

GEOECOLOGICAL CONSIDERATIONS REGARDING SOME PALEONTOLOGICAL SITES FROM CENTRAL AND SOUTHERN DOBROGEA (ROMANIA)

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Abstract. From a scientific point of view, most paleontological sites in Dobrogea are well documented in terms of scientific value (fossil content and geological framework, educational, aesthetic and even commercial value, as described in previous works) and in terms of area (established by law: surface, location). This paper brings an update of some sites in the Dobrogea Highland in terms of their conservation state and degree of in situ signalling, and proposes three new fossil sites.

Keywords: paleontological sites, nature reserve, nature monument, ecotourism.

Rezumat. Considerațiuni geologice privind câteva situri din Dobrogea Centrală și de Sud (România). Din punct de vedere științific siturile paleontologice sunt, majoritatea, bine documentate în ceea ce privește valoarea științifică (conținutul fosilifer, cadrul geologic, valoarea educativă, estetică și chiar comercială, descrise în lucrările de referință) și în ceea ce privește arealul (stabilit prin lege: suprafață, localizare). Lucrarea de față vine să aducă o actualizare a unor situri din Podișul Dobrogei în ceea ce privește starea de conservare și gradul de semnalizare in situ, și propune trei situri paleontologice noi.

Cuvinte cheie: situri paleontologice, rezervație naturală, monument al naturii, ecoturism.

INTRODUCTION

The ecotourism definition was established by The (International) Ecotourism Society in 1990 as “responsible travel to natural areas that conserves the environment and improves the well-being of local people” (BENNINGTON 1993). HONEY (1999) has proposed a more detailed version (Fig. 1): “ecotourism is travel to fragile,

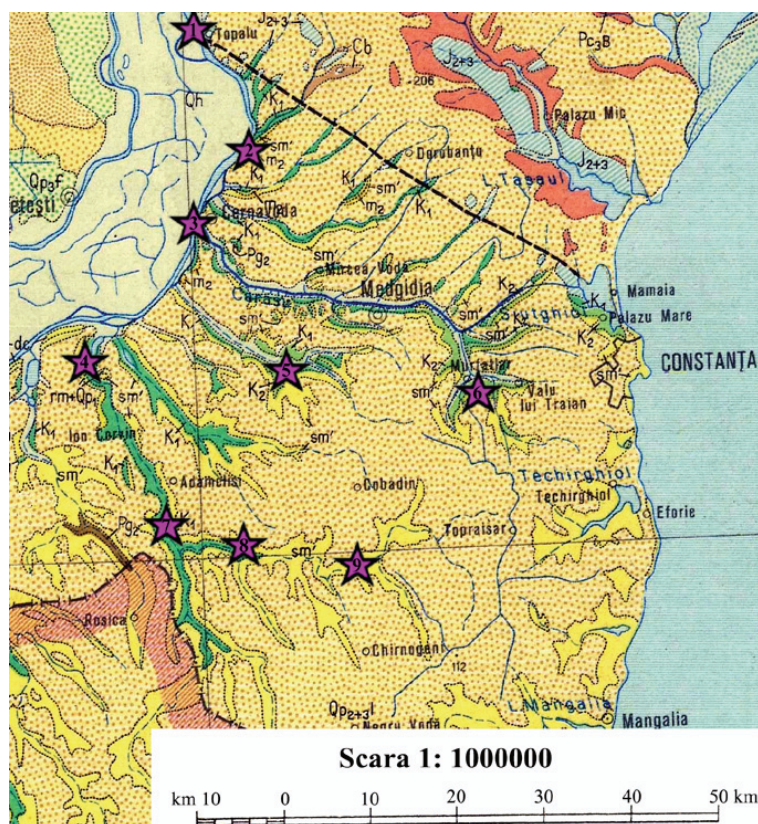


Figure 1. Location of sites presented in the paper on the geological map 1: 1.000.000 (SĂNDULESCU et al., 1978):

1. Topalu, 2. Seimeni Mari și Movila Banului, 3. Cernavodă, 4. Alimania, 5. Credința, 6. Murfatlar, 7. Peștera, 8. Șipote, 9. Petroșani;
Qh - Actual and subactual alluvions, Qp3f- Depozite fluviatile, Qp2+31- Medium and Upper Pleistocene, rm+Qp1- Romanian+Lower pleistocene, sm'- sarmatian extracarpatic, m2- Miocen mediu, Pg2- Eocen, K2- Cretacic superior, K1- Cretacic inferior, J2+3- Jurassic mediu and superior, Cb- Cambrian, Pc3B- Precambrian superior.

pristine and usually protected areas that strives to be low impact and (usually) small scale. It helps educate the traveller; provides funds for conservation; directly benefits the economic development and political empowerment of local communities; and fosters respect for different cultures and for human rights". However, consensus exists among organizations involved with ecotourism (including The Nature Conservancy) around the definition adopted in 1996 by the World Conservation Union (IUCN) which describes ecotourism as: "Environmentally responsible travel and visitation to natural areas, in order to enjoy and appreciate nature (and any accompanying cultural features, both past and present) that promote conservation, have a low visitor impact and provide for beneficially active socio-economic involvement of local peoples" (DRUMM & MOORE, 2005).

The level of legislative protection regarding the sites already declared and included in the law can be considered satisfactory in conditions of application of these provisions. Unfortunately, the level of awareness of local authorities but, especially, that of ordinary citizens about the importance of protecting the paleontological heritage is minimal.

The main action that should be carried out in order to conserve paleontological sites is to draw attention to their importance.

Legislative measures can also be adapted to better prevent the deterioration of these values. In a proactive sense, it is possible to develop a sustainable tourism (ecotourism) – several management plans and some papers that support the regional sustainable development are available for study. Most articles from Romanian laws mention the importance of the environment, of the landscape; but the mentions about the paleontological content are rare and not well documented.

Tourists arriving in the area do not benefit from adequate information without specialized help (specialized guide), as there are no warnings or means of monitoring / protecting the sites.

The present paper intends updating the state of the geological/paleontological sites (those comprised in the current laws) from the central and southern Dobrogea and makes three new proposals, previous known but without the legal steps accomplished. The site at Murfatlar presents the complete stage of the "Senonian" marina facies in chalk. The Peștera quarry is the only representative of the fossil Cenomanian. Point 2 of the Seimeni is an outstanding outcrop of the Sarmatian and Cretaceous stages that qualifies it as a potential tourist attraction or a place intended for specific educational activity.

MATERIALS AND METHODS

The sites presented here were revisited in order to assess their current state of preservation, access roads, signalling and current threats. We consulted the legislation on protected areas, as well as the information existing on the sites of the National and Local Environment Protection Agencies and of the National Agency for Natural Protected Areas.

The geological literature referring to these sites was also consulted. The most relevant geological and paleontological reserves in Dobrogea were described in a previously published book on geological reserves (BLEAHU et al., 1976), a photographic album related to the geological heritage of Dobrogea (SEGHEDI et al., 2018) and in the book of BLEAHU (2019) on natural heritage and nature protection in Romania. Many of the fossil sites were also used as stops in field trip guide books, elaborated for international scientific meetings (SEGHEDI ET AL., 1999; SEGHEDI & STOICA, 2011; KRÉZSEK et al., 2016), or for field activities with students (MELINTE-DOBRINESCU et al., 2020).

DESCRIPTION OF SITES

Topalu Neojurassic Reef (Fig. 2a, b, c, d) – ("Reciful Neojurassic de la Topalu" Nr. 2.352 Law 5/2000) extends on more than 4 km between Cernavodă and Hârșova, North of the village Topalu, on the right bank of the Danube, NW of DJ 223.

The Upper Jurassic deposits exposed in this paleontological reserve belong to the Casimcea Formation and the Tichilești Formation (pro-part) (DRĂGĂNESCU, 1976; DRĂGĂNESCU et al., 1979). The Oxfordian and Kimmeridgian deposits are well exposed. The main object of protection is represented by the biohermal constructions located near the village of Topalu (Fig. 2), but also the biostromal limestones, with a high content in various fossil organisms: brachiopods, bivalves, gastropods, crabs, sea urchins, belemnites, ammonites, Nautilus shells, foraminifera, sponges, corals, etc. (BĂRBULESCU, 1974; 1976). Several generations of researchers (DRAGASTAN, 1985; DRAGASTAN et al., 1998) and students have intensively studied the facies, biostratigraphy, paleoecology and paleogeography of the site. For a while, it has been considered an educational site, but also it has been a reference site, presented in almost all the thematic excursions of international conferences. For its many species, some unique in the world (corals, sponges, etc.), the site deserves more attention from the authorities.

Currently the site appears invaded by garbage; the saddest thing is that the part of the reef (which would be of maximum scientific importance) is "flanked" by garbage (Fig. 2a, c). The area of the site is not marked by explanatory panels.



Figure 2. Topalu paleontological site: (a) Overview of the site, exposed in the high terrace of the Danube, (b) Detail with the reef facies, (c) waste disposal in the site area, (d) Detail with abundant fossils (mollusks, brachiopods).

Movila Banului + Seimenii Mari (Fig. 3a, b) – („Movila Banului Fossil Site” Nr. **2.370** Law 5/2000).

The site is described by BLEAHU et al. (1976) as a geological reserve. Detailed descriptions of the biostratigraphy and lithology of the site are given by Avram et al. (1997) and Avram et al (in SEGHEDI & STOICA, 2011).

This site is usually mistaken with or included in the **Seimenii Mari** fossil site. However, the formation presented here is very different and has its own particularities. Seimenii Mari is a fossiliferous area located on the high bank of the Danube; it has boulders (sometimes of metric size) detached from the stratification, rich in fossils. Detached macrofossils are leached and can be found on the access road (unpaved road).

North from the Seimenii Mari, nearby, on route DJ223 Cernavodă – Hârșova (7 km north from Cernavoda), on the right bank of the Danube above the Cernavodă – Dunărea road, the top of the Cochirleni Formation is exposed, in its



Figure 3. Movila Banului – (a) Outcrop that presents weakly consolidated layers in the Seimenii Mari area, a fossiliferous place that has as distinctive character the presence of ammonites with partially preserved shells; (b) Belemnite and an ammonite fragment with ornamentation and well preserved shell.

only exposure in South Dobrogea. Here, the most comprehensive layer of phosphatic gravels is developed, in a 50 cm thick coquina bed including both the uppermost Lower Albian and the entire Middle and Upper Albian. The phosphatic layer lies between two decimetric sandstone interbeds, immediately below the last member of the Albian rock-sequence, consisting of a clayey glauconitic sandy bed, almost 30 cm thick and devoid of fossils, which underlie the transgressive Lower Cenomanian basal conglomerate. This conglomerate, about 30-40 cm thick, is quartzitic-phosphatic (including phosphatised fossils reworked from the Albian) and in its turn it is transgressively covered by a soft, conglomeratic, fossil-bearing limestone, 0.3-1.2 m thick. The limestone is rich in ostreids in its lower part and in pectinids in its upper part, all macrofaunal remains indicating a Kossovian age. The entire succession is covered by 0.05-0.25 m red clay and by Quaternary loess or loessoid deposits.

The bed with phosphatised fossils mainly includes ammonites (and other organisms): *Otohoplites destombesi*, *Hoplites paronai*, *Anahoplites praecox*, *Hysterocheras varricosum*, *Mariella gresslyi*, *Anisoceras pseudoelegans*, besides numerous other species of *Hamites*, *Anahoplites*, *Dimorphoplites*, which attest the Middle-Upper Albian (AVRAM et al., 1993; 1997). Reworked phosphatised fossils are found in the Lower Cenomanian conglomerate.

From the Kossovian index fossils we mention *Achanthocardia barrandei shafferi*, *Cardita partschi*, *Anomia squamula*, *Anadara turonica*, *Chlamys varnensis*, *C. brussonii defrancei*, *Corbula gibba*, *Ervilia pusilla*, *Crssostrea angusta*, etc. (POPESCU et al., in SEGHEDI & STOICA, 2011). The same limestone yielded foraminifera species, helping in establishing the age.

This site is somewhat protected from anthropogenic actions by the natural growth of vegetation, but this makes it inaccessible or difficult to access, study or visit. In terms of conservation, this site is on the verge of total destruction, naturally. The site also contains unconsolidated, or very friable rocks (sands or glauconitic sandstones), its state of degradation-alteration is pronounced, resulting in slope deposits, mainly altered sands, with degraded fossils (Fig. 3b). The site area is unmarked, not signposted. There is abundant vegetation at the site, the fossiliferous layers are not consolidated, or are strongly affected by secondary alteration, except the horizon of coarse sandstone / microconglomerate containing fossil fish tooth (similar to the widely open formation in the Peștera quarry).

Cernavodă (Fig. 4a, b) – (“Cernavodă Fossil Site” No. 2.354 Law 5/2000). The fossil site is located on the right bank of the Danube River and represents a continuous exposure of limestone sequences, about 35-38 m thick, extending for about 1 km from the Cernavodă bridge to the Cernavodă waterworks.

The paleontological reserve is the type section of the Late Berriasian-Valanginian Cernavoda Formation. The site shows the best exposures on the western side of the Hinog hill, south-west of the Cernavodă town.

Scientific studies of this site include the description of the algal facies and the Lower Cretacic formations (DRAGASTAN, 1985), of the Lower Cretacic fauna and its paleoecology (NEAGU et al., 1997), the facies, paleoecology, paleogeography, biostratigraphy, fossil fauna of Jurassic and Cretacic age (DRAGASTAN et al., 1998) and the lower Cretaceous biostratigraphy and zonation (DRAGASTAN et al., 2014). BLEAHU et al. (1976) first described it as a geological reserve; ANIȚĂI (2013) evaluated the site and described its main values for geoconservation. The site was presented as a stop in several geological field trip guidebooks (SEGHEDI et al., 1999; SEGHEDI & STOICA, 2011; MELINTE et al., 2020).

The Cernavodă outcrop shows shallow marine carbonate deposits formed in intertidal to upper subtidal environments. Several litho- and biofacies were described here more: a) “*Gastrochaenolites level*” - infralittoral of shallow marine environments, characterized by molluscs borings that correspond to the ichnogenus *Gastrochaenolites*; b) “reefal 3” - massive limestone with successive accumulation of shells (various organism); c) “reefal 4” - a patch-reef, with thickness between 2 and 4 m; at the base it consists of a bioaccumulated bed of pachyodonts, and at the top, a pachyodont-rich layer overlies the reef. Biostrome and gastropods shells occur around the reef area.

The access road on the bank of the Danube is undeveloped; it is used as a communal and utilitarian road, serving a small port and gravel pit situated next to the site. With the heavy traffic of ballast trucks, this road seriously impedes a possible tourist access in the area. In addition, the dust raised by the traffic of trucks and the rest of the equipment covers the vegetation at the base of the protected limestone walls. The site area is unmarked, not signposted. A commercial billboard is located above the site.

Aliman (Fig. 5a, b) – (“Aliman Fossil Site” No. 2.351 Law 5/2000) is a fossil site representing a large outcrop of the Alimanu Member of Cernavoda Formation; the limestone exposed along the left bank of the Vederoasa Lake is very rich in fossil fauna (especially large gastropods) attesting the Valanginian age. The Lower Cretaceous microfacies and algal facies was studied by DRAGASTAN (1978, 1999), while details on facies, fossil fauna, biostratigraphy, paleoecology, paleogeography and paleoecology are given in the monograph on Jurassic and Cretaceous by DRAGASTAN et al. (1998). The first description of the geological reserve belongs to BLEAHU et al. (1976). ANIȚĂI (2013) presented the main values of the site and assessed its state of preservation and major threats.

The road that passes by the base of the site is used daily by villagers and cattle breeders (sheep), who cross with livestock; the slopes and walls that expose the fossil-rich sedimentary deposits are partly overgrown naturally by vegetation, grass and especially shrubs. The site area is unmarked and not signposted.



Figure 4. Cernavodă site – (a) Outcrop in the right bank of the Danube; (b) Gastropod in the Lower Cretaceous deposits.



Figure 5. Aliman site: a. Outcrop view of the Aliman site more than half invaded by vegetation; b. internal molding of gastropod.

Peștera (Fig. 6a, b, c), a new site proposal (SEGHEDI et al., 2018), is a former quarry located close to the Peștera village on the right bank of Peștera Valley. Locals use it to extract sand for domestic needs and sometimes to dump garbage. These two current impediments could be removed through the involvement of the community and local administration.



Figure 6. Peștera site: a. Overview of the quarry, successive openings; b. detail from the outcrop, a section visible through a sea urchin; c. Conglomerate and gruss with fish teeth.

The abandoned quarry at Peștera exposes Cenomanian glauconitic sandstones and conglomerates, overlain by Badenian and Sarmatian deposits. The Cenomanian deposits (Peștera Formation) are represented by basal quartzose - phosphatic conglomerates and microconglomerates, sands or quartzose sandstones with glauconitic pebbles lenses, and long - angle tabular, parallel or cross-concave-stratification. The Cenomanian deposits overlie the Albian calcareous or glauconitic sandstones (Cochirleni Formation). The Konkian deposits (Seimeni Formation) transgressively overlies the

Cretaceous ones and are represented by thin, greenish clay and gravels. The Sarmatian sequence (Cotu Văii Formation) starts with massive greenish clay, covered by shelly and bioclastic limestones, calcarenites and calcareous sandstones. The Peștera Formation consists of five distinct lithological units: a basal conglomerate (20 – 100 cm) with ammonites, pelecypods and fish teeth; a gritty-sandy unit with microconglomerate lenses (up to 25 m thick); a transitional unit of quartzose-glaucopitic chaly sandstone (1 – 3 m) with echinoids, inoceramids, ammonites; a quartzose-glaucopitic chalk unit (up to 15 m thick) with echinoids, inoceramids, ammonites and a chaly quartzose-glaucopitic sandstone unit (5 – 10 m) with foraminifers (AVRAM et al., 1988). The age of the Peștera Formation was ascribed to the Early Cenomanian based on the macro- and microfaunal fossil remains (MACOVEI & ATHANASIU, 1934; CHIRIAC, 1988; SZÁSZ, 1983; AVRAM et al., 1988, 1993, 1997). Torcărescu & Călin (in press) present in the detail fish teeth from the site. A detailed description of the site is presented in a field-trip guidebook by SEGHEDI & STOICA (2011).

The quarry is well exposed, accessible by car, the slopes are relatively stable, the slope / steps are not standard. The exposed formations show weak cracks and superficial alteration that does not currently endanger their stability. The paleontological material is visible, accessible and can be detached from the layer (depending on the degree of post-depositional damage, more or less integral).



Figure 7. Murfatlar site: Quarry from Murfatlar (abandoned) – a large outcrop of Senonian.

Murfatlar (Fig. 7) – a new proposal, is a former quarry from which locals still stock up themselves with chaly limestone and in which garbage is accidentally dumped. The Basarabi-Murfatlar cave complex (including X-XI century churches, galleries and Christian graves dug in chalk) is an important archaeological site in the vicinity of the quarry. Located west of Constanța, in the south-western part of Murfatlar, on the road DN3, South of the Danube-Black Sea channel. It is the most representative opening of chalk deposits of Senonian age in Romania, with a biostratigraphic representation for the Santonian - Lower Campanian interval (based on micro- and macrofauna) (NEAGU, 1987). The Murfatlar formation (AVRAM et al., 1988) exposed in the abandoned Murfatlar quarry, includes several lithological terms (facies): a) quartz-phosphate basal microconglomerate; b) massive, friable glaucopitic sandstones or chaly sandstones with *Inoceramus* remains; c) massive or bioturbated chalk, with black cherts at top AVRAM et al. (1993). The fossil content is represented by benthic and planktonic foraminifera, ostracods, echinoderm spines, fragments and shells of gastropods and bivalves (NEAGU, 1987; 1989; 1993; AVRAM et al., 1993; CRUȘOVEANU, in press). Fossil fauna attests to a Lower Santonian-Campanian age of deposits. The microfauna (ION et al., 1998), as well as the nanoflora (MELINTE, 2006) that were described in the boreholes near the Poarta Albă - Năvodari Canal attest the presence of the Upper Maastrichtian deposits of the upper part of the Senonian.

Șipote (Fig. 8a, b) – new proposal, is a former sand and sandstone quarry, from which the villagers sometimes extract sand or sandstone or leave some garbage. The quarry is located Southeast of Șipotele Village, twelve km East from the Lespezi quarry.

Along about 500 m on the right bank of the Ghiolpunar valley, upstream of the captured Șipotele spring, a discontinuous succession from Valanginian to Cenomanian is exposed. At the base of this succession (around the spring) deposits of the Cernavoda Formation are exposed on 10 m thickness, consisting of limestones of various lithofacies from cryptalgal to bioconstructed type. Disposed discontinuously on these limestones, the sandy member of

the Albian Cochirleni Formation is represented by intensely burrowed and cross-bedded glauconitic sandy sandstones. In the same quarry the quartzose-phosphatic member of the Lower Cenomanian Peștera Formation is also exposed as a very hard conglomerate, about 1 m thick, overlain by the quartzose, cross-laminated and fossil bearing sandstone, almost 5-7 m thick. The next, transitional member, 2-3 m thick, contains one of the richest fossiliferous assemblage of the Lower Cenomanian in South Dobrogea, with: *Neohibolites ultimus*, *Hypoturrilites gravesianus*, *H. tuberculatus*, *H. mantelli*, *Mariella cenomanense*, *Mantelliceras mantelli*, *Inoceramus crippsi*, *Holaster* sp., etc. (AVRAM, in SEGHEDI & STOICA, 2011); planktonic and benthic forams, brachiopods, shark teeth, all from the Lower Cenomanian (AVRAM



Figure 8. Șipote site: a. The upper part of the outcrop in the southern part (right side) of the abandoned quarry; b. detail with ammonite remnant (note ventral line) and phosphatized concretion.



Figure 9. Petroșani site - (a) The site of the limestone walls from Petroșani where there are karst formations; (b) detail from the outcrop in which the cross-stratification is observed; (c) sample with negative molds of bivalve shells.

et al., 1988; 1993; 1997).

Petroșani (Fig. 9a, b, c) – (“Limestone walls at Petroșani” Nr. **2.350** Law 5/2000). This natural monument of mixed type, with an area of 4.8 ha, is represented by a limestone outcrop area located on the Urluia Valley, East of Petroșani Village (Fig. 9). The site is of geomorphological type, mainly and paleontological and stratigraphic secondarily. The reservation would have to be signalled, with the display of a description, addressed to tourists.

This section exposes the Cenomanian glauconitic sandstones and conglomerates (Peștera Formation) at the base, overlain by transgressive Sarmatian clastics and bioclastic limestones rich in *Maetra* shells (Cotu Văii Formation) (SEGHEDI & STOICA, 2011).

Around and Eastwards of Petroșani Village, on both sides of the Urluia Valley, elongated outcrops expose the Sarmatian (Basarabian) deposits transgressively overlaying Cenomanian glauconitic sandstones and conglomerates, with parallel or cross-concave stratification. The Sarmatian is represented by shelly limestones, calcarenites and calcareous sandstones with thin clay intercalations. They are very rich in mollusc shells (coquinas), especially of *Maetra* species.



Figure 10. Credința site: a. View of the two outcrops from Credința, close-up and a larger exposure of the formation in the distant plan; b. Detail from the upper part of the outcrop, exposing both type of facies - sandy and limy; c. Bivalve internal mold detached from the calcareous levers.

Credința (Fig. 10a, b, c) – (“Credința Fossil Site” Nr. **2.353** Law 5/2000). This area has two generous outcrops, highly fossiliferous, with unstable slopes. The material from the upper levels (Sarmatian) is well consolidated, almost earthy, followed by an area with less consolidated layers, but from which fossils can be easily extracted. At the base are well-consolidated layers, with an average macrofossil content, their recovery being a bit more difficult. A small quarry located north-west of Credința Village, exposes whitish-yellowish quartzose sandy deposits that belong to the Cotu Văii Formation (Sarmatian /Basarabian) - named “The quartzose Sand Horizon” or “The Credința Sand” (GRIGORESCU & DINU, 1978), up to 10-12m thickness overlie the Lower Limestones Unit and underlie the Upper

limestone Unit (12-14m). In these sands a rich vertebrate fauna (fish, birds, turtles, seals and cetaceans) was described (GRIGORESCU, 1978). To the upper part of the sandy sequence, calcareous sandstones and calcarenites become more frequent (GRIGORESCU & DINU, 1978). Sandstone concretions with carbonate cement can be also seen toward the upper part of sands

The exploitation of the sand from the site is also practiced locally, which in time might lead to the destruction of the fossil content. This is an unmarked site area, not signposted; when the weather is fine it can be reached by car (on unpaved country road).

Seimenii Mari (Fig. 11a, b) – (“Seimenii Mari Fossil Site” 2.355 Law 5/2000) is an outcrop of Sarmatian deposits about 200 m wide and variable height (in steps generated by the ravine) between 10 and 50 meters, with deposits of sandstone or marl, rich in fossils of gastropods and bivalves. The outcrop is located on the Danube River right bank, very close to the water, between the slope and water there is a portion with an access road (right next to the village hall is an easily accessible by car road); in the future it could be even arranged or partially arranged (alley). The site deserves to be proposed for protection only partially (rich fossil portions in part) the rest, even the blocks between the slope and the Danube (around the road) could be a geotourism attraction (samples can be offered).



Figure 11. Seimenii Mari site: a. Outcrop from the Seimenii Mari site; b. Coquina with *Mactra* and gastropods.

CONCLUSIONS

The present paper proposes three new paleontological sites: Mufatlar, Șipote and Peștera. In addition, we propose a disambiguation in the case of Movila Banului – Seimenii Mari. They are also sites of scientific interest – corresponding to the criteria presented by ANDRĂȘANU & GRIGORESCU (2012), and with the proper management, they can become tourist attractions.

It is important to maintain a balance between tourism development and the conservation of sites of scientific interest, and the ecotourism may be the answer. Also, this can provide some protection towards the exploitation of the sites as raw material by revealing to the locals that they have also a financial interest in preserving the sites (income generated by the tourism), that is a sustainable exploitation.

Legislation regarding the paleontological and geological protected areas is assured by the Law no. 5 from March 6, 2000 regarding the approval of The National Territory Planning Plan – Section III, protected areas, Government Emergency Ordinance no. 57/2007 on the regime of natural protected areas, conservation of natural habitats, wild flora and fauna, approved with amendments and completions by Law no. 49/2011. They need to be updated and also improve as regarding the conservation regulations.

A periodical assessment of the sites physical state is recommended, followed by immediate actions where the integrity of the sites is in jeopardy.

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