

A short note on the Middle Miocene pteropods from Northern Croatia



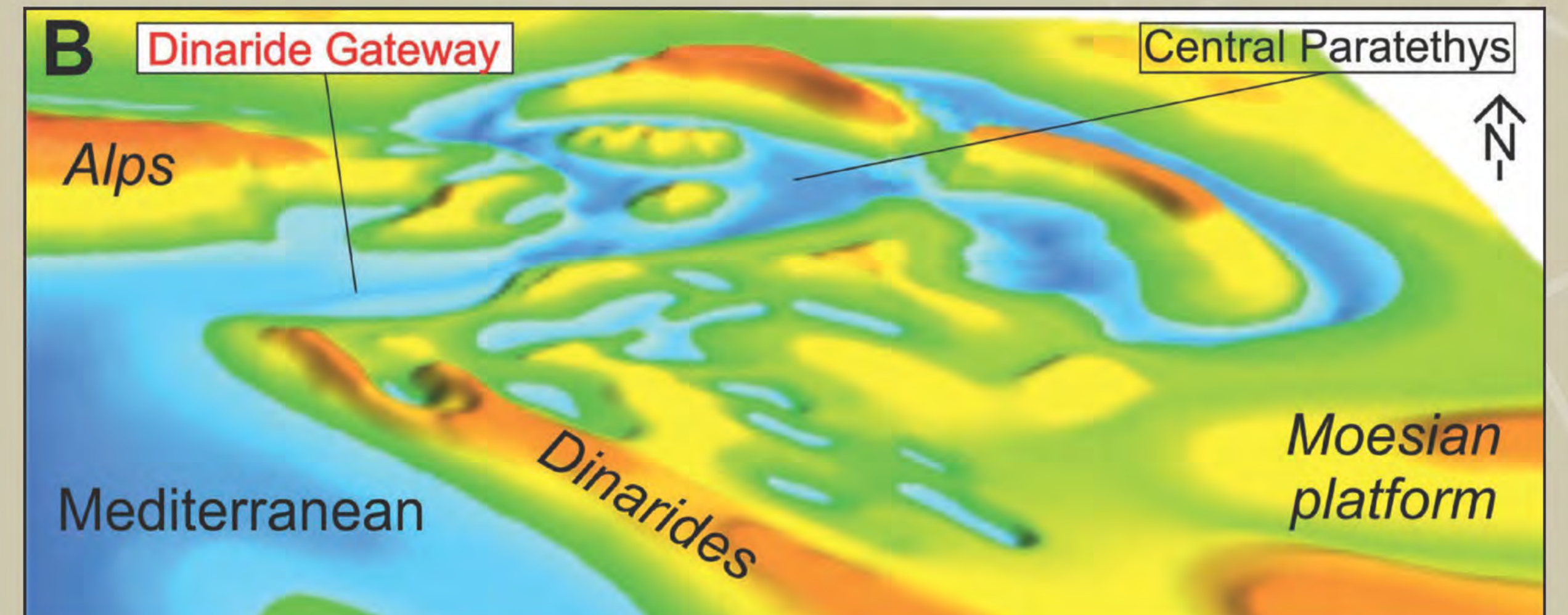
Figure 1: One of today's representatives of „sea butterflies“, *Limacina helicina helicina* (Phipps, 1774) (after Janssen et al., 2019)

Figure 2: A) Location of the investigated area marked with red ellipse (after Pavelić & Kovačić, 2018)

INTRODUCTION

Holoplanktic gastropods (Pteropoda) with aragonitic shells („sea butterflies“, Figure 1) are in fossil record usually present as casts and molds, but they are important for paleobiostratigraphical, paleoecological and paleogeographical research. Their findings in the Central Paratethys area are most common in the Middle Miocene deposits corresponding to the peaks of the Badenian transgressive-regressive cycles. Pteropods are found in the Badenian deposits of Austria, Czech Republic, Poland, Hungary, Slovenia, Croatia, Romania, Bulgaria and Ukraine (Figure 2). The most diverse and numerous genera are *Limacina* Bosc, 1817, *Vaginella* Daudin, 1800 and *Clio* Linnaeus, 1767 (e.g., Janssen, 1984; Zorn, 1991, 1999; Bohn-Havas & Zorn, 1993, 1994; Janssen & Zorn, 1993; Bošnjak et al., 2017 and references therein).

B) Central Paratethys area during the late Burdigalian-Langhian (Early Badenian in Central Paratethys, NN4 and NN5 zone) with marked marine gateway (after Kováč et al., 2018)



PTEROPODS IN BADENIAN DEPOSITS OF NORTHERN CROATIA

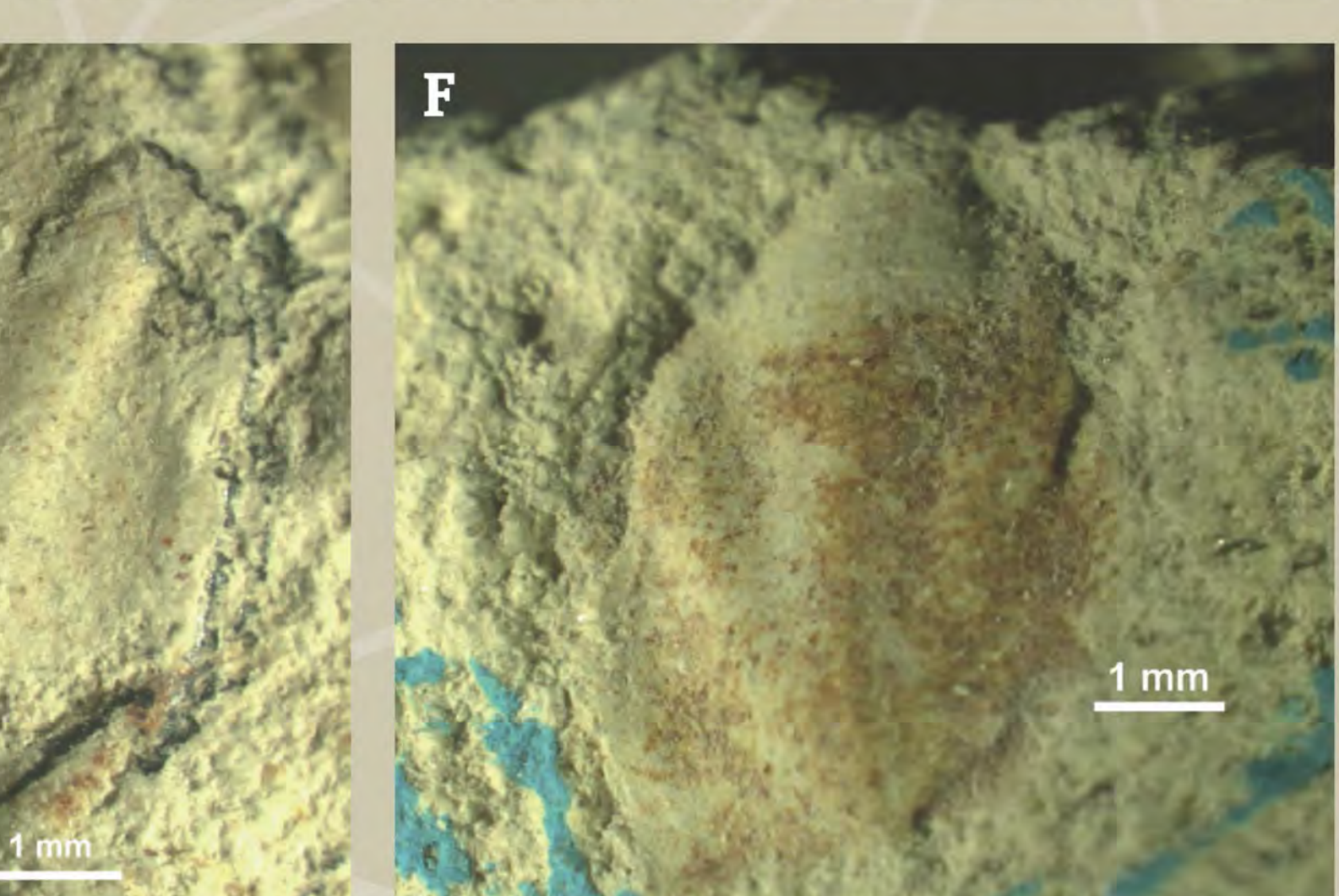
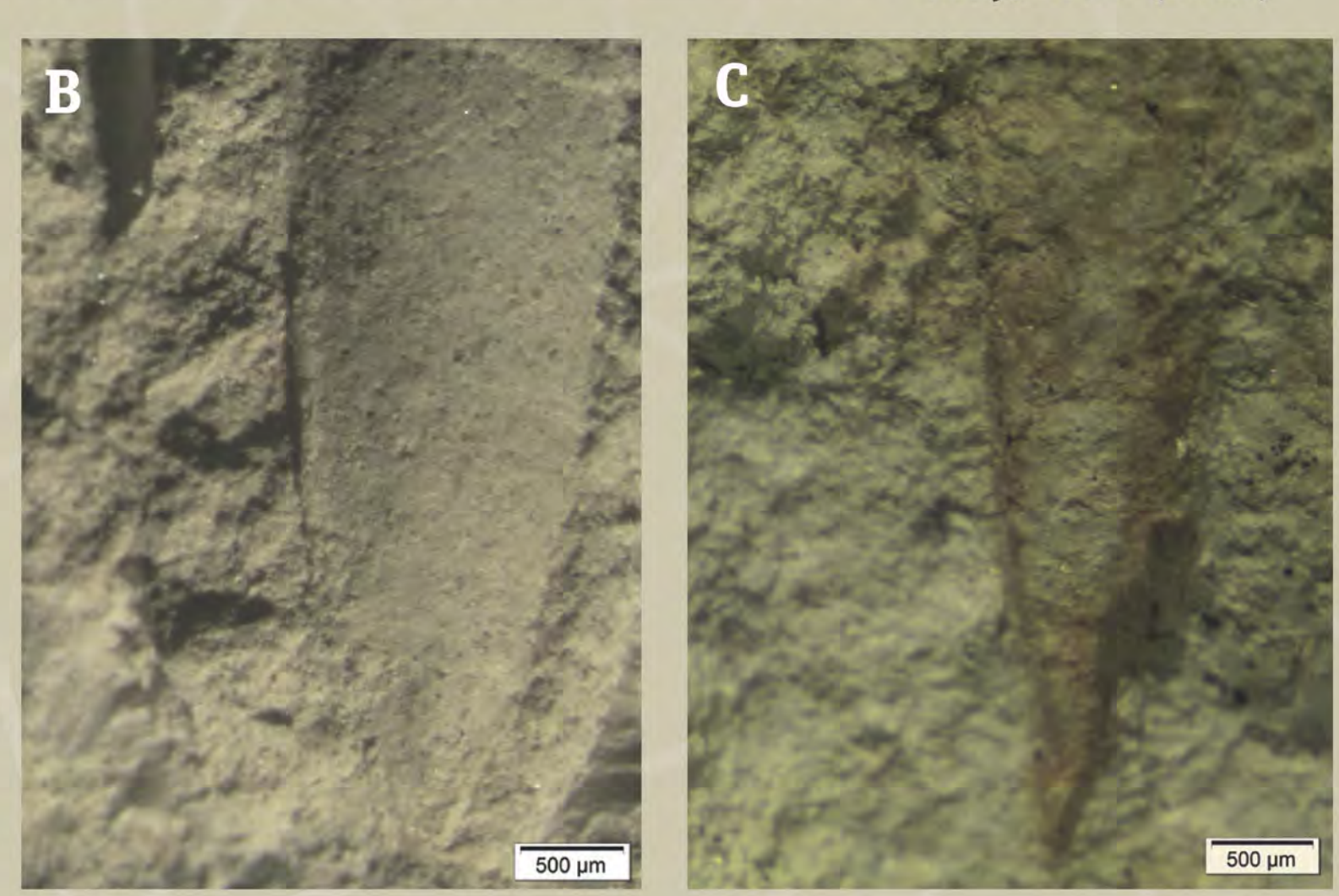
In Northern Croatia pteropods are mostly recorded in the Middle Miocene (Badenian) deposits of the Medvednica Mt. in vicinity of Zagreb (e.g., Gorjanović-Kramberger, 1908; Kochansky, 1944; Bosak, 2017; Bošnjak et al., 2017; Derežić, 2018). During Badenian this area paleogeographically belonged to the southwestern margin of the Central Paratethys, and geotectonically to the Pannonian Basin System (Figure 2). In the Badenian outcrops of the Medvednica Mt. several pteropod species have been recorded so far: *Vaginella austriaca* Kittl, 1886, *Clio pedemontana* (Mayer, 1868), *Clio fallauxi* (Kittl, 1886) and *Limacina valvatina* (Reuss, 1867) (Bošnjak et al., 2017 and references therein).

Recent pteropod research in Northern Croatia was mostly focused on the marine Badenian deposits from Goranec, Čučerje area (central part of the Medvednica Mt.; Figure 2A) (Derežić, 2018). The most numerous species in „pteropod marls“ (Figure 3A) at this locality is *Vaginella austriaca* (Figures 3B and C), which is in accordance with other findings from the Central Paratethys (e.g., Janssen, 1984; Janssen & Zorn, 1993; Zorn, 1991; 1999; Bohn-Havas & Zorn, 1993, 1994). Specimens of *Clio pedemontana* (Figure 3D) were also collected. For the first time we documented the occurrence of the representatives of the family Cavoliniidae Gray 1850 (1815) (Figure 3E,F) and ?*Creseidae* Rampal, 1973 in this area of Northern Croatia. Collected pteropods are preserved as molds and casts, and most of them are fragmented. Very interesting are two findings of the Cavoliniidae representatives preserved as casts (Figure 3E,F). One side of their shell is convex and divided in three parts as seen on Figures 3E and F, what differs them in shape from other recorded specimens (Figure 3B,C,D).



Figure 3. Part of the collected pteropod casts and molds.

A) One of the investigated outcrops of „pteropod marls“;
B), C) *Vaginella austriaca* Kittl, 1886;
D) *Clio pedemontana* (Mayer, 1868);
E), F) Cavoliniidae Gray, 1850 (1815)



DISCUSSION AND CONCLUSION

Nannoplankton and foraminifera analyses were done to determine the age of the deposits and paleoenvironmental conditions. Nannoplankton analyses indicate the NN5 nannozone, as described in the available papers (e.g., Čorić et al., 2009). Recorded foraminifera genera *Bathysiphon* and *Rhabdammina* point to the deep-marine environmental conditions, as well as selective dissolution of aragonite tests (Derežić, 2018). Ostracods, echinoid spines, fish remains, sponge spicules, bryozoans and scaphopod fragments were recorded as an associated fauna.

Recently collected pteropods from Goranec locality show similarity with the previously known pteropod fauna from the investigated neighbouring area on Medvednica Mt. (Bošnjak et al., 2017 and references therein). Here we present new forms of pteropods from Badenian deposits of Northern Croatia. Also, we have found foraminifera genera *Bathysiphon* and *Rhabdammina* for the first time in this area of Northern Croatia (Derežić, 2018). Future research will contribute to the knowledge of pteropod distribution within the Central Paratethys, their possible migration routes (e.g., Transtethyan Trench Corridor or Dinaride Gateway, e.g., Kováč et al., 2018, and possible short-term northern connection during the Langhian age proposed by Janssen & Zorn, 1993), and will give more insight into the deep marine Badenian deposits of the southwestern margin of Central Paratethys.

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