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LOFTUSIA CF. ANATOLICA HORIZON IN UPPER MAASTRICHTIAN LIMESTONES OF THE EASTERN GREECE PLATFORM (MOUNT PTOON, BOEOTIA, GREECE): PALAEOBIOGEOGRAPHICAL REMARKS

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ABSTRACT

Researches on upper Cretaceous limestones from the Eastern Greece platform in the area between Kokkinon and Akrefnion (Boeotia, Greece) revealed the presence of a horizon rich in *Loftusia* cf. *anatolica* (foraminifer). In this horizon, of late Maastrichtian age, *L.* cf. *anatolica* is associated with debris of Rudists, *Orbitoides media*, *O. apiculata*, *O. gensacicus*, *Siderolites calcitrapoides*, *Omphalocyclus macroporus*, *Hellenocyclina beotica*, Miliolidae, Dasycladaceae and echinoderms. It is found in an undisturbed sequence of limestones, where both the underlying and the overlying horizons are of the same facies and contain debris of Rudists, *Hellenocyclina beotica*, *Orbitoides media*, *Siderolites calcitrapoides*, *Sulcoperculina* sp., Rotaliidae, Mélobesiées, *Nummofallotia* sp., echinoderms. *L.* cf. *anatolica* is confined in the above mentioned horizon and it is found neither in the underlying nor in the overlying beds. This facies reflects an outer shelf environment in front of the rudist reefs.

It is the first time that this species is reported in situ in Greece in an undisturbed stratigraphic sequence of upper Cretaceous limestones up to Paleocene flysch.

KEY WORDS: *Loftusia* cf. *anatolica*, Maastrichtian, paleobiogeography, Eastern Greece platform, Boeotia, Greece.

1 INTRODUCTION

Loftusia is a benthic foraminifer of Maastrichtian, known from outer platform facies of the Tethys Ocean. The genus is abundant in arabo-iranian platforms, rare in eastern Mediterranean and totally absent in western Mediterranean (Fig. 7).

In Greece it has so far been reported from two sites:

- On Kassidiaris mount (MK in Fig.7) as debris in bioclastic upper Cretaceous limestones of the internal zones (Ferrière, 1982),
- On mounts Valtou (Gavrovo zone, MV in Fig.7) in an occasionally bioclastic conglomerate which is limited by faults that prohibit us from observing its relation with the surrounding formations (Fleury *et al.*, 1990).

In the area of Boeotia, on mount Ptoon (Fig. 1), a horizon rich in *Loftusia* cf. *anatolica* has been found (MP in Fig. 7) in an undisturbed sequence of upper Cretaceous limestones up to Paleocene flysch of the Eastern Greece zone. This recovery is considered very important for the paleogeography of the Tethys Ocean during late Cretaceous.

2 STRATIGRAPHIC DESCRIPTION

This section was realized along the road that from Kokkinon (Boeotia) leads to Akraifnion. More specifically it begins at the point where the road "Megali Rachi" is being constructed, 2 km before Akraifnion (Fig. 1).

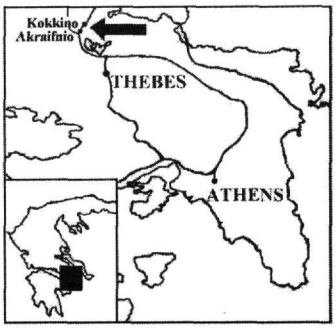


Fig. 1 Location of the study area.

From bottom to top we observed the following formations (Fig.2):

A: 20 m of gray, medium bedded to massive limestones, grainstone-rudstone with debris of Rudists (Fig.3a).

B: 3 m of light gray massive limestones, floatstone with *Orbitoides tissoti* (Fig.3b), *Orbitoides media*, *Lepidorbitoides* sp., *Siderolites calcitrapoides* (Fig.3b), *Sulcoperculina* sp. *Goupillaudina* sp., Rotaliidae, Mélobesiées and echinoderms. At the upper part only abundant shells of Rudists are observed.

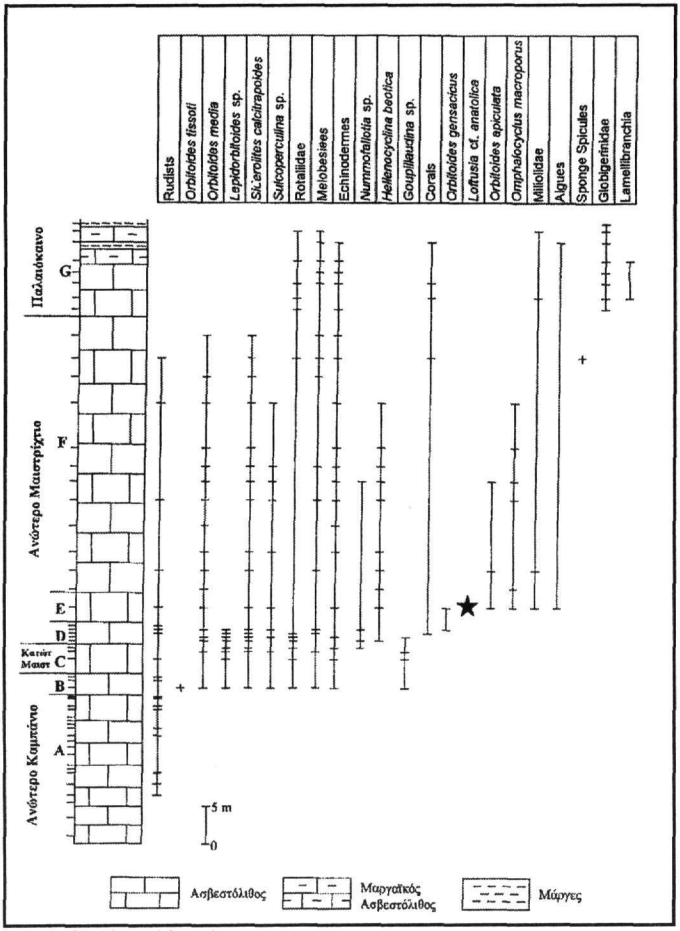


Fig. 2. Stratigraphic columr..

C: 4 m of light gray massive limestones, packstone-grainstone, with debris of Rudists, *Orbitoides media*, *Lepidorbitoides* sp., *Siderolites calcitrapoides* (Fig.3c), *Sulcoperculina* sp., *Nummofallotia* sp., *Goupillaudina* sp., Rotaliidae, Mélobesiées and echinoderms.

D: 3 m of light gray massive limestones, packstone-floatstone to grainstone, with debris and shells of Rudists, *Hellenocyclina beotica*, *Orbitoides media*, *Orbitoides gensacicus* (Fig.3d), *Lepidorbitoides* sp., *Siderolites calcitrapoides*, *Sulcoperculina* sp., *Nummofallotia* sp. (Fig. 3d), *Goupillaudina* sp., Rotaliidae, Mélobesiées, echinoderms and corals.

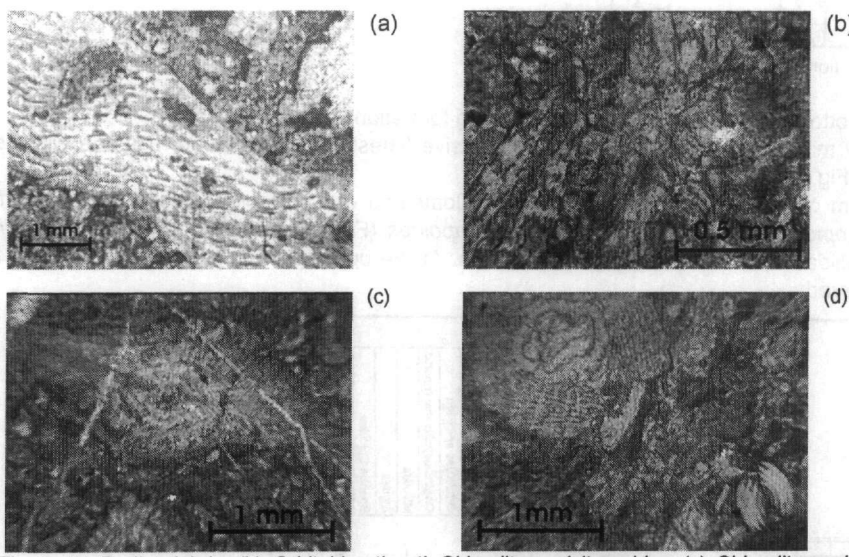


Fig. 3. (a) Rudist debris. (b) *Orbitoides tissoti*, *Siderolites calcitrapoides*. (c) *Siderolites calcitrapoides*. (d) *Orbitoides gensacicus*, *Nummofallotia* sp.

E: 4 m of light gray, thickly bedded limestones, floatstone, with debris of Rudists, *Loftusia* cf. *anatolica* (Fig. 4a, b), *Orbitoides media* (Fig. 4b), *Orbitoides apiculata* (Fig. 4b), *Orbitoides gensacicus*, *Siderolites calcitrapoides*, *Omphalocyclus macroporus* (Fig. 5a), *Hellenocyclina beotica*, *Sulcoperculina* sp., Miliolidae, echinoderms and algues.

F: 37 m of light gray, thickly bedded limestones, packstone-grainstone, with debris of Rudists, *Hellenocyclina beotica* (Fig. 5b), *Orbitoides media*, *Siderolites calcitrapoides*, *Orbitoides apiculata*, *Omphalocyclus macroporus*, *Sulcoperculina* sp., *Nummofallotia* sp., Mélobesiées, Rotaliidae, Miliolidae, echinoderms and corals.

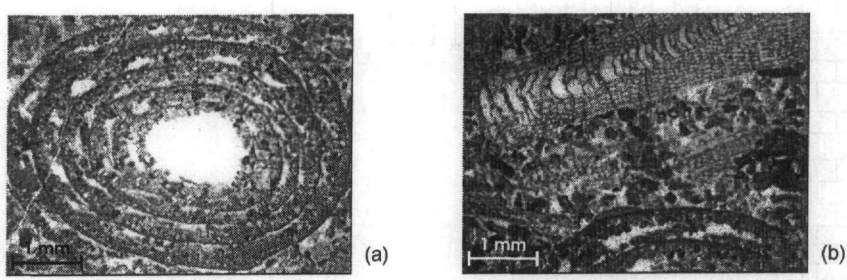
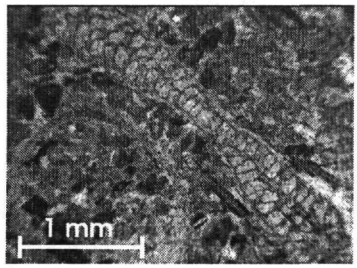
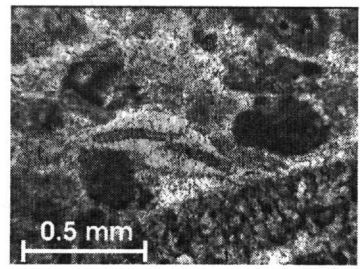


Fig. 4. (a) *Loftusia* cf. *anatolica*. (b) *Loftusia* cf. *anatolica*, *Orbitoides media*, *Orbitoides apiculata*, *Omphalocyclus macroporus*.



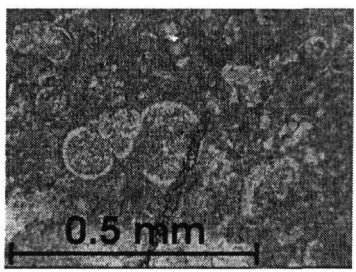
(a)



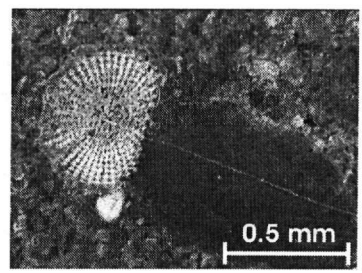
(b)

Fig.5. (a) *Omphalocyclus macroporus*, (b) *Hellenocyclina beotica*.

G: 13 m, of light gray, thickly bedded limestones, packstone-wackestone, with Globigerinidae (Fig. 6a), Rotaliidae, Mélobesiées (Fig. 6b), spicules and large shells of echinoderms (Fig. 6b), Miliolidae, corals, algues and debris of Lamellibranches. In the upper part, thin bedded marly limestones and marls are followed by flysch sedimentation.



(a)



(b)

Fig. 6. (a) Globigerinidae, (b) Mélobésiées, spicule of echinoderm.

We observe that *Loftusia* appears in relative abundance in a thin horizon (approximately 4 m) of late Maastrichtian age (association with *Hellenocyclina beotica*) and it is found neither in the underlying nor in the overlying beds. That could explain the rarity of the references of the genus.

In the study area the facies that contain *Loftusia* reflect an environment in the outer platform. The vicinity to the rudist reefs is indicated by the abundant debris and entire shells of Rudists in the horizon that underlies the one with *Loftusia*. This environment is in agreement with what is reported in the international literature concerning the biotope of the genus *Loftusia*.

3 MICROPALEONTOLOGICAL REMARKS

Order: Foraminiferida EICHWALD 1830
Suborder: Textulariina DELAGE & HEROUARD 1896
Superfamily: Loftusiacea BRADY 1884
Family: Loftusiidae BRADY 1884
Genus: *Loftusia* BRADY (in Carpenter & Brady 1870)
Type species: *Loftusia persica* BRADY (in Carpenter & Brady 1870)

Loftusia BRADY 1870 is a benthic planispiral foraminifera. It has a fusiform, ovoid, globose or nautiloid test. The wall of the spire is perforate, calcareous and alveolar with an arenaceous endoskeleton. It is tightly coiled with regular whorls whose thickness increases gradually from center to periphery. Primary, longitudinal, oblique septa divide the whorls into chambers with labyrinthic, endoskeletal structure. The last is composed of radially set pillars. Transverse secondary or partial septa may be formed from the fusion of pillars. Across the primary septa and arranged in transverse rows there are numerous apertures.

The determination of the species so far described is primarily based on size. Thus small, medium and large size species are distinguished (Brady, 1869 in Carpenter & Brady, 1870; Douvillé, 1904; Cox, 1937; Grubic, 1958; Meric 1965a, b, 1967, 1979; Al Omari & Sadek, 1976, El Asa'ad, 1989, Meric & Avsar, 1992).

Cox (1937) studied the *Loftusia* from Persia providing a historical review on the genus in detail. Furthermore based on measurements of their external dimensions e.g. maximum diameter, L/D ratio, he made up a table of the different species of the genus.

Loftusia anatolica MERIC 1965 was defined as a medium sized species with rounded poles. The measurements of the size and internal structures of *L. anatolica* and the other species of the genus as well as of our specimens are shown in Table 1. The specimens observed in our samples are megalospheric. The test is fusiform with alveolar structure and it has rounded poles.

Tab.1. Measurements on species of *Loftusia* (after Henson, 1948; Meric, 1965, 1979; Inan, 1988; El-Asa'ad, 1989). Measurements on specimens of *L.* cf. *anatolica* determined in Ptoon are included.

Species of *Loftusia*	N° of tours	Length (mm)	Diameter (mm)	Height of 1st tour (mm)	Height of last tour (mm)	Diam. of embr. chamber (mm)	N° of septa of 1st tour	N° of septa of last tour
anatolica	6-7	16.1-22 max-ave-min	4.7-6.1 Max-ave-min	0.2-0.4	0.3-0.4	0.9-1.4	8-11	8-22
arabica	10	58-33.9-16.5	6-3.9-2.1	-	-	-	-	-
baykali	2-3	2.3-4.2	1.6-2.4	0.3	0.2-0.3	0.4-0.8	6-7	9-10
coxi	3	max: 6.1 max-ave-min	Max: 3.3 max-ave-min	-	0.55	0.33-0.4	-	12-13
elongata	18	118-55.5-12	33-12.3-5.6	-	-	-	-	-
ketini								
(forme A)	1.5-2.5	1.8-5.3	1.4-2.5	0.35-0.39	0.31-0.39	0.5-1.0	4-5	9-10
(forme B)	8-10	23.9-41.8	5.2-10.7	0.43-0.78	0.43-0.67	-	4-5	23-25
minor								
(forme A)	6-7	2.75-7.5	2.30-4.32	0.14-0.2	0.16-0.38	-	-	-
(forme B)	2-2.5	1.5-1.7 max-ave-min	1.52-1.8 max-ave-min	~0.3	0.22-0.24	0.2-0.8	-	-
morgani	16	44.5-27-6	8-5.8-3	-	-	-	-	-
L. cf. *anatolica* in Ptoon	5-7	8.56	3.2-4.04	0.2 – 0.36	0.28-0.4	0.84-2		

Thus according to the measurements, our specimens are included in the group of medium-sized species of *Loftusia*. Based on previous data we conclude that the species with which our specimens present the greatest resemblance is *Loftusia anatolica* MERIC 1965. It is a species of medium size and it has been described only from megalospheric forms. The measurements in our specimens present small deviations from the typical *L. anatolica*, mainly in the total length, which was measured in only one specimen, and the diameter. Both were found smaller while the diameter of the embryonic chamber appears bigger. The observed deviations could not lead us to the identification of a new species due to lack of a sufficient number of specimens.

Al-Omari & Sadek (1976) investigated microscopically and statistically specimens of *Loftusia* from the Maastrichtian of Northern Iraq (Aqra Formation). They noticed that during this period the genus exhibited a gradual increase in size (length and diameter). Thus, they recognized an evolutionary line for the development of *Loftusia* considering the forms recorded from Cox (1937) as the early stages of the genus' development. In addition they recorded a tendency for tighter forms during the transition from Mid to Late Maastrichtian.

Meriç *et al.* (2001) studied the palaeogeographical distribution of the species of *Loftusia* on the Gondwanian and Laurasian platforms during the Maastrichtian based on the plate tectonic reconstructions of Sengör & Yilmaz (1981). The authors identified three main *Loftusia* groups according

to previous data on their dimensions: small, medium and large. Meriç *et al.* (2001) also noted that loftusiids show dimorphism with most of the *Loftusia* species having been identified from either megalospheric (A) or microspheric (B) (only few) forms. Both (A) and (B) forms are seen in only a few species.

4 PALEOECOLOGICAL AND PALEOGEOGRAPHICAL REMARKS

The genus *Loftusia* is already known since the 19th century. It is abundant in arabo-iranian platforms, rare in eastern Mediterranean and totally absent in western Mediterranean (fig. 7). It is reported from:

-Iran: Brady, 1869 in Carpenter & Brady, 1870; Douvillé, 1904; Cox, 1937 (ZA); Bozorgnia, 1964 (ZA); Sampo, 1969 (ZA).

-Iraq: Henson, 1948, 1950 (IN); Al Omari & Sadek, 1976 (IN); Schroeder & Darmoian, 1977 (IN); Al Naqib, 1967 (IN).

-Oman: Kuhn, 1929; Philip & Platel, 1987; Babinot & Bourdillon de Grissac, 1989.

-Saudi Arabia: Powers, 1968 (AS).

-Dinarides: Milovanovich, 1935, 1938, Serbia; Grubic, 1958, 1962 Serbia; Drobne & Hottinger, 1971 (SO); Chorowicz, 1977 (PK); Radoicic, 1980.

-Apennines: Molinary & Tilia, 1976; Chiocchini *et al.* , 1976; Chiocchini & Mancinelli, 1977 (ML); Carbone & Sirna, 1981 (ML).

-Taurides and Pontides: Meric, 1965 (TO); Meric & Mojab, 1977; Poisson, 1977 (NL); Meric, 1991.

-Syria: Sadek, 1979 (SY) and

-Hellenides: Ferriere, 1982 (MK); Fleury *et al.*, 1990 (MV) and present paper (MP).

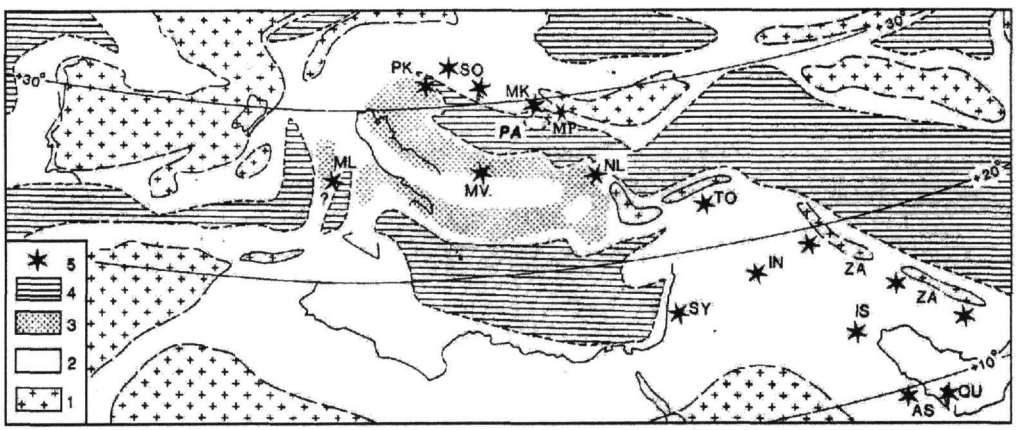


Fig. 7. Palinspastic distribution of the occurrences of the genus *Loftusia*. The pairs of letters correspond to the localities mentioned in the text (PA: Mount Parnassus, Greece) (from Fleury *et al.* 1990, modified).

1: land areas, 2: shelf and slope, 3: Adriatic-Aegean carbonate platforms, 4: deep water basins, 5: *Loftusia* occurrences.

In the majority of the sites, *Loftusia* is either transported (Chorowicz, 1977; Poisson, 1977; Ferriere, 1982) or the beds that enclose it are not in stratigraphic continuity with the underlying and the overlying formations. Thus:

On mounts Valtou (Gavrovo zone) (Fleury *et al.*, 1990) *Loftusia* is found in a conglomerate which comes in contact, by faults, with limestones probably of Cenomanian age, as well as with Paleocene breccias with Madrepores. The *Loftusia* shells are included in a grainstone-rudstone facies along with debris of Rudists, *Orbitoides* sp. (large size, up to 16 mm), *Lepidorbitoides* sp. and other

benthic foraminifers. The depositional environment at the margin of the platform, during Campanian-Maastrichtian is the contribution of this recovery on mounts Valtou.

Meric (1965a) found abundant specimens of *Loftusia* in eastern Turkey, among which he determined *L. anatolica* n.sp., in conglomeratic limestones of Maastrichtian age. The *Loftusia* shells usually constitute elements of the conglomerate therefore can be considered as transported. The Lutetian uncomformably overlies the Maastrichtian beds.

Al Omari & Sadek (1976) studied the evolution of the *Loftusia* species in a Maastrichtian sequence in northern Iraq. Nevertheless they do not provide information concerning its stratigraphic relation with the surrounding formations.

Henson (1950) notes that in the Aqra formation in northern Iraq, the compact reefal rudistic limestones pass into shallow facies of the reefal margin with *Loftusia*, *Omphalocyclus*, *Orbitoides*.

In Boeotia, the *Loftusia* are found in a calcareous Upper Maastrichtian horizon in a stratigraphic sequence of upper Campanian up to Paleocene age. The Loftusia horizon overlies a horizon with abundant Rudist shells and is associated with *Orbitoides media*, *Orbitoides apiculata*, *Siderolites calcitrapoides*, *Omphalocyclus macroporus*, *Hellenocyclina beotica*, *Sulcoperculina* sp., Miliolidae and echinoderms. The same fossils, but without the *Loftusia*, are also found in the overlying horizon, along with abundant large shells of echinodermes. This facies reflects an outer shelf environment in front of the rudist reefs of the Maastrichtian.

5 CONCLUSIONS

Loftusia cf. *anatolica* horizon of late Maastrichtian age is for the first time found in Greece in a continuous undisturbed sequence of upper Cretaceous limestones up to Paleocene flysch in Eastern Greece platform in Boeotia. Associated with debris of Rudists, *Orbitoides media*, *O. apiculata*, *O. gensacicus*, *Siderolites calcitrapoides*, *Omphalocyclus macroporus*, *Hellenocyclina beotica*, Miliolidae, Dasycladaceae and echinoderms it reflects an outer shelf environment in front of rudist reef.

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