In memory of Vladimir Georgiev (1954–2019)

Fossil gastropods *Campanile lachesis* Bayan, 1870 from the upper Eocene of the Eastern Rhodopes (Bulgaria)

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Abstract. The subject of this study is the description of eight specimens of fossil gastropods *Campanile lachesis* Bayan, 1870, family Campanilidae, from the fund of the Regional Museum of History in Kardzhali. They were found in the area of the village of Gorna Krepot, Kardzhali Municipality, at the eastern foot of the Archeological Complex Perperikon, in the upper Eocene (Priabonian) limestone layers of the so-called Beli Plast Rhyodacite Complex. The paleoecological traits of the present fauna give ground to infer that this was a very shallow reefal environment with a rocky substrate sandy bottom, overgrown with algae, and the water was warm, with normal salinity.

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INTRODUCTION

Representatives of the genus *Campanile*, family Campanilidae, are giant sea gastropods with a stout, high-spiral, tower-like shell, which can reach over 60 cm in length and can contain more than 30 whorls (Taylor and Lewis, 2005). The genus has a stratigraphical range from the Upper Cretaceous (Maastrichtian) to the present day. It is best known from the Eocene of the Paris Basin, where well-preserved finds of *Campanile giganteum* Lamarck, 1804, up to a meter long, have been found (Squires, 1993). These specimens, along with some from Jamaica, are among the largest gastropods to have ever existed on Earth (Squires, 1993). During the Paleogene, the genus *Campanile* underwent a wide geographical expansion (Squires, 1993). It was widespread in

the Eocene, with numerous records from North and South America, the Caribbean, Europe, Africa, and Asia, as far east as Japan (Salgeback and Savazzi, 2006). According to Jung (1987), the peak of diversity and distribution of the genus *Campanile* in Europe was reached during the middle Eocene. After the Oligocene, the genus disappeared from Eurasia and withdrew to the east-southeast (*ibid.*). After the middle Eocene, there has been a sharp worldwide decline in *Campanile* species diversity. Neogene and Pleistocene finds are scarce, and the single surviving species today is *Campanile symbolicum* Iredale, 1917 (Squires, 1993).

The reason for the sharp post-Eocene decline in species diversity of the genus *Campanile* is still unknown. Houbbrick (1981) proposed two hypotheses, although both of them have been criticized.

According to this author, there was trophic competition between the gastropods of Campanilidae and Strombidae, as the members of both families fed upon algae. He opined that Campanilidae ended up losing in this competitive relationship. As a second possible reason for the disappearance of Campanilidae from the Mediterranean region, he pointed out the Messinian Salinity Crisis. However, this event is unlikely to be connected, as Campanilidae withdrew from the region at the end of the Oligocene, about 17 Ma before the Messinian Salinity Crisis (Jung, 1987).

The single surviving species of the genus, *Campanile symbolicum* Iredale, 1917, lives in large populations on sandy patches between rocks in depths of 1 m to 4 m along the southwestern coast of Australia (Squires, 1993). This is a subtidal algal feeder, creeping on both rocky substrate and soft sediments. Unlike its Eocene predecessors, it reaches a maximum length of 24.4 cm (Houbrick, 1981). When living on sandy bottom, it either lies half-buried into the sediments or drags its shell through the topmost layer of sediment, leaving behind a deep furrow. The largest species of *Campanile* from the Eocene of Southern Europe inhabited a shallow-water nearshore environment. Recorded fossil finds indicate that they lived in an environment similar to that of modern-day *C. symbolicum* (Salgeback and Savazzi, 2006).

The aim of the present study is to describe and illustrate a fossil material of the genus *Campanile* from the fund of the Regional Museum of History in Kardzhali (Bulgaria). Despite being small in number, this material is a valuable addition to the previously obtained evidence of campanilid gastropods from Bulgaria and Europe.

GENUS CAMPANILE IN BULGARIA

In 1896, Stefan Bontscheff described the “Tertiary” Basin of the Haskovo region (SW Bulgaria) and made one of the first geological maps of this area. Among the fossils, which he found, a new species, *Cerithium haskovense* collected from a locality near the city of Haskovo was defined (Bontscheff, 1896). Bontscheff described the species in detail, identifying it as most closely related to *C. giganteum* Lam. and *C. parisiense* Desh. of the Paris Basin, but pointing out that it differs from the French forms by the shape and the location of the tubercles on the whorls. Later, Oppenheim (1901) revised Bontscheff’s taxonomic determination, claiming that *Cerithium haskovense* matches *Cerithium*

lachesis Bayan, 1870 in all aspects, but differs from *C. parisiense* in having fewer and slightly differently shaped tubercles. Gochev (1930) concurred with Oppenheim’s (1901) opinion that *C. haskovense* is a synonym of *C. lachesis* and found out that another specimen from Bonchev’s collection, identified as *C. parisiense* Desh., should also be interpreted as belonging to *C. lachesis* Bayan. Karagyuleva (1964) made a detailed characterization of the genus *Campanile*, including *C. lachesis*, and recorded a new Bulgarian locality, Chengene skele (Burgas Municipality). The latter author dated the known Bulgarian *Campanile* occurrences as late Eocene (Priabonian). Recently, Matsubara (2009) also opined that *Cerithium haskovense* and *Campanile lachesis* are synonyms.

GEOLOGICAL SETTING, LOCALITY AND MATERIAL OF THIS STUDY

The Rhodope Massif forms the innermost part of the Balkanides, extending over large areas of South Bulgaria. During the Late Cretaceous–Eocene, the Rhodope Massif encompassed intense processes of extension (Ivanov, 2000). As a result, huge meta-

Fig. 1. Geological map of the locality, from which the gastropods of this study were obtained (after Georgiev, 2012).

morphic core complexes (domes) were formed, separated by large depressions. The examined fossils were found within the inner parts of the East Rhodope complex depression (Georgiev, 2012; equivalent to the East Rhodope Paleogene depression of Ivanov, 1960). During the Eocene and Oligocene, this depression represented a shallow sea basin and an area of intense sedimentation and abundant volcanic activity. The sedimentary rocks are mainly located at the lower part of the overall stratigraphic section, whereas the upper part is predominantly composed of acid to intermediate volcanic rocks.

The fossils that are a subject of this study were collected from the area of the village of Gorna Krepost, Municipality of Kardzhali, at the eastern foot of the Archeological Complex Perperikon (N41.715528°; E25.472771°) (see Fig. 1). They were found in limestone layers of the so-called Beli Plast Rhyodacite Complex (Georgiev, 2012). The limestones are 2–3 m thick and are intercalated with tuffs and tuffites. They crop out to the east of the summit, upon which the Archeological Complex Perperikon is situated, in the scarps of the newly constructed road. The age of these limestones is determined as Priabonian (Boyanov *et al.*, 1990).

SYSTEMATIC PALEONTOLOGY

The classification of Bouchet and Rocroi (2005) is adopted herein.

Class Gastropoda Cuvier, 1797

Clade Sorbeoconcha Ponder and Lindberg, 1997

Superfamily Campaniloidea Douvillé, 1904

Family Campanilidae Douvillé, 1904

Genus *Campanile* Bayle in: Fischer, 1884

Type species. *Cerithium giganteum* Lamarck, 1804, middle Eocene, Paris Basin.

Campanile lachesis Bayan, 1870a

(Fig. 2a–c)

1870a. *Cerithium Lachesis* Bayan, p. 478.

1870b. *Cerithium Lachesis* Bayan: Bayan, p. 33, Pl. 4, Fig. 2; Pl. 5, Fig. 2.

1896. *Cerithium Haskovense* Bontscheff, p. 381, Taf. 6 (4), Fig. 7.

1896. *Cerithium Lachesis* Bayan: De Gregorio, p. 75, Taf. 10, Figs 1–4.

1901. *Cerithium (Campanile) lachesis* (Bayan): Oppenheim, p. 271, Taf. 15(5), Fig. 34.

1905. *Cerithium (Campanile) lachesis* (Bayan): Dainelli, pp. 46–50, Pl. 1, Figs 9–11.

1911. *Campanile lachesis* (Bayan): Boussac, pp. 284–285, Pl. 17, Fig. 52a.

1930. *Campanile lachesis* (Bayan): Gochev, pp. 27–28, Taf. 1, Fig. 3, Taf. 5, Fig. 1.

1958. *Campanile lachesis* (Bayan): Temkova, p. 113.

1964. *Campanile lachesis* (Bayan): Karagyuleva, p. 154, Pl. 41, Fig. 1.

Type. Data for the type specimen is not given.

Diagnosis. A very large species, closely related to *Cerithium parisiense* Desh. It is distinguished by its more voluminous shape, the tubercles of the adult are sharper and shorter, and by the number of granular ribs of the juvenile (6–7), which persist much later than in the *C. parisiense* (Bayan, 1870a). Subchannel suture. Two-folded columella (*ibid.*).

Material and record. Eight gastropod specimens hosted at the Regional Museum of History in Kardzhali (Inv. Nrs Kp 409 – Kp 415, Kp 417, original abbreviation of the inventory numbers in Cyrillic is “Кп”), found near the village of Gorna Krepost, Kardzhali Municipality.

Dimensions. See Table 1.

Description and discussion. The shell is very large to gigantic, highly-conical (pleural angle 20°–24°), with a spiral sculpture of 9 whorls in the most com-

Table 1
Dimensions of studied fossil specimens

Inventory Nr	Number of whorls preserved	Length (mm)	Diameter of the widest whorl section (mm)	Pleural angle
Kp 409	3	150	110	20°
Kp 410	2.5	170	140	20°
Kp 411	2.5	190	140	24°
Kp 412	3	210	120	20°
Kp 413	2.5	170	120	20°
Kp 414	3	170	130	20°
Kp 415	5	270	140	24°
Kp 417	9	330	120	24°

plete specimen – Kp 417 (Fig. 2a; Table 1). The last whorl is significantly larger than the others, with a prominent base. The aperture is rounded quadrangular, with a narrow, long, oblique and slightly backwardly curved siphonal canal. The outer labium is fanned and sharp. The columella has two folds, which are seen in specimen Kp 411 (Fig. 2b). Each whorl consists of two parts: a lower, barely convex one; and a flat, even slightly concave, upper one. The lower (or rather the middle) part is ornamented with 10 to 11 big tubercles (specimen Kp 410) (Fig. 2c).

Unfortunately, the most complete specimen Kp 417 (330 mm), is an internal mold, in which the relief and ornamentation of the shell are missing. However, these can be found on some of the other samples, especially Kp 410, where the tubercles on the last few whorls can easily be counted.

Fossil gastropods preserved as molds are found very often in the geological record since their shells are built of aragonite, which makes them prone to dissolution during the fossilization process (Taylor and Lewis, 2005). In the genus *Campanile*, much of the early whorls are secondarily thickened and sealed off by septa. Because of this, the internal molds of the large campanilids are substantially

shortened, compared to the original shells, and their apices are rounded into unusually large (up to 20 mm in diameter) protoconchs, resembling hemispheres, which correspond to the inner surface of the last septum (Salgeback and Savazzi, 2006).

According to Karagyuleva (1964), *C. lachesis* is closely related to *C. giganteum*, but differs by the outline of the whorls, as well as the arrangement of the tuberculation. The tubercles in *C. lachesis* can be found on the lower half of the whorls, whereas in *C. giganteum* they are situated on the upper whorls and have a different shape. According to other authors, the tubercles in *C. lachesis* are located not on the lower, but on the middle part of the whorls (Harzhauser *et al.*, 2013).

Paleoecological notes. The site, at which the fossils were found, strongly resembles that at Posušje, Western Herzegovina, where a remarkably well-preserved coral reef, with fossil macrofauna including *Campanile lachesis* Bayan, 1870 and other species of the genus *Campanile*, were found in Paleogene (middle Eocene) sediments. It is assumed that these gastropods fed upon the detritus of coral reefs (Glamuzina, 2015). In our case, near the village of Gorna Krepot, parts of large coral structures and red algae of the genus *Corallina* can be observed

Fig. 2. *Campanile lachesis* Bayan, 1870 from the late Eocene (Priabonian) near the village of Gorna Krepot, Eastern Rhodopes, Bulgaria: a) high-conical spiral structure of 9 whorls in specimen Nr Kp 417; b) columella with two folds in specimen Nr Kp 411; c) ornament of large tubercles on the last whorls in specimen Nr Kp 410.

in the field. In addition to *Campanile*, fossil gastropods of the genera *Velates*, *Conus* and *Euspira*, as well as accompanying bivalves of the genera *Pecten* and *Venus* and giant foraminifers of the genus *Discocyclus*, also occur. Based on the described fossil assemblage, we could conclude that the studied region was a part of an ancient sea with shallow reefal environment, a sandy-stony bottom, overgrown with algae, and the water was warm, with normal salinity.

Occurrence. As previously mentioned, *Campanile lachesis* was first recorded from the Eocene near Roncá township, Veneto region, Northeastern Italy (Bayan, 1870a, b). It was reported from the same area, but more accurately dated as middle Eocene, by De Gregorio (1896). The species is known from a few localities of the Eocene near Tribistovo, Konjovac and Posušje (Oppenheim, 1901; Sremac *et al.*,

2014, Glamuzina, 2015), as well as from the middle Eocene near Lukavac and the Bartonian–Priabonian strata near Zagorje (Soklić, 2019), Bosnia and Herzegovina. It is documented in the Eocene near Ostrovica, Žažvić and Bribir, Croatia (Dainelli, 1905; Milan, 1956), as well as in the upper Eocene of La Palarea, France (Boussac, 1911) and the Dragozel region, Republic of North Macedonia (Temkova, 1958). *Campanile lachesis* was also recorded in the middle Eocene of Central Anatolia, Turkey (Haymana region) (Deveciler and Taner, 2008), and the middle to upper Eocene of North Africa and Romania (Transylvania) (Deveciler and Taner, 2008). In addition, it was also found in an Eocene flysch succession in Western Slovenia (Mikuž *et al.*, 2013) and the middle to upper Eocene of Central Catalonia (Sant Salvador de Guardiola), Spain (Alcalá and Mampel, 2014) (Fig. 3).

Fig. 3. Paleogeographic map (middle–late Eocene; after van Der Boon *et al.*, 2019) showing the main fossil localities of *Campanile lachesis*: 1) Italy (Roncá) – middle Eocene; 2) Bosnia and Herzegovina (Tribistovo, Konjovac, Posušje – Eocene; Lukavac – middle Eocene; Zagorje – middle–late Eocene); 3) Croatia (Ostrovica, Žažvić, Bribir) – Eocene; 4) Western Slovenia (Eocene); 5) Turkey (Haymana region) – middle Eocene; 6) Spain (Central Catalonia) – middle–late Eocene; 7) Romania (Transylvania) – middle–late Eocene; 8) Republic of North Macedonia (Dragožel region) – late Eocene; 9) France (La Palarea) – late Eocene; 10) Bulgaria (Haskovo; Chengene skele, Burgas; Gorna Krepot, Kardzhali) – late Eocene.

BSB – Black Sea Basin; MB – Mediterranean Basin; CB – Caspian Basin; PS – Polish Strait; NSB – North Sea Basin; NAF – North Alpine Foreland Basin.

Eight fossil gastropod specimens, Priabonian in age, from the fund of the Regional Museum of History in Kardzhali were identified and described as *Campanile lachesis*. After the site near Haskovo and the one near Chengene skele, Burgas Municipality, the locality of fossil specimens of *Campanile lachesis* at the village of Gorna Krepot is the third registered in Bulgaria and a new field of upper Eocene campanilid gastropods in Europe. These finds, together with specific assemblage of gastropods,

bivalves and large foraminifers, indicate shallow reefal environment with sandy-stony bottom, warm water and normal salinity.

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