PALAEOGENE PLANKTONIC FORAMINIFERA OF THE REPUBLIC OF MACEDONIA

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Abstract

The present study deals with the taxonomy of the Palaeogene planktonic foraminifera of the Republic of Macedonia. Five species belonging to two genera, one family (GLOBIGERINIDAE Carpenter, Parker, and Jones, 1862), and one superfamily are described for the first time from this part of the Balkan Peninsula. The studied micropalaeontological material was obtained from eight outcrop sections belonging to five sedimentary basins.

Key words: planktonic foraminifera, taxonomy, Palaeogene, Republic of Macedonia

Introduction. The present article aims to introduce the taxonomy of the Palaeogene planktonic foraminifera on the territory of the Republic of Macedonia. Palaeogene sediments in this part of the Balkan Peninsula are distributed into three major (larger) basins and four isolated masses: Tikvesh, Ovche Pole, Skopje–Kumanovo basins, as main ones, and Delchevo, Deve Bair, Valandovo–Gevgelija, and Strumica basins, as isolated blocks (Fig. 1). They are located in the Vardar Zone and the Serbo–Macedonian Massif [1]. First data about the presence of planktonic foraminifera (list of taxa including Globigerina bulloides d’Orb., Globigerina eocena Gümbl., Globigerina eocenica Terq., Globigerinoides conglobatus Brandy, etc.) were given by Maksimović et al. [2] during the complex investigation of Ovche Pole and Tikvesh basins, but until now detailed taxonomical works on this microfossil group have not been carried out. Part of the above-mentioned species occur into younger stratigraphic levels only, that is why a taxonomical revision of them is necessary.
The data for the geological age (determined as Upper Eocene to Lower Oligocene) of the studied sediments in all basins have been obtained from many fossil remainings of macrofossil and microfossil groups including benthic and planktonic foraminifera [2–4].

**Geological setting.** The Palaeogene of the Republic of Macedonia has been subdivided into five lithostratigraphical units [2,3]: basal unit, lower flysh unit, unit of yellow sandstones, upper flysh unit and carbonate-sandy unit (Fig. 2). The basal unit (50–700 m) has been established in all basins. It is composed of red or violet conglomerates and sandstones with interbeds of shales and calcarenites. It is overlaid with gradual transition (in Tikvesh, Ovche Pole and Deve Bair basins) by rhythmic alternation of red or gray conglomerates, sandstones, siltstones, shales, and limestones comprising the lower flysh unit (300–1100 m), or it is transgressively covered by the unit of yellow sandstones (in Skopje–Kumanovo basin), and the upper flysh unit (in Delchevo and Strumitsa basins). In Valandovo–Gevgelija basin the boundary between the basal unit and the upper flysh unit is a gradual transition. The unit of yellow sandstones (100–1000 m) is known from Tikvesh, Ovche Pole and Skopje–Kumanovo basins. It consists mainly of yellow sandstones in association with conglomerates and shales. The unit is covered with normal transition by the upper flysh unit (in Tikvesh and Ovche Pole basins), or it is concordantly overlaid by the carbonate-sandy unit (in Skopje–Kumanovo basin). The upper flysh unit (100–2500 m) has been recorded from Tikvesh, Ovche Pole, Delchevo, Valandovo–Gevgelija, and Strumica basins. It is composed of rhythmic alternation of shales, sandstones, siltstones and limestones. It is covered transgressively by Neogene volcanic or sedimentary rocks. The carbonate-sandy unit (200 m) comprises predominantly yellow limestones associated with sandstones and shales. It is known from Skopje–Kumanovo basin only.

**Planktonic foraminiferal data.** Totally 151 samples from 12 outcrop sections have been investigated. One hundred and forty three of them come from the upper flysh unit, while the samples from the Skopje–Kumanovo basin (eight in number) were picked from the unit of yellow sandstones. The studied planktonic foraminifera were obtained from 42 samples picked from eight sections (Fig. 1). The species are rarely distributed in the upper levels of the two above-mentioned units. They are represented by single or rare specimens and in the majority of sections they occur at isolated levels. In all sections, with the exception of Nemanjici (Fig. 3), only one or two species were found.

Nemanjici section is located 6.5 km NE of the town of Sveti Nikole. 90–100 m of the upper flysh unit, represented by calcareous clay alternating with thin sandstone beds (Fig. 3), crop out here. Planktonic foraminiferal association containing all five taxa described below was established in most of the samples. All species were recorded in the whole section. Generally *Globigerina officinalis* Subb., *Globoturborotalia ouachitaensis* (Howe and Wallace), *Globotur-
Fig. 1. Sketch with the location of the Palaeogene basins in the Republic of Macedonia and the studied sections: 1 – Distribution of Palaeogene sediments; 2 – Tectonic boundary; WMZ – Western Macedonian Zone, VZ – Vardar Zone, SMM – Serbian–Macedonian Massif; 3 – Basin boundary; 4 – Basins: SKB – Skopje-Kumanovo, OPB – Ovče Pole, TB – Tikvesh, VGB – Valandovo-Gevgelija, DB – Delchevo, SB – Strumica, DBB – Deve Bair; 5 – Section with established planktonic foraminifers; 6 – Section without established planktonic foraminifers
Fig. 2. Schematic section of the spatial relationships of the Palaeogene lithostratigraphical units in the Vardar Zone with the positions of the sections containing planktonic foraminifera: 1 – Vojnik; 2 – Nemanjici; 3 – Kadrifakovo; 4 – Hadzi Jusufli; 5 – Krivolak; 6 – Rabrovo; 7 – Dedeli
Fig. 3. Stratigraphical distribution of planktonic foraminiferal taxa in Nemanjici section from Ovche Pole basin: 1 – thin bedded sandstones; 2 – clayey-carbonate sediments; 3 – sample

1955. *Globigerina officinalis* sp. n.; [7], p. 78, pl. 11, Figs 1a–7c. (in Russian).
1962. *Globigerina officinalis* Subbotina; [9], p. 88, pl. 9a-c; Fig. 16.
1975. *Globigerina officinalis* Subbotina; [10], p. 211, Fig. 71.

Taxonomy. The following pages give taxonomical description of five species, belonging to two genera of the family GLOBIGERINIDAE Carpenter, Parker, and Jones, 1862. Taxonomical determination at generic level is based on the classification of LOEBLICH and TAPPAN [5] and PEARSON et al. [6]. All the species are first described in the Republic of Macedonia.

Suborder GLOBIGERININA Delage and Hérouard, 1896
Superfamily GLOBIGERINACEA Carpenter, Parker, and Jones, 1862
Family GLOBIGERINIDAE Carpenter, Parker, and Jones, 1862
Subfamily GLOBIGERININAE Carpenter, Parker, and Jones, 1862
Genus *Globigerina* d’Orbigny, 1826

*Globigerina officinalis* Subbotina, 1953
Plate I, Figures 4, 5

1953. *Globigerina officinalis* sp. n.; [7], p. 78, pl. 11, Figs 1a–7c. (in Russian).
1962. *Globigerina officinalis* Subbotina; [9], p. 88, pl. 9a-c; Fig. 16.
1975. *Globigerina officinalis* Subbotina; [10], p. 211, Fig. 71.
Plate I. 1. *Globoturborotalia angulisuturalis* (Bolli, 1957); Ovche Pole basin, Nemanjici section, upper flysh unit, sample 13; spiral view; SEM × 300; 2, 3. *Globoturborotalia anguliofficinalis* (Blow, 1969); Tikvesh basin, Hadzi Jusufi section, upper flysh unit, sample 7; 2 – spiral view, SEM × 200; 3 – umbilical view, SEM × 220; 4, 5. *Globigerina officinalis* Subbotina, 1953; Ovche Pole basin, Nemanjici section, upper flysh unit; 4 – umbilical view, sample 14; SEM × 325; 5 – spiral view, sample 13; SEM × 240; 6, 7. *Globoturborotalia gnaucki* (Blow et Banner, 1962); Ovche Pole basin, Nemanjici section, upper flysh unit, sample 13; 6 – spiral view, SEM × 250; 7 – umbilical view, SEM × 340; 8–10. *Globoturborotalia ouachitaensis* (Howe and Wallace, 1932); 8 – Valandovo–Gevgelija basin, Rabrovo section, upper flysh unit, sample 14; apertural view; SEM × 200; 9, 10 – Tikvesh basin, Krivolak section, upper flysh unit, sample 7; 9 – spiral view, SEM × 250; 10 – umbilical view, SEM × 220; Scale bar – 100 µm

2006. *Globigerina officinalis* Subbotina; [6], p. 114, pl. 6.1, Figs 1–16.

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**Nomenclature.** The holotype (VNIGRI Coll. No 4038) is from the Upper Eocene (Bolivina Zone) of Northern Caucasus [7]. Here, the species is identified after the holotype figures and the SEM images of paratype No 4040 of the same collection [6].

**Material.** More than 20 specimens, most of them well preserved.

**Description.** The test is small, low trochospiral, with perforated wall, the chambers are globular. The spiral side of the ultimate whorl is composed of four chambers, while the umbilical side comprises 3.5 chambers. Their size grows gradually. The sutures are distinct and depressed on both sides. The aperture is umbilical, a low arch.

**Remarks.** Our specimens are closer to paratypes Nos 4040 and 4041 than to the holotype [7]. They are with 3.5 chambers only in the ultimate whorl on the umbilical side and with a very low arch aperture. *G. parva* Bolli is considered as a younger synonym of *G. officinalis* Subbotina.

**Stratigraphic range.** Middle Eocene to Oligocene (P12 to P20 Zone).

**Occurrence.** Ovche Pole basin (Kadrifakovo section – samples 5, 6, 9; Nemanjici section – samples 1–5, 8–10, 12–18), Skopje–Kumanovo basin (Vojnik section – samples 6–8).

Genus *Globoturborotalia* Hofker, 1976

*Globoturborotalia anguliofficinalis* (Blow, 1969) Plate I, Figures 2–3

1985. *Globigerina ciperoensis anguliofficinalis* Blow; [12], Fig. 13 (10–11).

2005. *Globoturborotalia anguliofficinalis* (Blow); [11], p. 113, pl. 17.


**Nomenclature.** The species was first described from the Lower Oligocene (Cipero Formation) of Trinidad. Here, it is identified after the refugured holotype [12].

**Material.** More than 50 well preserved specimens.

**Description.** The test is compact, trochospiral with a distinct ultimate whorl composed of 4.5 (in some cases 4) chambers on both spiral and umbilical sides. They are close to each other, globular, and grow gradually in size. The wall surface is cancellate, with normal pores. The peripheral outline is subquadratic. The sutures are straight and depressed, but not deep. The umbilicus is small and shallow. The aperture is umbilical, a low arch covered with a narrow lip.

**Remarks.** Most of the studied specimens are similar to *G. gnaucki* (Blow et Banner) by the number of the chambers in the ultimate whorl (4 to 4.5).

**Stratigraphic range.** Late Eocene to Late Oligocene (P15 to P22 Zone).

**Occurrence.** Tikvesh Basin (Krivolak section – samples 5–7; Hadzi Jusufli section – samples 3, 6, 7), Ovche Pole Basin (Nemanjici section – samples 1, 3, 4, 8, 13, 14, 16–18), Skopje–Kumanovo basin (Vojnik section – sample 8), Delchevo basin (Crna Skala section – samples 13, 16, 20, 22–24, 26), Vandalovo–Gevgelija Compt. rend. Acad. bulg. Sci., 66, No 5, 2013
basin (Dedeli section – samples 9, 11, 14, 15; Rabrovo section – samples 7, 14, 15).

**Globoturborotalia angulisuturalis** (Bolli, 1957)

Plate I, Figure 1

1957. *Globigerina ciperoensis angulisuturalis* subsp. n.; [8], p. 109, pl. 22, Figs 11a-c.

1962. *Globigerina angulisuturalis* Bolli; [9], 84, pl. 9a-c.

1975. *Globigerina angulisuturalis* Bolli; [10], 250, Fig. 104.

1981. *Globigerina angulisuturalis* Bolli; [13], 21, pl. 7, Fig. 2a-c.

1985. *Globigerina angulisuturalis* Bolli; [12], Fig. 13 (4–7).

2005. *Globoturborotalia angulisuturalis* (Bolli); [11], p. 113, pl. 17.

**Nomenclature.** The holotype (US Nat. Mus. Coll. No P5608) is from the Oligocene of Trinidad (Cipero Formation). Here, the species is identified after the original figure of the holotype [8], as well as SEM images of specimens from the same formation [10].

**Material.** More than 10 specimens, most of them well preserved.

**Description.** The test is high trochospire, subglobular. The ultimate whorl is composed of 4 chambers, well separated from each other. They are globular on the spiral side and slightly flattened on the umbilical one. The wall surface is cancellate, without cortex. The periphery is round and lobulate. The sutures are wide, short, straight and strongly depressed. The umbilicus is wide and shallow. The aperture is umbilical, a low arch, often with a rim.

**Remarks.** The taxon was proposed as a subspecies of *G. ciperoensis* (Bolli). Later on [9], it was proposed a separate species status, which was accepted by the majority of the authors. Its inclusion within genus *Globoturborotalia* Hofker is based on its spinose wall and cancellate test surface. The species is easily distinguished by its deep and wide septal seams. The majority of our specimens have 4 chambers in the ultimate whorl and a higher spiral than that of the holotype.

**Stratigraphic range.** Oligocene to Earliest Miocene (P21 (?) to N4 Zone).

**Occurrence.** Ovche Pole basin (Nemanjici section – samples 1, 2, 8, 10, 12–18).

**Globoturborotalia gnaucki** (Blow et Banner, 1962)

Plate I, Figures 6, 7

1962. *Globigerina ouachitaensis gnaucki* subsp. n.; [9], p. 91, pl. 9-l-n.

1985. *Globigerina ouachitaensis gnaucki* Blow and Banner; [12], Fig. 13 (16).


2006. *Globoturborotalia gnaucki* (Blow and Banner); [6], p. 118, pl. 6.4, Figs 1–15.

**Nomenclature.** The holotype (Nat. Hist. Mus. London Coll. No P44509) is from the Lower Eocene (Lindi area) of Tanzania. It was reillustrated by BOLLI and SAUNDERS [12] (Fig. 13: 16a-c). Here the species is identified after SEM images of the holotype [6].
**Material.** More than 10 well preserved specimens.

**Description.** The test is low trochospiral. Initial spire of chambers is flat. The ultimate whorl comprises 4.5 chambers on the spiral side, and 4 chambers on the umbilical side. They are globular and their size increases gradually. The wall surface is cancellate, normal perforate. The peripheral margin is rounded, distinctly lobulate. The sutures are concave, straight and not very deep. The umbilicus is wide and shallow. The aperture is a low arch with thin lip, umbilical to umbilical-extraumbilical.

**Remarks.** Our specimens are with a lower arch aperture than in the holotype and they are to a greater degree similar to the paratype of *Globigerina ouachitaensis* Howe and Wallace (USNM No 18946), which after a revision by Pearson et al. [6] was referred to *G. gnaucki* (Blow et Banner).

**Stratigraphic range.** Late Eocene to Early Oligocene (end of P15 Zone to P19 Zone).

**Occurrence.** Ovche Pole basin (Nemanjici section – samples 1–4, 9, 12–18).

*Globoturborotalia ouachitaensis* (Howe and Wallace, 1932)
Plate I, Figures 8–10
1962. *Globigerina ouachitaensis ouachitaensis* Howe and Wallace; [9], p. 90, pl. 9-d, h-k, Fig. 9(6).
1985. *Globigerina ouachitaensis ouachitaensis* (Howe and Wallace); [12], Fig. 13 (15).
2006. *Globoturborotalia ouachitaensis* (Howe and Wallace); [6], p. 122, pl. 6.5, Figs 1–16.

**Nomenclature.** The species was first found in the Upper Eocene (Jackson Formation, Louisiana) of the USA. Here the species is identified after the refugured holotype [12] and by SEM images from Yazoo Fm, Mississippi [6].

**Material.** More than 20 well-preserved specimens.

**Description.** The test is low trochospiral. Initial spire of chambers on the spiral side is convex. The ultimate whorl is composed of 4.5 chambers on the spiral side, and of 4 chambers on the umbilical side. They are globular and increase gradually in size. The periphery is rounded, distinctly lobulate. The wall surface is cancellate, normal perforate. The sutures are short, straight and concave. The umbilicus is relatively wide, shallow and open. The aperture is a high arch without lip, umbilical to umbilical-extraumbilical. Sometimes it is outlined with a rim.

**Remarks.** The number of chambers composing the spiral and umbilical side distinguishes our specimens from the holotype and the characteristics typical of the species.

**Stratigraphic range.** Middle Eocene to Late Oligocene (P10 to P22 Zone).

**Occurrence.** Ovche Pole basin (Nemanjici section – samples 1–4, 8, 11–18), Valandovo–Gevgelija basin (Rabrovo section – samples 7, 8, 14).

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