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A rare protoglobigerinid association (Foraminifera) from the Tithonian of Gerecse Mts, Hungary

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1 figure

A rich protoglobigerinid fauna was studied from the Tithonian limestones of Paprét-árok, Gerecse Mts, Hungary. The early planktonic foraminifera association was investigated in thin section and in isolated specimens as well, extracted using acetic acid treatment of rocks. This homogeneous, presumably monospecific protoglobigerinid fauna shows transitional characters between *Globuligerina oxfordiana* (GRIGELIS, 1958) and *Favusella hoterivica* (SUBBOTINA, 1953). An overview of Tithonian protoglobigerinids are given, which reveals, that the studied locality is the third one in the Tethyan Realm from where isolated Tithonian forms are figured.

Introduction

The protoglobigerinids are *Globigerina*-like planktonic foraminifera of the Jurassic. They are generally considered as the ancestors of the Cretaceous planktonic foraminifera. The tests of the Jurassic protoglobigerinids have a rather simple morphology with few discriminating characters. Both intraspecific and interspecific variability are great. In this respect, these foraminifera pose the same problems as the simple Tertiary "*Globigerina*" (*Subbotina*).

In our recent works (GÖRÖG & WERNLI, 2003) we collected data of the literature about these microfossils in the Middle Jurassic, so we can declare that they are relatively common in thin sections of the Bajocian-Oxfordian rocks, especially in the *ammonitico rosso* facies of the Tethyan Realm. Record of isolated forms is very poor and lacunal. Later, in the Kimmeridgian, Tithonian and also in the Berriasian the record became very rare, and this way the hypothetic link between the Jurassic and Cretaceous forms is not well documented. Surface ornamentation of the wall as well as the shape of the aperture are a fundamental criteria for the taxonomy, thus the analysis on isolated forms is necessary.

The aim of this work is to present a very rare association of the Tithonian protoglobigerinids, first from thin section then in isolated forms. The latter have been extracted by means of acetolysis from hard, indurated limestone of the Paprét-árok (Paprét ravine) section of Gerecse Mts, Hungary. This section is well dated by ammonites (HOFMANN, 1884; FÜLÖP, 1958; VIGH, 1971, 1984; FŐZY, 1993), and FÜLÖP mentioned (1958) and figured (1975) protoglobigerinids in thin section, not far from this locality. We also collected and analysed the data described in the literature and put on a palaeogeographical map.

Previous studies on Tithonian protoglobigerinids

From the Tithonian the records of the protoglobigerinids are very poor (Figure 1). At this time in the literature, only two localities could be found from which isolated Tithonian protoglobigerinids are described. One of them is situated near Stubel village, Moësian Platform, NW Bulgaria, from where IOVČEVA & TRIFONOVA (1961) described and gave drawings about their two new species, namely *Globigerina conica* and *G. terquemi*. Moreover, we can see on their plate 1, fig. 2 a thin section of *Globigerina*-like foraminifera, but the wall untypical for this group, because it is dark in colour. As all specimens are glauconitic moulds, we have no information about the wall surface and the aperture. In the English summary, the authors suppose that

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G. terquemi can be the synonym of *Globigerina bulloides* TERQUEM, 1883, from the Ammonites parkinsoni Zone (Oxfordian). Moreover they refer to the illustration of TERQUEM (1883, pl. XLI, fig. 6-9) which figured *Globigerina lobata* TERQUEM (in the caption the author is D'ORBIGNY!), while *G. bulloides* is figured on pl. XLI, fig. 10, and it was described by D'ORBIGNY.

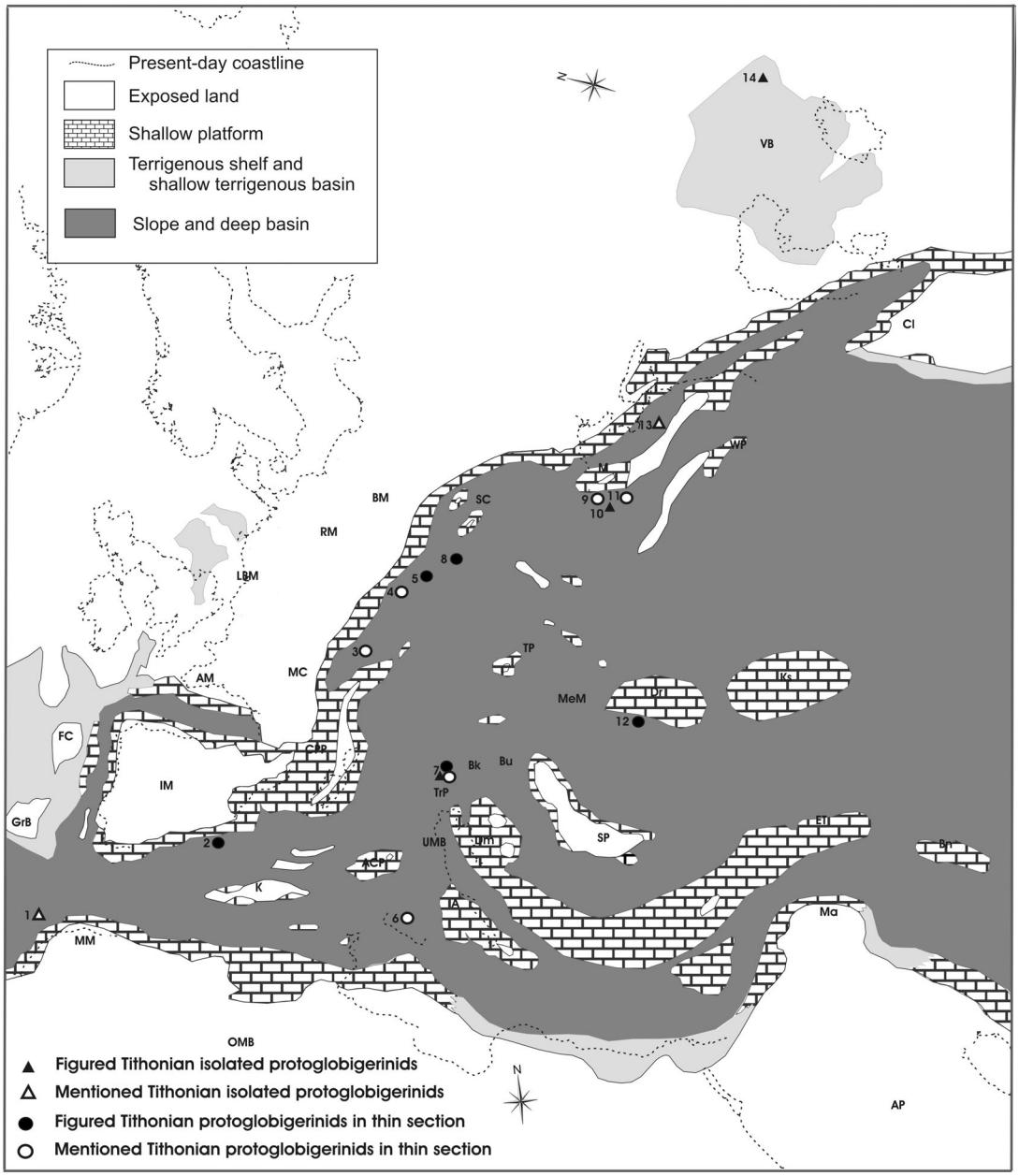

Fig. 1: Palaeogeographic distribution of the protoglobigerinids in the Tithonian. Map was modified after DERCOURT *et al.* (1993). **1** DSDP Leg 901, Atlantic Ocean (COLLINS *et al*., 1996); **2** Province Malaga, Spain (COLOM & RANGHEARD, 1966); **3** Departements Basses -Alpes, Isère, Jura, France (BEAUDOIN, 1967); **4** Bavarian Alps, SW Germany (EGGERT, 1977); **5** Salzburg, Alps, Austria (DIERSCHE, 1980); **6** W and SW Sicily (GIANOTTI, 1958); **7** Szél Hill, Tardos and Felsővadács, Gerecse Mts, Hungary (FÜLÖP, 1958); Tata, Gerecse Mts, Hungary (FÜLÖP, 1975); Paprét-árok, Gerecse Mts, Hungary (recent work); **8** Maríkova, Pieniny Klippen Belt, Western Carpathians, Slovakia (ANDRUSOV *et al.,* 1960; BORZA, 1969); **9** Craiova, Moësian platform, Romania (COSTEA & COMŞA, 1969); **10** Stubel village, Moësian platform, NW Bulgaria (IOVČEVA & TRIFONOVA, 1961); **11** NE Bulgaria (MIHAILOVA-YOVCHEVA & TRIFONOVA, 1967); **12** Ionian, Zone, W Greece (BERNOULLI & RENZ, 1970); **13** Zagrivochnaya, Pechora Basin, N Russia (GRIGELIS *et al*., 1977); **14** Crimea (GORBACHIK & KUZNETSOVA, 1983). **A** Apulia; **ACP** Apennine Carbonate Platform; **AM** Armorican Massif; **AP** Arabian Platform; **BK** Bakony; **Bn** Bisitoun; **BM** Bohemian Massif; **Bu** Bükk; **CI** Central Iran; **CPP** Corbières-Provence Platform; **DM** Dalmatia; **Dr** Drama; **ET** Eastern Taurus; **FC** Flemish Gap; **GrB** Great Bank; **IM** Iberian Meseta; **K** Kabylia; **Ks** Kirsehir; **LBM** London Brabant Massif; **M** Moesia; **Ma** Mardin; **MC** Massif Central; **MeM** Metaliferi Mountains; **MM** Moroccan Meseta; **OMB** Oued Mya Basin; **RM** Rhenish Massif; **SC** Silesian Cordillera; **SP** Serbo-Pelagonian; **TrP** Trento Plateau; **TP** Tisza Plate; **UMB** Umbria-Marches Basin; **VB** Volga Basin; **WP** Western Taurides.

The other locality is in Zagrivochnaya, Pechora Basin, Northern Russia, from where *Compactogerina stellapolaris* was described, and figured with drawings by GRIGELIS (GRIGELIS et al. 1977). Later BOUDAGHER-FADEL *et al.* (1987) figured three topotypes by electronmicroscope (pl. 2.7., figs 1-7, pl. 2.8., fig. 1.). The test is compact, low trochospired with four chambers in the last whorl resembling the recent *Neogloboquadrina pachyderma* (EHRENBERG, 1894). The last chamber is bulla-like with a low slit extraumbilical aperture. One of these individuals due to the lack of this last bulla-like chamber, shows a turborotalid aspect with a seemingly extraumbilical primary aperture. Apart from the surface ornamentation of the wall, this individual resembles to *Haeuslerina helvetojurassica* (HAEUSLER, 1881) of the same publication (BOUDAGHER-FADEL *et al.*, 1987, pl. 2.6., figs 1-8). GORBACHIK & KUZNETSOVA (1998) republished part of these photos.

Summarizing, apart from *C. stellapolaris* we have few information about the aperture and the wall surface of the Tithonian protoglobigerinids.

Additionally to these data isolated forms from the Tithonian were mentioned by COSTEA & COMŞA (1969, p. 108) who cited *Globigerina* sp. from Moësian platform, Romania. GORBACHIK & KUZNETSOVA (1983) on their map figure 2 mentioned isolated *G. stellapolaris* and *G. terquemi* from Crimea and COLLINS et al. (1996, p. 193) determined, but not figured *Globuligerina bathoniana* (PAZDROWA, 1969) and *G. oxfordiana* (GRIGELIS, 1958) from the DSDP Leg 901, in the Atlantic Ocean (appr. 41^0N, 11^0W).

We have little bit more records about Tithonian protoglobigerinids in thin section, but they were figured only from 5 localities. They are the following:

- Province Malaga, Spain (COLOM & RANGHEARD, 1966) — but the Tithonian age is not certain;
- NW from Maríkova, Pieniny Klippen Belt, western Carpathians, Slovakia (ANDRUSOV *et al*., 1960; BORZA, 1969);
- Western part of Greece (BERNOULLI & RENZ, 1970) — but the Tithonian age is not certain;
- Tata, Gerecse Mts, NW Hungary (FÜLÖP, 1975);
- Near Salzburg, Alps, Austria (DIERSCHE, 1980).

From some other localities the authors mentioned – without illustration – the presence of protoglobigerina-like foraminifers in Tithonian rock thin-sections:

- From Hungary FÜLÖP (1958) generally mentioned in the summary about the Lower Cretaceous layers of some localites (Szél Hill, Paprét-árok, Póckő) of Gerecse Mts (p. 18, p. 69), that "Globigerinas" occur in large numbers in the Late Tithonian limestones.
- GIANOTTI (1958) from Sicily, Italy;
- BEAUDOIN (1967) from the Departement Basses-Alpes, Isère, Jura, France – age is Kimmeridgian—Tithonian;
- MIHAILOVA-YOVCHEVA & TRIFONOVA (1967) from North Eastern part of Bulgaria;
- COSTEA & COMŞA (1969) from the Moësian platform, Romania and
- EGGERT (1977) from the Bavarian Alps, Southwest Germany.

Geological setting

The studied Paprét-árok profile is situated at the crossing of the Paprét ravine and the former narrow gauge railway line, to the south of Süttő, Gerecse Mts, Transdanubian Range, Hungary (Fig. 2). This is a well-known Upper Jurassic—Early Cretaceous section in the Hungarian geological literature since its first mentioning by HOFMANN (1884). Several authors dealt with the lithological features and the fossil content especially with the ammonites of the Upper Jurassic layers (HOFMANN, 1884; VIGH, 1968, 1971, 1984; FŐZY, 1993; CSÁSZÁR *et al*., 1998).

In the Paprét-árok profile the succession begins with red radiolarite (Lókút Radiolarite Formation) of Middle Jurassic—Kimmeridgian in age (Figure 3). It is followed by a rather condensed Kimmeridgian-Berriasian series forming a massive bank about 75 cm in thickness. These rocks are grey, pink and purple, extremely hard limestones, showing transitional characters between the Pálihálás Limestone and Calpionella-bearing Szentiványhegy Limestone Formations (CSÁSZÁR *et al*., 1998). Following the log in FŐZY (1993, fig. 7) here reproduced on Figure 3, this massive bank can be subdivided in 5 beds numbered 6 to 2, from the base to the top:

Beds 6-7 belong to the Beckeri and the Hybonotum Zones, bed 5 questionably to the Darwini Zone, bed 4 questionably to the Fallauxi Zone and beds 3 and 2 are considered as probably Late Tithonian in age according to FŐZY (1993). In the beds 5 to 3 traces of bioturbation can be recognised. Above this massive bank the upper part of the section with grey marl and breccia layers belong to the Lower Cretaceous Bersek Marl Formation.

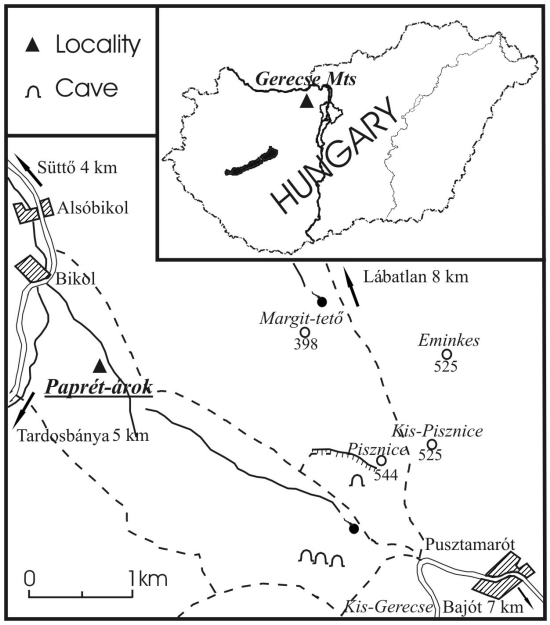

Figure 2. Sketch map of the location of the studied Tithonian section in Paprét-árok, Gerecse Mts, Hungary.

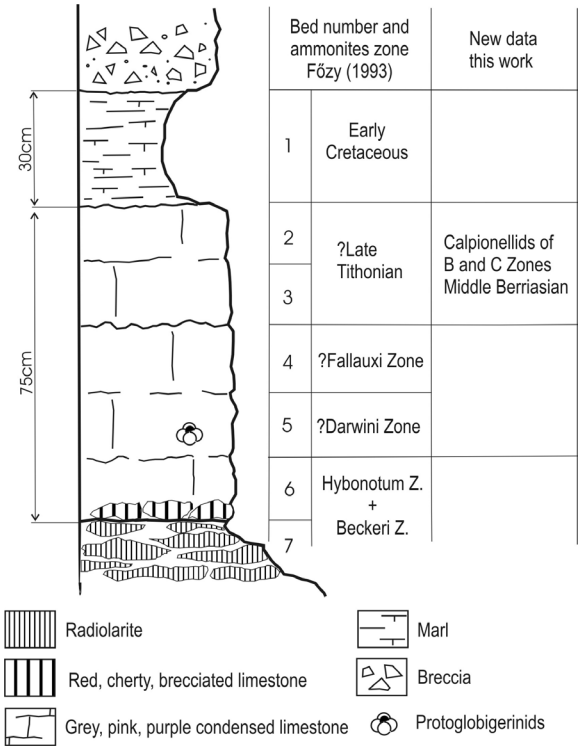

Fig. 3. Stratigraphical section of Paprét-árok, Gerecse Mts, Hungary.

Our provisional analysis of the massive bank brings some new data about the age of these beds. Calpionellids are present in beds 1 and 2. *Calpionella alpina* (LORENZ)*, C. elliptica* CADISCH*, Remaniella cadishiana* (COLOM) and *Tintinopsella carpathica* (MURGEANU & FILIPESCU) can be determined. These indicate the B Zone (part. sup.) and C Zone of REMANE (REMANE, 1985, GRÜN & BLAU, 1996, 1997) dating the Middle Berriasian and not the Tithonian.

Additionally based on the study of thin sections we could established that in the Berriasian layers there are rich small-sized planktonic foraminifera fauna, while bed 4 contains only very few protoglobigerinid specimens. Moreover, in bed 6 two microfacies can be distinguished with two different protoglobigerinid associations probably due to the strong bioturbation.

The particularly studied protoglobigerinid fauna comes from bed 5, that similarly to the underlying layers, does not contain calpionellids despite of the similarity in microfacies throughout the entire massive bank. According to the ammonite datation of FŐZY (1993) in the base of the massive bank and our calpionellids datation of the top, the studied bed deposited between the Hybonotum Zone (earliest Tithonian) and the Middle Berriasian. The absence of calpionellids should indicate an Early Tithonian age, what is also proved by ammonite fauna FŐZY, 1993).

Description of the protoglobigerinids from Paprét-árok, Gerecse Mts

A. In thin sections

Previously from the Gerecse Mts, from the same Calpionella-bearing Szentiványhegy Limestone Formation, which is also exposed in the studied Paprét-árok section FÜLÖP (1958, p. 18, 69) mentioned Tithonian protoglobigerinids in thin section (he did not identified the locality) and figured some section of them from Tata (1975, pl. XXXVIII, fig. 3). On these photos a very abundant, but relatively uniform, thin walled protoglobigerinid fauna together with calpionellids (i.e. *C. alpina*) and radiolarians can be seen.

The microfacies of our sample of Paprét-árok (from bed 5) is a pink micritic wackstone with microbioclasts, bioturbation and ammonite fragments. Radiolarians are the most abundant microfossils, but the protoglobigerinids are also very frequent (Plate 1, Figs 1-2). Calcispheres (*Colomisphaera* spp.), *Globochaete*, microbivalves, microgastropods, benthic foraminifers (mainly spirillinids, rare *Lenticulina, Nodosaria* and epistominids), bioeroded grains and very few small quartz grains could also be found.

The assemblage of the protoglobigerinids is homogeneous in the general morphology (outline), in wall structure, wall-thickness and in size of the tests. The thin sections show low trochospired protoglobigerinids with four chambers in the last whorl. The ratio of the height to the largest diameter of the test varies from 0.6 to 0.7. The wall is recrystallized in fine calcisparite indicating an aragonitic primary composition. It is also the case for the well-known aragonitic microfossils, which can also be found in the thin sections, like epistominids, ammonites or microgastropods. Wall thickness is nearly uniform throughout all whorls, about 6-8μm. The size of the tests varies from 100 to 150μm.

B. In isolated forms

In the washed residue the most abundant microfossils are the radiolarians, which are also divers. Among the foraminifers the planktonic specimens, the protoglobigerinids are very abundant, the planktonic/benthic ratio is about 1.1:1. The benthic fauna is relatively diverse, the most abundant group is *Spirillina-Trocholina* (i.e. *T. nodulosa* E. & I. SEIBOLD, 1960) group. Above them only a few specimens of the following taxa can be recognised: *Saccorhiza ramosa* (BRADY, 1879), *Ammobaculites agglutinans* D'ORBIGNY, 1846, *Verneuilinoides* sp., *Spirillina polygyrata* (GÜMBEL, 1862), *Lingulina franconica* (GÜMBEL, 1862), *Tristix* sp., *Lenticulina muensteri* (ROEMER, 1939)*, L. subalata* (REUSS, 1854), *L. quenstedti* (ROEMER, 1862), *Planularia* sp., *Dentalina bullata* SCHWAGER, 1865, *D. debilis* (BERTHELIN, 1880), *D*. spp., *Nodosaria* div., *Ramulina spandeli* PAALZOW, 1917, *Eoguttulina* sp., *Epistomina ventricosa* ESPITALIÉ & SIGAL, 1963. Few ostracods, gastropod embryos and aptychi can also be found.

In our material the studied isolated specimens (more than 200 individuals) form a relatively homogeneous association, with low variability. The gross morphology of the test corresponds to the well-known *G. oxfordiana* (GRIGELIS, 1958) as well as to *Favusella hoterivica* (SUBBOTINA, 1953). The description of the tests morphology and particularly its outline in umbilical view depends on the orientation chosen and whether the last (small) chamber is considered as a bulla or not. Moreover, the question also concerns the last visible aperture: is it the infralaminal aperture of a bulla or the normal aperture of the last formed true chamber? This problem has been discussed by WERNLI *et al.* (1995) on the Berriasian –Valanginian favusellids. Usually in a well-preserved material the bulla has a different colour and a different wall structure. In our material it is not possible to use these criteria because of the bad preservation of the walls.

In the protoglobigerinid association of Paprét-árok the majority of the tests show that the last chamber is smaller than the preceeding one. Moreover, it is generally not situated on the ontogeny progression line but more or less displaced in umbilical position. In the case when the last "chamber" is clearly smaller than the previous one and flattened (i.e. Plate 1, Figs 3-6) as at *Catapsydrax* or *Globigerinita*, we can consider it as a

bulla. This is questionable when the last "chamber" is more inflated and nearly reaches the size of the previous one (i.e. Plate 1, figs 7-9). We think that the shape of the aperture can help to answer this question. In our material we never found either clear primary aperture, with asymmetrical, loop-like arch like in *G. oxfordiana* or with wider and slightly asymmetrical arch like in *F. hoterivica*. On the protoglobigerinids of Paprét-árok the apertures vary from an umbilical hemicircular arch (Plate1, Fig. 8) to a low slit (Plate 1, Fig. 10), on some specimens the aperture is surrounded by a lip. In some case there are two small apertures on the last "chamber" (Plate 1, Fig. 7). Based on the above-mentioned arguments we consider that in all our specimens the last chamber is a bulla. We follow this concept in the description of the shells.

The tests are low trochospired, with 8-10 chambers in 2-3 whorls. The juvenile stage does not form an apex. There are four chambers on the last whorl. The chambers are spherical. The moderately depressed sutures give a relatively compact test, so the outline is only gently lobulated. As all tests possess a bulla we have no information about the primary aperture. Above we have already written about the aperture of the bulla. The wall is recrystallized, it is fine calcisparite of 3-5µ grains. Therefore, the surface ornamentation of the test is not visible. The tests measure150-200µ in the largest diameter. The majority of them are 160 to 180µ.

Variability: The variability of the fauna rests essentially on the size of the bulla and the shape of the aperture.

Remarks: In isolated forms the gross morphology of the test corresponds to *G. oxfordiana* (Grigelis) as well as *Favusella hoterivica* (SUBBOTINA). These two species differ essentially by the surface ornamentation of the wall, namely *G oxfordiana* has a tuberculated (with pseudomuricate) surface while *F. hoterivica* has a reticulated surface with small meshes. Unfortunately in our material due to the recrystallization of the wall this character is not visible so it is impossible to determine decidedly the type.

A part of the tests resembles more to *G. oxfordiana*, with a more lobated outline while an other part better approaches *F. hoterivica* due to a more compact test.

It appears that all specimens display an umbilical bulla similar to that of *F. hoterivica,* but sometimes *G. oxfordiana* with bulla can also be found.

In the studied Tithonian protoglobigerinids fauna we have not found any high trochospired forms like *Conoglobigerina conica* (IOVČEVA & TRIFONOVA, 1961) nor turborotalid forms with extraumbilical aperture like *Haeuslerina helvetojurassica* (HAEUSLER, 1881) nor forms with intra-extraumbilical aperture like in *Compactogerina stellapolaris* (GRIGELIS, 1977). It is difficult to compare our forms to *Conoglobigerina terquemi* (IOVČEVA & TRIFONOVA, 1961), because in the literature there is only description of glauconitic molds. This preservation does not allow determination at specific or even at generic level.

Conclusions

A unique, rich Early Tithonian protoglobigerinid fauna is described from the Paprét-árok section, Gerecse Mts, Hungary. The assemblage is homogeneous and it seems that all specimens have bulla. This kind of assemblage has not been recorded yet. Because the wall is recrystallized it is not possible to study the surface ornamentation, so they could not be precisely determined. In our opinion the protoglobigerinids of Paprét-árok morphologically show transitional characters between *Globuligerina oxfordiana* (Grigelis) and *Favusella hoterivica* (SUBBOTINA) according to chambers arrangement and omnipresence of a bulla. The knowledge about the Tithonian protoglobigerinids is very lacunal, there are only 7 illustrations about them in the literature. Therefore, in spite of the lack of the precise determination, this fauna gives a very important record of this group. Only future investigations on better-preserved material can solve the problem of the link between the Jurassic and Cretaceous planktonic foraminifers.

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Plate 1
Tithonian protoglobigerinids
of Paprét-árok, Gerecse Mts, Hungary

Fig. 1. Thin section with radiolarians, protoglobigerinids, *Globochaete*. Scale in micrometres.

Fig. 2. Thin section with radiolarians, protoglobigerinids, *Globochaete, Nodosaria* sp. Scale in micrometres.

Figs 3-11. Isolated protoglobigerinids, transitional forms between *Globuligerina oxfordiana* (GRIGELIS, 1958) and *Favusella hoterivica* (SUBBOTINA, 1953). Scale in micrometres.

Fig. 3. umbilical view with bulla,
Fig. 4. oblique umbilical view with bulla,
Fig. 5. lateral view with bulla,
Fig. 6. lateral view with bulla, aperture bordered by a lip
Fig. 7. oblique umbilical view, bulla with two apertures
Fig. 8. lateral view, bulla with hemicircular aperture bordered by a lip,
Fig. 9. lateral view, with a large bulla,
Fig. 10. lateral view with slit-like aperture,
Fig. 11. spiral side.

Plate 1