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A new species of *Nummulites* Lamarck (Nummulitidae, Foraminiferida) from Central Turkey

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Research Article

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ABSTRACT

A new nummulitid species Nummulites sireli n. sp. is described from the middle Lutetian of the Çayraz section, North of Haymana, South of Ankara, Turkey. The new species is referred to the *N. distans* group, of which six other species from the Haymana and Çiçekdağ regions of Central Anatolia are identified.

1. Introduction

Nummulites Lamarck, 1801 is one of the most studied larger benthic foraminiferal genus since the first paleontological investigations. In particular, the variations in its species and geographic distribution over Tethys region maket his genus an important index taxon for the late Thanetian to early Oligocene age (d'Archiach, 1850; Boussac, 1911; Doncieux, 1926; Lluca, 1929; Roveda, 1970; Blondeau, 1972; Schaub, 1981; Racey, 1995; Serra-Kiel et. al., 1998, Sirel and Deveciler, 2018)

The main purpose of this study is to describe *Nummulites sireli* n. sp. from the middle Lutetian (SBZ 14-15; Serra-Kiel et al., 1998) of the Çayraz section (north of Haymana, south of Ankara, central Turkey). In addition, four other relative species from the same locality (*Nummulites kaufmanni* Mayer-Eymar, 1877; *Nummulites polygyratus* Deshayes, 1838; *Nummulites nemkovi* Schaub, 1966; *Nummulites somaliensis* Nuttall and Brighton, 1931) and two others from the Çiçekdağ region (*N. distans* Deshayes, 1838; *Nummulites pratti* d'Archiac and Haime, 1853) are identified and compared in detail with *N. sireli* n. sp.. These species are considered to belong to the *N. distans* group *sensu* Schaub (1981) for their lateral and equatorial characteristics.

The Çayraz section (Figure 1-A, B), which is mainly composed of clayey limestone, marl, sandstone and sandy limestone, has been chosen as the reference section of Cuisian-Lutetian in Anatolian Peninsula by Sirel (2015) for its accessibility, completeness and rich benthic foraminiferal content (Figure 2). Because of these characteristics, it has been studied by many authors such as Hottinger (1960 a, b), Schaub (1962), Dizer (1964), Yüksel (1970), Gökçen (1976a, b), Sirel and Gündüz (1976), Ünalan et al. (1976), Toker (1979, 1980), Schaub (1981), Sirel et al. (1986), Koçyiğit (1991), Çiner et al. (1996), Özcan (2002), Özcan et al. (2007), Deveciler (2010), Sirel and Deveciler (2017) and Sirel and Deveciler (2018). Despite the abundance and diversity of nummulitids, only two species *Nummulites lehneri* Schaub (1962) and *Nummulites haymanensis* Schaub (1981) have their type locality here.

The other sampling area is located in the Çiçekdağ region of central Anatolia, Turkey (Figure 1-A). The general geological setting of this region can be divided into three main parts: Kırşehir massif, Ankara melange and post-Lower Cretaceous sediments (Şenalp, 1980). These different rock groups have been investigated by Birgili et. al. (1975), Erdoğan et. al. (1996), Akgün et. al. (2002), Akkiraz et. al. (2007) and Schweitzer et. al. (2007). The larger benthic foraminiferal content has not been studied in detail yet.

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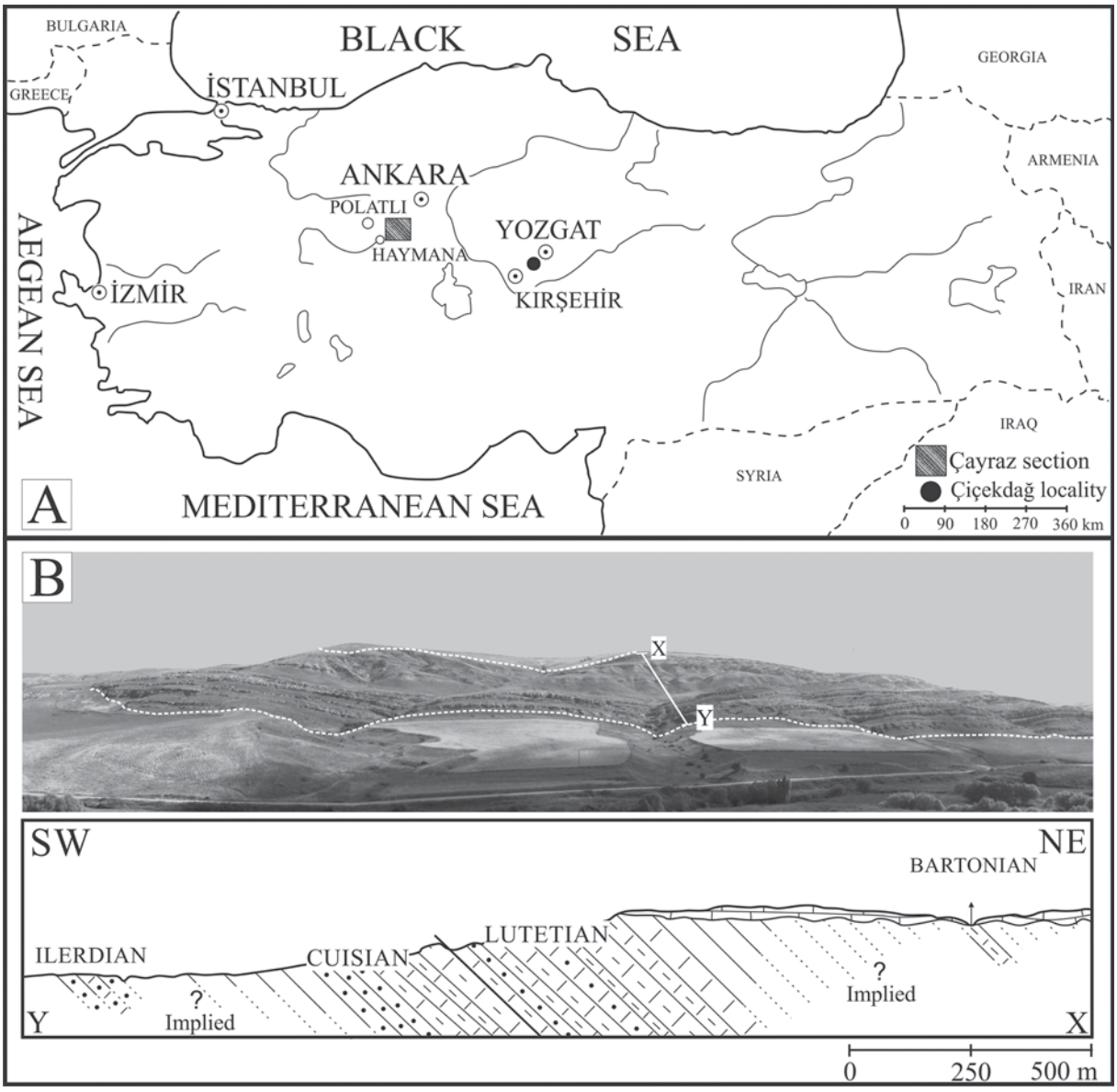

Figure 1- Location map of Çayraz section and Çiçekdağ locality (A) and the cross section of Çayraz succession (B).

2. Materials and Methods

All materials used in this study, except for *N.* distans and *N. pratti*, were collected from the argillaceous limestone and limestone series of the Çayraz locality (Figure 1-B; GPS reference: 36S 460078E – 4370296N) within the scope of the author's PhD Thesis (Deveciler, 2014). Specimens of *N. distans* and *N. pratti* from the Çiçekdağ region (GPS reference: 36S 641643E – 4382508N) were collected as a spot sample by Dr. Ercüment Sirel. Also, some of these materials except the specimens of *N. sireli* are discussed and illustrated in detail by Sirel and Deveciler (2018).

The twentytwo oriented thin sections were made from the free specimens of nummulitids of Çayraz and Çiçekdağ regions. Photographs were taken via Leica binocular microscope mounted Leica camera in Paleontology Laboratory of Ankara University Geological Engineering. All the individual samples and oriented thin sections are deposited in the collection of Ankara University, Faculty of Engineering, Department of Geological Engineering.

3. Systematic Paleontology

Order: Foraminiferida Eichwald, 1830

Family: Nummulitidae Blainville, 1825

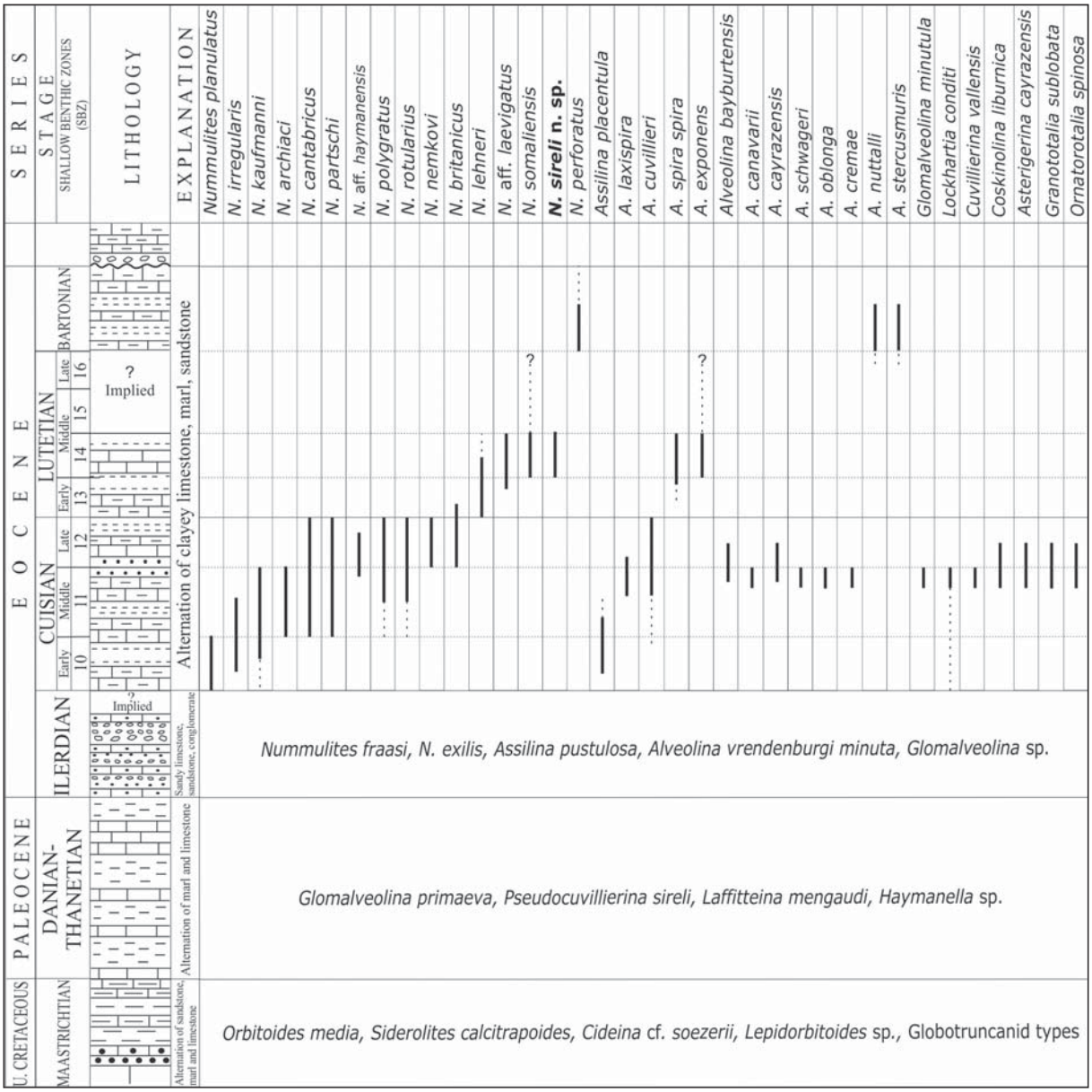

Figure 2- Biostratigraphic distributions of the nummulitid species in Çayraz section, modified after Sirel and Gündüz (1976), Deveciler (2010, 2014), Sirel (2015) and Sirel and Deveciler (2017) (not to scale).

Genus: *Nummulites* Lamarck, 1801

Type species: *Camerina laevigata* Bruguiére, 1792

Group: *Nummulites distans* sensu Schaub, 1981

Description: This group is characterized by lenticular to flat test with an undulated margin (Plate 1, Figures 2-4; Plate 2, Figures 4, 6; Plate 3, Figures 5, 11; Plate 4, Figures 2-3; Plate 5, Figure 3). Septal filaments are thin, curved, turbulanted and mostly meandric (Plate 1, Figure 6; Plate 2, Figures 2, 7; Plate 4, Figure 5; Plate 5, Figure 2). The surface is covered by small granules. Some species have a central knob in the center of the test (Plate 1, Figures 2-4, 11; Plate 4, Figures 2-3; Plate 5, Figures 3). The spire is irregular (Plate 2, Figures 1) or semi-irregular (Plate 2, Figures 5, 8). The septa are observed as thin, curved and undulated as from adult stage. Schaub (1981) defined nine species under *N. distans* group including *N. haymanensis*, *N. nemkovi*, *N. kaufmanni*, *N. distans*, *N. alponensis*, *N. polygyratus, N. millecaput*, *N. maximus* and *N. dufrenoyi* of Cuisian-Lutetian age. Unlike in Schaub (1981) *N. pratti* d'Archiac and Haime and in addition *N. somaliensis* Nuttal and

Bringhton are counted in this group because of their lateral and equatorial characteristics.

Nummulites sireli n. sp.

(Plate. 1, Figures 1-12)

1948 *Nummulites montefriensis* Douvillé, Doncieux, page 21, plate 2, figures 17-22.

2014 *Nummulites* sp. 3, Deveciler, page 63-64, plate 11, figures. 12-22; plate 12, figures 1-6.

Derivation of name: After Dr. Ercüment Sirel (Ankara University), for his seminal contributions on the systematics of larger benthic foraminifera fossil.

Holotype: Equatorial section of microspheric form illustrated in Plate 1, Figure 1. (label Cay 2/3/15).

Paratypes: Five microspheric and six megalospheric forms (Plate 1, Figures 2-12; labels are given in Plate 1).

Material: Twentyfour oriented thin sections and free specimens of holotype and paratypes from the Çayraz section.

Depository: Holotype and paratypes are deposited in the collection of Ankara University Department of Geological Engineering (Ankara, Central Turkey).

Type locality: Çayraz section, NW of Çayraz village, NE of Haymana, SW of Ankara, Central Turkey.

Type level: Middle Lutetian (SBZ 14-15).

Description: The microspheric (B-form) generation has a flat test and rounded periphery. The surface is generally straigth but, in some specimens it can be slightly undulated. Small granules are barely visible on abraded samples. Meandering septal filaments continue towards the periphery as slightly curved (Plate 1, Figure 6). The central knob disappears after the adult stage and than it cannot be observed on the surface (Plate 1, Figure 2-4). The equatorial diameter ranges between 16.6-23 mm, and the axial thickness is between 2.5-3.2mm. The first four whorls of the nepionic stage are 1.9-1.6 mm. After this stage the gap between the whorls increases gradualy and stays constant. The spire is thick and slightly irregular. There are 14-15 whorls in diameter of 10 mm. Curved septa are thin and undulated in the adult stage. Average height-length ratio (h/l) of the chambers is between 1.5-2. The septa count in the first 10 whorls of four specimens: 2nd- 25; 3rd- 28-32; 4th- 33; 5th- 34-38; 6th- 36-40; 7th- 45; 8th- 48-50; 9th- 54; 10th- 58-62.

The megalospheric (A-form) generation has a lenticular test with a pointed periphery (Plate 1, Figure 12). The central knob can be observed on the surface (Plate 1, Figure 7). Septal filaments are slightly curved. The equatorial diameter is between 2.5-3mm, the axial thickness is 1.3-1.4mm. The ovoid proloculus has a diameter between 0.25-0.35mm. After the proloculus, whorl height increases slowly. The spire is regular. There are four whorls in a diameter of 1.2 mm. Slightly bent septa join to the previous whorl upright. Average height-length ratio (h/l) of the chambers is between 1-1.76. The septa count in three whorls of four specimens: 1st, 11; 2nd, 23; 3rd, 26.

Remarks: *N. sireli* n. sp. shows the main characteristics of *N. distans* group by its size, outher view and coiling properties. *N. sireli* n. sp. differs from *N.somaliensis* Nuttal and Bringhton (Plate 2, Figures 1-4) with its flat test, much regular and tight spire and apparent central knob in its axial sections. *N. kaufmanni* Mayer-Eymar (Plate 3, Figures 1-5) is more irregular in coiling and lenticular in shape than *N. sireli* n. sp.. *N. nemkovi* has the similar equatorial characteristics with *N. sireli*, however it has a lenticular test with swollen center, and curved-turbulented septal filaments (Plate 2, Figures 5-8). *N. polygyratus* Deshayes (Plate 3, Figures 6-11) is different from *N. sireli* n. sp. with its multiple spire growth, tight coiling, elongated lenticular test and closely aligned curved septa. *N. distans* Deshayes (Plate 4, Figures 1-10) and *N. pratti* d'Archiac and Haime (Plate 5, Figures 1-7) are distinguished from *N. sireli* n. sp. because of their lax and irregular spire and their larger equatorial diameters. (Figure 3, Table 1).

In addition to the foregoing species, *N. haymanensis*

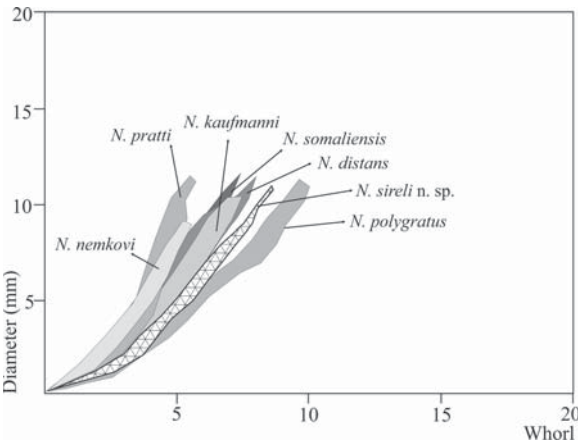

Figure 3- The spiral graph of the microspheric forms in this study.

Table 1- Comparison of the microspheric generations of *N. distans* group [the characteristics and biostratigraphic ranges of *Nummulites* species in the table is based on Nuttall and Brighton (1931), Schaub (1981), Racey (1995) and Serra-Kiel et al. (1998)].

Species	*N. kaufmanni* Mayer and Eymar, 1877	*N. nemkovi* Schaub, 1966	*N. distans* Deshayes, 1838	*N. pratti* d'Archiach and Haime, 1853	*N. polygyratus* Deshayes, 1838	*N. somaliensis* Nuttal and Brington, 1931	***N. sireli* n. sp.**
Shape of Test	Lenticular, sligtly pointed periphery	Lenticular, sligtly pointed periphery	Flat, thin lenticular, rounded periphery	Flat, thin lenticular, rounded periphery	Discoid lenticular, pointed perphery	Discoid lenticular, pointed perphery	Flat, thin lenticular rounded perihery
Granulation	Absent	Very small	Very small	Very small	Very small	Very small	Very small
Central Knob	Absent	Absent	Prensent	Prensent	Absent	Absent	Present
Diameter/Thickness	**22.8 mm** (lectotype in Schaub, 1981) 17.6-22.6/5.8-7 mm (present work)	**14.8 mm** (holotype in Schaub, 1981) 14.7-18.2/3.2-4.5 mm (present work)	**38.4 mm** (lectotype in Schaub, 1981) 32-35/2.8-3.2 mm (present work)	**39.2 mm** (neotype in Schaub, 1981) 35-36/2.52 mm (present work)	**32 mm** (lectotype in Schaub, 1981) 28.8-30.4/4.4 mm (present work)	**23 mm** (average) (cotype in Nut. and Br., 1931) 19.5-25/3-4mm (present work)	**23 mm** (holotype) 19.5-25/3-4 mm (paratypes)
Count of Whorls	**14 (in 20 mm diam.)** (lectotype in Schaub, 1981) 13-14 (in 20 mm diam.) (present work)	**10 (in 14 mm diam.)** (holotype in Schaub, 1981) 9-10 (in 14 mm diam.) (present work)	**12 (in 20 mm diam.)** (lectotype in Schaub, 1981) 12-13 (in 20 mm diam.) (present work)	**8 (in 20 mm diam.)** (neotype in Schaub, 1981) 8-10 (in 20 mm diam.) (present work)	**15 (in 20 mm diam.)** (lectotype in Schaub, 1981) 18-19 (in 20 mm diam.) (present work)	**12-13 (in 22,8 mm diam.)** (cotype in Nut. and Br., 1931) 11-12 (in 20 mm diam.) (present work)	**15 (in 20 mm diam.)** (holotype) 14-15 (in 20 mm diam.) (paratypes)
Stratigraphic Distribution	early-middle Cuisian SBZ 10-11 Present work: SBZ 10-11	late Cuisian SBZ 12 Present work: SBZ 12	middle-late Cuisian SBZ 11-12 Present work: SBZ 11-12	middle-late Cuisian SBZ 11-12 Present work: SBZ 11-12	middle-late Cuisian SBZ 11-12 Present work: SBZ 11-12	middle-late Lutetian SBZ 14-16 Present work: SBZ 14	middle Lutetian SBZ 14

Schaub (1981, plate 66, figure 11 (holotype)) from *N. distans* group differs from *N.* sireli n. sp. with its test shape and surface ornamentation. Furthermore other larger representatives of *N. distans* group including; *N. alponensis* Schaub (Schaub, 1981; plate 68, figure 14 (holotype)), *N. dufrenoyi* d'Archiac and Haime (Schaub, 1981; plate 69, figure 22 (lectotype)), *N. millecaput* Boubeé [Schaub, 1981; plate 68, figure 24 (neotype)] and *N. maximus* d'Archiac [Schaub, 1981; plate 69, figure 28 (lectotype)] are distinguished from *N. sireli* n. sp. with their tight spire.

N. sireli n. sp. shows identical characteristics with the figures of *Nummulites montefriensis* Douvillé (1906; page 212, plate XV, figures 1-8) in Doncieux (1948; plate II, figures 17-22) by its outer surface and equatorial sections. However, the equatorial section of the specimens figured by Doncieux (1948; figures 20-22) differ from that of the holotype of *N. montefriensis* Douvillé (plate XV, figure 7) because of their more regular and tight spire. Thus, the specimens figured by Doncieux (1948) are referred to here to *N. sireli* n. sp.

Stratigraphic distribution: Due to the co-occurrence of *N. lehneri, N.* aff. *laevigatus*, *N. somaliensis*, *Assilina exponens* and *A. spira spira* in the yellowish, hard clayey limestone beds of upper most of Çayraz section, the biostratigraphic age of *N. sireli* is considered in the middle Lutetian (SBZ 14-15).

4. Conclusions

The new nummulitid species here described as *Nummulites sireli* n. sp. is distinguished by its flat test with rounded periphery, small granules, a thin central knob and slightly irregular spire. It is associated with *N. lehneri*, *N.* aff. *laevigatus*, *N. somaliensis*, *Assilina exponens*, *A. spira spira* and *A. spira abrardı* in yellow colored clayey limestone beds of the middle Lutetian (SBZ 14) in the Çayraz section. Also the other five species of the *N. distans* group; *N. kaufmanni*, *N. distans, N. pratti*, *N. polygyratus*, *N. nemkovi* and *N. somaliensis* are identified for the first time from the middle Cuisian-middle Lutetian of central Anatolia, Turkey. These data are particularly significant for providing new paleobiogeographic and stratigraphic distributions of the *N. distans* group.

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PLATES

PLATE - I

Nummulites sireli n. sp.; all figures from middle Lutetian of Çayraz section, compiled from Deveciler (2014);

Figure 1- Centred equatorial section of B-form (Cay 2/3/15-holotype).

Figure 2- Axial section of B-form showing the central knob at the center of the test and the thin pillars (Cay 2/3/11).

Figure 3- Centred axial section of B-form (Cay 2/2/12).

Figure 4- Axial section of B-form (Cay 2/2/13).

Figure 5- Centred equatorial section of B-form (Cay2/3/16).

Figure 6- Lateral view of B-form showing meandering septal filaments and small granules on the edge of the surface (Cay 2/2/5).

Figure 7- Outer view of A-form showing radial septal filaments and central knob on the surface (Cay 2/2/1a).

Figure 8- Centred equatorial section of A-form showing proloculus (Cay 2/2/14).

Figure 9- Equatorial section of A-form (Cay 2/2/4).

Figure 10- Equatorial section of A-form (Cay 2/2/90).

Figure 11- Equatorial section of A-form (Cay 2/2/91).

Figure 12- Axial section of A-form showing central pillar (Cay 2/2/1b).

PLATE - I

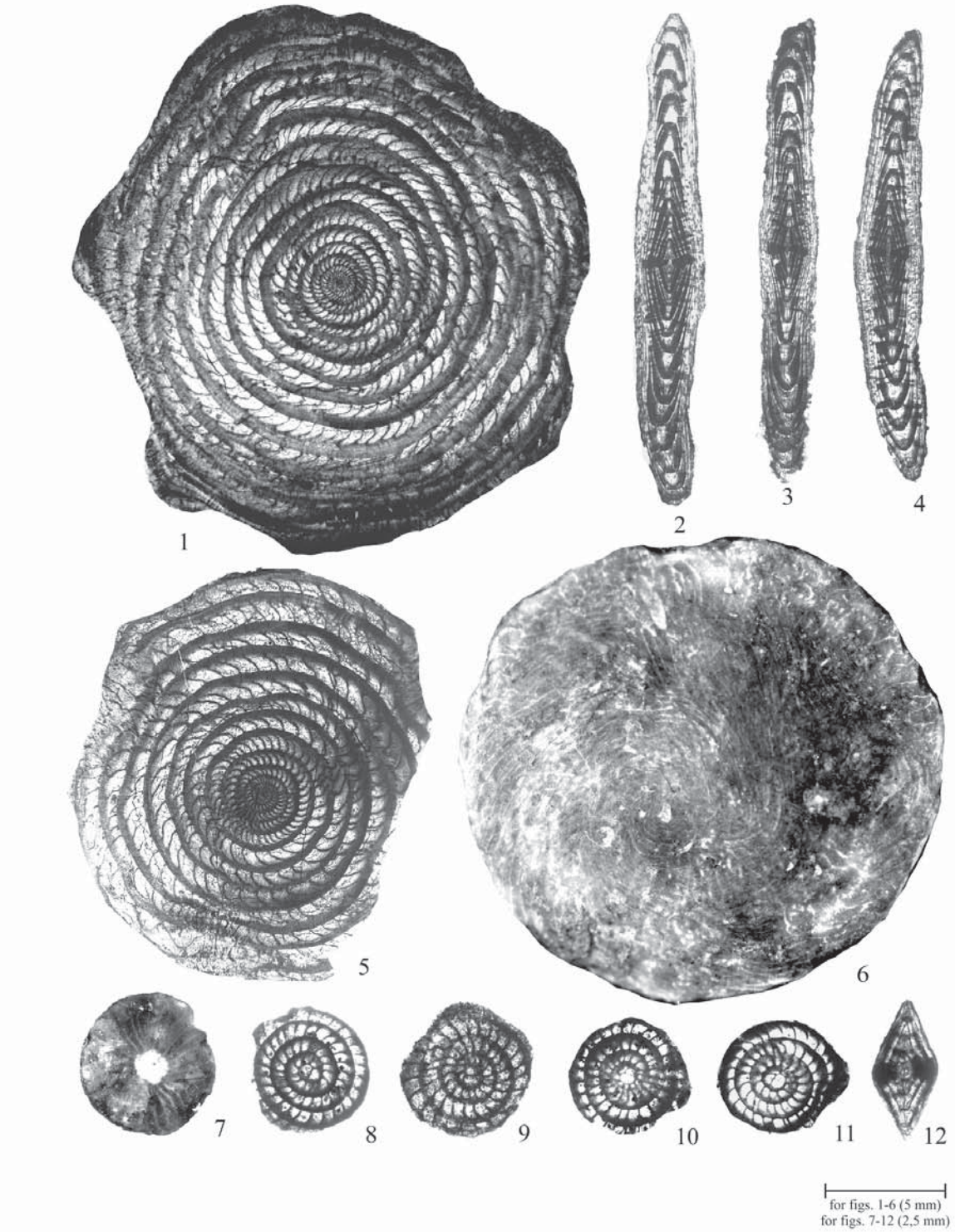

PLATE - II

Nummulites somaliensis Nuttall and Bringhton, 1931; all figures from middle Lutetian of Çayraz section, compiled from Deveciler (2014);

Figure 1- Centred equatorial section of B-form (Cay 2/3/7).

Figure 2- Outher view of B-form showing meandering septal filaments and thin granules on the surface (Cay 2/1/66).

Figure 3- Equatorial section of B-form (Cay 2/1/69).

Figure 4- Axial section of B-form (Cay 2/3/10).

Nummulites nemkovi Schaub, 1966; all figures from late Cuisian of Çayraz section, compiled from Deveciler (2014);

Figure 5- Equatorial section of B-form (Cyzd 10/17).

Figure 6- Axial section of B-form (Cyzd 10/21b).

Figure 7- Lateral view (Cyzd8/1).

Figure 8- Equtorial section (Cyzd 8/5).

PLATE - II

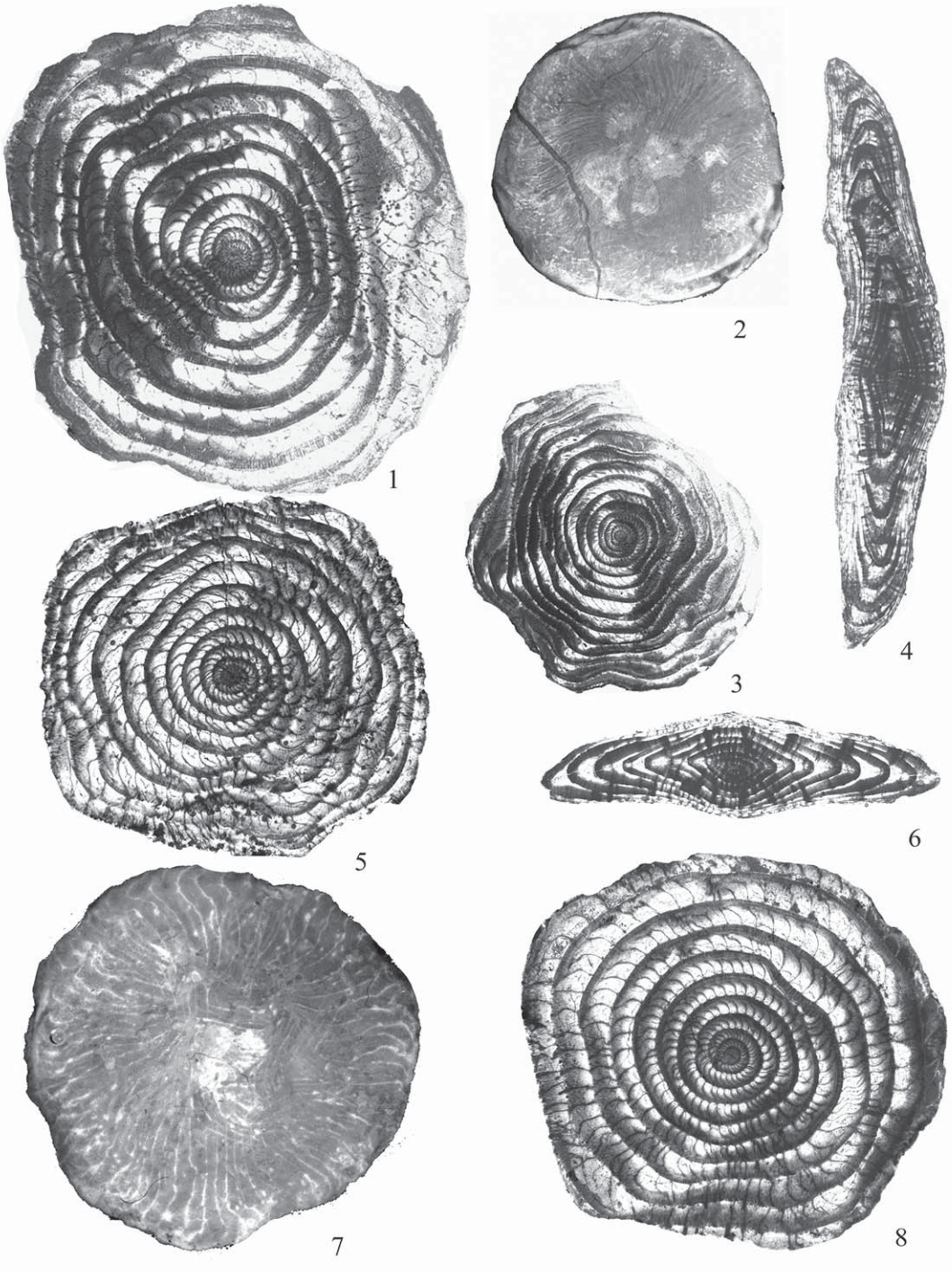

PLATE - III

Nummulites kaufmanni Mayer-Eymar, 1877; all figures from early-middle Cuisian of Çayraz section, figure 1, 5 from Deveciler (2014), figure 2-4 from Sirel and Deveciler (2018);

Figure 1- Equatorial section of B-form (Cyzd17-6).

Figure 2- Equatorial section of A-form (ka6/3).

Figure 3- Equatorial section of A-form (ka5/2).

Figure 4- Axial section of A-form (ka/7).

Figure 5- Axial section of B-form (Cyzd17-8).

Nummulites polygyratus Deshayes, 1838; all figures from middle-late Cuisian of Çayraz section, figure 6, 11 from Deveciler (2014), figure 7-10 from Sirel and Deveciler (2018);

Figure 6- Equatorial section of B-form (Cyzd9/18).

Figure 7- Equatorial section of A-form, (Ç. 17/6).

Figure 8- Equatorial section of A-form, (Ç. 17/7).

Figure 9- Equatorial section of A-form, (Ç. 17/8).

Figure 10- Equatorial section of A-form, (Ç. 17/9).

Figure 11- Axial section of B-form (Cyzd12/31b).

PLATE - III

PLATE - IV

Nummulites distans Deshayes, 1838; all figures are from middle-late Cuisian of Çiçekdağ region, compiled from Sirel and Deveciler (2018);

Figrue 1- Equatorial section of B-form (K-11).

Figure 2- Axial section of B-form showing central knob (K-12).

Figure 3- Axial section of B-form (K-4).

Figure 4- Equatorial section of B-form (K-13).

Figure 5- Lateral view of A-form (K-5).

Figure 6- Equatorial section of A-form (K-8).

Figure 7- Equatorial section of A-form (K-6).

Figure 8- Equatorial section of A-form (K-8).

Figure 9- Axial section of A-form (K-9).

Figure 10- Axial section of A-form (K-10).

PLATE - IV

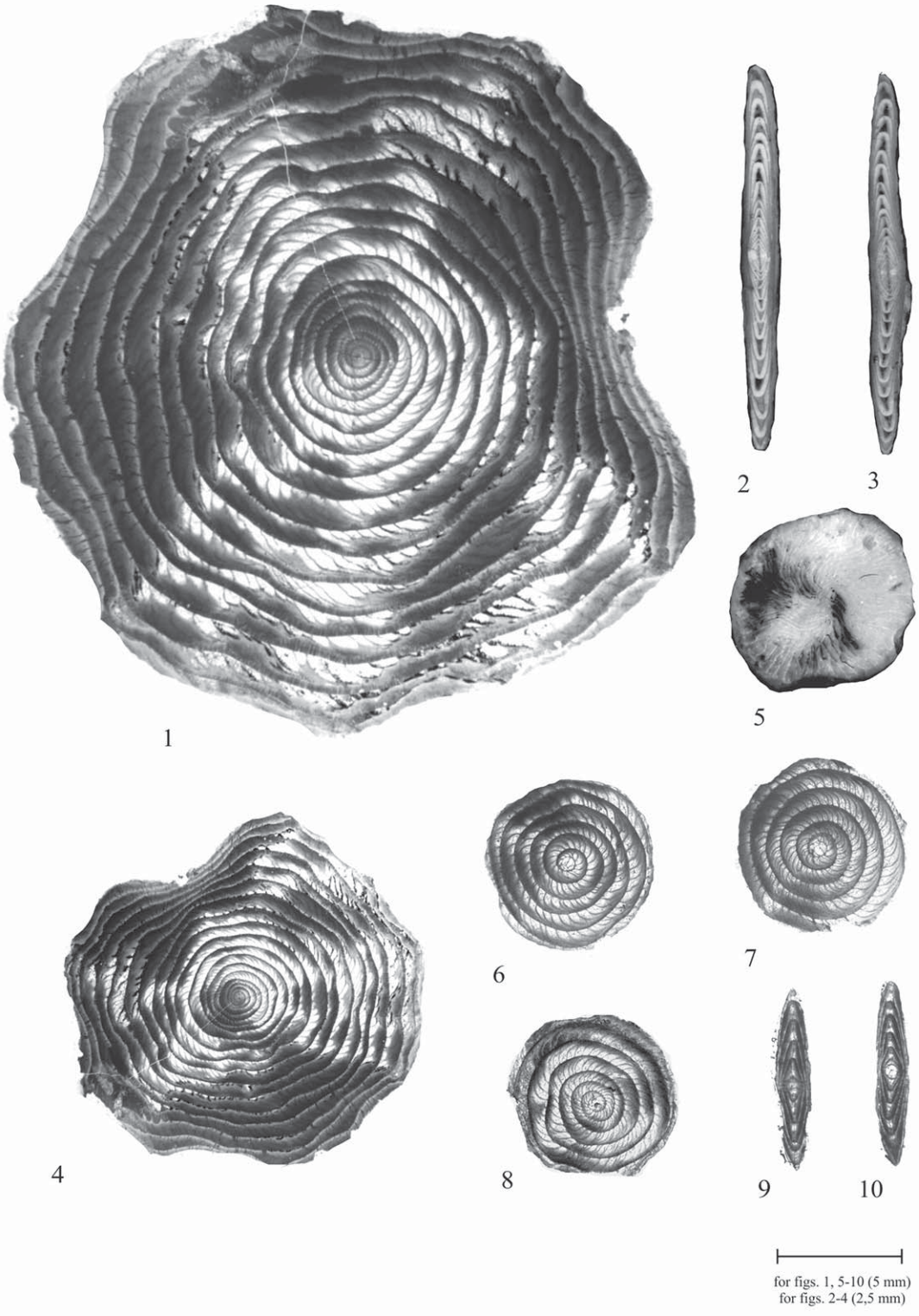

PLATE - V

Nummulites pratti d'Archiac and Haime, 1853; all figures are from middle-late Cuisian of Çiçekdağ region, compiled from Sirel and Deveciler (2018);

Figure 1- Equatorial section of B-form (Y-11).

Figure 2- Axial section (Y- 14).

Figure 3- External shape, showing turbulonant septal flaments (Y-17).

Figure 4- Equatorial section of A-form, (Y-15).

Figure 5- Axial section of A-form (Y-16).

Figure 6- Equatorial section of A-form (Y-12).

Figure 7- Equatorial section of A-form (Y-18).

PLATE - V