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MOLLUSCAN FAUNA AND STRATIGRAPHY OF THE UÇARSU AND KASABA FORMATIONS AT KASABA MIOCENE BASIN (WESTERN TAURIDES, SW TURKEY)

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ABSTRACT.- In the study, six stratigraphical section has been measured through mollusc-rich Uçarsu and Kasaba formations, outcropping at Kasaba Miocene Basin in western Taurides. By evaluating the paleogeographic and chronostratigraphic denotations of mollusc species, it has been concluded that, most of the samples were Mediterranean Tethyan in origin and the other forms, such as *Divaricella ornata subornata* Hilber, *Cerithium zejsneri* Pusch and *Pitar (Paradione) lilacinoides* Schaffer, that were peculiar to the central Paratethys have also been determined. So, for the investigation area, the Paratethyan marine stages were pictured too. By these findings, the age of the shallow-marine Uçarsu formation has been inferred as Upper Burdigalian (Upper Eggenburgian-Carpathian) and that of the other shallow-marine Kasaba formation as Langhian (Lower Badenian). The former is transgressive in nature at its basal parts and characteristically regressive toward the top, while the latter, grading into continental environment from a steady shallow marine, displays regressive character throughout. By context of the paleontological data from Uçarsu and Kasaba formations and superposing of the (studied) units, it is suggested that the emplacement of the Yeşilbarak nappe and the Lycian nappes into the region had initiated in the Upper Burdigalian and continued until the end of the Langhian.

INTRODUCTION

Kasaba Miocene Basin lies at the western side of gulf of Antalya, on the Teke peninsula, between Elmalı and Kaş townships (Fig. 1). Within the investigation area, the Miocene-aged units are observed within the Beydağları Autochton and Yeşilbarak nappe.

In the course of study, just two amongst the mollusc-bearing Miocene-aged units, the Uçarsu and Kasaba formations has been looked at thoroughly, and four sections from the former and two on the latter were traversed (Fig. 1). Along these, totally sixty-nine taxons have been recognized (İslamoğlu, 2001) and by examining the paleogeographic and chronostratigraphic denotations of those, ages of the formations could have been inferred (Table 1).

GEOLOGY

Initial works at the region were carried out by Lucius (1925), Kirk (1932), Mankiewicz (1946), Colin (1955), Holzer (1955), Flugel (1961) and Pisoni (1967).

The units at the region were subdivided into Beydağları autochton, Lycian nappes and Yeşilbarak nappe (Şenel, 1997a,b,c), and one of which, the Beydağları autochton has been subjected to detailed studies by several researchers (Colin, 1962; Poisson, 1977; Önalan, 1979; Erakman et al., 1982; Yalçınkaya et al., 1986; Şenel et al., 1989, 1994). The lowermost portion of the autochton is Jurassic-Upper Cretaceous-aged Beydağları formation, that extends over large areas and deposited at carbonate shelf environment, including patch reefs composed of rudists at its basal part (Şenel et al., 1989,

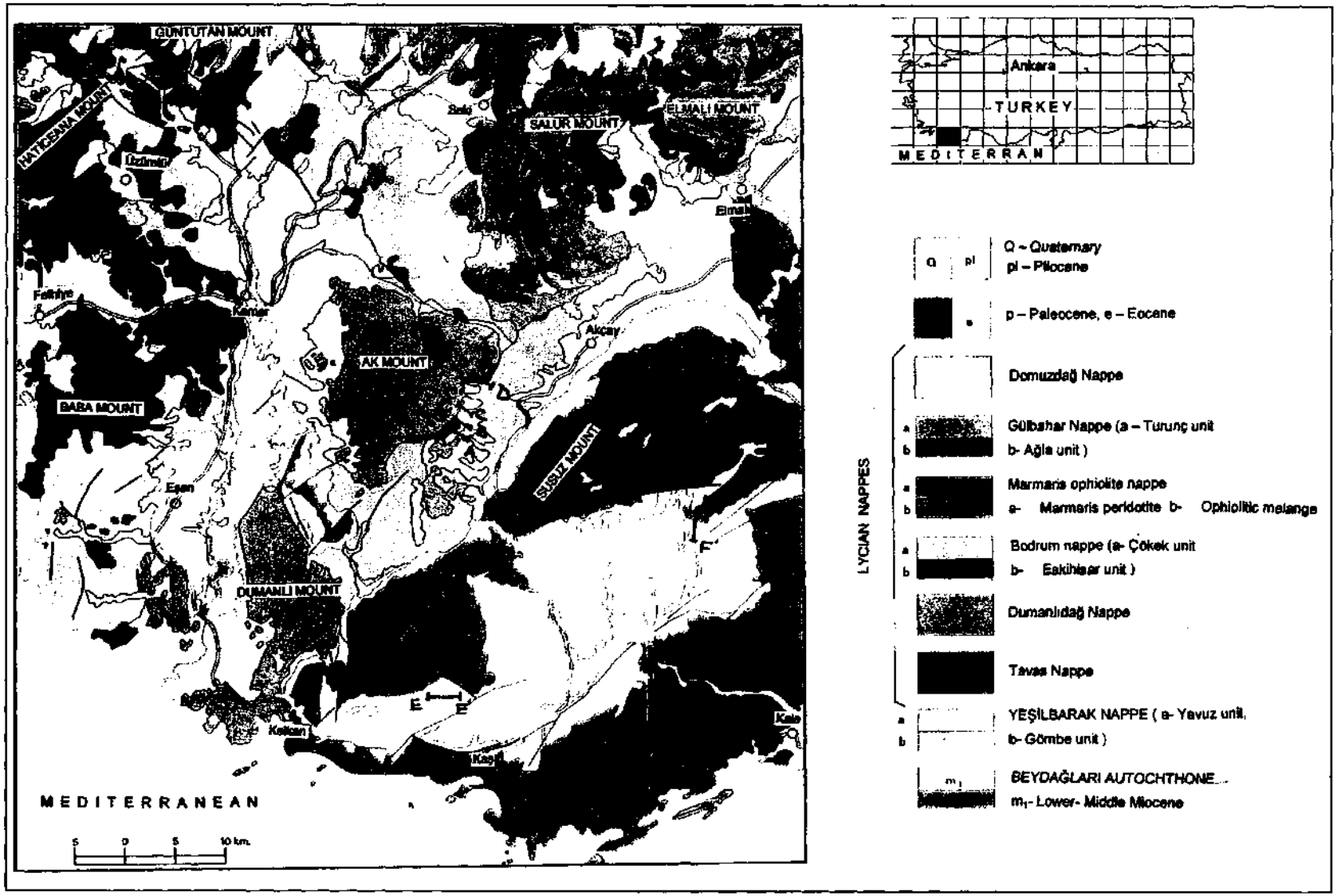

Fig. 1- Geological map of the Kasaba Miocene basin and surrounding area (adapted from Şenel, 1997 *a,b,c*) AA'- Bozgediktepe section, BB'- Akçasupınarı section, CC' Uçarsu section, DD'- Sıradona section, EE'- Boyacıpınar section, FF'- Ortabağ section.

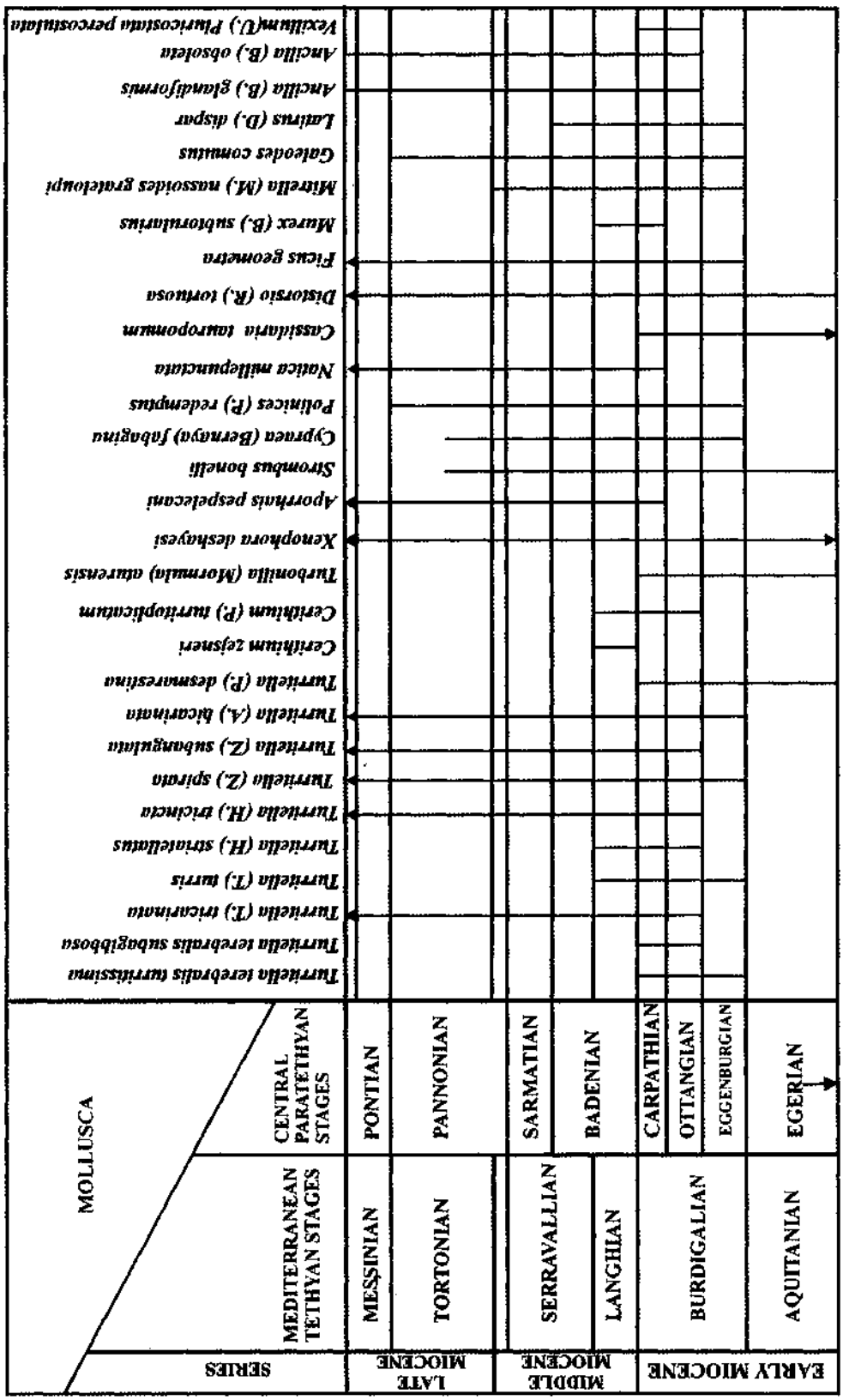

Table 1 - Stratigraphic denotations of the Miocene-aged mollusc species, found at Kasaba basin

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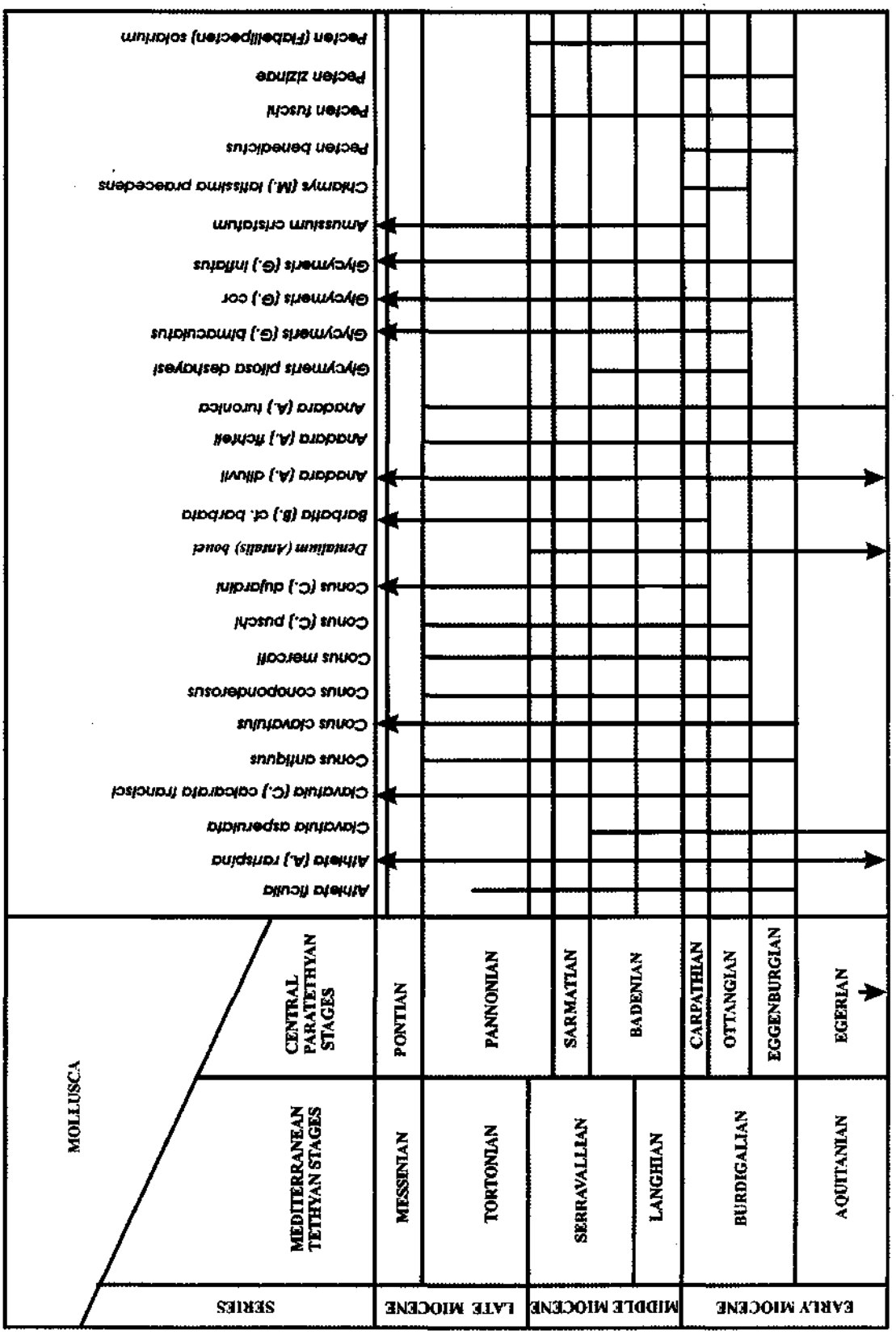

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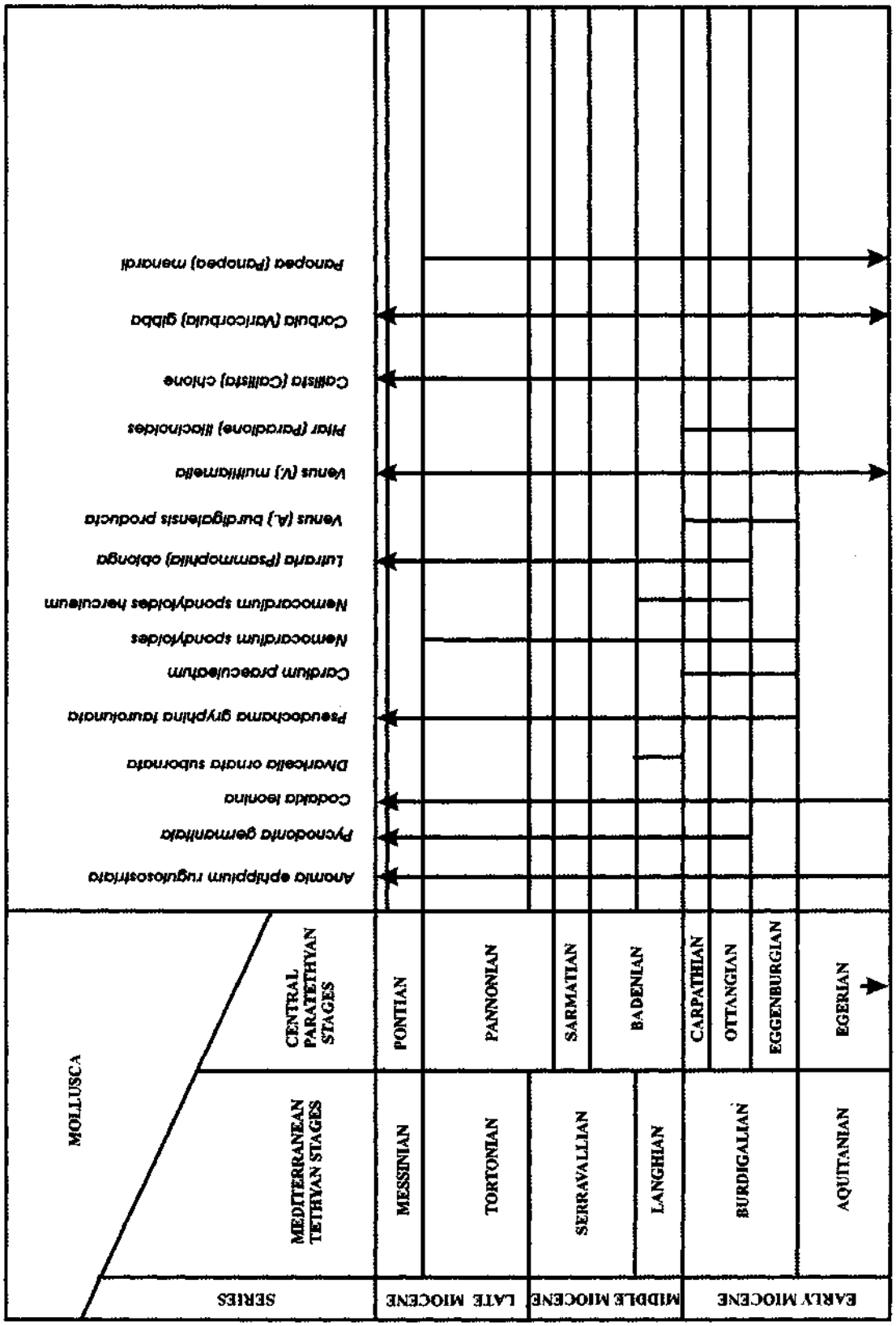

1994). Covering that unit, the Gedikbaşı formation, neritic limestone in nature, accumulated during Paleocene and sits on probably unconformably (Önalan, 1979; Şenel et al., 1989,1994). Resting unconformably upon the Gedikbaşı formation, the Susuzdağı formation represents Upper Lutetian-Priabonian age and settled down at shallow carbonate shelf fades (Önalan, 1979; Şenel et al., 1989, 1994). The following units are transgressive Karabayır formation, Aquitanian in age and Burdigalian-aged Sinekçi formation, respectively. Sinekçi formation is also transgressive and has been subdivided into three members, Gömüce algal limestone, Kıbrısdere clayey limestone and Çayboğazı claystone by Önalan (1979). Kasaba formation, sedimented during Langhian (Lower Badenian) overlies that unit. Both Kasaba and Sinekçi formations are tectonically capped by Elmalı formation, which is a component of Gömbe group in Yeşilbarak nappe (Şenel et al., 1989, 1994). The uppermost unit extending in the region is Felenkdağ conglomerate, blanketing the Miocene-aged units unconformably.

Lycian nappes have previously been called as Elmalı nappes and Lycian nappes by Colin (1962), Brunn et al. (1971), Önalan (1979), Erakman et al. (1982), Günay et al. (1982), Bölükbaşı (1987) and that has been subdivided into Tavas nappe, Bodrum nappe, Dumanlıdağ nappe, Marmaris ophiolitic nappe, Gülbahar nappe and Domuzdağ nappe by Şenel et al. (1987, 1989, 1994) and Şenel (1997a,b,c).

Another tectonic unit, seen in the region is Yeşilbarak nappe. Resting at the base of the nappes, that unit displays a lateral continuity between the autochton and the nappes (Önalan, 1979; Şenel et al., 1986, 1987, 1989, 1994 and Şenel 1997a,b,c) (Fig. 1). the unit has been separated into two substructural units, the Gömbe group and Yavuz formation by Şenel et al. (1,989), and of which, just one, the Gömbe group can be seen through investigation area. Gebeler formation, characterizing the base of the Gömbe group, deposited during Cenomanian-Santonian (Upper Cretaceous), outcrops outside the area. The overlying unit, transgressive Elmalı formation is composed entirely of turbiditic elastics, representing a Upper Lutetian-Lower Miocene age (Önalan, 1979). That formation appears around Gömbe and Elmalı.

The area and the surrounding region had undergone the compression regime, caused by the Alpine orogeny (Colin, 1962; Brunn et al., 1971; Özer et al., 1974; Poisson, 1977; Önalan, 1979; Erakman et al., 1982; Akay et al., 1985; Şenel et al., 1987, 1989, 1994; Robertson, 1993; Şenel, and Bölükbaşı,) 1997. Antalya nappes had initially moved from east-northeast during Senonian and consequently, during Danian they placed on the eastern and northeastern flanks of the autochton. Later on, these nappes had been pushed onto the Beydağları autochton, in east-west direction (Şenel et al., 1992, 1994). Lycian nappes, had probably clustered at the north of Menderes massif by the closure of Cretaceous, lodged in the south at the end of Eocene. All these allochthonous units, overriding the Yeşilbarak nappe, fell into the northern and western sides of the autochton during Miocene period (Şenel et al., 1992,1994) and that movement produced considerable effects on the Lower-Middle Miocene-aged sediments. As a consequence of oppositely thrustings, a huge amount of the elastics was transported into the basin, and that material formed the alluvial fans and fan deltas on the

coastal zone and the submarine fans in the basin, as a result of deposition. During tectonically steady-state phases, the small-scale patch reefs accumulated over the fan deltas (Hayward, 1982, 1984; Hayward and Robertson, 1996). Depending upon the extension regime following the emplacement of the nappes, Upper Miocene-Pliocene aged grabens developed (Şenel, 1997a,b,c).

LOCATIONS OF THE MEASURED SECTIONS

Bozgediktepe section (AA').- This section lies in Fethiye O23-d_4 quadrangle and has been measured at almost 400 m northwest of Bozgediktepe. Extending southeast to northwest, it is introduced at X_1: 33750, Y_1-,: 44350 and that terminates at X_2: 33630, Y_2: 44600 intersects. That has been crossed in Uçarsu formation and ranges 92 m, of which the basal 52 m is represented by sandstone-mudstone, and the following 40 m by polygenie conglomerates (Fig. 2).

Akçasupınarı section (BB').- That section, in the Fethiye O23-d_4 sheet, has been traversed in east-west direction at some 1.5 km northeast of Yaskam locality. It begins at X_1. 34350, Y_1: 47075 intersect and comes up to an end at X_2: 34650, Y_2: 47100. Reaching up a thickness approximately 225 m, that also characterizes part of Uçarsu formation (Fig. 3).

Uçarsu section (CC').- Depicted from Uçarsu spring in Fethiye O23-d_4 rectangle, that section ranges from X_1: 34375, Y_1: 48380 to X_2: 34250, Y_2: 48600 points and of which thickness reaches to 66 m. That also represents a portion of Uçarsu formation (Fig. 4).

Sıradona section (DD').- That section has been picked up at some 850 m northwest of Çukurbağ, in Fethiye O23-d_3 quadrilateral, through a northeast-southwest direction. Stretching for 137 m, it has been introduced at X_1: 36130, Y_1: 49580 intersect and of which termination is at X_2: 35900, Y_2: 49500 point (Fig. 5).

Boyacıpınar section (EE').- Going over Fethiye P23-a_4 sheet, this section has been practiced between X_1: 31750, Y_1: 18800 and X_2: 32750, Y_2: 18400 points, at nearly 950 m southwest of Boyacıpınar. Given a thickness reaching 67 m in Kasaba formation, it stretchs toward south firstly and then turns up to southwest (Fig. 6).

Ortabağ section (FF').- That section extends in Fethiye P23-b_2 quadrangle, between X_1: 49800, Y_1: 32740 and X_2: 49820, Y_2: 32500 intersects. It has been examined in a north-south direction at 3 km south of Ortabağ and is 18 m thick (Fig. 7).

STRATIGRAPHY

Uçarsu formation, one of molluscs-bearing Miocene units, is included in Gömbe group, a member of Yeşilbarak nappe and overlies the Elmalı formation while the other one, Kasaba formation is in Beydağları autochton and covers Sinekçi formation. Generalized stratigraphic columns of both the autochton and Gömbe group are displayed in Figs. 8 and 9.

Uçarsu formation

Description.- Although Önalan (1979) has observed the unit, consisting of light-brown colored limestones around Uçarsu and Akçasupınarı and has thought that as a part of Çayboğazı member, included in Sinekçi formation, Şenel et al. (1989) has called it as Uçarsu formation, since it has appeared in a different structural unit.

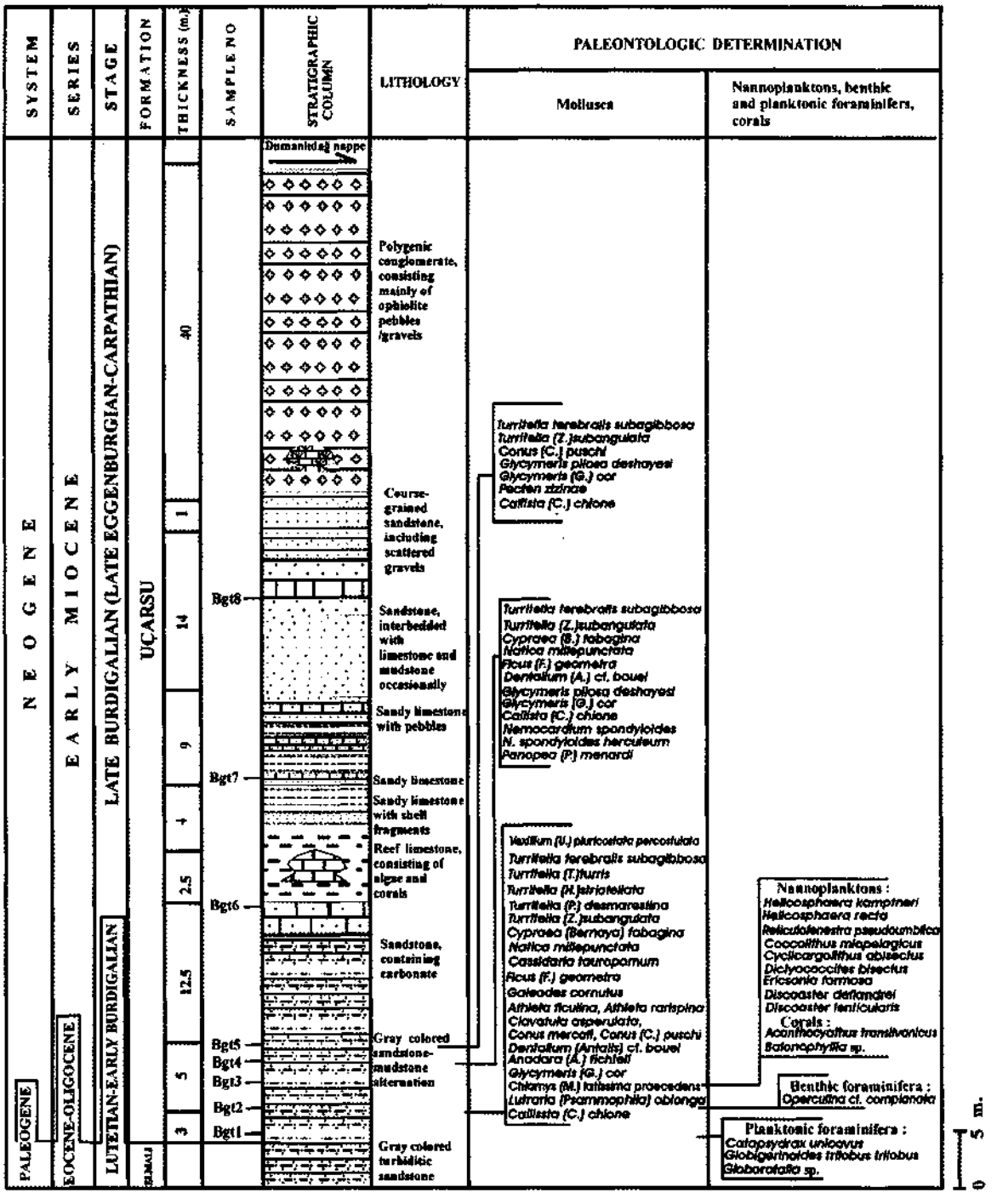

Fig. 2- Bozgediktepe stratigraphic section

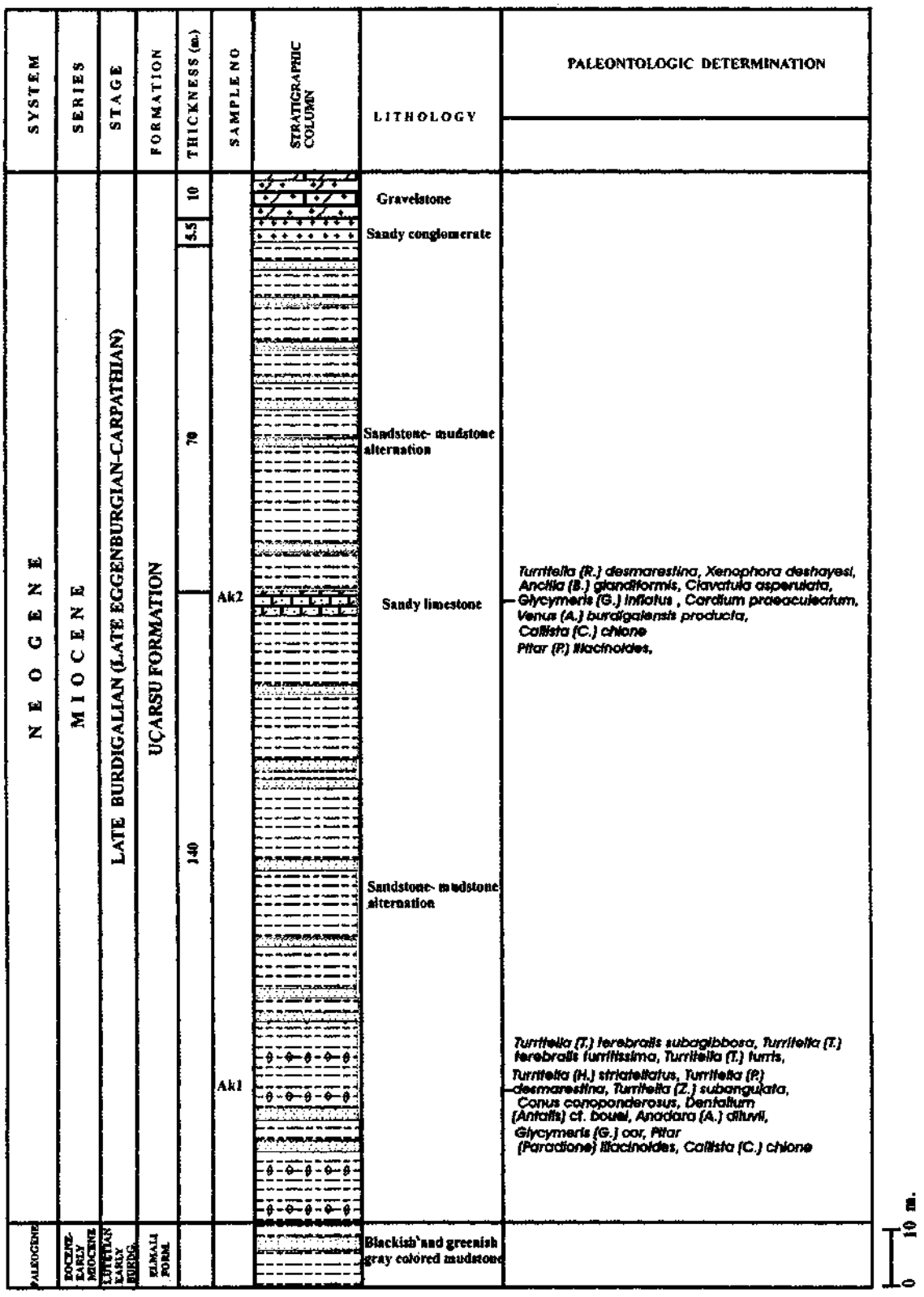

Fig. 3- Akçasupınarı stratigraphic section

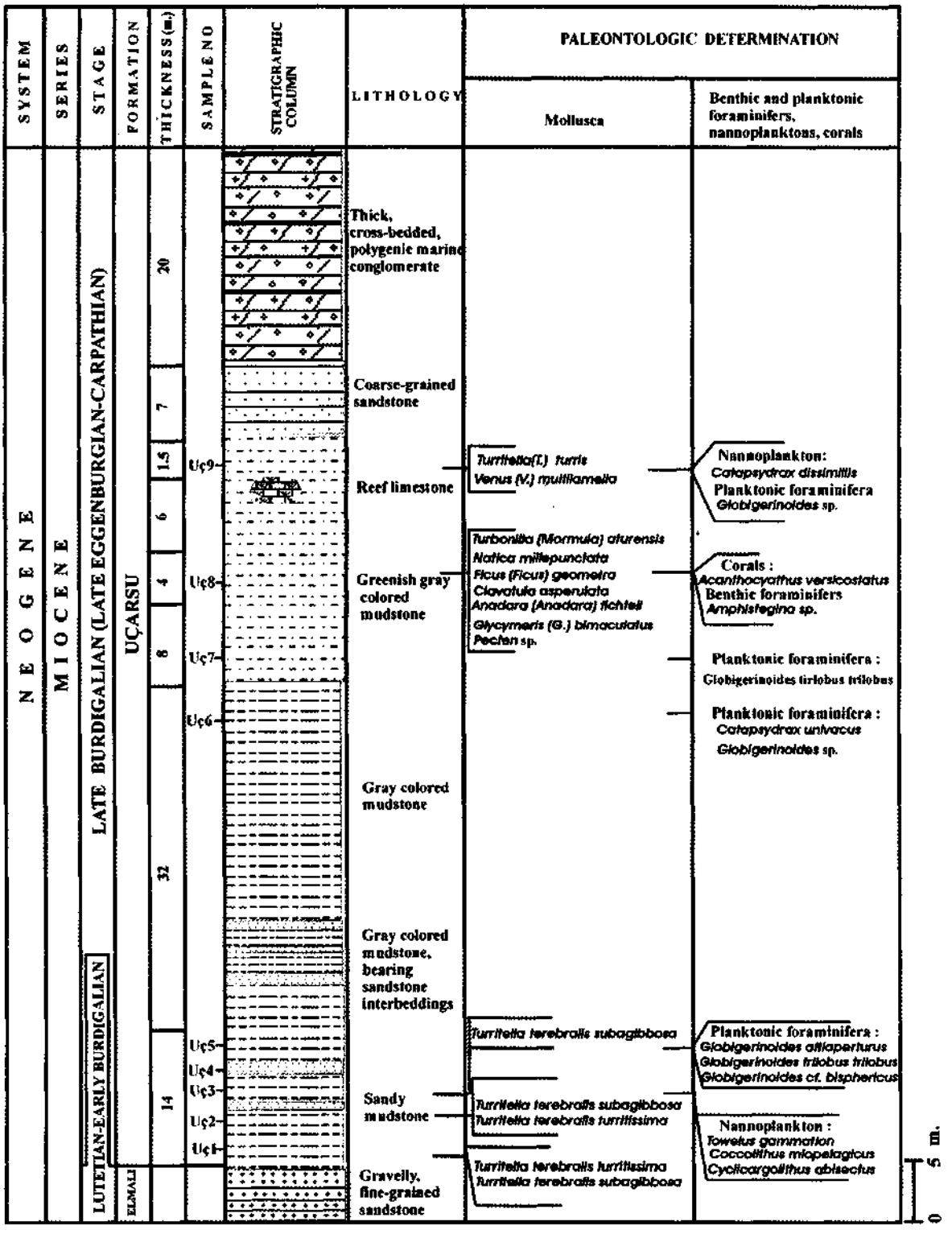

Fig. 4- Uçarsu stratigraphic section

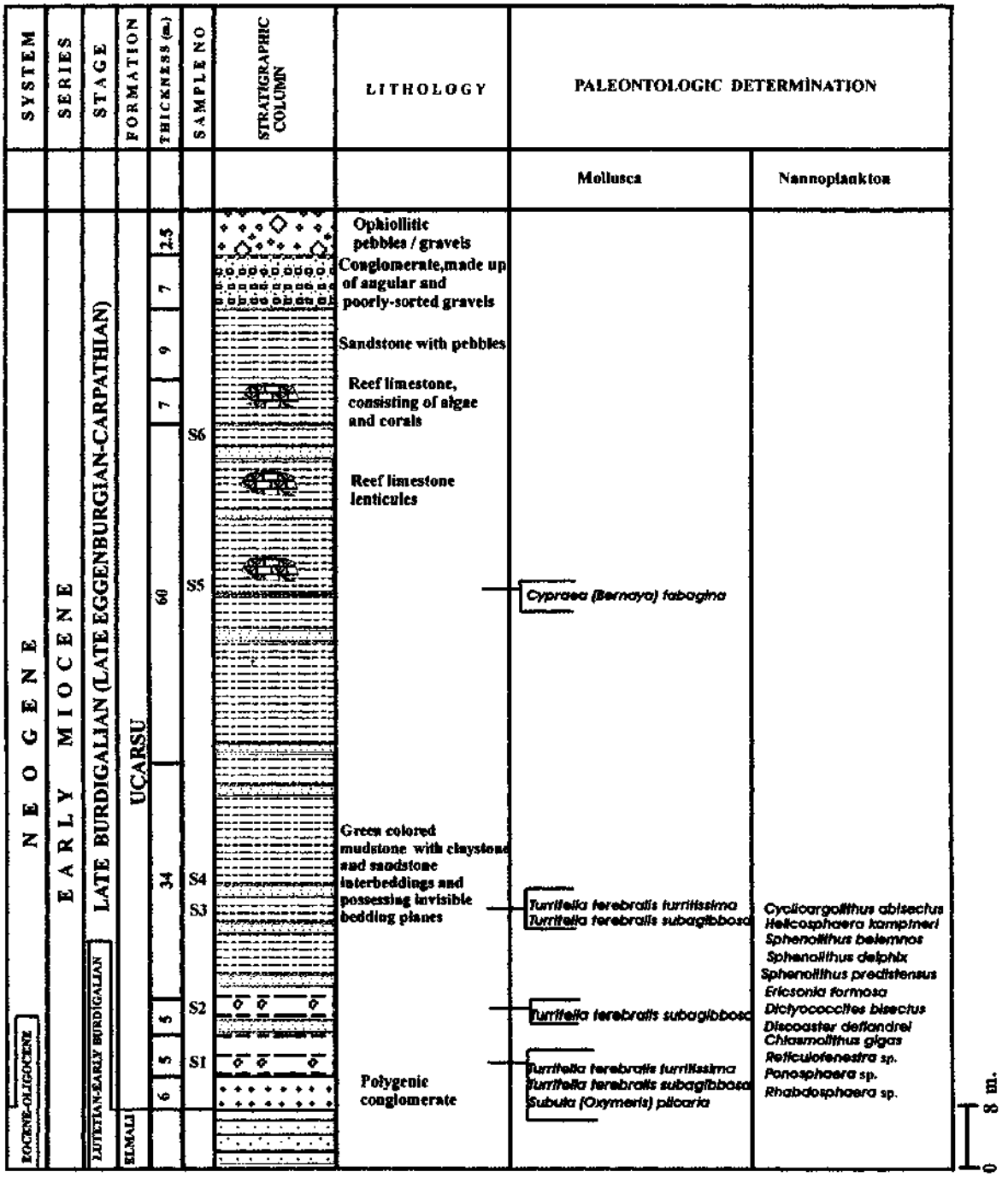

Fig. 5- Sıradona stratigraphic section

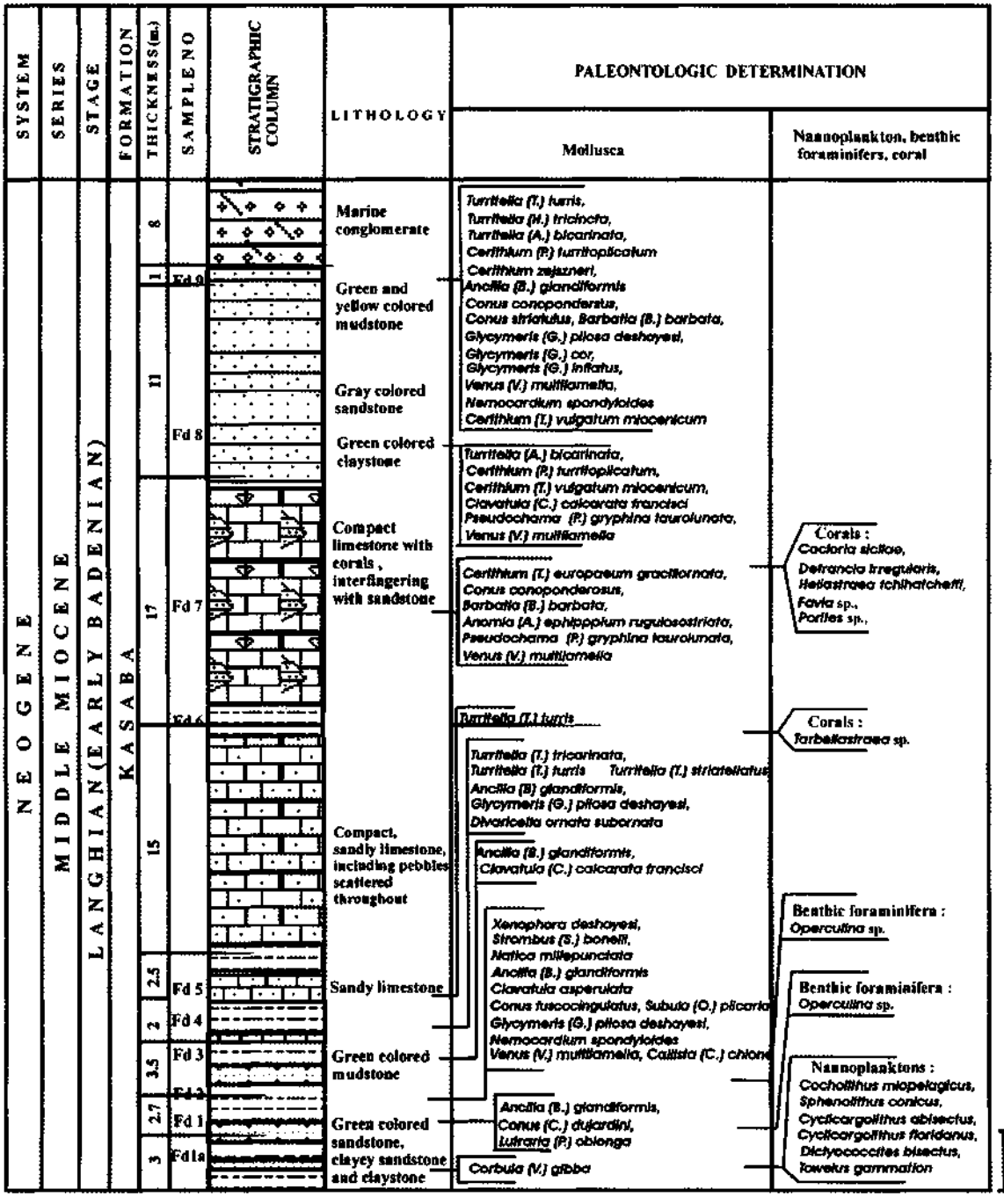

Fig. 6- Boyacıpınar stratigraphic section

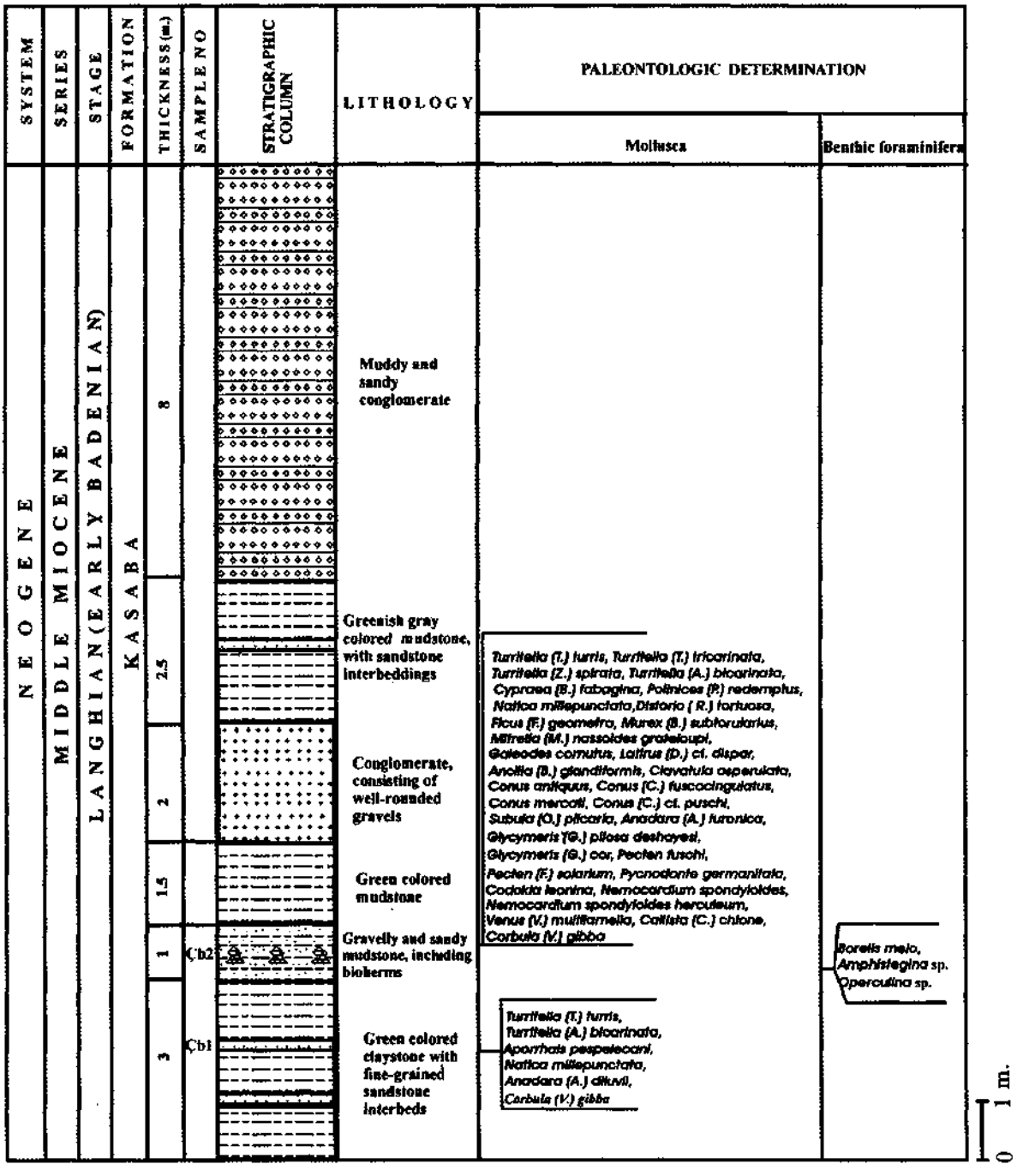

Fig. 7- Ortabağ stratigraphic section

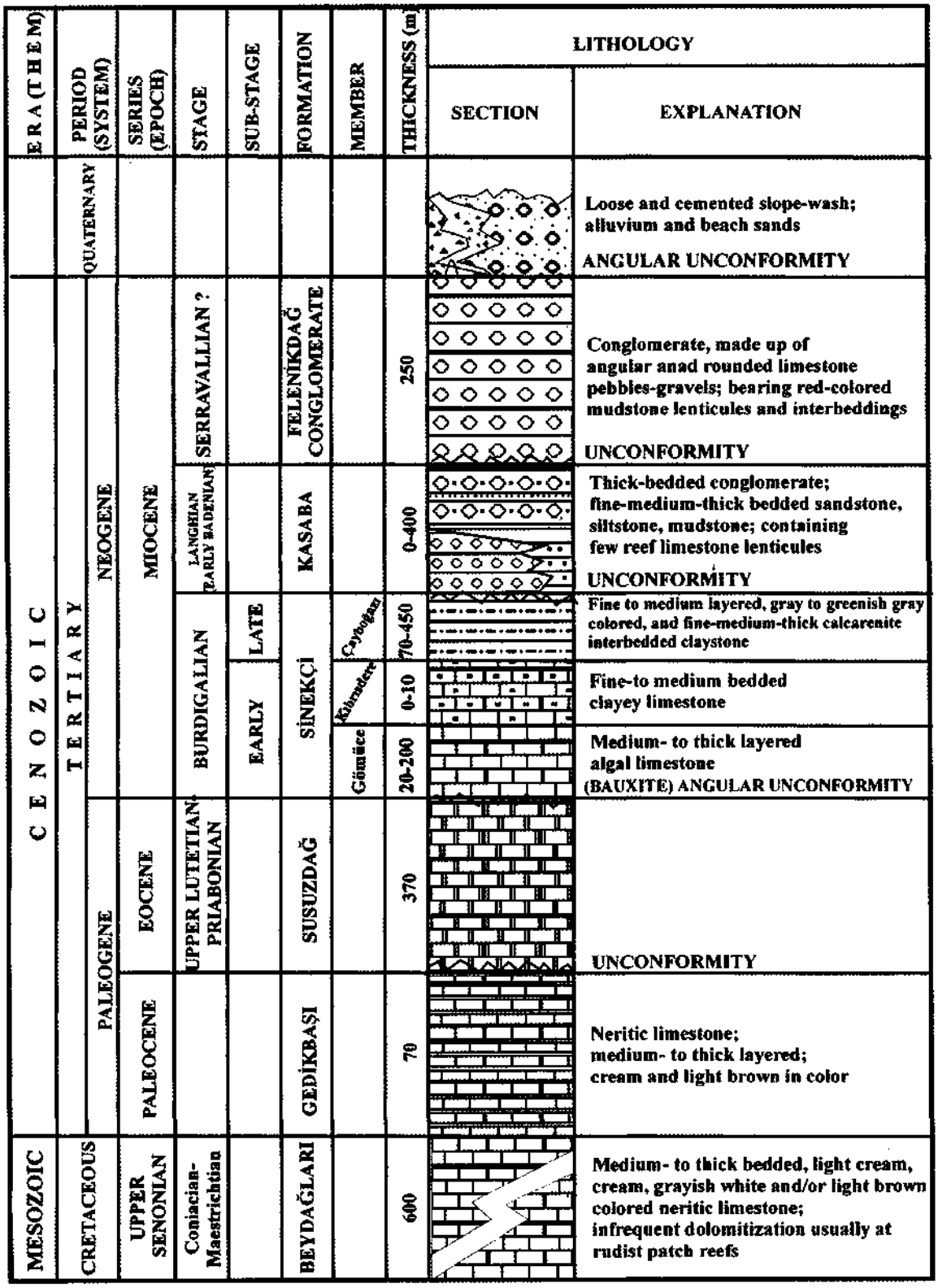

Fig. 8- Beydağları stratigraphic column of the Beydağları autochton (after Şenel et al, 1994)

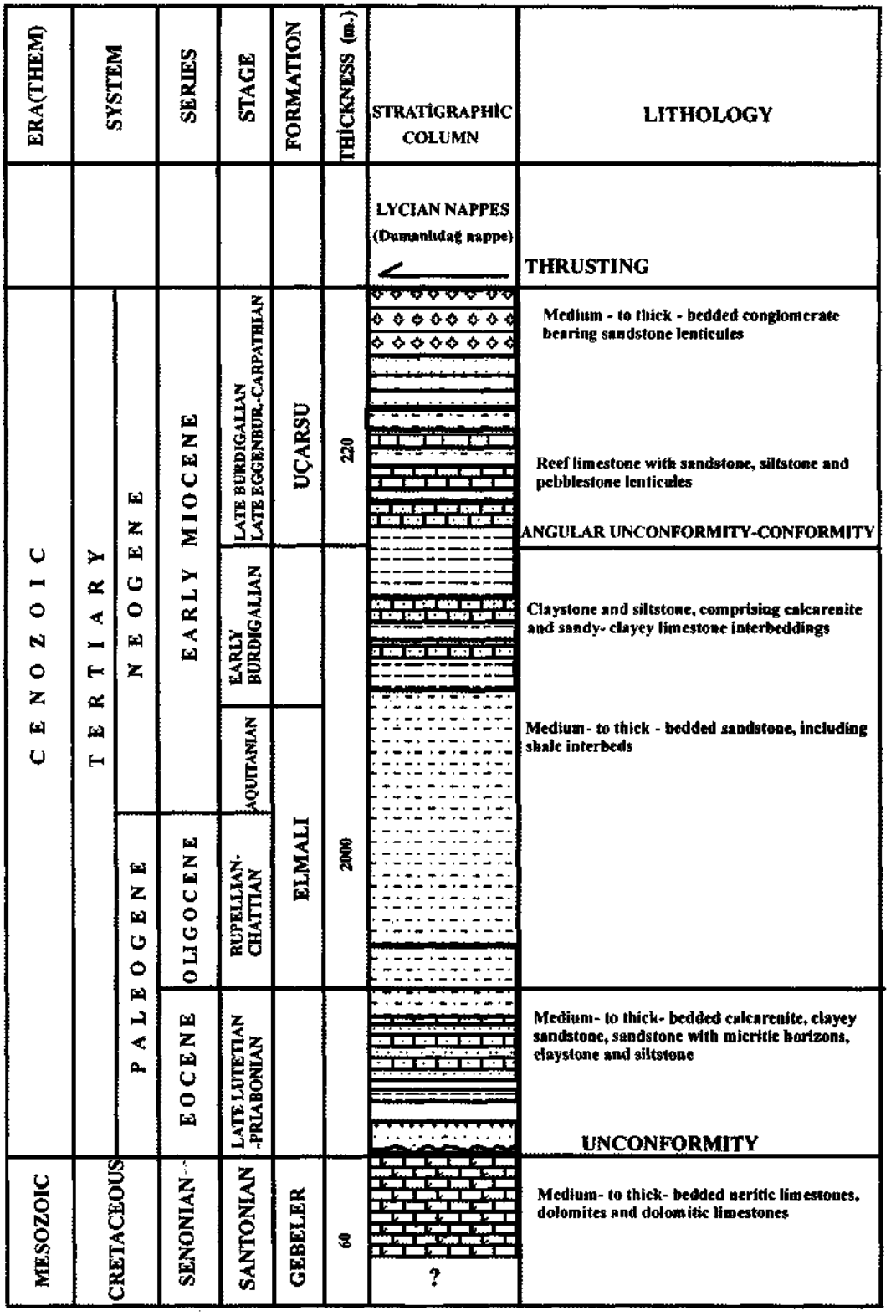

Fig. 9- Generalized stratigraphic section of Gömbe group (after Şenel et al, 1994)

Type locality.- Uçarsu spring.

Localities of the sections.- Akçasupınarı, Siradona locality, Bozgediktepe and southern and southeastern flanks of Akçağ.

Contact relationships.- Uçarsu formation sits on Elmalı formation with angular unconformity through Uçarsu and Sıradona sections while covers it conformably at ones, so-called Bozgediktepe and Akçasupınarı. The formation is underlain tectonically by Dumanlıdağ nappe, the lowermost slab of Lycian nappes.

Lithology.- Uçarsu formation consists up of light-dark gray and greenish gray colored conglomerate, sandstone, mudstone and reef limestones occasionally. The lower parts are predominated by macrofossil-rich sandstone and mudstone whilst the upper levels are characterized by polygenic conglomerate.

At the base of Bozgediktepe section, gray colored and unstratified mudstone (Uçarsu formation) overlies conformably the gray colored sandstone of Elmalı formation (Fig. 2). Along the first 20 m of the section, a medium-layered, gray colored sandstone and mudstone alternates with each other. Then, sandstone grades into sandy limestone by increase in carbonate content and that sandstone and sandy limestone interval reachs up to 15 m. On that, a sandstone including scattered gravels sits and the uppermost sect is made up of polygenic conglomerate including poorly sorted and angular limestone and ophiolite pebbles. Dumanlıdağ nappe overlies that sect tectonically. Through the section, fining upward in grain size, presence of intervening reef limestones consisting of algae and coral and then grain size coarsening again imply that the sequence was transgressive at first and then regressive.

Akçasupınarı section is predominated by an alternance of thin-medium layered and greenish gray colored mudstone with thin layered, calcareous sandstone interbeddings (Fig. 3), stretching for approximately 200 m. Then, a 5.5 m thick sandy pebblestone and conglomerate, reaching up to 10 m, blanket that level, respectively.

Uçarsu section initiates with poorly-stratified and greenish gray colored sandy mudstone, including poorly-sorted and weakly-rounded pebbles (Fig. 4). That level is 70 cm thick. The next interval is a greenish gray colored sandstone and mudstone alternation, reaching to 4.5 m in thickness. That sequence goes on with the brown colored sandstone (1 m) and gray colored mudstone. The mudstone encloses limestone lenticules, involving algae and corals, in its upper part. Further on, coarse grained sandstone and the terminating deposit, polygenic conglomerate have been penetrated.

The basal part of Syradona section exhibits a polygenic conglomerate, embracing angular, moderately to well-cemented, poorly sorted, graded pebbles-gravels and finer elastics (Fig. 5). Measuring 6 m, that horizon is overlain by a greenish gray-green colored, medium-layered pebblestone-sandstone-mudstone alternation. The latter reaches to 5 m The superimposing is the green colored mudstone, spreading out 5 m. The lower parts of the section is Gastropoda and nannoplankton-rich, although the upper parts enclose 3 to 4 m thick reef limestone lenticules, made up of algae and corals. The further one is the 8 m thick, poorly sorted and gray-brown colored gravelly sandstone. The 7 m thick polygenic conglomerate, comprising angular and poorly-sorted pebbles-gravels is the successive rock-type. At top of that succession, large

olistostromes, reaching 2.5 m and including ophiolite pebbles-gravels are seen.

Thickness.- The formation displays a thickness, reaching 225 m.

Fossil content and age.- The formation contains Upper Burdigalian (Upper Eggenburgian-Carpathian)-aged mollusc assemblage (Table 1). Especially, *Cassidaria tauropomum* (Sacco), *Vexillum (Uromitra) pluricostata percostulata* (Sacco), *Pecten zizinae* Blanckenhorn, *Chlamys (Macrochlamys) latissima praecedens* (Sacco), *Pitar (Paradione) lilacinoides* (Schaffer), *Cardium praeculeatum* Hölz and *Venus (Antigona) burdigalensis producta* Schaffer are the species that had disappeared at the end of Lower Miocene. *Turritella terebralis turritissima* Sacco and *Turritella (Peyrotia) desmarestina* Basterot are the species, that have been found only in Upper Burdigalian so far. Meanwhile, the species *Pitar (Paradione) lilacinoides* (Schaffer), *Cardium praeculeatum* Hölzl and Venus *(Antigona) burdigalensis producta* Schaffer have only been found in Eggenburgian stage of central Paratethys. It is also known that, several species are introduced in marine stages of central Paratethys too, namely Eggenburgian, Ottangian and Carpathian. Therefore, referring to both names for those stages has been preferred.

The ages hold by the planktonic foraminifera and nannoplanktons support the suggested periods for the formation. The following lines will explain the determined fossils and the intervals that they have been contained in, through the sections.

a) Bozgediktepe section departs with gray colored, unstratified mudstone (Fig. 2). In that level the planktonic foraminifera, *Catapsydrax unicavus* Bolli, Loeblich and Tappan, *Globigerinoides trilobus trilobus* (Reus) and *Globorotalia* sp., implying Burdigalian period were determined (Sample Bgt-1, determination by Hakyemez, A.). The overlying gray colored sandstone, from which Sample Bgt-2 was taken, embraces molluscs at high quantities. Gastropoda, *Turritella terebralis turritissima* Sacco, *Turritella (Turritella) turris* Basterot, *Turritella (Haustator) striatellatus* Sacco, *Turritella (Zaria) subangulata* (Brocchi), *Turritella (Peyrotia) desmarestina* Basterot, *Cyprae a (Bernaya) fabagina* Lamarck, *Natica millepunctata* Lamarck, *Cassidaria tauropomum* (Sacco), *Ficus (Ficus) geometra* (Borson), *Galeodes cornutus* (Agassiz), *Vexillum (Uromitra) pluricostata percostulata* (Sacco), *Athleta ficulina* (Lamarck), *Athleta (Athleta) rarispina* (Lamarck), *Clavatula asperulata* (Lamarck), *Conus mercati* Brocchi, *Conus (Chelyconus) puschi* Michelotti, *Conus (Conolithus) dujardini* Deshayes, scaphopods, *Dentalium (Antalis)* cf. *bouei* Deshayes and Bivalvia, *Anadara (Anadara) fichteli* (Deshayes), *Glycymeris (Glycymeris) cor* (Lamarck) *Chlamys (Macrochlamys) latissima praecedens* (Sacco), *Lutraria (Psammophila) oblonga* Chemnitz, *Callista (Callista) chione* (Linne) and benthic foraminifera, *Operculina* cf. *complanata* Defrance (representing usually Miocene period) have been sampled (determiation by Sirel, E.).

Within that level, from which Sample Bgt-3 has been collected, a nannoplankton fauna, exemplified by *Helicosphaera kamtneri* Hay-Mohler, *Helicosphaera recta* Haq, *Reticulofenestra pseudoumblica* (Gartner), *Sphenolithus conicus* Bukry, *Coccolithus miopelagicus* Bukry, *Cyclicargolithus abisectus* (Muller), *Dictyococcites bisectus* (Hay-Mohler-Wade), *Ericsonia formosa* (Kamptner), *Discoaster deflandrei* Bramlette-Riedel, *Discoaster*

lenticularis Bramlette-Sullivan characterizes late Lower Miocene-earliest Middle Miocene time interval (determined by Karakullukçu, H.). Besides those, a species belonging to ahermatype corals, living in beneath the photic zone of open shelf and characterizing the deeply waters, Acanthocyathus transilvanicus (Reuss), *Balonophyllia* sp. was held in (determined by Babayiğit, S.). That finding stresses that, until that level the environment has increasingly deepen.

The following 30 cm thick, gray colored sandstone is also productive for different species of Mollusca, illustrated by Gastropoda, *Turritella terebralis subagibbosa* Sacco, *Turntella (Zaria) subangulata* (Brocchi), *Cypraea (Bernaya) fabagina* Lamarck, *Natica millepunctata* Lamarck, *Ficus (Ficus) geometra* (Borson), Scaphopoda, *Dentalium (Antalis)* cf. *bouei* Deshayes, *Dentalium* sp. and Bivalvia, *Glycymeris pilosa deshayesi* (Mayer), *Glycymeris (Glycymeris) cor* (Lamarck), *Callista (Callista) chione* (Linne), *Nemocardium spondyloides* (Hauer), *Nemocardium spondyloides herculeum* Dollfus-Cotter-Gomez, *Panopea (Panopea) menardi* (Deshayes) (Fig. 2, Sample Bgt-4). Amongst the covering package, consisting of 1 m thick mudstone, 40 cm thick sandstone and again 1 m thick mudstone, from bottom to top, has only the last been exemplified by Sample Bgt-5, and that has been disclosured to include Gastropoda, *Turritella terebralis subagibbosa* Sacco, *Turritella (Zaria) subangulata* (Brocchi) and *Conus (Chelyconus) puschi* Michelotti and Bivalvia, *Glycymeris pilosa deshayesi* (Mayer), *Glycymeris (Glycymeris) cor* (Lamarck), *Pecten zizinae* Blanckenhorn, *Callista (Callista) chione* (Linne). The succession goes further on by a gray mudstone, having a thickness of 12.5 m and interbedded with 10 to 20 cm thick sandstone levels. The next one; 60 cm thick calcareous sandstone has been penetrated to gain Sample Bgt-6, displaying the presence of Gastropoda, *Natica millepunctata* Lamarck. The sequemce continues with a parcel, consisting of 70 cm thick mudstone, 2.5 m thick, light gray colored sandy limestone, embracing algal remains and corals, at which base shell accumulation has been met, and over which a 4 m thick mudstbne-sandstone alternation.

Examplified by Sample Bgt-7, the next lithology, the 20 cm thick sandy limestone, including algal remains and corals, exhibits a shell accumulation at the base and also includes Gastropoda, *Clavatula asperulata* (Lamarck). The units lying on that, are mudstone-sandstone alternance, exhibiting a 6.5 m thickness and the sandy limestone, including broken shells, respectively. The Sample Bgt-8 has been collected from the latter and that submits no paleontological form. Continuing on by the 1 m thick mudstone-sandstone and 1 m thick sandy limestone, 40 cm thick and including algae and pebbles, all these lithologies suggests a gradation into a shallow-water from relatively deep waters. The capping lithologies are 14 m thick sandstone, comprising limestone and mudstone interbeddings occasionally, 1 m thick sandstone, with gravels scattered throughout and the 40 m thick polygenic conglomerate, that is made up of poorly sorted and angular limestone and ophiolite pebbles. The sequence is covered tectonically by the lowermost slab of the Lycian nappes, the Dumanlıdağ nappe.

Through the section, coarsening in grain-size upwardly, increasing in sand percentage while the mudstone and claystone dominate the lower parts, presence of algal and coral

reef limestones within the succession and introducing to conglomerate, all these imply a regression.

b) Akçasupınarı section characterizes Uçarsu formation, at the base of which rests conformably upon the Elmalı formation (Fig. 3). The section generally consists of mudstone-sandstone alternation. The sample numbered Ak-1, picked up at around 30 m, contains Gastropoda, *Turritella terebralis turritissima* Sacco, *Turritella terebralis subagibbosa* Sacco, *Turritella (Turritella) turris* Basterot, *Turritella (Haustator) striatellatus* Sacco, *Turritella (Haustator) tricincta* (Borson), *Turritella (Peyrotia) desmarestina* Basterot, *Turritella (Zaria) subangulata* (Brocchi), *Conus conoponderosus* (Sacco), Scaphopoda, *Dentalium (Antalis)* cf. *bouei* Deshayes and Bivalvia, *Anadara (Anadara) diluvii* (Lamarck), *Glycymeris pilosa deshayesi* (Mayer), *Glycymeris (Glycymeris)* cor (Lamarck), *Pitar,(Paradione) lilacinoides* (Schaffer), *Callista (Callista) chione* (Linne).

The other sample numbered Ak-2 has been taken from the sandy limestone at 140 m and embraces Gastropoda, *Turritella (Peyrotia) desmarestina* Basterot, *Xenophora deshayesi* (Michelotti), *Ancilla (Baryspira) glandiformis* (Lamarck), *Ancilla (Baryspira) obsoleta* (Brocchi), *Clavatula, asperulata* (Lamarck) and Bivalvia, *Anadara (Anadara) diluvii* (Lamarck), *Glycymeris (Glycymeris) inflatus* (Brocchi), *Cardium praeaculeatum* Holzl, *Venus(Antigona) burdigalensis producta* Schaffer, *Pitar (Paradione) lilacinoides* (Schaffer), *Callista (Callista) chione* Defrance.

c) At the base of Uçarsu section, Uçarsu formation rests unconformably upon the Elmalı formation (Fig. 4). The formation initiates with the 70 cm thick, greenish gray colored sandy mudstone, containing poorly sorted and ill-rounded pebbles-gravels scattered throughout. The Sample Uç-1 from that basal portion possesses Gastropoda, *Turritella terebralis turritissima* Sacco, *Turritella terebralis subagibbosa* Sacco. The greenish gray colored sandstone-mudstone alternation having 4.5 m thickness sits on that lithology. The following rock-type is 1 m thick, brown colored sandstone from which Sample Ug-2 was gathered. That sample contains Gastropoda, *Turritella terebralis* Lamarck, *Turritella terebralis subagibbosa* Sacco and nannoplanktons, *Toweius gammation* (Bramlette-Sullivan), *Coccolithus miopelagicus* Bukry, *Cyclicargolithus abisectus* (Muller) depicting a Miocene age (determined by Karakullukçu, H.).

Sample Ug-4 is devoid of any fossil form and the Sample Ug-5 includes planktonic foraminifera, *Globigerinoides altiaperturus* Bolli, *Globigerinoides trilobus trilobus* (Reuss), *Globigerinoides* cf. *bisphericus* Todd, giving Upper Burdigalian age (determination by Hakyemez, A.). The sequence goes further on by 32 m thick, gray colored mudstone and again a 8 m thick, gray colored mudstone. Sample Ug-6 from the uppermost of underlying and Sample Ug-7 from the overlying lithologies respectively, holds Upper-Burdigalian aged *Catapsydrax unicavus* Bolli, Loeblich and Tappan, *Globigerinoides trilobus trilobus* (Reuss) and *Globorotalia* sp. forms (determined by Hakyemez, A.).

Sample Ug-8, taken from greenish gray colored mudstone involves Gastropoda, *Turbonilla (Mormula) aturensis* (Cossmann and Peyrot), *Natica millepunctata* Lamarck, *Ficus (Ficus) geometra* (Borson), *Clavatula asperulata* (Lamarck), and Bivalvia, *Anadara (Anadara) fichteli* (Deshayes), *Glycymeris (Glycymeris) bimaculatus* (Poli), *Pecten* sp. and besides those, an ahermatype coral,

Acanthocyathus versicostatus (Michelin), giving Upper Burdigalian-Langhian age (determined by Babayiğit, S.).

The blanketing 6 m thick mudstone comprises 50 to 100 cm thick reef limestone lenticules, including increasingly algae and corals. The concealing, 1.5 m thick, gray colored mudstone exhibits a sandstone lenticule and examination of the Sample Ug-9 from that lithology has displayed the presence of Gastropoda, *Turritella (Turritella) turns* Basterot and Bivalvia, *Venus (Ventricoloidea) multilamella* (Lamarck). Another finding from that is *Catapsydrax dissimilis* (Cushman), claiming a Burdigalian age (determination by Hakyemez, A.).

d) Siradona section has been commenced with polygenic conglomerate, 6 m thick, having grain-matrix and of which pebbles-gravels are angular, moderately and/or well cemented, poorly sorted and displaying normal grading (Fig. 5). This rock-type rests unconformably upon the Elmalı Formation. The following 3 m thick and gray-green colored conglomerate (pebblestone)-sandstone-mudstone alternation pictures medium-layering and is underlain by 2.3 m thick, green colored mudstone. The sample numbered S-1 from that contains Gastropoda, *Turritella terebralis turritissima* Sacco, *Turritella terebralis subagibbosa* Sacco and *Subula (Oxymeris) plicaria* (Basterot).

Through the testing of Sample S-2 from the uppermost part of mudstone, the Gastropoda, *Turritella terebralis turritissima* Sacco has been encountered.

The capping lithology is 34 m thick, greenish gray colored mudstone, bearing thin claystone interbeddings and of which bedding planes are invisible. At 9.5 m of that lithology the samples S-3 and S-4 were gathered together. By reviewing these samples, the Gastropoda, *Turritella (Turritella) turris* Basterot, *Turritella (Archimediella) bicarinata* (Eichwald), Scaphopoda, *Dentalium (Antalis)* cf. *bouei* Deshayes and nannoplanktons, *Cyclicargolithus abisectus* (Muller), *Helicosphaera kamptneri* Hay-Mohler, *Sphenolithus belemnos* Bramlette-Wilcoxan, *Sphenolithus delphix* Bukry, *Sphenolithus predistentus* Bramlette-Wilcoxan, *Ericsonia formosa* (Kamptner), *Dictyococcites bisectus* (Hay-Mohler-Wade), *Discoaster deflandrei* Bramlette-Riedel, *Chiasmolithus gigas* (Bramlette-Sullivan), *Reticulofenestra* sp., *Pontoshaera* sp., and *Rhabdosphaera* sp., giving Lower Miocene age, were found (determined by Karakullukçu, H.).

The Sample S-5 from 60 m thick mudstone embraces *Cypfaea (Bernaya) fabagina* (Lamarck), belonging to Gastropoda. Continuing upward with an alternation of mudstone and reef limestone, in the rest of the section no mollusc form has been encountered to obtain age determination. Reef limestones contain algae and corals. Upward coarsening of the grain size has been considered as a clue for the rapid shallowing. The sequence terminates with the ophiolite pebbles-gravels. The whole succession is capped tectonically by Dumanlıdağ nappe, a constituent of Lycian nappes.

Depositional Environment.- The formation represents a transgressive shallow marine setting at initial stages and includes tropical-subtropical molluscs. Over the time, the environment has increasingly deepen and ahermatype corals and planktonic foraminifera were become plentiful. Seemingly, the environment has intensely shallowed later on. The upper intervals of the formation consist of coarse pebbles and gravels throughly. According to Şenel et al., 1989, causal effect for the

regression and variation in grain size has been the approach and emplacement of the Lycian nappes. By that view, it could be concluded that the thrust movements have been effective toward the end of Upper Burdigalian throughout the region.

Kasaba formation

Description.- Rathur, 1967 and Zaralıoğlu, 1967 had described all Miocene aged rock-units within the region as Kasaba formation. Önalan, 1979 has restrained the unit, subdividing it into two. That researcher has called the Burdigalian-aged units as Sinekci formation and that has considered the ones recording Helvetian-Tortonian age as Kasaba formation, Helvetian-Tortonian in age. Şenel et al., 1989 have claimed that Kasaba formation has been observed within Beydağları autochton and so reexamined its extension.

Type locality.- Ortabağ township at Kasaba plain.

Localities of the sections.- Ardıçlıburun, Dikenlialan stream, Çamköy, Ortabağ and Boyacipman.

Contact relationships.- Kasaba formation rests unconformably upon the Beydağları formation and Kıbrısdere and Gömüce members of the Sinekçi formation, although it covers the Çayboğazı member of Sinekçi formation conformably. Toward northwestern it is underlain technically by Elmalı formation, involving in the Gömbe group of Yeşilbarak nappe, while at Sidek plain in southeast, Felenkdağ conglomerate overlies it with an unconformity.

Lithology.- The formation consists of thick-layered polygenic conglomerate (pebblestone), light gray, brownish-greenish gray and yellow colored sandstone-mudstone and intercalated reef limestone lenticules.

In Boyacipman section, the formation initiates with the claystones, 3 m thick and bearing thin sandstone and clayey sandstone beds occasionally. The overlying molluscs-rich sandstone suggests shallowing. Toward the upper sect, that rock-type alternates with the sandy limestone and mudstone. The succession comes to an end with a thick conglomerate, reaching to 8 m.

The Ortabağ section begins with the green colored claystone, 3 m thick and bearing greenish gray colored and 5-15 cm thick sandstone layers occasionally. On that, 1 m thick, gray-green colored gravelly-sandy mudstone is observed. The 2 m thick conglomerate, that is gray colored and made up of rounded and poorly sorted pebbles-gravels covers that. Going further on by muddy-gravelly sandstone, the succession terminates with the conglomerate.

Thickness.- The thickness varies between 0 and 200 meters.

Fossil content and age.- The species *Divaricella ornata subornata* Hilber and *Cerithium zejsneri* Pusch, found through the section, are peculiar to the Lower Badenian stage of central Paratethys. Moreover, it is known that several species, introduced in the formation are also included in marine Lower Badenian stage of central Paratethys. Thus, for the investigation area, the ages Langhian and Lower Badenian, that is contemporary with the former were demonstrated loo. The formation has been determined as characterizing that time interval (Table 1). The ages acquiring from the corals, benthic foraminifera and nannoplanktons, found in also support that establishment. The species and the levels at which they were captured through the section has been explained in the following lines.

a- Boyacıpınarı section is characterized by a 3 m thick, green colored claystone, bearing thin sandstone and clayey sandstone interbeddings (Fig. 6). Sample Fd-1a at that level contains Gastropoda, *Bulla* sp., Bivalvia, *Corbula (Varicorbula) gibba* (Olivi) and Miocene-aged nannoplanktons, *Helicosphaera kamptneri* Hay-Mohler, *Coccolithus miopelagicus* Bukry, *Sphenolithus conicus* Bukry, *Cyclicargolithus abisectus* (Muller), *Cyclicargolithus floridanus* (Roth-Hay), *Dictyococcites bisectus* (Hay-Mohler-Wade) and *Toweius gammation* (Bramlette-Sullivan) (determinated by Karakullukçu, H.). By those specimens, the environment is suggested as being at offshore and deeply waters of open shelf.

The following rock-type is the 50 cm thick, gray-green colored clayey sandstone, bearing Operculina sp. That is underlain by 1.2 m thick, medium-bedded, greenish gray colored and fine-grained sandstone. Changing in lithology reflects becoming shallower increasingly. The Sample Fd-1, gained from that sandstone exhibits Gastropoda, *Ancilla (Bayspira) glandiformis* (Lamarck), *Conus (Conolithus) dujardini* Deshayes and Bivalvia, *Lutraria (Psammophila) oblonga* Chemnitz.

The next one, sampled by Fd-2, is 1 m thick and green colored, molluscs-rich claystone and that bears Gastropoda, *Xenophora deshayesi* (Michelotti), *Strombus (Strombus) bonellii* Brongniart, *Natica millepunctata* Lamarck, *Ancilla (Baryspira) glandiformis* (Lamarck), *Clavatula asperulata* (Lamarck), *Conus (Chelyconus) fuscocingulatus* Bronn, *Subula (Oxymeris) plicaria* (Basterot) and Bivalvia, *Glycymeris pilosa deshayesi* (Mayer), *Nemocardium spondyloides* (Hauer), *Venus (Ventricoloidea) multilamella* (Lamarck), *Callista (Callista) chione* (Linne).

The overlying package consists of a 20 cm thick, gray-green colored sandstone, a 30 cm thick siltstone, bearing *Operculina* sp. abundantly, and a 3 m thick, green colored mudstone, sampled by Fd-3, containing Gastropoda, *Ancilla (Baryspira) glandiformis* (Lamarck), *Clavatula (Clavatula) calcarata francisci* Toula. The section advances with a 50 cm thick, gray-green colored, fine-grained sandy limestone and a 1.6 m thick, green colored mudstone. The sample numbered Fd-4 from that submits Gastropoda, *Turritella (Turritella) turris* Basterot, *Turritella (Turritella) tricarinata* (Brocchi), *Turritella (Haustator) striatellatus* Sacco, *Ancilla (Baryspira) glandiformis* (Lamarck) and Bivalvia, *Glycymeris pilosa deshayesi* (Mayer) and *Divaricella ornata subornata* Hilber.

Going on through a 2.5 m thick, medium layered sandy limestone, at which the section has been sampled by Sample Fd-5, bearing Gastropoda, *Turritella (Turritella) turris* Basterot, continues with a 60 cm thick, green colored mudstone, overlying that. The upcoming lithologies are 15 m thick, massive sandy limestone, bearing gravels scattered throughout and a 2 m thick, green colored algal mudstone. The Sample Fd-6 from that displays the presence of broken and washed coral fragments, as exemplified by *Tarbellastrea* sp., and algal flocculations (determined by Babayiğit, S.). The following lithology in the succession is 60 cm thick, green colored mudstone.

The rock type resting upon that is 17 m thick, gray colored, massive limestone, bearing fine grained sandstone interbeds. Within that, small algae-coral reefs, including bioclastic material and made up of large coral heads and red algae enveloping them are observed. Those reefs lenticulate laterally. The corals constituting the reefs are the ones such

as *Coloria sicilae* Chevalier, *Defrancia irregularis* (Defranee), *Heliastrea tchihatcheffi* Chevalier, *Favia* sp., *Porites* sp. These suggest a Upper Burdigalian-Lower Langhian time interval (determined by Babayiğit, S.). The Sample Fd-7, taken from the covering gray colored sandstones embraces Gastropoda, *Cerithium (Therichium) europaeum graciliornata* Sacco, *Conus conoponderosus* (Sacco) and *Bivalvia, Barbatia (Barbatia) barbata* (Linne), *Anomia (Anomia) ephippium rugulosostriata* Bronn, *Pseudochama (Pseudochama) gryphina taurolunata* (Sacco) and *Venus (Ventricoloidea) multilamellata* (Lamarck).

The sequence continues with 30 cm thick, green colored claystone and another lithology, 10.5 m thick and gray colored, medium-layered sandstone, from which Sample Fd-8 has been picked up blankets that. That specimen envelopes Gastropoda, *Turritella (Archimediella) bicarinata* Eichwald, *Turritella (Haustator) tricincta* (Borson), *Cerithium (Pychocerithium) turritoplicatum* Sacco, *Cerithium (Thericium) vulgatum miocenicum* (Vignal), *Clavatula (Clavatula) calcarata francisci* Toula and Bivalvia, *Pseudochama (Pseudochama) gryphina taurolunata* (Sacco), *Venus (Ventricoloidea) multilamella* (Lamarck). Sample Fd-9, taken from the 1 m thick, greenish yellow colored mudstone covering that lithology, contains gastropods, exemplified by *Turritella (Turritella) turris* Basterot, *Turritella (Haustator) tricincta* (Borson), *Turritella (Archimediella) bicarinata* Eichwald, *Cerithium (Pychocerithium) turritoplicatum* Sacco, *Cerithium zejsneri* Pusph, *Cerithium (Thericium) vulgatum miocenicum* (Vignal), *Ancilla (Baryspira) glandiformis* (Lamarck), *Cojnus conoponderosus* (Sacco), *Conus striatulus* Brocchi and bivalves, embodied by *Barbatia (Barbatia) barbata* (Linne), *Glycymeris pilosa deshayesi* (Mayer), *Glycymeris (Glycymeris)* cor (Lamarck), *Glycymeris (Glycymeris) inflatus* (Brocchi), *Amusium cristatum* (Bronn), Venus (Ventricoloidea) multilamella (Lamarck) and *Nemocardium spondyloides* (Hauer).

b-Ortabağ section is introduced with approximately 3 m thick, green colored claystone, bearing greenish gray colored sandstone interbeddings, of which thicknesses vary between 5 and 15 centimeters. The Sample Çb-1 from that claystone yields *Turritella (Turritella) turris* Basterot, *Turritella (Archimediella) bicarinata* Eichwald, *Aporrheis pespelecani* (Linne), *Natica millepunctata* Lamarck, owing to Gastropoda; *Anadara (Anadara) diluvii* Lamarck, *Corbula (Varicorbula) gibba,* the species of Bivalvia and Scaphopoda, *Dentalium* sp.

The section is extended by 1 m thick, gray-green colored gravelly-sandy mudstone. The Sample Çb-2 from that produces huge amounts of mollusc species, exemplified by gastropods, *Turritella (Turritella) tricarinata* (Brocchi), *Turritella (Turritella) turris* Basterot, *Turritella (Zaria) spirata* (Brocchi), *Turritella (Archimediella) bicarinata* Eichwald, *Cypraea (Bernaya) fabagina* Lamarck, *Polinices (Polinices) redemptus* (Michelotti), *Natica millepunctata* Lamarck, *Distorsio (Rhysema) tortuosa* (Borson), *Ficus (Ficus) geometra* (Borson), *Murex (Bolinus) subtorularius* Hoernes-Auinger, *Galeodes cornutus* (Agassiz), *Latirus (Dolicholatirus) dispar* (Peyrot), *Ancilla (Baryspira) glandiformis* (Lamarck), *Clavatula asperulata* (Lamarck), *Conus antiquus* Lamarck, *Conus clavatulus* d'Orbigny, *Conus (Chelyconus) fuscocingulatus* Bronn, *Conus mercati* Brocchi, *Conus (Chelyconus) puschi* Michelotti, *Subula (Oxymeris) plicaria* (Basterot); bivalves, exemplified *by Anadara (Anadara) turonica* (Dujardin), *Glycymeris pilosa deshayesi* (Mayer), *Glycymeris (Glycymeris)*

cor Lamarck, *Pecten fuschi* Fontannes, *Pecten (Flabellipecten) solarium* Lamarck, *Pynodonta germanitala* (de Gregorio), *Codokia leonina* (Basterot), *Nemocardium spondyloides* (Hauer), *Nemocardium spondyloides herculeum* Dollfuss-Cotter-Gomez, *Venus (Ventricoloidea) multilamella* (Lamarck), *Callista (Callista) chione* (Linne), *Corbula (Varicorbula) gibba* (Olivi). That sample also surrenders benthic foraminifera, exemplified by *Borelis melo* (Fichtel and Moll), *Amphistegina* sp., *Operculina* sp., implying a Late Burdigalian-Tortonian age (determined by Sirel, E.). By faunal assemblage it has been inferred that, that environment was shallower than the former and represented the shallow parts of the shelf.

Depositional environment - Mollusca-rich Kasaba formation pictures a subtropical climate and shallow parts of the shelf. Diversification in species implies that the environment has unchanged over a long time. It is thought that, the grain-size coarsening and disappearing of the fossil records afterwards have resulted from the moving in of Lycian nappes and regression, due to that approaching.

CONCLUSIONS AND DISCUSSION

Uçarsu and Kasaba formations, which have been examined for mollusc-contents, are observed within different tectonic units. For the ages and environmental characteristics of these units, different persuasions have been proposed. By those,

1. Overviewing the paleogeographic and chronostratigraphic denotations of the species, it has concluded that, several are the ones found in Lower and Middle Miocene marine stages of both Mediterranean Tethys and central Paratethys. *Divaricella ornata subornata* Hilber and *Cerithium zejsneri* Pusch, encountered in Kasaba formation, are the species peculiar to Lower Badenian stage and Pitar *(Paradione) lilacinoides* (Schaffer) can only be seen in Eggenburgian stage of the central Paratethys. These species, may not be come across in Burdigalian and Langhian stages, are the ones distinguishing Tethyan-fauna-rich central Paratethyan stages (Eggenburgian and Lower Badenian) from Mediterranean Tethyan stages. Therefore, for the investigation area, Eggenburgian-Carpathian-Lower Badenian marine stages of central Paratethys have pictured along with the Upper Burdigalian-Langhian with which the former ones are contemporaneous.

2. None of the species included in Uçarsu formation, *Cassidaria tauropomum* (Sacco), *Vexillum (Uromitra) pluricostata percostulata* (Sacco), *Pecten zizinae* Blanckenhorn, *Chlamys (Macrochlamys) latissima praecedens* (Sacco), *Pitar (Paradione) lilacinoides* (Schaffer), *Cardium praeculeatum* Hölzl, *Venus (Antigona) burdigalensis producta* Schaffer, *Turritella terebralis turritissima* Sacco, *Turritella (Peyrotia) desmarestina* Basterot, characterizing Lower Miocene could be registered in Kasaba formation, while the ones, found in Kasaba formation, namely *Divaricella ornata subornata* Hilber and *Cerithium zejsneri* Pusch proper to Lower Badenian, can not be observed in Uçarsu formation. Thus, these two formations are not contemporary and those developed in different periods, following one another.

3. Poisson, 1977 has claimed that the green colored marl, including levels with *Operculina* sp. at lowermost part of the Kasaba formation is Upper Burdigalian in age and the overlying marl and conglomerate represents the Langhian stage and he also has proposed a Serravallian time duration for the following parts of that section. Hayward

(1982, 1984), has emphasized that the Kasaba formation is Upper Mocene in age and that unit depicts a fan-delta, picturing a regressive marine sequence terminated with the alluvial fan systems. Şenel et al., 1989 has stressed that, Kasaba formation typifies a Upper Burdigalian-Lower Langhian duration and that has undergone the tectonic movements. Tuzcu et al. (1994) have also proposed that the formation characterizes a Upper Burdigalian-Lower Langhian time interval. For the auther of the text, by the context of mollusk-fauna, Kasaba formation deposited at a warm and shallow marine environment and that implies a regressive succession, giving a Langhian (Lower Badenian) age.

4. The age of the Uçarsu formation has previously been considered as Upper Burdigalian-Lower Langhian by Şenel et al. (1989,1994) and Tuzcu et al. (1994) although it has been concluded as Upper Burdigalian (Upper Eggenburgian-Carpathian) through this investigation, by the molluscs determined. Planktonic foraminifer and nannoplankton findings also uphold that approach. Uçarsu formation offers a sequential development, introduced with transgressive levels and comes up to an end through regressive character. On the contrarily, Kasaba formation submits a Langhian (Lower Badenian) duration, by the presence of *Divaricella ornata subornata* Hilber and *Cerithium zejsneri* Pusch, appearing at the initiation of Middle Miocene, These forms, as specified previously, are proper to Lower Badenian too.

5. It is known that at the region the Lycian nappes had firstly lodged and then the Yeşilbarak nappe had been fallen beneath those. All these have overlain the Lower-Middle Miocene aged units technically (Poisson, 1977; Önalan, 1979; Şenel et al., 1989,1991, 1992, 1994; Şenel, 1997). The duration of those emplacements have been estimated as Langhian by Poisson, 1977 though considered as Lower Langhian by Şenel et al. (1987, 1989, 1991, 1992, 1994) and Şenel 1997 *a,b,c.* But it might undeniably be clarified through the search that, the Nappes had begun effective toward the end of Upper Burdigalian and that phenomena continued until the closure of Langhian, as attested by the paleontological findings in both formations and stratigraphic relationships.

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