



## An updated diatom biostratigraphy of the Sivik Formation, Satovcha Neogene Basin (Southwestern Bulgaria)

### Актуализирана диатомейна биостратиграфия на Сивишката свита, Сатовчански неогенски басейн (Югозападна България)

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**Keywords:** diatoms, biostratigraphy, Miocene, Satovcha Basin.

#### Geological setting

The Satovcha Graben is located on the southern slopes of the Western Rhodopes (SW Bulgaria). It is about 7 km long, 1.5 km wide, and includes a total area of ~10 km<sup>2</sup>. The graben is filled with Oligocene–Neogene sedimentary and volcanic rocks. Two official lithostratigraphic units were recognized here: the Satovcha and the Sivik Formations (Vatsev, Pirumova, 1983). The Sivik Formation overlies discordantly the Oligocene volcanics and sediments of the Satovcha Formation and it consists of sandstones, siltstones, sandy clays and diatomites with coal seams (Pirumova, Vatsev, 1979; Vatsev, Pirumova 1983; Vatsev, 1999).

There is no consensus on the exact age of the studied strata. Jaranoff (1943) and Borisov et al. (1973) determined Oligocene age of the sediments of the Satovcha Graben. Vatsev and Pirumova (1983) suggested that the age of the Satovcha Formation was probably Early Oligocene. The same authors identified the Sivik Formation as Middle–Late Miocene based on the diatom thanatocenosis (Pirumova, Vatsev, 1979; Vatsev, Pirumova, 1983). Later on Vatsev (1999) gave Middle Miocene age for this formation, but his assumption was again for Late Miocene age of the sediments in Beli Bryag area. Ognjanova-Rumenova (2003) determined Late Miocene age for the top layers of the Sivik Formation based on diatom analysis. This formation is characterised by the presence of numerous plant fossils. It has yielded the richest palaeoflora in Bulgaria. It contains 103 fossil species as well as 28 taxa which are close to recent plant species (Bozukov, Ivanova, 2015). Based on the total content of the macroflora from all the layers of this formation, Bozukov (2002) determined Middle Miocene age. These data were also confirmed by pollen analysis (Ivanov, 2012).

#### Diatom biostratigraphy

Studies of diatoms from the Sivik Formation in the Beli Bryag section provide the framework for constructing the diatom biostratigraphy (Pirumova, Vatsev, 1979; Vatsev, Pirumova, 1983; Ognjanova-Rumenova, 2003).

Only scant information exists about the diatom flora in the investigated sediments. The studies of Pirumova and Vatsev (1979) and Vatsev and Pirumova (1983) show that the determined diatom assemblage has very poor taxonomic diversity and it is dominated by coarse-ornamented *Aulacoseira* species, varying in size. Many of the diatom thanatocenoses from the Neogene continental basins in Central and Eastern Europe are monotaxonic and comprise variable roughly silicified *Aulacoseira/Melosira* species. During the recent decades they have been determined according to Jousé (1952) as *Melosira praegrnulata* Jousé, *M. praeislandica* Jousé and *M. praedistans* Jousé. In 1992 Davidova and Moisseeva combined all these “prae” forms as different varieties and forms of one species – *Aulacoseira praegrnulata*. In 2004 the type material of this taxon was reinvestigated by Likhoshway from Miocene sediments in Khanka Lake. Use of the prefix “prae” for all of these forms was intended to reflect the similarity between fossil and modern representatives but all new data from these reinvestigations and comparisons with modern species showed only a similarity with *Aulacoseira distans* in the structure of the ring-leist, and the larger number of rimoportulae, their form and localization. In the fossil taxa many features are missing, e.g. the curved rimoportulae and the long tapering separation spines typical of *Aulacoseira granulata*. *A. islandica* and *A. praeislandica* have in common only the velum and the form of the rimoportula,

features shared by all representatives in the sample from Khanka Lake (Usoltseva, Likhoshway, 2005).

The non-marine Miocene diatom assemblage, presented in the uppermost layers of the Sivik Formation, is analysed by Ognjanova-Rumenova (2003). Emphasis is given to the abundant centric species, belonged to genus *Aulacoseira*. Because of their stratigraphic importance palaeoecological interpretation of the sediment formation is also given. Similarities and differences between the Satovcha diatom flora and those, known from other Balkan basins, are discussed. The dominant complex of the investigated diatom flora consists of different species *Aulacoseira*. The flora comprises typical species for the Late Miocene lakes and it is dated as Late Miocene (Pontian). Two phases can be distinguished in the lake history during the sediment formation.

The fossil material examined for this study originates from the Sivik Formation. The studied outcrop is located to the East from Satovcha village. The diversity of the diatom thanatocenosis is again very poor. The predominant forms in the diatom assemblage belong to genus *Aulacoseira* Thw. Comparisons with similar coarse-ornamented *Aulacoseira* species are carried out. One of the most similar species in several aspects (e.g., dimension, morphology and arrangement of areolae, striae orientation, and morphology of separation spines) is recently proposed as new combination – *Pseudoaulacoseira sculpta* (Ehr.) Usoltseva & Houk. (Usoltseva, Houk, 2016). Morphological and ultra-morphological features of this species are presented and discussed.

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