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Research Paper

REWORKED MARINE INVERTEBRATE FAUNA (GASTROPODA AND CORAL) FROM THE PALEOGENE EOCENE OF CENTRAL ANATOLIA (TURKEY)

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The fluviolacustrine Uzuncarsidere Formation outcrops near the village of Orhaniye in central Anatolia. The age of this rock unit is thought to be middle Eocene on the basis of its stratigraphic relationships and preliminary biostratigraphic and geochronological data. The lithology of the Uzuncarsidere Formation varies through its section, ranging from conglomerate at its base to sandstones, siltstones and mudstones that are developed into paleosols to finer-grained lacustrine mudstones at the top. Fossil vertebrates, including remains of fishes, reptiles and mammals, have been reported from the mudstone-dominated part of the section. The total thickness of this rock unit ranges from 100-180 m, and this total is variable from place to place. Reworked marine invertebrates from the Uzuncarsidere Formation include the ampullinid gastropod *Globularia (Globularia) vapincana*. This taxon is known from older rock units in central Anatolia, and it may provide useful paleogeographic data because the species was widely distributed around the Tethyan region during the early Paleogene. A solitary coral species closely resembling Balanophyllia irrorata has also been recovered from the Uzuncarsidere Formation, and unnamed Formation (Alnahwy Formation). This is the first report of reworked marine invertebrates in the both the Formations.

Keywords: Uzuncarsidere formation, Ampullinid gastropods, Solatiry corals

INTRODUCTION

The early Paleogene Macroinvertbrate fauna at Uzuncarsidere Formation (US) near Ankara at the basin (Orhaniye-Guvence Basin) such as Coral and the gastropod are not well studied. The coral and the gastropod record are particularly incomplete, which means they are reworked and older than this formation Uzuncarsidere Formation (USF). The UC- Formation is a part of the small sedimentary basin is called (Orhaniye-Guvence) Basin. This basin is located west of Ankara; Turkey Country. The distribution of this Formation is mainly northwest of Ankara City which is the capital city of Turkey. The main distance of the UC- Formation (UC) is almost 6km southwest town called Kazan.

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The pervious studies in this section were mainly paleontologists, which means this section UC- Formation (UC) is promising section for them. In the that section, you will see the marine Cretaceous rocks (Dikmendede Formation) which are beneath the UC-Formation, and the above marine limestone Middle Eocene rock (Orhaniye Formation) which above the UC-Formation. So, the age of this formation is problematic to all the geologists. The lithology of UC- Formation is mainly alluvial sediments, sandy limestone, siltstone, rare galcontie grains, clay and varieties of colors of mudstone; red, green, brown, and gray. The fossil content in this formation is almost rich by tooth, bones, and fragment of bones. Most of the previous studies do not mention anything about reworking marine invertebrate fauna in this Uzunçarþýdere Formation Formation (US) at all.

In addition, the first reported about this location in Tarakli Basin; the lithology of Unamed Formation unnamed Formation (Alnahwy Formation) is Fluvial sandstone, red, green, and gray clays, conglomerate. The fossil is tooth of mammals, and bone fragments. This Unnamed Formation in Tarakli Basin seems Early Paleogene and older than the UC Formation at Orhaniye-Guvence Basin, based on the vertebrate fossils. The total thickness of this formation is several than hundred meters.

Both of the Coral; *Balanophyllia irrorata* and the Gastropods; *Globularia (Globularia) vapincana* were important fauna in shallow marine environments during the end of the late Cretaceous and Paleogene time. They have excellent distributions in the Tethys region at all the bed rocks (Formation) in the Paleogene age in Tunisia, Turkey, France, Italy, Bulgaria, Romania, and Poland (Cossmann, 1889; Malaroda, 1954; Pavic, 1970; and Okan and Hosgor, 2007 and 2008).

GEOLOGICAL DISTRIBUTION AND BACKGROUND

The previous Studies mainly focus on the stratigraphy and structure, geology of this basin of the Teriary sedimentary basin (Orhaniye-Guvence Basin). Since In Gorur and Derman (1978), used the Kartal Formation in this formation. In Sengor and Yilmoz (1981), reported that country developed by interfering in the small or shallow basin with microceontental fragments. In Robertson and Dixon (1984), explained the type of collision in this region of the small ocean basin, microcontine, and carbonate platforms. In Gokten *et al.* (1988), the first described the sedimentary facies in this basin that is located Northwest of Ankara, they gave the name of this formation which is The UC-Formation, and also, described the facies are mainly changed in the thickness (lateral change) from 500 m to 10 m in thickness. In Kocyigiti (1991), gave the name of the UC-Formation only in the upper part of this section which is marine deposits. That is based on his data from the tectonic evolution of this basin. Both of them used the new name which is UC-Formation rather than the Kartal Formation.

In Kappelman *et al.* (1996) reported the micro-mammals in this formation (Marsuplia). In the Paleontological group (Kappelman *et al.*, 1996; and Maas *et al.*, 1998) described and found a new genus of the embrithopod, and condylath. In Decourt *et al.* (2000), mentioned the problematic issue of the Modern Anatolia, and this basin is nature paleogeography. In Bozkurt and Mittwede (2001), mentioned the five tectonic occurences, and making of the modern Turkey Country. In Maas *et al.* (2001), reported based on this fauna was

found in the UC-Formation, which was Central Anatolia was the link between Europe and Africa during the Early Paleogene. In Unay *et al.* (2001), explained that during the Early Paleogene Turkey appears as an island. In Maga and Maas (2004), used the name of the UC-Formation in all publications. In Seiffert (2006), considered the UC-Formation is older than Al Fayum Formation.

MATERIAL

Gastropods and Corals were found from the most fossil localities studied here. Both of them were found from Uzuncarsidere Formation in the both basins. All materials were sorted in the University of Kansas Natural History Museum, and described in the Geological Department of Ball State University. The serial number of the specimens was catalogued by Doke University MED.CTR (Turkey).

Locality

Localities of 42 samples (fossils) described in this paper are shown in the Figure 1. The localities, Guvence (N40°07'.8.69/E324°5'.38"), Orhaniye (N40°06'15.5"/E32°42'54.9"), and Hamam Dere (N40°06'.64.1"/E32°44'.44.93") Near Ankara, Turkey. Also, The Tarakli Basin (N40°20'47"/E30°31'48") Near Ankara, Turkey.

DATA AND RESULTS

Orhaniye-Guvence Basin

The Uzuncarsidere Formation

The total thickness of this rock unit ranges from 100-180 m, it is variable from place to place, and have different type of sediments. The Uzuncarsidere Formation Unit is middle Eocene based on the geochronological data, as shown in the Figure 2. The Uzuncarsidere Formation includes from conglomerat, sandstone, siltstone, mudstone, clays, and rare gypsum In addition, this formation has abundant fossil vertebrates such as reptiles, large and small mammals, fish, and birds as shown in the Figure 3. Reworked marine invertebrates from the Uzuncarsidere Formation includes the ampullinid gastropod

Figure 1: The Eocene Uzuncarsidere Formation of Central Anatolia (Turkey)

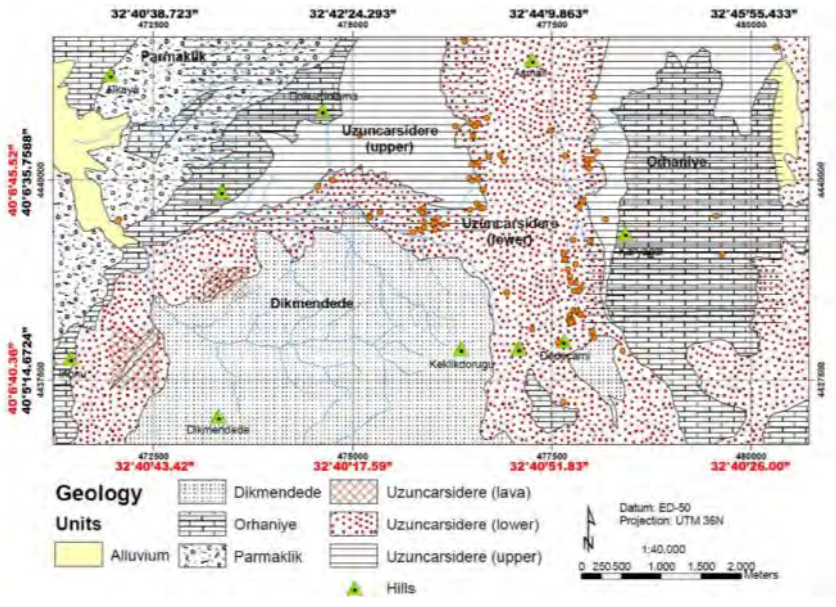


Figure 2: Shown the Outcrop of The Uzuncarsidere Formation at Orhaniye-Guvence Basin

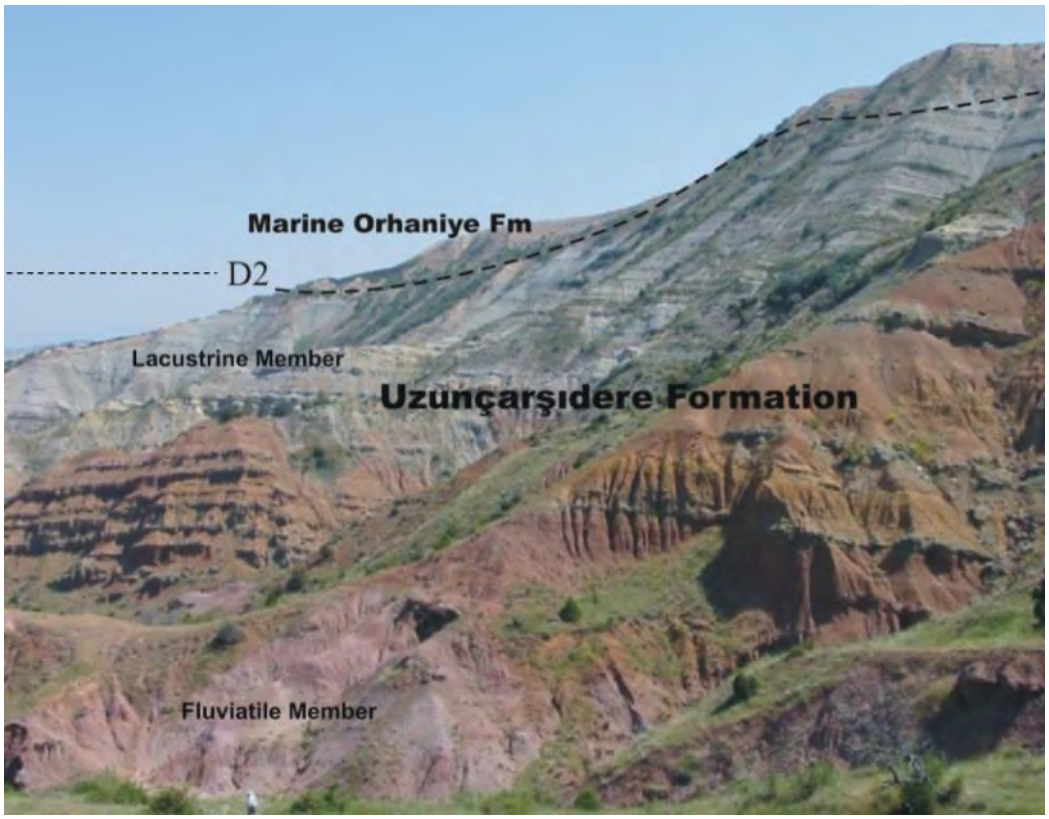


Figure 3: Shows the Columnar Section of The Uzuncarsidere Formation, and Right Photos show the Fluvial Sandstone, Mud Cracks and Conglomerate

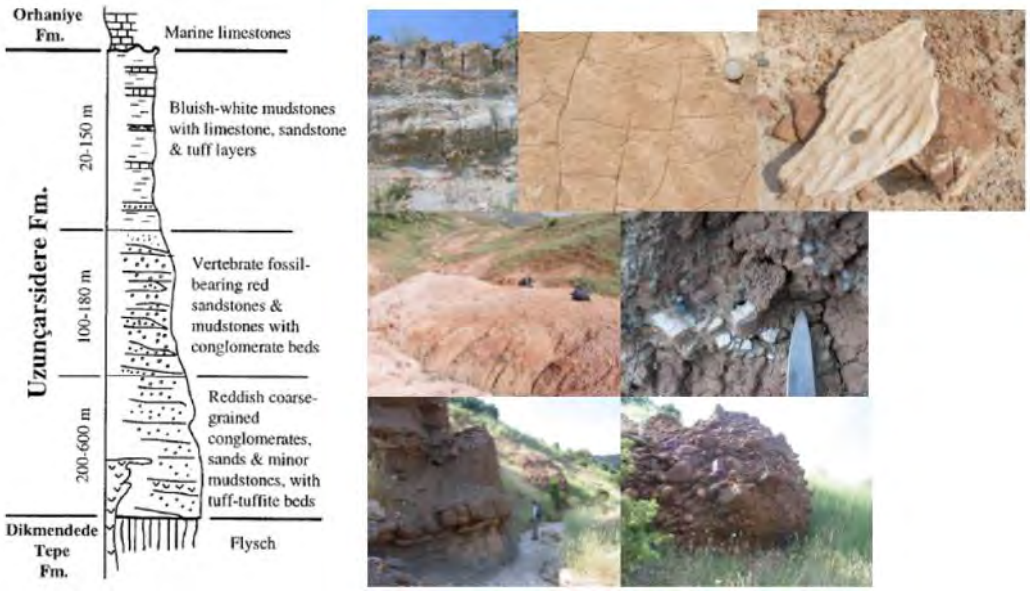


Table 1: Shown the Fossils Content in the Guvence, Turkey

Sample	Site	Lithology	Invertebrates	Vertebrates	Location
1	AK 1A	Redsandsonte –and Rare green Clay	Forams, Corals, Gastropods	Crocodile teeth Lizard vertebra	Guvence, Turkey
2	AK 1A 2"-1995	Red mudstone	Coral, Forams	Bone fragments	Guvence, Turkey
3	AK 1A 2-1995	Red mudstone	Forams, Corals, Gastropods	Bone and tooth fragments of mammals, Lizard vertebra and fragments	Guvence, Turkey
4	A 595 1A	Red clay	Forams	Bone fragments	Guvence, Turkey
5	1K-1D	Fine sandstone, red and gray grains			Guvence, Turkey
6	AK-1A 3 Kartal	Sandylimestone	Forams, Corals	Bone fragments	Guvence, Turkey
7	AK-1D 1995	Red Sandstone	Forams, Corals, Gastropods		Guvence, Turkey
8	AK-1D	Redsandsonte –and red, and green Clays	Forams, Corals, Gastropods	Skin Fragments fossils, Tooth of Mammals, Jaws of Lizard, Lizard vertebra and snakes	Guvence, Turkey
9	AK-1D Sample 5	Gypsum Fragments, Sandstone	Forams, Corals, Gastropods	Bone fragments.	Guvence, Turkey
10	AK-1D Sample 4	Green Conglamurates, sandstone	Forams, Corals, Gastropods	Bone fragments, Teeth of mammals, Lizard and bird vertebrates	Guvence, Turkey
11	AK-1A Sample 12	Green, brown clays	Forams, Corals, Gastropods	Fish tooth, Lizard tooth, Crocodile teeth, Bone fragments, Teeth and fragments of mammals	Guvence, Turkey
12	AK-1D Reworked	Green, brown clays	Forams, Corals, Gastropods	Finger bones	Guvence, Turkey
13	13	Sandstone, green, and gray clays			Guvence, Turkey
14	AK-39 Sample 7	Sandstone,red, green, and gray clays	Forams, Corals, Gastropods	Bone fragments	Guvence, Turkey
15	AK-1A Wash	Red, green, and gray clays	Forams, Corals, Gastropods	Bone fragments, Teeth of mammals	Guvence, Turkey
16	AK-1A	Bone fragments, Gypsum	Forams, Corals, Gastropods	Crocodile teeth, Lizard vertebrates	Guvence, Turkey
17	AK-1B	Red sandstone	Forams, Corals, Gastropods	Lizard vertebrates, Bone fragments	Guvence, Turkey
18	AK Rock Sample 7	Red, green, and gray clays, Sandstone	Forams, Corals, Gastropods	Bone fragments, Teeth of mammals, Lizard vertebrates and jaws, Teeth of Fish	Guvence, Turkey
19	Sample 17	Red, green, and gray clays	Forams	Bone fragments, Teeth of mammals	Guvence, Turkey
20	MF	Red sandstone		Bone fragments	Guvence, Turkey
22	AK 1-A-B	Red sandstone	Forams, Corals, Gastropods		Guvence, Turkey

Globularia (Globularia) vapincana, and A solitary coral species closely resembling *Balanophyllia irrorata* has also been recovered from the Uzuncarsidere Formation. Plus, we found a different type of species of foraminifrea.

The next Table 1 shows us the 22 samples that have fossil content in the Guvence, Turkey. Most of the samples are taken based on the later facies. Also, most of the sample has the same invertebrate fauna, but have unique and different kinds of vertebrate fauna such as reptiles, mammals, and birds.

The next graph, Figure 4 (bar chart) illustrates us the distribution of reworked invertebrate fossils in the Uzuncarsidere Formation in the Guvence, Turkey. The largest abundance in the samples is the coral, *Balanophyllia irrorata*, the other invertebrates which are gastropods (*Globularia (Globularia) vapincana),* and foraminifera. The reworked fauna a good indicator about the back reef. At the end the percentage of Coral (*Balanophyllia irrorata)* was almost double percentage than the that invertebrate groups.

The next graph Figure 5 shows us the number of distributions of the invertebrate fauna among the Uzuncarsidere Formation in Orhaniye, Turkey. The results as the same as the previous discussions in the Guvence, Turkey.

The next Table 3 shows us the 3 samples that have fossil content in the Hamam Dere, Turkey.

The next graph Figure 6 shows the distribution of the Uzuncarsidere Formation in Hamam Dere, Turkey. This graph has the same previous results with lowest amount and less distribution of gastropods, and foraminifera species.

The next graph Figure 7 shows us this formation has a large number and wide distribution of vertebrate fauna, this fauna younger

Figure 4: Distribution of Reworked Invertebrates (Paleocene) in the Uzuncarsidere Formation, Guvence, Orhaniye-Guvence Basin, Turkey

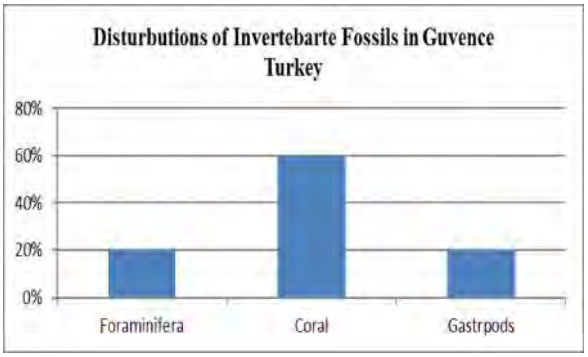


Figure 5: Distribution of Reworked Invertebrates (Paleocene) in the Uzuncarsidere Formation, Orhaniye-Guvence Basin, Turkey

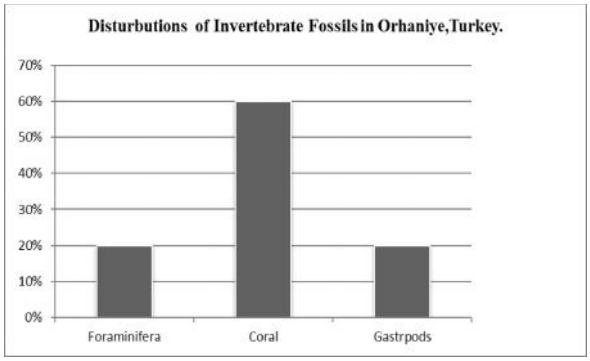


Figure 6: Distribution of Reworked Invertebrates (Paleocene) in the the Uzuncarsidere Formation, Hamam Dere, Orhaniye-Guvence Basin, Turkey

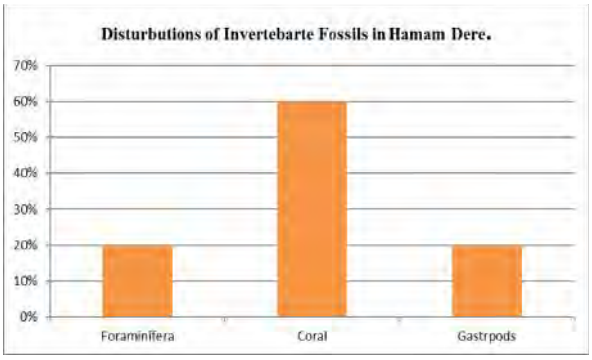


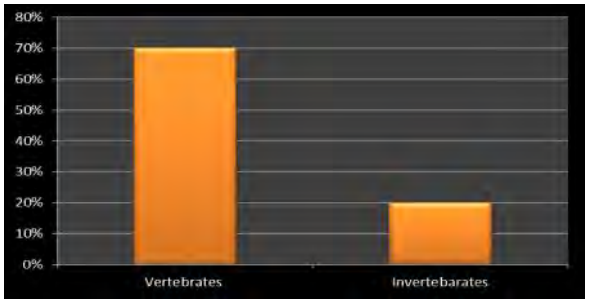
Table 2: Shown the Fossils Content in the Orhaniye, Turkey

Sample	Site	Lithology	Invertebrates	Vertebrates	Location
1	AK-17	Green, grey,red Clays	Forams, Corals	Bone fragments, Coprolites	Orhaniye, Turkey
2	AK-20 Bone Sample 14	Sandstone, in different colors	Forams, Corals, Gastropods	Bone fragments	Orhaniye, Turkey
3	AK 32 Sample 6	Yellow to white mudstone	Forams, Corals, Gastropods	Bone fragments, Teeth of mammals, Frog bones	Orhaniye, Turkey
4	AK-20 Bone Sample 4	Sandstone, red, green, and gray clays		Fish tooth	Orhaniye, Turkey
5	AK-20 Sample 8	Sandstone, brown, red, green, and gray clays	Forams, Corals	Lizard, mammals and bird fragments	Orhaniye, Turkey
6	AK-32 1-B	Red, green, and gray clays	Forams, Corals, Gastropods		Orhaniye, Turkey
7	AK-32	Red, green, and gray clays, Sandstone			Orhaniye, Turkey
8	AK-32 Sample 10	Red, green, and gray clays, Sandstone	Forams, Gastropods	Bone fragments	Orhaniye, Turkey
9	AK-32 3	Red, green, and gray clays, Sandstone	Forams		Orhaniye, Turkey
10	AK-20 Tooth AK-W	Red, green, and gray clays, Sandstone	Forams, Corals	Bone fragments	Orhaniye, Turkey
11	AK-32 Sample 4	Red sandstone	Corals, Gastropods		Orhaniye, Turkey

Table 3: Shown the Fossils Content in the Hamam Dere, Turkey

Sample	Site	Lithology	Invertebrates	Vertebrates	Location
1	AK-34 Sample 9	Red sandstone	Forams, Gastropods	Bone fragments Teeth of mammals	Hamam Dere, Turkey
2	AK-34	Red sandstone	Gastropods	Bone fragments	Hamam Dere, Turkey
3	AK-32 Sample 4	Red sandstone	Corals, Gastropods		Hamam Dere, Turkey

Figure 7: Distribution of Reworked Invertebrates and Vertebrate in the Uzuncarsidere Formation, Orhaniye-Guvence Basin, Turkey



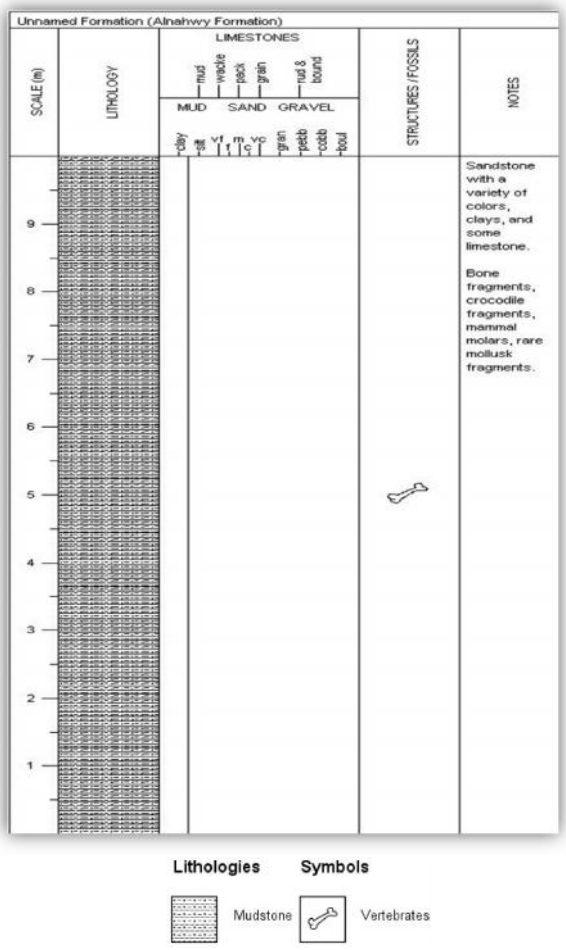
than the invertebrate fauna, which is an excellent indication that the invertebrate fauna are reworked in the Uzuncarsidere Formation.

Tarakli Basin

Unnamed Formation

This is the first report of vertebrates at the Unnamed Formation. The lithology of Unamed Formation is sandstone, red, green, and gray clays. The vertebrate fossil mammal teeth, and varieties of bone fragments as shown Figure 8.

Figure 8: The Clomanr Section of the Study Area



This formation is Early Paleogene and older the UCF Formation at Orhaniye-Guvence Basin. The total thickness of this formation is several than hundred meters as shown in Figure 9.

Another basin has no recorded for invertebrate fauna, but has promising about bone fossil fragments. The next ten samples (Table 4) show the types of lithology and fossil content in this section.

The next graph Figure 10 shows us the distribution of fauna in the Unnamed Formation (Al Nahwy Formation) in Tarakli Basin. This formation has fauna older than the Uzuncarsidere Formation. In addition, this formation is unlike the Uzuncarsidere Formation in the type of sediments and type of fossils. This is the first documentation of this formation.

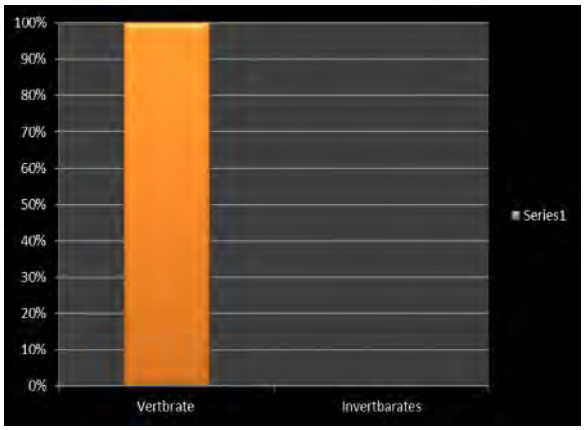
Figure 9: Shown the Outcrop of the Unnamed Formation

Note: Al Nahwy Formation in Tarakli Basin (top), and bottom photo shows the fluvial sandstone and conglomerate (bottom). Photo credited by Metais.

Table 4: Shown the Fossils Content in the Tarakli Basin, Turkey

Sample	Site	Lithology	Invertebrates	Vertebrates	Location
1	TK	Mudsanstone			Tarakli Basin, Turkey
2	TK Fine	Sandstone, red, green, and gray clays		Bone fragments	Tarakli Basin, Turkey
3	Tk 8-2015	Clastic Sandstone			Tarakli Basin, Turkey
4	TK Fine	Variety color of sandstone		Bone fragments	Tarakli Basin, Turkey
5	TKFine	Variety color of sandstone			Tarakli Basin, Turkey
6	TK Tarakli wash	Variety color of sandstone			Tarakli Basin, Turkey
7	TK-15-1	Gray sandstone		Bone fragments	Tarakli Basin Turkey,
8	TK-15-3	Gray sandstone		Crocodile tooth, Bone Fragments	Tarakli Basin, Turkey
9	TK-15-4	Gray sandstone		Bone Fragments	Tarakli Basin, Turkey
10	TK-15-5	Gray sandstone		Complete Upper Molar of Mammals, Crocodile tooth	Tarakli Basin, Turkey

Figure 10: Shown the Distribution of Reworked Invertebrates and Vertebrate from the Unnamed Formation (Al Nahwy Formation) in Tarakli Basin



Systematic Paleontology

Anthozoa - Scleractinia – Dendrophylliidae- Balanophyllia irrorata

Synonyms: *Balanophyllia (Eupsammia)* Milne-Edwards and Haime (1848) *Ceratopsammia* Alloiteau (1958), *Eupsammia* Milne-Edwards and Haime (1848), Kosnik (2002) acording to Wagner (2006).

Remark It has a wide distribution from Early Paleocene to Quaternary. Paleocene Paleogegraphy of this solarty stone coral was in AlgeriA, Cote D'Ivoire, France, Greenland, Austria, Poland, Ukraine, United States.

Paleoenviroment, off shore (shallow marine environment)

Systematic Paleontology

Gastropoda - Architaenioglossa - Ampullinidae

Alternative spelling: Ampullina (*Globularia*)

Globularia vapincana d'Orbigny 1850

Parent Taxon: Ampullinidae according to

Figure 11: Shows the Balanophyllia Irrorata from a Different View, with the Bottom is Showing the Internal Structure and the Septa Arrangement on it (Scale in mm)

Vredenburg (1928), Gardner (1947), Woodring (1959), Abbass (1967), Iqbal (1973), Ladd (1977), Kase (1984), Pacaud and Le Renard (1995), Lozouet *et al.* (2001), Sepkoski (2002), Harzhauser (2004), Rosenberg *et al.* (2006), Harzhauser (2007), Okan and Hosgor (2008), Harzhauser *et al.* (2009) and according to Reuter (2009).

Remark: It has a wide distribution from Paleocene to Eocene. Paleography Localities; Turkey, Belgium, Bulgaria, Egypt, France, India, Indonesia, Pakistan, Panama, Saudi Arabia, Spain, United Kingdom, United States .

Paleoenvrioment: Marine shallow marine to lagoonal environment

Figure 12: Shows us the Globularia Vapincana, with the Scale in mm

CONCLUSION

In this study area, All the invertebrate fauna came from one basin, which is (Orhaniye-Guvence Basin). The coral fragment samples are more abundant than gastropod samples at Uzuncarsidere Formation Formation (UC) but neither are found in the unnamed Formation (Al Nahwy) as shown in the previous tables, this is a good indicator for the back reef reworked facies. Also, all the clastics sediments are good evidence for the coastal environment. In addition, The *Globularia vapincana* is evidence of the presence of brackish water. These features along with the presence of the invertebrate fauna *Balanophyllia irrorata* and *Globularia vapincana*. Indicate a development coastal facies in a warm, and shallow sea environment.

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