence on biodiversity pattern.

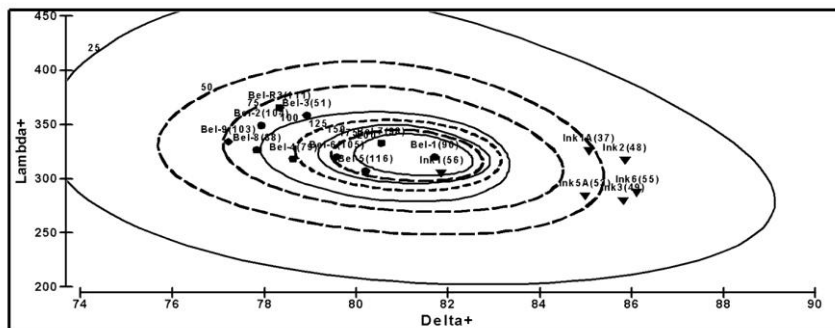


Fig. 2. Ellipse 95% probability plot for AvTD and VarTD pairs, corresponding to observed diversity indices values for the 16 estuarine locations and their species list size (in brackets)

Observed Δ^+ and Λ^+ values for Bel-1 and Ink-1 sites (nearest to rivers outfall points) situated nearby center of the simulated ellipse. It can denote that phylogenetic structure of diatom taxocene in both these stations is similar to the expected mode, corresponding to structure of whole Black Sea benthic diatoms inventory ($\Delta^+ = 83.5$; $\Lambda^+ = 306$).

The AvTD for Inkerman stations Ink-3 and Ink-6 have reached the highest values ($\Delta^+ = 85.9$ – 86.1) along with rather lowered Λ^+ values and positioned below the expected mode (at the right-bottom corner of the simulated contour). It can evidence about more share of mono/oligo-species taxonomic branches in phylogenetic structure comparatively with other stations. So, ratios representing the relative species richness ("saturation") in the higher taxonomic levels, i.e. spp/gen, spp/fam and spp/order were the lowest: 1.83, 2.03 and 2.89, correspondingly.

On the contrary, stations Bel-2, Bel-3 and Bel-R3 displayed the pronounced reverse relationship and placed around the left-top of the simulated contour. VarTD in these points was the highest ($\Lambda^+ = 360$ – 372) that evidence about widely ranged and uneven phylogenetic structure across the taxonomic tree and large share of polyspecies branches comparatively with expected mode of Black Sea inventory. Relative species richness in the higher taxonomic levels reached the highest values: 2.23, 2.83 and 4.64, for spp/gen, spp/fam and spp/order ratios, correspondingly.

At general, decreasing of Δ^+ values can be related to reduction of taxonomic tree structure when some entire oligospecies branches disappear and the polyspecies branches begin to prevail. In such taxocene initial vertical phylogenetic structure across the taxonomic tree becoming relatively more flat and species are closing-up at the common node corresponding to rather low taxonomic level (genus or rarely – family). The obtained results have provided a statistically reliable summary regarding to spatial differences in phylogenetic relatedness patterns within the benthic diatom assemblages caused by environmental heterogeneity, including natural disturbances and anthropogenic impact in nearshore ecosystem of the SW Crimea.