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PRESENCE OF *CRASSOSTREA GRYPHOIDES* (SCHLOTHEIM) FROM THE LOWER-MIDDLE MIOCENE SEQUENCE OF KAHRAMANMARAŞ BASIN (SE TURKEY); ITS TAXONOMY, PALEOECOLOGY AND PALEOGEOGRAPHY

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ABSTRACT.- The Miocene rocks of the Salyan formation between the Salyan and Ahmetcik village in southeastern Turkey and northeastern Kahramanmaraş, contain Miocene bivalves and gastropods typical of the Tethys provence. The abundant and generally well-preserved bivalves are dominated by *Crassostrea gryphoides* (Schlotheim). The taxonomy, paleoecology and palaeogeography of the Neogene ostreid bivalve *Crassostrea gryphoides* (*Schlotheim*), and its paleogeographic effect the larval development from the Late Burdigalian-Early Langhian Salyan formation of the northwestern Kahramanmaraş Basin (southeastern Turkey) are discussed.

Key words: Bivalvia, *Crassostrea*, Early-Middle Miocene, paleogeography, taxonomy, Turkey.

INTRODUCTION

The Miocene rocks exposed in the north of the Kahramanmaraş Basin, southeastern Turkey, (Figure 1) contain a rich macro fauna, dominated by mollusc. With their large size and distinct shape, the bivalve genus *Crassostrea* form a conspicous element of this fauna, and is particularly well represented in Miocene succession. So far, presence of oysterids from the Kahramanmaraş Basin were briefly mentioned (Yılmaz et al., 1992; Baydar and Yergök, 1996). The aim of this study is to describe *Crassostrea gryphoides* (Schlotheim) from the Northwestern Kahramanmaraş Basin and to discuss its paleoecologic and paleogeographic significance.

During the Late Cretaceous-Tertiary period a number of sedimentary basins formed within the Tauride-Anatolide Platform. The most complete Miocene succession is exposed in the Kahramanmaraş Basin in the east Taurus Belt. The Miocene of the northern Kahramanmaraş Basin refers to the Salyan Formation (SW Çardak) and its unconformably overlays the Eocene units (sandstone and limestone) (Ericek Formation), Göksun ophiolithe (diabase, granite, volcanics and sedimentary units) and Malatya metamorp-

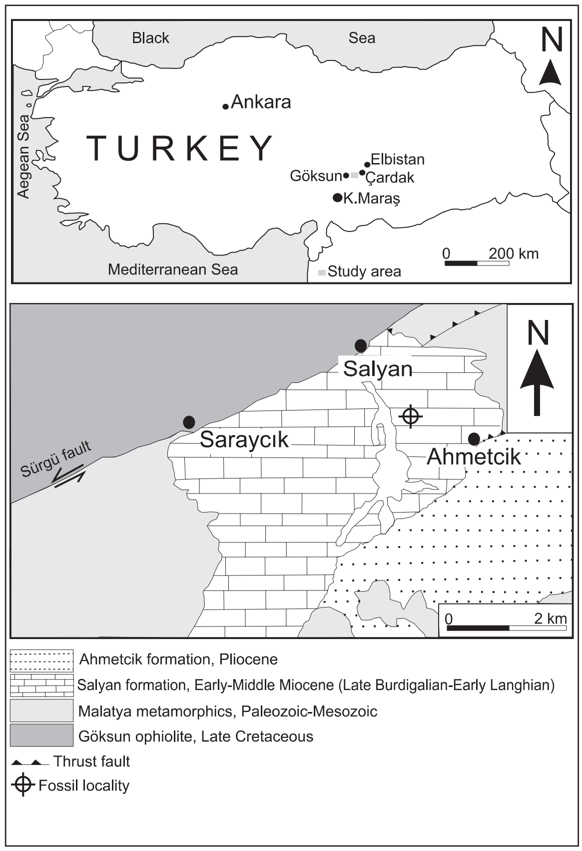

Figure 1- Geological map of the study area (Yılmaz et al., 1997).

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hics (marble and micaschist) (Figure 2). The Ahmetcik Formation (Pliocene) (conglomerate, marl, sandstone) is unconformably over the unit. The Salyan formation is characterized by thin marine and coastal plain carbonates with terrestrial conglomerates. The typical location of the unit in the area was around Salyan, Saraycık and Ahmetcik Valleys.

The formation, which was named for the first time in Tarhan (1982)'s study, starts with conglomerate at the base in the exposures between Salyan and Ahmetcik Valleys and continues with a sandstone, marl, shale and limestone (Figure 3). The limestones exposing around Salyan Valley, are sandy, bioclastic and characterized with

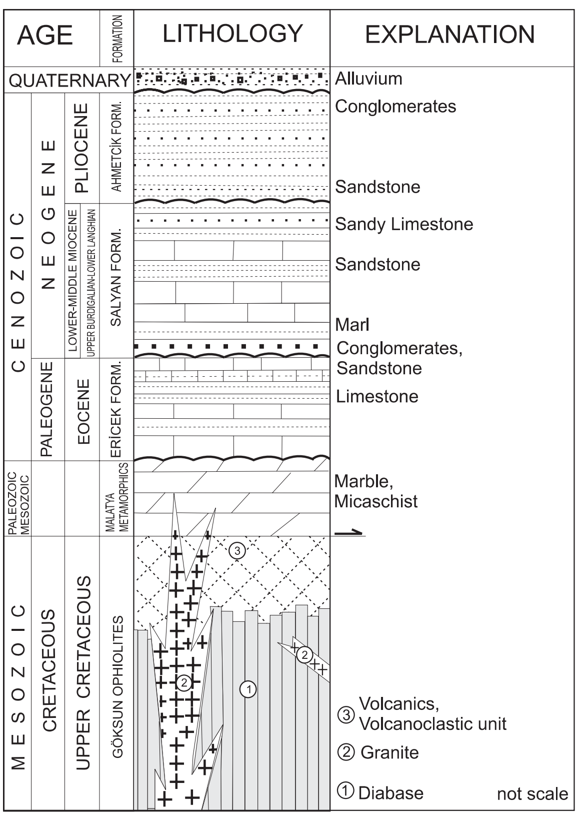


Figure 2- Stratigraphic column showing the relations of the Göksun ophiolite, Malatya metamorphites and sedimentary units (Yılmaz et al., 1997).

abundant macro (Figure 3) and micro fossils. It contains Early-Middle Miocene fauna. The crassosterids fossils are found associated with *Globigerinoides trilobus* (Reuss), *Praeorbulina transitoria* (Blow), *Praeorbulina sicana* (de Stafani), *Globorotalia obesa* (Bolli), *Globigerina* sp., *Miogypsina* sp., *Amphistegina* sp. (Yılmaz et al., 1992). According to Berggren et al. (1995), *Praeorbulina sicana* indicate M5a zone. According to this microfauna association, the Salyan Formation is Late Burdigalian-Early Langhian in age.

The geological evolution and the development of the marine Miocene of the Kahramanmaraş Basin were discussed by several authors (Gözübol and Gürpınar, 1980; Perinçek and Kozlu, 1983; Tarhan, 1984; Baydar, 1989; Yiğitbaş, 1989; Baydar and Yergök, 1996; Yılmaz et al., 1997).

MATERIAL

This study is based on an oyster material collected from the Early-Middle Miocene Salyan Formation, 28 m thick, exposed at Göksun area, northwestern Kahramanmaraş Basin (Figure 3). This section lies in L 34-d_4 quadrangle, and to the southeast of Ahmetcik village; in the coordinates of X_1: 11 008, Y_1:94 450 and X_2: 10 988, Y_2: 94 300. Oysters occur in great amount in greenish marls and sandy limestones. The material consists of poorly to moderately well-preserved internal moulds. *Crassostrea gryphoides* (Schlotheim) forms distinct shell beds, in the lower part of the Salyan Formation, just above a 0-3 m thick sandy-limestone. The associated macrofauna consists of bivalves (Figure 3). The abundant and generally well-preserved bivalves are dominated by *Crassostrea gryphoides* (Schlotheim) (68%). This lithologic units contains abundant veneroid (*Tellina* (P.) *sacyii* (Cossman and Peyrot), *Pitar* (P.) *rudis* (Poli), *Mactra corallina* (Linne)) and arcoid bivalves (*Anadara* (A.) *diluvii* (Lamarck)) that have both valves intact and the commissural plane oriented normal to the bedding plane, oysters are attached to other

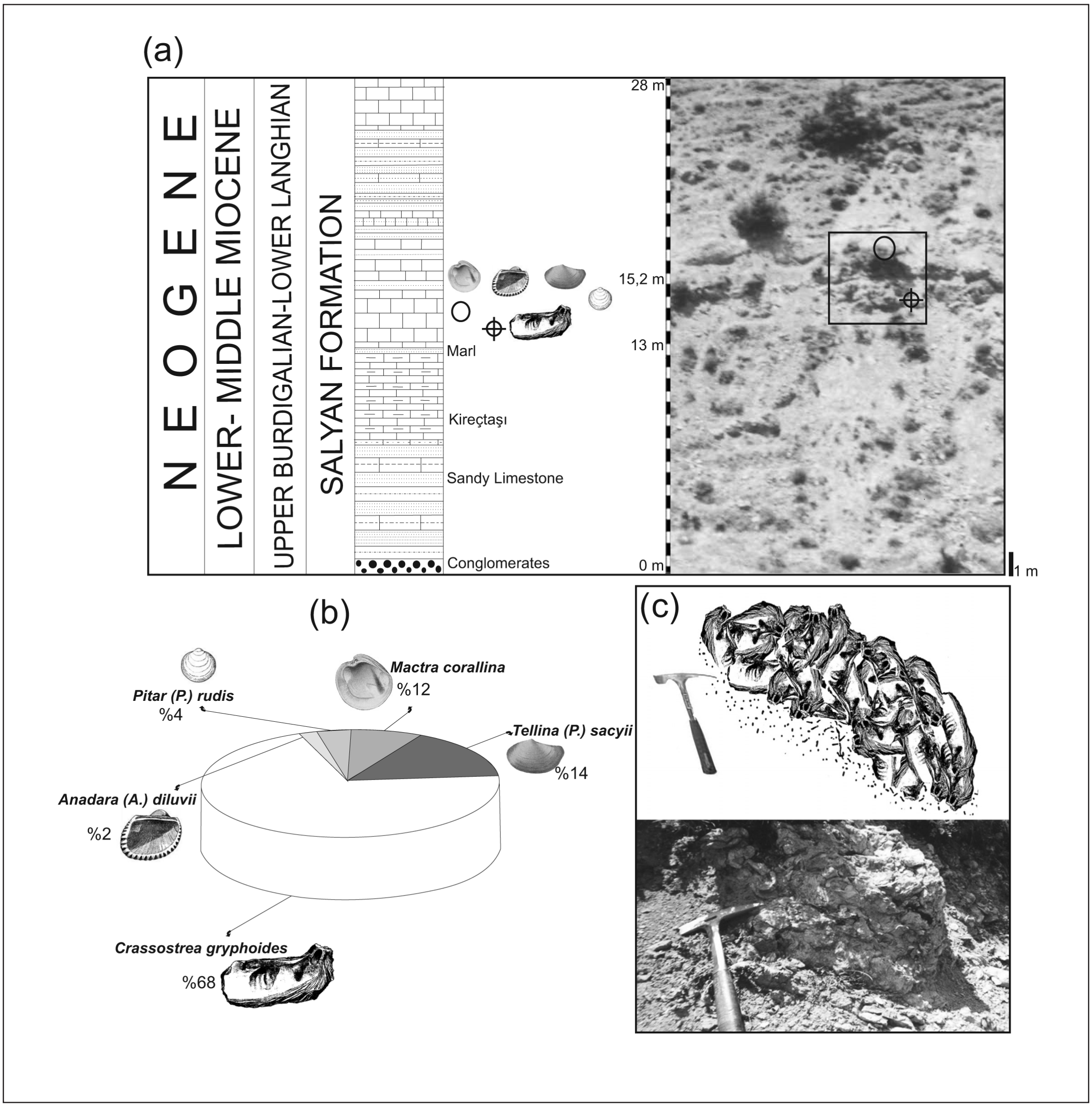


Figure 3- (a) Stratigraphic section from the Salyan Formation, (b) bivalves assemblage composition from the Salyan formation, (c) large and massive valves of *Crassostrea gryphoides* (Schlotheim).

oysters and consitıtute radially arranged, bouguet-like aggregates (Figure 3).

The specimens are housed in the collections of the Paleontology Laboratory of the University of Ankara, Turkey.

SYSTEMATIC PALEONTOLOGY

The descriptive terminology for the external and internal characters of the oyster shell follows that of Laurain (1980) and Bieler and Mikkelsen (2006).

Class : Bivalvia Linne, 1758
Subclass : Pteriomorphia Beurlen, 1944
Order : Pterioida Newell, 1965
Suborder : Ostreina Ferussac, 1822
Superfamily : Ostroidea Rafinesque, 1815
Family : Crassostreidae Scarlato and Starobogatov, 1979
Genus : *Crassostrea* Sacco, 1897

Type species: *Ostrea virginica* Gmelin, 1792

Diagnosis.- Shells are composed of two asymmetrical valves, joined at their hinges by ligament. Right valve flat in shape having relatively small hinge. Left valve larger in size, concave in shape, and has a large hinge. Outline high, slender-spatulate. Chambers common, with well-developed umbonal cavity in left valve. No chomata. Adductor muscle imprint close to postero-ventral margin. Outline crescentic or reniform, with fairly sharp corners in dorsal margin (Aqrabawi, 1993) (Figure 4).

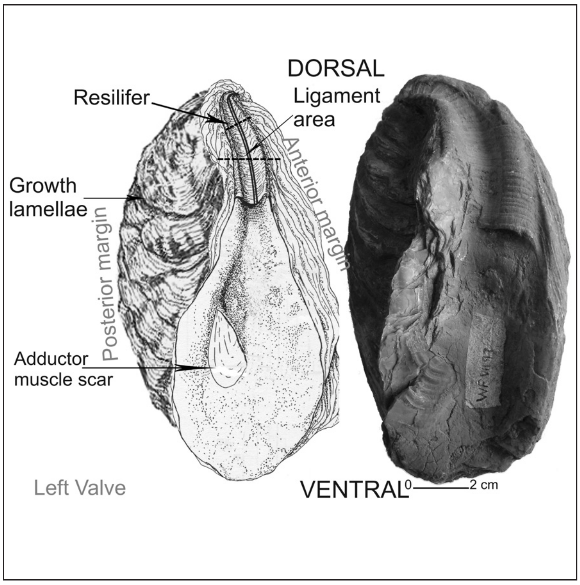


Figure 4- Internal and external morphological features of Crassostrea gryphoides (Schlotheim) (Laurain, 1980).

Crassostrea gryphoides (Schlotheim, 1813)
Plate 1, Figures 1-5.

1813 *Ostracides gryphoides* Schlotheim, p. 72.

1819 *Ostrea crassisima* Lamarck, p. 217.

1870 *Ostrea gingensis* Schlotheim, Hoernes, t. 2, p. 452, pl. 77, figs. 1-2; pl. 78. fig. 1; pl. 79. figs. 1-2; pl. 80. fig. 1.

1870 *Ostrea crassissima* Lamarck, Hoernes, p. 455, pl. 81, figs. 1-2; pl. 82. figs. 1-2; pl. 83. figs. 1-3.

1890 *Ostrea crassissima* Sowerby, Blanckenhorn, p. 21.

1897 *Ostrea* (*Crassostrea*) *crassissima* Lamarck, Sacco, pp. 15-16, pl. 4, figs. 1-3.

1904 *Ostrea gryphoides* Schlotheim var. *gingensis* Schlotheim, Dollfuss and Dautzenberg, p. 465, pl. 49, figs. 1-5.

1904 *Ostrea gryphoides* Schlotheim var. *crassissima* Lamarck, Dollfuss and Dautzenberg, p. 465, pl. 50, figs. 1-5.

1910 *Ostrea gingensis* Schlotheim, Schaffer, pp. 15-16, pl. 4, figs. 1-2; pl. 5, figs. 1-3.

1910 *Ostrea* (*Crassostrea*) *crassissima* Lamarck, Schaffer, pp. 19-20, pl. 8, figs. 1-2; pl. 9, figs. 1-2.

1914 *Gryphaea* (*Crassostrea*) *gingensis* (Schlotheim), Cossmann and Peyrot, pp. 391-393, pl. 21, figs. 16-18.

1933 *Gryphaea* (*Crassostrea*) *crassissima* (Lamarck), Pauca, p. 204, pl. 7, fig. 1-4.

1939 *Ostrea* (*Gryphea*) *gingensis* Schlotheim, Stchepinsky, p. 23, pl. 7, figs. 4-5; pl. 8, figs. 2-4; pl. 9, fig. 1.

1946 *Ostrea* (*Gryphea*) *gingensis* Schlotheim, Stchepinsky, p. 66, pl. 33, fig. 14.

1946 *Ostrea crassissima* Lamarck, Stchepinsky, p. 67, pl. 35, fig. 1.

1952 *Gryphaea gryphoides* Schlotheim, Lecointre, p. 30, pl. 13, figs. 1-5.

1954 *Ostrea gryphoides* Schlotheim, Korobkov, pp. 197-198, pl. 83, figs. 2-3.

1955 *Ostrea gryphoides* Schlotheim, Merklin and Nevesskaja, pp. 106-107, pl. 32, figs. 1-2.

1958 *Ostrea gryphoides* (Schlotheim), Azzaroli, p. 108, pl. 28, fig. 8.

1958 *Ostrea gryphoides* Schlotheim, Erünal-Erentöz, pp. 168-169, pl. 30, fig. 3; pl. 31, fig. 3.

1963 *Ostrea* (*Crassostrea*) *gingensis* (Schlotheim), Venzo and Pelosio, p. 165, pl. 53, figs.1-2.

1963 *Ostrea* (*Crassostrea*) *crassissima* (Lamarck), Venzo and Pelosio, p. 168, pl. 52, fig. 3; pl. 54, fig. 16.

1968 *Gryphaea* (*Crassostrea*) *gryphoides crassissima* (Lamarck), Iliescu et al., pp. 93-94, pl. 11, fig. 1

1968 *Gryphaea* (*Crassostrea*) *gingensis* (Schlotheim), Iliescu et al., p. 94, pl. 12, figs. 1-2; pl. 13, fig. 1.

1969 *Gryphaea* (*Crassostrea*) *gryphoides crassissima* (Lamarck), Dermitzakis, p. 380, pl. 69, figs. 1-2.

1971 *Crassostrea gryphoides* (Schlotheim), Freneix et al., p. 23, 27, pl. 6, figs. 1-4; pl. 7, figs. 1-3; pl. 8, figs. 1-5.

1974 *Crassostrea gryphoides* (Schlotheim), Freneix et al., p. 78, pl. 5, fig. 4.

1975 *Gryphaea* aff. *aginensis* Tournouer, Baldi and Steininger, pp. 341-342, pl.14, fig. 7.

1980 *Crassostrea gryphoides* (Schlotheim), Laurain, pp. 24-25, pl. 1, figs. 1-3.

1984 *Crassostrea gryphoides* (Schlotheim), Laurain, pp. 76-77, pl. 4, fig. 4.

1985 *Crassostrea* (*Crassostrea*) *gingensis* (Schlotheim), Moisescu, p. 30, pl. 2, fig. 1.

1985 *Crassostrea gryphoides* (Schlotheim), Tanar, p. 22, pl.1, figs. 1-3.

1993 *Crassostrea gryphoides* (Schlotheim), Nevesskaja, p. 62, pl. 9, figs.1-2; pl. 10, figs. 1-4.

1998 *Crassostrea gryphoides* (Schlotheim), Pfister and Wegmüller, p. 458, pl. 1, figs. 1-5; pl. 2, figs. 1-4.

2002 *Crassostrea gryphoides* (Schlotheim), Videt and Neraudeau, p. 153, pl. 1, fig. 3.

2003 *Crassostrea gryphoides* (Schlotheim), İslamoğlu and Taner, pp. 9, 10, pl. 3, fig. 1.

2005 *Crassostrea gryphoides* (Schlotheim), El-Hedeny, p. 720, pl. 1, figs. 1-7; pl. 2, figs. 3-5; pl. 4, figs. 7-9.

Figured Specimens.- Left valve, KMS. 04. SD01; Left valve, KMS. 04. SD04; Right valve, KMS. 04. SD05; Left valve, KMS. 04. SD11; Right valve, KMS. 04. SD12.

Description.- In general, *Crassostrea gryphoides* (Schlotheim), outline high, slender-spatulate. Chambers common with-developed umbonal cavity in the left valve. No chomata. Adductor muscle imprint close to postero-ventral margin, outline crescentic or reniform with fairly sharp corners in the dorsal margin. Shell, inequivalve, elongate, height much greater than length. Outline variable, usually straight or slightly curved. Shell becomes gradually broader toward the ventral margin; surface not smooth, strong fold ribs and growth lamellae. Growth and lenghty cylindiric ligament area in right valves. Nearly wide-length resilifer. Adductor muscle scar reniform or crescentic in some individuals. Left valve convex or moderately inflated; right valve slightly convex or flat. Chomata absent along the entire margin of both valves.

Horizons and Localities.- NE Göksun, Salyan Valley, limestone units in the centre of Salyan Fm.

*Dimensions.- (*Figure 5).

Discussion: Most of the Tethys or Paratethys, Miocene-Pliocene crassostrids have been assigned to *Ostrea crassissima* Lamarck, *Ostrea* (G.) *gingensis* Schlotheim, *Gryphea* (C.) *gingensis* (Schlotheim). In fact, these specimens are accepted as *Crassostrea gryphoides* (Schlotheim). According to literature (Cossman and Peyrot,1914; Erünal-Erentöz, 1958; Freneix et al., 1971; Laurain, 1980; Videt and Neraudeau, 2002; İslamoğlu and Taner, 2003) supporting its names.

Crassostrea virleti (Deshayes) is a very similiar species described from the Pliocene of the Madagascar (Freneix et al., 1971; p. 27-30, pl, I, fig. 1-4; pl. J, fig. 1-5). It is differented from

Specimen	Valve	H	L	L/H	lh	ll	lr	dlm	dlp
KMS.04.SD01	left	160	40	0,25	60	22	15	22	65
KMS.04.SD02	left	150	55	0,36	63	40	20	40	90
KMS.04.SD03	left	135	56	0,41	36	27	20	50	100
KMS.04.SD04	right	105	68	0,65	30	35	20	30	60
KMS.04.SD05	right	110	42	0,4	44	25	15	-	63
KMS.04.SD06	left	120	57	0,47	25	28	21	42	100
KMS.04.SD07	left	180	40	0,22	125	22	18	22	35
KMS.04.SD08	left	175	90	0,51	80	40	20	65	100
KMS.04.SD09	left	160	95	0,59	60	40	23	40	110
KMS.04.SD10	left	140	60	0,42	40	36	25	50	95
KMS.04.SD11	left	125	65	0,52	45	35	25	60	90
KMS.04.SD12	right	100	40	0,4	40	16	11	-	60

(mm)

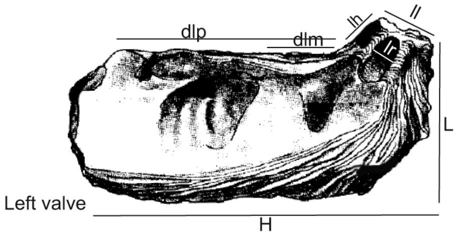


Figure 5- Measurements (H-height, L-length, lh-ligament high, ll-ligament length, lr-resilifer length, dlm-dimensions of between liga ment area and adductor muscle scar, dlp-dimensions of between ligament area and commissure shelf (likely pallial line)).

Crassostrea gryphoides by having fewer concentric growth lamellae and by the lack of a straight umbonal margin.

Crassostrea margaritacea (Lamarck) from the Miocene to Pliocene of the Africa coastal plain in Mediterranean (see Ranson, 1951; p. 8-9, text-fig. 6) is distinguished by its slender fold ribs, more convex anterior margin and rounded commissure shelf.

Crassostrea bersonensis (Matheron) shows similarities to forms regarded by Freneix et al., (1971), from the Aquitanian of Europe and Burdigalian of the Africa coasts. It is differented from *Crassostrea gryphoides* by having a slender and narrow ligament area and bigger valves.

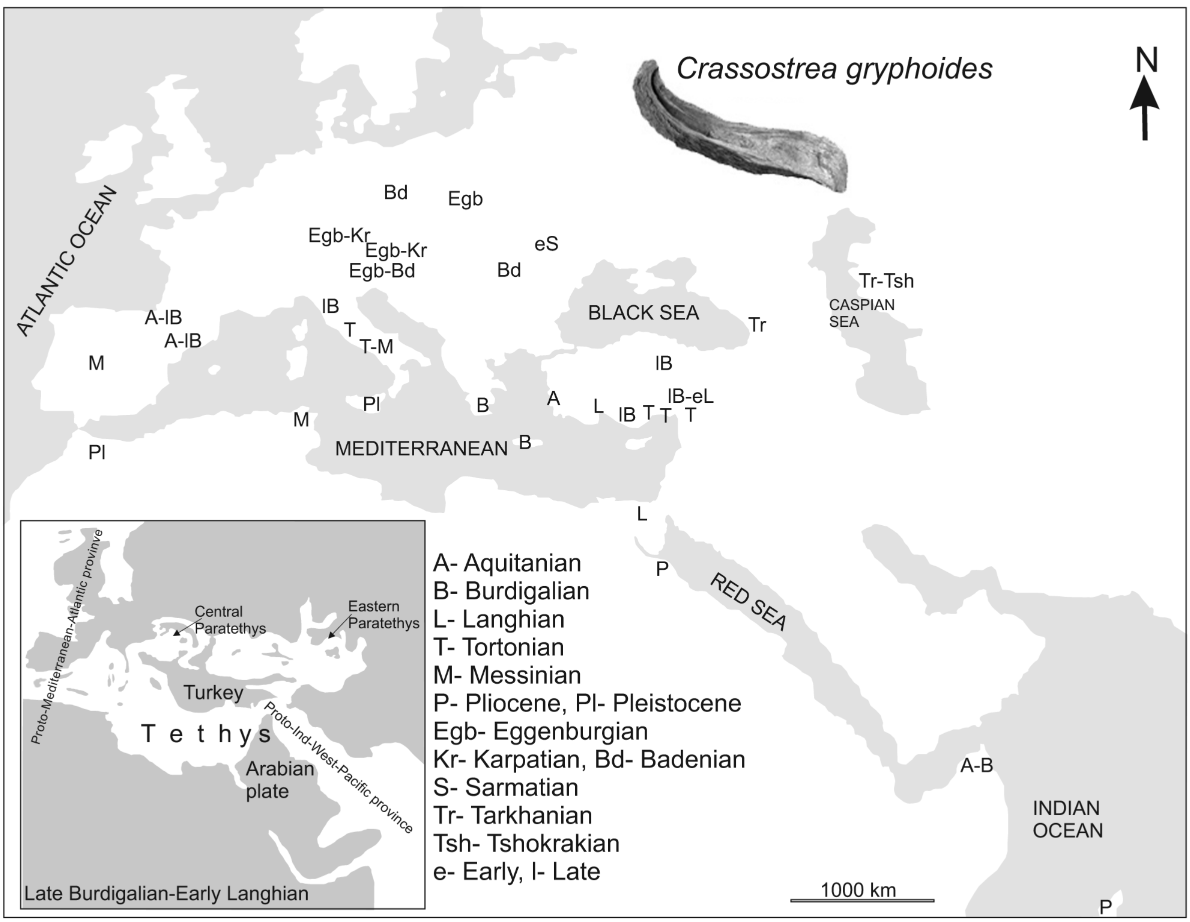
PALEOECOLOGY

Like their modern representatives, Miocene oysters lived nearshore in shallow, low-energy marine environment introduced with the onset of the Miocene transgression in southeast Anatolia. Oysters cement themselves onto the substrate by their left valves. Most cementing bivalves are found in shallow-water environments at depths less than 35 m. Modern oysters are typically found in estuaries, sounds, bays and tidal creeks from brackish water (5 ppt salinity) to normal marine water (35 ppt salinity) (İslamoğlu and Atabey, 1999; El-Hedeny, 2005). They are very tolerant organisms and able to withstand wide variations in temperature, salinity, suspented sediments, and dissolved oxygen. Throughout its range, the oyster occurs only in subtidal areas. Intertidal recent oysters typically have elongated and irregularly shaped shells (Hoffmann et al., 1978; El-Hedeny, 2005). When submerged by the tide, oysters feed by filtering phytoplankton from the water column. The morphology of oyster shell is strongly influenced by ecological factors particularly the nature of the substrate, degree of crowding and water turbulence. In addition, morphological features of oysters may change during their ontogenic evolution (Stenzel, 1971).

The Miocene oyster shells of the studied area are characterized by large and massive valves when compared with their recent represantatives. Bivalves living in warm and high energy environments tend to have thicker shells and more prominent growth lines in comparision to those living in cold and quiet water environments. However, oysters in fluctuating salinity grow faster than those under constant conditions (El-Hedeny, 2005). On the other hand, oysters show same growing rate both in tidal zone and continuously submerged region. Long exposure, however, reduces growth; those animals exposed 20% of the time grow twice as fast as those exposed 60% of the time. The Neogene *Crassostrea* oysters had large and thick shells, whereas their descendants, living *Crassostrea,* have comperatively smaller and thinner shells (Kirby, 2000).

PALEOGEOGRAPHIC DISTRIBUTION

Crassostrea gryphoides (Schlotheim) is a stratigraphically and geographically widely distributed species (Figure 6). In Turkey, it occurs in the Late Burdigalian of the Sivas and Karaman, Late Burdigalian-Early Langhian of the northwest Kahramanmaraş Basin (Salyan Formation), from the Aquitanian of the Denizli, from the Langhian of Antalya Basin, from the Tortonian of Kahta-Adıyaman and Tarsus-Mersin area (Kuzgun Formation) (Stchepinsky, 1939-1946; Erünal-Erentöz, 1958; Meriç, 1965; Tanar, 1985; İslamoğlu and Taner, 2003; İslamoğlu et al., 2005 and descriptions herein). In Tethys (Proto-Mediterranean Atlantic Region) provence, it is described from the Aquitanian to Pleistocene of Europe and Mediterranean coast, for example France (Aquitan Basin and Rhon Basin), Italy (Laguria Basin, Sicily Island, Vigoleno Basin, Alba Basin and Tuscany), Portugal (Umbra Basin), Spain (Sorbas Basin), Morocco, Algeria (Lalla Kouba Basin), Greece (Crete Island and Lakonia) (Sacco, 1897; Dolfuss and Dautzenberg, 1904; Cossman and Peyrot, 1914; Lecointre, 1952; Venzo and Pelosio, 1963; Dermitzakis, 1969; Freneix et al., 1974; Laurain, 1984; Videt and Neraudeau, 2002), the Burdigalian-Langhian of the eastern Mediterranean and the Near East, for example Syria and Egypt, morover from the Pliocene of Egypt (Red Sea coastal plain) (Blanckenhorn, 1890; Kora and Abdel-Fattah, 2000; El-Hedeny, 2005). It is well established that *Crassosstrea gryphoides* (Schlotheim) inhabited the western



Şekil 6- Crassostrea gryphoides (Schlotheim)'in paleocoğrafik yayılımı ve Erken-Orta Miyosen (Geç Burdigaliyen-Erken Langiyen) devrinin konumu (Rögl, 1998, 1999).

and central Mediterranean region during Pleistocene, a few areas with numerous and well-studied basins. In contrast, there are rare data about the Miocene to Pleistocene of the eastern Mediterranean and the Atlantic region (Figure 6).

During the Miocene (Eggenburgian to Sarmatian) *Crassostrea gryphoides* (Schlotheim) is found in the Central Paratethys, for example Austria (Vienna Basin), Hungary, Romania (Mera Basin), Poland, Switzerland (Bern Basin), Slovakia (Slaske Basin), Ukraine (Hoernes, 1870; Schaffer, 1910; Iliescu et al., 1968; Baldi and Steininger, 1975; Pfister and Wegmüller, 1998), the Tarchanian to Tschokrakian of Eastern Paratethys, for example, Georgia and Turkmenistan (Merklin and Nevesskaja, 1955; Nevesskaja, 1993).

In Proto-Indo-West-Pacific regions it occurs in the Early Miocene of Somalia and from the Pliocene of Madagascar (Azzaroli, 1958; Freneix et al., 1971).

Approximately 30 species of the Ostreidae, which make up the bulk of living oysters, are many recent oysterids possess teleplanic (long distance) larvae, capable of being transported over long distances (Malatesta and Zarlenga, 1986; Malchus, 1995; Foighil et al., 1998). Such larvae might have been also present in *Crassostrea virginica* and, along with external factors, such as climatic and palaeoceanographic conditions, controlled its wide distribution (Foighil and Taylor, 2000; Harzhauser et al., 2002, 2003). However, the actual and fossil distribution patterns of the aquatic gastropod genera that avian dispersal was an important dispersal mechanism in the geological past (Wesselingh et al., 1999).

The Early Miocene was characterised by warm climate and high sea-levels in the southeastern part of the Taurus Belt. Moreover, the Early Miocene period was characterised by a globally warm water faunas (Rögl, 1998 and 1999). During the Early Miocene the southeastern part of the Taurus belt was influenced by warm climatic conditions and the development of extensive shallow marine shelf areas in general study field, apparently favoured rapid and wide dispersal of taxa (Staesche, 1972; Steininger et al., 1985; Görür et al., 1998).

CONCLUSIONS

The Early-Middle Miocene oysters, *Crassostrea gryphoides* (Schlotheim), of Salyan Formation are characterized by large and massive valves. Paleoecologically, they were living in nearshore shallow, low-energy, lower salinity, warm climatical condition of marine environments. Paleogeographically, *Crassostrea gryphoides* (Schlotheim) is a stratigraphically and geographically widely distributed species. In the Proto-Mediterranean Atlantic area, it occurs in the Aquitanian to Pleistocene of the west and south Europe, west Africa coasts, and east Mediterranean area (Turkey); in the Early-Middle Miocene of the northern inland seas (Central and Eastern Paratethys). Moreover, in Indo-Pacific seas, the species in the Aquitanian to Pleiocene of the Red Seas coasts, Somalia and Madagascar.

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PLATE

PLATE I

Figure 1 - Right valve, internal view, KMS. 04. SD12.

Figure 2 - Left valve, internal view, KMS. 04. SD04.

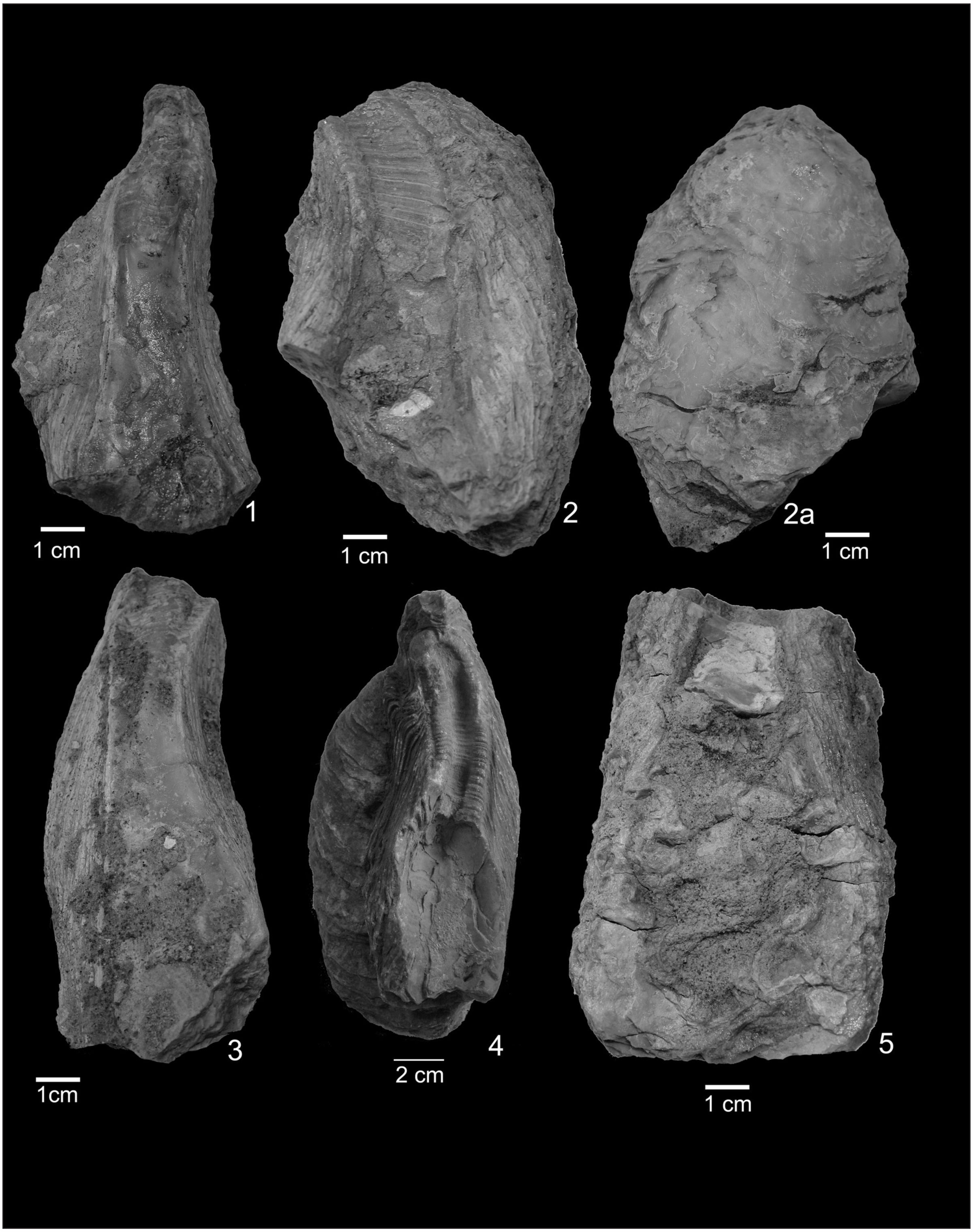
Figure 2a - Left valve, external view.

Figure 3 - Right valve, internal view, KMS. 04. SD05.

Figure 4 - Left valve, internal view, KMS. 04. SD01.

Figure 5 - Left valve, internal view, KMS. 04. SD11.

PLATE - I



BOS SAYFA