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RELATIONSHIPS BETWEEN THE ANATOLIAN AND ARABIAN PLATES DURING THE MAASTRICHTIAN RELATED TO THE RUDIST FAUNA

RUDIST FAUNASINA GÖRE ANADOLU VE ARABİSTAN PLAKALARININ MAESTRIHTİYEN'DEKİ İLİŞKİSİ

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ABSTRACT

The rudists are very common in the Anatolian and Arabian plates and they represent important paleobiogeographic data explaining the relationships between the plates during the Maastrichtian.

The rudists of the Arabian plate are localized between K.Maraş and Diyarbakır. They are locally observed in the surroundings of Gaziantep and Hatay. The rudist fauna of this plate are poor and they are represented by three endemic genera (*Vautrinia*, *Dictyoptychus*, *Hatayia*) and two species (*Hippurites syriaca*, *Pironaea syriaca*) showing a geographic distribution in Syria, Iran and the Oman Peninsula beside Southeastern Anatolia.

The rudists of the Anatolian plate are observed around Malatya, Ankara and to the east of Tuz Lake. The generic and specific diversities are very high and many species belong to the Hippuritidae, Radiolitidae and Caprinidae have been determined. The Anatolian plate is also characterized by the existence of several new genera and species. The rudists of the plate show a wide distribution in the countries of Central Mediterranean sub-province such as Yugoslavia, Bulgaria, Italy, Sicily and Greece.

According to the paleobiogeographic data, the Anatolian and Arabian plates are characterized by different rudist fauna and they were separated by an obstacle in the Maastrichtian. This barrier corresponds with the southern branch of Neo-Tethyan Ocean and it played an active role for the interruption of the faunal changes and individualisation of paleobiogeographic units.

INTRODUCTION

The geographic distributions, ecological characteristics, evolution ranges, taxonomic diversity, abundances and preservations of the rudists form important criteria for the recognition of paleobiogeographic provinces in Tet-

hyan realm. On the basis of these criteria, two entite paleobiogeographic units have been separated such as Caribbean Province and the Mediterranean Province and also the endemic centers have been established in the Upper Cretaceous of the Tethyan realm. The opening of the mid-Atlantic and the climatical factors are accepted as being main reasons for the development of the high evolution rudist fauna and for the distributions of the rudists in these provinces (Coates, 1973; Kauffmann, 1973).

In the Mediterranean Province, the distributions of Upper Senonian rudists have been studied and three sub-provinces have been separated by Philip (1982, 1985). In detail, the relationships of the Upper Cretaceous rudist platforms in the Mediterranean Province have been discussed or demonstrated by many authors some of these are as follows: Philip and Allemann (1972), Camoin et al. (1983), Ferrandini et al. (1985), Negra and Philip (1986), Philip and Platel (1987), Sladic-Trifunovic (1987), Gili et al. (1987), Pamouktchiev and Plenicar (1988) and Pons and Vicens (1988).

The paleobiogeography of the rudists are not sufficiently examined in Turkey; however, the distribution of the Maastrichtian rudists in Central Anatolian basins and their resemblances with those of the Apulian platform have been demonstrated by Üzer (1983, 1985), and the rudists of Southeastern Anatolia have been described as "Arabian Platform Rudist Fauna" according to their distributions in the Mediterranean Province (Üzer, 1992 a).

The purpose of this paper is to reveal the relationships between the Anatolian and Arabian plates in the Maastrichtian time related to the rudist fauna and their distributions. In the paleobiogeographic approaches, the rudists of Southeastern Anatolia are used for the Arabian Plate and those of Central and Eastern Anatolia for the Anatolian Plate. The studies of Üzer (1983, 1985, 1986, 1988 a, b and c, 1991, 1992 a and b) are taken as the basis references for the faunal correlations. On the geographic distributions from the rudist cata-

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log of Sanchez (1981) and for the Maastrichtian paleogeographic map from Dercourt et al. (1985), are benefited.

FAUNA AND DISTRIBUTION

The rudists of the Anatolian and Arabian plates are listed in the Table I and their geographic distributions are presented in Fig. 4. The rudists of the Arabian plate are observed in Southeastern Anatolia, and those of the Anatolian plate in Central and Eastern Anatolia. Their faunal content and geographic distributions are as follows:

Southeastern Anatolia

The rudists of this region are located between K.Maraş and Diyarbakır area (Fig. 1). The principal rudist localities are observed in the surroundings of K.Maraş (Yellibelen Hill, Çamoloğu Ridge, east of Elmalı village, Payamlı river), in the Adıyaman area (Gölbaşı, Terbüzek, Besni, Eskikahta, Alıdamı) and to the north of Diyarbakır (Besin village, Çermik). To the south of this area, near Nasırlı

(Gaziantep) and Yayladağı (Hatay), the rudists are also observed (Üzer, 1988 c; 1992 a).

The rudists of Southeastern Anatolia occur in the units of the Maastrichtian transgressive sequence (Sungurlu, 1974; Yalçın, 1976; Perinçek, 1979; Üzer, 1986, 1988 c, 1991; Meriç, 1987).

The rudist fauna are poor and consist of Maastrichtian forms. Thirteen genera and 14 species can be determined (Table I; Fig. 2).

Four species belong to only the genus *Dictyoptychus* Douvillé. The species *Vautrinia syriaca* (Vautrin) and the genus *Dictyoptychus* Douvillé are abundant in all of the localities. The species *Hippurites syriaca* Vautrin and *Pironaea syriaca* Vautrin are generally associated to these forms.

The genus *Vautrinia* Milovanovic, *Dictyoptychus* Douvillé, *Hatayia* Karacabey-Öztemür and the species *Hippurites syriaca* Vautrin and *Pironaea syriaca* Vautrin have geographic distributions indicating endemism. The species *Vautrinia syriaca* (Vautrin) and the genus *Dictyoptychus* Douvillé are described from the Maastrichtian formations of Syria and Iran and the

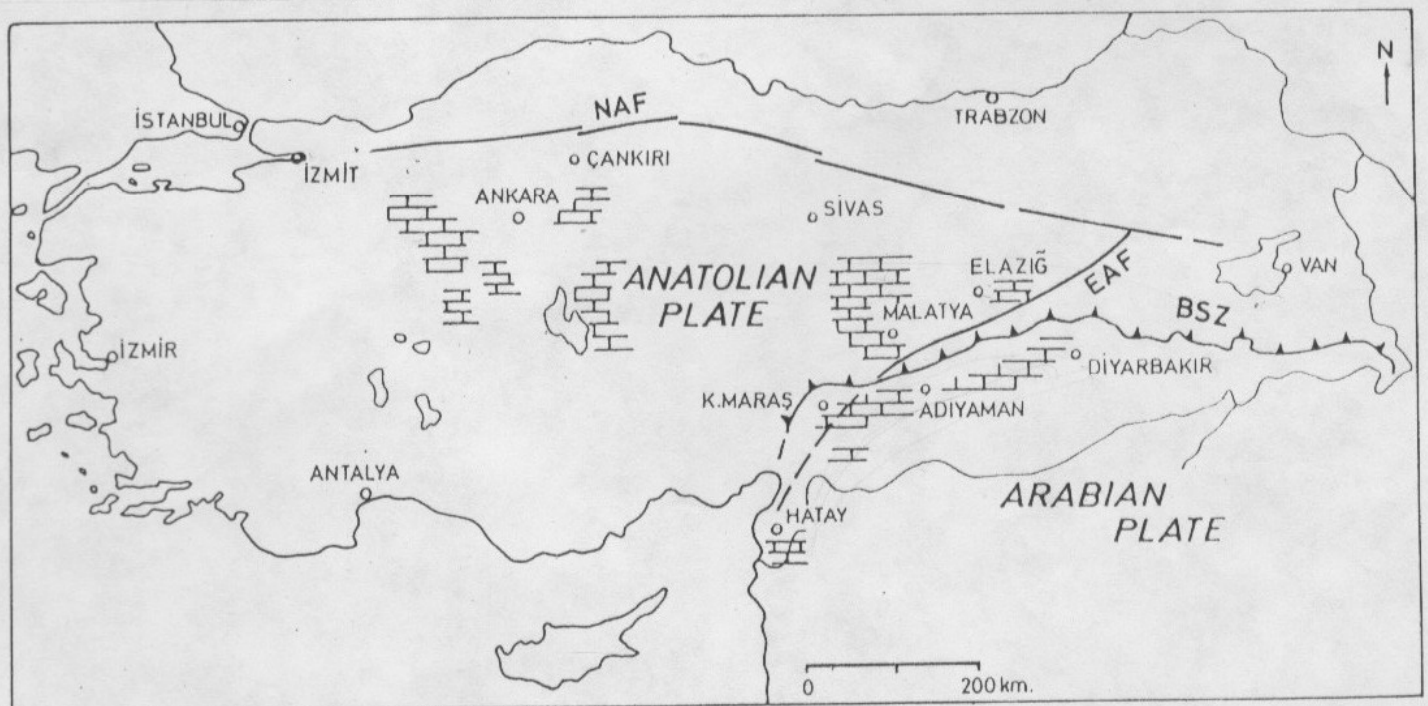


Fig. 1- Simplified structural sketch map of Turkey showing the distributions of the Maastrichtian rudistid outcrops (hachure) in the Anatolian and Arabian plates. NAF- North Anatolian Fault, EAF- East Anatolian Fault, BSZ- Bitlis Suture Zone.

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ANATOLIAN PLATE

Central-Eastern Anatolia

<i>Hippurites cornucopiae</i>	<i>Balabania acuticostata</i>	<i>Sphaerulites solutus</i>
<i>Hippurites colliciatu</i> s	<i>Balabania elongata</i>	<i>Biradiolites bulgaricus</i>
<i>Hippurites heritschi</i>	<i>Balabania densicostata</i>	<i>Bournonia anatolica</i>
<i>Hippurites lapeirousei</i>	<i>Balabania melitenensis</i>	<i>Pseudopolyconites ovalis</i>
<i>Hippuritella variabilis</i>	<i>Kurtinia hemispherica</i>	<i>Lapeirousia jouanneti</i>
<i>Vaccinites loftusi</i>	<i>Darendeella anatolica</i>	<i>Lapeirousia plana</i>
<i>Vaccinites ultimus</i>	<i>Miseia regularis</i>	<i>Sabinia rtanjica</i>
<i>Vaccinites orientalis</i>	<i>Miseia hekimhanensis</i>	<i>Mitrocaprina bulgarica</i>
<i>Vaccinites braciensis</i>	<i>Miseia osculata</i>	<i>Branislavia bacevicensis</i>
<i>Vaccinites vesiculosus</i>	<i>Miseia meriçi</i>	<i>Branislavia orientalis</i>
<i>Pironaea corrugata</i>	<i>Miseia bilacunosa</i>	<i>Radiolites angeoides</i>
<i>Pironaea timacensis</i>	<i>Colveraia variabilis</i>	<i>Radiolites squamosus</i>
<i>Pironaea praeslavonica</i>	<i>Colveraia darendeensis</i>	<i>Praeradiolites sp.</i>
<i>Pironaea anatolica</i>	<i>Joufia reticulata</i>	<i>Sauvagesia sp.</i>
<i>Gorjanovicia sp.</i>	<i>Joufia cappadociensis</i>	<i>Durania sp.</i>
<i>Eoradiolites sp.</i>		

ARABIAN PLATE

Southeastern Anatolia

<i>Hippurites cornucopiae</i>
<i>Hippurites syriaca</i>
<i>Hippuritella (Tetracoinites) sp.</i>
<i>Vaccinites braciensis</i>
<i>Pironaea syriaca</i>
<i>Pironaea anatolica</i>
<i>Pironaea praeslavonica</i>
<i>Vautrinia syriaca</i>
<i>Hatayia spinosus</i>
<i>Dictyoptychus euphratica</i>
<i>Dictyoptychus orantica</i>
<i>Dictyoptychus leesi</i>
<i>Dictyoptychus striatus</i>
<i>Pseudopolyconites ovalis</i>
<i>Sabinia klinghardti</i>
<i>Lapeirousia sp.</i>
<i>Biradiolites sp.</i>
<i>Radiolites sp.</i>
<i>Bournonia sp.</i>

Table I- Rudist lists from the Maastrichtian of the Anatolian and Arabian plates.

Oman Peninsula respectively. The genus *Hatayia* Karacabey-Üztemür is not found out of its type locality (Yaylaçiftliği-Hatay) in Southeastern Anatolia. The species *Hippurites syriaca* Vautrin and *Pironaea syriaca* Vautrin have geographic distributions only in Southeastern Anatolia. These rudist forms are not found until today in the other regions of Anatolia and also in the Mediterranean countries. So, these forms have been recently described as "Arabian Platform Rudist Fauna" by Özer (1992 a). The genus *Osculigera* Kühn, may be an addition to this fauna, which are determined from the Maastrichtian of Iran (Kühn, 1932; Grubic, 1960; Vogel, 1970).

Other forms of Southeastern Anatolia present widely geographic distributions in Mediterranean Province. The species *Hippurites cornucopiae* Defrance, *Pironaea praeslavonica* Milovanovic, Sladic, Grubic, *Pseudopolyconites*

ovalis Milovanovic and *Vaccinites braciensis* Sladic-Trifunovic are determined from the various localities of Anatolia and also the Central Mediterranean sub-province.

Central and Eastern Anatolia

In Eastern Anatolia the rudists are observed between Malatya and Sivas. Around Hekimhan, Darende, Balaban, Yeşilyurt, HasanÇelebi and Divriği, the rudists are very abundant. In the surroundings of Elaziğ-Harput, they are also locally found. The rudistid formations are dispersed in Central Anatolia in contrast to Eastern Anatolia. The rudists are mainly observed to the east of Tuz Lake (Karapınar, Asmayaylası, Mezgit, Kızıközü localities), around Haymana and Çaldağ (Ahırlıkuyu village), to the west of Ankara (Yurtçu and Alçı villages), south of Çankırı (Maliboğazı) and around Çayırhan (Çeçiköy and Yeşilyurt localities).

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The rudists of Eastern and Central Anatolia are observed in the formations of Maastrichtian in age (Akkuş, 1971; Karacabey-Öztemür, 1979, 1980; Görür, 1981; Üzer, 1983, 1988 a, b, c; Görmüş, 1992).

Central and Eastern Anatolia show a rich rudist fauna. Twenty-four genera and 41 species indicating Maastrichtian age, are determined (Fig. 2). Taxonomic diversity is very high according to the Arabian plate (Table I)

Hippuritidae and Radiolitidae are dominants (Fig. 3). Eastern Anatolia is characterized by the presence of new genera and species. The genera *Joufia* Böhm, *Colveraia* Klinghardt, *Balabania* Karacabey-Öztemür, *Branislavia* Sladic-Trifunovic, *Mitrocaprina* Böhm, *Gorjanovicia* Polsak and *Miseia* Patruilius and the species *Hippurites colliciatus* Woodward, *Hippurites heritschi* Kühn, *Vaccinites lottusi* Woodward, *Vaccinites ultimus* Milovanovic, *Pi-*

ronaea corrugata Woodward, *Pironaea timacensis* Milovanovic, *Sphaerulites solutus* Pethö, *Radiolites angeoides* (Lapeirouse), *Sabinia rtanji* Pejovic and *Biradiolites bulgaricus* Pamoukchiev present geographic distributions in the Central-Eastern Mediterranean sub-province (Fig. 4). These forms are not yet found in the Arabian platform.

Other rudists of Central and Eastern Anatolia have wide geographic distributions in the Mediterranean Province. These forms seem to be adaptable rudists to the variation of ecological conditions. Some benthic Foraminifera show also the same character in the Mediterranean Province (Fleury et al., 1985; Meriç, 1985).

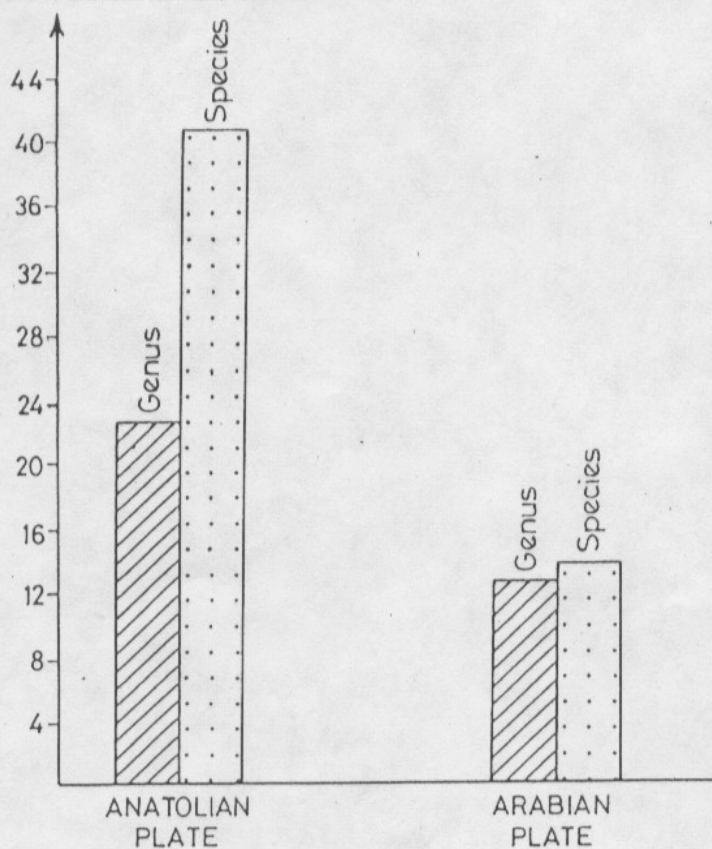


Fig. 2- Graph showing the numbers of the genus and species in the Anatolian and Arabian plates.

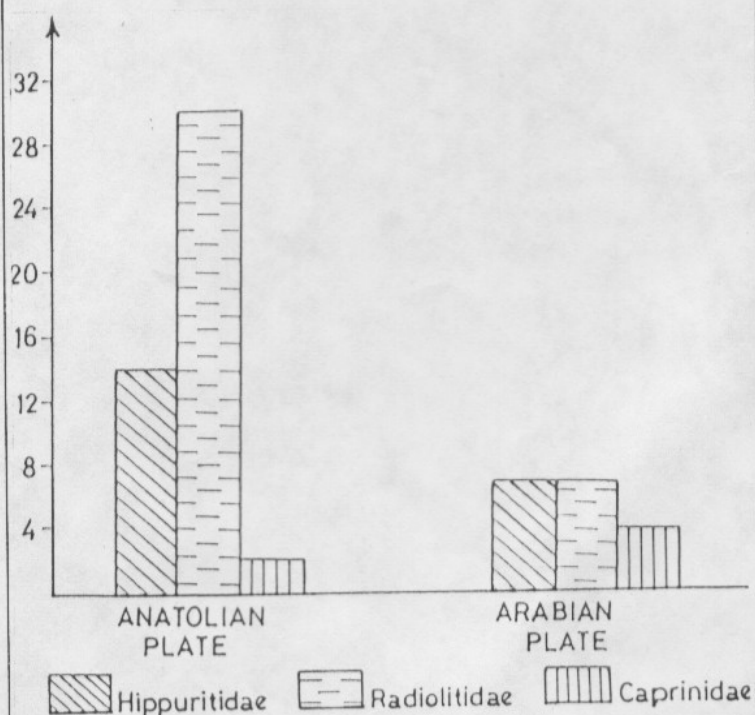


Fig. 3- Graph showing the numbers of families in the Anatolian and Arabian plates.

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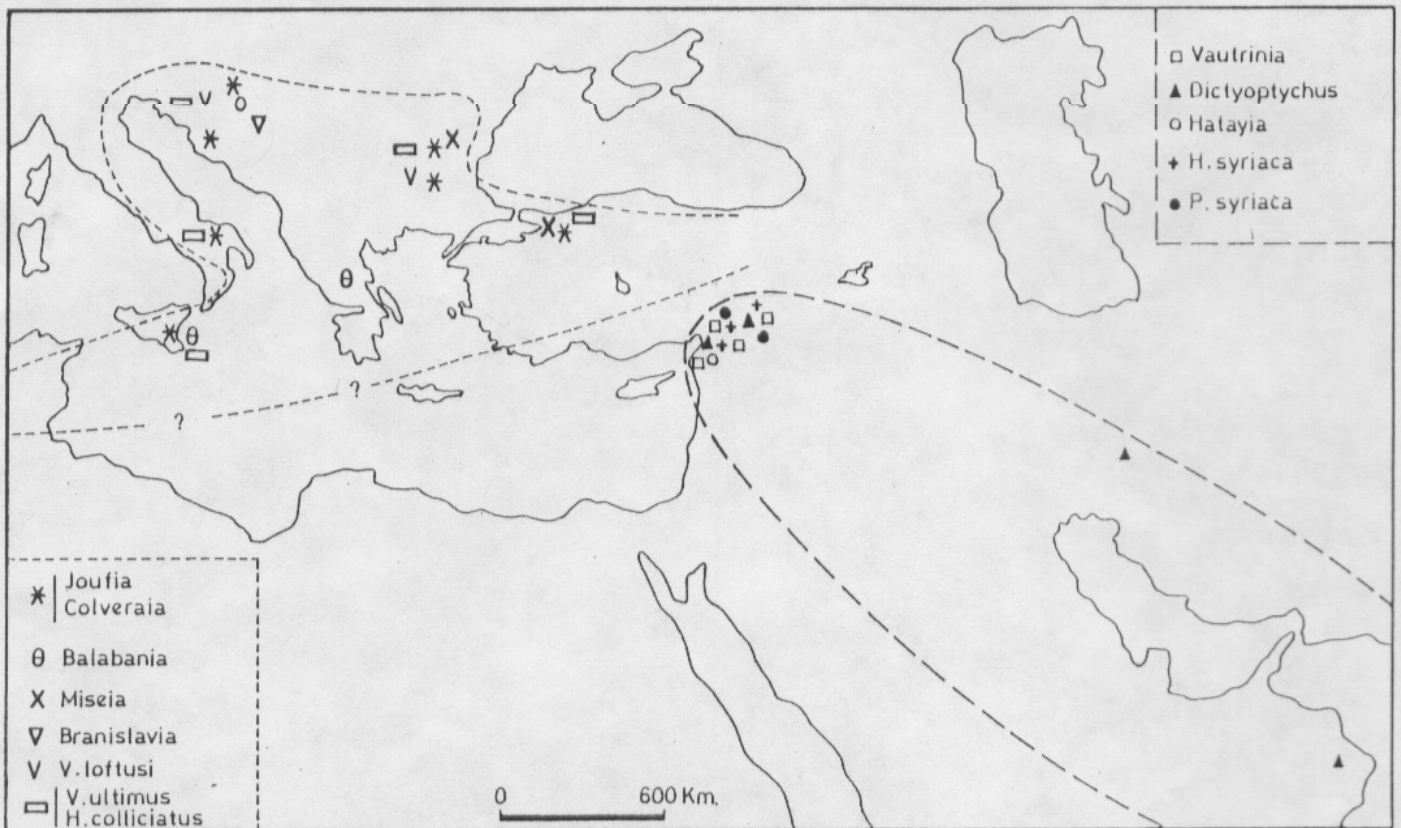


Fig. 4- Distribution areas of the rudists of the Anatolian (short lines) and Arabian (long lines) plates in the Central-Eastern Mediterranean sub-province.

PALEOBIOGEOGRAPHY

The faunal content and geographic distributions of the rudists of Central, Eastern and Southeastern Anatolia are important paleobiogeographic data which allow the explanation of the relationships between the Anatolian and Arabian plates during the Maastrichtian.

The Anatolian and Arabian plates are inconsistently characterized by taxonomic differences. The Anatolian plate has a rich rudist fauna in contrast to the Arabian plate. The rudists of these two plates have characteristic geographic distributions which indicate endemism. Southeastern Anatolian rudists have a very characteristic distribution in the Mediterranean Province including the Arabian platform.

The sharp breaks of the diversity gradient and the geographic characteristics of rudists indicate the presence of a barrier separating the Anatolian and Arabian plates in the Maastrichtian time (Fig. 5). This obstacle corresponds with the southern branch of the Neo-Tethyan Ocean (Şengör and Yılmaz, 1980) and it played an active role for the individualisation of the paleobiogeographic units. The communication between the two plates were greatly reduced allowing only some forms having also wide geographic distributions in the Mediterranean Province.

The faunal deficiency and the distribution characteristics of the rudists of Southeastern Anatolia indicate that the effective larval dispersion can not be developed in the Arabian plate, because the rudistid platforms are very sparse and also dispersed. The rudistid platforms of Southeastern Anatolia are

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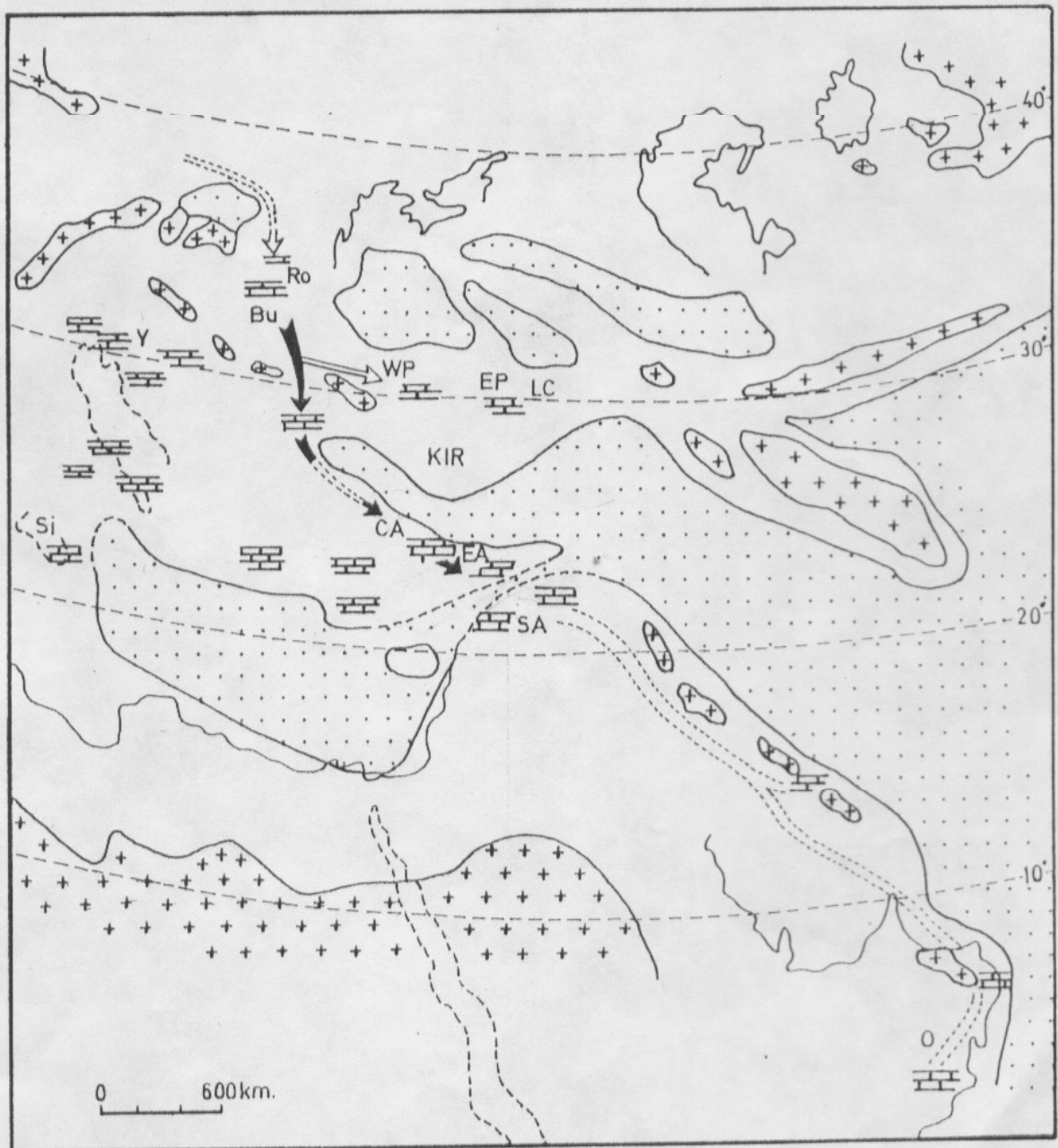


Fig .5-Paleobiogeographic sketch for the Maastrichtian time. Oceanic units (dots), continental areas (plus), paleolatitudes are simplified and modified from Dercourt et al. (1985). Horizontal strata correspond with the rudistid platforms. Arrows and short lines indicate the direction of rudist migrations. CA- Central Anatolia, EA- Eastern Anatolia, SA- Southeastern Anatolia, O- Oman, Si- Sicily, Y- Yugoslavia, Bu- Bulgaria, Ro- Romania, WP- Western Pontids, EP- Eastern Pontids, KIR- Kırşehir, LC- Lesser Caucasus.

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located on the northern border of the Arabian plate, about 22° N paleolatitude (Dercourt et al., 1985); whereas the others are observed in the southern parts of the plate, for example in Iran on the 14° N paleolatitude and in Oman Peninsula about 5°-8° N paleolatitudes (Fig. 5). The paleocurrents were probably established across the eastern part of the Arabian plate; however the direction of migration can not yet be clearly defined.

The rudists of the Anatolian plate show a close resemblance with those of the Apulian platform. The faunal richness and resemblances may be explained by the existence of several rudistid platforms in the Central-Eastern Mediterranean sub-province (Philip, 1985). According to Luyendyk et al. (1972) and Gordon (1973), the ocean surface currents in the Tethyan realm had been dominantly developed during the Upper Cretaceous from east to west. Philip (1982) also presented that some rudist forms show a similar migration in the Mediterranean Province. The examinations of some of the rudists in time and space reveal a new ocean surface current developed from west to east. For example, the type locality of the genus *Miseia* Patruilius is in the Monts Apuseni (Romania) where it is represented by the species of the Santonian-Campanian in age. This genus shows a widespread distribution out of its type locality in the Maastrichtian of Kocaeli Peninsula (Bithynia), Central and Eastern Anatolia by the new species (Karacabey-Öztemür, 1979; Özer, 1992 b). This data suggest that the genus *Miseia* Patruilius showed a migration with the intermediary of Kocaeli Peninsula, between Romania and Anatolia in the Upper Senonian time (Fig. 5). The presence of some rudists such as *Biradiolites bulgaricus* Pamouktchiev, *Joufia cappadociensis* (Cox) and *Mitrocaprina bulgarica* Tzankov determined from Bulgaria and Romania support this assertion. Philip (1985) also proposed a migration of rudists from Aquitain to Bulgaria in a west-east direction. It is probable that the continuation of this ocean surface current had developed toward Anatolia in the same direction.

The paleobiogeographic data related to the Maastrichtian rudists of the Anatolian and Arabian plates seem to be correspond with the distributions of benthic Foraminifera which are mostly associated with rudists. Due to the distributions of some benthic Foraminifera, Meric (1985) distinguished, in Turkey, two sub-provinces which may be correlated with the distribution areas of rudists in the Anatolian and Arabian plates. According to the Maastrichtian benthic Foraminifera dist-

tributions, Fleury et al. (1985) separated a province, located on the Apulian-Anatolian platform which may be also confronted with the distribution area of rudists of the Anatolian plate.

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