Çukurova Üniversitesi Mühendislik Mimarlık Fakültesi Dergisi, 34(1), ss. 91-102, Mart 2019
Çukurova University Journal of the Faculty of Engineering and Architecture, 34(1), pp. 91-102, March 2019

Ostracoda and Foraminifera Assemblages of the Lower-Middle Miocene Reefal Carbonates within the Değirmençay Area, NW Mersin/S Turkey

Güldemin DARBAŞ*[1], Murat GÜL[2]

[1]*Kahramanmaraş Sütçü İmam University, Faculty of Engineering and Architecture, Department of Geological Engineering, Kahramanmaraş*
[2]*Muğla Sıtkı Koçman University, Faculty of Enginnering, Depratment of Geological Engineering, Muğla*

Geliş tarihi: 08.07.2018 Kabul tarihi: 27.03.2019

Abstract

The occurrence and development of reefal carbonates depend on biological activity and depositional conditions. Besides of fossil assemblages, it is also critical to determine depositional parameters of environment such as sea level change, substratum or clastic input. This study is realised on an important reefal carbonate units as known the Kaplankaya and Karaisalı formations in the Değirmençay locality of Mersin Province, Mediterranean. In this study, the ostracod and foraminifer assemblages were determined in the samples collected from reefal carbonate units of the Early-Middle Miocene age. The base of the investigated area consists of Upper Cretaceous ophiolite and Upper Cretaceous-Palaeocene ophiolitic mélange. These units are unconformably overlain by Miocene sediments. This study determine ostracod and foraminifera assemblages of the Early-Middle Miocene reefal carbonate system. While abundance ostracod species were observed at the reefal carbonate levels, also a few planktonic foraminifer species. As a result of paleontological studies, 12 genera and 15 species from Ostracoda, 3 genera and 3 species from planktonic foraminifera have been determined. The Ostracoda species (*Aurila soummamensis*, *Hemicyprideis villandarutensis*), and planktonic foraminifer species (*Globigerinoides trilobus*, *Globoquadrina dehiscens* and *Orbulina universa*) point out that these reefal carbonates deposited at the Early-Middle Miocene time interval.

Key words: Ostracod, Foraminifer, Reef, Early-Middle Miocene, Adana basin, Turkey

*Corresponding author (Sorumlu yazar): Güldemin DARBAŞ, *guldemin@ksu.edu.tr*

Değirmençay Bölgesindeki Alt-Orta Miyosen Resifal Karbonatların Ostrakod ve Planktonik Foraminifer Topluluğu, KB Mersin/G Türkiye

Öz

Resifal karbonatların oluşumu ve gelişimi büyük ölçüde biyolojik aktivite ve çökelme ortam koşullarına bağlıdır. Bu nedenle resifal karbonatların oluşum ve gelişimini anlayabilmek için fosil toplululuğunu ortaya koymak, çökelme ortam koşullarını yansıtan deniz seviyesi, deniz tabanı ve klastik girdisini bilmek kadar önemlidir. Bu çalışma Akdeniz'de önemli bir resifal karbonat sistemi olan Kaplankaya ve Karaisalı Formasyonları üzerinde yürütülmüştür. Çalışma bölgesi Mersin İli'nin kuzeybatısındaki Değirmençay ilçesinin çevresinde yer almaktadır. İnceleme alanının tabanı Üst Kretase ofiyolitleri ve Geç Kretase-Paleosen yaşlı ofiyolitik melanjden oluşmaktadır. Bu birimler uyumsuz olarak Miyosen çökelleri tarafından örtülür. Bu çalışmada, Erken-Orta Miyosen resifal karbonat sisteminin ostrakod ve foraminifer toplulukları belirlenmiştir. Bu çalışmaların sonucunda resif düzeylerinde tespit edilen ostrakod içeriğinin planktonik foraminifer içeriğine göre daha fazla olduğu gözlenmiştir. Paleontolojik çalışmalar sonucunda, ostrakodlardan 12 cins ve 15 tür, planktonik foraminiferlerden ise 3 cins ve 3 tür tespit edilmiştir. Ostrakodlardan *Aurila soummamensis* ve *Hemicyprideis villandrautensis* ve planktonik foraminiferlerden *Globigerinoides trilobus*, *Globoquadrina dehiscens* ve *Orbulina universa* gibi türler bu resifal karbonatların Erken-Orta Miyosen zaman aralığında çökeldiklerini göstermektedir.

Anahtar Kelimeler: Ostrakod, Foraminifer, Resif, Erken-Orta Miyosen, Adana baseni, Türkiye

1. INTRODUCTION

Miocene coral reefs are common in the Neogene sediments in the Mediterranean region. These reefs include rich faunal assemblages and represent the reefs complexes in the Antalya, Mut, Adana, İskenderun-Hatay basins. These sediments have been studied for several researches in different areas: the Antalya Basin [1]; the Mut Basin [2-4]; the Adana Basin [5-9] and the İskenderun-Hatay Basin [10]. This study was conducted on the Lower-Middle Miocene reefal carbonates in the Adana Basin around Değirmençay village (NW Mersin-S Turkey) (Figures 1 and 2). The Miocene Gildirli, Kaplankaya and Karaisalı Formations, unconformably overlie Paleozoic and Mesozoic units (Figure 3). Early to Middle Miocene reefal limestone–of the Karaisalı Formation extends in a parallel zone to the southern of Taurides Mountains in the Adana Basin. The Karaisalı Formation was deposited on the pre-Miocene topographical highs and influenced by relative sea-level changes [8,11]. The Karaisalı reefal carbonates show lateral and vertical facial transition to the Kaplankaya and Gildirli Formations at the base.

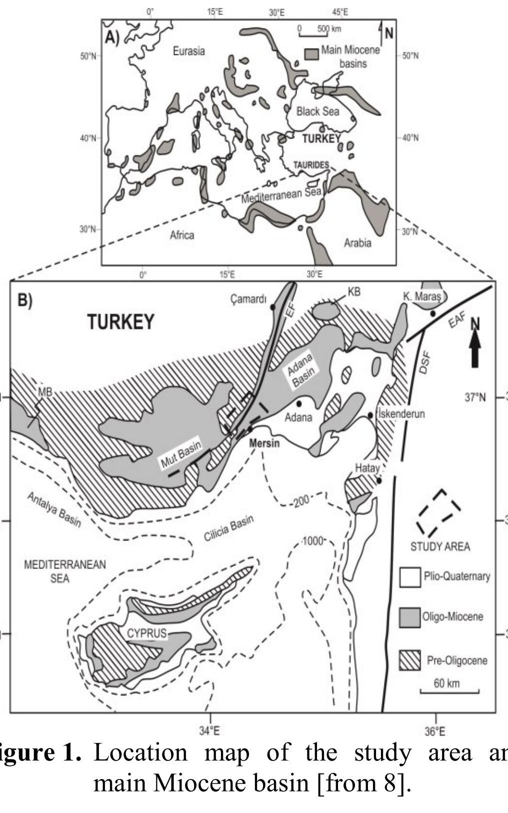

Figure 1. Location map of the study area and main Miocene basin [from 8].

The understanding of both occurrence and development of a reef is very important to determine characteristics of depositional environments. Because carbonate-shelled organism are more easily affected by any changes in depositional condition such as sea level change, antecedent topography or clastic input [8,10,12]. The micropaleontological studies of reefal carbonate and related to other deposits are limited. The assemblages of planktonic and bentonic foraminifera, ostracods and mollusc fauna of these sequences were identified by previously researches [5,13-17].

This paper focuses to determine ostracod assemblages, and to obtain some stratigraphical and palaeoenvironmental data of the study area.

2. GEOLOGICAL SETTINGS

The stratigraphic record of the Adana Basin starts with Paleozoic basement rocks, including Permo-Carboniferous strongly folded limestone and dolomite, and have widespread distribution in the northern part and localized distributions in the northeastern-eastrean part of the study area [18,19] (Figures 2 and 3).

In the study area, the Mesozoic rocks are represented by the Triassic Karagedik Formation (sandstone, conglomerate); the Jurassic-Cretaceous Cehennemdere Formation (limestone and dolomite); the Upper Cretaceous Yavça Formation (clay-sandy planktonic foraminifera-bearing limestone, calciturbidite); the Upper Cretaceous Mersin Ophiolite (harzburgites, mafic-ultramafic cumulates, alkaline and tholeiitic basalts) and the Upper Cretaceous-Paleocene Fındıkpınarı Melange (gabbro, serpentinized peridotite, pyroxenite and sedimentary blocks of mostly limestone) [18,20-22] (Figure 2).

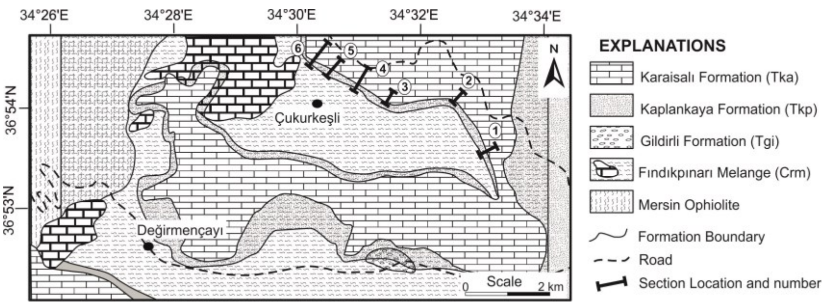

Figure 2. General geological map [8]

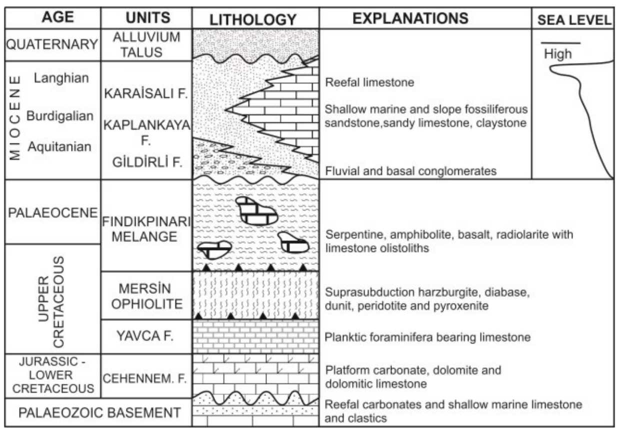

Figure 3. Generalized stratigraphy of the Adana Basin and related sea level variations during the Miocene (modified from 29)

The Tertiary sequence of the Adana Basin can be subdivided into the six formations (Figure 2). The Gildirli Formation composed of terrestrial conglomerates, sandstones, siltstones and mudstones is placed at the bottom of Neogene basin. Fossils have not been found within this formation up to now. According to its stratigraphical position, the age of Gildirli Formation probably ranges from the Oligocene to earliest Miocene (Aquitanian) [23].

The Gildirli Formation passes upwards which laterally into the shallow marine the Kaplankaya Formation and is concordantly overlain by the reefal Karaisalı Formation. These formations were deposited at the paleotopographic high and the marginal parts of the Adana Basin, while the Cingöz and Güvenç formations were deposited in deeper parts of the basin in Early-Middle Miocene time interval [24]. The Kaplankaya Formation concordantly overlies the Gildirli Formation and was deposited in the late Burdigalian-earliest Langhian [25,26].

The Kaplankaya Formation displays lateral and vertical transitional contacts with the reefal Karaisalı formation [5,22]. The age of the Karaisalı Formation ranges from Burdigalian to Langhian [5]. The turbidite sequence of the Adana Basin is represented by the Cingöz Formation which was described by Yetiş [27] and Ünlügenç and Demirkol [28]. This formation has a remarkable lobate geometry characterized by a large lobe to the East and a smaller lobe to the West [9,29,30]. The age of the Cingöz formation was determined as Langhian-Serravallian based on planktonic foraminifer contents [25]. The Güvenç Formation evolves to deeper part of submarine fans of the Cingöz Formation during the Langhian-Serravallian interval [25]. Likewise these units passed up into the fluvial sediments of the Kuzgun Formation. The Kuzgun Formation (Tortonian) is characterized by fluvial, deltaic and shallow marine conditions and overlies the Güvenç Formation with low angle unconformity. This formation is subdivided into three members: such as the Kuzgun, Salbaş Tuff, and Memişli Members [18,27]. The Kuzgun Formation is overlain by the Handere Formation (Late Miocene-Pliocene) [27,32]. Handere Formation consists of fluvial sediments and shallow marine sediments (sandstones and mudstones with conglomerates). A few layers of gypsum-bearing mudstones occur in the western part of Adana basin. Gypsum level as the Gökkuyu Gypsum Member of the Handere Formation has been reported by Yetiş [27]. The Handere formation is unconformably covered by Quaternary aged alluvium, terrace conglomerates and caliches [18,27].

3. MATERIAL AND METHODS

The study area is located 20 km north-west of Mersin and 5 km north-east of Fındıkpınarı town and around the Değirmençayı village (Figure 1). In this study, six sedimentary logs were measured from Miocene reefal carbonates levels and the ostracod and foraminifera content of the reefal carbonate was identified.

For identify planktonic foraminifers and ostracods, 100 g of rock material were washed through 100 and 150 mm mesh sieves. Fossils were picked up residue materials under the stereomicroscope.

4. RESULTS

4.1. Stratigrapic Measured Sections and Ostracod Assemblages

Six stratigraphic sections were measured to describe the lateral and vertical changes in the Miocene reefal carbonates and alternation claystones (Figure 4).

The first log starts from the bottom part of the first reef level. The basement of the first log is represented by very weathered serpentinized the Fındıkpınarı Melange. The sediments of the Gildirli Formation consisting of red colored, clast supported, pebbly conglomerates as five meters unconformably overlie the basement rocks. These continental deposits were observed only at the bottom levels of the first log. The Gildirli Formation vertically passes into the Kaplankaya Formation and consists of fossil and ophiolithic fragment bearing pebbly to granular conglomerates and sandstone, approximatelly ten meter thickness in shallow marine environment**.** Then, claystone of the Kaplankaya formation comes over these sequences and alternates with the fossiliferous fine grained sandstones and sandy limestone. The upper levels of the first log includes the sediments of the Karaisalı Formation consisting of exactly red algae, coral and benthic foraminifera bearing reefal limestone).

Four paleontological samples were collected from the first log. Fourth sample of these include ostracod fauna: Six species belonging to six genera of ostracods were identified (Figure 5): such as *Hemicyprideis villandrautensis, Paracypris polita, Thalmannia hodgii; Sagmatocythere* sp. *Leptocythere* sp., *Propontocythere* sp.

The second log was measured to start from a claystone layer of the third reef level. This claystone belonging to the Kaplankaya Formation includes pelecypoda, benthic and planktonic foraminifers and fossiliferous sandstone interval. These sediments continue toward the northwest unchanged and overlain by deposits of the Karaisalı Formation (contains thick to very thick bedded pelecypoda gastropoda limestone)

Six paleontological samples were collected from the second log (Figure 5). Four ostracod and four planktonic species were determined within these samples: *Hemicyprideis villandrautensis*, *Ruggieria tetraptera tetraptera*, *Paracypris polita*, *Thalmannia hodgii*, *Neomonoceratina mouliana* from ostracods and *Globigerinoides trilobus, Globoquadrina dehiscens, Globigerinella obesa,* and *Orbulina universa* from planktonic foraminifers.

The third, fourth and fifth logs were measured from the fourth reef level. The third log includes clastic units of the Kaplankaya Formation (medium to thin bedded limestone, claystone and fifty-centimeter thickness Ostrea build-ups at the bottom).

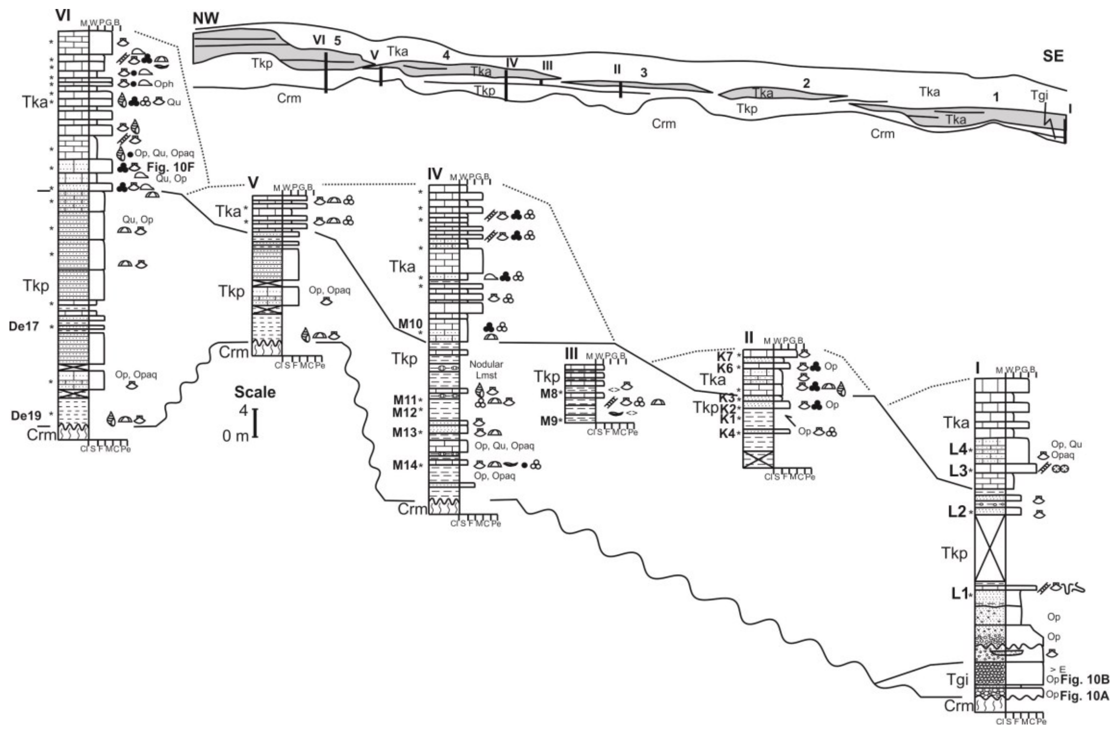

Figure 4. Measured stratigraphical section of the study area

Two samples have been taken from third log (Figure 5). Eleven ostracod species and a planktonic foraminifera were identified within samples taken from the third log: *Aurila soummamensis, Hemicyprideis villandrautensis, Paracypris polita, Thalmannia hodgii, Krithe* sp., *Cushmanidea elongata, Neomonoceratina helvetica, N. mouliana* and *Globigerinoides trilobus.*

The fourth log was measured to start uppermost part of the very weathered serpentinized ophiolitic mélange units. It is represented by the Kaplankaya Formation with pelecypods, gastropods, echinoids, red algae claystone bearing fine grained sandstone alternations at the base and the Karaisalı Formation (the reefal limestone) at the top.

Five samples were taken from fourth log and only one sample has fossil (Figure 5). Nine species of ostracods and a planktonic foraminifera species were determined within these sediments: *Aurila soummamensis*, *Hemicyprideis villandrautensis, Neomonoceratina mouliana, Paracypris polita, Thalmannia hodgii, Leptocythere* sp., *Sagmatocythere* sp. and *Callistocythere* sp.

	SPECIES	1. LOG	2.LOG	3.LOG	4.LOG	6.LOG
OSTRACODS	*Aurila soummamensis*			X	X	X
	Hemicyprideis villandrautensis	X		X	X	X
	Hemicyprideis sp.			X		X
	Paracypris polita	X	X	X	X	X
	Cushmanidea elongata		X	X		
	Krithe sp.			X		
	Neomonoceratina helvetica			X		
	Neomonoceratina mouliana		x	X	X	X
	Thalmannia hodgii	X	X	X	X	
	Ruggieria tetraptera tetraptera		X			X
	Cytherella sp.			X		
	Leptocythere sp.	X			X	
	Sagmatocythere sp.	X			X	X
	Propontocypris sp.	X				
	Callistocythere sp.				X	X
FORAMINIFERS	*Globigerinoides trilobus*		X	X		
	Globoquadrina dehiscens		X			
	Globigerinella obesa		X			
	Orbulina universa		X			

Figure 5. Distribution of ostracod and planktonic foraminifer in the logs

The fifth log similar to the fourth log overlies ophiolitic mélange units. It starts with gastropod, pelecypod, echinoid claystone and ophiolite fragments bearing fine-grained sandstone alternations (the Kaplankaya Formation). The reefal carbonates of the Karaisalı Formation are located at the upper parts of the log. The fifth log was studied only sedimantological characters of the reefal carbonates.

The sixth log was measured from the last reef level. The fine-grained and fossiliferous sandstone deposits of the Kaplankaya Formation are observed at the lower part of the sixth log. These clastic deposits gradually pass into the thirty meters reefal limestone (the Karaisalı Formation).

Two samples have been taken from the sixth log (Figure 5). *Aurila soummamensis*, *Hemicyprideis villandrautensis, Neomonoceratine mouliana, Paracypris polita Ruggieria tetraptera tetraptera, Sagmatocythere* sp. *and Callistocythere* sp.

4.2. Ostracod Analysis

Twenty paleontological samples were analized in this study and six of them contain ostracod fossils. The ostracod specimens are well preservation. Fifteen species belonging to 12 genera from ostracod were recognized (Figure 6). Five species were left open nomenclature, due to scarcity. The distribution of the species within the logs is given in shown in Figure 5. The faunal content is characterized by *Thalmannia* (34%), *Hemicyprideis* (25%), *Aurila* (14%), planktonic foraminifer (10%), *Neomonoceratina* (4%) and *Paracypris* (4%) The remaining taxa are scarcely represented, making up only 9% of the total population (Figure 7).

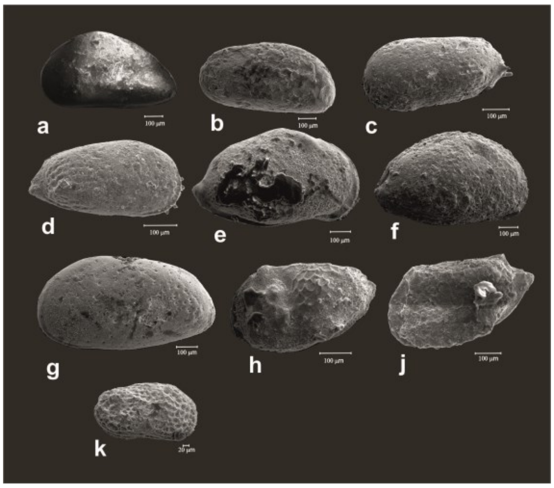

Figure 6. Electron microscopy (SEM) images of the Ostracods

a. *Propontocypris* sp. (outside view of left valve) **b.** *Krithe* sp. (outside view of right valve) **c.** *Thalmannia hodgii* (Brady)(outside view of left valve) **d.** *Thalmannia hodgii* (Brady) (outside view of right valve), **e**. *Aurila soummamensis* Coutella & Yassini (outside view of right valve) **f.** *Aurila soummamensis* Coutella & Yassini (outside view of right valve), **g.** *Hemicyprideis* sp. (outside view of left valve) **h.** *Neomonoceratina helvetica* (Oertli) (outside view of left valve), **j.** *Neomonoceratina mouliana* (Sissing) (outside view of left valve), **k.** *Leptocythere* sp. (outside view of right valve),

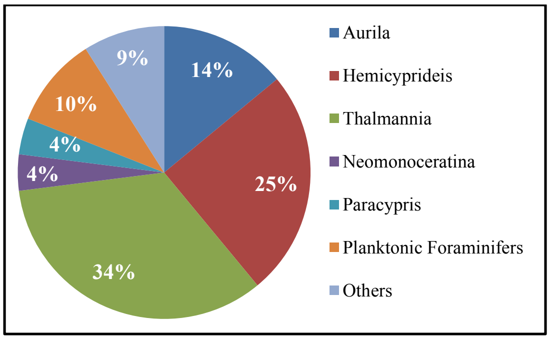

Figure 7. Qualitative fossil analyse of the all samples

4.3. Biostratigraphy

In the following paragraphs, the geographical and stratigraphical distributions of all the ostracod species were given in alphabetical order.

Aurila soummamensis Coutella and Yassini has been found middle Miocene of Adana [36]; Early Miocene of Antakya [37]. Early Miocene of Mersin [38]; Burdigalian-Langhian of Gözne-Mersin [16]; and Early-Middle Miocene of Kahramanmaraş [35].

Hemicyprideis villandrautensis Moyes has been identified in the Aquitanian of France [38], Burdigalian of Gözne-Mersin [16], and Early-Middle Miocene of Kahramanmaraş [35].

***Thalmannia hodgii* (Brady)** has been observed in the Burdigalian-Langhian of Mut [39]; Burdigalian-Serravallian of Antakya [37]; Tortonian of the Adana Basin [39].

***Neomonoceratina helvetica* (Oertli)** has been found in the Burdigalian-Langhian of Antakya Basin [37], Neogene of the Turkey [40]. and Burdigalian-Langhian of Karsantı [41].

***Neomonoceratina mouliana* (Sissingh**) has been found in the Middle-upper Miocene of South Aegean Islands [47]; end of Burdigalian-Langhian of Mut Basin [41]; Late Burdigalian-Early Langhian [45]; Upper Miocene of Adana [44].

***Paracypris polita* Sars** has been identified in the end of Burdigalian-Langhian of Mut basin [41]; Burdigalian-Early Langhian of Mersin [16]; Serravallian of Antakya [37]; Upper Miocene-Pliocene of Tarsus-Mersin [17].

***Cushmanidea elongata* (Brady)** has been determined Tertiary-Recent of Algeria [48]; Tortonian-Messinian [49]; Upper Miocene of Adana [44].

***Ruggieria tetraptera tetraptera* (Seguenza)** has been found in Upper Miocene of Tunisia [46]; Langhian of Antakya [37]; Upper Miocene-Pliocene of Adana [43].

The biostratigrahical interpretation according to the age of ostracod and planktonic foraminifer assemblages in previous studies was evaluated as early-middle Miocene by the presence of *Hemicyprideis villandrautensis* and *Aurila soummamensis* from ostracod and *Globigerinoides trilobus,* first occurence of *Orbulina universa* and *Globoquadrina dehiscens* from planktonic foraminifers [16,35,37,38,50].

4.4. Palaeoenvironmental Interpretation of the Study Area

The environmental interpretation of the study area was constructing mainly on the ostracod and planktonic foraminifera fauna and lithological characteristic of the Değirmençayı reef complex. The reef complex consists of some bioclastics deposits of the Kaplankaya formation mainly composed of benthic foraminifera, ostracods and very few planktonic foraminifera, molluscs and limestones of the Karaisalı Formation including coral, red algae, large benthic foraminifera.

The study area is the southern part of the Adana Basin, identified microfauna was obtained from fine grained sand-silty-claystone of the Kaplankaya-Karaisalı Formation boundary.

In this research, fifteen ostracod species were obtained from the study area and these assemblages are widely distributed in the modern shallow waters of Mediterranean. Taking into account of paleoecological characteristics of ostracods, the study area referred to littoral environments, mainly represented by *Hemicyprideis*, *Thalmannia, Aurila, Cushmanidea* and *Paracypris* species, and infralittoral environments, represented by the Thalmannia*, Neomonoceratina*, *Krithe* and *Propontocypris* [51-53].

The Kaplankaya Formation was deposited under the coastal-shallow marine condition, and the Karaisalı Formation was formed in the littoral environmental condition including tidal flat as a reefal product [5,7,18]. Yetiş and Demirkol [18] supposed that take into consideration the transitionally lateral and vertical relationship contact of the Early-Middle Miocene Kaplankaya and Karaisalı Formation, it can be said the Kaplankaya Formation deposited in the shallow part of the Miocene marine filled palaeotopographical depressions, also during this time, the high hill as resting under the marine became suitable to live reefal organism and the Karaisalı Formation was formed in this area. According to micropalentological analysis from the Değirmençayı reefal units may be product of two major environments: back and front of the reef (Figure 8).

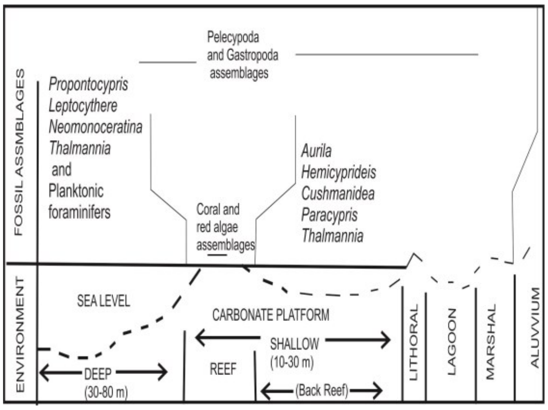

Figure 8. Disribution of the fossil assemblages of a reef (modified from Ünal [55])

Hemicyprideis (80%) and *Thalmannia* (19%) are the dominant genera of the first log (Figure 9). According to this fauna it can be suggested that this sequence deposited in the back of the reef.

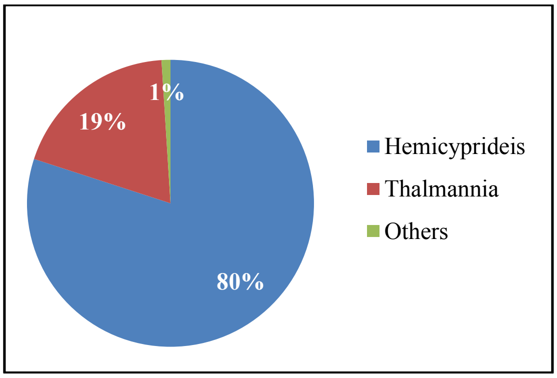

Figure 9. Qualitative fossil analyse of log number 1

According to this fauna it can be suggested that this sequence deposited in the back of the reef. The planktonic foraminifer content of the second log was determined as a percentage relatively high (64%), besided that it was calculated frequency of the genus *Thalmannia* and genus *Cushmanidea* respectively (12%) and (10%). So, it can be accepted that the second log is a in front of the reef deposits (Figure 10)

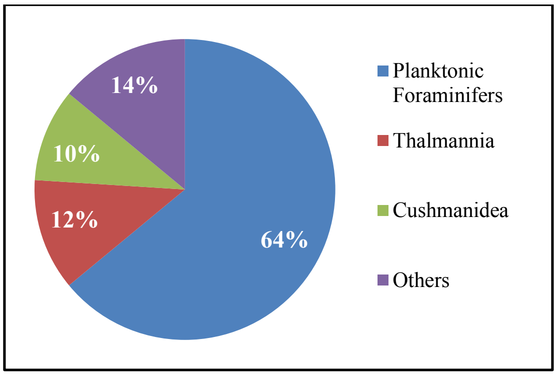

Figure 10. Qualitative fossil analyse of log number 2

Thalmannia (34%), *Hemicyprideis* (30%) and *Aurila* (20%) were dominated species in the third log. In the fourth log, genus *Thalmannia* was determined in the high percentage (73%). *Aurila* (40%) and *Hemicyprideis* (35%) were common genera in the sixth log. According to fossil content of the third, fourth and sixth logs, it can be estimated these sequences were deposited under the back of the reef condition (Figures 11-13).

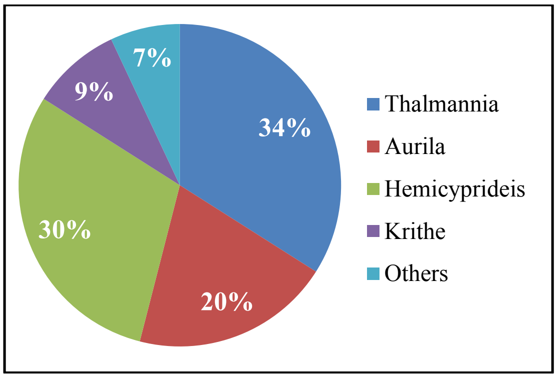

Figure 11. Qualitative fossil analyse of log number 3

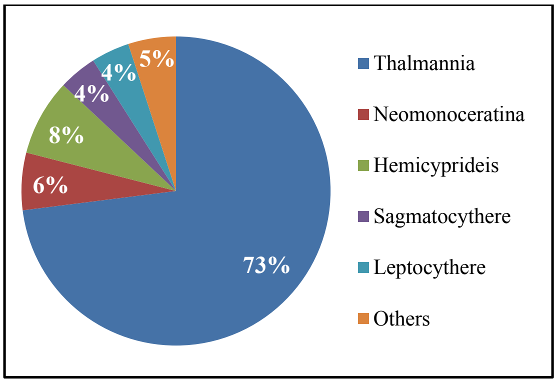

Figure 12. Qualitative fossil analyse of log number 4

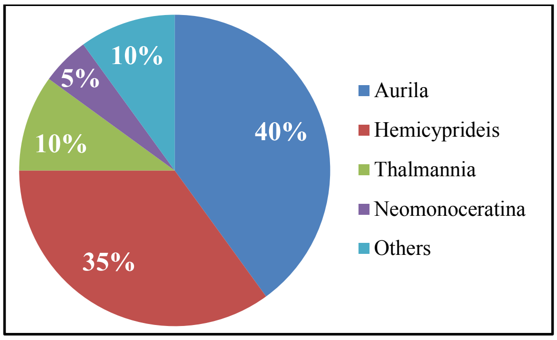

Figure 13. Qualitative fossil analyse of log number 5

5. CONCLUSION AND DISCUSSION

Miocene carbonate systems composed of three supercyles whole Mediterranean according to Haq et al. [54]: TB1 (Chattian and the most of Aquitanian: 21-30 My), TB2 (uppermost Aquitanian, Burdigalian-Langhian and Serravallian: 21-10.5 my) and TB3 (Tortonian to Recent). Lithologic and paleontological analyses is revealed the Karaisalı reefal carbonates corresponded to other Mediterranean Miocene reefal complex as faunal and facies characteristics and their stratigraphical positions. The Karaisalı reefal carbonates and associated sediments in the study area were evaluated in the TB2 supercycle and under high sea level and warm climatic conditions in the Early-Middle Miocene time according to Haq et al, 1987.

The stratigraphical classification of an Early-Middle Miocene age for the reef complex can be supported mainly by the presence of *Hemicyprideis villandrautensis and Aurila soummamensis* from ostracod and *Globigerinoides trilobus, Globoquadrina dehiscens* and *Orbulina universa* from planktonic foraminifers.

Take into the paleoecological characteristics of ostracods and planktonic foraminifers, the study area is represented by mainly back and front of the reef in neritic environment (*Hemicyprideis, Thalmannia, Aurila, Cushmanidea* and *Paracypris* species) (Figure 7).

6. REFERENCES

1. Karabıyıkoğlu, M., Tuzcu, S., İner, A., Deynoux, M., Orcen, S., Hakyemez, A., 2005. Facies and Environmental Setting of the Miocene Coral Reefs in the Late-orogenic Fill of the Antalya Basin, Western Taurides, Turkey: Implications for Tectonic Control and Sea-level. Sedimentary Geology, 173(1–4), 345–371.

2. Gül, M., Eren, M., 2003. The Sedimentary Characteristics of Dağpazarı Patch Reef (Middle Miocene, Mut-Içel/Turkey). Carbonates and Evaporites, 18(1), 51–62.

3. Şafak, Ü., Kelling, G., Gökçen, N.S., Gürbüz, K., 2005. The Mid-cenozoic Succession and Evolution of the Mut Basin, Southern Turkey, and its Regional Significance. Sedimentary Geology, 173(1-4), 121–150.

4. Janson, X., Buchem F.S.P., Dromart, G., Eichenseer, H.T., Dellamonica, X., Boichard, R., Bonaffe, F. And Eberli, G., 2010. Architecture and Facies Differentiation within a Middle Miocene Carbonate Platform, Ermenek, Mut Basin, Southern Turkey. Geological Society, London, Special Publications, 329, 265-290.

5. Görür, N., 1979. Sedimentology of the Karaisalı Limestone (Miocene). Geological Bulletin of Turkey, (in Turkish with English abstract). 22–2, 227-232.

6. Görür, N., 1980. Diagenetic Evolution of the Karaisalı Limestone (Miocene). In: Fifth Petroleum Congress of Turkey, Ankara, 123-128 (in Turkish with English abstract).

7. Görür, N., 1994. Tectonic Control in the Development of a Lower Miocene Reef at a Complex Triple Junction: Depositional History of the Karaisali Formation of the Adana Basin, Turkey. Geol. Mediterr, 49–67

8. Gül, M., 2007. Effects of Antecedent Topography on Reefal Carbonate Deposition: Early-Middle Miocene of the Adana Basin, S. Turkey. Jornal of Asian Sciences, 31, 18-37.

9. Cronin, B.T., Gurbuz, K., Hurst, A., Satur, N., 1999. Vertical and Lateral Organization of a Carbonate Deep-water Slope Marginal to a Submarine Fan System, Miocene, Southern Turkey. Sedimentology, 47, 801–824.

10. İkram, M., Varol, B. 2011. Neogene Reefal Limestones and Their Significance in the Basin Architecture, Osmaniye-Bahçe and Neighbouring Sub-basins, SE Turkey Carbonates and Evaporites, 217-234.

11. Büyükutku, A.G., 2009. Reservoir Properties of Karaisalı Formation in the Adana Basin, Southern Turkey. Journal of Petroleum Science and Engineering, 65, 33–44.

12. Buchem, F.S.P.V., Gerdes, K.D., Esteban, M., 2012. Mesozoic and Cenozoic Carbonate Systems of the Mediterranean and the Middle East: Stratigraphic and Diagenetic Reference Models-an Introduction. Geological Society, London, Special Publications, 329, 1-7.

13. Sirel, E., Gündüz, H., 1981. Description of New Species of Borelis from the Hatay South of Turkey) and Elazığ regions (East of Turkey). Bulletin of the Mineral Research and Exploration Institute (MTA) of Turkey, 92, 70–74.

14. Yalçın, N.M., Gorur, N., 1984. Sedimentological Evolution of the Adana Basin. In: International Symposium on the Geology of the Taurus Belt, Proceedings, pp. 165–167 (in Turkish).

15. Tanar, Ü., 1985, The Mollusca Assemblages of Karaisalı, Kuzgun and Memişli Formations of Körlü (Tarsus-Adana) Region. Körlü (Tarsus-Adana) Bölgesi Karaisalı, Kuzgun, Memişli Formasyonlarının Molluska Faunası Jeoloji, Müh. Der., 24, 17-31, Ankara (in Turkish).

16. Nazik, A., 1993. The Ostracod Biostratigraphy and environmental interpretation of Gözne (Mersin) Clastic Sequences. Doğa-Yerbilimleri, 2, 167-173, Ankara (in Turkish).

17. Safak, U., Nazik, A., 1994. Eshab-ı Kehf (Tarsus-Mersin) Dolayı Neojen İstifinin Ortamsal Yorumu. Yerbilimleri Geosound, 15. Yıl Sempozyumu, 22, 291–300, (in Turkish).

18. Yetiş C., Demirkol, C., 1986. Detailed Geologic Investigation of the Western Side of the Adana Basin, MTA Rep. No: 8037-8037a, 70p. (unpublished, in Turkish).

19. Ünlügenç, U.C., Kelling, G., Demirkol, C., 1990. Aspects of Basin Evolution in the Neogene Adana Basin, SE Turkey. In: Savas_c, in, M.Y., Eronat, A.H., Eds.), Proc. Int. Earth Science Cong. On Aegean Region, İzmir, 1, 353–370.

20. İşler, F., 1990. Geology of the Ophiolite in the Fındıkpınarı (Mersin). Cumhuriyet University, Journal of Engineering, Serie A, Geosound, 6-7, 1-2, 45-53 (in Turkish with English abstract).

21. Parlak, O., Delaloye, M., 1996. Geochemistry and Timing of Postmetamorphic Dyke Emplacement in the Mersin Ophiolite (southern Turkey): New Age Constraints from 40Ar/39Ar Geochronology. Terranova 8, 585–592.

22. Özer, E., Koc, H., Özsayar, T., 2004. Stratigraphical Evidence for the Depression of the Northern Margin of the Menderes-Tauride Block (Turkey) During the Late Cretaceous. Journal of Asian Earth Science, 22, 401–412.

23. Yetiş, C., Kelling, G., Gökçen, S.L., Baroz, F. 1995. A Revised Stratigraphic Framework for Later Senozoic Sequences in the Northeastern Mediterranean Region. Geologishe Rundschau, 84, 794–812

24. Schmidt, G.C., 1961. Stratigraphic Nomenclature for the Adana Region Petroleum District VII. Petroleum Administration Bulletin 6, 47–63, (in Turkish).

25. Nazik, A., Gurbuz, K., 1992. Karaisalı-Çatalan-Eğner Yöresi (KB Adana) Alt-Orta Miyosen Yaşlı Denizaltı Yelpazelerinin Planktonik Foraminifer Biyostratigrafisi. T.J.K. Bult. 35(1), 67–80, (in Turkish).

26. Gürbüz, K., Kelling, G., 1993. Provenance of Miocene Submarine Fans in the Northern Adana Basin: a Test of Discriminant Function Analysis, Geol. J. 28, 277–295.

27. Yetiş C., 1988. Reorganization of the Tertiary Stratigraphy in the Adana Basin, Southern Turkey. Newsl. Stratigr, 20(1), 43-58.

28. Ünlügenç, U.C., Demirkol, C., 1988. Kızıldağ Yayla (Adana) Dolayının Stratigrafisi, Jeoloji Mühendisliği Dergisi, Ankara, 2-33, 17-25.

29. Gürbüz, K., 1999. Regional Implications of Structural and Eustatic Controls in the Evolution of Submarine Fans: An Example from the Miocene Adana Basin, southern Turkey. Geol. Mag, 136.

30. Satur, N., Hurst, A., Cronin, B., Kelling, G., Gurbuz, K., 2000. Sand Body Geometry in a Sand-rich, Deep-water Clastic System, Miocene Cingoz Formation of Southern Turkey. Mar. Petrol. Geol, 17(2), 239–252.

31. Nazik, A., Gürbüz, K., 1992. Karaisalı-Çatalan-Eğner Yöresinin (KB-Adana) Alt-Orta Miyosen İstifinin Planktonik Foraminifer Biyostratigrafisi. Türkiye Jeoloji Bülteni, 35(1), 67-80.

32. Öğrünç, G., Gürbüz, K., Nazik, A., 2000. Adana Baseni Üst Miyosen-Pliyosen İstifinde Messiniyen Tuzluluk Krizi'ne ait Bulgular. Yerbilimleri, 22, 183-192.

33. Nazik, A., 1994. The Holocene Ostracods of İskenderun Bay. MTA, 116, 5-20.

34. Şafak, Ü., 1998. The Tertiary Ostracod Assemblages of Çamlıyayla (İçel) Region. Çamlıyayla (İçel) Yöresi Tersiyer Ostrakod Topluluğu, 20th Anniversary of Geological

Engineering Education Symposium in Firat University, Proceedings,183-189, (in Turkish).

35. Darbaş, G., Gül, M., 2006. The Paleontology of Coal Units in Alacık Formation (Kahramanmaraş Basin). KSU Journal of Science and Engineering, 9(2), 71-81, (in Turkish).

36. Şafak, Ü., Ünlügenç, U.C., 1993. The Ostracod Assemblages and Biostratigraphy of Oligocene-Middle Miocene Units of Outcropped Around Kozoluk, Solaklı and Kevizli (N Adana), Geosound, 21, 117-141, (in Turkish).

37. Şafak, Ü., 1993. The Ostracod Biostratigraphy of Antakya, TJB, 36, 115-137, (in Turkish).

38. Carbonel, P., 1985. Atlas Des Ostracodes de France. Bull. Centres Rech. Explor.-Prod. Elf-Aquitaine, Mem. 9, Pau, (Ed: Oertli, H.J.).

39. Avşar, N., Nazik, A., Dinçer, F., Darbaş, G., 2006. Environmerntal Inerpretation of the Kuzgun Formation in the Adana Basin through Microfossils. Yerbilimleri, 27(1), 1-21.

40. Gökçen, N., 1984. Neomonoceratina Helvetica Superzone and Carinocythereis Datumplane in Neogene Sequences of Turkey, Newsl. Statigr. 2 Tab, Berlin-Stuttgart, 13(2), 94-103.

41. Tanar, Ü., 1989. The Stratigraphical and Micropaleontological (Ostracod and Foraminifer) Investigation of Tertiary Unit of Mut Basin. PHD Thesis, Çukurova University, 199, (in Turkish).

42. Şafak, Ü., 1993. Karsantı Yöresinde (KKD Adana) Yüzeyleyen Tersiyer İstifinin Ostrakod Dağılımı ve Ortamsal Özellikleri, Türkiye Jeoloji Bülteni, 36, 1.

43. Nazik, A., 1996. Salbaş-İmamoğlu (Adana) Bölgesi Geç Tersiyer Ostrakodlan. Yerbilimleri, Ankara 19, 213-233.

44. Darbas, G., Nazik, A., 2010. Micropaleontology and Paleoecology of the Neogene Sediments in the Adana Basin (South of Turkey). Journal of Asian Earth Sciences. 39(3), 136-147.

45. Bilen, C., 1996. The Ostracod Biostratigraphy of Kasaba (Kaş) Neogene Basin. Hacettepe University, MSc, Ankara, 125. (in Turkish).

46. Bonaduce, G., Ruggieri, G., Russo, A., Bismuth, H., 1992. Late Miocene Ostracods from the Ashart 1 Well (Gulf of Gabes, Tunisia). Bollettino Soc. Paleontol. Italian, 31(1), 3–93.

47. Sissingh, W., 1972. Late Cenozoic Ostracoda of the South Aegean Island Arc. Utrecth Micropaleontological Bulletins, 6, 1-187.

48. Yassini, I., 1979. The Littoral System Ostracodes from the Bay of Bou-Ismail, Algiers, Algeria. National Iranian Oil Company. Rev. Espanoia Micropaleontol, XI(3), 353–416.

49. Nazik, A., Gokcen, N., 1995. Ostracods of the Uppermost Tertiary Sequence of the North Adana Basin and Misis Area. Ostracoda and Biostratigraphy. In: Riha Jaroslav (Ed.), Proceedings of 12^{th} International Symposium on Ostracoda Prague, Czech Republic, 251-264.

50. Iaccarino, S.M., Premoli Silva, I., Biolzi, M., Foresi, L.M., Lirer, F., Turco, E.,. Petrizzo M.R., 2007. Practical Manual of Neogene Planktonic Foraminifera/Perugia: International School on Planktonic Foraminifera (Neogene, 6. Course).

51. Faranda, C., Gliozzi, E., Mazzini, I. 2007. Paleoenvironmental Evolution of the Plio-Pleistocene Monte Mario Succession (Roma, Italy) Inferred from Ostracod Assemblages. Rivista Italiano di Paleontologia e Stratigrafia, 113, N:3, 473-485.

52. Szcxechura, J., 2007. Middle Miocene Ostracods from the Dzialoszyce Trough, Northern Part of the Carpathian Foredeep. Joannea Geol. Palaon 9, 109-110.

53. Faranda, C., Gliozzi, E., 2008. The Ostracod Fauna of the Plio-Pleistocene Monte Mario Succession (Roma-Italy). Bollettino Della Societa Paleontologica Italiana, 47(3), 215-267.

54. Haq, B.U., Hardenbol, J., Vail, P.R., 1987. Chronology of Fluctuating Sea-levels Since the Triassic. Science, 235, 1156-1167.

55. Ünal, A., 2006. Gözne (Mersin) Güneydoğusundaki Miyosen Yaşlı Karaisalı Formasyonu Kireçtaşlarının Bentik foraminiferleri. Mersin Üniversitesi Fen Bilimleri Enstitüsü, Yüksek Lisans Tezi, 127.