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MORAVA MOUNTAIN OLIGOCENE-MIDDLE MIOCENE SUCCESSION OF ALBANIAN-THESSALIAN BASIN, SE ALBANIA

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Abstract

The Morava Mountain Oligocene-Middle Miocene molasse deposits take part in the Albanian-Thessalian Basin, which developed NW-SE from eastern Albania to Thessaly in Greece, where called as Mesohellenic Basin. The 4.5 km thick basin infill subdivided into three molasse cycles separated by two regional unconformities at the Eocene/Oligocene and Aquitanian/Burdigalian boundaries. The Morava Mountain Oligocene-Middle Miocene molase, ~ 3500 m thick, represent an exposed continuous, rich in fossil fauna succession. Six stratigraphic sections were studied and measured. The Oligocene succession contains a rich, well preserved and diversified fossil faunas dominated by molluscs, abundants corals, larger foraminifers and echinoids, whereas the Miocene succession contains sparse, moderate preserved and little diversified molluscs, mainly bivalvia, and several larger foraminifers and corals. The biostratigraphy and palaeoecological reconstruction are treated based mainly on the presence of diverse mollusc assemblages and their comparative analysis with coeval assemblages of the Mediterranean Province. The Oligocene deposits ~ 650 m thick start with the basal conglomerates and coalbearing marls, passing upwards with marine rich in fossils siliciclastic deposits and coral reefal limestones intercalation of Rupelian, to 300 m thick, following by the greyish-blueish marls and intercalation of stratiphied or massive sandstones and marls containing marine molluscs, large foraminifers and plant leafosils of Chattian, of ~ 340 m thick. Intercalation of marls and clays with fine sandstones, passing upwards into massive sandstones and conglomerates, ~ 850 m thick, were dated of Aquitanian. The transgressive Early-Middle Miocene deposits, ~ 2200 m thick, reached only in the southern part of the Albanian-Thessalian Basin and are composed mostly of shallow marine white corallinacean red algae limestones, sandstones and marls of Burdigalian, ~ 450 m thick, following by deep marine bluish marls, clays, rich in planktonic Pteropoda and thin pectinids of Langhian, ~ 900 m thick, and final marine regressive predominant *sandstone series of Serravallian, 760 m thick. Freshwater Late Miocene-Pleistocene deposits unconformably overlie the Oligocene-Middle Miocene molasse.*

Keywords: *Morava Mt, Oligocene-Middle Miocene succession, Biostratigraphy, Molluscs.*

Περίληψη

Οι Ολιγοκαινικές- Μεσομειοκαινικές μολασσικές αποθέσεις του όρους Μοράβα, που ανήκουν στην Αλβανο-Θεσσαλική λεκάνη, η οποία εκτείνεται ΒΔ-ΝΑ της Αλβανίας έως τη Θεσσαλία, είναι γνωστή ως Μεσοελληνική Αύλακα. Τα ιζήματα πάχους 4,5 km της λέκανης υποδιαιρούνται σε τρεις μολασσικούς κύκλους που διαχωρίζονται με δύο τοπικές ασυμφωνίες, μία στο όριο Ηώκαινο-Ολιγόκαινο και άλλη μία στο όριο Ακουιτάνιο–Βουρδιγάλιο. Η Ολιγοκαινική-Μεσομειοκαινική μόλασσα του όρους Μοράβα, πάχους περίπου 3500 m., αντιπροσωπεύει μία εμφανή συνεχή ακολουθία, πλούσια σε απολιθωμένη πανίδα. Εξι στρωματογραφικές τομές μελετήθηκαν και μετρήθηκαν. Η Ολιγοκαινική ακολουθία περιέχει πλούσιες, καλά διατηρημένες απολιθωμένες πανίδες, στις οποίες επικρατούν μαλάκια, άφθονα κοράλλια, μεγαλύτερα τρηματοφόρα και εχινοειδή. Η Μειοκαινική ακολουθία περιλαμβάνει μαλάκια, κυρίως δίθυρα, σποραδικής εμφάνισης με μέτρια διατήρηση και ποικιλία καθώς και διάφορα μεγαλύτερα τρηματοφόρα και κοράλλια. Η βιοστρωματογραφική και παλαιοοικολογική ερμηνεία βασίζεται στην μελέτη των διαφόρων συγκεντρώσεων μαλακίων και των συγκριτικών αναλύσεων με συγκεντρώσεις σύγχρονης ηλικίας της περιοχής της Μεσογείου. Οι Ολιγοκαινικές αποθέσεις πάχους ~650 m ξεκινούν με βασαλτικά κροκαλοπαγή και ανθρακοφόρες μάργες, οι οποίες μεταβαίνουν προς τα πάνω σε θαλάσσιες πυρiτοκλαστικές αποθέσεις πλούσιες σε απολιθώματα και ενδιαστρώσεις με κοραλλιογενείς ασβεστόλιθους ηλικίας Ρουπέλιου πάχους 300 m. Ακολουθούν κυανόγκριζες μάργες με ενδιαστρώσεις στρωματοποιημένων ή συμπαγών ασβεστολίθων και μαργών που φέρουν θαλάσσια μαλάκια, μεγάλα τρηματοφόρα και απολιθωμένα φύλλα ηλικίας Σάττιου, πάχους 340 m. Οι ενδιαστρώσεις μαργών και αργίλων με λεπτούς ψαμμίτες μεταβαίνουν σε συμπαγείς ψαμμίτες και κροκαλοπαγή πάχους 850 m, ηλικίας Ακουϊτάνιου. Οι επικλυσιγενείς αποθέσεις του Νεωτέρου –Μέσου Μειοκαίνου, πάχους 2200 m., εμφανίζονται μόνο στο βόρειο τμήμα της Αλβανο-Θεσσαλικής Λεκάνης και αποτελούνται κυρίως από ρηχούς θαλάσσιους λευκούς ασβεστόλιθους με κοράλλια και κόκκινα φύκη, ψαμμίτες και μάργες ηλικίας Βουρδιγάλιου, πάχους 450 m, ακολουθούν θαλάσσιες κυανές μάργες και άργιλοι πλούσιες σε πλαγκτονικά Πτερόποδα και λεπτά *pectinids (Κτενοειδή , Pecten?) ηλικίας Λάγγιου, πάχους ~900 m και τέλος κυριαρχούν ψαμμίτες θαλάσσιας προέλευσης ηλικίας Σεραβάλλιου, πάχους 760 m. Πάνω από τις Ολιγοκαινικές-Μεσομειοκαινικές μόλασσες υπέρκεινται ασύμφωνα αποθέσεις γλυκών υδάτων, ηλικίας Ανω Μειόκαινου- Πλειστόκαινου.*

Λέξεις - Κλειδιά: *Όρος Μοράβας, Ολιγόκαινο – Μέσο Μειόκαινο, Βιοστρωματογραφία, Μαλάκια*

1. Introduction

The objective of the present paper is more a synthesis of stratigraphic investigation mainly based on mollusc fauna for the Oligocene-Middle Miocene molasse of the Morava Mountain succession in Albanian-Thessalian Basin (Bourcart, 1925) (afterwards abbreviated ATHB) in SE Albania. The rich Oligocene mollusc fauna of the Morava Mt attracted the attention of the French, Austrian and German geologists at the beginning of the second half of the 19th century. The first geological description and molluscs determination of Morava Mt. was made by Dreger (1892), later the German paleontologist Oppenheim, studied and illustrated the Oligocene molluscs founds by Phillipson, among other Oligocene species give out the new Barbatia albanica now Trisdos albanica Oppenheim (Philippson and Oppenheim 1894). V. Hilber (1894, 1896) investigated the lignites of Drenova and their Oligocene mollusc fauna was studied and published by K. Penecke (1896). The first modern geological and stratigraphical investigation of the Morava molasse has been carried out by J. Bourcart during the World War I. Bourcart was the first geologist that compiled the geologic map and published many studies about the Tertiary deposits' stratigraphy of the southeastern Albania (Boucart 1922, 1925; Cossmann and Bourcart, 1921). He described in detail the stratigraphy of Morava Mt Oligocene-Miocene succession ("Neonummulitique") transgressively overlying the ophiolites and subdivided into several litho-stratigraphical units. Later, Nummulites of the Korça area are described by de Cizancourt (1930). The new era of geological investigations was initiated with rapid increasing of prospecting and mining activities during the second half of the 20th century. Having an economic potential, due to the content of lignite deposits, many stratigraphical studies of Oligocene-Miocene deposits of ATHB has been performed after the Second World War. A complete detailed stratigraphic unpublished framework and later some papers on the Eocene, Oligocene and Miocene molasse deposits for the ATHB, were carried out (Papa 1967, Pashko 1975ab, 1977a). According to these studies, three periods of regional extension have conditioned three marine molasse depositional cycles: i) the first Eocene (Late Lutetian-Priabonian) cycle; ii) the second Oligocene-early Miocene

(Aquitanian) cycle, and iii) the third Early Miocene (Burdigalian)-Middle Miocene (Serravallian) cycle. The most comprehensive Oligocene-Middle Miocene molasse succession of ~3500 m thick of Morava Mountain, located east of Korça town, represents a complete, lithologically remarkable and vertically continuous exposed section in the ATHB of SE Albania.

The Morava succession is characterized by very rich and well diversified (Oligocene) or moderately rich and little diversified (Miocene) mollusc assemblages (gastropods, bivalvia, scaphopods and cephalopods), associated with locally abundant corals, and foraminifers, echinoids. Later on, the information about biostratigraphy, palaeogeography and palaeoecology are given in some publications by Pashko (1977ab, 1981, 1986, 1987), also on stratigraphy and molluscs in an unpublished paper by D. Marku, while the stratigraphy of the lignitic deposits is represented in some unpublished works and papers (Dimo et al. 1982, 1989, Pashko et Milushi 2014). Results of micropaleontological investigations on the foraminifers and nannoplanktons are given by Kumati (1996) and Kumati et al. (1995, 1996). Kleinholter (2004) has presented the first investigation on the fossil plants. Recently, the calcareous nannofossils were studied by Kallanxhi M-E, Coric S. (2014). The geologic evolution of the ATHB was treated in some publications by Aliaj (1997, 1998), and Aliaj et al. (1996). This paper is the first compilation on Morave Mt. Oligocene-Middle Miocene stratigraphy that comprises all unpublished and published data combined with new records compares it to other Mediterranean area, particularly Northern Italy and Mesohellenic Basin in Greece (Table 1 and 2 and Figure 15).

2. Geological setting

The studied area is located in the southeastern part of the formerly named Albanian-Thessalian (Bourcart, 1925) or Korça Basin (Kossmat, 1925, Pashko 1977a, Pashko et al. 1973) called also as the Mesohellenic Basin (abbreviated to MHB) (Brunn, 1956). The ATHB represents a narrow prolongated marine trough, trends NW-SE parallel to the Hellenides structures from south-eastern Albania to Thessalian Plain in Greece and covers the suture between Apulian microplate and the Korabi-Pelagonian structural units. From Middle Eocene (Late Lutetian) to Middle Miocene (Serravallian) the ATHB developed transgressively on the Mirdita and partly Korabi zones (Fig. 1). The ATHB has a thick basin infill, ~ 4.5 km, and it is consisted of a continuous sedimentary succession of predominant shallow marine molasse deposits, that unconformably lying on the pre-Cenozoic Triassic-Cretaceous basements and overlain by late Miocene to Pleistocene lacustrine, swamp, fluvial lignite deposits (Pashko, 1970). The evolution of the ATHB was characterized by two main tectonic compressional events: i) an important inversion at the Eocene/Oligocene transition when established ATHB as a high subsidence basin with molassic-type sedimentation; ii) tectonic phase related to the Aquitanian/Burdigalian boundary and marked by the unconformity of Burdigalian deposits on the oldest basin formations. Results of these tectonic phases during three periods of regional extension have developed three marine molasse cycles.

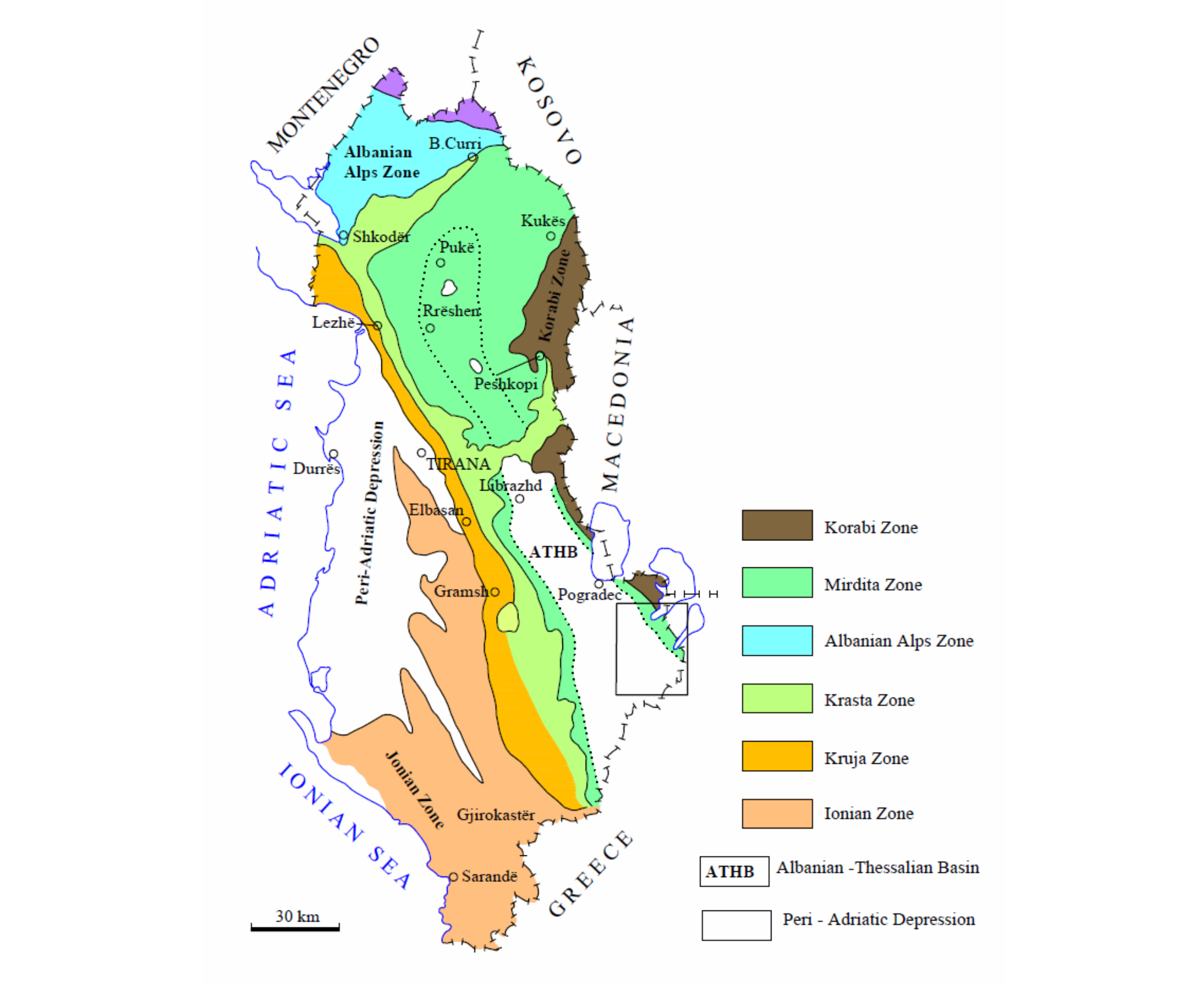

Figure 1: Tectonic map of Albania showing the Albanian-Thessalian Basin and location into it of the studied area.

The first cycle of Eocene (Lutetian-Priabonian) age, up to 300 m with *Orbitolites complanatus*, *Nummulites perforatus*, *N. laevigatus*, *Campanile giganteum*, *Amussium corneum* (Cervenaka cross-section (Figure 2; Pashko, 1975a, b) and up to 1000 m thick Stravaj Priabonian flysh (Pashko, 1985) was accumulated during the maximum regional flooding of the ATHB, but it was partly eroded and now preserved in limited erosional outcrops along eastern and western margins of a syn-sedimentary basin of 20-70 km width (Figure 1).

The second cycle of Oligocene-Early Miocene (Aquitanian) age, about 3500 m thick, is developed throughout the basin as a narrow asymmetric syncline of maximum to 40-45 km width up to Librazhd area and more in Northern Mirdita Zone, where it is evidenced by the several isolated outcrops of the Oligocene ophiolitic basal conglomerates in Cerruje (Burrel) and predominant marls sequence with *Trisidos albanica* Oppenheim and *Tympanotonus margaritaceus* (Brocchi) in Kaçinar (Mirdita) areas.

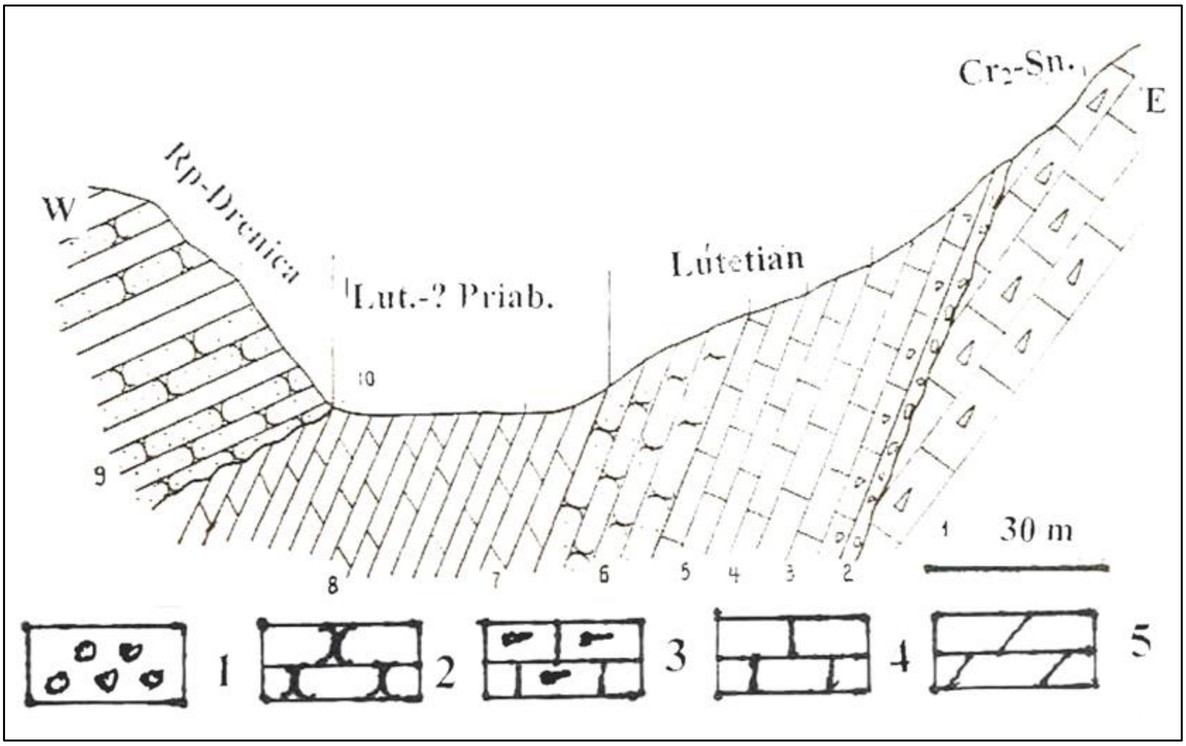

Figure 2: Cervenaka (Pogradec) geological cross-section showing an unconformable lower boundary of the Eocene-Lutetian deposits with the underlaing Cretacic-Senonian limestone and an unconformable upper boundary of the Eocene, Lutetian-? Priabonian deposits with overlain Oligocene-Rupelian, Drenica Fm. (Pashko, 1975a).
Legend: 1- Conglomerates, 2- Sandstones, 3- Cretasic-Senonian limestones, 4- Limestones, 5- Marls.

The third marine transgessive cycle of Early-Middle Miocene (Burdigalian-Serravallian) age, ~2100 m thick, was restricted to SE part of the basin. Finally, a compressional event affected the uplifting of the ATHB from Middle Miocene to the present, and a series of smaller freshwater basins filled mainly by coalbearing lacustrine and fluvial-lacustrine deposits were formed (Pashko, 1970). The substratum of the ATHB consists mainly of ophiolitic rocks and Cretaeous carbonates (Mirdita Zone), or of Triassic-Jurassic carbonates (Mali i Thate, Korabi Zone) (Figure 1, 2 and 3). The Morava succession is described throughout the western flank of the high asymmetric

Devolli syncline structure, when the outcrops show a complete continuous stratigraphic sequence from the Lower Oligocene to the end of the Serravallian (Figure 3), which is unconformably overlain by the freshwater Late Miocene-Pleistocene deposits (Pashko,1970). The average inclination of the strata is ~ 14-30° mainly toward E. The Morava Mt. lithostratigraphy and biostratigraphy is based on data obtained from six stratigraphic sections carried out there (Figure 3, 5 and 12).

The Oligocene-Middle Miocene succession in the Morava Mt. with well (Oligocene) or moderately (Miocene) preserved and diversified fossil faunas, shows a continuous, the most complete and representative stratigraphic section within the ATHB, and was lithologically subdivided in a number of formations (Pashko, 1977a, 1983). Those studies are based mainly on the rich mollusc assemblages (gastropods, bivalvia, scaphopods, cephalopods), and foraminifers, nannoplanctons and echinoids (Pashko 1977a, b, 1986, 1987, 1996; Pashko et al. 1973, 2014; Kumati 1996, Kumati et al. 1995, 1996).

Molluscs are important for the biostratigraphy of the Oligocene-Miocene sequence and in general it has been noticed a biostratigraphic correlation over a larger distance similarity with coeval molluscs assemblages of well studied Northern Italy (Michelotti, 1847, 1861; Fuchs 1870; Sacco 1872-1904; Bonci et al. 2000; Zunino et al. 2009), and also Mesohellenic Basin and Iran (Harzhauser 2004; Wielandt-Schuster et al. 2004) (Tables 1 and 2 and Figure 15).

The present paper is the most complete study primarily based on the biostratigraphy of the molluscs of the Morava Mt. Oligocene-Middle Miocene succession.

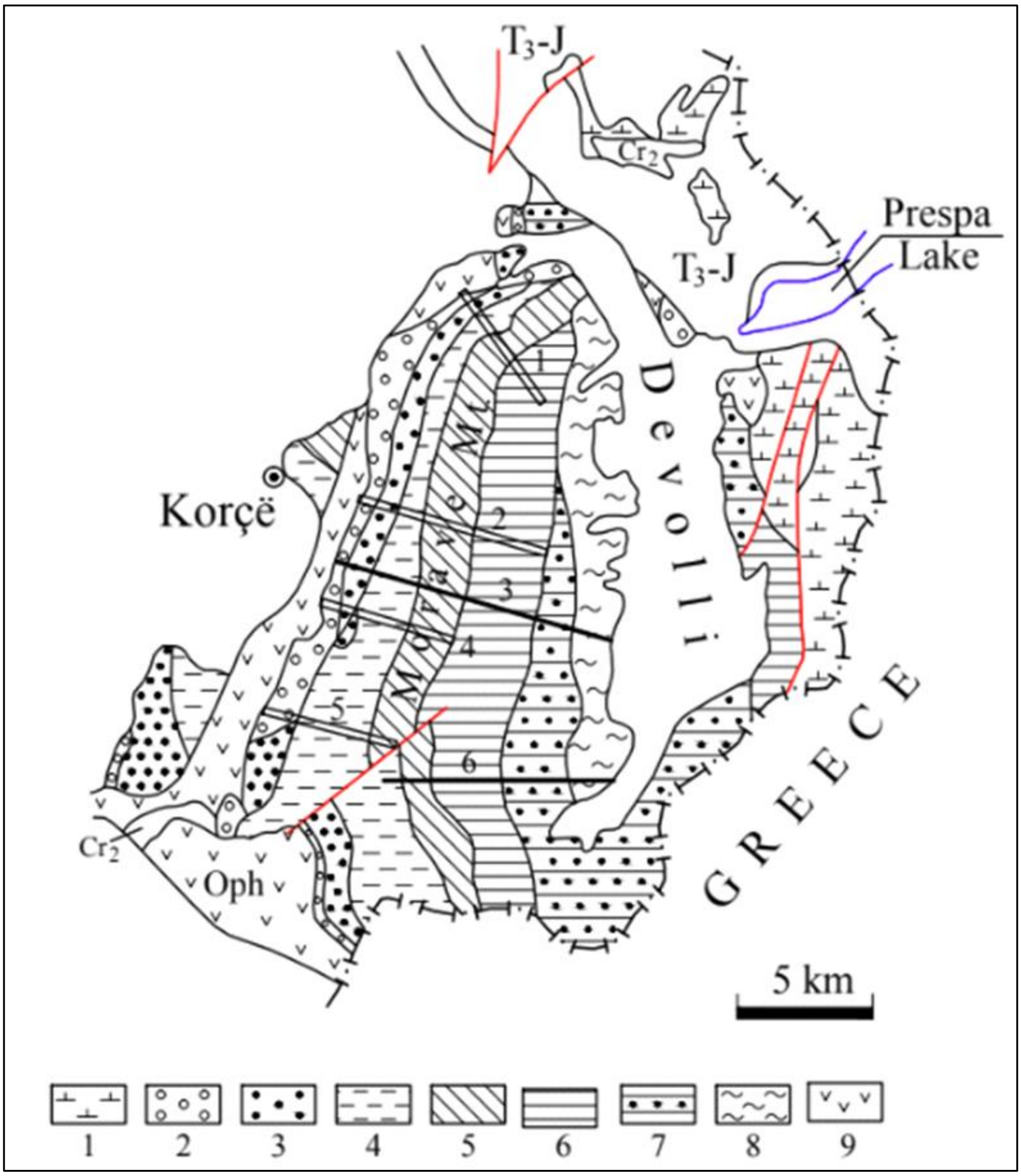

Figure 3: Geological map of the Morava area (modified from Xhomo et al. 2002) showing the location of the six studied sections. 1- Plasa, 2- Mborja, 3- Drenica, 4- Drenova, 5- Boboshtica and 6-Dardha sections. Bold line, more detailed sections.

Legend: 1 – Eocene, 2- Oligocene Late Rupelian, 3- Oligocene Chattian, 4- Early Miocene Aquitanian, 5- Early Miocene Burdigalian, 6- Middle Miocene Langhian, 7- Middle Miocene Serravalian, 8- Late Miocene-Pleistocene, 9- Ophiolites. Abbreviations: TJ- Triassic-Jurassic limestones, Oph- Jurassic ophiolites, Cr2- Late Cretaceous limestones.

3. Material and methods

The material of the molluscs derived mainly from the six stratigraphic sections (Figures 3, 4, 5 and 12) covers the Morava Mt. molasse from the Oligocene basal conglomerates to the top Middle Miocene deposits, which were measured and studied in detail during the stratigraphic investigations of Paleogene-Miocene deposits in ATHB. The investigated material was collected from all fossil levels and a detailed sampling for palaeontological analyses has been carried out. The rich fossil faunas are dominated by highly diverse and well preserved molluscs, especially Oligocene assemblages, locally associated by abounded corals, and echinoids, micro- and larger foraminifers, as well as by calcareous nannofossils.

The Morava sedimentary succession shows continuous biostratigraphic molluscs records. The additional studied material, especially Oligocene molluscs found and studied during the stratigraphic investigation for coal deposits in ATHB, we find useful (Dimo et al. 1982, 1989; Pashko et Milushi, 2014). The rich Oligocene mollusc assemblage included specimens with well preserved mostly large sized shells (Table 1 and 2) whereas the Miocene assemblage in general represented by sparse mollusc specimens with poor to moderate preserved shells, mostly bivalvia (Tab. 3). The Langhian marls contain rich mollusc assemblage of typical deeper water species such as pectinids with thin shells and planctonic gastropods Pteropoda. In total a taxonomic identification resulted in 181 taxa, containing 113 Oligocene and 68 Miocene mollusc taxa were found and determined in the Morava Mt. areas. The Oligocene taxa: 59 Gastropods, 3 Scaphopods (Table 1), 50 Bivalvia, 1 Cephalopoda (Nautilus) (Table 2) and the Miocene taxa: 21 Gastropods, 3 Scaphopods (Table 3) and 44 Bivalvia (Table 4), within there the numeruous good key species were identified. The studied material is deposited in the Geological Institut of Tirana.

4. Litho and Biostratigraphy

In the Albanian-Thessalian Basin due to three periods of regional extension it has been conditioned three marine molasse depositional cycles: i) the first Eocene (Late Lutetian-Priabonian) cycle (Figure 2, Pashko 1975a); ii) the second Oligocene-Early Miocene (Aquitanian) cycle (Figure 5), and iii) the third Early (Burdigalian) - Middle (Serravallian) Miocene cycle (Figure 12). The Morave Mt. Oligocene-Middle Miocene molasse deposits comprise two last cycles. The stratigraphy of Morava Mt. Oligocene-Middle Miocene sequence is described based mostly on Drenica and Dardha sections, which show a more complete continuous stratigraphic sequence from the Oligocene to the end of the marine Miocene (Serravallian) and comparable to the stratigraphic standard scale.

4.1. The Oligocene-Aquitanian Cycle

4.1.1 Oligocene

The Oligocene sequence of ~ 650 m thick, the Drenica section of 498 m thick, located in the particular Drenova erozional circus (Bourcart, 1922) (Figure 4), represents a marine succession unconformably lying on the ophiolitic basement. It consists of basal alluvial deltaic (conglomerates and brackish with lignite) deposits (Mborja Fm and Drenova Fm), which is followed by thick intercalated siliciclastic with corals limestones and shallow marine fossils (Drenica Fm) and upwards by marine gray-blue marls (Chama Marls) followed by intercalation of stratified or massive sandstones with marls (Plasa Fm) (Figure 5). According to the molluscs (Pashko, 1977a) and microfauna (Kumati 1996; Kumati et al 1995, 1996) in this lithologically remarkable succession the Rupelian and Chattian stages were determined.

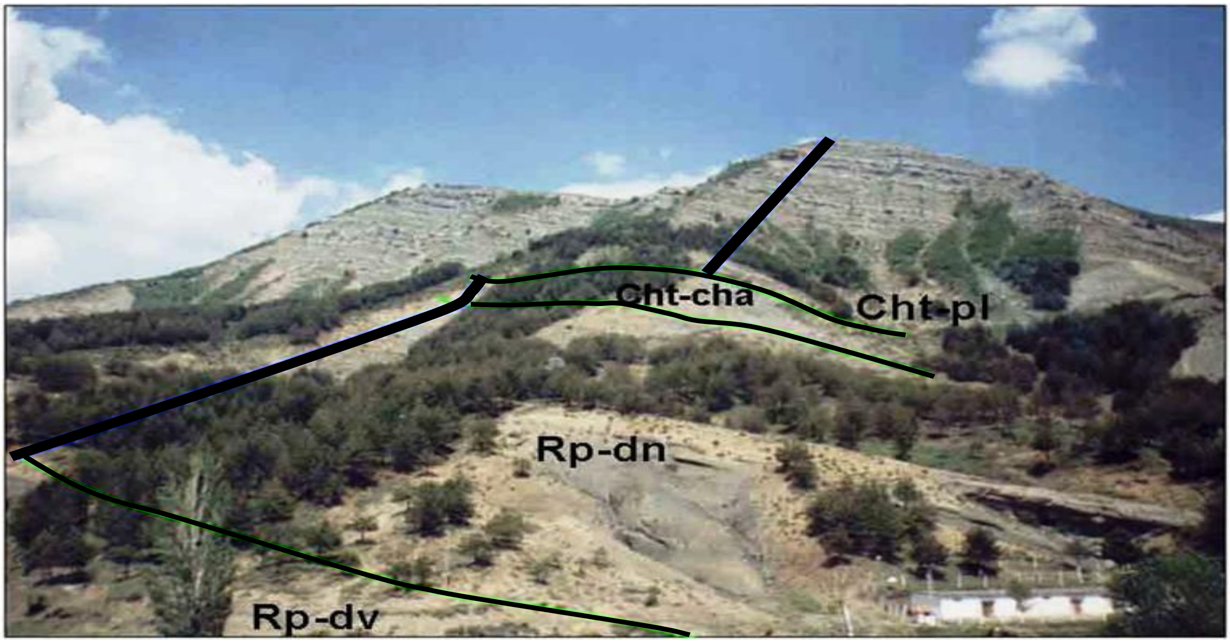

Figure 4: Oligocene deposits in the Drenova "Erosional Circus" (Bourcart, 1922). Abreviations: Rp- dv Rupelian Drenove lignite Fm, Rp-dn Rupelian Drenice corals Fm, Cht-cha Chattian Chama Marls, Cht-pl Chattian Plase Fm. (Photograph A. Serjani).

4.1.1a Rupelian Stage

The Rupelian up to 300 m (Drenica section 248 m) thick sequence (Figure 4, 5) consists of the basal conglomerates passing upward to brackish with lignite deposits and thick intercalations of siliciclastic deposits with reefal coral limestones rich in predominant shallow marine fossils. Three formations were distinguished.

The Mborja Conglomerate Fm represents a continental basal sequence, 25 (Drenica section) to 60 m (Mborja section) thick, of mostly ophiolitic conglomerates, enclosed in a matrix of coarse-grained sandstones, which directly overlies the ophiolites and partly carbonates of the ATHB basement. In Drenova sequence a layer of greyish fine-grained, 2-6 m thick, tuffaceous sandstones occurs at the top of the conglomerates. Further to SW, in Mali i Kuq the conglomerates are consisted mainly of limestone pebbles within redish sandstone matrix, reaching a thickness of 80-90 m.

Palaeoecology: the mostly ophiolitic conglomerates, enclosed in a matrix of coarse-grained sandstones of Mborje Fm have the character of transgressive deposits and can by interpreted as aluvial fans and deltaic facies.

The Drenova Lignite Fm, of 36 m (Mborja section) to 79 m (Drenice section) thick, starts with lowermost coalbearing part, that is consisted of ~22 m thick grey marls and siltstones with intercalations of dolomite layers ~0.2-0.3m thick (Figure 6), and two 0.8-0.9 m and ~2.0 m thick coal seams. At the top of coal seams, it overlies 0.2 to 0.4 m thick greyish-blueish, laminated limestone with pressed and deformed shells of Mytilopsis cf. basteroti (Deshyes). This interval contains monospecies assemblage (coquinas) of Polymesoda subarata convexa Brongniart, Crassostrea cyathula Lamarck, benthic brackish foraminifera mainly Ammonia beccari and plant fossils (Kleinholter, 2004). The next upward succession, ~28 m thick, of monotonous intercalations of thick greyish marls and dolomitic layers, is rich in well preserved molluscs, predominantly gastropods such as abundant polymorphic species Tympanotonos margaritaceus (Brocchi) (Figure 7) T. subcorrugata (D'orbigny), T. stropus (Bongniart), rare Terrebralia cf. bidentata (Grateloup), Granulolabium plicatum (Bruguiere), Charona delbosi Fuchs, Ampullinopsis crassatina (Lamarck), Globularia gibberosa (Grateloup), and in mass occurrence of the bivalvia Trisidos albanica (Oppenheim), and other mainly euryhaline species such P. subarata convexa (coquinas), Cr. cyathula, Cyprina islandica rotundata (Agassiz) and Cordiopsis incrassata (Nyst). Numerous fresh water Melanopsis impressa Krauss were also identified.

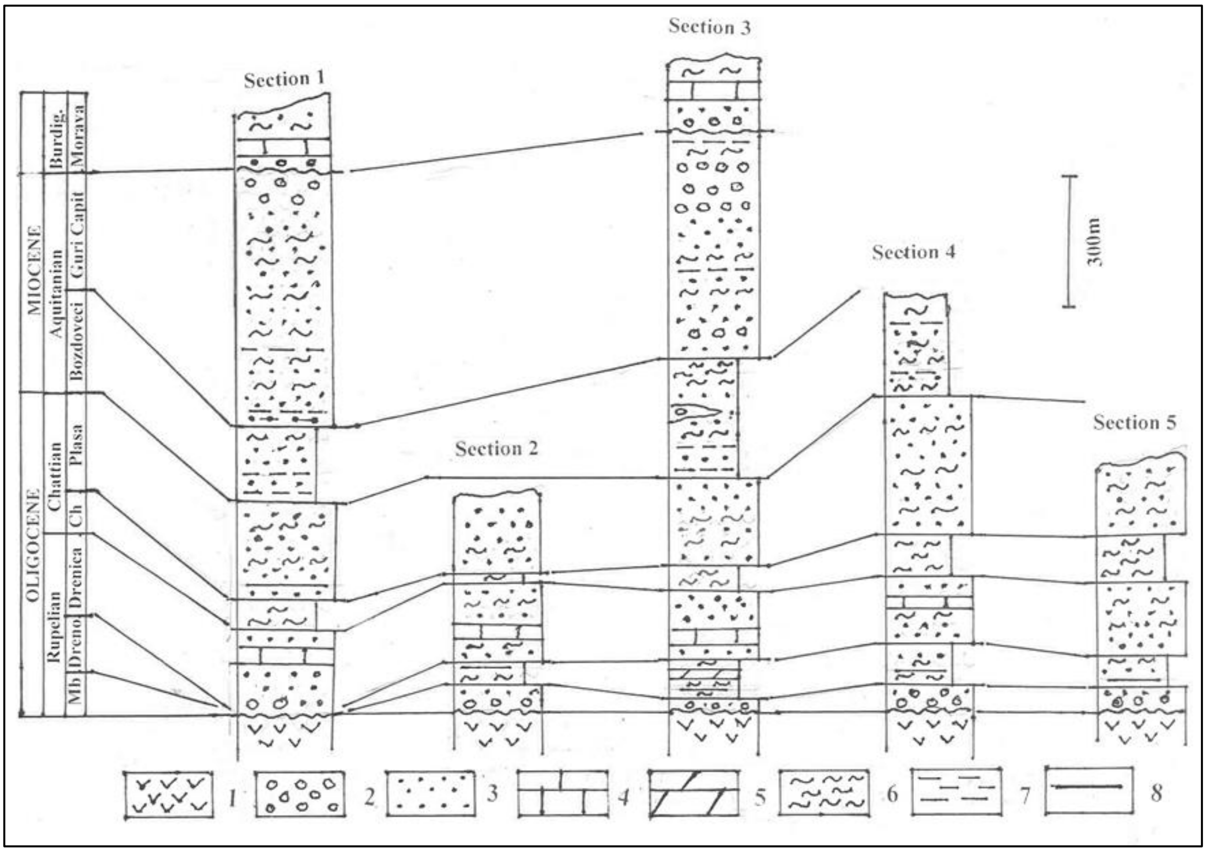

Figure 5: Stratigraphic correlation between the studied and measured setions in the Oligocene-early Miocene (Aquitanian) deposits (second cycle): 1- Section 1 (Plasa), Section 2 (Mborja), Section 3 (Drenica), Section 4 (Drenova), and Section 5 (Boboshtica).
Legend:1- Ophiolites, 2- Conglomerates, 3- Sandstones, 4- Limestones, 6- Marls, 7- Clays,
8- Coal.

The next interval intercalation of gray marls and dolomite strata starts with coquina 0.8 m thick, clayey-coal layer and G. plicatum and T. margaritaceus its lower part of 10 m thick has abundant A. crassatina and Trisidos albanica, whereas the upper part of interval 10,5 m thick, bear a rich mollusc assemblage composed of T. margaritaceus, G. plicatum, M. impressa, A. crassatina and bivalvia T. albanica, C. incrassata, P. subarata convexa (in coquinas). The 0.9 m thick coal-clayey layer with scarce pressed and fragmented potamids and melanopsids overlie laminated, greysh-bluish limestones, 0.5 m thick, with M. cf basteroti and 14 m thick intercalations of grayish marls, dolomite layers, scarce lignite-clayey seams yields brackish-marine (euryhaline) molluscs such as A. crassatina, T. albanica, C. incrassatus, Cr. cyathula and others consisting the uppermost part of formation.

Figure 6: Intercalation of the grey marls, siltstones and dolomite layers ~0.2-0.3m thick in the deltaic deposits in the Drenova Fm, (Drenica section).

Palaeoecology: The lowermost coal-bearing part with freschwater molluscs M. cf. basteroti shows the coastal swamps environments, and passing into marls with coquinas of P. subarata convexa and Cr. cyathula indicates the first marine influence in the basin. Onwards, communities of numerous well preserved polymorphic Tympanotonos margaritaceus, associated of G. plicatum (0.8 m thick coquinas), rare Terebralia bidentata, generally eurhyaline detritus feeders and fluviatile-estuaries dweler Melanopsis impressa, show mesohaline environments in the coastal marshes or lagoons and brackich water of estuarine facies (Harzhauser, 2004, Harzhauser et Mandic 2001) of the tropical and subtropical zones (Piccoli et al. 1983). The abundant and larger sized infaunal active predators A. crassatina being best developed in brackish shallow sublittoral environment, whereas the abundant well developed with articulated bivalve B. albanica indicate very calm conditions, within a suitable optimal habitat (Pashko, 1977b). These best developed hypohaline (swamps) to mesohaline gastropod and bivalve assemblages suggest a suitable brackish with mangrove swampy to lagoonal environment within warm tropical and subtropical climate, also like Oligocene assemblages of Strati di Sangonini of Northern Italy (Fabiani, 1915) brackish and lagoonal inhabitans of “Marne a Huitres” of Paris Basin (Cavelier, 1962, 1968), type 2 assemblages of Kypourio section of Greece (Harzhauser, 2004), and late Oligocene of Central Paratethys (Harzhauser et al. 2001; Reinchenbacher et al 2004).

Biostratigraphy: Among this mollusc assemblage rich in gastropods such as T. margaritaceus, T. subcorrugata, G. plicatum, A. crassatina, G. gibberosa, M. impressa and bivalvia T. albanica, Cr. cyathula, P. subarata convexa are also many common characteristic taxa: 8 gastropods of total 12 species and 4 bivalvia of total 6 species with assemblages of the Strati di Sangonini in Veneto Basin (Northern Italy) and 8 gastropods species of the Kypourio Type 2 assemblage in MHB, Greece (Table 1 and 2 first column) These mollusc assemblages also shows similarity and can be correlated with "Marne a Huitres" of Paris Basin (Cossmann et Lambert1884).

Figure 7: Marls and siltstone with abundant shells of Tympanotonus margaritaceus and Trisidos albanica of the Drenova Fm (Drenica section) (a) and its detail (b).

Drenica Coral Fm is represented from 154 (Drenica section) to 178 m thick succession, mostly massive sandstones, some time calcareous, grayish sandy marls, conglomeratic lenses and thick reefal corralinacean limestones with abundant shallow marine molluscs and corals, accompanied by scarce micro- and well-developed larger foraminifers Lepidocyclina and Operculina. The Drenica formation is characterized by relatively high lateral differences in the calcareous content, the number of layers and the grain size. In the Morava area this formation overlain the Drenova Lignite Fm, but during its extension further to NE in Plasa section overlap the ophiolitic basement. This formation begining of ~49.0 m thick interval of the medium-coarce grained sandstones with conglomeratic lenses, passing upward into grayish sandy marls, is characterized by the first appearence of corals and many fossil horizons, predominant gastropods, larger sized A. crassatina, Turritella (Haustator) magnasperula Sacco, T. (H) conofasciata Sacco etc., rare T. margaritaceus, P. subarata convexa, and remains of echinoids. The next interval comprises 2.5 m thick mainly carbonataceous sandstones and bioclastic limestones with branching and massive corals, upward passes into organogenic, discontinuous reefal coralinaceous red algae bed 2.5-5 m thick (Figure 8a), which in lateral extension reaches several kilometers (Plasa section) show litological differences: further to NE changes into a large reef ranging from 5-20 m (Plasa section) (Figure 8

b) to up to 50 m thick (Dishnica), whereas further to SW does not reefal limestone beds, (Drenova and Boboshtica sections). The next interval of ~68.5 m thick consists of mostly massive coarce-grained grayish, some time cross-bedded sandstones with conglomerate lenses (to 2.5 m thick), and minor carbonataceous layers rich in massive colonial coral agregates and marine molluscs such as gastropods Tectus lucasianus Brongniart, Angaria scobina appenninica Sacco, Cerithium pupoides Fuchs, T. (H.) strangulata Grateloup, T. (H.) magnasperula Sacco, Strombus radix Brongniart, Oostrombus auricularius (Grateloup), Ficus conditus Brongniart, Athleta ficulina Lamarck, Conus ineditus Michelotti, scaphopods Dentalium simplex Michelotti, D. kickxii Nyst, bivalvia pectinids Costellamussiopecten cf. oligosquamosus (Sacco), Cst. deletus Michelotti, Pecten hofmanni Goldfus, Cardium fallax Michelotti, Laevicardium anomalum (Matheron), Discors subdiscors Rovereto, Venus aglaurae Brongniart, Cordiopsis incrassata (Nyst), borings Gastrochaena sp. (Pashko, 1986, 1987), Panopea menardi Deshayes, and cephalopoda Nautilus decipiens Michelotti. Among foraminifer species abundant Nummulites fichteli (Michelotti) (in two 10-15 cm thick gray-yellowish sand layers), and rare Lepidocyclina (Eulepidina) dilatata Michelotti, Operculina complanata (Defrance) are found.

Figure 8: Reefal coralinaceous red algae limestone beds of Drenica Fm reashing 2,5-5 m thick (Drenica section) (a) and larger reef ranging to 20 m thick (Plasa section) (b).

The overlying up to 54.0 m interval starts with massive some time carbonataceous sandstone beds with molluscs Cerithium puppoides Fuchs, Voluthilites apenninica Michelotti, abundant polymorph Pholadomya puschi Goldfuss and Panopea herberti Bosquet, corals, scattered irregular echinoids, Amphistegina sp. passes upward into intercalations of grayish sandy marls, clays and sandstones of 34.5 m thick with several fossil horizons of Corbula carinata oligolaevis (Sacco), D. kickxii and other molluscs bivalvia. The uppermost interval of 6.0 m thick is composed of grayish-dark, massive soft sandstone, with thin conglomeratic lenses, a larger number of concretions (5-10 centimetre in diameter) and bears massive corals (0.25-0.60 m), rare specimens of A. crassatina, C. fallax, Cardita laurae Brongniart, Macrocallista beyrichi Semper. In these concretions moulds of fossils: plant debris, big and well-preserved fruits of Juglans (Figure 9), mainly molluscs, can regularly be found. Also, spines of echinoids occur in this massive sandstone.

Figure 9: Well preserved fruit Juglans grecae founds in concretions moulds of uppermost interval of 6.0 of the Drenica Fm (Drenica section). Dimensions are 4.4 x 3.8 x 3.2 cm.

Palaeoecology: The comparison of the environment of Drenica Coral Fm to the previous coalbearing deposits, the brackish-euryhaline taxa disappears and the mollusc assemblage is substituted by rich diverse molluscs, predominantly gastropods assemblage, associated with corals. The abundant mostly infaunal larger sized Turritella accompanied of Strombus, Oostrombus, many Cassis, Conus, Cerithium, Trochus, mostly active detritivorous feeders are habitants in shallow normal marine conditions (Picoli, 1983). The presence of massive colonies of the coral and thin large sized, fragile shells of Cst. deletus point to a local calm relatively deeper environment, whereas Cardium, Pholadomya, Panopae, and several coquina layers of Corbula, all infaunal suspension feeders are most common in the shallow calm marine environments. Also, this mollusc assemblage shows similarity with tropical nearshore molluscs of Oligocene d'Etampes (Cossmann et Lambert. 1884). Active living Nautilus decipiens was a fore-reef species that prefere subtropical environment. To conclude, this rich marine mollusc assemblage associated with corals, coralinacean red algae and larger foraminifers deposited in a shallow marine littoral to sublittoral conditions, shows probably lagunal environments of warm tropical to subtropical climate (Harzhauser 2004; Wielandt-Schuster et al. 2004).

Taxa	Rp-dv	Rp-dnc	Cht-chm	Cht-pls	N Italy	Greece
Gastropoda						
Vitta picta (Ferussac, 1825)				+	+	+
Tectus lucasianus Bbrongniart, 1823		+			+	+
Tectus vertex Michelotti, 1861		+			+	
Angaria scobina apenninica Sacco, 1896		+			+	+
Ampullinopsis crassatina (Lamarck, 1804)	+	+			+	+
Globularia. gibberosa (Grateloup, 1847)	+	+			+	+
Melanopsis impressa Krauss, 1852	+					+
Cerithium pupoides Fuchs, 1870		+			+	
C. vivarii alpinum Sacco, 1895		+			+	
C. (Ptychocerithium) ighinai (Michelotti, 1861)		+			+	
Terebralia cf. bidentata Grateloup, 1832	+				+	+
Granulolabium plicatum Bruguiere, *1792*	+			+	+	+
Tympanotonos subcorrugata (d' Orbigny, 1852)	+			+	+	+
Tympanotonos margaritaceus (Brocchi, 1814)	+	+		+	+	+
T. margaritaceus calcaratus (Grateloup, 1840)	+				+	
T. margaritaceus moniliformis (Grateloup, 1840)	+				+	
T. deperditus Michelotti, 1861		+			+	
T. stroppus Brongniart, 1823	+				+	+
Diastoma elongata (Brongniart, 1823)		+			+	+
Risoina similis Fuchs, 1870		+			+	
Turritella (Haustator) venus D'Orbigny, 1852		+			+	+
T.(H) conofasciata Sacco, 1895		+		+	+	+
T. (H) magnasperula Sacco, 1895		+		+	+	
T. (H) asperula Brongniart, 1823	+	+			+	+
T. (Peyrotia) strangulata Grateloup, 1822		+		+	+	+
T. (P.) desmarestina substrangulata Sacco, 1895		+			+	+
T. turgida Koenen, 1868		+			+	
Oostrombus auricularius (Grateloup, 1847)		+			+	+
Strombus radix Brongniart, 1823		+			+	+
Xenophoria (Tugurium) scrutarium (Philippi,, 1843)		+			+	+
X. (Tugurium) cumulans (Brongniart, 1823)		+			+	
X. (T.) subextensium (D'Orbigny, 1852)		+			+	
Neverita josephinia antiquus Sacco, 1891		+			+	
Cypraea splendens Grateloup, 1827		+			+	
Eocypraea subexcisa Michelotti, 1847		+			+	
Aporrchais pescarbonis Brongniart, 1823		+			+	
Ficus condita (Brongniart, 1823)		+			+	+
F. tarbellianus (Grateloup, 1847)		+				
Cassis mammillaris apenninica Sacco, 1890		+			+	+
C. vicentina Fuchs, 1870		+			+	
C. vialensis Fuchs, 1870		+			+	+
C. anceps Sacco, 1890		+			+	
C. nodosa Solander, 1766		+			+	
Phalium rondeleti apenninica Sacco, 1890		+			+	
Bursa (Ranella) hoernesi Fuchs, 1870		+			+	
Charona (Tritonium) subclathrata (D'Orbigny, 1852)		+			+	
Charona delbosi Fuchs, 1870	+				+	
Melongena aff. basilica Bellardi, 1873		+			+	
Fasciolaria lugensis Fuchs, 1870		+			+	
Athleta ficulina Lamarck, 1822		+			+	
Voluthilites apenninica Michelotti, 1861		+			+	
Voluta suesi Fuchs, 1870		+			+	
Amalda glandiformis anomala (Schlotheim, 1820*)*		+				+
Conus ineditus Michelotti, 1861		+		+	+	
C. diversiformis Deshayes, 1824		+			+	+
C. carcarensis Sacco, 1893		+			+	+
Bulla ampliconus Fuchs, 1870		+			+	
B. rregularis Fuchs, 1870		+			+	
Architectonica carocollata (Linne, 1822)						
Scaphopoda						
Dentalium apenninicum Sacco, 1897			+	+	+	
D. simplex Michelotti, 1861		+	+		+	
D. kickxii (*Nyst, 1843*)		+			+	

Table 1: *List of the Gastropoda and Scaphopoda taxa showing their content and distribution in the Morava Oligocene sequence correlated with Northern Italy and Greece-Iran. Abreviations: Rp-dv (Late Rupelian, Drenova Fm), Rp-dnc (Late Rupelian, Drenica Fm), Cht-chm (Chattian Chama Marls), Cht-pls (Chattian, Plasa Fm).*

Biostratigraphy Fossil faunas of the Drenica Fm represented by dominance of mollusc assemblage results in 41 gastropods, 29 bivalvia, 1 cephalopod accompanied of branching and colonial reefal corals, larger foraminifers (typical Rupelian species N. fichteli, and Lepidocyclina, Operculina) and echinoids displays a very strong similarity and could be correlated to those from the well studied of the Piedemont and Venetian Basins of Northern Italy (Michelotti 1847, 1861, Sacco 1872-1904, Fabiani 1915, Bonci et al. 2000, Boschele et al. 2011, 2016), especially with "Stratti di Castelgomberto" of the Regione di Veneto, which have very higher percentage of its common mollusc taxa: 47 gastropods, 1 scaphopod, 29 bivalvia, 1 cephalopod (Table 1, 2 and 3, second column), and also are associated by branching and massive corals, coral reefal limestones and larger foraminifers Nummulites, Lepidocyclina, Operculina (Pashko 1977a). Similar gastropod faunas are recorded from Oligocene of the Mesohellenic Basin (Kypourio type 1) and from Iran (Harzhauer 2004; Wielandt-Schuster et al 2004), where are 20 gastropoda common taxa and can be correlated with mollusc assemblage of Oligocene d'Etampes (Cossmann et Lambert, 1884). The investigations of sparce poorly preserved and litlle diversified microfauna identifie Globigerina ciperoensis angulisuturalis Subzone (Paragloborotalia opima opima Zone) of foraminifera and Sphenolithus distentus Zone of nannoplancton (Kumati et al. 1995, 1996). Also, the occurrence of the Nummulites fichteli, a typical Rupelian species in the lower part of the Oligocene sequence coincide with Oligocene subdivision in Northern Italy (Azzaroli et Cita, 1957).

4.1.1b Chattian Stage

The Chattian deposits from 240 m (Drenice section) to 350 m thick are composed of hemipelagic grayish-blueish marls with marine molluscs and larger foraminifers, (Chama Marls), following by the intercalation of marls with stratified or massive sandstones rich in marine molluscs (Plasa Fm). The Chama Marls Fm is represented by predominantly hemipellagic grey to blueish marls which are direct evidence of the further basin deepening, from 50 m (Drenica section) to 80 m thick (Mborja section), but in south-westward direction, in the Boboshtica section reaches 90 m thick and directly overlying the ophiolitic basement. More in Kamenica it reaches up to 120 m thickness. In Drenica sequence starts with 28 m thick of the gray to blueish marls or sandy marls particulary fossiliferous with the dominant molluscs bivalvia such as abundant Costelamussiopecten deletus and Eucrassatella carcarensis (Michelotti), E.

neglecta (Michelotti), Cyprina brevis Fuchs, Lucina miocenica Michelotti, Phacoides columbella (Lamarck), Chama granulosa (D'Archias), Ch. tongriana Rovereto, Corbula carinata oligolaevis Sacco, abundant scaphopods Dentalium apenninicum, D. simplex and larger foraminifera which also costruit a coquinas of 0.6-0.7 m thick of Lepidocyclina (Eulepidina) dilatata, Operculina complanata and Amphistegina sp. The overlying 22-23 m thick interval shows intensive intercalation of highly fossiliferous 2.5-3.5 m thick grey to blueish marly package and fine-grained sandstones 5-25 cm thick, mostly in upper part of sections with molluscs such P. hofmanni, Spondylus cisalpinus Brongniart, Eucrassatella gigantea (Rovereto), Chama granulosa, Ch. tongriana and larger foraminifera Lepidocyclina, Operculina.

Bivalvia	Rp-dv	Rp-dn	Cht-Chm	Cht-pl	Italy	Greece-Iran
Trisido albanica Oppenheim, 1894	+			+		
Glycymeris aff. oblitus Michelotti, 1861		+			+	
Crassostrea cyathula (Lamarck, 1806)	+	+			+	
Costellamussiopecten deletes (Michelotti, 1861)		+	+	+	+	+
Cst. ? oligosquamosus (Sacco, 1897)		+			+	
Pecten hofmanni Goldfus, 1833		+		+		
P. arcuatus (Brocchi, 1814)			+	+	+	+
Chlamys oligoflabellatus (Sacco, 1897)			+	+	+	
Spondylus cisalpinus Brongniart,1823			+		+	
Mytilopsis basteroti Deshayes, 1824				+		
Mytilopsis cf. *basteroti* Deshyes,1824	+					
Eucrassatella carcarensis (Michelotti, 1847)		+	+	+	+	
E. neglecta (Michelotti, 1861)			+		+	
E. gigantea (Rovereto, 1900)		+	+		+	
Cardita arduini (Brongniart, 1823)		+		+		
C. corbuloides Sacco, 1889		+		+	+	
C. laurae (Brongniart, 1823)		+			+	
Polymesoda subarata convexa (Brongniart, 1823)	+	+			+	
Cyprina islandica rotundata (Agassiz, 1845)	+	+		+	+	
C. splendens Grateloup, 1847		+			+	
C. brevis Fuchs, 1870			+		+	
Lucina miocenica Michelotti, 1847		+	+		+	
L. rollei Michelotti, 1861		+			+	
L. aff. delbosi (D'Orbigny), 1850)		+				
Phacoides columbella (Mayer), 1868			+		+	
Miltha (Megaxinus) deperditus Michelotti, 1861		+			+	
Corbis lamellosa Lamarck, 1806			+			
Chama granulosa (D'Archias 1853)			+		+	
Ch. tongriana Rovereto, 1900			+		+	
Cardium fallax Michelotti, 1861		+			+	
C. corbuloides Sacoo, 1901		+			+	
Discors subdiscors Rovereto, 1900		+				
Laevicardium anomalum (Matheron, 1842)		+		+		
L. cyprium (Brocchi, 1814)		+			+	
L. tenuisulcatum Nyst, 1881		+				
Venus aglaurae Brongniart, 1823		+				
V. experplex Sacco, 1900		+			+	
V. exintermedia Sacco, 1900				+	+	
Pitar beyrichi Semper, 1861		+			+	
P. erycinoides (Lamarck, 1804)		+		+	+	
Cordiopsis incrassata (Nyst, 1836)	+	+	+	+	+	
Panopea menardi Deshayes, 1824		+		+	+	
P. oligofaujasi Sacco, 1901		+			+	
Corbula carinata Dujardin, 1837		+	+		+	
C. carinata oligolaevis Sacco, 1901		+ -	+	+	+	

Gastrochaena sp.		+				
Thracya speyeri (Koenen), 1868		+		+	+	
Pholadomya puschi puschi Goldfus, 1840		+			+	
Ph. puschi virgula Michelotti, *1861*		+			+	
Ph. puschi quaesita Michelotti, 1861		+			+	
Cephalopoda						
Nautilus decipiens Michelotti, 1861		+			+	

Table 2: List of the Bivalvia and Cephalopoda taxa showing their content and distribution in the Morava Oligocene succession compared with Northern Italy and Greece-Iran. Abreviations: See Table 1.

Palaeoecology: The Rupelian/Chattian boundary coincides with the remarkable lithological dictinct boundarywhich is the result of basin deepering and shows a rapid change in composition of the fossil assemblages. The Chama Marls deposits contain fully marine molluscs assemblage predominants bivalvia, particulary stenohaline pectinids and other mixed benthic, mostly epifauna molluscs species as Chama, Crassatella, which are inhabitants of shallow to relative deeper marine environment and scaphopods. Among the stenohaline pectinids such P. arcuatus adapted in shallow to medium sublittoral depths, Costelamussiopecten indicates a calm and relatively deeper medium depth sublittoral environment (Mandic Piller 2001; Wielandt-Schuster et al 2004; Diedrich, 2012). Scaphopods burrow into the sand and in general occurring in moderately deep sublitoral (Harzhauzer, 2004). Fixsesile shallow sublittoral Spondylus with big relatively preserved shells may have been transported from the coastal shallow area before their final deposition in the basin. Abundant larger foraminifera as Lepidocyclina and Operculina, accompanied by plankton foraminifers play an important role and indicate shallow marine mostly lagoonal environments. In conclusions based on the lithology and on the marine fossils' assemblage, the Chama Marls deposited mostly in the warm lagoonal-sublitoral zone represents marine moderate to relative deep sublittoral conditions.

Biostratigraphy: Chama Marls contains a rich fully marine bivalvia assemblage (16 species) such as S. cisalpinus, Eucrassatella carcarensis, Ec. neglecta, Ec. gigantea, Chama. granulosa, Ch. tongriana and several pectinids as Cst. deletus, P. arcuatus, which have higher percentage (15 taxa) of the common Oligocene mollusc taxa from the Northern Italy (Boschele et al. 2011, 2016). On the one hand this assemblage shows some similarity with the molluscs of Chattian fauna di Glauconie Bellunesi (Venzo, 1937). Also, Dentalium apenninicum and D. simplex have been reported from Oligocene of Piedmont (Michelotti 1861; Sacco 1897; Bonci et al. 2000; Steiner et al. 2004) and Veneto (Fabiani, 1915) basins in Northern Italy. As Kumati et al. (1995) Chama Marls with Miogypsina complanata represent the top of G. opima angulisuturalis Subzone of foraminifers and Sphenolithus distentus Zone of nannoplanctons. At the same time abundant larger foraminifera such as L. dilatata and

O. complanata and also the absence of the N. fichteli, that become extint in the Chattian stage, point to the Late Oligocene age (Azzaroli et Cita1957; Boschele et al 2016). To conclude, based on the mollusc and foraminfer biostratigraphic data the age of the Chama Marls can be point to a Late Oligocene, Chattian age seems to be the most probable.

Plasa Fm reaches from 190-200 m (Drenica section) to 255 m (Plasa section) thick deposits and consists of the alternation of grayish-blueish marls rich in marine molluscs and larger foraminifera with stratified, laterally predominantly massive sandstones. This formation starts with ~114 m thick gray-yellow fine-medium grained sandstones (0,5-1,8 m thick) with fossil plant imprints (Kleinholter, 2004 and Figure 10), and Clupea scales intercalated with some meters fossiliferous grey-blue marls. The fossil fauna of marls is characterized by thecoquinas of Lepidocyclina, little Operculina and molluscs Turritella strangulata Grateloup, T. magnasperula Sacco, Conus ineditus Michelotti of gastropods, Trisidos albanica, E. carcarensis, Cardita arduini corbuloides (Sacco), Venus exintermedia Sacco, Panopae menardi, Corbula carinata oligolaevis Sacco of bivalvia and scaphopod D. apenninicum. In this part of the Plasa Fm a rather lateral litologically differences occur: marine succession changed in a marine-brackish succession which starts with gray medium-grained sandstones of 9-10 m thick with leaf flora and followed upwards by up to 50 m thick intercalation of gray or yellow clays-marls packages (from 2-3 to 12m thick) and ~3 m thick medium-grained carbonataceous sandstones with marine Cst. deletus, P.cf. hofmanni, Aequipecten oligoflabellatus Sacco, euryhaline G. plicatum, Tympanotonos margaritaceus, T. subcorrugatum molluscs and larger foraminifera Lepidocyclina, Operculina, including two ~0.3 m thick scarce lignite seams with brackich mollusks Vitta picta Defrance and Dreissena basteroti Deshayes.

The upper part of the Plasa sequence is represented by up to 76 m thick stratified, laterally massive of 4 to 12 m thick sandstones with abundant thin Lepidocyclina restricted in several coquina horizons (10-20 cm thick) that are enriched the carbonate content of sandstones, intercalated with grayish sandy marls rich in marine molluscs. The molluscs most commonly encourented in this succession are pectinids as abundant Cst. deletus and P. arcuatus, A. oligoflabellatus, scaphopoda D. apenninicum, and larger foraminifers mainly Lepidocyclina. The bivalve dweling Kuphus were found below the marine sandstone layers.

Figure 10: Stratified sandstone of Plasa Fm (Drenica section) with plant remains.

Palaeoecology: Community of stenohaline Pectinidae and other mostly shallow marine molluscs accompanied of the bivalve dweling Kuphus a lagoonal-mangrove inhabitant and abundant thin Lepidocyclina and Operculina were most common mostly in the shallow warm, normal saline lagoonal environment. The lower part marine facies of this sequence laterally, in the Plasa section, like in Apulia (Southern Italy; Esu at Giroti 2010, Esu et al 2005), passes into coalbearing facies with a community euryhaline or brackich molluscs (Tympanotonos, Mytilopsis) and Vitta picta a typical inhabitant of fluvial-estuarine environment indicates environmental changes to regressive marine trends and brackish swampy coastal conditions. In conclusion, the Plasa Fm sequence with predominant normal marine mollusc and foraminiferal assemblages was probably deposited in the shallow to moderately deep sublittoral marine zone, partly in lateral facies of lagoonal-mangrove swamps environment. The fauna indicates a tropical to subtropical sea.

Biostratigraphy: A total of 27 mollusc taxa occurred in Plasa Fm sequence given in Tab. 1 and 2 consists of dominant bivalvia (17 taxa) particulary pectinids within there some good key taxa and comprises 8 gastropods and 2 scaphopod taxa. This mollusc assemblage typical for the Oligocene age includes also P. arcuatus, a Tethyan type species which appears in Late Eocene persist during the Oligocene and disappears in Miocene (Demarcq 1990; Bongrain 1992; Boschele et al 2011,2016), and Cst. deletus which commune in the Rupelian-Chattian of Aquitaine, Piedmont, Mesohelenic Basins and other Mediterranean areas (Pashko, 2017). Also D. apenninicum have been reported from Oligocene of Piedmont and Veneto Basins in Northern Italy and Late Oligocene of Paratethys. According to the micropaleontological investigations of Plasa (Oligocen)-Guri i Capit (Aquitanian) formations G. ciperoensis ciperoensis and G. kugleri of microforaminifers and Sphenolithus ciperoensis of nannoplanctons Zones are identified (Kumati et al. 1995). To conclude based on the faunal assemblages also on the position of these deposits in the Morava Oligocene sequence Plasa Fm can be refered to the Late Oligocene Chattian Stage.

4.1.2 Early Miocene: Aquitanian

The Aquitanian deposits comprise the uppermost part of this molase cycle, composed of 790 (Drenica section) to 845 m thick sequence, with marine fossil assemblages, accumulated during the final Oligocene-Aquitanian regression and subdivided into the **Bozdoveci** and **Guri i Capit** formations.

The **Bozdoveci Fm** consists of 180 to 270 (Drenica section) m thick sequence of mostly marls and clays with fine grained sandstones, starting with a 2-3 m thick sandstone beds rich in marine molluscs such as Turritella desmarestiana substrangulata Sacco, T. tricarinata (Brocchi), Venus multilamella Lamarck, Pecten vezzanensis Oppenheim, Aequipecten scabrellus (Lamarck), A. opercularis (Linnaeus), Spondylus concentricus (Brongniart), Chama benoisti Cossmann et Peyrot, and echinoids Scutella subrotundaeformis Schauroth, Clypeaster rostriformis Agassiz and followed by up to 80 m grayish and blueish clays and sandy marls interbeded with thin (0.2-0.5 to 1.0 m) sandstone strata with marine molluscs as Cst. cristatus, A. opercularis, and several coquinas to 0,3 m thick of large foraminifers (Eulepidina elephantina). It is overlain by a ~60 m thick flyschoid series of grayish clays and fine sandstones. A relatively rich mollusc assemblage appears in overlying succession consisting of grayish clays ~120 m thick with a polyclastic conglomeratic bed up to 25 m thick and 3-4 km long (from Drenica to Boboshtica sections). Mollusc assemblage consists of gastropods Turritella strangulata Grateloup, Tritonium grateloupi Fuchs, Cassis mammillaris Grateloup, Xenophora (Tugurium) postextensum Sacco, Conus diversiformis Deshayes and bivalvia Nucula peligera Sandbergeri, N. nucleus Linnaeus, Discors aquitanicus (Mayer), Crassatella sulcata speciosa Sacco, Cardita arduini Brongniart, Venus exdeleta Sacco, Laevicardium anomalum (Matheron), Pitar erycinoides Sacco, P. dubius Michelotti, Tapes vetulus Basterot.

Paleoecology: The mollusc fauna derived from the Bozdovec sequence are consisted exclusively of relatively rich fully marine mixing molluscs assemblage bivalvia, particulary stenohaline Pectinids and other benthic, mostly epifauna molluscs species from different habitats of shallow water environment. Turritellids are present by larger sized suspension feeder species and indices shallow nearshore conditions. Pecten vezzanensis probable is a taxa adapted to active free-living in shallow sublitoral environment. Echinoids taxa of Scutella and Clypeaster geners are typical abitants of marine litoral zone.

Biostratigraphy: A total of 26 molluscs, 7 gastropods and 19 bivalvia taxa were dated in Bozdovec Fm sequence and are given in Tab 3 and 4. According to the biostratigraphic data of this mollusc assemblage some taxa such as T. tricarinata, F. canditus of gastropods, and Gl. insubricus, S. concentricus and L. anomalum, Pitar erycinoides, T. vetulus especially Pectinids Cst. cristatus, A. scabrellus, A. opercularis of bivalvia are been reported as Miocene age. On the other hand, the echinoids S. subrotundaeformis and Cl. rostriformis indices Aquitanian of Sardegne (Stara et al. 2010). Based on the micropaleontological investigations of all Aquitanian deposits the Globoquadrina dehiscens Zone of plancton foraminifera, Helicosphaera carteri of nannoplancton Zones and larger foraminifera Lepidocyclina morgani are identified (Kumati et al. 1995).

Guri i Capit Fm is represented by a sequence of 520 (Drenica section) to 586 m thick marine deposits with poor mollusc assemblage and starts with ~60 m thick polymict conglomerates with well rounded clast. Overlying sequence of ~380 m thick represented by the intercalation of predominantly greyish sandy clays and sandstone layers with sparse and poorly preserved molluscs Pecten sp., and sparse echinoids Cl. cf. rostriformis. The uppermost part of the sequence consists of 85 m strong conglomerates with mainly small to medium sized clasts and coarce grained sandstones (Guri i Capit) (Fig. 9), followed by varied in thickness from 20-30 m (Drenica) to up to 100 m (Dardha Section) grayish sandy marls of Dardha shlir (Bourcart, 1922). This upperrmost part of the formation in Drenica section represented by grayish marls-clays contains many pectinid specimens of very common Costellamussiopecten northamptoni (Michelotti) and some other molluscs such Glycymeris insubricus (Brocchi).

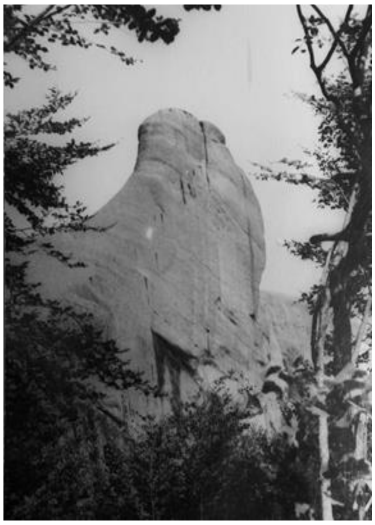

Figure 11: Wind erosional Aquitanian Guri i Capit conglomerates, analogous of Meteora conglomerates of MHB.

Palaeoecology: The mollusc fauna derived from the Guri i Capit sequence comprises exclusively marine mixing fossils of shallow water environment particulary stenohaline Pectinids such aboundant in the marls of the uppermost part of the section Cst. northamptoni with thin shelled and inflated valve indicated more calm, medium deeper sublittoral conditions (Mandic 2004; Mandic et al. 2001; Wielandt-Schuster 2004; Diedrich 2012) and litoral habitants echinoid Cl. rostriformis.

Biostratigraphy Abundant Cst. northamptoni have great biostratigraphic significance for Aquitanian deposits and is the best marker of this stage. It appears in Aquitanian of Aquitaine Basin and known from the Aquitanian-Lower Burdigalian of Northern Italy (Torino Hills) (Michelotti, 1847, 1861; Sacco 1897; Zunino et Pavia 2009), Corsica, Sardegna associated of Cl. latirostris (Stara et al. 2010), and reached Burdigalian-Serravalian of Spagnia De Porta (1969) and Egerian of Central Parathetis (Demarcq 1990). Based on the micropaleontological investigations of the Aquitanian deposits the Globoquadrina dehiscens Zone of plancton foraminifera, Helicosphaera carteri of nannoplancton Zones and larger foraminifera Lepidocyclina morgani are identified (Kumati et al. 1995, 1996).

4.2 Early-Middle Miocene Cycle

The Early-Middle Miocene of ~ 2100 m thick succession accumulated during the marine Miocene transgression (third cycle) lying onto the oldest molasse deposits or on rock of the basement; they are restricted only in southern part of the ATHB (Figure 12). According to the molluscs (Pashko, 1977a, Pashko al. 1973) the Burdigalian, Langhian and Serravallian stages and to the microfauna (Kumati al 1995, 1996) the Burdigalian and Langhian stages were dated.

4.2.1 Burdigalian

Burdigalian sequence of up to 430 m thick, represent the basal part of the Miocene succession transgressive on the oldest molasse deposits or on rocks of basin basement. Burdigalian deposits include relatively rich mollusc assemblage and subdivided in two formations.

Morava Fm. of about 187 m thick in Drenica section starts with basal of~20 m thick redish-yelowish sandstones with a scarce 0.3-0.4 m coal layers and 3 m thick conglomerates covered by a limestone bed usually of 1-2 to up to 25 m, locally to ~ 40-45 m thick (Guri i Vjeshtes Dardhe) of white corallinaceous predominant red algae Lithothamnion limestone includes many pectinids, corals, larger foraminifers and abound echinoids. That limestone bed crops out along the top of the Morava Mt (Fig. 13) and upward pass into ~137 m thick sequence of sandy grayish-blueish marls intercalated with more thin sandstone layers and rare fine conglomeratic lenses. The fossil fauna includes marine mollusc bivalvia such as Flabellipecten burdigalensis Lamarck, Costellamussiopecten? martelli (Ugolini), Laevicardium discrepans (Basterot), Cordiopsis incrassata (Nyst), Tapes vetulus (Basteroti), abundant echinoids as Clypeaster latirostris Michelin, Cl. crassus (Agassiz), Scutella sp., Echinolampas sp., and large foraminifers as Lepidocyclina, Miogypsina (in Lithothamnion beds).

Palaeoecology: The basal thick white corrallinacean algae Lithothamnion limestone contain moderate preserved pectinids (Pashko 1964, 1974, 2017) and echinoids mostly with large very flat relative thin shells of the Clypeaster, Scutella accompanied by larger foraminifera Lepidocyclina and Miogypsina that indices marine marginal shallow and calm conditions (Mandic et Piller, 2001; Mandic et Hauzhauser, 2003); the lower part of the Burdigalian deposits (Morava Fm) accumulated in littoral and shallow sublittoral environments.

Biostratigraphy: The age of Morava formation based on the typical Burdigalian pectinid taxa (Pashko, 2017) such as Flabellipecten burdigalensis now referred which appears to the Burdigalian (de Porta 1969; Lirer et Iacarino 2011; Stara et al 2011), and other pectinids Cst.martelli and Fl. passini which are known from the Burdigalian of Sardegna (Ugolini 1907; Stara et al. 2011) and other basins of Tethys (Zunino et Picoli, 2010) and Central Paratethys (Baldi et al 1999; Studencka et al. 1998).

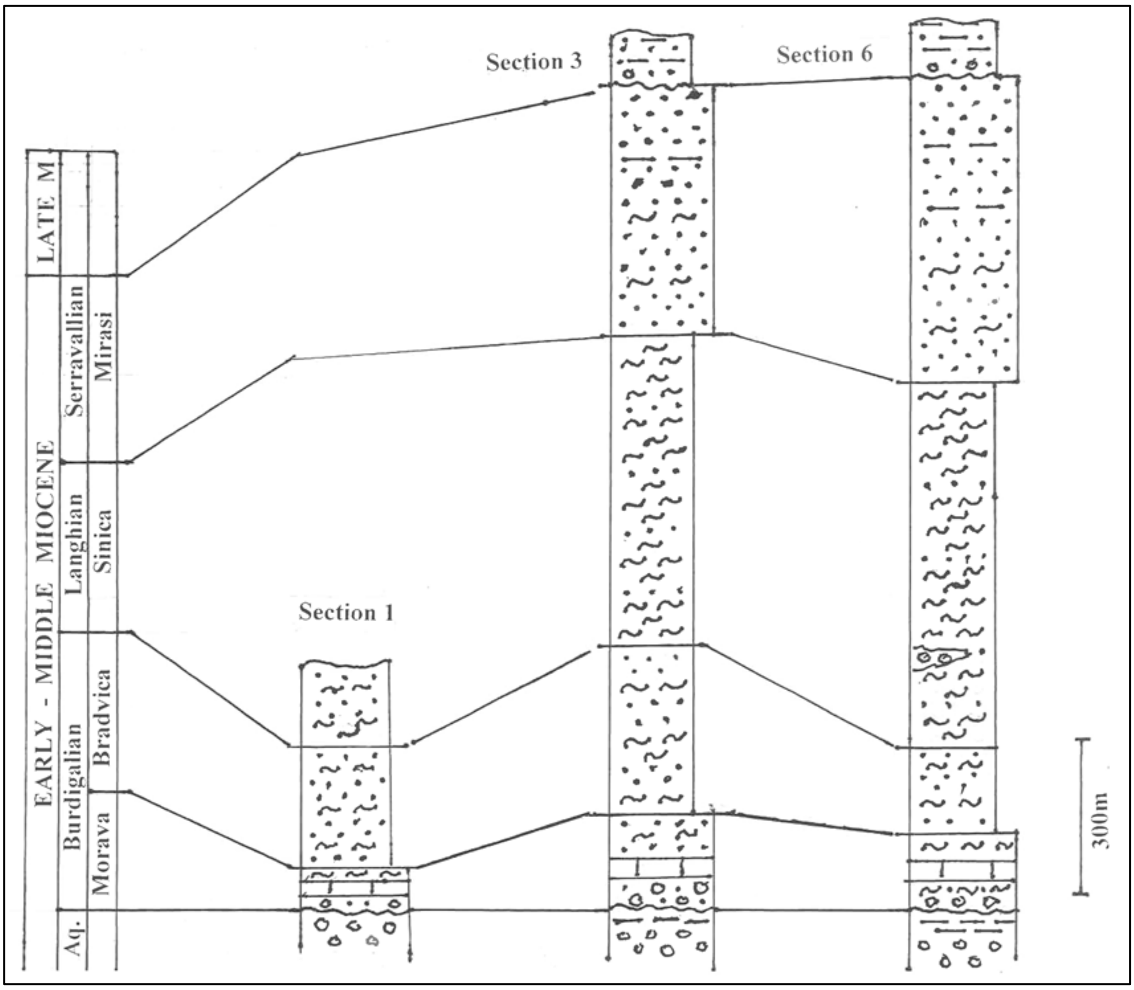

Figure 12: Stratigraphic correlation between the studied and measured sections in the Early-Middle Miocene deposits (third cycle): Section 1 (Plasa), Section 3 (Drenica) and section 6 (Dardha). Legend: See Figure 5

Bradvica Fm. of ~240 (Plasa section) to 430 (Drenica section) m thick sequence starts with intercalation of calcareous sandstones and grayish-blueish sandy marls with scarce pectinids and pass upwards into a thick sequence of ~180 m formed by intercalations of sandy marls and thick beds of fine to coarce-grained locally massive and cross bedded sandstones with channel structure and fine lenses of polyclastic conglomerates. Poor and rare mollusc assemblage consisted of gastropods Turritella vermicularis Lamarck, Conus antiquus Lamarck and bivalve pectinids mostly scattered fragment of F. cf. burdigalensis, Aequipecten submalvinae (Blackenhorn), A. scabrellus, A. opercularis, and Ostrea sp., Pitar erycinoides Sacco and Tapes vetulus Basterot. The uppermost part of sequence consists of 50-70 m thick grayish marls with Cst. cristatus (Pashko, 2017).

Figure 13: Guri i Vjeshtes (Dardha) Burdigalian white corallinacean red algae Lithothamnion limestone with Pectinids and echinoids that extended and construits the top of the Morava Mt. (Dardha section).

Palaeoecology: The upper part of the Burdigalian sequence includes some horizons with marine relative sparse and moderately preserved molluscs as Flabellipecten, Pitar, Tapes, and scaterred Aequipecten. Large-sized eurybathic sublitoral inhabitant gastropods Turritella and Conus are documented as indices nearshore environments (Wielandt-Schuster et al. 2004). The moderate preserved planktonic foraminifera point to a slighty deepering of the marine environment. Therefore, it can be concluded that in general the upper part (Bradvica Fm), based on the molluscs and planctonic foraminifers were formed in the shallow basinal conditions.

Molluscs	Aquit Bozd.	Aquit -G.Cp	Burd-Mor.	Burd-Bradv.	Lang. Sinice	Serr.-Miras
Gastropoda						
Cerithium sp.						+
Turritella tricarinata (Brocchi, 1814)	+			+		
T. vermicularis Lamarck, 1822				+		
T. strangulata Grateloup, 1809	+					
T. terrebralis Lamarck, 1822					+	
T. desmarestiana substrangulata Sacco, 1895.	+				+	
Cassis mammillaris Grateloup, 1827	+					
Triton grateloupi Fuchs, 1870	+					
Xenophora (Tugurium) postextensum Sacco, 1894	+					
Natica millepunctata Lamarck, 1822					+	
Ficus candidus Brongniart, 1823					+	
Conus diversiformis Deshayes, 1835	+					
C. antiquus Lamarck, 1810				+		
Clio bellardi (Audenino, 1899)					+	

C. triplicata (Audenino, 1897)					+	
C. sturani Robba, 1971					+	
Vaginella austriaca Kittl, 1886)					+	
V. lapugyensis (Kittl, 1886)					+	
V. calandrelli (Mishelotti, 1847)					+	
V. rotundata (Blackenhorn, 1889)					+	
V. testidunaria (Michelotti, 1947)					+	
Scaphopoda						
Dentalium miocenicum Michelotti, 1861					+	
D. badense Hoernes, 1856					+	
D. badense planicostata Sacco, 1897					+	

Table3: List of the gastropods and scaphopods taxa showing their content and distribution in the Morava Miocene succession. Abreviations: Aquit-Bozd. (Aquitanian Bozdoveci Fm), Aquit- G.Cp (Aquitanian Guri i Capit Fm), Burd-Mor (Burdigalian Morava Fm), Burd-Brad (Burdigalian Bradvica Fm), Lang-Sinice (Langhian, Sinica Fm), Serr-Miras (Serravalian, Mirasi Fm).

Biostratigraphy: Molluscs assemblage of Bradvica Fm contains very common Burdigalian pectinids such as P. burdigalensis and A. submalvinae (Pashko, 2017) that also is known from Burdigalian deposits of Greece (Wiellandt-Schuster et al. 2004), Sardegna (Ugolini 2007; Stara et al. 2012,) and other Mediterranean areas (Demarcq 1990). The Burdigalian microforaminifers Globigerinoides trilobus-Globigerina bisphaericus and nannoplanktons Helicosphaerae ampliaperta Zones, and larger foraminifera Miogypsina globulina are identified in Morava and Bradvica formations (Kumati et al. 1995, 1996).

4.2.2 Langhian

The Langhian succession is consisted of mostly deep marine blueish marls or marls interbedded with fine sandstone layers and thick massive sandstone beds.

Sinica Fm, of up to 810 (Dardha section) to ~1120 (Drenica section) m thick, very fossiliferous in peculiar mollusc assemblages, particulary pteropods and relatively large number deep-water benthic taxa such as the deep-water pectinids with thin shells, planctonic foraminifers and nannoplanctons.

The Burdigalian/Langhian boundary corresponds with a drastically increased diversity of the mollusc fauna. The thick Langhian succession starts with a basal package ~40 m thick of blueish, sandy marls and followed by 460 m series dominated by blueish hard marls intercalated with fine siltstone-sandstone layers, sometime massive to 3-4 m thick bioclastic sandstone-limestone with thin microconglomeratic lenses and channel structures includes shallow marine molluscs. Channel structure (Figure 14) erosively cuts into the underlying beds represented by fine intercalation of hard marls and siltstone-sandstone layers with mollusc maynly debries of molluscs and corals. The bioclastic beds of massive sandstones contains Lithothamnion aggregates, individual corals and molluscs such as Turritella terrebralis Lamarck, Turritella desmarestina mediosubcarinata Sacco, Ficus conditus Brongniart, Cst. cf. northamptoni, P. revolutus, F. cf. burdigalensis, A. submalvinae, Ostrea frondosa De Serres and Azorinus chamasolen (Da Costa).

The overlying part of the sequence, up to 90 m thick, of blueish marls upwards passes into ~530 m of interbeded marls with fine sandstone layers. All this predominantly marls sequence is rich in highly diverse and typically deep water molluscs, particulary deep water pectinids and pteropods. The mollusc assemblage include gastropods Natica millepunctata Lamarck, and mass occurrences of pteropods consisting of Clio sturani Robba, C. bellardi Audenino, C. triplicata Audenino, Vaginella austriaca Kittl, V. callandrelli Michelotti, V. lapugyensis Kittl, V. oligmostoma Tate, V. rotundata Blanckenhorn, V. testudinaria Michelotti, scaphopods Dentalium miocenicum Michelotti, D. (Entalis) badense Hoernes, D. badense planicostata Sacco, and bivalvia Anadara diluvii (Lamarck), many deep water pectinids such as Costellamussiopecten cristatus badense (Fontannes), Lentipecten corneus denudatus (Reuss), Parvamussium duodecimlamellatum (Bronn), Propeamussium anconitanum Foresti, and other bivalvia Cardita arduini Brongniart, Myrtea taurinia Michelotti, Megaxinus bellardianus (Mayer), Cardium multicostatum miorotundatum Sacco, Venus multilamella Lamarck, Pitar taurorugosa Sacco, P. dubius Michelotti, Lutraria oblonga Chemnitz, Corbula gibba (Olivi), Cuspidaria cuspidata (Olivi).

Palaeoecology: The drastically increased diversity of the mollusc fauna of the Langhian marls includes the abundant planktonic pteropods, some pectinids with thin very fragile shells as Parvamussium, Propeamussium. The numeruous planktic taxa are main constituents of the microforaminifers. This high diversity and grown-up taxonomic number in hemipelagic marls with some alternating turbititic bioclastic sandstone beds are evidence of a reflection of the further marine basin deepening. The modern representatives of Parvamussium were adapted to live in the upper part of the bathyal zone (Studencka et al. 2012). In addition to those fossil species in the Langhian of Erzen sequence accompanied with Aturia aturi and pteropods (Pashko,1965). The Parv. felsineum is known to occur in the upper part of the bathyal zone and was recognized within the Karpathian and Badenian (Studencka et al. 2012) mollusc assemblages point mostly to deep water of upper part of bathyal Zone (Studencka et al. 2012). Thereto, Dentalium is habitant of relatively deep sublittoral. The fossil fauna of the bioclastic bedsintercalated within thick marls sequence includes mostly shallow marine molluscs, as Ostrea, Pecten, Flabellipecten, individual corals and coraline algae aggregates, therewith bioclastic chanel fill deposits of lower part of sequence are resulting into piggy back basin conditions, which were transported from a shallow sublittoral into a deeper basinal setting. Therefore, to conclude, in generall the abundance and distribution of the pteropods taxa and co- occurrrence with fine pectinids adapted to live-in deep-water conditions, also abundant planktonic foraminiferal assemblage point to a depening of the marine basin associated in the lower part of sequence with subaqueous debris fllow deposits.

Figure 14: Channel structure of ~ 2,5-3 m thick and lateral extension of more 20 m which erosively cuts into the underlying deposits of lower part of Sinica sequence represented by fine intercalation of hard marls and siltstone-sandstone layers with molluscs and debries of molluscs, corals (Dardha section).

Bivalvia	Aquit -Bozd	Aquit -G.Cp	Burd. -Mor.	Burd-Bradv.	Lang. Sinice	Serr.-Miras
Nucula nucleus Linnaeus, 1767	+					
N. peligeri Sandberger, 1856	+					
Anadara diluvia (Lamarck, 1805)					+	
*Glycymeris insubricus (*Brocchi, 1814)		+				
Glycymeris cf. *insubricus* (Brocchi, 1814)					+	
Ostrea frondosa De Serres, 1839					+	
Crassostrea gryphoides (Schlotheim, 1820)						+
Costellamussiopecten haveri (Michelotti, 1847)					+	
Cst. northamptoni (Michelotti, 1839)		+			+	
Cst. ? martelli (Ugolini, 1907)			+			
Cst. cristatus (Bronn, 1827)	+			+		
Cst. cristatus badense (Fontannes, 1882)					+	
Pecten vezanensis (Oppenheim, 1903)	+					
P. revolutus (Michelotti, 1847)					+	

Pecten sp.		+				
Flabellipecten burdigalensis (Lamarck, 1809)			+			
Aequipecten scabrellus (Lamarck, 1809)	+			+	+	
A. submalvinae (Blackenhorn, 1901)				+	+	
A. opercularis (Linnaeus, 1758)	+		+	+		
Parvamussium felsineum (Foresti, 1895)					+	
Parvamussium fenestratum (Forbes, 1843)					+	
P. duodecimlamellatum (Bronn, 1831)					+	
Propeamussium anconitanum (Foresti, 1879)					+	
Spondylus concentricus (Bronn, 1848)	+					
Crassatella sulcata speciosa Sacco, 1899	+					
Cardita arduini (Brongniart, 1823)	+					
Megaxinus bellardianus (Mayer, 1864)					+	
Discors aquitanicus (Michelotti, 1861)	+					
Chama benoisti Cossmann & Peyrot,	+					
Cardium multicost. miorotundatum Sacco, 1899					+	
Laevicardium discrepans (Basteroti, 1815)			+			
L. anomalum (Matheron, 1842)	+					
Azorinia chamasolen (Da Costa, 1778)					+	
Venus exdeleta Sacco, 1900	+					
V. multilamella (Lamarck, 1818)	+				+	
Pitar erycinoides Sacco, 1900	+			+		
P. taurorugosa Sacco, 1900					+	
P. dubius Michelotti, 1861	+					
Cordiopsis incrassata (Nyst1836)	+					+
Tellina planata (Linnaeus, 1758)	+		+			
Tapes vetulus (Basterot, 1825)	+		+	+	+	
Lutraria oblonga (Chemnitz, 1782)					+	
Cuspidaria cuspidata (Olivi, 1792)					+	
Corbula gibba (Olivi, 1792)					+	

Table 4: List of the Bivalvia taxa showing their content and distribution in the MoravaMiocene succession. Abreviations: See Tab. 3.

Biostratigraphy: At the Burdigalian/Langhian boundary has happenend a particulary differentiation of Lower Miocene toward Middle Miocene (Langhian stage) mollusc assemblages, that comprises a total of 36 taxa consists of 12 gastropods, 3 scaphopods and 21 bivalvia mostly Langhian age that given in Tab. 3 and 4. This mollusc assemblage has many Langhian good key taxa and according to its biostratigraphic data, this assemblage shows affinity with those of the Langhian type sequence from Italy (Roba 1971, 1972; Bonci et al. 2000), and from Middle Miocene (pectinids) of Badenian of Paratethys (Mandic et Harzhauzer 2003; Studencka et al. 2012). In addition to this, some pectinids such as Parv. felsineum, Prop. anconitanum, Prop. duodecimlamellatum, are known from Italy and associated with Aturia aturi BASTEROT from Upper Burdigalian (Langhian) deposits of Erzen and Guri Kalerit sequences (Pashko 1964, 1965, 2017), whereas the Parv. felsineum are referred from Badenian deposits of Paratethys (Mandic 2004; Studencka et al. 2012). Some species of pteropods as Clio bellardi, C. pedemontana, Cavolinia sacchoi, Vaginella austriaca and V. lapugyensis (that appears in Langhian) characterize Langhian age (D'Alessandro et Roba1981; Robba 1971, 1972) or 18a Zone (Janssen, 2013) of Italy. Planktonic foraminifera with appearance of Praeorbulina date this succession to the Langhian stage (Pashko et al. 1973). To conclude, according to the biostratigraphic data on the Langhian molluscs, particulary on the pectinids, abundant pteropods, high similarity with coeval assemblage of Preadriatic Basin (Papa et Pashko 1963; Pashko 1965, 2017), planktonic feraminifera (Praeorbulina Zone; Pashko et al. 1973; Kumati et al. 1995, 1996) and nannoplanktons of Sphenolithus heteromorphus Zone (Kumati et al. 1995, 1996) this sequence may be correlated to Langhian age.

4.2.3 Serravallian

They represent the uppermost part, regressive sequence Mirasi Fm of fully marine succession of the ATHB. It is made of about 750 m thick deposits and starts with an about 90 m thick bed of massive cross-bedded, concretionary (1-1.5 m diameter of concretions) fine and medium grained sandstone. Upward the succession composed of intercalation of 10-15 to 30 m thick massive, sometime stratified sandstone and more thin gray clays in layers of 15-20 m, with 0.5-0.8 m thick oyster coquinas predominantly formed by single valves, and thin coal-clayey seams. The thickness of the interval reached about 240 m. The next interval is represented of 160 m thick grey clays and siltstones with 24 m thick massive concretionary sandstones. The 12-16 m thick intercalation of grey clays-siltstones with thin layers of sandstones and 8-12 m thick sandstone beds compose the uppermost interval, 260-270 m thick, of the Serravallian and also marine sequence of the ATHB. The fossil content decreases quicly in this formation, as far as known up to now only a poor mollusc assemblage consisting of Cerithium sp., Crassostrea gryphoides (Schlotheim), Cordiopsis islandicoides, whereas foraminifer assemblage yielded mainly benthic and some planctic foraminifers.

Paleoecology: The thick sandstone sequence of the Mirasi Fm include epibenthic molluscs, comprise the autochthonous coquinas of great shells Crs. gryphoides that is a dweller adapted to shallow-marine towards estuarine intertidal environments (Harzhauzer et al. 2016), and shallow-water epibenthic bivalvia C. islandicoides associated with dominated benthic foraminifere points to an estuarine environment which developed on top of the latest marine regression in the ATHB.

Biostratigraphy: Crassostrea gryphoides is a common oyster which was described from the Early-Middle Miocene of Mediterranean Basin, and are been reported from Middle Miocene of Northen Italy (Sacco 1896), from Early Miocene of Central Paratethys (Harzhauzer et al. 2016) and from Serravallian-Tortonian deposits of western Albania, when construit many thick reefs to 8 m (Rogozhine). Cordiopsis islandicoides is generally known from the Serravalian-Tortonian of the Italy and Albania. Microforaminifer assemblage composed predominantly of benthic and some planctonic species such as Globorotalia mayeri, Gl. praemenardi and Globigerinoides obliqus of Orbulina universa Biozone (Pashko et al. 1973; Kumati 1996, Kumati et al. 1995, 1996).

At the end of the Middle Miocene (Mirasi Fm) as a result of short compressive event the marine evolution of the ATHB interrupted and passes into a freshwater mostly lacustrine coalbearing lake and fluvial deposits of Late Miocene-Pleistocene age, which unconformably lie on the marine Miocene sequence and more oldest rocks (Pashko 1970). Contains and distribution of the faunal assemblages, particularly molluscs of Oligocene-Middle Miocene succession show similarity in species and faunal succession and has correlated with faunal assemblages from Mesohellenic Basin (Figure 15).

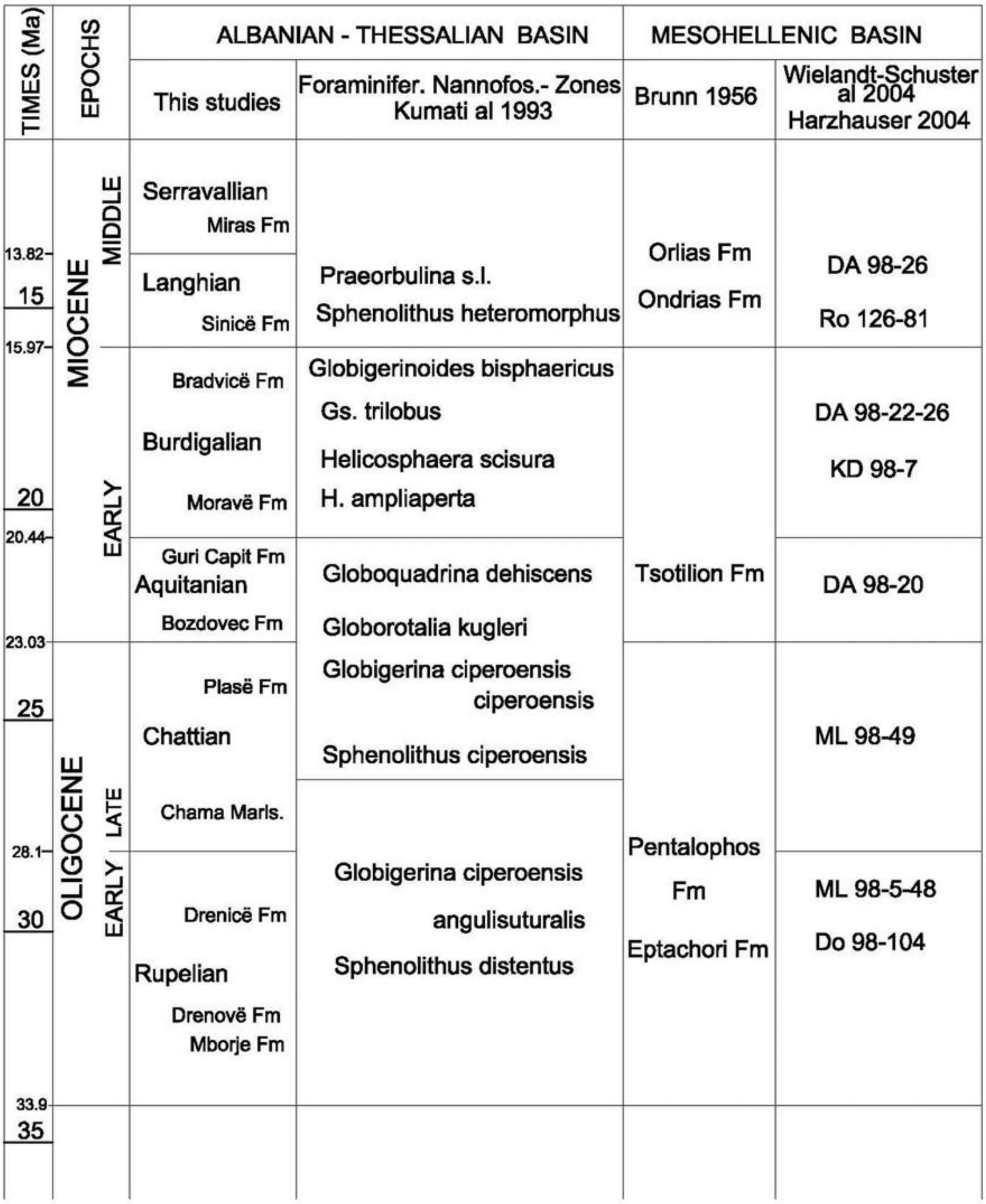

Figure 15: Oligocene-Miocene Fms of the ATHB compared with stratigraphic succession of MHB (Greece) according to Brunn (1956), Wielandt-Schuster et al (2004) and Harzhauser (2004).

5. Conclusions

Based on the results obtained from the detailed six sections carried out in the Morava Mountain Oligocene-Middle Miocene deposits of the Albanian-Thessalian Basin and the treated in this paper their litho- and biostratigraphy, the following main conclusions can be remarked:

1. The Morava Mountain Oligocene-Middle Miocene molasse deposits take part in the intermountain marine Albanian-Thessalian Basin (ATHB), NW-SE developed from south-eastern Albania to Thessaly in Greece. Three periods of regional extension have conditioned three molasse type depositional cycles in ATHB, as follows: i) the first Late

Lutetian-Priabonian cycle, ii) the second Oligocene- Aquitanian cycle and iii) the third Burdigalian-Serravalian cycle. The last two cycles are comprised in the Morava Mt. O2. Based on the occurrence of the molluscs assemblages, particularity on the similarity between Morava Mt molluscs and mollusc assemblages from the Northern Italy and ligocen e-Middle Miocene molasse deposits above treated.

2. Based on the occurrence of the molluscs assemblages, particularity on the similarity between Morava Mt molluscs and mollusc assemblages from the Northern Italy and gastropod assemblage from Mesohellenic Basin, the Morava Mt Oligocene deposits are of Rupelian Stage (Mborja conglomerate Fm., Drenova lignite Fm. and Drenica coral Fm.), whereas the upper part belongs to the Chattian stage (Chama Marls and Plasa Fm.). Also, according the occurrence of larger foraminifers from Tethys Oligocene deposits, the lower part of the Morava Mt deposits with coexistence of the Nummulites and Lepidocyclina represent the second biozone (‘Middle Oligocene’) and belongs to the Rupelian, whereas its upper part with abundant Lepidocyclina dilatata and Operculina complanata, and without Nummulites represent third, upper biozone (‘Upper Oligocene’) can by assigned to the Chattian. Intercalation of marls-clays and fine sandstones (Bozdovec Fm), that grading upwards into massive sandstones and conglomerates (Guri i Capit Fm) includes marine mixing molluscs assemblage particulary stenohaline pectinids inhabitants of shallow nearshore or more calm, medium deeper sublittoral conditions, and according to its good key taxa can be dated as Aquitanian.

3. The Early-Middle Miocene thick marine cycle restricted in SE part of the basin consists of Burdigalian, Langhian and Serravallian deposits. The basal mostly shallow marine white Lithothamnion limestones, sandstones and marls (Morava Fm) passes upward in the intercalation of marls and sandstones layers with marine relative sparse and moderately preserved bivalves (Bradvica Fm), thereto some Burdigalian type pectinids in general abitants of shallow nearshore environment.

Following upwards the thick marine blueish marls and intercalation of marls and fine layers of sandstones, (Sinica Fm) are rich in thin pectinids and abundant pteropods adapted to live-in deep-water conditions. Also, some relatively thick massive sandstones and chanell structures with molluscs were found. According to the presence of its numerous good key taxa this Miocene sequence could be dated as Langhian. The marine sedimentation continued until the final marine regressive stages of ATHB represented by thick Serravallian mostly sandstone series (Mirasi Fm) with coquinas of great oysters and other shallow water molluscs which points to an estuarine environment. The freshwater Late Miocene-Pleistocene deposits unconformably overlie the Oligocene-Middle Miocene molasse.

4. Oligocene-Miocene molluscs assemblages are important for the biostratigraphy of the Morave succession and based on its similarities allow correlation with one of Mesohellenic Basin in Greece.

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