Ostracoda of Fat'ha Formation (Middle Miocene) from (Darbandikhan and Aghjalar) sections, Sulaimani- Kurdistan Region/ Northeastern Iraq

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Abstract:

The present study investigated Middle Miocene Ostracoda from the two outcrops of Fat'ha Formation (M.Miocene), Sulaimani area, Kurdistan region NE Iraq. Twenty six Ostracod species belongs to twenty genera recorded in the present study in addition to new two morphotypes. On the basis of the stratigraphic distribution of the Ostracode species recorded in the present study, three Ostracode Assemblage Biozones were proposed in Darbandikhan section, and two Ostracode Assemblage Biozones in the Aghjalar section. Correlation based on the geographical distribution of the recorded genera with India, Iran, Turkey, North Africa and South Europe, in order to identify the Bioprovinces during the Miocene and the nature of marine connections. Based on the Ostracoda genera and the sedimentary evidence, the environment of the Fat'ha Formation interpreted in the studied area.

1-INTRODUCTION:

Fat´ha Formation is the most important and wide spreading Formation in Iraq, its work as a cap-rocks for the most Oil reservoirs. onset, its described in Faris Field, Southwestern of Iran, under Lower Fars Formation nomenclature by (Busk & Mayo, 1918 , in Bellen *etal*.,1959), The Formation is changed to Gachsaran Formation by (James & Wynd,1965). In Iraq a new type section defined to the Lower Fars Formation in Al-Fat´ha zone (the point of intersection of the Tigris River with a series Makhoul – Hamrin) 10 Km North of Baiji city, Then name of the Formation was changed to Fat´ha Formation (Al-Rawi *etal*. , 1992).

2-STUDY LOCATION:

The study area is located geographically within the Sulaymani area(Kurdstan region) Northeast of Iraq and within the longitudes (44° 56' 28.4" , 45° 41' 46.7") N, and the Latitudes (35° 07' 18.2" , 35° 39' 18.8") E To include so Darbandikhan and Aghjalar regions. Tectonically, the studied area sited within the Unstable Shelf and within the High Folded Zone. (Fig. 1)

3- SAMPLES:

Ninety three rock samples were collected from two outcrops of Fat´ha Formation in Sulaimani region (fig. 1), depend of the variations of the lithological properties including 47specimens from Darbandikhan section, and 46 specimens from Aghjalar section. The rock samples that were obtained for the study represent marl, argillaceous limestone claystone and siltstone.(fig. 2).

4- SAMPLES PREPARATIONS:

In this work we follow the the preparati on samples methods of Moore and Pritrat,

1961 . After the disintegration of th e sam ples into smallgrains and pices less than 1 0 cm, then immersed for 24 -48 hours in water for briitle smaples. The tough smaples are treated using Hydrogene Peroxide (H2O2) of 10-15%, as optional cases, we use adds few grams of Sodium Bicarbonates for those very tough samples After the disintegration of the rock pieces, sieving the samples with 200 mesh sieve size and put it under the stream of water to get rid of outstanding clays. Then drying the rest of the specimens and sieving it by sieves arranged from the smallest in the below to the biggest in the upper, within sieve sizes (20,40,60,80,100 and 120) mesh. After that separated every size alone to capture the shells and set it in the fossil slides by a special brush used for this purpose . The Fauna that obtained in this study are sited in Mosul University under the following codes:

MoU . Fh.F . Su. (MoU : Mosul University .Fh.F : Fat`ha Formation .Su : Sulaimani .)

5- SYSTEMATICS :

In this study the ostracode fauna are Classified according to the system of Moore and Pitart, 1961, Morkhoven, 1963; Hartman and Puri, 1974.

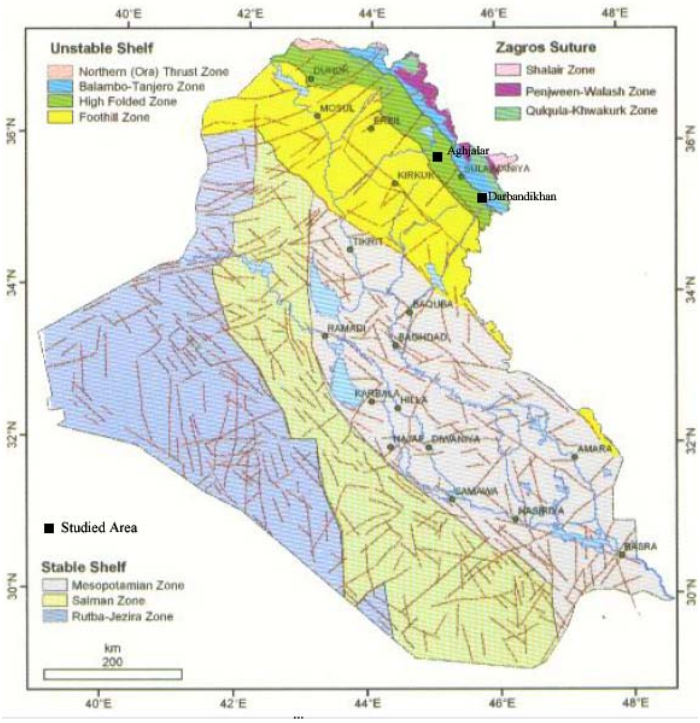


Fig.1: Location of the studied sections in the tectonic map of Iraq by Jassim and Goff ,2006)

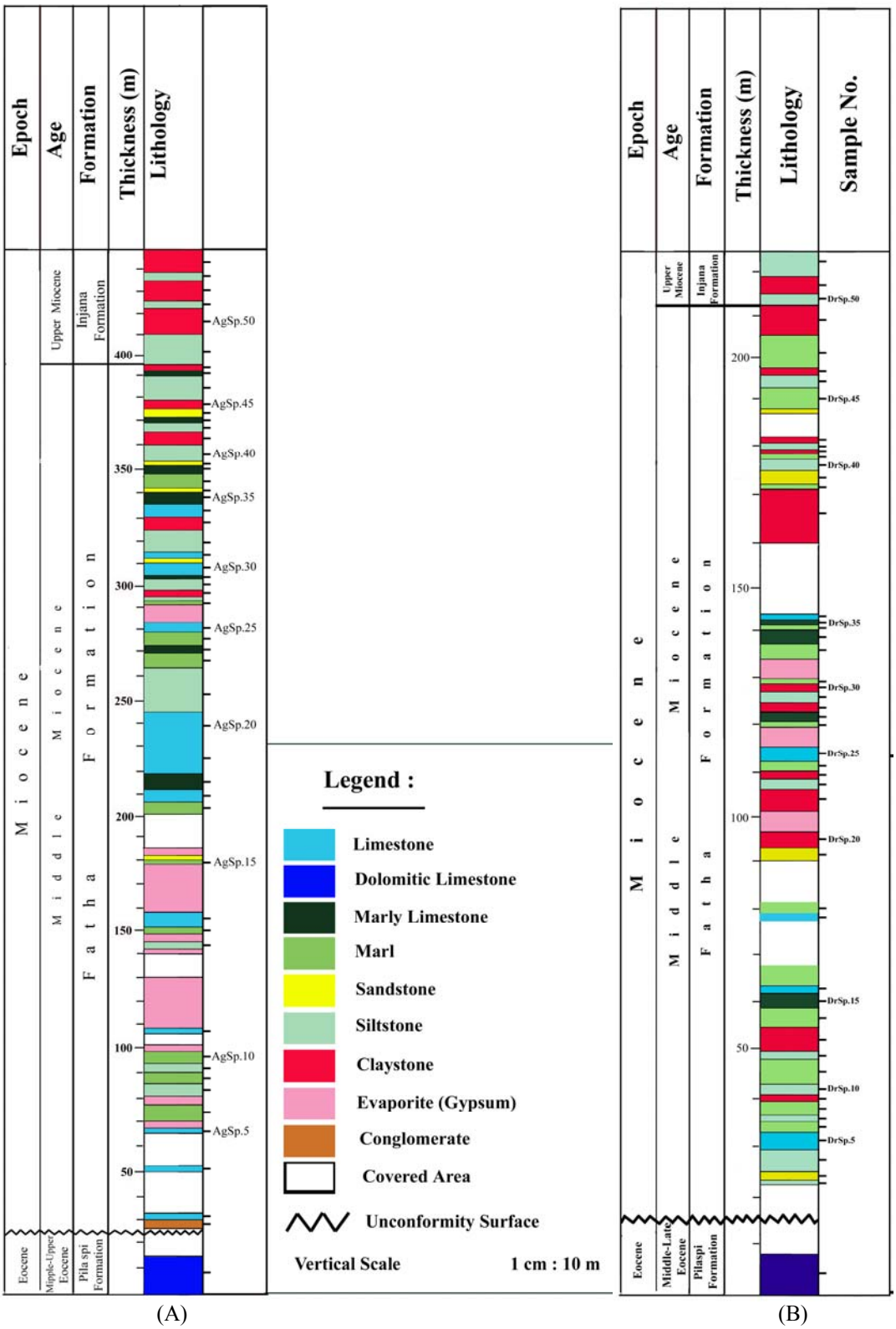


Fig. 2 . Lithology and location of the samples in the studied sections (A-Aghjalar, B-Drabanadikhan).

Phylum :	**Crustacea**	**Pennant,1777**
Class :	**Ostracoda**	**Latreille,180**
Order :	**Podocopida**	**Muller,1896**
Suborder :	**Podocopina**	**Sars, 1866**
Superfamily:	**Cytheracea**	**Baird,1850**
Family :	**Cytherellidae**	**Sars,1866**
Genus :	***Cytherella***	**Jones,1849**
Type species:	***Cytherina ovata***	**Roemer, 1840**

***Cytherella sayyabi* Khalaf,1993a**
(pl 1, figs. 1,2)

1993 a *Cytherella sayyabi* Khalaf , Iraqi Geol. Jour. ,26(3) ,p.179 , pl. 1, Figs. 7-12 .
No. of Individuals : 9c, 1v .
Type Horizon : DrSp.49
Measures of the Carapace:
Length: 416 µm **Hight:** 305 µm **Width:** 233 µm
Previous records:

Khalaf,1993a	Middle Miocene	N. Iraq
Kharruffa,2008	Middle Miocene	N. Iraq

Genus:	*Cytherelloidea*	Alexander,1929
Type species:	*Cythere williamsoniana*	Jones,1849

***Cytherelloidea flexicostata* Khalaf,1993a**
(pl. 1, figs. 3,4)

1993 a *Cytherelloidea flexicostata* Khalaf, Iraqi Geol. Jour., 26(3), p182, pl. 2, figs. 7-12 .
No. of Individuals : 2v .
Type Horizon : AgSp.37
Measures of the Carapace :
Length: 678 µm **Hight:**392 µm **Width:** 238 µm
Previous records:

Khalaf,1993a	M.Miocene	N. Iraq
Kharruffa,2008	M.Miocene	N. Iraq
Al-Shumam,2009	M.Miocene	N. Iraq

***Cytherelloidea hamrinensis* Khalaf, 1993a**
(pl. 1, figs. 5,6)

1993a *Cytherelloidea hamrinensis* Khalaf , Iraq. Geol. Jour. 26(3), pp. 184-186, pl. 3, figs. 1-4 .
No. of Individuals :4c .
Type Horizon : AgSp.8
Measures of the Carapace :
Length: 489 µm **Hight:** 270 µm
Previous records :

Khalaf,1993a	**M.Miocene**	**N. Iraq**
Family:	**Cytheridae**	**Baird,1850**
Genus:	***Schneiderella***	**(Schneider,1939)**
Type species:	***Cythereis dromas***	**(Schneider,1939)**

***Schneiderella unispinata* Khalaf, 1993b**
(pl. 1, figs. 7,8,9)

1993b *Schneiderella unispinata* Khalaf, Mu`tah Lil-Buhooth Wa Al-Dirasat, 8(3), pp. 72-75. pl. 2, figs. 1-6,9 .
No. of Individuals :720c , 230v .
Type Horizon : AgSp.8
Measures of the Carapace :
Length: 602 µm **Hight:** 366 µm **Width:** 320 µm
Previous records :

Khalaf,1993b	M. Miocene	N. Iraq

***Schneiderella unispinata* Khalaf, 1993**
Morphotype A
(pl. 1, fig. 10)

No. of Individuals : 291c , 47v .
Type Horizon : DrSp.33
Measures of the Carapace :
Length: 612 µm **Hight:** 336 µm **Width:** 320 µm
Remarks: this Morphotype represent a new Morphotype for this species. The difference is in the curvature in the antrodorsal corner of the carapace with more convexity of ventral margin.

Family:	**Leptocytheridae**	**Hanai, 1957**
Genus*:*	***Callistocythere***	**Ruggieri,1953**
Type species*:*	***Cythere littoralis***	**Muller, 1894**

***Callistocythere hipposideros* Khalaf, 1993c**
(pl. 1, figs. 11,12)

1993c *Callistocythere hipposideros* Khalaf , Mu`tah Lil-Buhooth Wa Al- Dirasat, 8(3), pp. 80-83, text fig. 9, pl. 1, fig. 1-6.
No. of Individuals : 1c .
Type Horizon : AgSp.24
Measures of the Carapace :
Length: 395 µm **Hight:** 213 µm
Previous records :

Khalaf,1993c	M.Miocene	N. Iraq

Family:	**Cytherideidae**	**Sars,1925**
Genus:	***Miocyprideis***	**Kollmann,1960**
Type species:	***Miocyprideis jonoscheki***	**Kollmann,1960**

***Miocyprideis ovalis* Khalaf,1989**
(pl. 1, figs. 13,14)
1989,*Miocyprideis ovalis* Khalaf, p.1115 ,pl.1 , Figs. 6-12
No. of Individuals : 82c , 52v .
Type Horizon : DrSp.25
Measures of the Carapace :
Width: 343 µm**, Hight:** 369 µm**,**
Length: 570 µm
Previous records:

Khalaf,1993a	M. Miocene	N. Iraq
Abdol Rassul & Al-Sheikhly, 2001	M. Miocene	N. Iraq
Kharruffa,2008	M Miocene	N. Iraq

Genus:	*Hemicyprideis*	Malz & Triebel,1970
Type species:	*Hemicyprideis aucta*	Malz & Triebel,1970

***Hemicyprideis angulata angulata* Khalaf, 1994**
(pl. 1, figs. 15,16)
1994 *Hemicyprideis angulata angulata* Khalaf, Iraqi Geol. Jour, 27(3), pp. 200-228, pl. 1, fig. 1-6 .
No. of Individuals : 183c , 5v .
Type Horizon : AgSp.8
Measures of the Carapace :
Length: 633 µm **Hight:** 344 µm **Width:** 292 µm
Previous records :

Khalaf, 1994	M Miocene	N. Iraq

Family :	Cushmanideidae	Puri, 1973
Genus :	*Pontocythere*	Dubowsky, 1939
Type Species :	*Pontocythere tcherjawskii*	Dubowsky, 1939

***Pontocythere* sp. Szczechura and Abd El-Shafy, 1988**
(pl. 1, fig. 17)
1988 *Pontocythere* sp. Szczechura and Abd El-Shafy , Acta Palaeontologica Polonica, 33(4) , 296-297, pl. 9, figs. 14-16 .
No. of Individuals : 4c .
Type Horizon : DrSp.17
Measures of the Carapace :
Length: 601 µm **Hight:** 231 µm
Previous records:

Szczechura & Abd-Elshafy, 1988	M.Miocene	Egypt

Family:	**Krithidae**	**Mandelstam,1960**
Genus:	**Krithe**	**Brady *et al.*,1874**
Type Species:	***Ilyobates praetexta***	**Sars,1866**

***Krithe langhiana* Ortli 1961**
(pl. 1, figs. 18,19)
1961 *Krithe langhiana* Ortli, Riv. Ital. Palaeonto. Strat. 67(1), 17-44, Milano.
No. of Individuals : 80c , 2v .
Type Horizon : DrSp.49
Measures of the Carapace :
Length: 568 µm **Hight:** 301 µm **Width:** 185 µm
Previous records :

Oertli, 1961	M. Miocene	Italy
Guha, 1980	Miocene, Pliocene	E. India
Kharruffa, 2008	M. Miocene	N. Iraq

Genus:	*Dentokrithe*	Khosla & Heskins, 1980
Type species:	*Cythere bartonensis*	Jones,1857

***Dentokrithe comma* Khalaf, 1993**
(pl. 1, figs. 20,21)
1993 c, *Dentokrithe comma* Khalaf, PP. 28-41, Pl. 1, Figs. 11-14 .
No. of Individuals : 56
Type Horizon : AgSp.16
Measures of the Carapace :
Length: 625 µm **Hight:** 336 µm **Width:** 273 µm
Previous records :

Khalaf,1993c	M. Miocene	N. Iraq
Abdol Rassul & Al-Sheikhly,2001	M. Miocene	Center of Iraq
Kharruffa, 2008	M. Miocene	N. Iraq
Alshumam, 2009	L. Miocene	N. Iraq

Genus :	***Parakrithe***	**Bold,1958**
Type species:	***Cytheridea (Dolocytheridea) vermunti***	**(Bold,1946)**

***Parakrithe dectylomorpha* Ruggieri,1962**
(pl. 1, fig. 22)

1962 , *Parakrithe dectylomorpha* Ruggieri , 56, Cn.ser. , u. 267, 1-68, pls. 1-7, figs. 1-10 .
No. of Individuals: 227 c.
Type Horizon : AgSp.37
Measures of the Carapace:
Length: 631 µm **Hight:** 289 µm
Previous records:

Ruggieri,1962	Miocene	Italy
Benson,1976	Miocene	Spain
Abdol Rassul & Al-Sheikhly,2001	Middle & Late Miocene	N. Iraq

Family:	**Trachyleberididae**	**Sylvester & Bradley, 1948**
Genus :	***Stigmatocythere***	**Siddiqui, 1971**
Type species:	***Stigmatocythere obliqua***	**Siddiqui, 1971**

***Stigmatocythere nodosa* Khalaf, 2000**
(pl. 1, fig. 23)

2000 *Stigmatocythere nodosa* Khalaf , Raf. Jour. Science, 11(2), pp. 65-72 .
No. of Individuals : 7c .
Type Horizon: DrSp.34
Measures of the Carapace :
Length: 381 µm **Hight:** 260 µm
Previous records :

Khalaf, 2000	M. Miocene	N. Iraq

Genus :	***Actinocythereis***	**Puri,1953**
Type species:	***Cythere exanthemata***	**Ulrich & Bassler, 1904**

***Actinocythereis iraqensis* Khalaf,1982a**
(pl. 2, figs. 1,2)

1982*a* *Actinocythereis iraqensis* Khalaf ,Stero-Atlas 9(9) 51-54 .
No. of Individuals :64c , 25v .
Type Horizon : AgSp.16
Measures of the Carapace :
Length: 943 µm **Hight:** 580 µm **Width:** 568 µm
Previous records:

Khalaf , 1982b	M. Miocene	N. Iraq
Abdol Rassul & Al-Sheikhly,2001	M. Miocene	Center of Iraq
Kharruffa, 2008	M. Miocene	N. Iraq
Alshumam, 2009	L. Miocene	N. Iraq

***Actinocythereis libyansis* El-Waer,1991**
(pl. 2, figs. 3,4,5)

1991 *Actinocythereis libyansis* El-Waer , p.13, pl. 2, figs.15,17,18 .
No. of Individuals :95c , 16v .
Type Horizon : AgSp.38
Measures of the Carapace :
Length: 775 µm **Hight:** 443 µm **Width:** 387 µm
Previous records :

El-Waer, 1991	M. Miocene	NE Libya
Kharruffa, 2008	M. Miocene	N. Iraq

Genus:	***Falunia***	**Grekoff & Moyes, 1955**
Type species:	***Falunia girondica***	**Grekoff & Moyes, 1955**

***Falunia scula* Aruta, 1966**
(pl. 2, fig. 6)

1966 *Falunia scula* Aruta, p.4 , text fig. 2, N. 1, pl. 1, fig. 1 .

No. of Individuals :2c .
Type Horizon : AgSp.20
Measures of the Carapace :
Length: 529 µm **Hight:** 297 µm
Previous records :

Aruta, 1966	L. Miocene	Italy
El-Waer, 1991	M. Miocene	NE Libya

Genus:	***Echinocythereis***	**Puri, 1954**
Subgenus:	***Scelidocythereis***	**Siddiqui, 1971**
Type Species:	***E. (S.) multibullata***	**Siddiqui, 1971**

***Echinocythereis (Scelidocythereis) multibullata* Siddiqui, 1971**
(pl. 2, fig. 7)

1971*Echinocythereis(Scelidocythereis) multibullata* Siddiqui, pp. 34-35, pl. 16, figs. 3-9 ؛ pl. 17, figs. 1,2,7 .
No. of Individuals :25 c .
Type Horizon : AgSp.8
Measures of the Carapace :
Length: 504 µm **Hight:** 264 µm
Previous records :

Siddiqui, 1971	Miocene	Pakistan

***Echinocythereis (Scelidocythereis) multibullata* Siddiqui, 1971**
Morphotype A
(pl. 2, figs. 8,9,10)

No. of Individuals :9 c.
Type Horizon : AgSp.8
Measures of the Carapace :
Length: 480 µm **Hight:** 278 µm
Width: 236 µm
Remarks: representing a new Morphotype with very distinective large tubercles in the posterior half compared with smaller and less in number in the anterior half..

Genus :	***Alocopocythere***	**Siddiqui,1971**
Type Species:	***Alocopocythere transcendens***	**Siddiqui,1971**

***Alocopocythere fossularis* (Lyubimova & Guha,1960)**
(pl. 2, figs. 11,12,13)

1960 *Trachyleberis fossularis* Lyubimova & Guha in Lyubimova, Guha & Muhn,1960,pp. 40-41,pl. 3,fig. 7 .
1960 *Cytheretta cheropadiensis* Tewari & Tandon , pp. 159-160, Text fig. 5, figs. 4a-b .
1960 *Cytheromorpha* sp. Indet. Bhatia & Mandwal p. 282, pl. 41, fig. 10 .
1961 *Echinocythereis fossularis* (Lyubimova & Guha) Guha, p. 4, figs. 5-9 ؛ Guha et al.,1965 , p. 13, pl. 3, fig. 12 .
1968 *Quadracythere fossularis* (Lyubimova & Guha) Guha, pp. 215-216, pl. 21, fig. 20 .
1971 *Alocopocythere fossularis* (Lyubimova & Guha) 1960, Siddiqui, P. 14, 15 .
No. of Individuals :35 c , 13v .
Type Horizon : AgSp.16
Measures of the Carapace :

	Length (µm)	Hight (µm)	Width (µm)
Male	722	402	408
Female	666	430	441

Previous records :

Lyubimova & Guha, 1960	Miocene	India
Tewari & Tandon,1960	Tertiary	India
Bhatia & Maundwall, 1960	Tertiary	India
Guha,1961,1968,1975	Tertiary	India
Siddiqui,1971	Miocene	Pakistan
Khosla,1978	Paleocene -Eocene	India
Khalaf,1984	M. Miocene	N. Iraq
Kharruffa, 2008	M. Miocene	N. Iraq

***Alocopocythere transversa* Siddiqui,1971**
(Morphotype C)
(pl. 2, fig. 14)

1971 *Alocopocythere transversa* Siddiqui, pp. 19-22, pl. 6, figs. 5-8 ؛ pl. 7, figs. 1-4, ؛ pl. 8, fig. 4 .

No. of Individuals : 6c , 8v .
Type Horizon : AgSp.10
Measures of the Carapace :
Length: 677 µm **Hight:** 338 µm
Previous records :

Siddiqui, 1971	M-L. Eocene	Pakistan

Genus:	***Hermanites***	**Puri,1955**
Type species:	***Hermanites reticulata***	**Puri, 1955**

***Hermanites transversicostata* Khalaf,1982b**
(pl. 2, figs. 15,16,17,18)

1982b *Hermanites transversicostata* Khalaf, Stero-Atlas Of Ostracoda Shells, 9(11), 59-62 .

No. of Individuals : 77c , 25v .
Type Horizon : DrSp.33
Measures of the Carapace :

	Length (µm)	Hight (µm)	Width (µm)
Male	613	363	270
Female	790	430	299

Previous records :

Khalaf,1982b	M. Miocene	Iraq
Kharruffa, 2008	M. Miocene	N. Iraq
Alshumam, 2009	L. Miocene	N. Iraq

Genus:	*Quadracythere*	Hornibrook, 1952
Subgenus:	*Hornibrookella*	Moos,1965
Type species:	*Cythere anna*	Lienenklaus, 1894

***Quadracythere (Hornibrookella) subquadra* Siddiqui,1971**
(pl 2, fig. 19)

1971 *Quadracythere (Hornibrookella) subquadra* Siddiqui, pp. 68-69, pl. 34, figs. 6-11 .
No. of Individuals : 4c .
Type Horizon : AgSp.8
Measures of the Carapace :
Length: 729 µm **Hight:** 445 µm
Previous records :

Siddiqui,1971	Miocene	Pakistan

***Quadracythere (Hornibrookella)* sp.1 Siddiqui,1971**
(pl. 2, fig. 20)

1971 *Quadracythere (Hornibrookella)* sp.1 Siddiqui, pp. 69 , pl.34, figs. 12-14 .
No. of Individuals : 5c .
Type Horizon : AgSp.8
Measures of the Carapace :
Length: 729 µm **Hight:** 445 µm
Previous records :

Siddiqui,1971	Miocene	Pakistan

Family:	**Cytherettidae**	**Triebel,1952**
Genus:	***Flexus***	**Neviani,1928**
Type species:	***Cythere plicuta***	**Munster, 1830**

***Flexus trifurcata* (Lyubimova & Guha,1960)**
(pl. 2, fig. 21)

1960 *Cytheretta trifurcata* Lyubimova & Guha in Lyubimova, Guha & Mohn, p. 45-46 , pl. 4 , Fig. 3 .
1960 *Cytheretta* sp Indet. Bhatia & Mandwal, p. 283, pl. 41, Fig.13 .
1960 *Cytherelloidea ktaphrawarensis* Tewari & Tandon, p.160, text.1 , Fig.5.
1978 *Flexus trifurcate* Khosla, p.217 , pl. 3, Figs. 3-4 .
No. of Individuals : 7c .
Type Horizon : AgSp.20
Measures of the Carapace :
Length: 520 µm **Hight:** 295 µm

Previous records :

Lyubimova & Guha,1960	Miocene	India
Tewari & Tandon,1960	Miocene	India
Bhatia & Mandwal,1960	Miocene	W. India
Kosla,1978	E. Miocene	India
Kharruffa, 2008	M. Miocene	N. Iraq
Alshumam, 2009	L. Miocene	N. Iraq

Family :	**Loxoconchidae**	**Sars, 1926**
Genus :	***Loxoconcha***	**Sars, 1866**
Subgenus:	***Loxoconcha***	**Sars, 1866**
Type species:	***Cythere impressa***	**Baird , 1850**

***Loxoconcha (Loxoconcha) hamrinensis* Khalaf,1998**
(pl. 2, figs. 22,23,24)

1998 *Loxoconcha (Loxoconcha) hamrinensis* Khalaf , p. 2, pl. 1, figs. 1,2,4,5.

No. of Individuals : 114 c
Type Horizon : DrSp.25
Measures of the Carapace :
Length: 572 µm **Hight:** 348 µm **Width:** 325 µm
Previous records :

Khalaf,1998	M. Miocene	N. Iraq
Abdol Rassul & Al-Sheikhly,2001	M-L. Miocene	Center of Iraq
Kharruffa, 2008	M. Miocene	N. Iraq
Alshumam, 2009	L. Miocene	N. Iraq

Family :	Cytheruridae	Muller, 1894
Genus:	*Paijenborchellina*	Kuznetsova (in:Mandelstam *etal*, 1957)
Subgenus:	*Eupaijenborchella*	Keij, 1967
Type species:	*Paijenborchella libyca*	Triebel, 1949

***Paijenborchellina (Eupaijenborchella) iraqensis* Khalaf, 1989**
(pl. 2, figs. 25,26)

1989 *Paijenborchellina (Eupaijenborchella) iraqensis* Khalaf, Jour. Geol. Soc. Iraq, 1989, 22(1), pp. 35-40.
No. of Individuals : 12c .
Type Horizon : AgSp.8
Measures of the Carapace :
Length:666 µm **Hight:**288 µm **Width:**200 µm

Previous records :

Khalaf, 1989	M. Miocene	N. Iraq

Family:	Propontocyprididae	Muller,1894
Genus :	*Propontocypris*	Sylvester & Bradley, 1947
Type Specei:	*Pontocypris trigonella*	Sars, 1866

***Propontocypris solitaria* Carbonnel, 1969 (pl. 2, fig. 27)**

1969 *Propontocypris solitaria* Carbonnel, Docum. Lab. Geol. Fac. Sci. Lyon. P. 24, pl. 10, fig. 1-4 .

No. of Individuals : 7c .

Type Horizon : DrSp.27

Measures of the Carapace :

Length: 886 µm **Hight:** 436 µm

Previous records :

Carbonnel, 1969	Miocene	Franc

6- STRATIGRAPHIC DESTRIBUTION:

Based on the stratigraphic ranges of the species obtained from two sections in the present study, the sections were divided into five Assemblage Biozones and two Subzones distributed among the two sections as in below:

6- BIOSTRATIGRAPHY

6-1 Darbandikhan Section:

Twenty two species were described in this section. Darbandikhan Section distinct from Aghajalar section in having 47 meter of Barren Zone in the upper part representing a covered area with presence of the Evaporate Rocks. This section has been divided into three Assemblage Biozones and two sub-zones (fig.3):

1- *Loxoconcha hamrinensis* Assemblage Biozone:

With 78 meter thickness in the lower part of Formation, this Assemblage Biozone divided into two Assemblage Subbiozones:

a- E*chinocythereis (Sc.) multibulata* Subzone :

With 32 meter thickness middle part of the formation.

b- *Pontocythere* sp. Subzone:

With 46 meter thickness.

2- *Paijenborchallina (E.) iraqensis* Assemblage Biozone :

With 38 meter thickness middle part of formation.

3- *Cytherella sayyabi* Assemblage Biozone :

With 18 meter thickness upper part of the formation.

6-2 Aghajalar Section :

Twenty sex species were described in this section and according to the ranges of these fauna two Assemblage Biozones with two Assemblage Subbiozones were defined, as in (fig.4) :

1- *Miocyprideis ovalis* Assemblage Biozone:

The thickness of this Biozone reach to 215 meter lower to middle part of the formation

2- *Cytherella sayyabi* Assemblage Biozone:

With 65 meter thickness upper part of the formation, the lower boundary of this Biozone represent the upper boundary of *Miocyprideis ovalis* Assemblage Biozone , and the upper boundary represent the line of the fauna disappearing in this section due to the change in environmental conditions.

7-PALEOGEOGRAPHICAL SIGNIFICANCE:

Previous studies of the Middle Miocene Ostracoda from different areas of the world has been outlined in (table -1) in order to know the geographical distribution of some genera and species recorded in the present study, correlated in particular with India, Middle East, Mediterranean region and North Africa.

7-1 FAUNAL RELATIONSHIP AND REGIONA COMPARISON:

Most studies have emphasized the importance of the biological factor in determining the nature of the ancient marine connection , also to know the nature of the sedimentary basins relation with each other. In the current study by observing the geographical spread of the genera under study in different areas, we noted the presence of four bioprovince somewhat connected with each other in terms of a common generas between these areas (figs. 5,6). As follows:

1. **South and West India Bioprovince:**

With occurrence of:
Actinocythereis , Alocopocythere , Cytherella , Cytherelloidea, Dentokrithe , Flexus , Hemicyprideis , Hermanites , Krithe , , , Parakrithe , Quadracythere , Schneiderella , Stigmatocythere .

2. **Southwestern and Northwestern of Iran – North Iraq Bioprovince:**

With occurrence of:
Actinocythereis , Alocopocythere , Cytherella , Cytherelloidea, Dentokrithe , Echinocythereis , Falunia , Flexus , Hemicyprideis , Hermanites , Krithe , Loxoconcha , Miocyprideis , Paijenborchallina , Parakrithe , Pontocyprella , Propontocypris , Quadracythere , Schneiderella , Stigmatocythere .

3. **Southeastern Turkey Bioprovince.**

With occurrence of:
Cytherella , Cytherelloidea , Falunia , Flexus , Hemicyprideis , Hermanites , Krithe , Loxoconcha , Miocyprideis , Parakrithe , Quadracythere .

4. **North Africa Bioprovince.**

With occurrence of:
Actinocythereis , Cytherella , Cytherelloidea , Falunia , Hemicyprideis , Hermanites, Krithe , Loxoconcha , Miocyprideis , Paijenborchallina .

Of the basis of Ostracoda that described from the Fat´ha Formation in the study areas in South Eastern of Kurdstan region, show relationship with the Ostracoda that have been described in India, Iran, Turkey, the Eastern Mediterranean and North Africa. Which indicated a marine connection between these areas during the Miocene time so they are apart of the Neotethys realm. This also confirms that the Fat´ha Formation basin is a regional extended basin. (Al-Jubouri *et al*.,2008) , (Allen *et al*., 1986), (Stocklen, 1968), stated that the Fat´ha Formation basin is about 2000 Km long and runs from Bandar Abbas in Southern Iran toward Iraq, Syria, towardes Turkey and the Mediterranean region to links between the Indian Ocean basin on the one hand and the Mediterranean basin on the other. (Stoklen, 1968) stated that there is a marine arm extending from Fat´ha Formation basin towards the north linking the Caspian Sea, the present study confirmed the presence of this marine arm through the high abundance in the number of the individuals that belonging to the genus *Schneiderella* Which described in the first time in Caspian region.

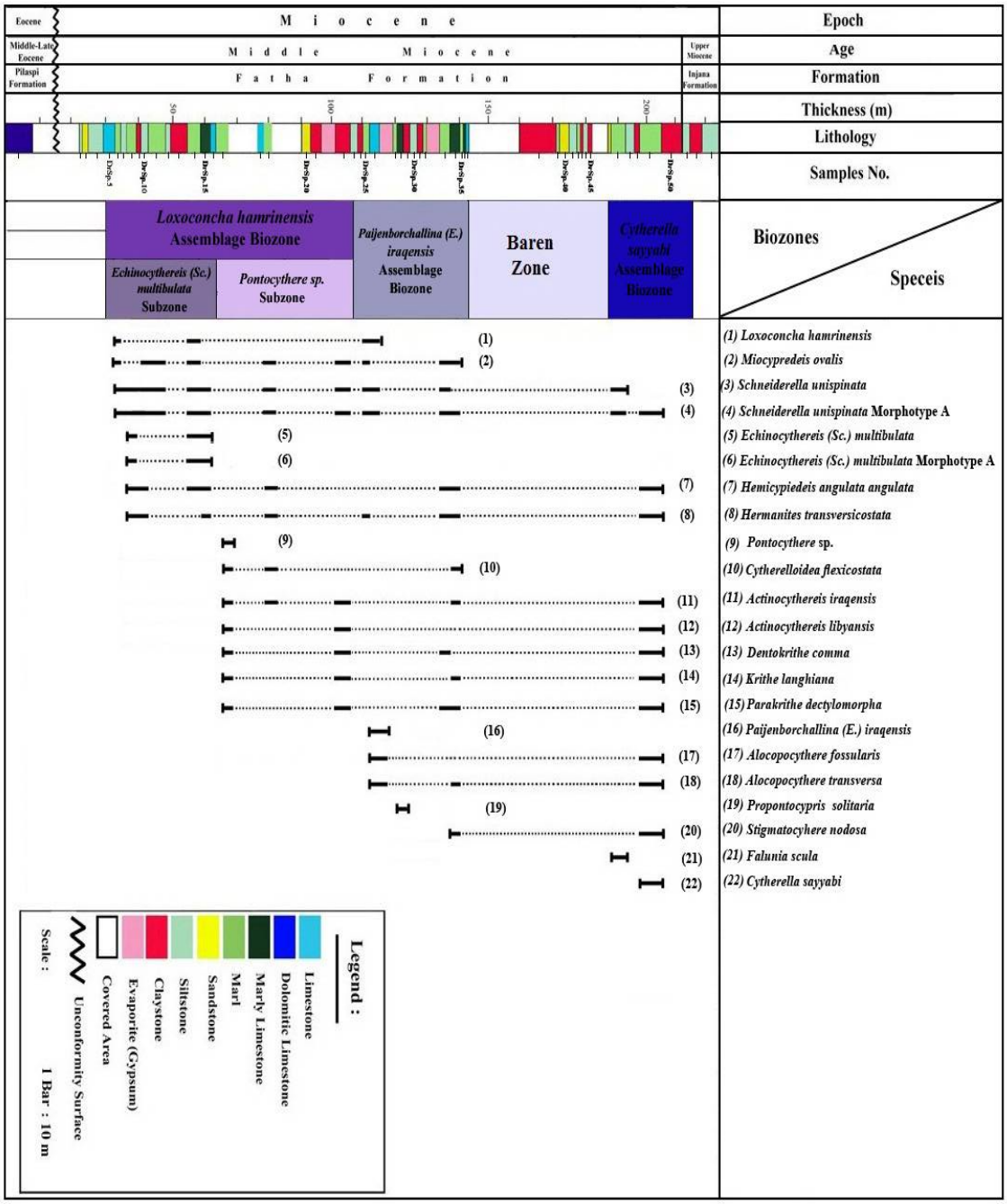
8- CONCLUSION:

1. Twenty six Ostracoda species belonging to twenty one genus were described from Fat´ha Formation in two outcrops in southeastern of Kurdstan region N.Iraq. In addition to that two new Morphotypes were recorded.

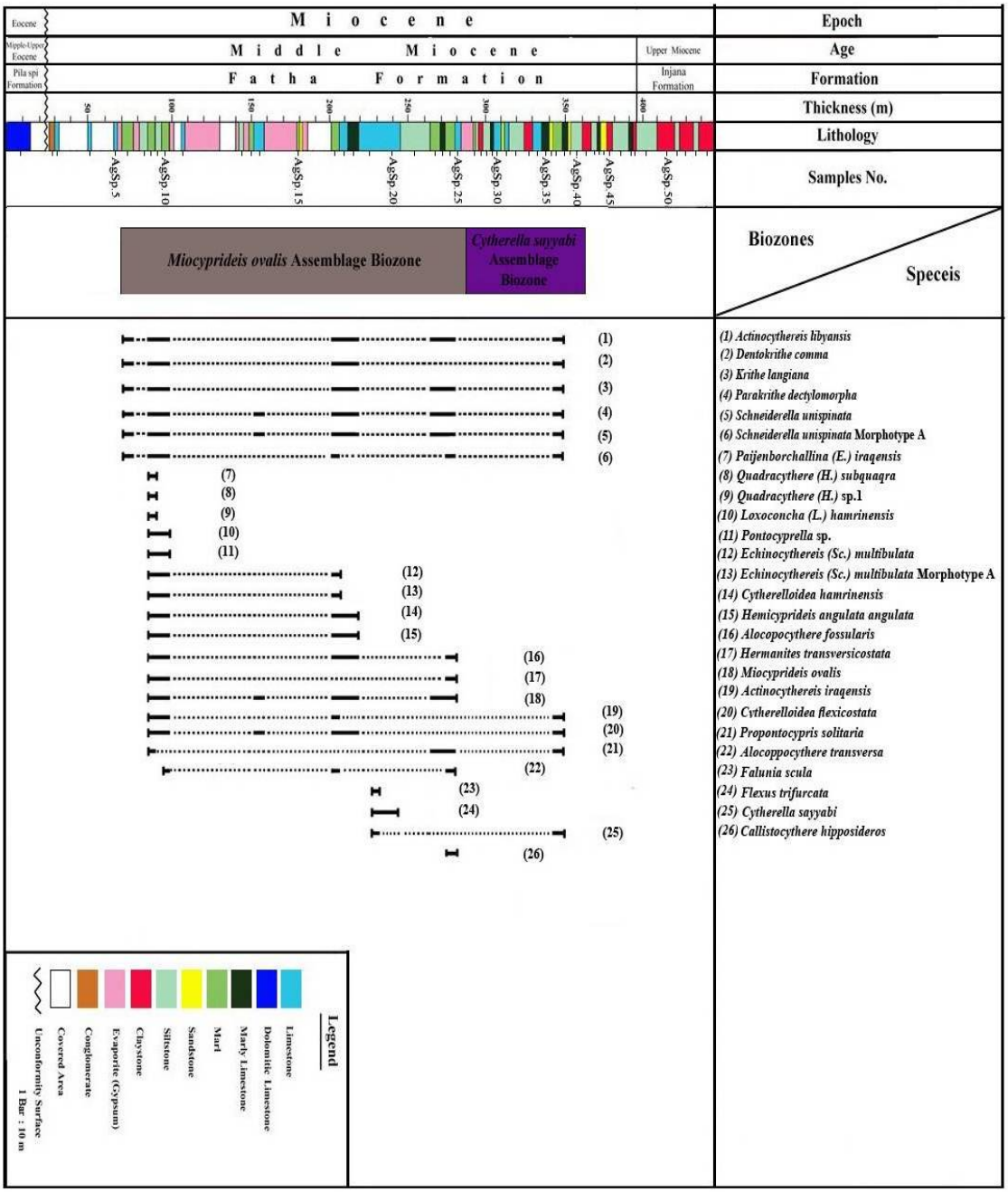
2. Five Assemblage Biozones in addition to two Assemblage Subbiozones were identified in Iraq and neighboring area indicated M.Miocene age for the Fat´ha Formation .
3. The Ostracode distribution from the M.Miocene north Iraq indicated that northern Iraq represent intermediate bioprovences zone between Mediteranean and Indopacific.
4. Depending on the Ostracoda genera that obtained in this study, and the lithological characters, deduced that Fat´ha Formation in the booth sections was deposited in a shallow basin turns same times to a Lagoonal environment and within fluctuations in salinity. Also the presence of the genus *Cytherelloidea* indicating that Middle Miocene sea was of warm temperature.

ACKNOWLEDGEMENTS:

We would like to express our thanks to Dr. Mahfoudh Abdullah, University of Mosul, and we also extended our thanks to Dr. Kamal Haji, Mr. Jabbar Mohammed Amin and Mr. Karwan Mustafa from the University of Sulaymani to bring in aid access to the study areas.



(Fig. 3) Biotratigraphic distribution and the ranges of the Ostracoda species of Fat′ha Formation in Darbandikhan section kurdstan region(NE.Iraq)



(Fig. 4) Biostratigraphic distributions and the ranges of Ostracoda species of Fat′ha Formation in Aghjalar section kurdstan region(NE.Iraq)

Table (1): Geographical distribution of the recored genera in the present study and other region.

Genus	occurrence	Age	Othor
Actinocythereis	Jamnagar & Probandar Districts-India	E. Miocene	Khosla, 1978
	West Coast of India	Miocene-Pliocene	Guha, 1980
	Tunisia	L. Miocene	Banaduce *et al.*, 1988
	Alkums Formation-NW Libya	M-L Miocene	El-Waer, 1991
Alocopocythere	India	Miocene	Lyubimova & Guha1, 960
	Kutch-India	Miocene	Guha, 1961
	Gujarat-India	Miocene	Khosla, 1978
	West Coast of India	Miocene-Pliocene	Guha, 1980
	India	E. Miocene	Khosla & Nagori, 1989
Buntonia	Jamnagar & Probander Destricts,Gojarat, India	E. Miocene	Tewari & Tandon, 1978
	Adana & Antakya Basins, Turkey	Miocene	Doruk, 1979
	NE Algeria	M. Miocene	Szczechura & Abd Al-Shafy, 1988
	NW Libya	Miocene	El-waer, 1991
	North Sardinia, Italy	Miocene	Bassio *et al*., 2006
Callistocythere	Italy	M-L Miocene	Ruggieri, 1969
	France	M-L Miocene	Carbonnel, 1969
	Adana & Antakya Basins, Turkey	Miocene	Doruk, 1979
Cytherella	Jamnagar & Probander Destricts, India	E. Miocene	Khosla, 1978
	Al-Kums Formation, NW Libya	M-L Miocene	El-Waer, 1991
	Gulf of Suez, Egypt	M. Miocene	Szczechura & Abd Al-Shafy, 1988
	India	Oligocene-Miocene	Guha *et al.*,1960
	Kutch, India	M. Miocene	Lyubimova & Guha, 1960
	India	E. Miocene	Guha, 1962
	South India	E. Miocene	Guha *et al*., 1965
	Italy	Miocene	Roggieri, 1967
	India	Miocene	Khosla, 1978
	Adana & Antakya Basins, Turkey	Miocene	Doruk, 1979
	Gujarat, India	E. Miocene	Jain, 1980
	Qum Formation, Iran	E. Miocene	Daneshain & Dana, 2007
Cytherelloidea	Coxs Bazar, Bangladesh	Miocene	Ahmed, 1994
	Chasra , Kutch, India	E. Miocene	Guha, 1961
	Bombay high	E. Miocene	Guha, 1975
	Bombay Off-shoar	M.-L. Miocene	Jain, 1980
	Gujarat, Kerala, India	M. Eocene- L.	Jain, 1980

		Miocene	
	Gulf of Suez, Egypt	M. Miocene	Szczechura & Abd Al-Shafy, 1988
	Sirte Basin, Libya	M. Miocene	Szczechura & Abd Al-Shafy, 1988
	Italy	L. Miocene-E. Pleistocene	Bossio *et al*., 2006
	Greece	L. Miocene-E. Pleistocene	Bossio *et al*., 2006
Dentokrithe	India	E. Miocene	Lyubimova & Guha, 1960
	India	Miocene	Guha, 1968
	India	Miocene	Khosla, 1978
	South & West India	E.-M. Miocene	Khosla, 1978
	India	Eocene-Miocene	Khosla & Haskins, 1980
Echinocythereis	Qum Formation Iran	E. Miocene	Daneshain & Dana, 2007
Falunia	Adana &Antakya Basins, Turkey	Miocene	Doruk, 1979
	Gulf of Suez, Egypt	M. Miocene	Szczechura & Abd Al-Shafy, 1988
	Sirte Basins , Libya	M. Miocene	Szczechura & Abd Al-Shafy, 1988
	Gozne (Mersin) Region, Turkey	E. Miocene	Nazik, 1993
	NW Libya	Miocene	El-Waer, 1991
Flexus	India	Miocene	Lyubimova & Guha, 1960
	W India	Miocene	Bhatia & Mandwal, 1960
	France	E. Miocene	Carbonnel, 1960
	Jamnagar & Probander Destricts, India	E. Miocene	Khosla, 1978
	Iran	E. Miocene	Kristic, 1979
	Porto toris, N. Sardinia, Italy	Miocene	Bassio *et al*., 2006
	Qum Formation, Iran	E. Miocene	Danishian & Dana, 2007
Hemicyprideis	India	Mioceene	Khosla, 1978
	Gujarat, India	M. Miocene	Jain, 1980
	Gulf of Suez, Egypt	M.Miocene	Szczechura & Abd Al-Shafy, 1988
	Sirte Basin, Libya	M. Miocene	Szczechura & Abd Al-Shafy, 1988
	Gonzne (Mersin) Region, Turkey	E. Miocene	Nazik, 1993
Hermanites	Adana & Antakya Basins, Turkey	E. Miocene	Doruk, 1979
	Western Coast of Gulf of Suez, Egypt	M.Miocene	Szczechura & Abd Al-Shafy, 1988
	India	E, Miocene	Khosla & Nagori, 1989
	Gonzne (Mersin) Region,	E. Miocene	Nazik, 1993

	Turkey		
	Al-Kums Formation, NW Libya	Miocene	El-Waer, 1991
Keijella	Adana & Antakya Basins, Turkey	Miocene	Doruk, 1979
	Gulf of Suez, Egypt	M. Miocene	Szczechura & Abd Al-Shafy, 1988
	Sirte Basin, Libya	M. Miocene	Szczechura & Abd Al-Shafy, 1988
	Gonzne (Mersin) Region, Turkey	L. Miocene	Nazik, 1993
	Al-Kums Formation, Nw Libya	M-L Miocene	El-Waer, 1991
	NE Algeria	M. Miocene	Coseutino, 2004
Krithe	Italy	M. Miocene	Ortili, 1961
	France	Tertiary	Ducasse, 1969
	India	Miocene	Khosla, 1978
	Adana & Antakya Basins, Turkey	Miocene	Doruk, 1979
	Gujarat, India	E. Miocene	Jain, 1980
Krithe	Gulf of Suez, Egypt	M. Miocene	Szczechura & Abd Al-Shafy, 1988
	Sirte Basin, Libya	M. Miocene	Szczechura & Abd Al-Shafy, 1988
	Gonzne (Mersin) Region, Turkey	E. Miocene	Nazik, 1993
	SE Bolanda	M. Miocene	Szczechura, 1994
	Estern Mediterrenian	L. Miocene	Cosentino *et al.*, 2006
	Qum Formation, Iran	E. Miocene	Daneshain & Dana, 2007
Leptocythere	North Apennens Area, Italy	M-L Miocene	Ruggieri, 1967
	Jamnagar & Probander Destrict, India	E. Miocene	Khosla, 1978
	SE Turkey	Neogene	Bassiouni, 1979
	West Coast of India	Miocene-Pliocene	Guha, 1980
	Western Coast of Gulf of Suez, Egypt	M. Miocene	Szczechura & Abd Al-Shafy, 1988
Loxoconcha	Italy	L. Miocene	Farnda *et al.*, 2007
	Saurashtra, India	Miocene	Khosla, 1978
	SE Turkey	Neogene	Bassiouni, 1979
	France	Miocene	Carbonnel, 1969
	Adana & Antakya Basins, Turkey	Miocene	Doruk, 1979
	Shams Abad & Rahniz, Iran	E. Miocene	Kristic, 1979
	Gujarat, Bombay Off-Shore, Kerala, Tamil Nado, Andaman Islands, India	E. Miocene	Jain, 1980
	Gulf of Suez, Egypt	M. Miocene	Szczechura & Abd Al-Shafy, 1988
	Sirte Basin, Libya	M. Miocene	Szczechura & Abd Al-Shafy, 1988
	Egypt	L. Miocene	Abd-Al-Muinium, 1990

	Gonzne (Mersin) Region, Turkey	E. Miocene	Nazik, 1993
	Tanzania	E. Miocene	Ahmed *et al*. 1991
	Al-Kums Formation, Nw Libya	Miocene	El-Waer, 1991
	Qum Formatio, Iran	E. Miocene	Daneshain & Dana, 2007
Miocyprideis	NE Venezuela	L. Miocene	Bold, 1966
	Burma	Eocene-Miocene	Gramann, 1975
	Jamnagar & Probander Destrict, India	E. Miocene	Khosla, 1975
	SE Turkey	Neogene	Bassiouni, 1979
	Shams Abad & Rahniz, Iran	E. Miocene	Kristic, 1979
	Gulf of Suez, Egypt	M. Miocene	Szczechura & Abd Al-Shafy, 1988
	Sirte Basin, Libya	M. Miocene	Szczechura& Abd Al-Shafy, 1988
	Gonzne (Mersin) Region, Turkey	E. Miocene	Nazik, 1993
	Coxs Bazar, Bangladesh	Neogene	Ahmed *et al*., 1991
Mutilus	Adana & Antakya Basins, Turkey	Miocene	Doruk, 1979
	Al-Kums Formation, Nw Libya	Miocene	El-Waer, 1991
Neomonocyratina	Saurashtra, India	E. Miocene	Khosla, 1978
	Gujarat, Bombay Off-Shore, Kerala, Tamil Nado, India	E. Miocene	Jain, 1980
Neomonocyratina	Gulf of Suez, Egypt	M. Miocene	Szczechura & Abd Al-Shafy, 1988
	Al-Kums Formation, Nw Libya	Miocene	El-Waer, 1991
	Coxs Bazar, Bangladesh	Neogene	Ahmed *et al*., 1991
	Messara Plain, Crete Island	L.Miocene	Faranda, 2007
Paijenborchallina	Burma	Tertiary & Holocene	Gramann, 1975
	Shams Abad & Rahniz, Iran	E. Miocene	Kristic, 1979
	Sirte Basin, Libya	M-L Miocene	Szczechura, 1980
	Gulf of Suez, Egypt	M. Miocene	Szczechura & Abd Al-Shafy, 1988
	India	E. Miocene	Khosla & Nagori, 1989
	Al-Kums Formation, Nw Libya	Miocene	El-Waer, 1991
Paracythereidea	Saurashtra, India	Miocene	Khosla, 1978
	Andaman Islands	M-L Miocene, Pliocene	Jain, 1980
	Gujarat, India	E. Miocene	Jain, 1980
	Gulf of Suez, Egypt	M. Miocene	Szczechura & Abd Al-Shafy, 1988
	Italy	Miocene	Bassio *et al*., 2006
Parakrithe	Italy	M-L Miocene	Ruggieri, 1962
	Gabon	Neogene	Bold, 1966
	NE Venezuela	L. Miocene	Bold, 1966
	Rajasthan, India	E. Miocene	Jain, 1980

	Western of Philippin Sea	L. Oligocene-M. Miocene	Whatly & Quan hong, 1998
Pontocyprella	Western Coast of Gulf of Suez, Egypt	M. Miocene	Szczechura & Abd Al-Shafy, 1988
Quadracythere	Pale-Yellow Kankary Limstone, India	Miocene	Khosla, 1978
	Adana & Antakya Basins, Turkey	Miocene	Doruk, 1979
	Gujarat, India	E. Miocene	Jain, 1980
	Tanzania	E. Miocene	Ahmed *et al*., 1991
Schneiderella	Euxino-Caspino Basin, Bulgaria	Miocene	Stanchiva, 1974
	Shams Abad & Rahniz, Iran	E. Miocene	Kristic, 1979
Stigmatocythere	Gujarat , India	Miocene	Khosla, 1976, 1978
	Tanzania	Oligocene-Miocene	Ahmed, 1977
	Gujarat, India	E. Miocene	Jain, 1980
	W India	Miocene	Siddiqui, 1983
	NW Libya	Miocene	El-waer, 1991
	Qum Formation, Iran	E. Miocene	Danishian & Dana, 2007
Uroleberis	Andaman Islands	L.Oligocene-E. Miocene	Jain, 1980
	Tanzania	E. Miocene	Ahmed *et al*., 1991
	Qum Formation, Iran	E. Miocene	Daneshain & Dana, 2007
Xestoleberis	Saurashtra, India	Miocene	Khosla, 1978
	Adana & Antakya Basins, Turkey	Miocene	Doruk, 1979
	Andaman Islands	M-E. Miocene	Jain, 1980
Xestoleberis	Western Coast of Gulf of Suez, Egypt	M. Miocene	Szczechura & Abd Al-Shafy
	Sirte Basin, Libya	M. Miocene	Szczechura & Abd Al-Shafy, 1988
	Gonzne (Mersin) Region, Turkey	E. Miocene	Nazik, 1993
	Al-Kums Formation,NW Libya	L. Miocene	El-Waer, 1991
	Qum Formation, Iran	E. Miocene	Daneshain & Dana, 2007
	Messara Plain, Crete Island	L. Miocene	Faranda, 2007

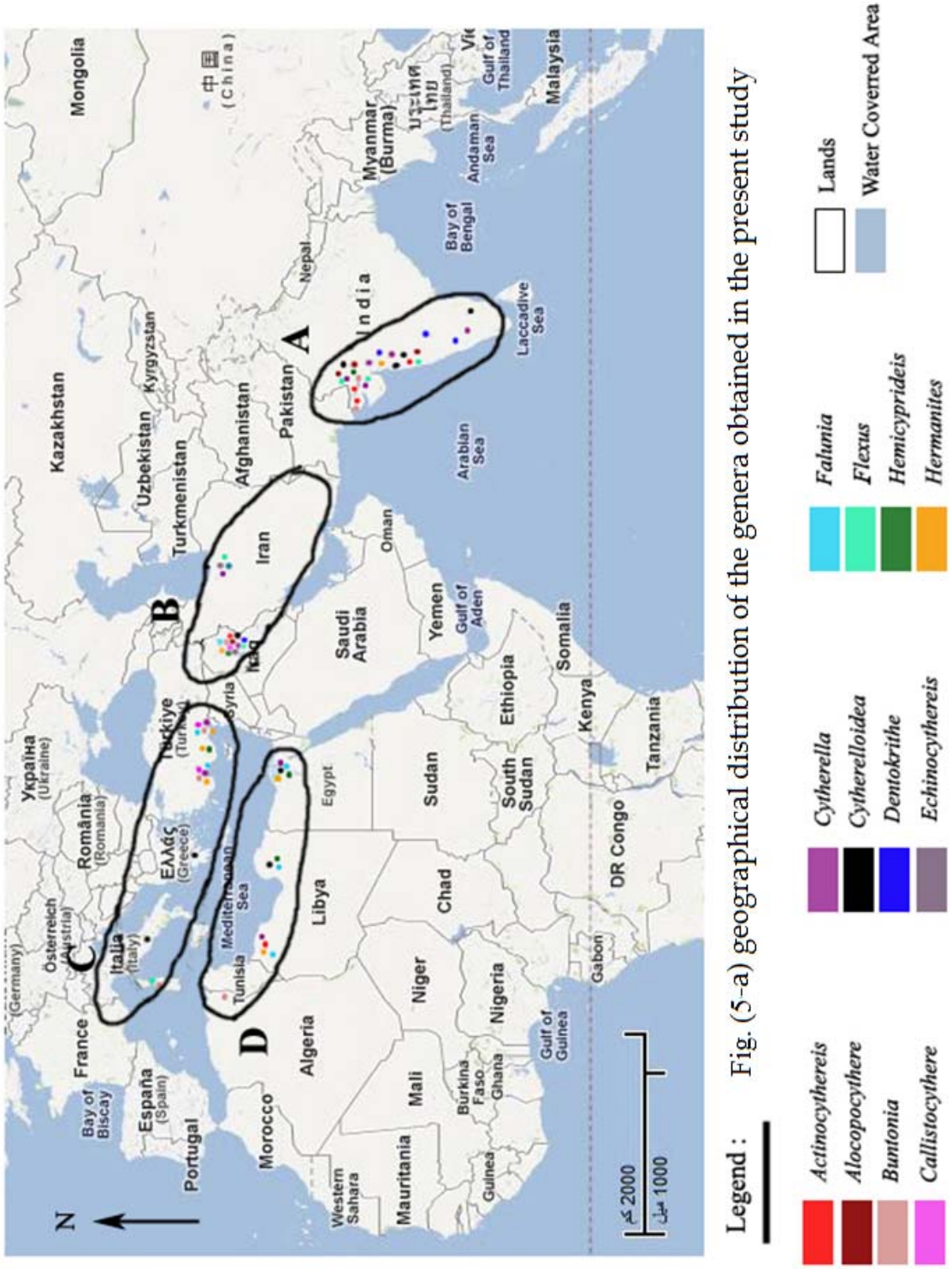


Fig. (5-a) geographical distribution of the genera obtained in the present study

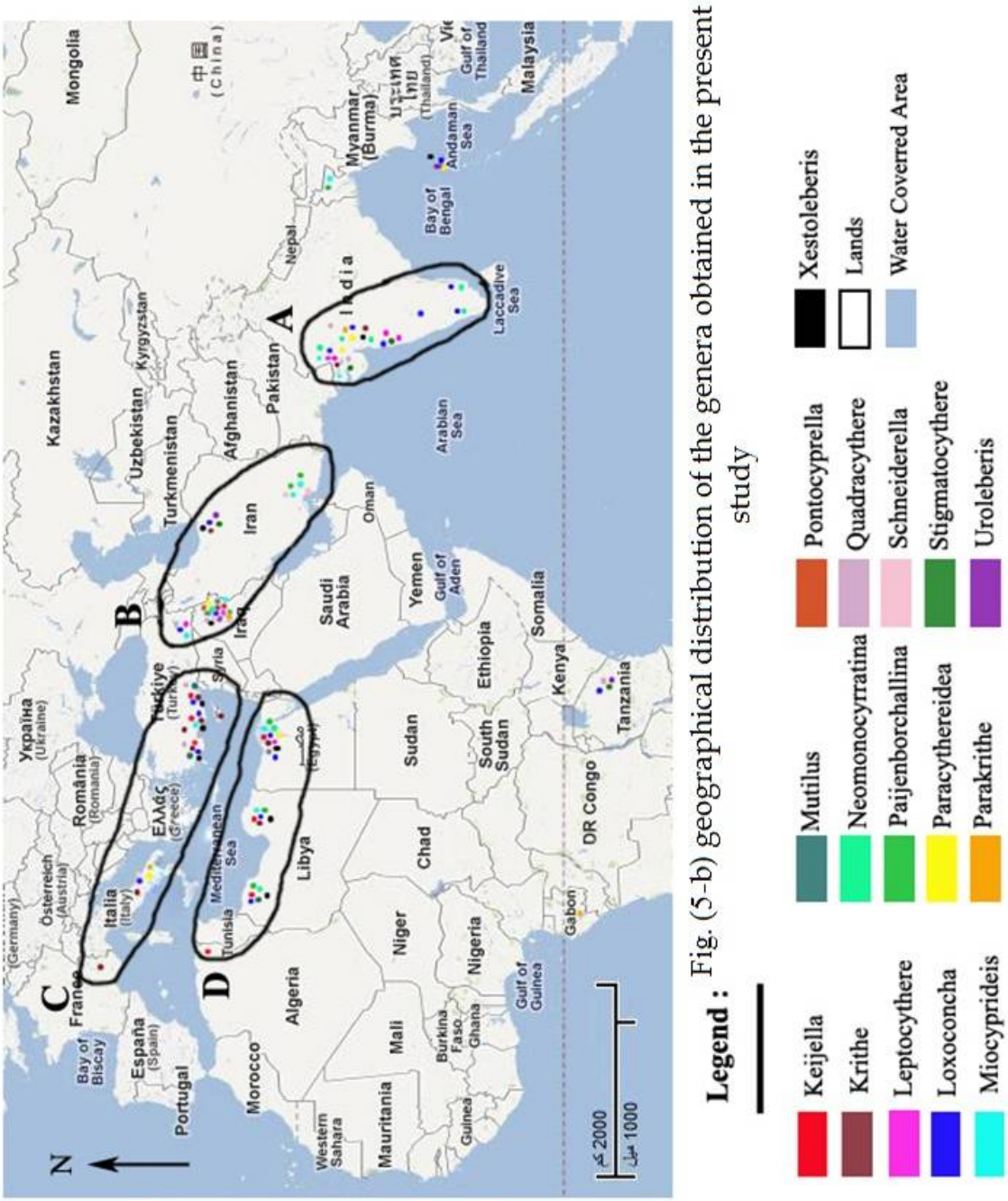


Fig. (5-b) geographical distribution of the genera obtained in the present study

Explanation of the Plate -1-

***Cytherella sayyabi* Khalaf, 1993**

1. Mou.Ft.F.Su.1, Side view of the left valv.
2. Mou.Ft.F.Su.2, dorsal view of the carapace.

***Cytherelloidea flexicostata* Khalaf, 1993**

3. Mou.Ft.F.Su.3, Side view of the left valv.
4. Mou.Ft.F.Su.4, dorsal view of the carapace.

***Cytherelloidea hamrinensis* Khalaf, 1993**

5. Mou.Ft.F.Su.5, Side view of the right valv.
6. Mou.Ft.F.Su.6, Side view of the left valv.

***Schneiderella unispinata* Khalaf, 1993**

7. Mou.Ft.F.Su.7, Side view of the right valv.
8. Mou.Ft.F.Su.8, dorsal view of the carapace.
9. Mou.Ft.F.Su.9, Side view of the left valv.

***Schneiderella unispinata* Morphotype A**

10. Mou.Ft.F.Su.10, Side view of the right valv.

***Callistocythere hipposideros* Khalaf, 1993**

11. Mou.Ft.F.Su.11, Side view of the right valv.
12. Mou.Ft.F.Su.12, Side view of the left valv.

***Miocyprideis ovalis* Khalaf, 1989**

13. Mou.Ft.F.Su.13, Side view of the right valv.
14. Mou.Ft.F.Su.14, dorsal view of the carapace.

***Hemicyprideis angulate angulate* Khalaf, 1994**

15. Mou.Ft.F.Su.15, Side view of the right valv.
16. Mou.Ft.F.Su.16, dorsal view of the carapace.

***Pontocythere* sp. Szczechura and Abd El-Shafy, 1988**

17. Mou.Ft.F.Su.17, Side view of the right valv.

***Krithe langhiana* Ortli, 1961**

18. Mou.Ft.F.Su.18, Side view of the right valv.
19. Mou.Ft.F.Su.19, dorsal view of the carapace.

***Dentokrithe comma* Khalaf, 1993**

20. Mou.Ft.F.Su.20, Side view of the right valv.
21. Mou.Ft.F.Su.21, dorsal view of the carapace.

***Parakrithe dectylomorpha* Ruggieri, 1962**

22. Mou.Ft.F.Su.22, Side view of the left valv.

***Stigmatocythere nodosa* Khalaf, 2000**

23. Mou.Ft.F.Su.23, Side view of the left valv.

Plate -1-

Explanation of the Plate -2-

***Actinocythereis iraqensis* Khalaf, 1982**

1. Mou.Ft.F.Su.24, Side view of the right valv.
2. Mou.Ft.F.Su.25, dorsal view of the carapace.

***Actinocythereis libyansis* El-Waer, 1991**

3. Mou.Ft.F.Su.26, Side view of the right valv.
4. Mou.Ft.F.Su.27, Side view of the left valv.
5. Mou.Ft.F.Su.28, dorsal view of the carapace.

***Falunia scula* Aruta, 1966**

6. Mou.Ft.F.Su.29, Side view of the left valv.

***Echinocythereis (Scelidocythereis) multibulata* Siddiqui, 1971**

7. Mou.Ft.F.Su.30, Side view of the left valv.

***Echinocythereis (Scelidocythereis) multibulata* Morphotype A**

8. Mou.Ft.F.Su.31, Side view of the right valv.
9. Mou.Ft.F.Su.32, Side view of the left valv.
10. Mou.Ft.F.Su.33, dorsal view of the carapace.

***Alocopocythere fossularis* (Lyubimova and Guha1960)**

11. Mou.Ft.F.Su.34, ♂, Side view of the right valv.
12. Mou.Ft.F.Su.35, ♀, Side view of the right valv.
13. Mou.Ft.F.Su.36, ♀, Side view of the left valv.

***Alocopocythere transversa* (Morphotype C) Siddiqui, 1971**

14. Mou.Ft.F.Su.37, Side view of the right valv.

***Hermanites transversicoststs* Khalaf, 1982**

15. Mou.Ft.F.Su.38, ♀, Side view of the right valv.
16. Mou.Ft.F.Su.39, ♀, dorsal view of the carapace.
17. Mou.Ft.F.Su.40, ♂, Side view of the right valv.
18. Mou.Ft.F.Su.41, ♂, dorsal view of the carapace.

Quadracythere (Hornibrookella) subquadra Siddiqui, 1971

19. Mou.Ft.F.Su.42, Side view of the right valv.

***Quadracythere (Hornibrookella)* sp.1 Siddiqui, 1971**

20. Mou.Ft.F.Su.43, Side view of the right valv.

***Flexus trifurcate* (Lyubimova and Guha, 1960)**

21. Mou.Ft.F.Su.44, Side view of the right valv.

***Loxoconcha hamrinensis* Khalaf, 1998**

22. Mou.Ft.F.Su.45, Side view of the left valv.
23. Mou.Ft.F.Su.46, Side view of the right valv.
24. Mou.Ft.F.Su.47, dorsal view of the carapace.

***Paijenborchallina (Eupaijenborchalla) iraqensis* Khalaf, 1989**

25. Mou.Ft.F.Su.48, Side view of the left valv.
26. Mou.Ft.F.Su.49, dorsal view of the carapace.

***Propontocypris solitaria* Carbonnel, 1969**

27. Mou.Ft.F.Su.50, Side view of the right valv.

Plate -2-

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