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LINGULA DREGERI (BRACHIOPODA) FROM THE MIDDLE MIOCENE OF HUNGARY

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Abstract: Lingulide brachiopods, assigned to *Lingula dregeri* Andreae, 1893, have been identified from the Middle Miocene (Upper Badenian) of the Hungarian part of the Pannonian Basin. Although widely distributed in the Miocene of the Central Paratethys (Austria, Poland, Ukraine, Romania), the genus *Lingula* was not described previously from Hungary. Outside of the Central Paratethys, *L. dregeri* also has been recognized in the Atlantic and Mediterranean provinces and most probably in the Eastern Paratethys.

Key words: Brachiopoda, *Lingula*, Middle Miocene, Pannonian Basin, Hungary.

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INTRODUCTION

Despite the fact that lingulide brachiopods have been reported from several localities in the Middle Miocene of the Central Paratethys (Dreger, 1889; Friedberg, 1921, 1930; Meznerics, 1944; Barczyk & Popiel-Barczyk, 1977; Popiel-Barczyk, 1980; Bărbulescu & Rado, 1984; Popiel-Barczyk & Barczyk, 1990; Schmid *et al.*, 2001; Emig & Bitner, 2005), the genus *Lingula* Bruguière, 1791 was not described up to now from the Miocene of Hungary. However, its presence was mentioned in the faunal lists by Müller (1978) and Kókay *et al.* (1984).

Lingula has a very low taphonomic potential. Its thin, fragile shell, composed of alternating chitinous and phosphatic layers, undergoes rapid post-mortem degradation. Recent observations show that after death the valves of *Lingula* are reduced to unrecognizable fragments and they disappear from the sediment in 2–3 weeks (Emig, 1990). Only a catastrophic event allows the preservation of lingulide shells in the fossil record. Typical environments of living *Lingula* are from intertidal-infralittoral zones to depths of about 20 m and rarely deeper (Emig, 1997a, b, fig. 417). It lives in vertical burrows, in compact and stable, sandy sediments under the influence of moderate, near-bottom currents (Emig, 1997a). All lingulides live in biotopes under normal, marine salinities, but they are able to withstand strong salinity variations. However, none has adapted to brackish- or fresh-water conditions (Emig, 1997a).

This paper describes the first occurrence of the genus *Lingula* in the Cenozoic deposits of the Hungarian part of the Pannonian Basin.

GEOLOGICAL SETTING

The Paratethys was an epicontinental sea that began to form in the Oligocene and existed until the Middle Miocene. The area from the present-day Austria to Poland, Ukraine, Romania and Bulgaria is called the Central Paratethys, and the part of it within the Carpathian arch is known as the Pannonian Basin. The Badenian (16.4 to 13.0 Ma) is a regional stage used in the Central Paratethys for part of the Middle Miocene (Langhian to Middle Serravallian) (Papp *et al.*, 1978). The Early Badenian corresponds to a climatic peak, the so-called Middle Miocene Climatic Optimum – a global warming event at approximately 17–15 Ma (Kováč *et al.*, 2007), when coral reefs made their northernmost Neogene appearance (southern Poland, Pisera, 1996). The Middle Badenian may correspond to a global eustatic lowstand that resulted in the formation of evaporites (Cendón *et al.*, 2004). The Late Badenian stage corresponds again to a climatic optimum, with coral patch reefs in Hungary (Saint

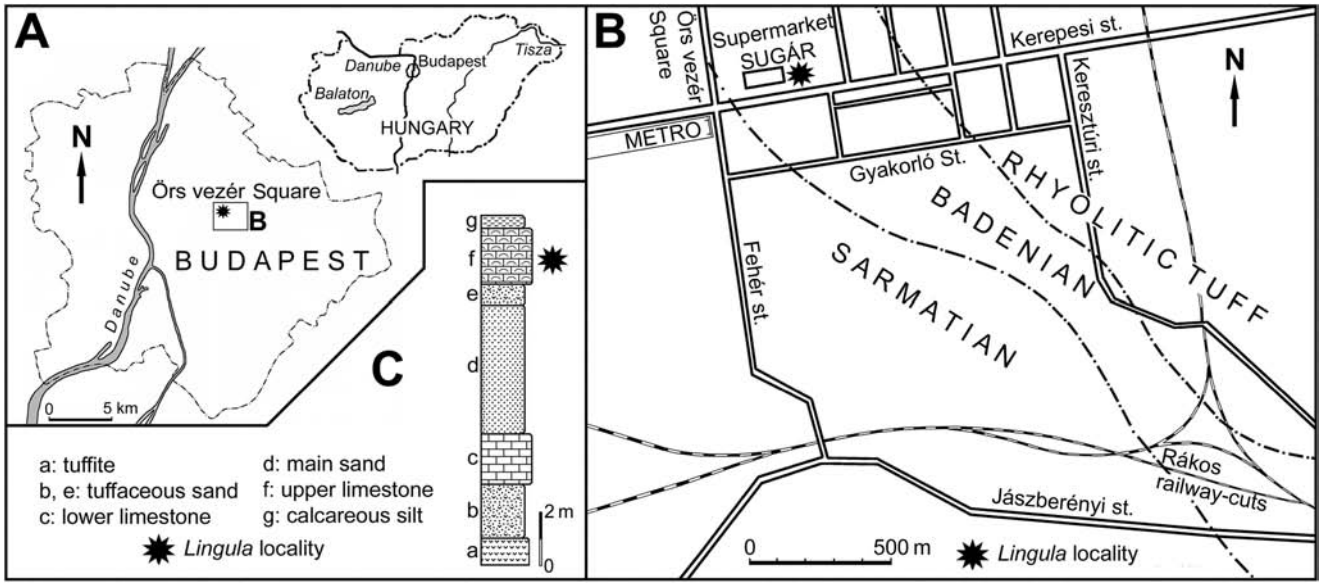

Fig. 1. **A.** Sketch map showing the location of the studied locality within Budapest. Modified after Müller (1984). **B.** Detailed street map around the locality, showing the distribution of Miocene deposits. Modified after Kókay *et al.* (1984, fig. 1). **C.** Simplified section of Miocene deposits around the *Lingula* locality. Modified after Kókay *et al.* (1984, fig. 2)

Martin *et al.*, 2000). However, in contrast to the rich Early Badenian assemblages, these patch reefs are impoverished, owing to a less than optimal climate and/or a slight change in salinity (Moissette *et al.*, 2006).

In the Budapest area (Pannonian Basin) the dacitic tuffs (Tar Dacite Tuff Formation; Fig.1C-a) of Karpatian age are covered directly by the Upper Badenian deposits (Kókay *et al.*, 1984). The Upper Badenian sequence (Rákos Limestone Formation; Fig. 1C-b-g) begins with a 2 m-thick tuffaceous sandstone with remnants of coral patch reefs. The sandstone is covered by a 2 m-thick layer of limestone (the "lower limestone" of Kókay *et al.*, 1984; Fig. 1C-c) with a rich molluscan fauna. The limestone is overlain by a 5 m-thick fossiliferous sandstone (the "main sand-layer" of Kókay *et al.*, 1984; Fig. 1C-d). The sequence is covered again by limestones (the "upper limestone"; Fig. 1C-f). The Badenian is terminated by a dacitic tuff, which is covered by the Sarmatian breccia-like deposits.

The species *Lingula dregeri* Andreae, 1893 studied here was found at Örs vezér Square in Budapest in a temporary outcrop, not accessible today, made during the construction of a supermarket called "SUGÁR" (Fig. 1A, B). At this locality, the sequence starts with the main sand-layer, which is covered by carbonate sandstone (see Fig. 1C-d). The 2.2 m thick biodetrital calcarenite contains a rich and almost euhaline fauna (among others *Lingula*). On the basis of the mollusc, echinoid and decapod faunas, Kókay *et al.* (1984) interpreted this limestone as having been deposited in a sublittoral environment, at depths of 20–30 m. Among the mollusc fauna, numerous Eastern Paratethyan (Konkian) elements have been recognized (see also Kókay, 1985). These deposits have been dated on the basis of molluscs (*Flabellipecten leythajanus – Pecten aduncus* subzone of Bohn-Havas *et al.*, 1987) as Late Badenian in age. Kókay *et al.* (1984) have identified 331 mollusc, 49 decapod and 30 echinoid species from the Upper Badenian "Leitha Limestone" (= Rákos Limestone Formation) of the Örs vezér Square and its surroundings.

COMMENTS ON *LINGULA DREGERI* ANDREAE, 1893

Material

The investigated material of *Lingula dregeri* (Fig. 2) consists of four nearly complete specimens with broken posterior parts, and several fragments, all adhering to the limestone. As none of the valves is complete, only the width (W) can be measured, and it is 10.3 mm. The length (L) can be deduced from the W/L ratios given by Emig and Bitner (2005), i.e. W/L is 0.37–0.52, with a mean of 0.47. Thus, the specimens are about 20 mm in length. Because external shell characters have no taxonomic value, the identification of lingulides requires examination of the muscle scar arrangement (Emig, 2003). The investigated specimens were adhered to the limestone and did not yield such data. However, earlier investigations showed that all the lingulide specimens from the Badenian of the Central Paratethys could be assigned to one species, *Lingula dregeri* (see Emig & Bitner, 2005). Therefore most probably the specimens from Hungary also belong to this species. The well preserved, nearly complete material of *L. dregeri* found in France allowed the diagnosis of this species to be emended (Emig *et al.*, 2007).

The studied material is housed in the Hungarian Natural History Museum, Budapest under the inventory numbers M 2010.333.1 – M 2010.335.1.

Distribution

Lingula dregeri was originally described as *L. suessi* by Dreger (1889) from the Vienna Basin (Fig. 3). However,

because the species name was preoccupied by a Late Triassic species of the same genus, Andreae (1893) proposed replacement of the name *suessi* with *dregeri*. *Lingula* was found at several localities in the Middle Miocene of the Central Paratethys (Fig. 3), being described under various names, i.e., *L. dregeri*, *L. dumortieri*, *L.* aff. *Dumortieri*. However, only the name *L. dregeri* is valid for that material (see Emig & Bitner, 2005). *L. dumortieri*, originally described from the Pliocene of Belgium, was transferred to the genus *Glottidia* by Chuang (1964). *L. dregeri* was also recognized in the Serravallian (Middle Miocene) deposits in the Aquitaine Basin, south-western France, by Emig *et al.* (2007).

Specimens from Cagliari (Sardinia, Italy) were described as *L.* cf. *dregeri* by Dreger (1911). However, there is a need for re-examination to verify assignment to this species (see also comments in Emig & Bitner, 2005 and Emig *et al.*, 2007). Nevertheless this is the only known report of Miocene *Lingula* in the Mediterranean province.

Lingulide brachiopods, reported from the Konkian (= Upper Badenian) of the Eastern Paratethys, were described as a new species, *Lingula menneri* by Merklin (1954). This author emphasises the great similarity of his material to that of *L.* aff. *Dumortieri*, described from Ukraine by Friedberg (1921); and he synonymized both species. This material might also represent *L. dregeri*, which would extend the distribution of *L. dregeri* from the Atlantic province to the eastern shore of the present Caspian Sea (Eastern Paratethys; Fig. 3). Additionally, a possible connection of the Central Paratethys to the Konkian Sea of the Eastern Para-

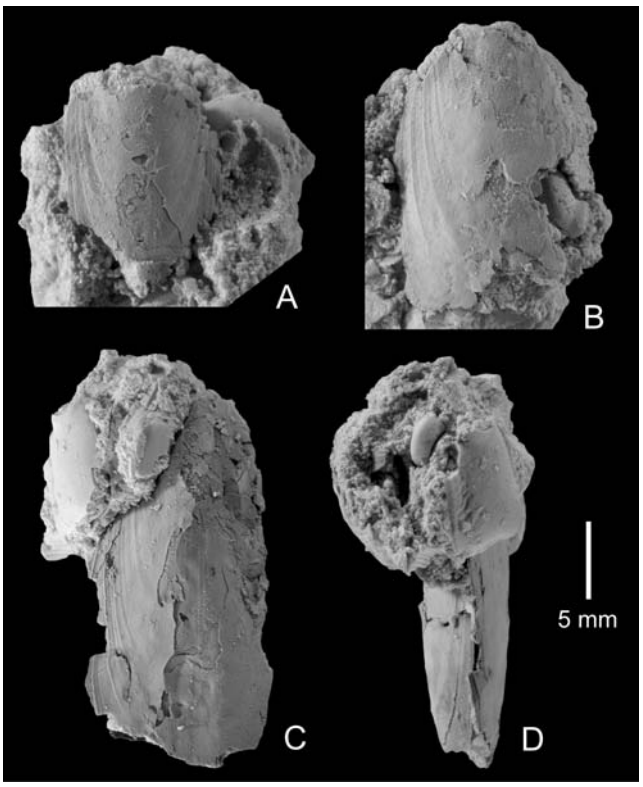

Fig. 2. *Lingula dregeri* Andreae, 1893, Late Badenian, Örs vezér Square, Budapest, Hungary. **A, B.** External views of shell fragments (A – M 2010.333.1, B – M 2010.334.1). **C, D.** External (C) and lateral (D) views of nearly complete shell (M 2010.335.1)

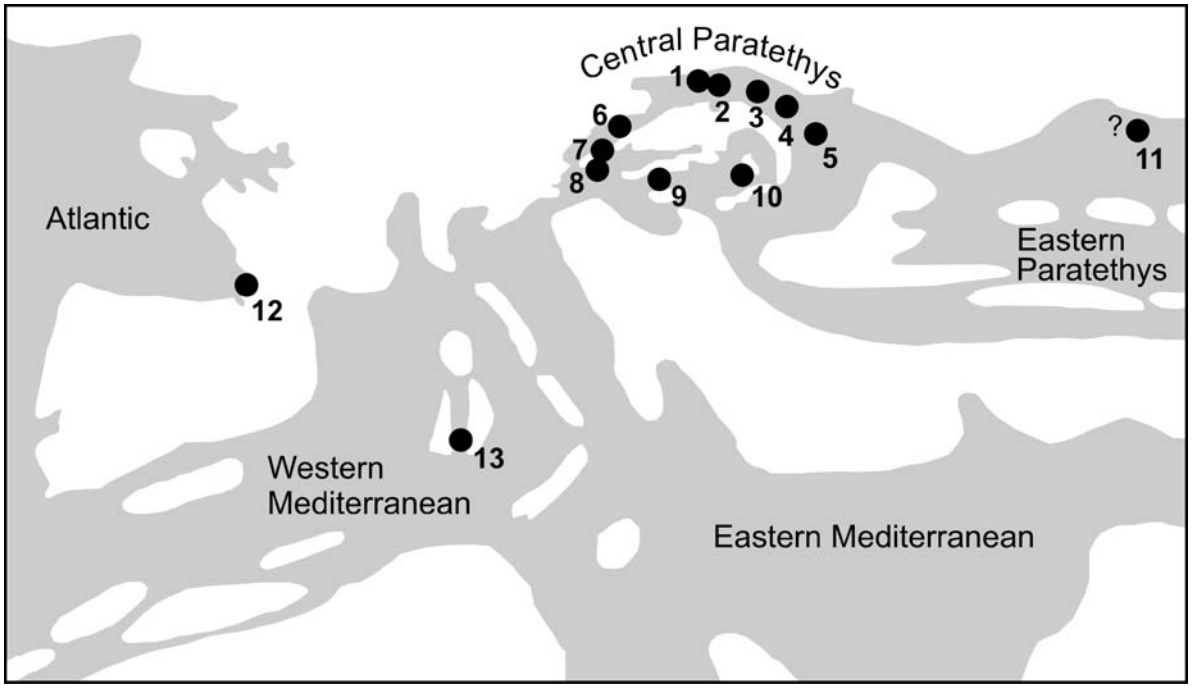

Fig. 3. Geographical distribution of *Lingula dregeri* Andreae, 1893 in the Middle Miocene of Europe: 1 – Korytnica, Poland (Barczyk & Popiel-Barczyk, 1977; Emig & Bitner, 2005); 2 – Wójcza-Pińczów Range, Poland (Popiel-Barczyk & Barczyk, 1990; Emig & Bitner, 2005); 3 – Węglin, Poland (unpubl. data); 4 – Huta Lubycka, Długi Goraj (Popiel-Barczyk, 1980; Emig & Bitner 2005); 5 – Obertasów near Zolochiv, Ukraine (Friedberg, 1921); 6 – Austränk, Austria (Dreger, 1889); 7 – Loretto, Austria (Dreger, 1889); 8 – St. Margarethen, Austria (Meznerics, 1944; Schmid *et al.*, 2001); 9 – Budapest, Hungary (this paper); 10 – Lăpugiu, Romania (Bărbulescu & Rado, 1984); 11 – Kara-Bogaz-Gol, Turkmenistan (Merklin, 1954); 12 – Salles, France (Emig *et al.*, 2007); 13 – Cagliari, Sardinia (Dreger, 1911). Paleogeographic map after Popov *et al.* (2004) and Moissette *et al.* (2006), simplified

tethys is suggested (Studencka *et al.*, 1998; Kováč *et al.*, 2007). This opinion can be supported by the Konkian faunal elements in the *Lingula*-bearing Upper Badenian deposits of the Central Paratethys (Kókay *et al.*, 1984; Kókay, 1985).

It is noteworthy that lingulide fragments have been reported recently from the Early Miocene (Ottnangian) strata of Swabia and Bavaria, southern Germany (Bitner & Schneider, 2009).

At the present time, although displaying low species diversity, *Lingula* has a world-wide distribution (except for the Americas), being restricted to the continental shelf of tropical to temperate areas (Emig, 1997a, b, 2003). The Badenian climate of the Central Paratethys was characterized by fairly uniform, subtropical conditions (Kováč *et al.*, 2007). However, in the Late Badenian, changes in the faunal composition clearly indicate decreasing surface water temperatures (e.g. Báldi, 2006; Moissette *et al.*, 2006), although this cooling is only slightly marked in the southern regions of the Central Paratethys, and the discovery of *Lingula*, a warm climate indicator, in the Pannonian Basin confirms that the cooling was minor.

CONCLUSIONS

The first occurrence of lingulide brachiopods in the Hungarian part of the Pannonian Basin is reported here from the Upper Badenian (Middle Miocene) limestone of Budapest. The specimens are assigned to *Lingula dregeri* Andreae, 1893, which is widely distributed in the Middle Miocene of the Central Paratethys (Austria, Poland, Ukraine, Romania and Hungary) and also is recognized in the Mediterranean and Atlantic provinces to the west. It probably also occurs in the Caspian Sea region of the Eastern Paratethys. The presence of *Lingula* may indicate an even shallower environment than that, based on the associated fauna. *Lingula*, a warm water indicator, also confirms that the cooling, observed in the Central Paratethys in the Late Badenian, was poorly marked in the southern part.

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