Available online at http://geology.uaic.ro/auig/
Analele Stiintifice ale Universitatii "Al. I. Cuza" din Iasi
Seria Geologie 63 (1–2) (2017) 51–63

AUI
GEOLOGIE

First report of the genus *Euciphoceras* (Nautiloidea, Mollusca) from the latest Eocene rocks of the North-western Thrace Basin (Bulgaria)

Paul Țibuleac[1], George Ajdanlijsky[2]

[1] "Alexandru Ioan Cuza" University of Iaşi, Department of Geology, 20A Carol I Blv, 700505 Iaşi, Romania
[2] "St. Ivan Rilski" University, Department of Geology and Geoinformatics, Student Town, "Prof. Boyan Kamenov" Str., Sofia, 1700, Bulgaria

Abstract

The unique nautiloid specimen recorded so far from the latest Eocene marl bed of Durhana Quarry (DQ), Haskovo County (North-western Thrace Basin, Bulgaria) is described and discussed herein. It represents a phragmocone mould collected from the bench of level 103 of DQ. In the outcrop, one lateral side was exposed to the weathering process and the other was embedded in the rocks of the so-called "Tuff-Limestone Package" Member ("First Acidic Volcanic" Formation). The host-beds were previously documented as latest Eocene by a larger foraminifer and echinoid assemblage.
The specimen belongs to the genus *Euciphoceras* Shultz, 1976. The attempt to assign a species name failed because the nautiloid has been compressed and slightly deformed by the diagenetic processes within the host-rocks.
The general overview of the Eocene nautiloid records from the surrounding areas suggests a continuity of the same genera from Western Europe to South-central Asia (Tethyan Realm).

Keywords: Durhana, phragmocone, Priabonian, paleogeographical overview.

1. Introduction

The nautiloid specimen of Durhana Quarry was an incidental finding. Afterward, several successive field trips failed to sample new ones. This is not unusual, because in the Cenozoic the nautiloids are rather scattered records among the faunas, although they were documented in the widespread occurrences on all continents. Generally, only a few specimens are known from one Cenozoic stratigraphic level or from one sedimentary succession. The nautiloids are greatly surpassed by other mollusks (e.g., Hochstetter 1870; Frauscher, 1895; Vogl, 1908; Lőrenthey and

Corresponding author's e-mail: paul.tibuleac@uaic.com

Beurlen, 1929; Kummel, 1956; Shimansky, 1957; Squires, 1988; Hewitt, 1995; Saunders et al., 1996; Galácz, 2004; Micuź, 2009; Micuź and Bartol, 2012 etc.). However, several exceptions have been noticed (e.g., Zinsmeister, 1987; Ward et al., 2016). The short events of increased frequency during the early Paleocene, early and middle Eocene and middle Miocene were connected with episodes of warm climate expansion to the high latitudes (e.g., Miller, 1949; Dzik and Gaździcki, 2001) and also with the extinction of the ammonoid competitors after the Cretaceous-Paleogene (K-Pg) mass extinction (e.g., Miller, 1949: 231-232).

After the Neogene, several occurrences document the nautiloid continuity up to the present day. It should be mentioned the presence of nautiloid shell fragments in the Pleistocene cemented eolianitic sands of Ciovai Island from the Bajuni Islands, Archipelago of Somalia (Carbone et al., 1999; Matteuci, 2015). Also, the specimens of *Nautilus pompilius* were reported by Wani et al. (2008) from the Pleistocene siltstone exposed on Tambac Bay (Tambac Island, Philippines) and by Kase et al. (unpublished data – fide Wani et al., 2008) from the Holocene reefal rocks in Leyte (Philippines).

2. Geological framework

The Durhana Quarry is situated about 2 km west of Dimitrovgrad town (Haskovo County, Fig. 1D) in the north-western part of the extensive Cenozoic Thrace Basin or Thracian Basin (TB, Fig. 1A). Clayey limestone, calcareous clays, and marls were mined in the quarry up to the mid-20th century for clinker and cement production.

The TB has been extended from its Turkish traditional area towards west and south-west on Bulgarian and Greek territories (e.g., Görür and Okay, 1996). It was divided into several sectors, i.e., Central-eastern (Turkey), North-western (Bulgaria), and South-western (Greece) (Caracciolo et al., 2015).

The Bulgarian branch of TB (North-western Thrace Basin=NWTB) represents the "biggest negative structure within the Balkan Orogenic System" (Popov et al., 2015, and references therein) between Sredna Gora-Strandzha and the Rhodope Mountains. It was referred to by different names in the previous Bulgarian papers: "Upper Thracian Depression" (Boyanov and Goranov, 2001 and references therein), "Upper Thracian Lowland" (Popov et al., 2015) etc. The NWTB was first explained as post-orogenic graben (Bončev and Bakalov, 1928), but was later related with the "Maritsa suture" (Bončev, 1961; 1971; Boyanov and Goranov, 2001 and references therein; Popov et al., 2015 and references therein).

The implication of a continental rift system (Upper Thracian Rift System =UTRS) in the evolution of NWTB during the Eocene-Quaternary post-collisional processes was summarized by Boyanov and Goranov (2001) and Popov et al. (2015). During the main Alpine compressional events of latest Cretaceous – early Paleogene age originated by the northward subduction of the Vardar oceanic crust (Mureș-Vardar-Izmir-Ankara-Erzincan suture – Cavazza et al., 2013) beneath the active margin of the Euroasian paleocontinent, the Serbo-Macedonian and Balkan orogenic belts were formed. The latter was divided into: 1) Balkan s. str./External Balkanides/Stara

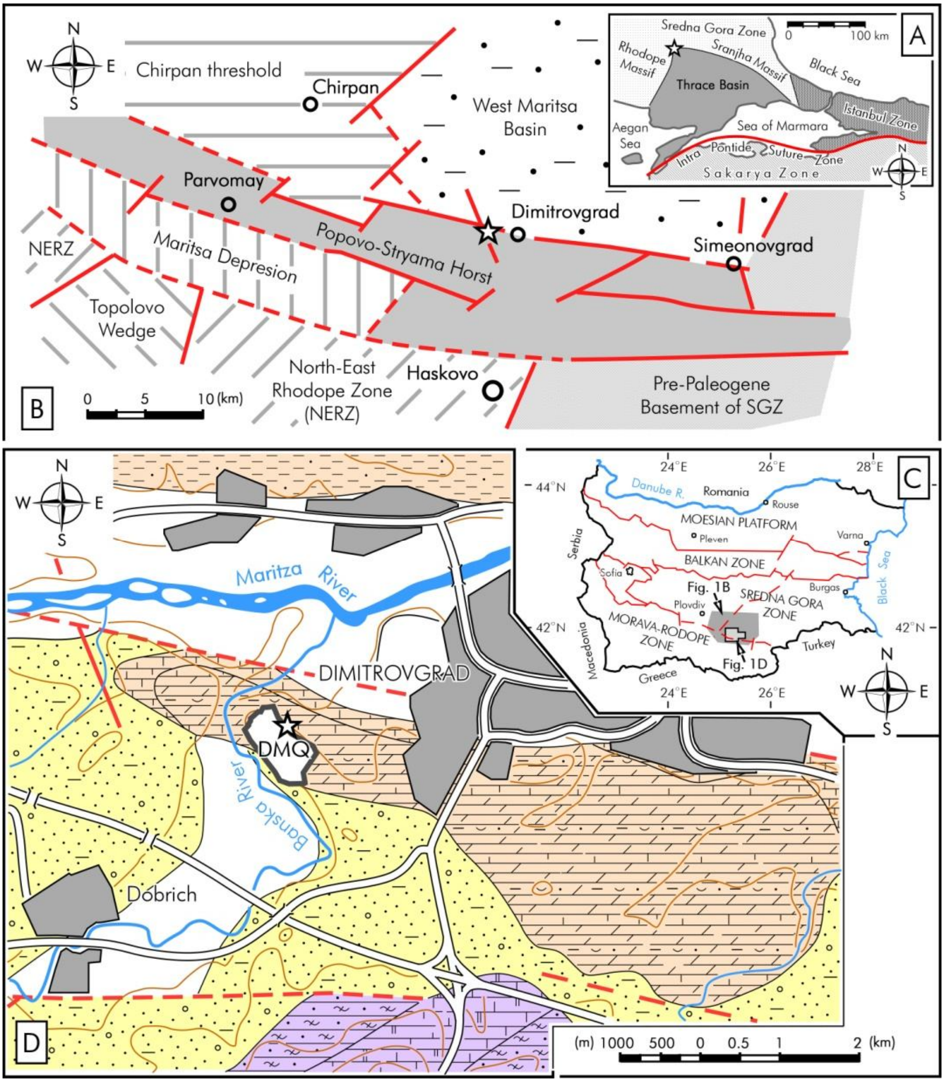

Fig. 1 Location of Durhana Quarry: A – Thrace Basin (after Görür and Okay, 1996); B – Development of Popovitsa-Stryama Horst (after Boyanov and Goranov, 2001); C – The main tectonic units of Balkan orogenic belt on the Bulgaria territory (after Dabovschi et al., 2002). D – Geological map of the DQ surrounding area (after Bojanov et al., 1993, with additions).

Planina, 2) Sredonogorie/"middle mountain belt", and 3) Rhodope/Morava-Rhodope/ Internal Balkanides (Dabovschi et al., 2002 and references therein). These tectonic units have different orogenic polarity: Rhodope Mountains generally prove a southern polarity (pro-wedge), whereas Balkan s. str. and Sredonogorie (retro-wedge) are overthrusted northward on the Moesian Platform (Gocev, 1991 – fide Vangelov et al., 2013).

After the latest Cretaceous – early

Paleogene orogenetic phases, a post-orogenic collapse formed in several steps a radial graben-mosaic (Boyanov and Goranov, 2001) between Sredna Gora and Morava-Rhodope zones (Fig. 1C, A) facilitated by a complex inter-related system of faults (*en echelon* pattern – Doglioni et al., 1996). Starting with the Eocene (? Bartonian-Priabonian), a marine transgression marked the beginning of sedimentation in the NWTB (e.g., Boyanov and Goranov, 2001; Popov et al., 2015 and references therein). From the lastest Priabonian, the depositional environment evolved into a continental-transitional-nearshore setting. Several reef limestone levels built by corals, green algae, bryozoans, and other invertebrates occurred in the intervals of relative tectonic stability within Priabonian – Rupelian time-span (Boyanov and Goranov, 2001; Cavazza et al., 2013 and references therein).

The next southern extensional regime (Oligocene–Neogene) which occurred from Turkey to Greece with the opening of the Aegean Sea, determined the extension of the upper plate and the formation of the UTRS along the major Maritsa Fault/ Maritsa graben system (Boyanov and Goranov, 2001; Cavazza et al., 2013 and references therein). Also, the opening of the Black Sea (Cretaceous–Paleogene) have influenced the tectonic evolution of the region, at least for the eastern part of Balkans/Bulgaria (Doglioni et al., 1996).

Cavazza et al. (2013) summarized the main hypotheses for the genesis and evolution of the entire TB: (1) the post-orogenic collapse after the closure of the Vardar ocean branch (the old hypothesis proposed by Bončev and Bakalov, 1928), (2) the upper-plate extension related to slab retreat in front of the Pindos remnant ocean or (3) a combination of these two processes.

The depositional processes developed various patterns in the different basins (basin-mosaic), which were associated with an intense volcanic activity during Oligocene (Boyanov and Goranov, 2001; Cavazza et al., 2013; Popov et al., 2015 and references therein). Then, the sedimentation continued up to the Quaternary through Oligocene – middle Miocene, late Miocene–Pliocene and Quaternary cycles (Popov et al., 2015).

3. Geological settings

The Durhana Quarry belongs to Popovo-Stryama Horst (PSH), a second-order tectonic unit of NWTB which played the role of longitudinal barrier (WNW–ESE) during the Paleogene evolution (Fig. 1B). PSH developed along the Maritsa deep fault/suture, which controlled the Oligocene volcanic activity, especially in the eastern part (Boyanov and Goranov, 2001).

The rocks cropping out in the Durhana Quarry belong to the Triassic basement (pre-Late Cretaceous rocks), on one hand, and the post-collisional rocks of Paleogene–Neogene, on the other. Ustrem Formation (intensively metamorphosed clastic rocks) and Srem Formation (metamorphosed carbonates) represent the Triassic basement (Kozuharov et al., 1968; Čatalov, 1985). It is covered by relatively thick Cenozoic volcano-sedimentary succession (tuffs and tuffites, marls, sandstones, nodular limestone, breccias etc., Fig. 2B). The later succession is not yet formalized and bears different names, i.e., “First Moderate-Acid Volcanic”=FMAV (Priabonian) and “First Acid Volcanic”=FAV (Priabonian–Rupelian) (Bojanov et al., 1989; 1993).

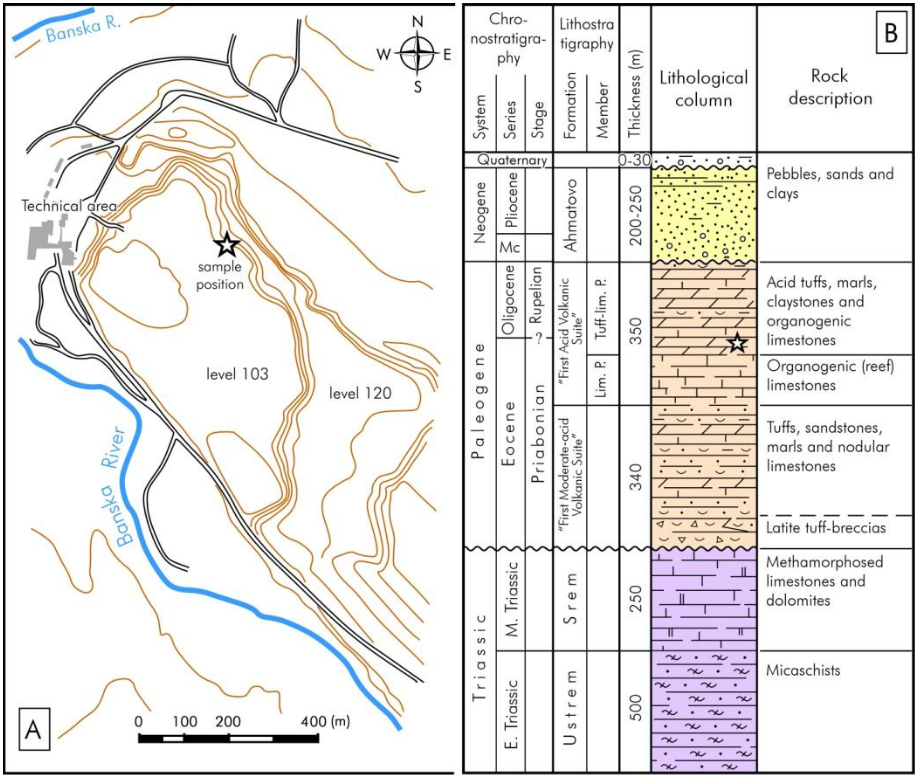

Fig. 2 A – Location of the nautiloid specimen within the Durhana Quarry framework; B – Sedimentary succession (pre and post-collisional rocks) of Durhana Quarry (North-western Thrace Basin, Bulgaria) and the stratigraphical level of the nautiloid specimen.

"FMAV" (340 m thick) is built up by latite, psammite, tuff, and tuff-breccia layers, with intercalations of marine sandstones, marls and nodular limestone (Fig. 2). The early Eocene rocks are involved in block-mosaic structures (Late Alpine) in the periphery and the basement of Zagora depression (Bojanov et al., 1989). Some local syncline north-dipping structures are reported by recent studies in the area (e.g., Jelev et al., 2011).

"FAV" (350 m thick) consists of acidic tuff, limestone, marl and sandstone layers (Bojanov et al., 1989; 1993), including the Eocene–Oligocene boundary. It is subdivided into two lithological sub-units/members: "Limestone Package" in the lower part, conformably followed by the "Tuff-Limestone Package". The so-called "Limestone Package" is formed by white-beige reefal limestone reaching from 15–m 20 m to more than 40 m thick. This unit is relatively fossiliferous and yields mollusks, echinoids, nummulites, corals, bryozoans, and algae. Atanasov et al. (1964) proposed the Priabonian age for the "Limestone Package". The upper "Tuff-Limestone Package" is built up by alternation of acid tuffs, marls, bentonite clays, and also reefal/organogenic limestone and it contains the Eocene–Oligocene boundary. However, *Nummulites intermedius* d'Archiac (1846), *Echinolampas sulcatus* (Pomel, 1885), and *Clypeaster biarritzensis* Cotteau, 1891 documented the latest Priabonian age for the nautiloid-bearing bed (Korobkov, 1963; Atanasov et al., 1965).

The irregular alternation of fluvial and alluvial pebbles, sands and clays of the Late Miocene–Pliocene age (Ahmatovo Formation, after Koumdjieva and Dragomanov, 1979) discordantly covers the Rupelian rocks.

4. Material and methods

The specimen was sampled from the northern bench of level 103 of Durhana Quarry (Fig. 2A). It represents a marl mould from a layer of "Tuff-Limestone Package". The occurrence of the specimen is relatively dating paying attention to the general rarity of fossils within the sedimentary succession. Also, the taphonomic conditions are not conspicuous. On one hand, the drift of empty shell by the marine currents is well known, both in the recent or past time (e.g., House, 2010; Matteucci, 2015). On the other hand, the nautiloids can also tolerate sporadic changes in oxygen being more competitive in comparison with other invertebrates (Wells et al., 1992).

The systematic paleontology follows Kummel et al., (1964) and Schultz (1976). The biometrical parameters taken into account are Ds – diameter of the shell/ phragmocone; Du – diameter of the umbilicus; H – height of the last whorl section; W – width of the last whorl section; and the ratios Du/Ds; W/Ds, W/H.

The following parameters were used for the taxonomic assessment: the suture line, the umbilical morphology, the siphuncle position, general shell morphology, and the shape of the whorl section.

The nautiloid specimen was prepared with a mechanical tool and the result is merely satisfactory.

5. Sistematic Paleontology

Class Cephalopoda Cuvier, 1745
Subclass Nautiloidea Agassiz, 1847
Order Nautilida de Blainville, 1825
Superfamily Nautilaceae de Blainville, 1825
Family Nautilidae de Blainville, 1825

Genus *Euciphoceras* Schultz, 1976

Euciphoceras sp.
Fig. 3

Type species – *Nautilus regalis* Sowerby, 1822

Material: 1 specimen (Collection Ajdanlijski and Țibuleac – Eocene Durhana Quarry1 (EDQ 1).
Age: Latest Priabonian.

Description: The specimen represents a mould of narrowly umbilicated phragmocone. It was exposed to the weathering process on one side (Fig. 3A), which led to uncovering of the suture line. On the other side, the shell wall is preserved (Fig. 3E), the metasomatic replacement being the reason of similar composition with the internal mould. During the sampling, the specimen was broken, and several small fragments of the lateral-dorsum were not recovered for the restoration (Fig. 3A). However, the last phragmocone fragment is mainly broken along a septum, exhibiting a moderate concave shape and the siphuncle opening (Figs. 3B, C).

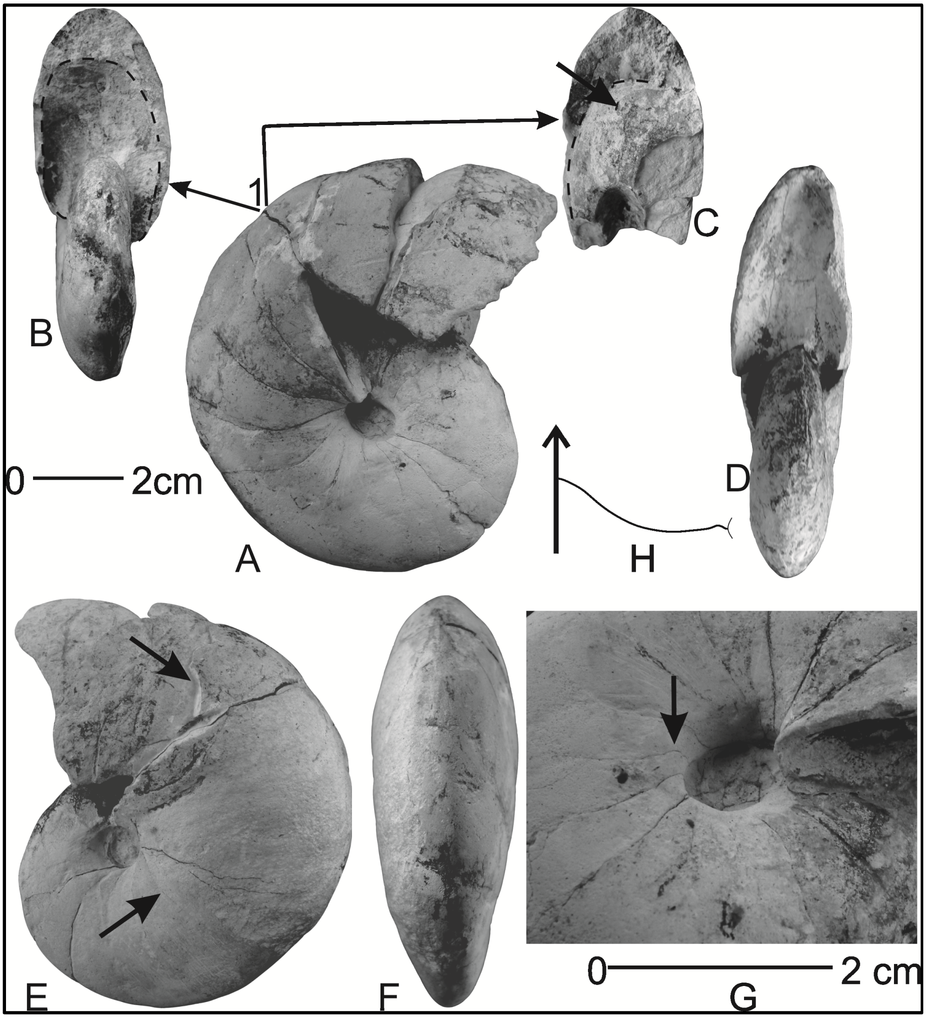

Fig. 3: *Euciphoceras* sp. from the Durhana Quarry: A – lateral view of the phragmocone mould exposed to the weathering process; B – transversal view of the main part of the phragmocone on point 1; C – transversal view of the detached adoral part of phragmocone on point 1; D – transversal view of the last phragmocone whorl; E - lateral view of the phragmocone mould, which was embedded in rocks; F – ventral view of the phragmocone; G – details on the umbilical border; H – the general suture line.

Viewing the displaced umbilicus openings on the lateral sides (Figs. 3A, E), and the septum shape (Figs. 3B, C), an oblique compression and deformation of the shell during the diagenetic processes has been taken into account. Consequently, the specimen changed its shape and size, and the sub-angular venter is an acquired feature (Figs. 3D, F).

Concerning the suture line, the specimen shows the typical *Euciphoceras* pattern. It displays a high large ventral saddle, most probably accentuated by the above-mentioned deformation, followed by a large shallow lateral lobe and an obvious small dorsal saddle located exactly on the umbilical shoulder (Figs. 3A, G, H). It continues on the umbilical wall without drawing an annular lobe (Fig. 3G). Moreover, the presence of the annular lobe is rather an exception for the *Euciphoceras/Eutrephoceras* stock (Miller, 1947). Ontogenetically, the suture line slightly varies in the depth of the saddles and lobes (Fig. 5A).

The umbilicus is slightly open and relatively deep, with the umbilical seams slightly rounded, and most probably without callus. Also, weak inflation can be inferred around the umbilicus marking the small, dorsal saddle (Fig. 3G).

The siphuncle displays an oval (compressed) opening placed between the center and the venter (and closer to the former reper).

The nautiliconic shell was of medium size (Ds = 92.32 mm; Du = ?7.73 mm; H = ?55.10 mm; W = ?27.54 mm, and the ratios Du/Ds = 0.084; W/Ds = 0.30, W/H = 0.50). The biometric parameters do not significantly matter because of the diagenetic deformation.

6. Discussion

Euciphoceras is herein used as a separate genus of nautilids. Schultz (1976: 9) proposed *Euciphoceras* as a subgenus of *Eutrephoceras* or even a distinct genus, taking into account the intermediate features of several specimens between *Eutrephoceras* and *Cimomia* genera. The most important feature is the change of the suture line, especially a small saddle rising near the umbilicus. Hewit (1989) ranked it as a distinct genus, a reasonable decision after Dzik and Gaździcky (2001) who supposed a different lineage from *Eutrephoceras* leading to the new *Euciphoceras* taxon since the Cretaceous. Still on, there are researchers who didn't accept it (e.g., Hughes, 1985 – in Hewitt, 1989).

Actually, several specimens show different steps between the so-called "end-members" of the transitional *Eutrephoceras*–*Cimomia* morph series. E.g.: the specimen TTKM A 0789 collected by Hantken and described by Vogl (1908) as "*Nautilus parallelus* (Schafthautl) var. *acuta* nov. var." was reassigned by Galácz (2008) to *Cimomia parallela* (Schafthäutl, 1863) taking into account the compressed shell mould during the diagenesis. The specimen exposes a suture line similar to our specimen, but the small saddle is not exactly placed on the umbilical shoulder (Galácz, 2008: 161, pl. 4, fig. 1), arguing the assignment to *Cimomia*. The specimen TTKM A 0780 of the same *C. parallela* (Galácz, 2008: 161, pl. 1, fig. 1) has the dorsal saddle more distant from the umbilical border in comparison with the previous specimen. Consequently, a study of intraspecific variability of a rich collection from the same outcrops would bring new insights into the definition of these genera.

Generally, the species of *Eutrephoceras* stock (including *Eutrephoceras, Euciphoceras* and *Simplicioceras* genera – extending Schultz's proposal, 1976) have an almost globular shell, the width of the whorl section being bigger than the similar height or they develop close dimensions. Also, they frequently expose a punctiform umbilicus or a very narrow one (e.g., *Euciphoceras regalis* (J .de C. Sowerby, 1822), with few exceptions (e.g., *E. decipiens*, (Micheloti 1861).

Moreover, several species exhibit a more discoidal shape: *Eutrephoceras oregonense* Miller, 1947 from the Oligocene rocks of USA, *Euciphoceras decipiens* from the Bartonian of Northern Italy, "*Nautilus tumescens*" Frauscher, 1895 from the Eocene rocks of Guttaring (Germany).

It is difficult to assign a species name to the Durhana specimen taking into account the asymmetrical deformation within the host-rocks. We also tried to reconstruct/draw the shell following to obtain a round siphonal opening without conclusive results.

The shell shape of the Durhana specimen strongly remembers "*Nautilus tumescens*" described by Frauscher (1895: 190-193). Unfortunately, on the holotype cannot be assessed the umbilicus opening and the suture line pattern. Also, the siphuncle is almost centrally placed within the septum (fig.-text p. 191) in comparison with the more ventral position for the Bulgarian specimen.

Euciphoceras decipiens (Michelotti, 1861) displays a similar suture pattern and umbilical diameter (Michelotti, 1861; Benoist, 1899; Sacco, 1904; Manni, 2015: 57, fig. 16). Instead, the whorl section is largely rounded being quite improbable that a specimen of this species to gain during diagenesis the morph of Durahana specimen. And also, the siphuncle is almost centrally positioned (towards the dorsal side; Benoist, 1899: 17, pl. I, fig. 2a).

7. Historical overview of the Eocene nautiloids from the adjacent areas

Nearest to the Thrace Basin, Hochstetter (1870: 375) listed from the Eocene rocks of the Jarim-Bourgas (Bourgas Basin) fragments of *Nautilus* (*Aturia*) *lingulatus* Buch." (= *Aturia ziczac lingulata* (Buch, 1834) and "*Nautilus undulatus* Sow." (= *Anglonautilus undulatus* (J. Sowerby, 1813). The nautilid specimens were found together with Eocene fauna (crabs, bivalves, nummulites etc.). Today, *Anglonautilus undulatus* is restricted to the Aptian-Cenomanian time-span (Lehman et al., 2017), and its presence in Eocene of Bourgas Basin is doubtful, consequently.

Vogl described in few successive papers (1908, 1910, and 1911) sixteen nautilid taxa from different Eocene outcrops of Hungary and Romania, including three new taxa: "*Nautilus (Hercoglossa) crassiconcha*", "*Nautilus parallelus* (Schafthautl) var. *acuta* nov. var.", and "*Nautilus* nov. sp. indet." (= "*Nautilus Szontaghi*" after Vogl, 1910). Several species of the *Eutrephoceras* stock were also mentioned: genus *Euciphoceras* was recorded by "*Nautilus regalis* Sow." (= *Euciphoceras regalis*) from the Eocene limestone of Mănăștur, near Cluj-Napoca (Romania) and from the "Orbitoid limestone" (Szépvölgy Formation) of Kissvábhegy-Budapest (Hungary). The later beds also provided a specimen of a relative species – "*Nautilus* cf. *urbanus* Sow." (= *Simplicioceras urbanus* (J. de C. Sowerby, 1843). From Romania, Vogl (1908) also mentioned "*Nautilus umbilicaris* Desh." (= *Euciphoceras umbilicaris* (Deshayes, 1824) and "*Nautilus centralis* Sow." (= *Simplicioceras centrale* (J. Sowerby, 1812) from the limestone and marl beds of Cluj-Napoca surroundings (fide Galácz, 2008).

Most parts of the almost one hundred specimens studied by Vogl (1908) were later lost, including the holotype for the "*Nautilus (Hercoglossa) crassichonca* n. sp." (= *Cimomia crassiconcha* Vogl, 1908), and the numerous specimens of *Aturia rovasendiana* Parona, 1985 (Galácz, 2008). Consequently, the revision was possible on a significantly smaller collection, Galácz (2008) describing and systematically updating six species of four genera.

Lőrenthey (1917 – fide Galácz, 2008) mentioned the presence of "*Nautilus*" (= *Cimomia*) *parallelus* in the Eocene rocks of North Albania. Later, Lőrenthey and Beurlen (1929) noted by passing the presence of *Nautilus* sp. at Rózsahegy= Ružomberok (Slovakia) within a rich Eocene assemblage of crab remains and also nummulitids, mollusks, bryozoans, echinoids, and annelids.

Galácz (1987) validated the new Vogl's species "*crassiconcha*" by a new occurrence at Dudar Transdanubian Central Range (= TCR, Hungary), where the species seems to be common in the Middle Eocene rocks (Galácz, 2008). Two new specimens of *Euciphoceras regalis* and *Cimomia elliptica* (Schafthäutl, 1863) were later reported by Galácz (2004) from the Middle Eocene of Iszkaszetgyörgy (TCR, Hungary).

Micuž (2009) and Micuž and Bartol (2012) reported from the Eocene beds outcropping near Grdoselo, north of Pazin (Eocene flysch basin – Grey Istria, Croatia) a specimen of *Aturia* cf. *ziczac* (J. Sowerby, 1812) and one of *Eutrephoceras (Simplicioceras) centrale*. A general overview of the nautiloid records from Istria area was inserted in the former paper: over ten species were recorded in several old and relatively new papers from the Eocene flysch basin and two from its north-western prolonging (Rogovići area – Micuž, 2009: Table 1).

Consequently, between the classic Western Europe (London and Paris basins) and north-western Pakistan and India areas (Sind and Kutch), the Eocene nautiloids are also known by the occurrences from Italy, Egypt, intra-Carpathians areas, Apulian Shelf (Istria Peninsula), and Thrace Basin. Generally, the same Eocene genera are documented, the species being merely paleogeographically restricted, a paradox already highlighted by Halder (2012).

8. Conclusions

The nautiloid specimen found on the northern bench of level 103 of Durhana Quarry (Haskovo County, Bulgaria) is described as *Euciphoceras* sp. taking into account the suture pattern, umbilical opening, and the siphuncle position within the septum. The compressed and slightly deformed shell hampers a more accurate assignment. The host-beds were previously documented as late Priabonian ("Tuff-Limestone Package" of "First Acidic Suite" Formation) by a larger foraminifer and echinoid assemblage.

The general overview of the nautiloid records from the surrounding areas suggests a continuity of Eocene nautiloid occurrences from Western Europe to South-central Asia (Tethyan Realm).

Acknowledgements

We sincerely thank to dr. András Galácz (Eötvös Loránd University, Budapest-Hungary) and dr. Kalyan Halder (Presidency University, Kolkata-India) for the thorough review of the manuscript.

References

Atanasov, G., Stefanov, D., Trashliev, S., Goranov, A., 1964. Bentonite clays from the area of Dimitrovgrad. Annuaire de l'Université de Sofia, Faculté de Géologie et Géographie, **57**, 1, 75–89. (In Bulgarian).

Atanasov, G., Belmustakov, E., Trashliev, S. Goranov, A., 1965. Stratigraphy and lithology of the Paleogene in the vicinity of Zlatnalivada village, Chirpan district. Annuaire de l'Universitée Sofia, Faculté de Géologie et Géographie, **58**, 1, 75–105. (In Bulgarian).

Benoist, E.A., 1889. Coquilles fossils des terrains tertiares moyens du Sud-Ouest de la France. Description des cephalopods, ptéropodes et gastropods opistobranches (Acteonidae). Actes de la Société Linnéenne de Bordeaux, **42**, 11–84.

Bojanov, I., Goranov, A., Šiljafova, Ž., Ruseva, M., 1989. Geological map of Bulgaria in scale 1:100 000, Dimitrovgrad sheet. Bolid, S. (In Bulgarian).

Bojanov, I., Šiljafova, Ž., Goranov, A., Ruseva, M., 1993. Explanation note to the geological map of Bulgaria in scale 1:100 000, Dimitrovgrad sheet. Bolid, S., 67p. (In Bulgarian).

Bončev, S., Balakov, P., 1928. Les tremblements de Terre dans la Bulgarie du Sud les 14 et 18 avril. Review of the Bulgarian Geological Society, **1-2**, 51–63. (In Bulgarian, with French abstract).

Bončev, E., 1961. Notizen üeber di wichtigsten Bruchlinien in Bulgarien. Travaux sur la Géologie de Bulgarie, Serie Stratigraphie et Tectonique, **2**, 5–29. (In Bulgarian, with German abstract).

Bončev, E., 1971. Problems of the Bulgarian Geotectonics. Tehnika, 204p. (In Bulgarian).

Boyanov, I., Goranov, A., 2001. Late Alpine (Palaeogene) superimposed depressions in parts of Southeast Bulgaria. Geologica Balcanica, **31**, 3-4, 3–36.

Caracciolo, L., Orlando, A., Critelli, S., Kolios, N., Manetti, P., Marchev, P., 2015. The Tertiary Trace Basin of SE Bulgaria and NE Greece: a review of petrological and mineralogical data of sedimentary sequences. Vulcanologica, 25.qxp, Special Issue, 21–41.

Carbone, F., Accordi, G., Angelucci, A., Matteucci, R., 1999. The modern coral colonization of the Bajuni Barrier Island (Southern Somalia). A facies model for carbonate-quartzose sedimentation. Geologica Romana, **35**, 111–149.

Čatalov, G., 1985. Stratigraphy of Strandža-type Triassic (Strandža Mountain, Southeastern Bulgaria). Geologica Balcanica, **15**, 6, 3–38. (In Russian).

Cavazza, W., Caracciolo, L., Critelli, S., d'Atri, A., Zufa, G.G., 2013. Petrostratigraphic evolution of the Thrace Basin (Bulgaria, Greece, Turkey) within the context of Eocene-Oligocene post-collisional evolution of the Vardar-Izmir-Ankara suture zone. Geodinamica Acta, **26**, 1-2, 12–26.

Dabovschi, C., Boyanov, I., Khrischev, K., Nicolov, T., Sapunov, I., Yanev, Y., Zagorchev, I., 2002. Structure and alpine evolution of Bulgaria. Geologica Balcanica, **32**, 2-4, 9–15.

Doglioni, C., Busatta, C., Bolis, G., Mariannini, L., Zanella, M., 1996. Structural evolution of the eastern Balkans (Bulgaria). Marine and Petroleum Geology, **13**, 2, 225–251.

Dzik, J., Gaździcky, A., 2001. The Eocene expansion of nautilids to high altitude. Palaeogeography, Palaeoclimatology, Palaeoecology, **172**, 297–312.

Frauscher, K.F., 1895. IV. Nautilusse von Guttaring. Jarhbuch vom Naturhistorischen Landes-Museums von Karnten, **23-25**, 185–201.

Galácz A., 1987. A Middle Eocene nautiloid Dudar (Transdanubian Central Range, Hungary). Annales Universitatis Scientiarum Budapestinensis, Sectio Geologica, **27**, 79–88.

Galácz A., 2004. Nautiloid cephalopods from the Middle Eocene of Iszkaszentgyörgy, Transdanubian Hungary. Annales Universitatis Scientiarum Budapestinensis, Sectio Geologica, **34**, 1–7.

Galácz A., 2008. A revision of VOGL's Eocene Nautilids from Hungary. Anniversary of the Department of Paleontology at Budapest University – A Jubilee Volume Hantkeniana, **6**, 151–171.

Görür, N., Okay, A.I., 1996. A fore-arc origin for the Thrace basin, NW Turkey. Geologische

Rundschau, **85**, 4, 662–668.

Halder, K., 2012. Cenozoic nautiloids (Cephalopoda) from Kutch, western India. Paleoworld, **21**, 116–130.

Hochstetter, F., 1870. IV. Die geologischen Verhältnisse des östlichen Theiles der europäischen Türkei. , **20**, 3, 365–461.

House, M.R., 2010. Geographic distribution of Nautilus shells. In: Saunders, W.B., Landman, N.H., (Eds.), 2010. Nautilus: The Biology and Paleobiology of a Living Fossil. Reprint with additions, Chapter 4, 53–64.

Hewitt, R.A., 1988. Nautiloid shell taphonomy: interpretations based on water pressure. Palaeogeography, Palaeoclimatology, Palaeoecology, **63**, 1-3, 15–25.

Hewitt, R., 1989. Outline of research on the ecology and evolution of the Eocene nautilid cephalopods from the London Clay, England. Tertiary Research, **10**, 65–81.

Hewitt, R., 1995. London Clay Nautiloid Collections. Geological Curator, **6**, 3, 117–124.

Jelev, V., Lakov, A., Ajdanlijksy, G., Georgieva, T., 2011. Geostructural and engineering-geological investigations in the "Urt Dere" quarry (Dimitrovgrad). I. Geostructural investigations. Annual of the University of Mining and Geology "St. Iv. Rilski", **54**, 1, 33–38. (In Bulgarian).

Korobkov, I.A., 1963. The Eocene-Oligocene boundary. International Geological Review, **5**, 3, 321–330.

Koumdjieva, E.L., Dragomanov, L., 1979. Lithostratigraphy of the Oligocene and Neogene sediments in Plovdiv and Pazardjik area. Palaeontology, Stratigraphy, and Lithology, **11**, 49–61. (In Bulgarian).

Kozuharov, D., Boyanov, I., Savov, S., 1968. Geology of the area between Klokotnitsa village and town of Maritza, Haskovo district. Jubilee Collection Geological Institute and Committee of Geology, **32**, 12, 37–50. (In Bulgarian).

Kummel, B., 1956. Post-Triassic Nautiloid genera. Bulletin of the Museum of Comparative Zoology at Harvard College in Cambridge, **114**, 319–494.

Kummel, B., Furnish, W.M., Glenister, B., 1964. Nautiloidea–Nautilida. In: Moore, R.C. (Ed.), 1964. Treatise on invertebrate paleontology, part K, Mollusca 3, 383–457. Geological Society of America and the University of Kansas Press.

Lőrenthey, E., Beurlen, K., 1929. Die fossilen Decapoden der Länder der Krone. Geologica Hungarica, Serie Palaeontologica, **3**, 421p.

Lehman, J., Maisch, W.M., Baudouin, C., Salfinger-Maisch, A., 2017. Origin and evolutionary history of Anglonautilus (Nautilida, Cymatoceratidae) and a new species from the lower Aptian of Spain. Cretaceous Research, **72**, 66–80.

Manni, R., 2015. Catalogue of the type fossils stored in the Paleontological Museum of Sapienza University of Rome. Journal of Mediterranean Earth Sciences, **VII**, 51–62.

Matteucci, R., 2015. Drifted Nautilus shells from the Bajuni Islands (southern Somali coast of Indian Ocean). Journal of Mediterranean Earth Sciences, **7**, 35–50.

Micuź, V., 2009. Navtilid iz srednjeecenskih plasti pri Grdoselu v Istri na Hrvaškem. Geologjia, **51**, 1, 33–43.

Micuź, V., Bartol, M., 2012. A new cephlalopod find in the Eocene beds near Grdoselo in Istria, Croatia. Geologjia, **55**, 2, 263–270.

Miller, A.K., 1947. Tertiary nautiloids of the Americas. Memoir 23, The Geological Society of America, 234p.

Miller, A.K., 1949. The last surge of the nautiloid cephalopods. Evolution, **3**, 3 231–238.

Popov, K., Vilichkov, D., Popov, P., 2015. The post-collisional Upper Thracian Rift System (Bulgaria) and the formed exogenous uranium deposits. Part 1 – Lithostratigraphy and tectonic. Review of the Bulgarian Geological Society, **76**, 2-3, 35–49.

Sacco, F., 1904. I molluschi dei terreni tertiarii dei Piemonte e dela Liguria. Parte XXX, Agiunte e Correzioni, **XXXVI**, 231p.

Saunders, W.A., Shimansky, V.N., Amitrov, V., 1996. Clarification of Nautilus praepompilius Shimansky from the Late Eocene of Kazachstan. Journal of Paleontology, **4**, 609–611.

Schultz, O., 1976. Zur Systematik der Nautilidae. Anzeiger der mathematische-naturwissenschaftliche Klasse der Österreichischen Akademie der Wissenschaften, **6**, 1, 1–9.

Shimansky, V.N., 1957. Noviy predstaveli otryada Nautilida v SSSR. Paleontologicheski Institut Materialy k Osnovam Paleontologii, **1**, 35–41.

Squires, R.L., 1988. Cephalopods from the Late Eocene Hoko River Formation, northwestern Washington. Journal of Paleontology, **62**, 1, 76–82.

Vangelov, D., Gerdjikov, Y., Kounov, A., Lazarova, A., 2013. The Balkan Fold-Thrsut belt: an

overview of the main features. Geologica Balcanica, **42**, 29–47.
Vogl, V., 1908. Über Eozäne Nautiliden. Földtani Közlöny, **38**, 535–549.
Vogl, V., 1910. Neuere Beiträge zur Kenntnis der alttertiären Nautiliden Ungarns. Centralblatt für Mineralogie, Geologie und Paläontologie, **21**, 707–710.
Vogl, V., 1911. Die Fauna des sogennanten Bryozoenmergels von Piszke. Jahrbuch der Geologische Reihsanstalt, **XVIII**, 3, 197–228.
Wani, R., de Campo, R.S.P., Aguilar, Y.M., Zepeda, M.A., Kurihara, Y., Hagino, K., Hayashi, H., Kase, T., 2008. First discovery of fossil Nautilus pompilius Linnaeus, 1758 (Nautilidae, Cephalopoda from Pangasinan, northwestern Philippines. Paleontological Research, **12**, 1, 89–95.
Ward, P.D., Flannery, D., Flannery, E., Flannery, T.F., 2016. The Paleocene cephalopod fauna from Pebble Point, Victoria (Australia)-fulcrum between two Eras. Memoirs of Museum Victoria, **74**, 391–402.
Wells, M.J., Wells, J., O'Dor, R.K., 1992. Life at low oxygen tensions: the behaviour and physiology of Nautilus pompilius and the biology of extinct forms. Journal of the Marine Biological Association of the United Kingdom, **72**, 2, 313–328.
Zinsmeister, W.J., 1987. Unusual nautilid occurrence in the upper Eocene La Meseta Formation, Seymour Island, Antarctica. Journal of Paleontology, **61**, 4, 724–726.