

## Systematic of Albian - Cenomanian Gastropods and Bivalves from the Kazhdumi Formation, Zagros Basin

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### Abstract

The Albian- Cenomanian (Kazhdumi Formation) sediments from northeast of Shiraz, Zagros Basin, represents a carbonate sedimentary succession and contain diverse gastropods and bivalves. Detailed studies on 80 samples of invertebrate macrofauna on two stratigraphic sections led to recognized 2 species and 5 genera of gastropods and 7 species and 13 genera of bivalves assemblages. The absence of large gastropods and bivalves fauna and abundance of suspension-feeders indicated instability of the substrate and a medium energy condition. From a palaeobiogeographic point of view, the fauna from the Kazhdumi Formation were similar to the Central Iran and North Jordan and Wadi Qena (Egypt).

**Keywords:** Gastropoda; Bivalve; Kazhdumi Formation; Fars Zone; Zagros Basin.

### Introduction

The sediment of Kazhdumi Formation was deposited during a relative sea level rise and act as a regional source of hydrocarbons mainly in the southwestern Iran [20].

The Kazhdumi Formation was described for the first time by Kent et al., in an unpublished report in 1951. The formation is named after Kazhdumi Castel in the Tang-e- Gurguda, 10 km north of Gachsaran. The basal contact of Kazhdumi Formation with underlying Daryan Formation is associated with a zone of iron oxide, suggesting either a shallowing or a possible diastem. The upper contact shows a gradational transition to the basal of Sarvak Formation. Prior to its formal definition, the rocks of the Kazhdumi Formation were designated as the Ebad Formation [36]. The original description

was amended by James and Wynd [27]. According to this report [26], the formation divided into two lateral facies, deep facies (type section) and shallow facies. Former contains dark, bituminous shale with subordinate, dark, argillaceous limestone with pelagic microfossils such as planktonic foraminifera and is present in Dezful Embayment, Izeh and southwestern of the Fars Zones. It was limited to the SE by the Fars platform ( Shallow facies of Kazhdumi Formation), to the north, it was limited by the EW Bala Rud carbonate shoal, Which separated Dezful Embayment from Lorestan Zone. To the east, it was bordered by a sill, on which anoxic and oxic facies fluctuated according to sea level changes, however little information is available on a possible eastern extension [9]. Shallow facies is spread in the Fars Zone and contains shallow limestone.

Deposits of the shallow facies of Kazhdumi

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Formation are full of fossil fauna such as foraminifers, echinoderms and mollusks especially bivalve and gastropoda. Unfortunately, there are few studies on these fauna in Iran. In this study, therefore, the author tries to introduce some of the macrofauna assemblages of shallow facies of Kazhdumi Formation at 2 sections, Naqshshah Rostam and Marve Dasht in northeastern of Shiraz, Fars Zone.

samples are housed in the Department of Geology, Lorestan University. The material includes a large proportion of crushed, distorted, imperfect, or weathered individuals, although it is plentiful, Well preserved specimens were cleaned by means of a mild detergent, and whenever necessary, an ultrasonic vibrator and a preparation needle. Finally, a light binocular microscope was used, where it was necessary.

**Materials and Methods**

80 samples from the Kazhdumi Formation were studied in the selected stratigraphic sections. All rock

**Results**

The closure of the Tethys realm between Arabian and



Figure 1. Structural-sedimentary zones of Zagros Belt [47].

Iranian plates produced the NW- SE trending Zagros Orogenic Belts. The Zagros collision orogen is divided in four main tectonic domain, Urumieh Dokhtar Magmatic arc; Sannadaj- Sirjan; Imbricated Zone and Zagros Folded - Belt [3]. Zagros Folded is bounded

along its most external limit by the Mountain Front Flexure. Mountain Front shows an irregular geometry with arcs and embayment, which from SE to NW are: Fars Zone, Dezful Embayment and Lorestan Basin.

The stratigraphic sections under study are located at

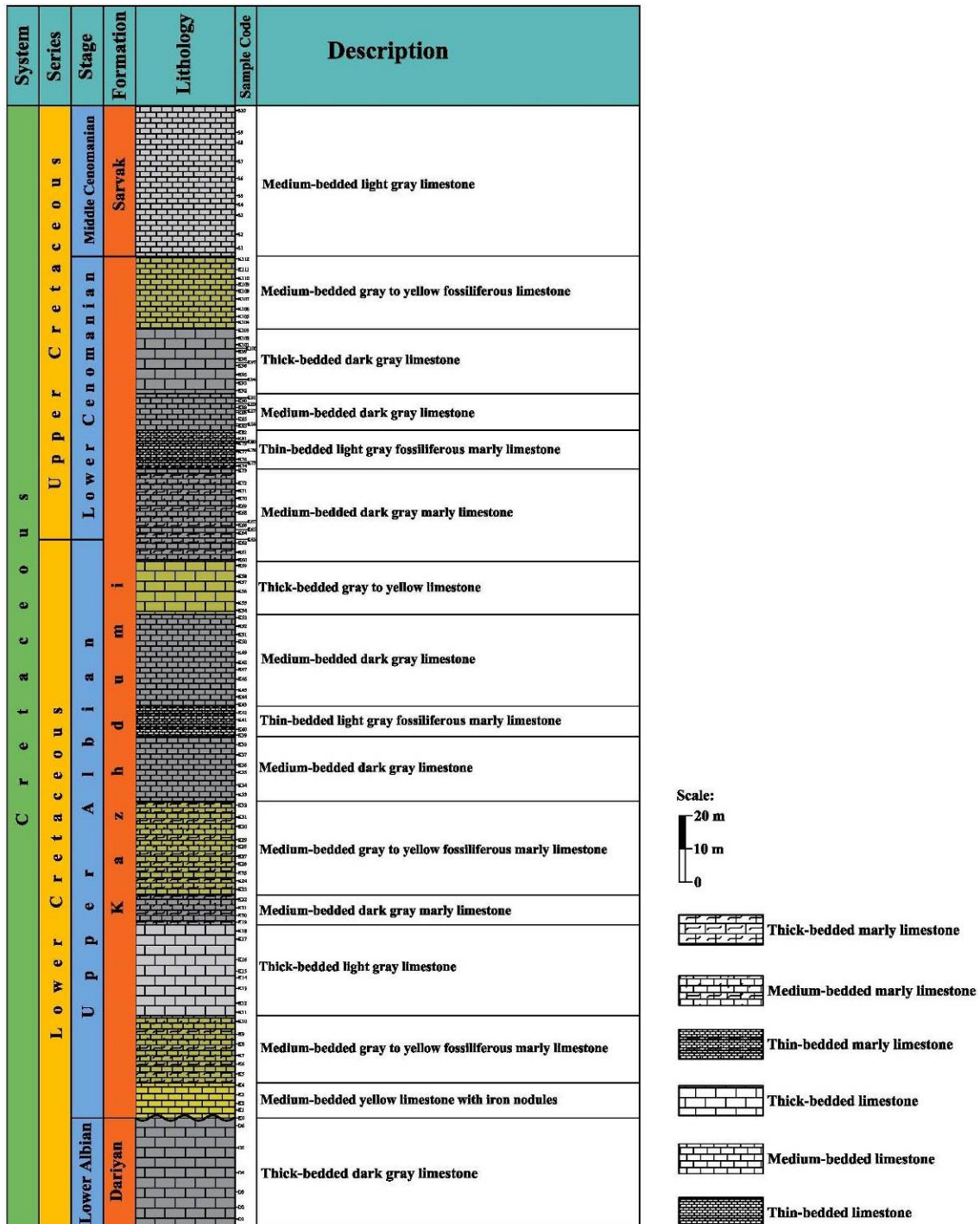


Figure 2. Schematic of the lithostratigraphic column in the Naqsh Rustam section, northeast of Shiraz.

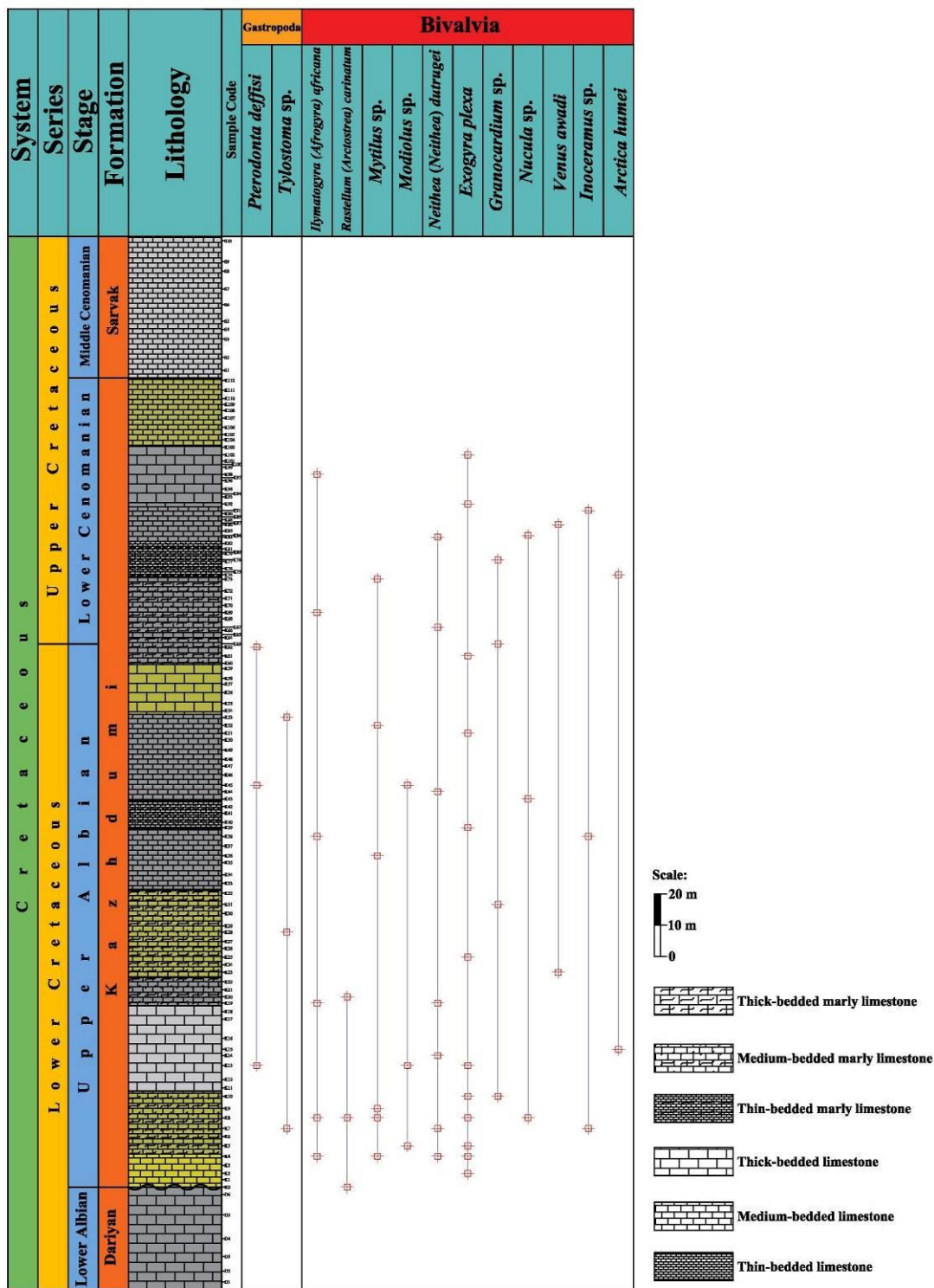


Figure 3. Vertical distribution of bivalves and gastropods in the Naqsh Rustam section, northeast of Shiraz.

the northeast of Shiraz, Fars Zone [Fig. 1] with geographic coordinates of: Marv Dasht 52° 52' 42" E and 29° 50' 33" N; Naqsh rustam 52° 54' 2" E and 29°

58' 28" N.

The Kazhdumi Formation of Naqsh rustam and Marv Dasht sections consist essentially of gray medium to

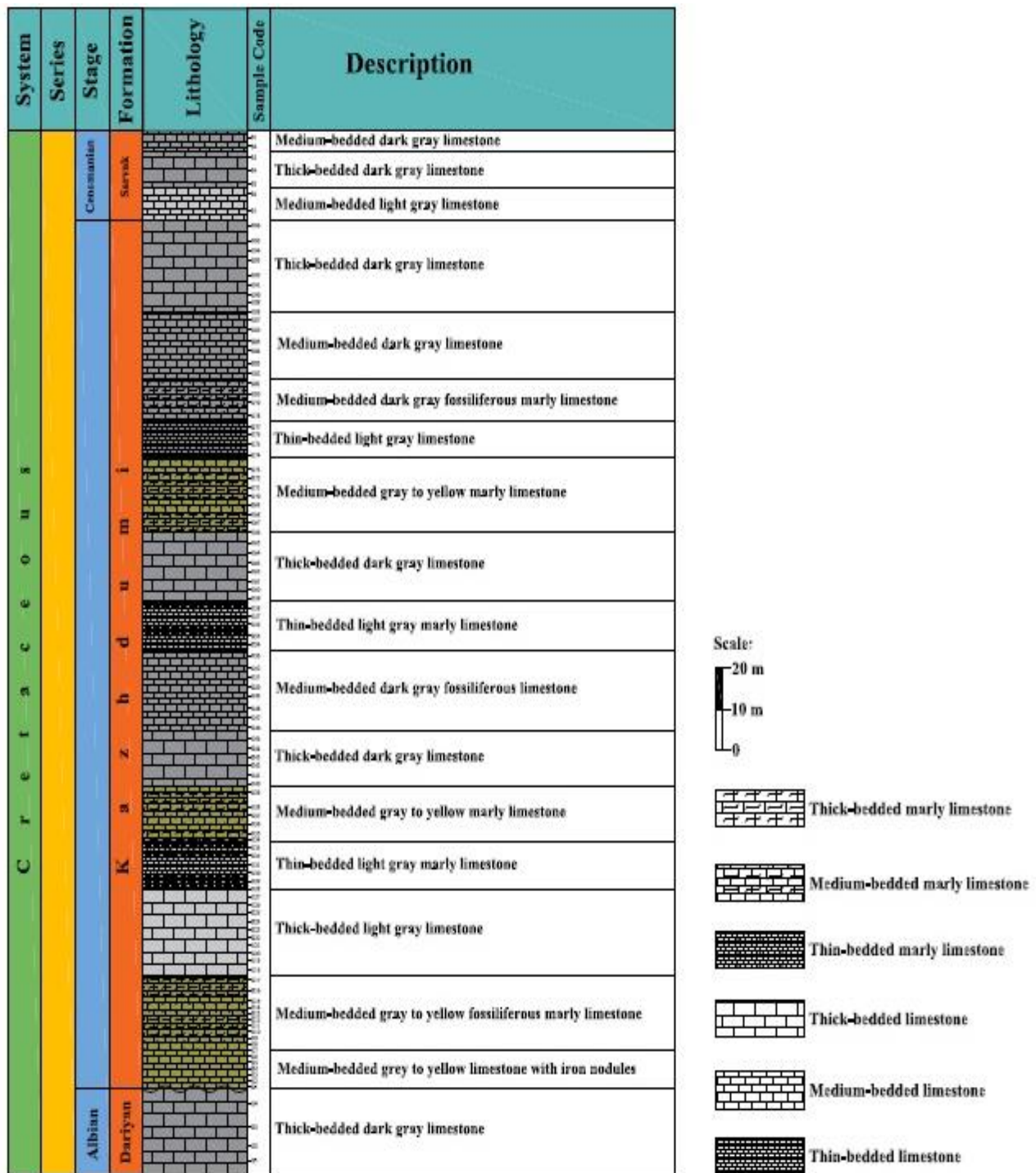


Figure 4. Schematic of the lithostratigraphic column in the Marv Dasht section, northeast of Shiraz.

thick limestone and gray to yellow marly limestones and lies between the Daryan Formation at the base and Sarvak Formation at the top. According to the distribution of index foraminifera, Kazhdumi Formation

is Albian- Cenomanian in age [39]. Detailed studies on two stratigraphic sections led to recognized 2 species and 5 genera of gastropods and 7 species and 13 genera of bivalves' assemblages [Figs. 2, 3, 4, 5].

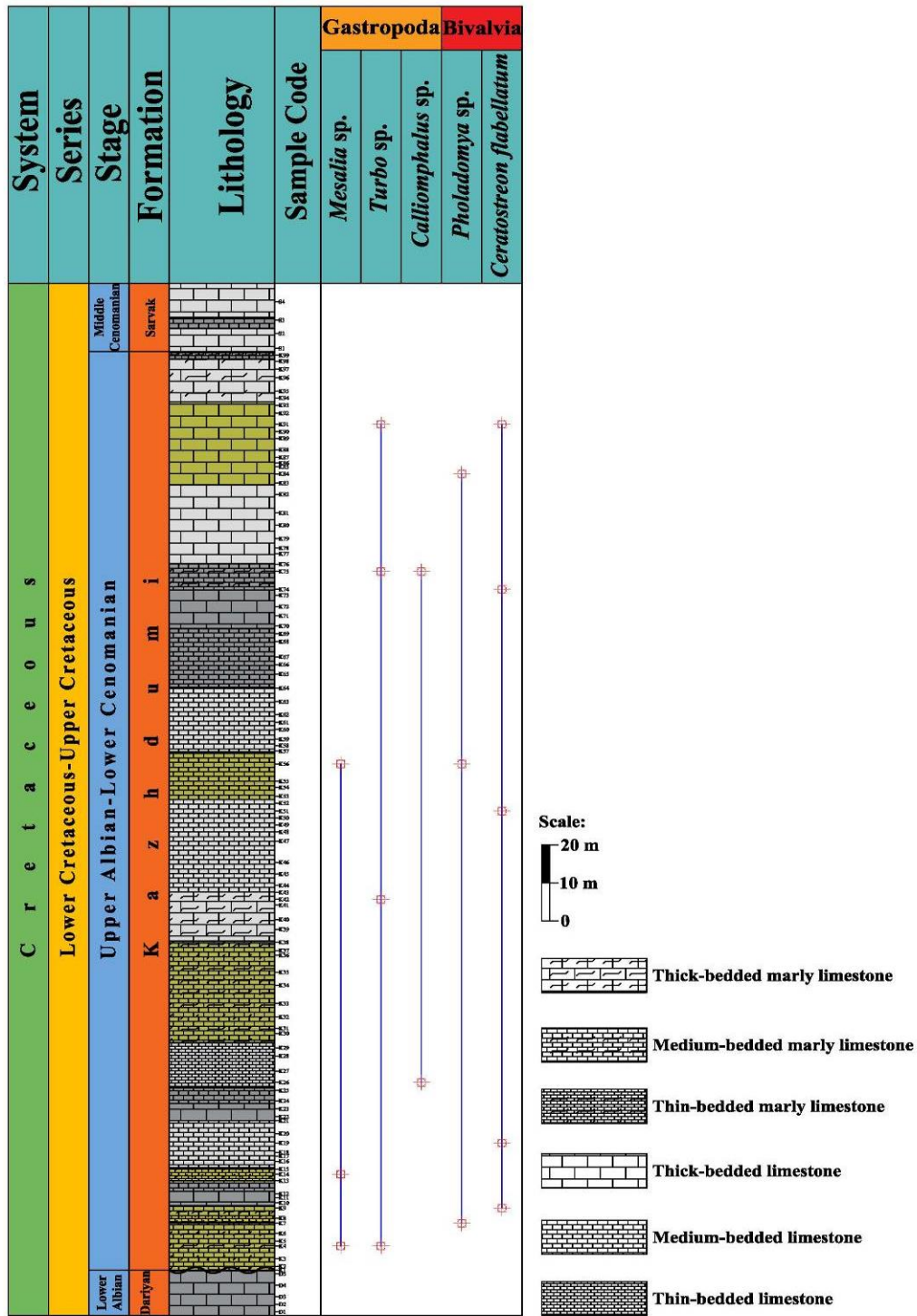


Figure 5. Vertical distribution of bivalves and gastropods in the Marv Dasht section, northeast of Shiraz.

Systematic Paleontology  
 Phylum Mollusca [33]  
 Class Gastropoda [14]  
 Subclass Caenogastropoda [12]

Order Littorinimorpha [22]  
 Superfamily Stromboidea Rafinesque, 1815  
 Family Colombellinidae [18]=  
 Columbelleriidae [57]

**Genus *Pterodonta* [16]**  
***Pterodonta deffisi* [55]**  
**Plate 1, Figs. a, b**

**Material:** 3 internal molds from the Kazhdumi Formation, Naqsh Rustam section.

**Description:** Shell fusiform, Body whorl large little more than the half of the shell height. Protoconch and



**Plate 1**

**a)** *Pterodonta deffisi* [55], Lateral view, X 2/3, Naqsh Rustam section; **b)** *Pterodonta deffisi* [55], Apertural view, X 2/3, Naqsh Rustam section; **c)** *Tylostoma* sp. Apertural view, X 2/3, Naqsh Rustam section; **d)** *Tylostoma* sp. Lateral view, X 2/3, Naqsh Rustam section; **e)** *Mesalia* sp. Lateral view, X 1, Marv Dasht section; **f)** *Mesalia* sp. Apertural view, X 1, Marv Dasht section; **g)** *Turbo* sp. Apertural view, X 1.2, Marv Dasht section; **h)** *Turbo* sp. Lateral view, X 1.2, Marv Dasht section; **i)** *Calliomphalus* sp. Lateral view, X 1, Marv Dasht section; **k)** *Pholadomya* sp. Left Valve, X 1, Marv Dasht section; **j)** *Ceratostreon flabellatum* [24], Left Valve, X 2, Marv Dasht section; **m)** *Ceratostreon flabellatum* [24], Internal part of Left Valve, X 2, Marv Dasht section; **n)** *Ceratostreon texanum* [44], Left Valve, X 2, Naqsh Rustam section; **o)** *Ceratostreon texanum* [44], Internal part of Left Valve, X 2, Naqsh Rustam section. Scale bar represents 1 cm.

first whorls not preserved. Spire with convex 3-4 whorls, Suture deep furrowed, Spire height 21 mm, Body whorl height 38- 40 mm, Base width 11 mm.

**Remark:** This species having conical body with overlapping spire whorls and a triangular anterior base.

**Ecology:** epifaunal grazer

**Environments:** open and restricted shallow and deep subtidal, offshore ramp, reef, buildup or bioherm.

**Age range:** Jurassic- Paleocene

**Distribution in the Aptian -Cenomanian:** Egypt (Late Aptian- Cenomanian), Italy (Albian), Madagascar (albian).

**Family Tylostomatidae [53]**

**Subfamily Tylostominae [52]**

**Genus *Tylostoma* [53]**

*Tylostoma* sp.

Plate 1, Figs c, d

**Material:** 3 internal molds from the Kazhdumi Formation, Naqsh Rustam section.

**Description:** Shell moderate conical, the spire conical consists of 4 overlapping smooth whorls. These whorls are slightly convex and separated by slightly depressed sutures. Body whorl is large and semi-conical with convex flanks and accounting for about two-thirds of the total height. Aperture is partly broken but most probably narrow and lanceolate. Body whorl is two three of shell height, Outer lip elongated. Spire height is 9 mm, Body whorl height is 14- 15 mm and base width is 8 mm.

**Ecology:** epifaunal grazer

**Environments:** open shallow and deep subtidal, shelf, reef buildup or bioherm, deltaic, estuary/bay, shore face, lagoon, coastal, paralic , offshore ramp.

**Age range:** Jurassic- Paleocene

**Distribution in the Aptian - Cenomanian:** China (Aptian- Albian), Egypt (Albian- Cenomanian), Ethiopia (Aptian), Germany (Cenomanian), Italy (Cenomanian), Japan (Late Aptian), Mexico (Albian), Portugal and Spain(Albian), Switzerland (Albian).

**Superfamily Turritellidea [19]**

**Family Turritellidae [34]**

**Genus *Mesalia* [25]**

*Mesalia* sp.

Plate 1, Figs e, f

**Type species:** *Turritella (Mesalia) jovis-ammon* [42]

**Material:** 3 internal molds from the Kazhdumi Formation at Naqsh Rustam section and 2 internal molds at Marv Dasht section.

**Description:** Shell small, turriculate, the spire high consists of 4 whorls. These whorls are slightly convex and separated by slightly depressed sutures. Body whorl

is moderate. Aperture partly broken but most probably round. Spire height 4-5 mm, Body whorl height 6- 8 mm, Base width 2 mm.

**Ecology:** Mobile epifaunal, suspension feeder

**Environments:** shallow and deep subtidal, coastal, offshore, deltaic, carbonate estuary, marginal marine, lower shoreface.

**Age range:** Cretaceous- Quaternary

**Distribution in the Aptian- Cenomanian:** France, (Early Albian), Germany (Cenomanian), Madagascar (Albian), Mexico (Late Aptian), England (Aptian), UASA (Cenomanian).

**Subclass Vetigastropoda [45]**

**Family Turbinidae [42]**

**Subfamily Turbininae [42]**

**Genus *Turbo* [33]**

*Turbo* sp.

Plate 1, Fig. g, h

**Material:** 3 internal molds from the Kazhdumi Formation at Naqsh Rustam section and 2 internal molds at Marv Dasht section.

**Description:** Small -sized, turboform, moderately low-spired gastropod. Spire conical and consisting of three overlapping convex whorls with weakly shelf. Sutures weakly impressed. Body whorl accounting for more than 2/3 of the total shell height. Umbilicus deep. Aperture partly broken but most completely round. Spire height 4-5 mm, Body whorl height 8- 10mm, Base width 8 mm.

**Ecology:** Epifaunal grazer

**Environments:** shallow subtidal, coastal, offshore, deltaic , deep subtidal , carbonate estuary, marginal marine, lower shoreface

**Age range:** Silurian- Recent

**Distribution in the Aptian – Cenomanian:** Brazil(Middle Albian), Germany (Cenomanian), France (Albian), Mexico (Albian), Serbia and Montongro (Late Aptian), Switzerland (Albian).

**Superfamily Trochoidea [42]**

**Family Trochidae [42]**

**Subfamily Trochinae [42]**

**Genus *Calliomphalus* [10]**

*Calliomphalus* sp.

Plate 1, Fig. i

**Material:** 2 internal molds from the Kazhdumi Formation of Naqsh Rustam section and 2 internal molds of Marv Dasht section.

**Description:** Small -sized, trochiform, moderately high-spired gastropod. Spire conical and consisting of two overlapping convex, smooth whorls. Sutures weakly impressed. Body whorl accounting for more



than half (62%) of the total shell height. Umbilicus deep and whorl height 10- 12 mm, Base width 12 mm.

**Ecology:** Epifaunal grazer

**Environments:** shallow subtidal, coastal, offshore, deltaic, deep subtidal, carbonate estuary, marginal marine, lower shoreface

**Age range:** Jurassic- Eocene

**Distribution in the Aptian- Cenomanian:** Egypt (Late Cenomanian), French (Albian), Japan (Late Aptian).

**Class Bivalvia** [33]

**Subclass Heterodonta** [42]

**Infraclass Euheterodonta**

**Order Anomalodesma** [15]

**Superfamily Pholadomyoidea** [28]

**Family Pholadomyidae** King [28]

**Genus *Pholadomya*** [48]

*Pholadomya* sp.

**Plate 1, Fig. k**

**Material:** 3 shells from the Kazhdumi Formation at Naqsh Rustam section and 2 shells Marv Dasht section.

**Description:** Shell small-sized, elongate-ovate, inequilateral, equivalve; broadly rounded umbonal region; valves gaping posteriorly; ventral margin rounded; sculpture of broad concentric ribs in the whole surface separated by narrow interspaces; length 19 mm, height 12 mm.

**Ecology:** deep infaunal suspension feeder

**Environments:** shallow and deep subtidal, coastal, offshore, deltaic, estuary, marginal marine, lower shoreface.

**Age range:** Triassic- Pliocene

**Distribution in the Aptian - Cenomanian:** Angola (Early Albian), Egypt (Cenomanian), Ethiopia (Early Aptian), England (Aptian- Cenomanian), France (Valngian- Aptian), Greenland (Albian), Hungary (Campanian), Iran, East Isfahan (Late Baramian- Late Aptian). Japan (Aptian - Cenomanian), Jordan (Cenomanian), Mexico (Albian and Masstrichtian), Peru (Albian), Portugal (Albian), South Africa (Late Albian), Switzerland (Baramian- Aptian), United Arab Emirates (Cenomanian), USA, Kansas (Albian).

**Subclass Pterimorph** [8]

**Order Ostreoida** [18]

**Superfamily Ostreoidea** [42]

**Family Gryphaeidae** [56]

**Subfamily Exogyrinae** [56]

**Genus *Ceratostreon*** [7]

*Ceratostreon flabellatum* [24]

**Plate 1, Figs. l, m**

**Synonym:** *Exogyra flabellata* [24]; *Ceratostreon*

*flabellatum* (Goldfuss)[2].

**Material:** 6 left valve from the Kazhdumi Formation of Naqsh Rustam and 2 left valve of Marv Dasht section.

**Description:** Small size. Shape oval to narrow, comma-shaped. Shell thick with strong corrugated margin; ornament of variable radial ribs, some with short spines. Length is 0.7- 0.9 mm, height 23 -25mm.

**Ecology:** stationary epifaunal suspension feeder

**Environments:** shallow and deep subtidal, shoreface, offshore shelf, reef, buildup or bioherm, lagoonal/restricted, basinal carbonate.

**Age range:** Cretaceous

**Distribution in the Aptian- Cenomanian:** Algeria (Late Aptian), Ecuador (Albian), Egypt (Cenomanian), Iran: Alborz ( Cenomanian), Kerman( Cenomanian), Japan (Aptian), Jordan (Cenomanian), Peru (Early Albian), Poryugal (Aptian), Spain (Early Aptian), Switzerland (Early Aptian), England (Aptian), USA (Albian), Venezuela (Aptian).

*Ceratostreon texanum* [43]

**Plate 1, Figs, n, o**

**Synonym:** *Exogyra texana* [45]

**Material:** 2 left valve from the Kazhdumi Formation of Naqsh Rustam.

**Description:** Medium to large size. Shape oval and convex, comma-shaped. Shell thick with strong corrugated margin; ornament of variable radial ribs. Length 31 mm, height 41 mm. Resembling *Ceratostreon texanum* differs with *Ceratostreon flabellatum* in having more convex left valve and course nodes on the radial ribs of the left valve. Shell turns less than of *C. flabellatum*. Attachment area distinct and relatively large. Ligamental area variable in size.

**Ecology:** stationary epifaunal suspension feeder

**Environments:** shallow and deep subtidal, shoreface, offshore shelf, reef, buildup or bioherm, lagoonal/restricted, basinal carbonate.

**Age range:** Cretaceous

**Distribution in the Aptian - Cenomanian:** Afghanistan (Cenomanian), Algeria (Late Aptian), Brazil (Cenomanian), Ecuador (Albian), Egypt (Cenomanian); Japan(Aptian), Jordan (Cenomanian), Peru (Early Albian), Poryugal (Aptian), Spain ( Early Aptian), Switzerland (Early Aptian), England (Aptian), USA (Albian), Venezuela (Aptian).

*Exogyra plexa* [13]

**Plate 2, Fig. h, i**

**Material:** 4 left valve from the Kazhdumi Formation of Naqsh Rustam.

**Description:** Shell very small not exceeds 2 cm. ligament small with slightly curved hinge. Ornaments

by strong radial ribs. Muscle scar small and kidney-shape. Dorsal margin narrower than the ventral one.

**Ecology:** stationary epifaunal suspension feeder

**Environments:** shallow and deep subtidal,



### Plate 2

**a)** *Ilymatogyra (Afrogyra) africana* [30], Left Valve, X 1, Naqsh Rustam section; **B)** *Ilymatogyra (Afrogyra) africana* [30], Internal part of Left Valve, X 1, Naqsh Rustam section; **c)** *Rastellum (Arctostrea) carinatum* [31], Internal part of Left Valve, X 2, Naqsh Rustam section; **d)** *Rastellum (Arctostrea) carinatum* [31], Internal part of Left Valve, X 2, Naqsh Rustam section, **e)** *Mytilus* sp. Left Valve, X 1/3, Naqsh Rustam section; **f)** *Modiolus* sp. Right Valve, X 2/3, Naqsh Rustam section; **g)** *Neithea (Neithea) dutrugei* [10], Valve, X 1/3, Naqsh Rustam section; **h)** *Exogyra plexa* [13], Internal part of Left Valve, X 2, Naqsh Rustam section **i)** *Exogyra plexa* [13], Left Valve, X 2, Naqsh Rustam section; **k)** *Granocardium* sp. Right Valve, X 1, Naqsh Rustam section; **l)** *Granocardium* sp. Left Valve, X 1, Naqsh Rustam section; **m)** *Nucula* sp. Right Valve, X 1, Naqsh Rustam section; **n)** *Nucula* sp. Right Valve, X 1, Naqsh Rustam section; **o)** *Venus awadi*, Right Valve, X3, Naqsh Rustam section; **p)** *Inoceramus* sp. Lateral view, X2, Naqsh Rustam section; **q)** *Inoceramus* sp. Right valve, X2, Naqsh Rustam section; **r)** *Arctica humei* Cox, 1955, Left Valve, X3, Naqsh Rustam section. Scale bar represents 1 cm.

shoreface, offshore shelf, reef, buildup or bioherm, lagoonal/restricted, basinal carbonate.

**Age range:** Cretaceous

**Distribution:** Egypt (Cenomanian), UsA (Texas, Aptian-Albian).

**Subfamily Pycnodonteinae [51]**

**Genus *Ilymatogyra* [50]**

**Subgenus *Afrogyra* [35]**

***Ilymatogyra (Afrogyra) africana* [30]**

**Plate 2, Figs a, b**

**Synonym:** *Gryphaea africana* [29]

**Material:** 4 left valve from the Kazhdumi Formation of Naqsh Rustam and 2 left valve of Marv Dasht section.

**Description:** Small to medium sized. Oval to elongated-oval, partly obliquely drop-like. Inequivalve and inequilateral; left valve commonly strongly convex; right valve flat or slightly convex. Umbo weakly to helicoidally twisted, with a tendency to uncoiling. Length 11 mm, height 18 mm.

**Ecology:** stationary epifaunal suspension feeder

**Environments:** open shallow subtidal, offshore shelf, reef, buildup or bioherm.

**Age range:** Cretaceous- Paleocene

**Distribution in the Aptian- Cenomanian:** Brazil (Cenomanian), Egypt (Cenomanian), Italy (Cenomanian), Jordan (Cenomanian), Iran, Kerman (late Aptian- Early Cenomanian), Tunisia (Cenomanian).

**Family Ostreidae [42]**

**Subfamily Lophinae [56]**

**Genus *Restellum* [17]**

**Subgenus *Arctostrea* [37]**

***Restellum (Arctostrea) carinatum* [31]**

**Plate 2, Figs c, d**

**Synonym:** *Ostrea carinata* [31]

**Material:** 3 left valve from the Kazhdumi Formation of Naqsh Rustam and 2 left valve of Marv Dasht section.

**Description:** Shell moderate in size, left valve and its surface appear as zigzag line. Surface corrugated by course strong ridges. Length 29 mm, height 42 mm.

**Ecology:** stationary epifaunal suspension feeder

**Environments:** perireef or subreef, buildup or bioherm, shoreface, lagoonal/restricted shallow subtidal, peritidal, coastal, offshore shelf.

**Age range:** Jurassic- Cretaceous

**Distribution at the Aptian- Cenomanian:** Egypt (Cenomanian), Brazil (Late Albian), Iran, Kerman (late Aptian- Early Cenomanian).

**Order Mytilida [17]**

**Superfamily Mytiloidea [17]**

**Family Mytilidae [17]**

***Mytilus* [33]**

***Mytilus* sp.**

**Plate 2, Figs. e**

**Material:** 2 right valves from the Kazhdumi Formation of Naqsh Rustam.

**Description:** Shell large in size and Sub triangular to wedge in shell outline. Equilateral to semiequivalent valves. Dorsal margin triangular, umbo prosogyral, anterior margin smoothly, posterior margin strongly convex ventrally, both margins converging towards the ventral side. Shell surface ornamented by numerous faint concentric fila. Ligament external and slightly curved posteriorly towards the umbo, no hinge teeth. Length 17 mm, height 41 mm.

**Ecology:** stationary infaunal suspension feeder

**Environments:** coastal, shallow and deep subtidal, reef, buildup or bioherm, prodelta, e, basinal siliceous, offshore ramp.

**Age range:** Silurian- Recent

**Distribution at the Aptian- Cenomanian:** France (Aptian), Japan (Late Aptian), New Zealand (Aptian), Spain (Aptian), Sweden (Late Albian), Switzerland (Aptian).

**Subfamily Modiolinae [54]**

**Genus *Modiolus* [29]**

***Modiolus* sp.**

**Plate 2, Fig.f**

**Material:** 2 complete shells from the Kazhdumi Formation of Naqsh Rustam and 2 left valve of Marv Dasht section.

**Description:** Shell moderate in size mytiliform, elongated and inflated. Umbo subterminal, thick. Anterior side is higher than the posterior one. Ventral margin convex and joins both anterior and posterior sides at rounded edges.

**Ecology:** stationary infaunal suspension feeder

**Environments:** shallow and deep subtidal, reef, buildup or bioherm, shoreface, deep subtidal prodelta, delta plain (2), deep-water), basinal (siliceous) interdistributary, lacustrine.

**Age range:** Devonian- Recent.

**Distribution at the Aptian- Cenomanian:** South Africa (Albian), New Zealand (Cenomanian), Egypt (Albian- Cenomanian) Sweden (Albian), France (Early Cenomanian).

**Superfamily Pectinoidea [42]**

**Family Pectinidae [42]**

**Genus *Neithea* [11]**

***Neithea (Neithea) dutrugi* [11]**

**Plate 2, Fig. g**

**Type species.** *Pecten aequicostatus* [32]

**Material:** 1 shell from the Kazhdumi Formation of Naqsh Rustam and 2 left valve of Marv Dasht section.

**Description:** Shell medium-sized, inequivalve. Sculpture of six primary radial ribs, interspaces with four secondary radial ribs being the medial one slightly stronger. No auricles preserved. Length 24 mm, height 35 mm.

**Ecology:** stationary semi-infaunal suspension feeder

**Environments:** shallow and deep subtidal reef, buildup or bioherm shoreface, lagoonal

**Age range:** Cretaceous

**Distribution at the Aptian - Cenomanian:** Afghanistan (Cenomanian), Egypt (Albian-Cenomanian), Ethiopia (Early Aptian), Lebanon (Aptian), Hungary (Aptian), Italy (Cenomanian), United Arab Emirates (Cenomanian).

**Superfamily Cardioidea [32]**

**Family Cardiidae [32]**

**Genus *Granocardium* [20]**

***Granocardium* sp.**

**Plate 2, Figs. k, l**

**Type species:** *Cardium carolinum* [16]

**Material:** 2 inner mold from the Kazhdumi Formation of Naqsh Rustam section.

**Description:** Shell medium to large sized, equivalve, inequilateral, oval, elongated; strongly inflated, inflation increasing toward umbonal region; umbones relatively broad and incurved protruding beyond hinge line; beaks prosogyrate; anterior, posterior, and ventral margins rounded; posterodorsal margin broad, straight; sculpture of relatively broad with ribs with narrow interspaces, with pores. Length 16mm, height 28 mm.

**Ecology:** stationary semi-infaunal suspension feeder

**Environments:** shallow and deep subtidal, reef, buildup or bioherm, submarine fan (1), shoreface, perireef or subreef.

**Age range:** Cretaceous- Paleocene

**Distribution at the Aptian- Cenomanian:** Egypt (Aptian- Cenomanian), France (Cenomanian), England (Albian).

**Subclass Protobranchia [39]**

**Order Nuculida [15]**

**Superfamily Nuculoidea [26]**

**Family Nuculidae [26]**

**Genus *Nucula* [29]**

***Nucula* sp.**

**Plate 2, Figs. m,n**

**Material:** 4 internal molds from Kazhdumi Formation of Naqsh Rustam section and 3 internal molds of Marv Dasht section.

**Description:** shell small to medium in size and

oval, Umbo prosogyral, equivalve, inequilateral, posterior, and ventral margins rounded; Anterior side relatively higher than the posterior one.

**Ecology:** facultatively mobile infaunal deposit feeder-suspension feeder

**Environments:** shallow and deep subtidal, reef, buildup or bioherm, lagoonal, perireef or subreef, prodelta, basinal (siliciclastic), sand shoal.

**Age range:** Ordovician- Recent

**Distribution at the Aptian- Cenomanian:** Egypt (Aptian - Cenomanian), France (Cenomanian), Jordan (Cenomanian), Switzerland (Albian).

**Family Veneridae [42]**

**Subfamily Venerinae [42]**

**Genus *Venus* [33]**

**Subgenus *Venus* [33]**

**Type species:** *Venus verrucosa* [26]

***Venus* sp.**

**Plate 2, Fig. o**

**Material:** 3 internal molds from Kazhdumi Formation of Naqsh Rustam section and 2 internal molds of Marv Dasht section.

**Description:** subequilateral. Umbo premedian and prosogyral. Anterodorsal margin straight while the ventral margin strongly convex. Ornamented by concentric ridges of different strength. Length 9 mm, height 14 mm.

**Ecology:** stationary semi-infaunal suspension feeder

**Environments:** shallow and deep subtidal, reef, buildup or bioherm, lagoonal, perireef or subreef, prodelta.

**Age range:** Cretaceous- Recent

**Distribution at the Aptian- Cenomanian:** Egypt (Aptian- Cenomanian), England (Albian), France (Cenomanian), Jordan (Cenomanian), Switzerland (Albian).

**Order Pterioidea [38]**

**Superfamily Pterioidea [26]**

**Family Inoceramidae [24]**

**Genus *Inoceramus* [48]**

**Type species.** *Inoceramus* [48]

***Inoceramus* sp.**

**Plate 2, Figs. p,q**

**Material:** 2 complete from Kazhdumi Formation of Naqsh Rustam section.

**Description:** Shell medium-sized, slightly inequivalent, inequilaterally, subovate to subcircular; moderately convex. Left valve slightly more inflated than right one with slightly incurved, prosogyrate beak. Anterior margin nearly straight,

Ventral margin semi-circular. Sculpture of costae

with narrow interspaces; faint radial lines. Length 13 mm, height 28 mm.

**Ecology:** stationary semi-infaunal suspension feeder

**Environments:** shallow and deep subtidal, reef, buildup or bioherm, lagoonal, perireef or subreef, prodelta.

**Age range:** Cretaceous- Recent

**Distribution at the Aptian- Cenomanian:** Egypt (Aptian - Cenomanian), England (Albian), France (Cenomanian), Jordan (Cenomanian), Switzerland (Albian).

**Sub class Pteriomorpha** [8]

**Order Arcoida** [55]

**Superfamily Arcoidea** [32]

**Family Arctidae** [32]

**Genus *Arca*** [31]

*Arca* sp.

**Plate 2, Fig.r**

**Material:** 2 left gave from Kazhdumi Formation of Naqsh Rustam section.

**Description.** Shell small-sized, slightly inequivalve, inequilateral, Trapezoidal; moderately convex. Left valve slightly convex, prosogyrate beak. Anterior margin straight, ventral margin semi-circular. Sculpture contains costae with narrow interspaces; faint radial lines. Length 23 mm, height 18 mm.

**Ecology:** facultatively mobile infaunal suspension feeder

**Environments:** coastal, shallow subtidal, estuary/bay, lagoonal, reef, buildup or bioherm.

**Age range:** Permian - Recent

**Distribution at the Aptian- Cenomanian:** England (Cenomanian), French (Cenomanian), Germany (Cenomanian), Japan (Albian), Jordan (Cenomanian), Madagascar (Albian), New Zealand (Aptian), Peru (Albian), Spain (Albian), Switzerland (Aptian- Albian).

## Discussion

### *Paleoecology*

Paleoecological features of gastropods and bivalves of the sections under study are summarized in Table 1. With respect to life habits of bivalves and gastropods, stationary epifauna organisms prevail, followed by epifaunal mobile. Deep-infaunal is rare and there is no epifaunal cemented. This indicates the existence of soft substrate [6]. The absence of large and heavy gastropods and bivalves indicates instability of the substrate. According to feeding habits, suspension-feeders dominate strongly the association followed by grazer. Deposit feeder is rare. This means that water energy was medium, low enough for organic matter, nutrients for deposit-feeders, to accumulate in the sediment, but sufficiently high for suspension-feeder [5].

The sections under studied contain also microfossils such as agglutinate foraminifera which have been studied by Parvaneh Nezaad Shirazi et al., [40]. The

**Table 1.** Life habit, trophic groups and abundance of the studied gastropods and bivalves genera. DI-deep infaunal, ME- mobile epifaunal, MI, Mobile infauna, SE – Stationary epifauna, SI, Semi Infauna, S - suspension feeders, G – Grazer (herbivores), D - deposit-feeder, N\_ number of individuals.

| Genera              | Life Habit | Trophic Group | N  |
|---------------------|------------|---------------|----|
| <b>Bivalves</b>     |            |               |    |
| <i>Pholadomya</i>   | DI         | S             | 5  |
| <i>Ceratostreon</i> | SE         | S             | 10 |
| <i>Exogyra</i>      | SE         | S             | 4  |
| <i>Ilymatogyra</i>  | SE         | S             | 6  |
| <i>Rastellum</i>    | SI         | S             | 5  |
| <i>Mytilus</i>      | SE         | S             | 2  |
| <i>Modiolus</i>     | SE         | S             | 4  |
| <i>Neuthea</i>      | SI         | S             | 3  |
| <i>Granocardium</i> | SI         | S             | 2  |
| <i>Nucula</i>       | MI         | D             | 7  |
| <i>Venus</i>        | SI         | S             | 5  |
| <i>Inoceramus</i>   | SI         | S             | 2  |
| <i>Arca</i>         | ME         | S             | 2  |
| <b>Gastropods</b>   |            |               |    |
| <i>Pterodonta</i>   | ME         | G             | 3  |
| <i>Tylostoma</i>    | ME         | G             | 3  |
| <i>Mesalia</i>      | ME         | S             | 5  |
| <i>Turbo</i>        | ME         | G             | 5  |
| <i>Calliophalus</i> | ME         | G             | 4  |

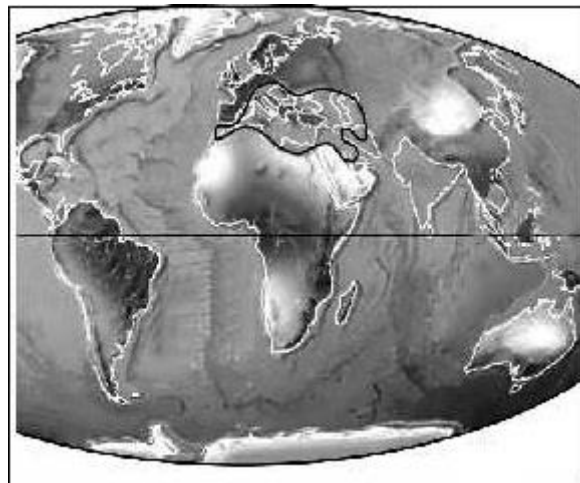


Figure 6. Distribution of Gastropods during the Cenomanian [2].

association of agglutinate foraminifera, such as orbitolinids, with calcareous algae is interpreted to have been deposited in relatively mesotrophic.

Similar studied sections have also been reported from Kerman [4] and Central Alborz [50]. As Asghari et al. [4] noted, They are equivalent of Albian – Cenomanian deposits of northern Jodran [40], North wadi Qena in Egypt [1, 2] and southern Tethys [Fig. 6]. But this taxa have a somewhat younger stratigraphic age in Western Tethys than in Iran.

### Conclusion

Albian- Cenomanian gastropods and bivalves reported for the first time in the Kazhdumi Formation of Fars Zone, Zagros Basin. The co-occurrence of epifaunal mobile and shallow infaunal Gastropods and bivalves indicates that the substrate was soft during this time. Also, the presence of deposit-feeders and suspension feeders in the association reflects a medium water energy. The water energy was low enough for organic matter, the food for deposit-feeders, to accumulate in the sediment, but sufficiently high for suspension-feeder. The Gastropod and bivalve taxa mentioned above are similar to other assemblages of the western Tethys that show the existence of a possible passage which was open during this interval.

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