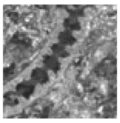
Refinements in biostratigraphy of the foraminiferal zone MFZ11 (late early Viséan, Mississippian) in the Cebeciköy Limestone (İstanbul Terrane, NW Turkey) and palaeogeographic implications

Cengiz Okuyucu, Daniel Vachard & Mehmet Cemal Göncüoğlu



The Cebeciköy Limestone from the Variscan flysch of the İstanbul Terrane is assigned to the foraminiferal MFZ11 zone (late early Viséan, formerly V2a). This zone is essentially the range zone of *Uralodiscus rotundus*. Additional bioevents are proposed for characterizing the upper part of this biozone (MFZ11B subzone): the LAD of *Eoendothyranopsis* and the FAD of *Pararchaediscus* and *Conilidiscus*. The majority of foraminifers and algae, belonging locally to MFZ11 are well-known, except for the following taxa: *Issinella luteotubulifomis* sp. nov., *I. enormis* sp. nov., *Vicinesphaera parasqualida* sp. nov., *Planogloboendothyra modesta* sp. nov. and *Endothyra irinaeformis* sp. nov. The Istanbul Terrane is connected with the southern branch of the Palaeotethys, whereas the Zonguldak Terrane is connected with the northern branch of this one. • Key words: Viséan, Turkey, İstanbul Terrane, foraminiferal zone MFZ11, biostratigraphy, foraminifers, algae incertae sedis, systematics, palaeogeography.

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The closure of the Rheic Ocean during the Middle-Late Palaeozoic in Europe resulted in the formation of the Variscan Belt. In western and central Europe, the rock units of this belt and their stratigraphic features have been studied in detail. Towards eastern Europe, the Variscan Belt can be followed in the Balkan (Yanev 1993, 1997, 2000), NW Anatolian (Göncüoğlu *et al.* 1997, 2006) and Caucasian (Yanev & Adamia 2010) terranes (Fig. 1). In NW Anatolia, Variscan successions are known since the mid 19th century as the "Palaeozoic of İstanbul" (Verneuil 1836–1837, Strickland 1840, Tschihatcheff 1854). The Mississippian limestones are widespread in Turkey (*e.g.*, Çatal *et al.* 1978, Lys 1988, Leven & Okay 1996, Görür *et al.* 1997, Kalvoda 2003). The Viséan foraminifers and algae are relatively well-known in southern Turkey (Güvenç 1965, Altıner 1981, Altıner & Özgül 2001, Okuyucu & Vachard 2006, Göncüoğlu *et al*. 2007) but their knowledge remains poor in central and northern Turkey (Kaya & Mamet 1971; Dil 1975, 1977; Dil *et al.* 1977; Caridroit *et al.* 1997; Pille *et al*. 2010).

In the İstanbul Terrane, the Cebeciköy Limestone yielded the oldest precise dating (Kaya & Mamet 1971), with the characterization of "V2a" foraminifers. The V2a, originally defined as a middle Viséan division, is currently connected with the late early Viséan. Our goals in this paper have been: (1) to provide a detailed analysis of the foraminifers and algae of Cebeciköy; (2) to verify that the Cebeciköy Limestone contained the MFZ11 biozone (Poty *et al*. 2006, Hance *et al.* 2011) corresponding roughly to the ancient "V2a"; (3) to revise the eponymous locality of Cebeciköy in order to provide a new detailed analysis of this biozone; (4) to discuss if the subzonation into MFZ11A and MFZ11B existed also locally; (5) to provide some elements of a palaeogeographical analysis of the northern terranes of Turkey.

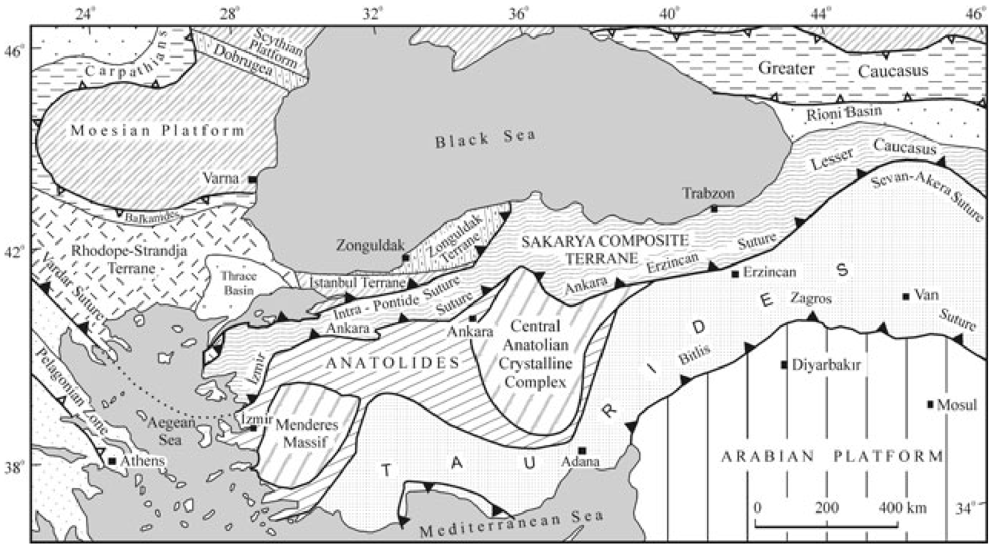


Figure 1. Geological map of Turkey and surrounding area (modified after Göncüoğlu *et al.* 1997 and Okay & Tüysüz 1999).

Geological setting of Cebeciköy Limestone

The oldest Palaeozoic successions of the İstanbul Terrane are Early? Ordovician fluviatile (Kocatöngel and Kurtköy formations) to lagoonal sediments (Kaya, unpublished TPAO report 1982, Özgül 2012). The earliest marine transgression (Aydos Formation) occurred during the end-Ordovician. Its platform margin environments prevailed up to the late Middle Devonian (Fig. 2: Gözdağ, Dolayoba, Istinye and Kartal formations). The macrofaunal and microfaunal data of this period indicate that the palaeogeographic position of the İstanbul Terrane remained unchanged compared to the Central European Variscan basins (Haas 1968, Kalvoda *et al.* 2003, Dojen *et al.* 2004, Yanev *et al.* 2006). From Late Devonian onwards, a rapid subsidence and deposition of slope-type sediments (Fig. 2, Büyükada Fm.) started (Önalan 1981). The latest Devonian–earliest Carboniferous interval is characterized by deposition of radiolarian cherts (Göncüoğlu *et al.* 2004, Noble *et al.* 2008) in basinal conditions (Fig. 2, Ayineburnu Formation). They are followed by a rapid shallowing-upward sequence, composed of plant-bearing proximal turbidites (Kaya 1969, 1971). They grade into a more than 2000 m-thick succession of flyschoid sediments of the Trakya Formation, originally named as the "Thrazische Serie" by Penck (1919). Except for a few Lower Carboniferous foraminifers found in shally lenses (Kaya & Mamet 1971) in the lower part of the formation, these mass-flow deposits are barren. The only age data had been obtained from the randomly distributed carbonate lenses named as the Cebeciköy Limestone Member (Yalçınlar 1951, 1954).

In this study, the stratigraphy, depositional features as well as the foraminiferal content of the Cebeciköy Limestone in its type locality to the west of Bosphorus (Fig. 3) will be reviewed and correlated with other limestone occurrences east of the Bosphorus. It should be noted, however, that the original succession described by Yalçınlar (1954) has been completely quarried and his fossil collection is no longer available. Thus, the recently sampled section very probably differs in lithological detail and also in the exact age of the upper and lower boundaries from the earlier one. The distribution of foraminiferal fauna and systematic positions are revised and compared with the published data of the Cebeciköy Limestone. Finally, the fossil content of these intra-flysch deposits is compared with that of the coeval formations in central and western Europe and Alborz (Iran) to search for a palaeogeographic/palaeobiogeographic relationship.

Lithostratigraphy. – The Trakya Formation, in general, comprises a very thick package of turbiditic sandstones and siltstones with minor conglomerate and shale interlayers, and a limestone member (Fig. 2, Cebeciköy Limestone). The formation, with lateral facies changes, covers vast areas on both sides of the Bosphorus. Özgül *et al.* (2005) subdivided it into four members; from bottom to top: 1) Acıbadem Mb., 2) Cebeciköy Limestone Mb., 3) Kartaltepe Mb., and 4) Küçükköy Mb. (Fig. 2).

The Acıbadem Mb. consists of silty shales with thin siltstone and fine-grained sandstone interlayers and is transitional to the underlying radiolarian cherts with phosphate nodules (Baltalimanı Fm). The nodules, rich in radiolarians, were recently dated as "middle to late" Tournaisian by Noble *et al*. (2008), although these stratigraphic subdivisions are now obsolete in the stratotypic Belgian area (Poty, pers. com.). Regionally, it is better developed on the east side of the Bosphorus, with a type locality situated in Acıbadem (Kaya 1971). In the Gebze-Denizliköy area, it shows a 2–15 cm thick ostracod-rich black limestone with shale interlayers (Göncüoğlu *et al.*, unpublished MTA report, 2006). Upwards, it is represented by greenish-grey muscovite-rich quartz-arenites with laminar siltstone. In

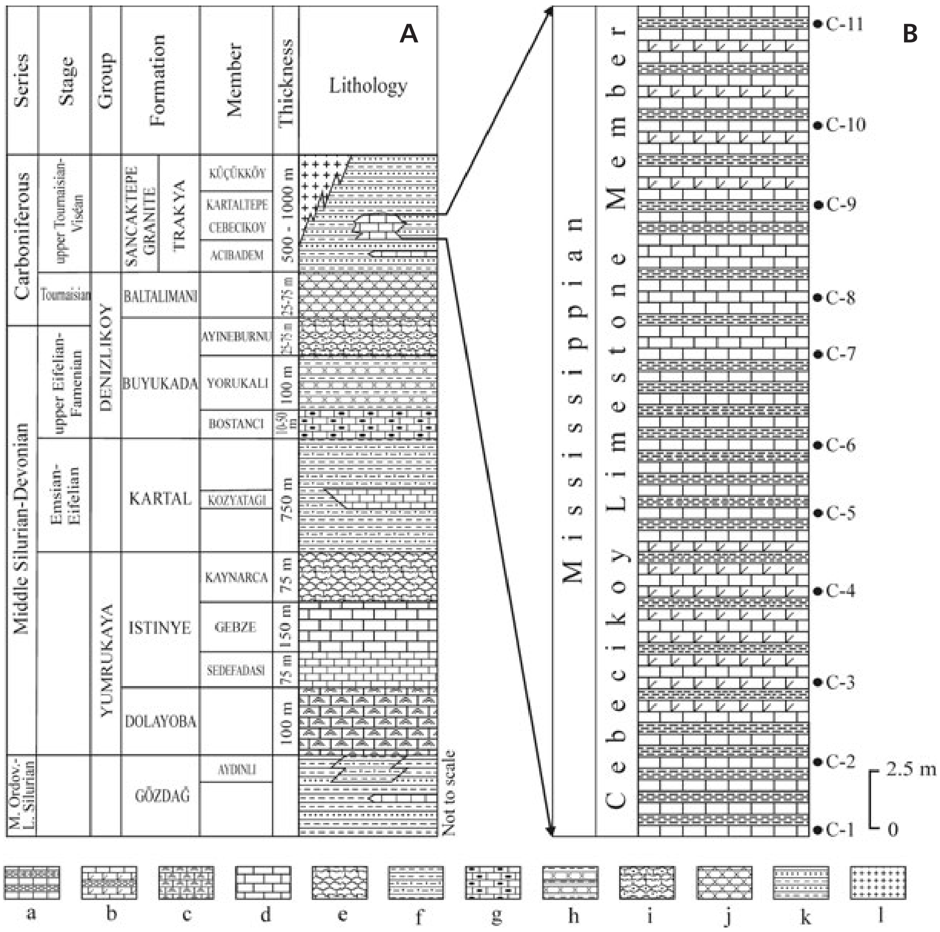


Figure 2. A – Silurian-Carboniferous series of the İstanbul Terrane (after Gedik *et al.*, unpublished MTA report, 2005, Özgül *et al.* 2005, Göncüoğlu *et al.* 2006). • B – measured section of Cebeciköy Limestone Member with sample locations. Legend: a – shale and limestone alternation; b – limestone, dolomitic limestone and shale alternation; c – reefal limestone; d – limestone; e – thick nodular clayey limestone and shale; f – shale, sandstone and limestone alternation; g – cherty limestone; h – siliceous shale and chert alternation; i – thin nodular limestone and shale alternation; j – radiolarite with nodular phosphate, chert and shale; k – turbiditic sandstone and shale; l – granites.

Gebze-Denizliköy Dam section, the silty laminae include plant remains (*Cyclostigma hercynicum*; det. Yanev). The thickness of the member varies from 90 m (Kaya 1971) to 200 m (Özgül *et al.* 2005).

The development of the overlying Cebeciköy Limestone Mb. is variable in the E and W of the Bosphorus. In the E, in Plastik Sanayi, it occurs as a 4–5 m thick package of dark grey to black limestone and dolomitic limestones with siltstone interlayers. In the W, in its eponymous type locality, the Cebeciköy Limestone Mb. covers an area of 3.5 km^2 and is more than 60 m-thick according to the unpublished reports of the Limestone Quarrying Company (Fig. 3). The succeeding Kartaltepe Mb., initially named by Kaya (1971), is mainly represented by thin-bedded siliceous shales and laminated lydites. It occurs as irregularly distributed, up to 30 m-thick bands and lenses within the Küçükköy Mb., where the coarser grained turbiditic sandstones gradually grade into shales. In the vicinity of Cebeciköy, this member is dominated by beige-coloured shales and mudstones.

The Küçükköy Mb. represents the main body of the Trakya Fm. and comprises mica and quartz-rich, coarse- to medium-grained turbiditic sandstones, greywackes, siltstones and shales. It conformably overlies the Acıbadem Mb. and is unconformably overlain by continental clastics of the Triassic Kapaklı Fm. The Küçükköy Mb. includes medium- to coarse-grained channel-fill-type conglomerates in different stratigraphic positions. The pebbles are dominated by quartz-arenite, quartzite, arkose, lydite, metamorphic and rhyolitic rock fragments together with mineral clasts such as igneous and metamorphic quartz and feldspars. Flute-casts, load-casts and laminations are common features. The member is affected by deformation and includes open to tight folding.

Microfacies. – The microfacies are composed of bioclastic packstone (C1, C8–C11), bioclastic wackestone (C5–C7) and poorly fossiliferous dolomicrosparite (C2–C4). Among the bioclasts, cyanobacteria are very rare, true green and red algae absent, moravamminids always frequent, aoujgaliids rare or very rare, and foraminifers always present, more or less diversified and abundant (Fig. 4).

Therefore, these microfacies display a mixed character between heterozoan and photozoan assemblages. Three explanations can be proposed: (1) There are influxes of cool deep water currents (James 1997, Samankassou 2002) on a subtropical to warm temperate (30–40° of latitude) shallow carbonate platform (Gallagher 1998, Pille 2008). (2) These assemblages might be typical of the pre-LPIA (Late

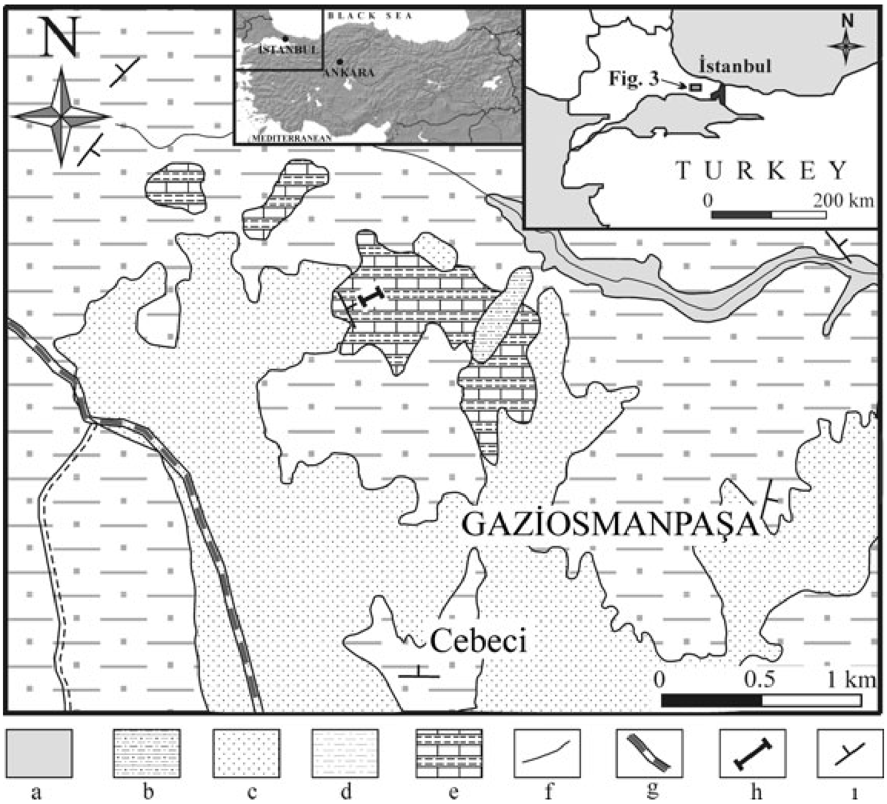


Figure 3. Geological map of the study area (simplified after Gedik *et al*., unpublished MTA report, 2011). Legend: a – Alluvium, b – Belgrad Formation (Plio-Quaternary); c – Güngören Formation (Upper Miocene), d – Trakya Formation (upper Tournaisian–Viséan), e – Cebeciköy Limestone Member (late early Viséan), f – stream, g – main road, h – line of logged section, i – bedding.

Palaeozoic Ice Age) period, where the climate was poorly characterized (Kalvoda 2002) and/or the photozoan carbonate factory with foraminifers occupied a narrow belt (Kalvoda *et al.* 2011). (3) The assemblages are greatly influenced by the first regional phase of cooling of this LPIA, coevally identified in northern Iran (Termier *et al.* 1977).

The biozone MFZ11 and its subdivisions

The biozone MFZ11 of Poty *et al.* (2006) is situated between the base of the range-zone of *Uralodiscus rotundus* and the base of the interval-zone of *Pojarkovella nibelis* (Durkina). The foraminiferal guide-fossil is *Uralodiscus rotundus* or occasionally the assemblage of *Uralodiscus rotundus* and *Viseidiscus primaevus* (*e.g*., Kagarmanov & Donakova 1990, Einor 1996). In the Belgian stratotypes, MFZ11 is represented by the Neffe Limestone (Conil & Naum 1976, Conil *et al.* 1977, Hance 1988).

The definition of MFZ11 is more precise than that of previous subdivisions, more or less synonymous. The Subzone Cf4δ (Conil *et al.* 1991), Zone 12 (Mamet & Skipp 1970, Mamet 1974), Zone 10 (Kalvoda 1983), Zone 3.3.13 (Kalvoda 2002), Arundian (which covers in fact MFZ10 and MFZ11; Poty, personal communication), late Moliniacian, Bobrikovsky, Ilychsky, Ust-Grekhovsky, Karakiinsky, and Shishikhinsky regional stages and substages in England, Belgium and Russia, as well as the base of the Jiusi Formation in South China, are more or less equivalent (Malakhova 1975; Mikhno & Balakin 1975; Kagarmanov & Donakova 1990; Marfenkova 1991; Einor 1996; Kalvoda 1999; Kulagina *et al.* 2003; Hecker 2002, 2009; Hance *et al*. 2011). The subzones $C_1{}^vd_1$-$C_1{}^vd_2$ of Ukraine are also more or less contemporaneous (Vdovenko 1980, 2001; Hecker 2009; Davydov *et al.* 2010).

The radiometric age of MFZ11 can be currently established between *ca* 345 and 344 My (Menning *et al.* 2006, Davydov *et al.* 2010).

The biozone MFZ 11 is also characterized by numerous FAD (first appearance datum) and LAD (last appearance datum) of foraminifers: (1) LAD of *Eoendothyranopsis*; (2) FAD of *Paraarchaediscus*; (3) FAD of various subspecies of *Uralodiscus rotundus*; (4) FAD of *Cribranopsis*; (5) FAD of *Conilidiscus*; (6) LAD of *Eoparastaffella*; (7) LAD of *Pseudolituotubella*; (8) LAD of *Condrustella*; (9) LAD of *Eotextularia* (Hance *et al.* 1994, 2011; Poty *et al.* 2006). The MFZ11 algae in Belgium are marked by: (1) a general rarity of the codiaceans, dasycladaceans and solenoporaceans (Hance 1988, Devuyst 2006); (2) the FO of bilayered *Koninckopora* (Conil & Groessens 1974, Hance 1988, Hance *et al.* 1994); (3) the abundance of *Luteotubulus* and absence of true *Issinella* (Hance 1988, Vachard 1994); (4) a lineage of *Palaeoberesella* to *Exvotarisella* is poorly documented.

Recent data in South China (Hance *et al.* 2011) permitted to subdivide MFZ11 in two subzones MFZ11A and

MFZ11B; the second of which is characterized by the FAD of rare *Pojarkovella* sp. The FO (first occurrence) of this genus in Belgium, with the species *P. nibelis* (Durkina), is an index of the MFZ12 zone. Some other references confirm this FO of *Pojarkovella*, before its acme-zone, in Tarim and Alborz (Brenckle 2004: sample 3, Brenckle *et al.* 2009: sample 807).

The biozone MFZ11 in Cebeciköy. – In Cebeciköy, we found the following markers of the stratotypic Belgian area: *Uralodiscus rotundus*, *Eotextularia diversa*, *Paraarchaediscus*, *Conilidiscus*, *Pseudolituotubella*, *Eoendothyranopsis*, *Eoparastaffella*, *Spinoendothyra*, and *Endospiroplectammina* (Fig. 4). Conversely, some important Belgian taxa (Hance 1988, Conil *et al.* 1989, Hance *et al*. 1994, Devuyst *et al.* 2006) are absent in Cebeciköy: *Eogloboendothyra* or true *Globoendothyra*, *Pseudolituotuba*, *Spinobrunsiina* (= ?*Pseudoplanoendothyra*), *Paraendothyra*, *Granuliferella*, *Latiendothyranopsis menneri solida* (Conil & Lys), *Endolaxina laxa* (Conil & Lys) emend. Hance, Hou & Vachard, *Urbanella* (*Brenckleites*) *fragilis* (Lipina) emend. Hance, Hou & Vachard, *Florennella*, *Dainella*, *Bessiella* and *Valvulinella*. Except for *Dainella* and *Pseudoplanoendothyra*, the Cebeciköy assemblages have many common taxa with the Orenburg area of Russia (Kulagina *et al.* 1988).

The foraminiferal assemblages summarized herein (Fig. 4) differ from those identified by Kaya & Mamet (1971) in the Cebeciköy Limestone. In fact, these latter authors dated equivalents of zones MFZ12 and MFZ13. Probably, most of parts of these possible MFZ12 and MFZ13 levels of Cebeciköy Limestone were completely destroyed because of quarry works. However, our assemblages are relatively similar to that indicated by Mamet (1973) for a Heybeliada Limestone assigned by this author to the middle early Viséan (*i.e*., MFZ10 *sensu* Poty *et al.* 2006). Consequently, some mistakes in the field-sampling and or thin/sections numbering occurred probably during the ancient studies.

As the archaediscids are absent in the eponymous localities of the MFZ11B subzone in South China, we propose, thanks to our Cebeciköy data, to add the FAD of *Paraarchaediscus* and *Conilidiscus* (Fig. 5) as a characteristic of the base of MFZ11B in western and central Palaeotethys. Three data confirm this interpretation: (1) The joint occurrence of *Pojarkovella* and *Uralodiscus* was reported in Moravia by Kalvoda (1990), (2) in Tarim (NW China), Brenckle (2004; text-fig. 3) indicated coeval FO of *Pararchaediscus* and *Pojarkovella* (in his samples 2 and 3), (3) in Alborz (N Iran), a FO of *Pojarkovella* is located between the FO and LO of *Uralodiscus* (Brenckle *et al.* 2009, text-figs 7, 8). Finally, the FAD of *Pojarkovella* sp. can currently characterize the base of MFZ11B in eastern Europe and Middle and Far-East; those of *Paraarchaediscus* spp. and *Conilidiscus* spp. characterize this one in Europe and Near-East, where the migration of *Pojarkovella* is delayed.

Correlatively with these FAD of *Paraarchaediscus* and *Conilidiscus*, the assemblages of Cebeciköy indicate that the LAD of *Eoendothyranopsis* occurs probably near or at the MFZ11A-MFZ11B boundary (Fig. 5).

Among the algae, the bilayered *Koninckopora* are not present in Cebeciköy. True *Issinella* dwelt in Turkey, whereas they are replaced by *Luteotubulus* in Belgium in MFZ11 (Vachard 1994, Hance 1988). The lineage of *Palaeoberesella* to *Exvotarisella* might provide another biostratigraphic criterion in Turkey, due to its relative richness; nevertheless, the distribution of the *Palaeoberesella lahuseni-Exvotarisella index* assemblage in Russia spreads over a long interval of time, including the MFZ11 and MFZ12 equivalents (Ivanova & Bogush 1992).

In the Central Tauride Belt (southern Turkey), the biozones VT2a and VT2b (Altıner & Özgül 2001) might correspond to MFZ11A-B; indeed, they contain particularly *Uralodiscus rotundus*, *Latiendothyranopsis menneri solida*, (*Para*?)-*archaediscus*, *Eoparastaffella simplex*, *Pseudolituotubella* sp., and *Eotextularia diversa*. Nevertheless, they are followed by the biozone VT3, which still contains *Latiendothyranopsis menneri solida*, *Uralodiscus rotundus*, *Paraarchaediscus* and *Eoparastaffella simplex*. If some *Uralodiscus* persist in MFZ12 in South China with many species of *Archaediscus* at concavus stage and rare species at involutus stage (Hance *et al.* 2011), the LAD of *Eoparastaffella simplex* is everywhere located at the top of MFZ11. Consequently, we suggest that VT2a is coeval with MFZ11A, and VT2b+VT3 coeval with MFZ11B.

Systematic palaeontology

Abbreviations. – L – length, H – height, D – outer diameter, d – inner diameter, s – wall thickness, w – width, w/D – ratio width to outer diameter, p – proloculus diameter, n – number of whorls, h – height of last whorl or last chamber.

Algae incertae sedis

Class Algospongia Termier, Termier & Vachard, 1977 emend. Vachard & Cózar, 2010
Order Moravamminida Pokorny, nom. translat. Termier, Termier & Vachard, 1975, emend. Vachard & Cózar, 2010
Suborder Moravamminina Pokorny, 1951, nom. translat. Vachard & Cózar, 2010
Family Issinellidae Deloffre, 1987, emend. Vachard & Cózar, 2010

Genus *Issinella* Reitlinger, 1954, emend. Vachard & Cózar, 2010

Type species. – Issinella devonica Reitlinger, 1954.

TAXA	SAMPLES										
	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11
Girvanella wetheredii Chapman, 1908					ε			ε			
Issinella ex gr. *devonica* Reitlinger, 1954	+	+	+	+	ε	+	+	ε		ε	
Issinella luteotubuliformis sp. nov.									++	+	
Issinella enormis sp. nov.											++
Evlania scabrosa Vachard, 1980									ε	ε	
Pseudokamaena cf. *armstrongi* Mamet *in* Petryk & Mamet, 1972	ε							ε			
Kamaena pirleti Mamet & Roux, 1974	+	+	+	+				ε	+		
Palaeoberesella lahuseni (Möller, 1879) Mamet & Roux, 1974	+	+	+	+	ε	ε	ε	ε	+	ε	
Palaeoberesella sp. 1	ε				ε		ε				
Exvotarisella index (Ehrenberg, 1854, emend. Möller, 1879) Mamet & Roux, 1974	+	+	+	+	ε		ε	ε		ε	ε
Stacheoides cf. *tenuis* Petryk & Mamet, 1972	ε					ε		ε	ε		
Calcisphaera grandis (Lipina, 1950)								ε	ε	ε	ε
Radiosphaera ponderosa Reitlinger, 1960	ε					ε			ε		
Eotuberitina reitlingerae Miklukho-Maklay, 1958	ε				+	ε	+	ε			
Vicinesphaera parasqualida sp. nov.	++				+	ε	+	ε	ε	ε	+
Brunsia pulchra Mikhailov, 1939	+					ε	+		ε		
Brunsia spirillinoides (Grozdilova & Glebovskaya, 1948)	+					ε	ε		ε	ε	+
Uralodiscus rotundus rotundus (Chernysheva, 1948a)	+					ε	+	ε	ε	ε	
Uralodiscus rotundus elongatus (Conil & Lys, 1964)	+				ε	ε			ε	ε	
Uralodiscus rotundus inflatus (Conil & Lys, 1964)	+				+	+		ε		ε	ε
Uralodiscus rotundus vastus (Popova, 1970)									ε	ε	ε
Conilidiscus cf. *bucculentus* (Conil & Lys, 1964)									ε	ε	
Paraarchaediscus cf. *sumsariensis* (Skvortsov, 1965)					+						
Paraarchaediscus regularis (Brazhnikova & Vdovenko, 1973)										ε	
Paraarchaediscus aff. *pauxillus* (Shlykova, 1951)					ε						
Earlandia ex gr. *elegans* (Rauzer-Chernousova & Reitlinger *in* Rauzer-Chernousova & Fursenko, 1937)	+				+		ε				
Earlandia ex gr. *minor* (Rauzer-Chernousova, 1948b)	+				+	ε	+				+
Earlandia ex gr. *vulgaris* (Rauzer-Chernousova & Reitlinger *in* Rauzer-Chernousova & Fursenko, 1937)	ε				ε	ε					ε
Magnitella cf. *agapovensis* (Ivanova, 1988)						ε	ε	ε	ε	ε	
Baituganella ex gr. *vulgaris* Lipina, 1955	ε										
Forschia parvula Rauzer-Chernousova, 1948b	ε				+	ε	+			ε	

Figure 4. Microfauna and microflora of the Cebeciköy Member (to be continued on p. 7). For sample location see Fig. 2.

Diagnosis. – Small or medium sized tubular thallus, rarely bifurcated rarely bearing diaphragms. Wall yellowish, homogeneous (not maculate) with relatively numerous, aspondyl, acrophore perpendicular canalicules.

Remarks. – Some *Issinella* show rare diaphragms: *I. luteotubuliformis* sp. nov., *I.*? *ilychensis* Ivanova, 1988 and *I. devonica* (*sensu* Mamet & Roux, 1981, pl. 1, figs 6, 7 and *sensu* Bogush *et al*., 1990, pl. 12, fig. 9). *Luteotubulus* Vachard *in* Vachard *et al.*, 1977, emend. Vachard, 1994 differs by relatively common diaphragms, a maculate wall and more numerous thinner, filiform, curved canalicules in the wall.

Occurrence. – Early Devonian–late Serpukhovian; cosmopolitan.

***Issinella* ex gr. *devonica* Reitlinger, 1954**
Figures 6A, 9, 7A–C, 9I, 11, 12T, 13B

Discussion. – Three criteria separate our material from true *I. devonica*: (a) different dimensions (L = 1.000–1.670 mm, D = 0.125–0.350 mm, d = 0.070–0.150 mm, s = 0.015–0.050 (rarely 0.070) mm; the wall is notably thicker); (b) a specimen seems to show ramified canalicules (Fig. 6C); (c) the type material of *I. devonica* comes from the late Frasnian and the identifications of this species in the Early Carboniferous are generally erroneous (Mamet & Roux 1981, Vachard & Cózar 2010). *Issinella grandis* Chuvashov, 1965, another species mentioned in the Viséan (Bogush *et al.* 1990), is larger.

Occurrence. – MFZ11A-B of Cebeciköy.

TAXA	SAMPLES										
	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11
Viseina? sp.					ε						
Planogloboendothyra modesta sp. nov.	+										
Pseudolituotubella orientalis (Chernysheva *in* Dain, 1953)	+				+	ε	+				
Pseudolituotubella aff. *tschernyshevi* (Dain, 1953)	ε				+						
Condrustella cf. *modavensis* (Conil & Lys, 1967)					ε	ε	ε				
Eotextularia diversa (Chernysheva, 1948b)	ε				ε	ε	ε	ε			
Eotextularia cf. *mongeri* Mamet *in* Mamet *et al.*, 1970	ε										
Endothyra prisca Rauzer-Chernousova *in* Rauzer-Chernousova *et al.*, 1936	ε							+			
Endothyra praesimilis (Lin, 1981)	ε				ε						
Endothyra similis amplis Shlykova, 1951	+				ε	ε	ε		+		
Endothyra similis inops (Conil & Lys, 1964)	+				+	+	ε	ε	+		ε
Endothyra paraprisca Shlykova, 1951	+				ε	+	+		+	ε	
Endothyra irinaeformis sp. nov.	ε										
Endothyra acantha (Conil & Lys, 1964)							ε				
Endothyra gratiodentalis (Lin, 1981)							ε				
Endospiroplectammina cf. *conili* Lipina, 1970	ε					ε	ε				
Mediendothyra barzassiensis (Lebedeva, 1954)	+				+	+	+	+	+	ε	
Omphalotis aff. *involuta* (Brazhnikova, 1956)	ε				+	ε	+	+	ε		
Omphalotis cf. *parasamarica* (Bogush & Yuferev, 1962)								+	+		ε
Inflatoendothyra aff. *multispira* (Simonova, 1975a)	?						ε				
Latiendothyranopsis? cf. *menneri* (Bogush & Yuferev, 1960)						ε					
Plectogyranopsis convexa (Rauzer-Chernousova, 1948a)	ε				ε	+	ε				
Plectogyranopsis ampla (Conil & Lys, 1964)	ε						ε				
Plectogyranopsis cf. *dendrei* (Conil & Lys, 1964)							ε				
Eoendothyranopsis? cf. *ermakiensis* (Lebedeva, 1954)	+										
Eoendothyranopsis donica tumefacta Postoyalko, 1975	+										
Tetrataxis immatura Grozdilova & Lebedeva, 1954	+				ε	ε	ε		ε	ε	
Tetrataxis aff. *angusta* Vissarionova, 1948					ε	ε			ε		ε
Tetrataxis bogushi Ueno & Nakazawa, 1993					ε				ε	ε	
Tetrataxis cf. *quasiconica* Brazhnikova, 1956	ε									ε	
Mediocris breviscula (Ganelina, 1951)	ε							ε			
Eoparastaffella simplex lata Vdovenko, 1971	ε					ε	ε	+			
Eoparastaffella simplex ovalis Vdovenko, 1954	+				ε	ε	+	ε	ε	ε	ε

***Issinella luteotubuliformis* sp. nov.**
Figures 6B, C, E, 7D–F

Etymology. – Similar to *Luteotubulus* by its diaphragms but different by its type of wall and perforations.

Holotype. – Fig. 6.3, sample C-9(5).

Type horizon. – Late early Viséan (MFZ11B).

Type locality. – Cebeciköy (NW Turkey).

Diagnosis. – This unquestionable *Issinella* (because of the type of perforations) is characterized by its medium size and rare individuals with diaphragms.

Description. – Test regularly cylindrical, medium-sized. Perforations acrophore relatively wide. Some bifurcated thalli show an angle of *ca* 120° (Fig. 6B). One to four micritic diaphragms per tube; or very rare yellowish diaphragms (Fig. 7E). Inner surfaces always smooth; outer surfaces very rarely faintly serrated (ontogenetically, not diagenetically by stylolitization). No constrictions. Wall homogeneous, yellowish. L = (rarely 0.750)–1.250–4.750 mm, D = (0.215)–0.250–0.500 mm, d = (0.135)–0.185–0.400 mm, s = (0.030)–0.060–0.120 mm.

Material. – Approximately 250 specimens.

Repository of the types. – University Lille 1 collection (USTL1/1097).

Discussion. – This new species differs from *I.* ex gr. *devonica* by larger dimensions; from *I. enormis* sp. nov. by

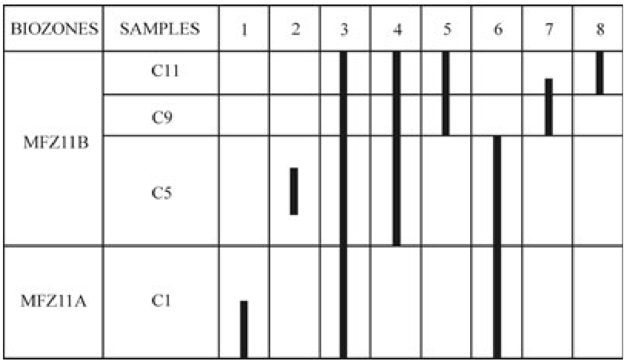


Figure 5. Main markers of the subbiozone MFZ11A and MFZ11B in Cebeciköy (Turkey). • 1 – *Eoeodothyranopsis* ex gr. *donica*; 2 – *Latiendothyranopsis*? ex gr. *menneri*; 3 – *Uralodiscus*; 4 – *Pararchaediscus*; 5 – *Conilidiscus*; 6 – *Issinella* ex gr. *devonica*; 7 – *Issinella luteotubuliformis* sp. nov.; 8 – *Issinella enormis* sp. nov.

smaller dimensions; from *I.*? *ilychensis* by its larger dimensions, the angle of thallus bifurcation, and a more regularly cylindrical growth of the thallus. *Luteotubulus licis* (Malakhova, 1975) Vachard *in* Vachard *et al.*, 1977, whose dimensions are similar, has a maculate, slightly constricted and intensively perforated thallus.

Occurrence. – Type locality and type horizon.

***Issinella enormis* sp. nov.**
Figures 6D, 7G–I

Etymology. – Enormis, huge.

Holotype. – Fig. 6D, sample C-11(2).

Type horizon. – Late early Viséan (MFZ11B).

Type locality. – Cebeciköy (NW Turkey).

Diagnosis. – Huge *Issinella* with few canalicules in the wall and no diaphragms.

Description. – Test regularly cylindrical, but slightly undulating; enormous for the genus. Perforations very rare. No bifurcated thalli have been observed, nor diaphragms. No constrictions. Wall homogeneous, yellowish. L = 2.500 to 8.000 mm, D = 0.775 to 1.200 mm, d = (rarely 0.260)–0.385–0.820 mm, s = 0.150 to 0.325 (rarely 0.370) mm.

Material. – 120 specimens.

Repository of the types. – University Lille 1 collection (USTL1/1098).

Discussion. – This new species differs from *I.* ex gr. *devonica* and *I. luteotubuliformis* sp. nov. by its very larger dimensions, and from small corallites of syringoporids (Tabulata), by slightly undulating tubes (like the holotype) and some perforations in the wall.

Occurrence. – Type locality and type horizon.

Subphylum Foraminifera d'Orbigny, nom. translat. Cavalier-Smith
Class Fusulinata Möller, nom. translat. Gaillot & Vachard
Order Parathuramminida Bykova, nom. translat. Mikhalevich

Genus *Vicinesphaera* Antropov, 1950

***Vicinesphaera parasqualida* sp. nov.**
Figures 6F, 9J, K, R, 10H, 11G, 12U, 13D

Etymology. – Similar to *V. squalida* Antropov, 1950.

Holotype. – Fig. 10H, sample C-1.2[13/2(4)].

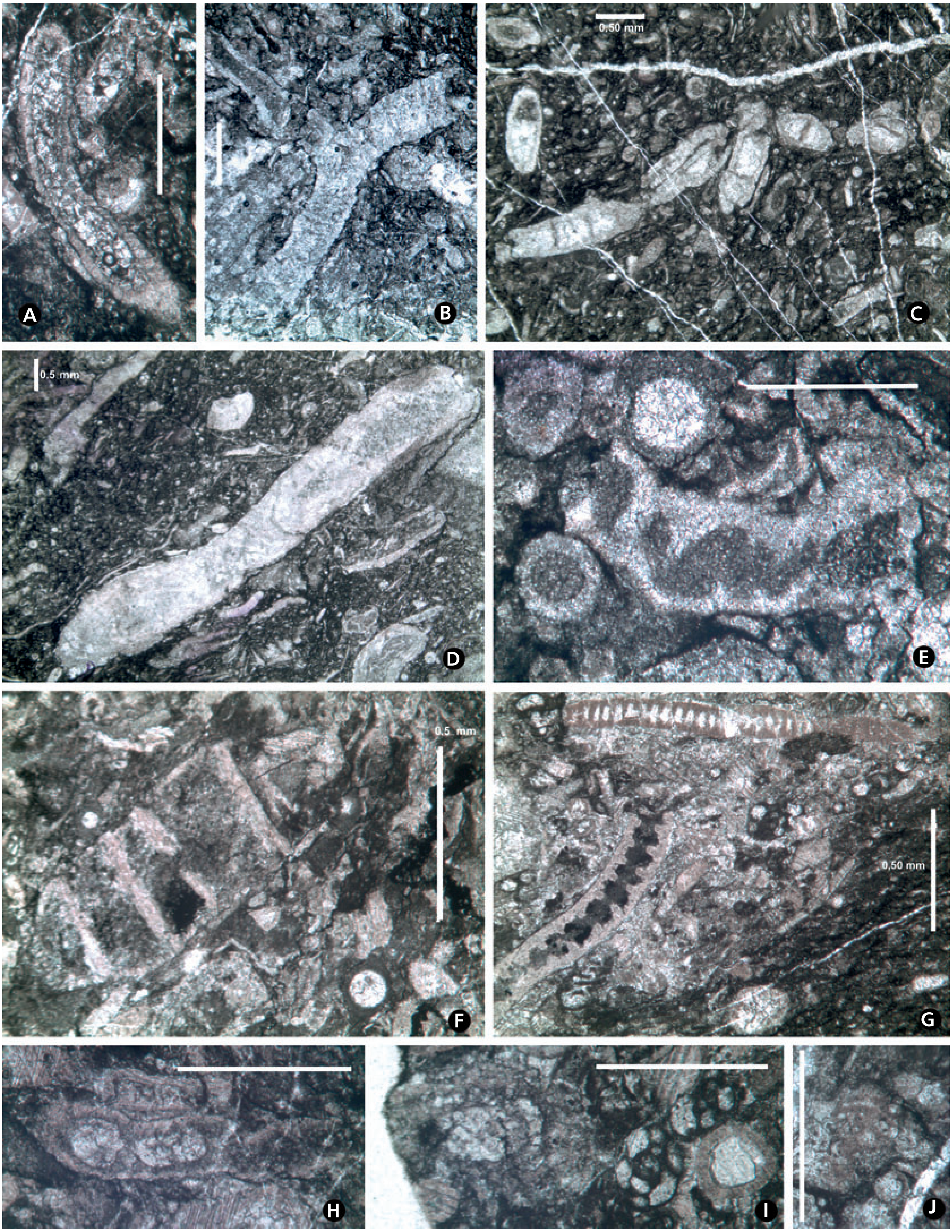
Type horizon. – Late early Viséan (MFZ11A).

Type locality. – Cebeciköy Limestone (NW Turkey).

Diagnosis. – A species of *Vicinesphaera* characterized by a relatively thin wall and few pyramidal protuberances. Occasionally, the wall displays a thin clear central layer.

Description. – The test measures a total length of 0.100–0.350 mm. The internal chamber is remarkably regular, spherical, wide and measures 0.040–0.180 mm. The wall shows two parts: (a) a regular envelope of the internal chamber, the thickness of which is 0.005–0.030 mm; (b) some protuberances, generally one or two per section, pyramidal, with a height of (rarely 0.010)–0.025–0.100 mm. The sections through the regular envelope (a) resemble a lot to *Calcisphaera*. The wall is microgranular, dark, homogeneous; nevertheless, rare specimens (including the holotype) show a very

Figure 6. Scale bars = 0.5 mm. For the authors of taxa of Figs 6–13, see Fig. 4. • A – *Issinella* ex gr. *devonica*. C-1.3(6). • B, C – *Issinella luteotubuliformis* sp. nov.; B – paratype. C-9.1(9), C – holotype. C-9(5). • D – *Issinella enormis* sp. nov., holotype. C-11(2). • E – *Evlania scabrosa* with four sections of *Issinella luteotubuliformis* sp. nov. (paratypes). C-9(1). • F – *Kamaena pirleti* with *Vicinesphaera parasqualida* sp. nov. (paratype; bottom, right?). C-1.3(19). • G – *Exvotarisella index* with *Palaeoberesella lahuseni* (top) and scattered *Endothyra similis amplis*. C-1(22). • H – *Pseudokamaena* cf. *armstrongi*. C-1(9). • I, J – *Stacheoides* cf. *tenuis*; I – left with *Endothyra prisca* (centre) and *Issinella* ex gr. *devonica* (right). C-1(27), 10 - C-9[3/2(1)].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thin, clear, central layer, similar to that of *Calcisphaera polydermoides* (Conil & Lys 1964). No apertures are obvious.

Material. – 52 specimens.

Repository of the types. – University Lille 1 collection (USTL1/1099).

Discussion. – Vicinesphaera squalida have a more homogeneously thicker wall of 0.020–0.060 mm (see Lipina 1955).

Occurrence. – MFZ11A-B of Cebeciköy.

Order Endothyrida Brady, nom. translat. Fursenko
Superfamily Tournayelloidea Dain, nom. translat. Dain *in* Rauzer-Chernousova & Fursenko, emend. Hance, Hou & Vachard
Family Globoendothyridae Reitlinger *in* Voloshinova & Reitlinger, nom. translat. Hance, Hou & Vachard
Subfamily Globoendothyrinae Reitlinger *in* Voloshinova & Reitlinger

Genus *Planogloboendothyra* Hance, Hou & Vachard, 2011

***Planogloboendothyra modesta* sp. nov.**
Figures 9P–R, 10A, 12T

?1980 *Globoendothyra* sp. – Conil *et al*., pl. 9, fig. 5.
?1982 *Globoendothyra* sp. 2. – Groessens *et al*., pl. 7, figs 150, 151.

Etymology. – Latin *modestus*, modest.

Holotype. – Fig. 10A, sample C-1.3(27).

Type horizon. – Late early Viséan (MFZ11A).

Type locality. – Cebeciköy (NW Turkey).

Diagnosis. – A species of *Planogloboendothyra* characterized by large test, compressed and biumbilicate; with few deviations of the coiling axis, except in the eventually excentred, last whorl.

Description. – The test is large with moderately numerous chambers, weakly oscillating coiling axes and asymmetrical semi-evolute last whorls, and broadly rounded peripheries. Proloculus spherical, relatively wide. There are up to 9 chambers in the last whorl, and they are well individualized although few inflated. Progressively enlarging, the successive chambers overlap partially the umbilical area, the test becoming nautiloid involute but remaining biumbilicate. In adult forms, the latest chambers are slightly inflated. In equatorial sections, the chambers appear subrectangular and vaulted whereas, in axial sections, they are oval, becoming kidney-shaped in the last whorls. Septa are moderately thick, slightly inclined forwards. The septa, as thick as the wall, straight, perpendicular to the spiral suture in equatorial section and curved, with a tangential approach to the spiral suture in more tangential sections. Sutures are prominent and incised. Supplementary deposits are represented by crustae and a terminal hook. The wall is relatively thick but moderately differentiated; it agglutinates scattered, poorly sorted fine-silt to silt-sized calcareous grains. The last whorl is deviated and slightly evolute. Aperture single basal.

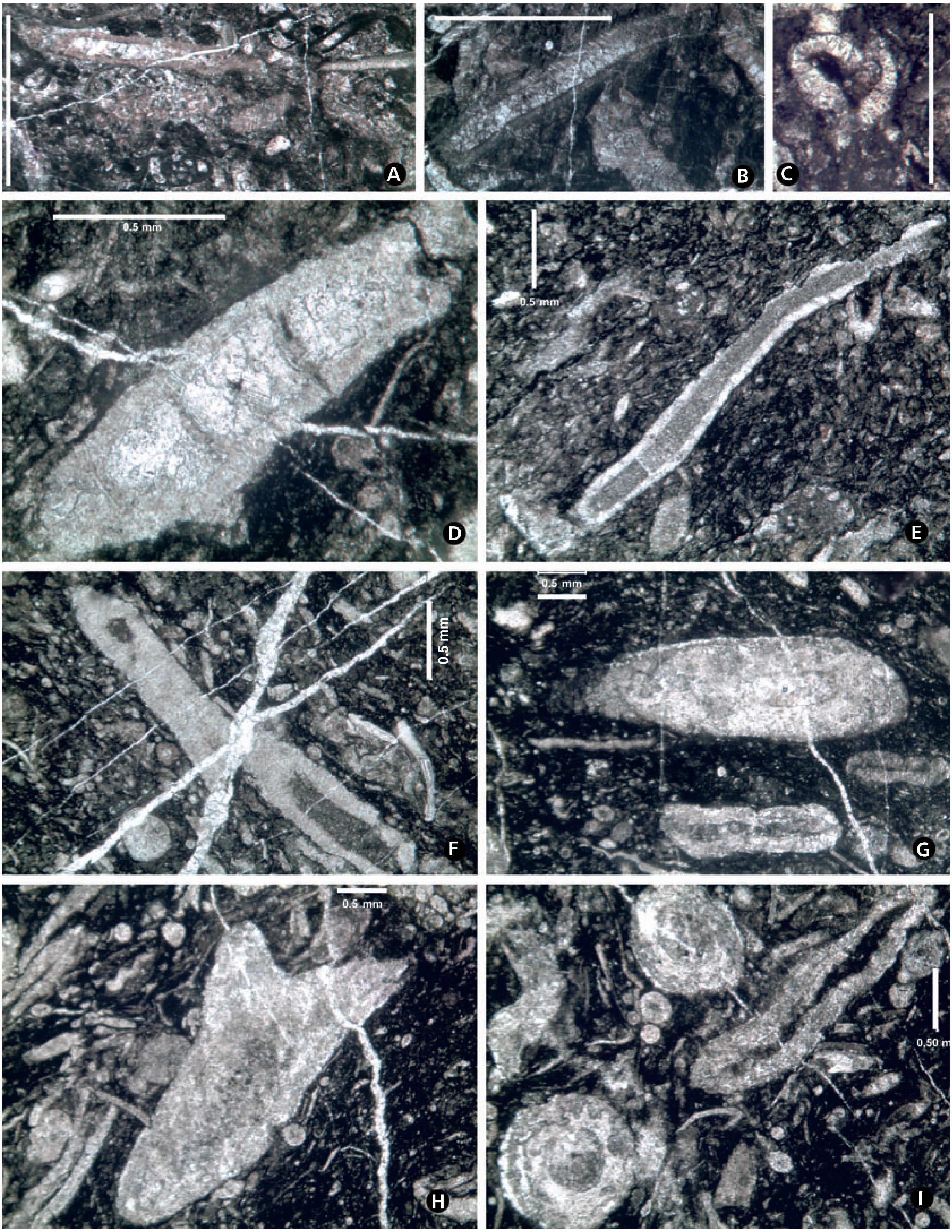
Dimensions. – D = 0.665–1.350 mm, w = 0.350–0.500 mm, w/D = 0.37–0.52, n = 2.5–3 (4.5) (with 7–9 chambers), p = 0.030–0.080 mm, h = 0.060–0.150 (0.225) mm, s = 0.010–0.040 (0.070) mm.

Comparisons. – It differs from *Planogloboendothyra splendens* Hance, Hou & Vachard, 2011 by the nearly planispiral coiling and the larger dimensions (D = 0.867 to 1.000 mm, w = 0.373–0.467 mm, w/D = 0.43–0.49 for *P. splendens*); from *P. arcuata* (Grozdilova & Lebedeva, 1954) by a larger test (although immature specimens are similar; Fig. 8R); from *P. nekutchanica* (Bogush, 1987), it differs by more deeper umbilici, less broad whorls, and a little larger dimensions (D = 0.62–0.81 mm, w = 0.31–0.44 mm for *P. nekutchanica*); from *P. insigna* Postoyalko *in* Postoyalko & Garan, 1972, which is also biumbilicate, it differs by less deviations of axis and a more compressed test, from *P. ishimica* (Rauzer-Chernousova, 1948), which has almost the same dimensions, by a test more compressed (w/D of *P. ishimica* = 0.69 according to Grozdilova & Lebedeva 1954, or 0.60–0.73 for Lebedeva 1954).

Material. – Ten sections.

Repository of the types. – University Lille 1 collection (USTL1/1100).

Figure 7. Scale bars = 0.5 mm. • A–C – *Issinella* ex gr. *devonica*; A – associated with *Earlandia* ex gr. *elegans* and *Endothyra paraprisca* (bottom centre). C-1[2/2(2)], B – (left) with *Palaeoberesella lahuseni* (right). C-1.3(9), C – the perforations seem to be ramified (an exceptional character in this genus). C-8[3/2(3)]. • D–F – *Issinella luteotubuliformis* sp. nov.; D – detail of the holotype showing several dark diaphragms. C-9(6), E – paratype with a yellowish diaphragm. C-9(5), F – paratype, typical view of the individuals devoid of diaphragms. C-9(8). • G–I – *Issinella enormis* sp. nov.; G – three paratypes. C-11(5), H – a bifurcated paratype. C-11(1), I – three paratypes. C-11(3).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Occurrence. – Type locality and type horizon. Questionable in Belgium and England.

Family Endothyridae Brady, nom. translat. Rhumbler
Subfamily Endothyrinae Brady

Genus *Endothyra* Phillips *sensu* Brady, emend. China

***Endothyra irinaeformis* sp. nov.**
Figures 11A, J–N

Etymology. – Relatively similar to *Endothyra irinae* Reitlinger, 1950.

Holotype. – Fig. 11L, sample C-1(+2).

Type horizon. – Late early Viséan (MFZ11A).

Type locality. – Cebeciköy (NW Turkey).

Diagnosis. – A medium sized *Endothyra* very compressed (in axial as well as transverse planes), with very thick crustae, and a faintly differentiated wall.

Description. – Test free, lenticular, symmetric, slightly biumbilicate, with a rounded periphery. It is formed by a globular, medium-sized proloculus followed by a succession of chambers, endothyroidally coiled on 2.5 to 3 whorls (the deviations of the whorls are generally approximately 60°). Slowly enlarging, the successive chambers overlap partially the umbilical area, the test becoming subdiscoidal involute. 8 chambers may be observed in the last whorl. Chambers hemispherical, typically endothyroid, increasing moderately in height. They communicate by a single, basal high median opening (probably an arch). In equatorial sections, the chambers appear subrectangular whereas, in axial sections, they are oval in the last whorls. The wall, microgranular, dominantly dark, is occasionally differentiated but less than in *Mediendothyra*. The septa, as thick as the wall, are straight, perpendicular to the spiral suture in equatorial section and slightly curved. The crustae are thick, with a curved forwards hook in the last chamber (Fig. 11L, N). The corner fillings are very developed (Fig. 11K) and occasionally resemble pseudochomata (Fig. 11M). Aperture single, basal, relatively low and narrow.

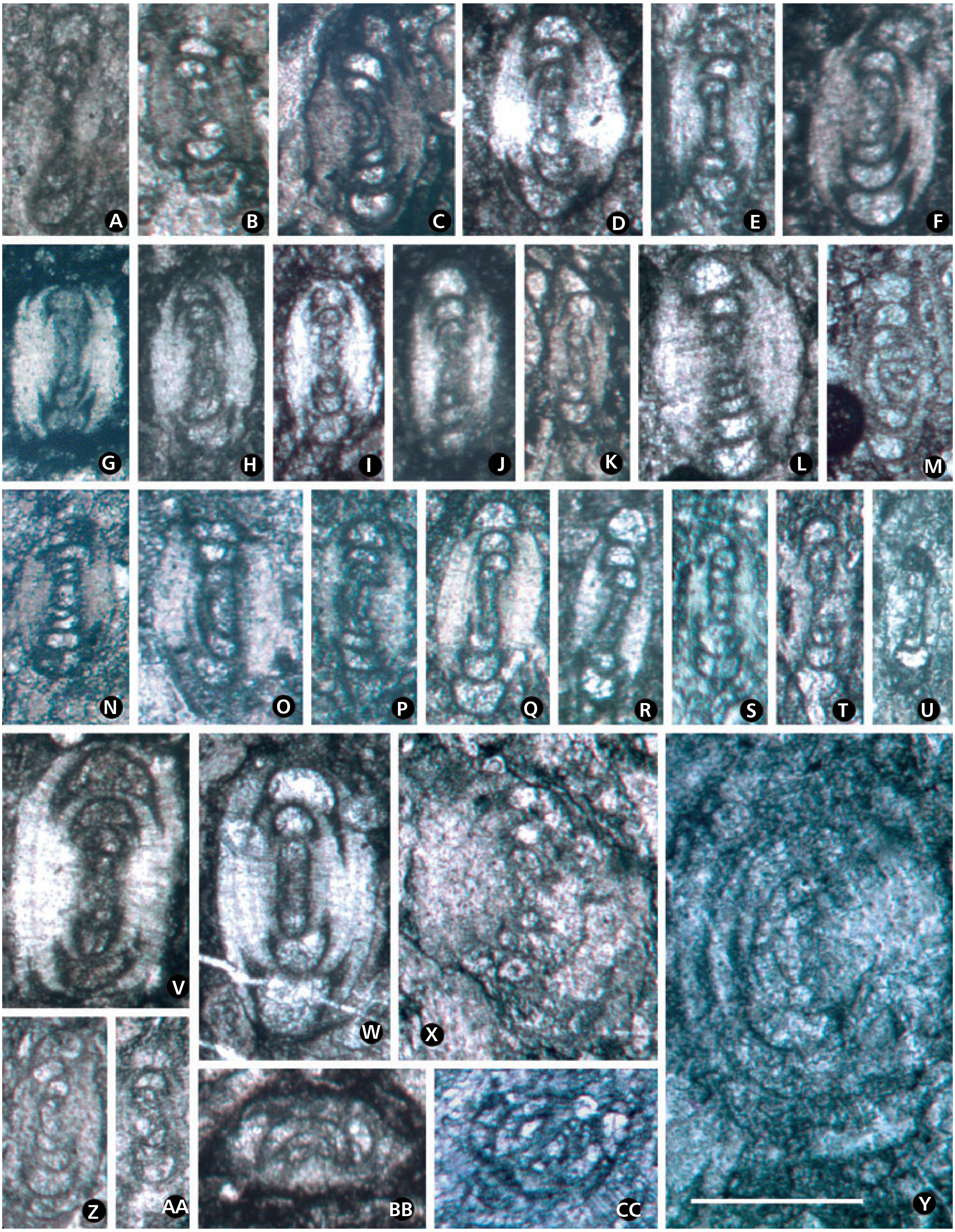
Dimensions. – D = 0.550–0.700 mm, w = 0.170–0.240 mm, w/D = 0.31–0.48, n = 2.5–3 (for 8 chambers at last whorl), p = 0.040 mm, h = 0.100–0.150 mm, s = 0.007 mm.

Discussion. – It differs from *E. irinae* by more compressed transverse sections, more compressed and less evolute axial sections, and stronger crustae. It differs from *E. apposita*

Figure 8. Scale bar = 0.5 mm (see Fig. 8Y). • A, J–L? – *Uralodiscus rotundus elongatus*; A – C-1.2(3), J – C-9B(7), K – C-10.2(+1), L? – C-6(1). • B–D, F, L, N, O – *Uralodiscus rotundus inflatus*; B – C-1.3(21), C – C-1(2/2(3)), D – C-6(3), F – C-6(8), L – C-6(2), N – C-5[2/2(4)], O – C-5B(3). • E, G–I – *Uralodiscus rotundus rotundus*; E – C-6(6), G – C-8(5), H – C-8(6), I – C9B(1). • M? – deformed *Uralodiscus* sp. C-6.2(+2). • V, W – *Uralodiscus rotundus vastus*; V – C-9(11), W – C-9(1). • P?, Q–U – *Paraarchaediscus* (stage involutus) cf. *sumsariensis*; P? – C-5[2/2(1)], Q – C-5[2/2(5)], R – C-5(+3), S – C-5[31/1(2)], T – C-5(+4bis), U – C-5[31/1(1)]. • X, Y – *Conilidiscus* cf. *bucculentus*; X – C-10(3), Y – C-9.1(10). • Z, AA, BB? – *Paraarchaediscus* (stage involutus) *regularis*; Z – C-10(5), AA – C-10(4), BB? – C-9.1(1). • CC – *Paraarchaediscus* (stage concavus) aff. *pauxillus*. C-5.3(+1).

Figure 9. Scale bar = 0.5 mm (see Fig. 9E). • A – *Kamaena pirleti*. C-1.3(3). • B – *Palaeoberesella* sp. 1. C-5B(6). • C, D – *Palaeoberesella lahuseni*. Two axial sections with bracelets; C – C-10.2(6), D – C-10[10/2(4)]. • E – *Exvotarisella index* with *Uralodiscus rotundus inflatus*. C-1.3(4). • F – *Calcisphaera grandis* (Lipina 1950). C-8(+1). • G – *Magnitella* cf. *agapovensis*. C-10(8). • H, J, K – *Brunsia spirillinoides*; H – with *Exvotarisella index* (top). C-1(19), J – with *Vicinesphaera parasqualida* sp. nov. (paratype; bottom, right). C-1(+5), K – with *Vicinesphaera parasqualida* sp. nov. (paratype), *Endothyra prisca*, *Palaeoberesella lahuseni* and *Issinella* ex gr. *devonica*. C-1.3(26). • I – *Brunsia pulchra* with *Palaeoberesella lahuseni* (top) and *Issinella* ex gr. *devonica* (bottom). C-1.3(20). • L–O – *Forschia parvula*; L – with *Earlandia* ex gr. *minor*, *Exvotarisella index* and *Endothyra praesimilis*. C-1(16), M – with *Omphalotis* aff. *involuta*. C-5B(1), N – C-5B(4), O – C-5. • P–R – *Planogloboendothyra modesta* sp. nov.; P – paratype with *Vicinesphaera parasqualida* sp. nov. (paratype, centre right). C-1(35), Q – paratype with *Endothyra similis amplis* (bottom, left) and *Uralodiscus rotundus elongatus* (top, right). C-1.3(40), R – paratype with *Endothyra similis amplis* (top, left and centre). C-1.3(38).

Figure 10. Scale bars = 0.5 mm (Fig. 10A, J have that of Fig. 10J; Fig. 10B–I, K–N, that of Fig. 10D). • A – *Planogloboendothyra modesta* sp. nov. Holotype. C-1.3(27). • B – *Eotextularia diversa*. C-8.4(2). • C – *Viseina*? sp. C-5[13/2(1)]. • D – *Exvotarisella index*. C-10.2(1). • E–G, J, M, N – *Pseudolituotubella orientalis*; E – C-1.2[13/2(1)], F – C-1.3(33), G – C-1(5), J – with *Eotextularia diversa* (top, right), *Earlandia* ex gr. *minor* (centre) and *Endothyra paraprisca* (top, left). C-6(9), M – C-7(1), N – with an *Endothyra prisca*. C-1(29). • H – *Vicinesphaera parasqualida* sp. nov. Holotype (left) and three paratypes (centre and right). C-1.2[13/2(4)]. • I – *Baituganella* ex gr. *vulgaris*. C-1.3(21). • K – *Magnitella* cf. *agapovensis*. C-7[13/2(5)]. • L – *Forschia parvula*. C-7[13/2(3)].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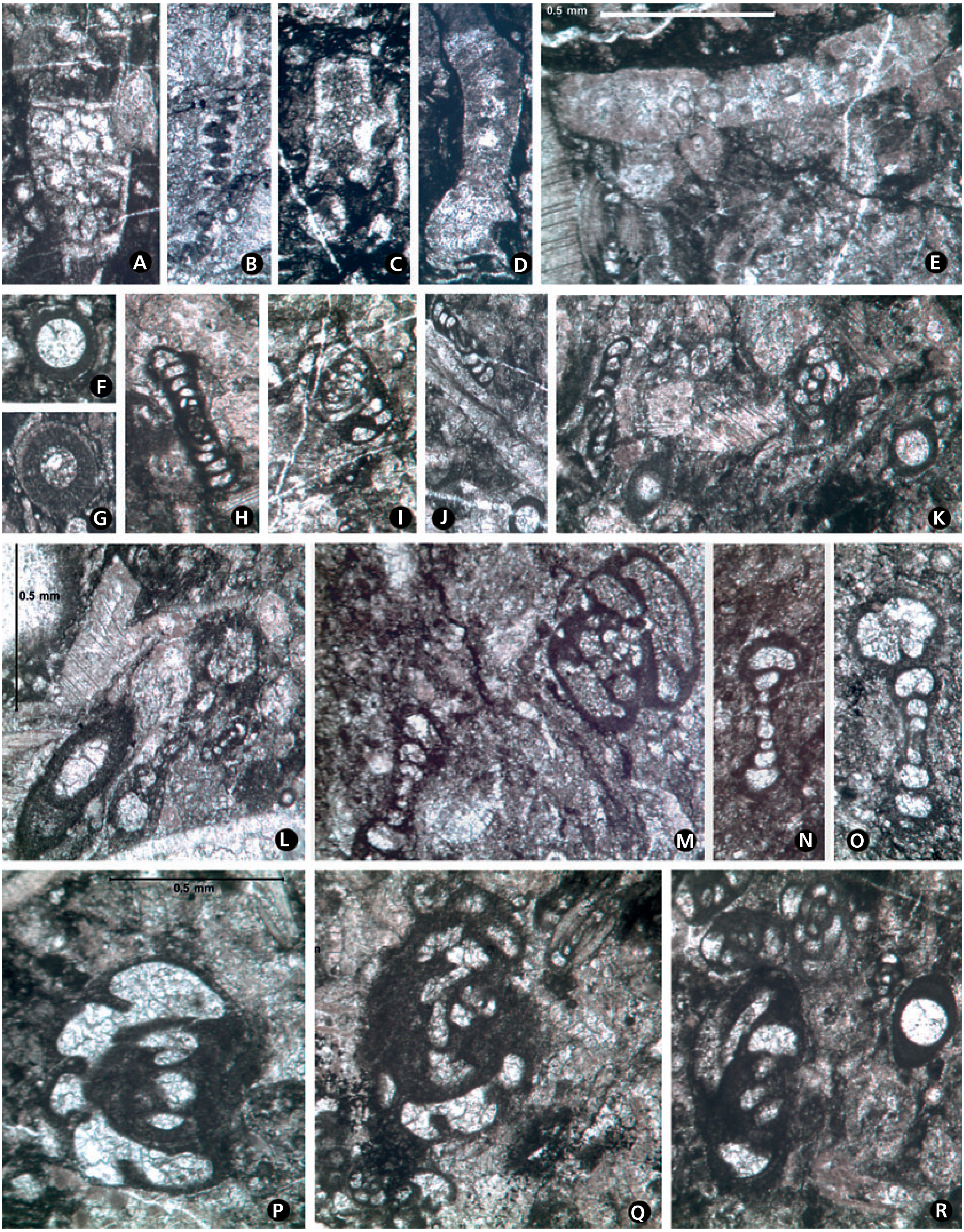
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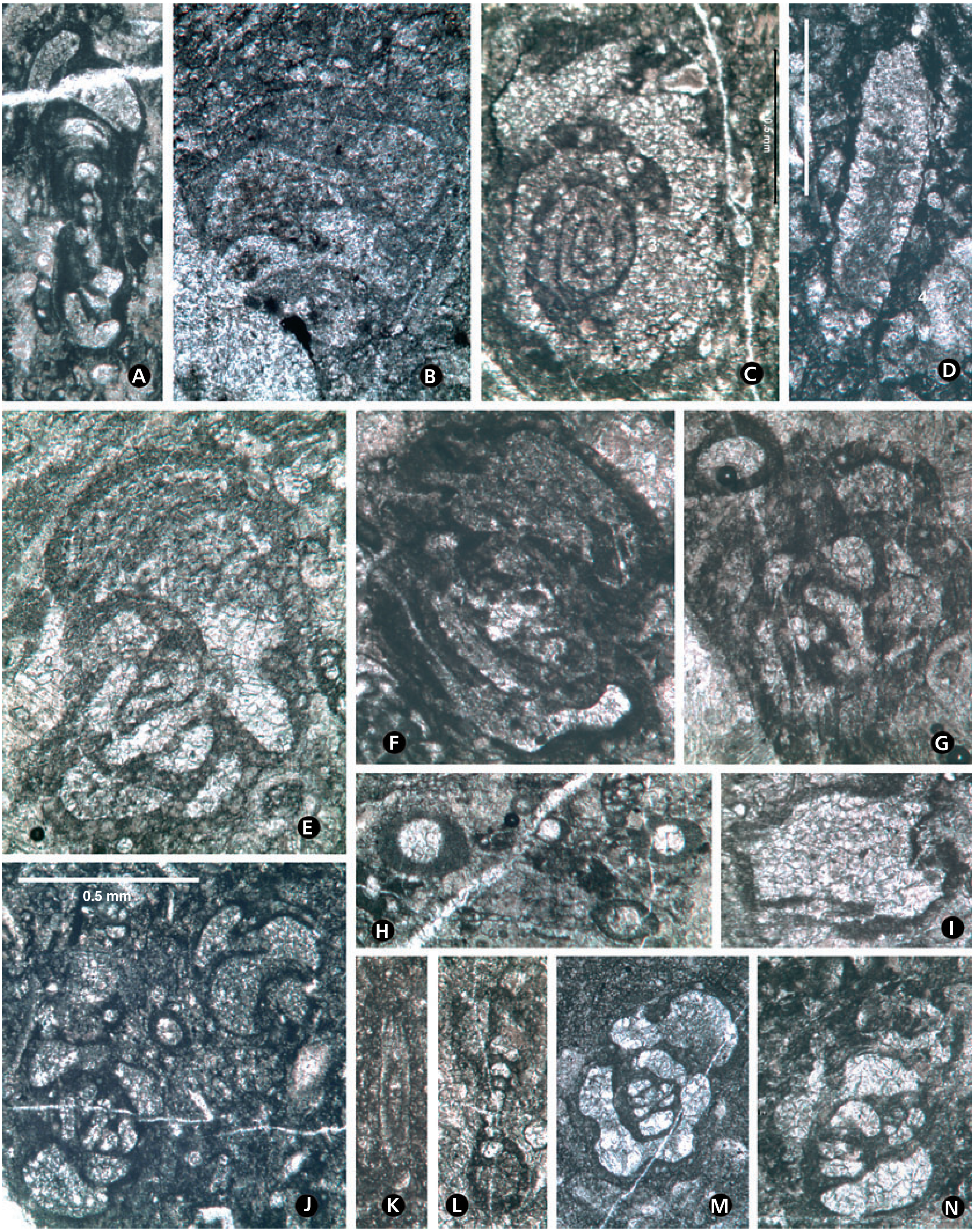
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Ganelina, 1956 by the very more compressed test (w/D = 0.61–0.67 in this latter species). It differs from *E. neglecta* Vachard, 1977 by the more compressed test and the very narrowly expanding spire. It differs from *E. torta* Conil & Lys, 1968 by less deviations, less whorls and less chambers at the last whorl, but both species are probably phylogenetically related. From the more compressed *Omphalotis* and/or *Mediendothyra*, it remains distinct by more compressed and less differentiated walls.

Material. – Twelve sections.

Repository of the types. – University Lille 1 collection (USTL1/1101).

Occurrence. – Type locality and type horizon.

Palaeogeographical hypothesis

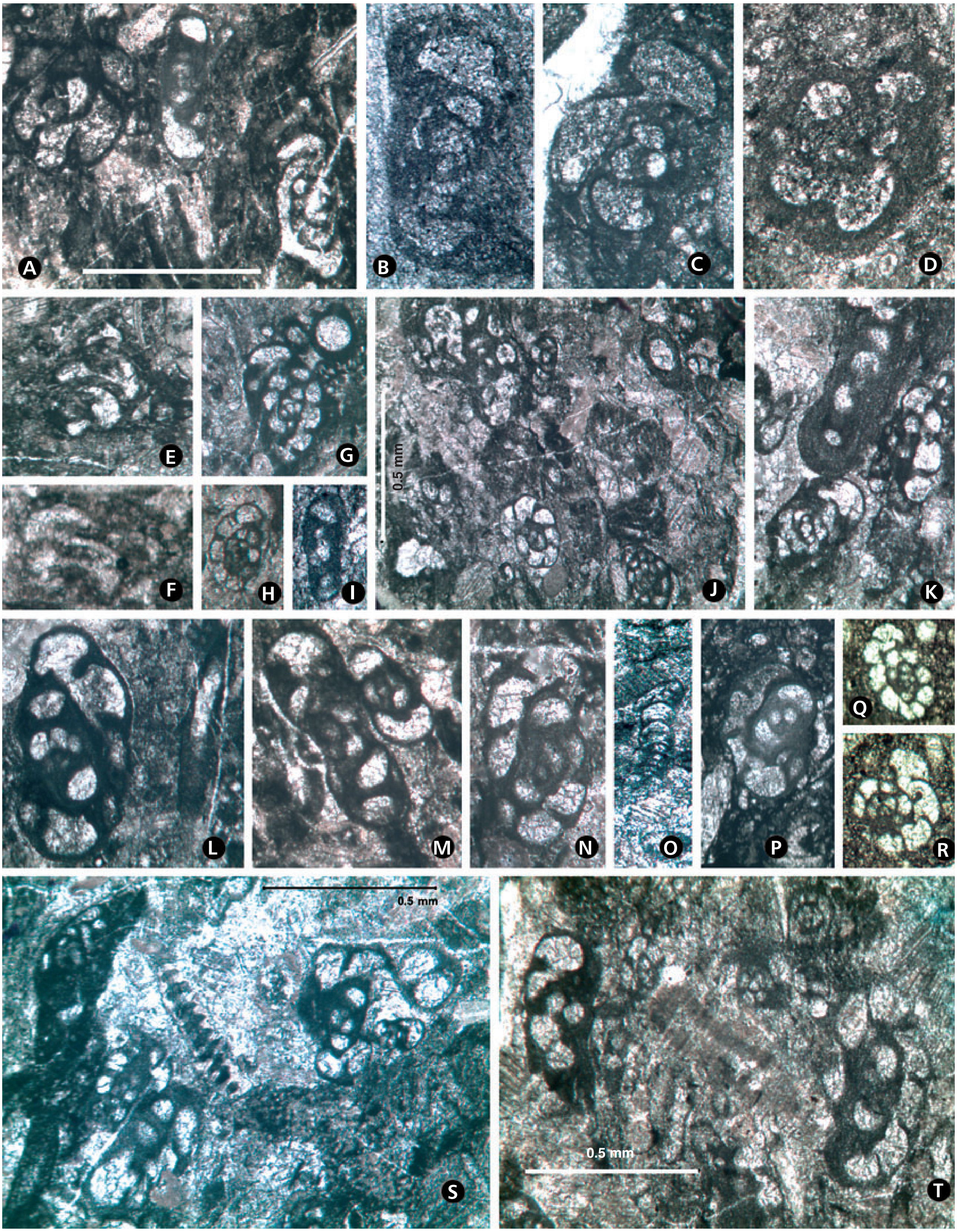
The Zonguldak and İstanbul terranes (Fig. 1) are often considered as one geodynamic unit (Okay & Tüysüz 1999; Kalvoda 2003; Moix *et al*. 2008, 2011); nevertheless, as first admitted by Göncüoğlu & Kozur (1998), they can be considered as distinct and included in some Viséan palaeogeographic models of western Europe (Franke & Engel 1986, Korn 1997, Vachard *et al.* 2006, Pille 2008, Kalvoda *et al.* 2008) where the western Palaeotethys is subdivided in two branches (Fig. 14): a northern branch (partially linked in the Rheno-Hercynian and Saxo-Thuringian traditional German Zones or Brunovistulian Terrane: Franke & Engel 1986, Yanev 2000, Kalvoda 2002, Weyer 2006, Meinhold *et al.* 2008, Kalvoda *et al*. 2008), and a southern branch (the *Eovelebitella* subprovince: Vachard *et al.* 2006 and Pille 2008; *i.e*., an extension of the Mediterranean Zone of Franke & Engel 1986). Because of their complete lithological and microfaciological differences, both branches are probably separated by an emerged barrier (Fig. 14). Due to their common location in the subtropical or tropical domain during the Viséan, both branches have generally the same microfauna and microflora; nevertheless, a species like *Quasiendothyra kobeitusana* (Rauzer-Chernousova) seems only located in the northern branch. Although favourable carbonate facies existed in the southern branch (Dil 1975, Vachard & Clément 1994), the stenotherm and stenobath *Quasiendothyra kobeitusana* is absent because its migration is stopped by palaeotopographic or palaeoclimatic barriers. *Eovelebitella* Vachard is an excellent palaeobiogeographic index for the southern branch. We try to identify more segregating taxa.

The Zonguldak Terrane is probably located at the extremity of the northern branch (Fig. 13) because its Late Devonian, Mississippian and Early-Middle Pennsylvanian series are similar to those of the Dniepr-Donetz Basin and Dobrugea (Bulgaria), especially the foraminiferal succession composed of *Quasiendothyra*, *Chernyshinella*, *Uralodiscus*, *Pojarkovella*, *Eostaffella*, *Euxinita*, *etc*. (*e.g*., Vdovenko 1986). The algal microfauna remains poorly known.

The İstanbul Terrane is probably located at the extremity of the southern branch (Fig. 14). This terrane has many similarities with the Montagne Noire in southern France, at the western part of the same branch: Late Devonian red nodular limestone of griotte-type; Tournaisian black shales rich in radiolarian; rare MFZ10 olistoliths; first rich assemblages of foraminifers in MFZ11 olistoliths reworked in a flysch. *Quasiendothyra kobeitusana* is absent, but this palaeobiogeographic criterion is misleading, because of unfavourable lithofacies (radiolarian cherts or nodular micritic limestones). Similarly, carbonate deposits favourable to the presence of the shallow marine tropical *Eovelebitella* in the late Viséan deposits of the İstanbul Terrane were not encountered.

Southwards, the Turkish terranes are represented by the Sakarya composite terrane (Göncüoğlu *et al*. 1997; Figs 1, 14) or Sakarya complex (Yılmaz 1991, Altıner & Özgül 2001, Moix *et al.* 2008). The first name is preferred here because Sakarya is indeed a composite terrane with Variscan, Cimmerian and Alpine components, whereas the Sakarya complex refers only to the Karakaya unit, *i.e*., to the Palaeotethyan mélange. The Sakarya composite terrane is geodynamically connected with Chios, Rhodope, Pelagonia and Tizia (Meinhold *et al.* 2008, Okay *et al.* 2011). It is also eventually connected with the Alborz, due to the common and successive presence of the following foraminifers: *Eoparastaffella simplex* Vdovenko (Bozorgnia 1973, pl. 18, figs 6, 7, 13 and Leven & Okay 1996, pl. 1, fig. 16: as *Pseudoendothyra simplex*), *Pojarkovella*

Figure 11. Scale bars = 0.5 mm (Fig. 11B–I, K–T have that of Fig. 10T). • A – *Pseudolituotubella* aff. *tschernyshevi* (bottom, right) with *Plectogyranopsis convexa* (top, left) and *Endothyra irinaeformis* sp. nov. (paratype; top, centre). C-1.3(31). • B–D – *Condrustella* cf. *modavensis*; B – C-5(2), C – C-6(6), D – C-7[13/3(1)]. • E, F – *Eotextularia* cf. *mongeri*; E – C-1(30), F – C-1(4). • G, H, Q – *Endothyra similis inops*, G – with *Vicinesphaera parasqualida* sp. nov. (paratype, top right), C-1(+5), H – C-1(5), Q – C-7[3/2(2)]. • I – *Endothyra praesimilis*. C-5(+4bis). • J–N – *Endothyra irinaeformis* sp. nov.; J – paratype (top left) with *Endothyra prisca* (top, centre), *Earlandia* ex gr. *minor* (top, right), *Endothyra similis inops* (bottom, left) and *Mediocris*? sp. (bottom, right). C-1(2), K – paratype (top, centre) with *Inflatoendothyra*? sp. (bottom, left) and *Endothyra similis inops* (centre, right). C-1, L – holotype (left) with *Earlandia* ex gr. *elegans* (right). C-1(+2), M – paratype (left) with *Endothyra similis amplis* (top, right). C-1.3(39), N – paratype. C-1.3(42). • O – *Endospiroplectammina* cf. *conili*. C-1[2/2(5)]. • P – *Mediendothyra barzassiensis*. C-1[10.2(3)]. • R – *Endothyra acantha*. C-7[3/2(2)]. • S, T – *Endothyra similis amplis*, S – C-1(+3), T – C-1.2 [13/2(2)].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ex gr. *nibelis* (Zandkarimy & Vachard, unpublished data and Leven & Okay 1996, pl. 1, fig. 26: as *Endothyranopsis* sp.), and *Howchinia gibba* (Möller) (Bozorgnia 1973, pl. 29, figs 5, 7, 8 and Leven & Okay 1996, pl. 1, fig. 15).

Due to this probable location and composition of its foraminiferal assemblages, the İstanbul Terrane seems to be located at a palaeobiogeographical crossroads or under several currents crossing these areas. Consequently, it received rapidly the new genera and species from the centres of radiation of Siberia, Kazakhstan, and adjacent southern Urals, and dispatched them to (a) Sakarya and Alborz, (b) Taurus and Egypt; (c) westernmost parts of the southern branch of Palaeotethys. Nevertheless, the very great rarity of the loeblichioids in the Cebeciköy Limestone strongly constrasts with the diversity of this superfamily in the Alborz (Bozorgnia 1973, Devuyst 2006, Hance *et al.* 2011).

Conclusions

1. The Cebeciköy Limestone, which covers vast areas on both sides of the Bosphorus in the İstanbul Terrane (NW Turkey), yielded new micropalaeontology data.

2. The cyanobacteria are very rare; true green and red algae absent; moravamminids (incertae sedis algae algospongia), always frequent, show two new species: *Issinella luteotubulifomis* sp. nov. and *I. enormis* sp. nov.; aoujgaliids are rare or very rare.

3. The foraminifers are always present but more or less diversified and more or less abundant; some groups are entirely absent: dainellids, loeblichiids, true *Globoendothyra* or *Eogloboendothyra*, and *Valvulinella*. It is a mixed heterozoan-photozoan assemblage developed in a subtropical to warm temperate climatic zone (30–40° of latitude).

4. Interesting taxa (yet described) in Cebeciköy are: *Uralodiscus rotundus*, *Conilidiscus* spp., *Paraarchaediscus* (stage involutus) *sumsariensis*-*minimus*, *Magnitella* spp., *Pseudolituotubella orientalis*, *Condrustella modavensis*, *Eotextularia diversa*, *E. mongeri*, *Mediendothyra barzassiensis*, *Latiendothyranopsis* spp., and *Eoendothyranopsis* spp.

5. Three species are new: *Vicinesphaera parasqualida* sp. nov., *Planogloboendothyra modesta* sp. nov., and *Endothyra irinaeformis* sp. nov.

6. The deposits correspond to the biozone MFZ11. Our data in Turkey confirm the data in Belgium and South China and permit to confirm and precise the boundary of the two subzones MFZ11A and MFZ11B.

7. The boundary between both subzones is characterized by the FAD of *Conilidiscus* and *Paraarchaediscus* and LAD of *Eoendothyranopsis*.

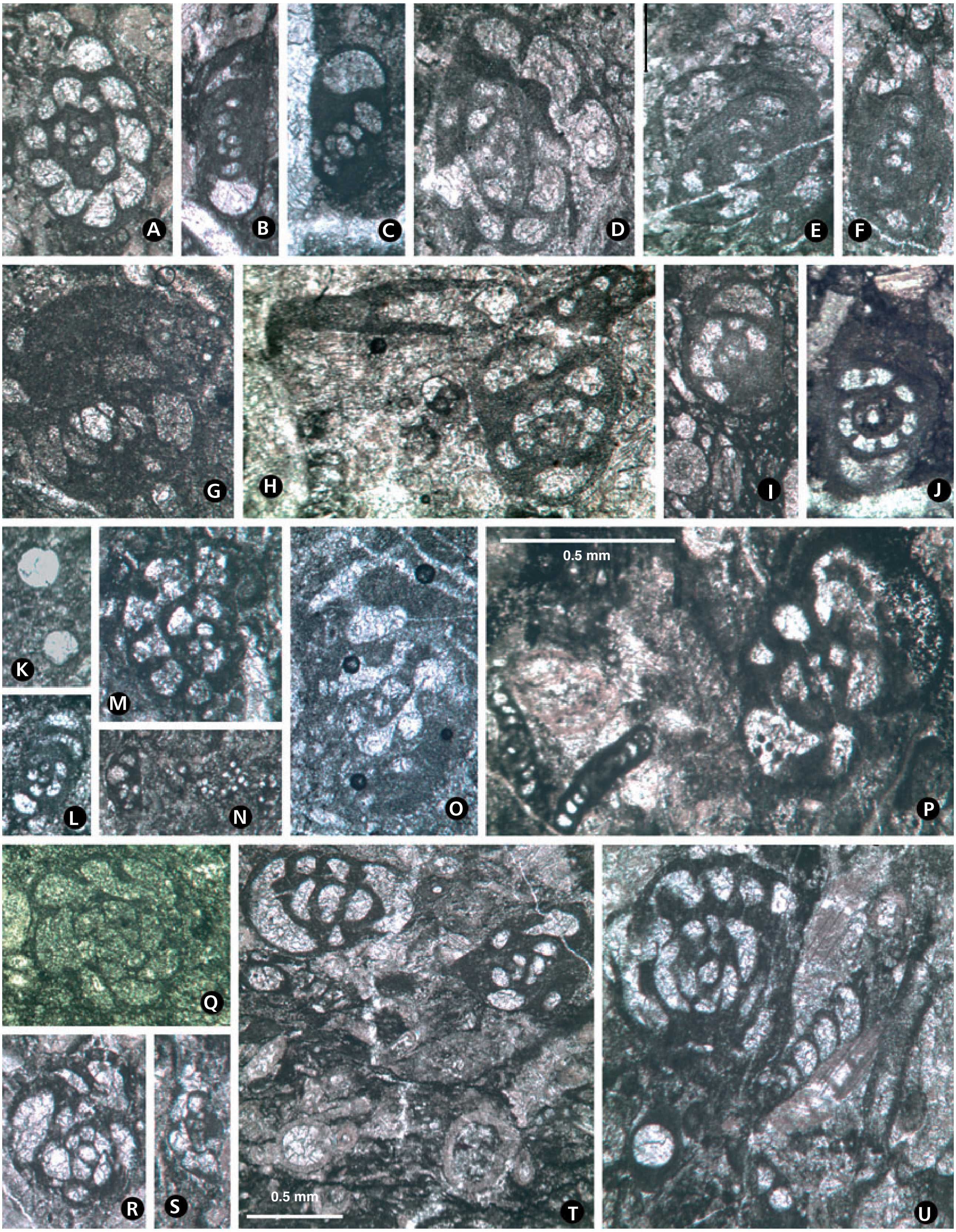
8. The palaeobiogeographical value of some taxa [*e.g.*, *Uralodiscus rotundus*, *Conilidiscus* spp., *Paraarchaediscus* (stage involutus) *sumsariensis*-*minimus*] permits to provide some precisions about the reciprocal location of the Turkey terrane and their relationships with the adjacent areas.

9. The Zonguldak Terrane can be connected to the northern branch of the Palaeotethys and İstanbul Terrane belongs to the southern branch of this ocean.

10. The İstanbul Terrane seems to be located at a palaeobiogeographical crossroads which received the new taxa of the centres of radiation of southern Urals, Kazakhstan and Siberia, and dispatched them to (a) western Palaeotethys, (b) Sakarya and Alborz, (c) Taurus and Egypt.

Figure 12. Scale bars = 0.5 mm (Fig. 12A–S, U have that of Fig. 11P). • A–C – *Mediendothyra barzassiensis*; A – C-1(13), B – C-1(1), C – C-6(2bis). • D–F – *Omphalotis* aff. *involuta*; D – C-1.2(+2), E – C-1.3(20), F – C-1.3(43). • G – *Endothyra gratiodentalis*. C-7[13/2(4)]. • H–J – *Omphalotis* cf. *parasamarica*; H – with *Earlandia* ex gr. *minor* (top, left), *Endothyra prisca* (centre) and *E. similis amplis* (top, right). C-1.2[13/2(3)], I – with *Uralodiscus rotundus elongatus*. C-10.2(+1), J – C-8[3/2(3)]. • K – *Eotuberitina reitlingerae*. C-5(+3). • L – *Endothyra similis amplis*. C-6(5). • M, O – *Latiendothyranopsis*? cf. *menneri*; M – C-6(5bis), O – C-6(1). • N – *Endothyra praesimilis* with *Girvanella wetheredii*. C-5[2/2(2)]. • P – *Plectogyranopsis ampla* with two *Brunsia spirillinoides*. C-1.3(28). • Q – *Plectogyranopsis* cf. *dendrei*. C-7[3/2(3)]. • R – *Plectogyranopsis convexa*. C-1(4). • S – *Endothyra similis inops*. C-1(4). • T – *Eoendothyranopsis* cf. *ermakiensis* (top, left) with *Planogloboendothyra modesta* sp. nov. (paratype; top, right), *Issinella* ex gr. *devonica* (bottom left and right), *Palaeoberesella lahuseni* (centre, left) and *Earlandia* ex gr. *elegans* (top, left). C-1(17). • U – *Eoendothyranopsis donica tumefacta*, with *Endospiroplectammina* cf. *conili*, *Vicinesphaera parasqualida* sp. nov. (paratype), *Palaeoberesella lahuseni*, and *Earlandia* ex gr. *elegans*. C-1(33).

Figure 13. Scale bars = 0.5 mm (Fig. 13A, D–P have that of Fig. 13M). • A, E – *Eoendothyranopsis donica tumefacta*; A – C-1.2(1), E – C-1(25). • B–D – *Eoendothyranopsis* cf. *ermakiensis*; B – with *Issinella* ex gr. *devonica* (centre), *Endothyra praesimilis* (top, left), and *E. paraprisca* (bottom, centre). C-1.3(35), C – C-1.2(2), D – with *Palaeoberesella lahuseni* (bottom, right), *Endothyra praesimilis* (top, right) and with *Vicinesphaera parasqualida* sp. nov. (paratype, top right), C-1(34). • F, G – *Tetrataxis immatura*; F – C-6(1), G – C-1(28). • H, J – *Tetrataxis* aff. *angusta*; H – C-6(1bis), J – C-5[31/1(3)]. • I, M – *Tetrataxis bogushi*; I – C-5B(5), M – *Globobotetrataxis* stage. C-5(3). • K, L – *Tetrataxis* cf. *quasiconica*; K – with *Uralodiscus rotundus vastus*. C-10.2(2), L – C-1.3(13). • N – *Mediocris breviscula*. C-1(3). • O, P?, Q, R, T? – *Eoparastaffella simplex lata*; O – C-1.3(22), P? – with *Uralodiscus rotundus rotundus*. C-6.2(+1), Q – C-8(4), R – C-8(1), T? – C-10(2). • S, U–X – *Eoparastaffella simplex ovalis*; S – C-1(5), U – C-1.2(5), V – C-1(10), W – C-1(+6), X – C-10(9).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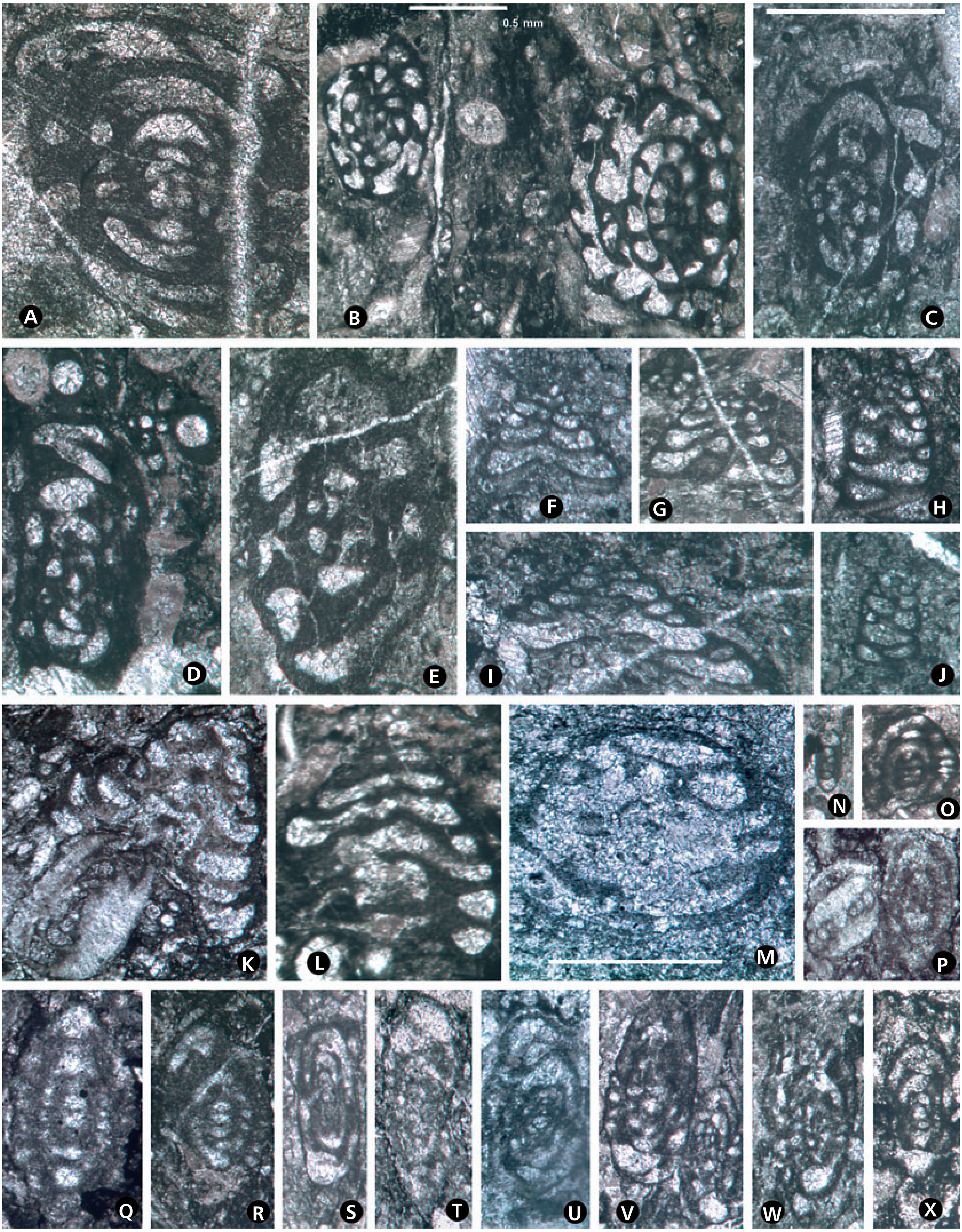
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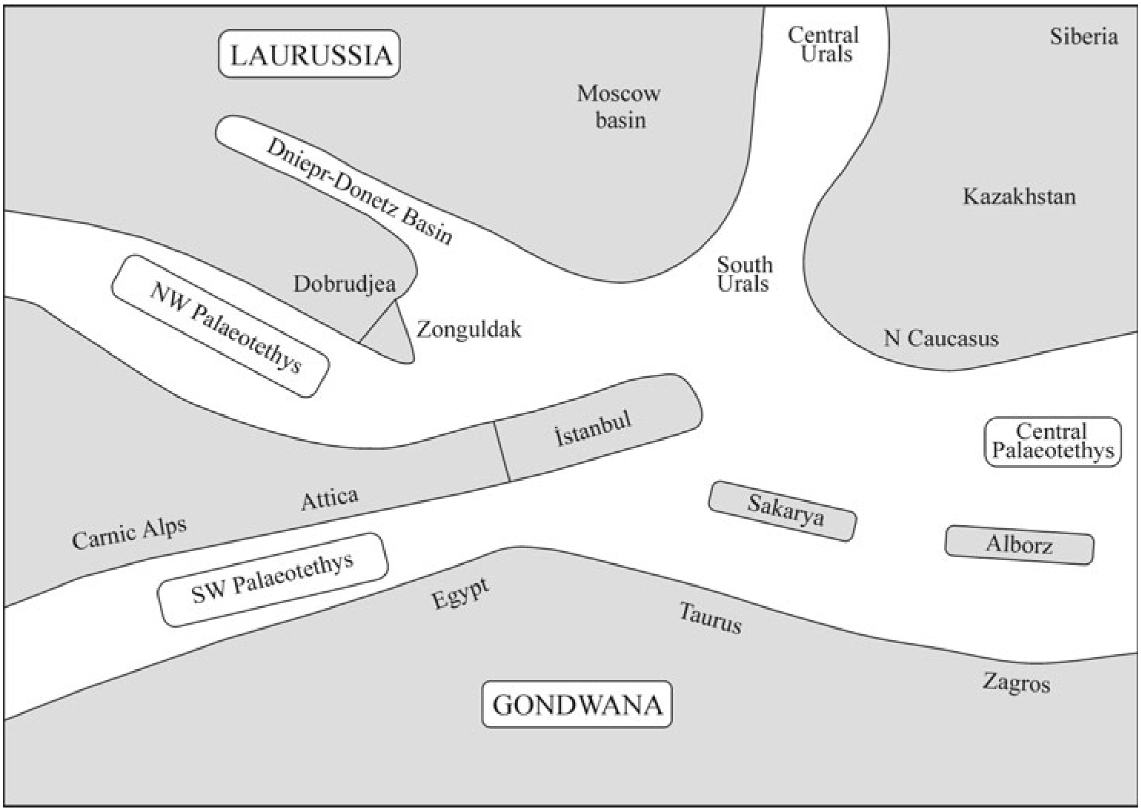

Figure 14. Palaeogeographic reconstruction of the mainlands and islands in western and central Palaeotethys based on foraminiferal palaeobiogeographic data.

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