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SOME NEW OSTRACOD SPECIES OF GENERA *SCHNEIDERELLA*, *SULCOSTOCYTHERE*, AND *NEOMONOCERATINA*, FROM THE FAT'HA FORMATION (MIDDLE MIOCENE) IN THE TAKIA AREA, DARBANDI BAZIAN ANTICLINE, SULAIMANIYAH AREA, KURDISTAN REGION, NORTHEASTERN OF IRAQ

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ABSTRACT

Five new ostracod species belonging to three genera from the Fat'ha Formation (Middle Miocene) in the Takia area, Darbandi Bazian anticline Sulaymaniyah, Northeastern Iraq. These species are *Schneiderella takensis* sp.nov., *Schneiderella bazensis* sp.nov., *Sulcostocythere takensis* sp.nov., *Sulcostocythere bazeansis* sp.nov., and *Neomonoceratina takensis* sp.nov. Those genera are showing affinities with ostracods of Mediterranean and Indopacific Bioprovinces.

INTRODUCTION

The information about the ostracods of Iraq are, somehow, restricted to only a few papers, due to the shortage of ostracodalogists, especially a few workers in the Tertiary of Iraq. The present study is part of an ostracod investigation in the Fat'ha Formation (Middle Miocene) from an outcropped section belonging to the Darbandi Bazian anticline in the Takia area, Sulaymaniyah city, Northeastern Iraq, with coordinates between 35° 41' 51.48" N and 35° 34' 41.17" N, and 44° 48' 46.39" E and 45° 08' 4.22" E. Geologically, the studied area is located within the High Folded Zone (Al-Hakari, 2011; Figure 1).

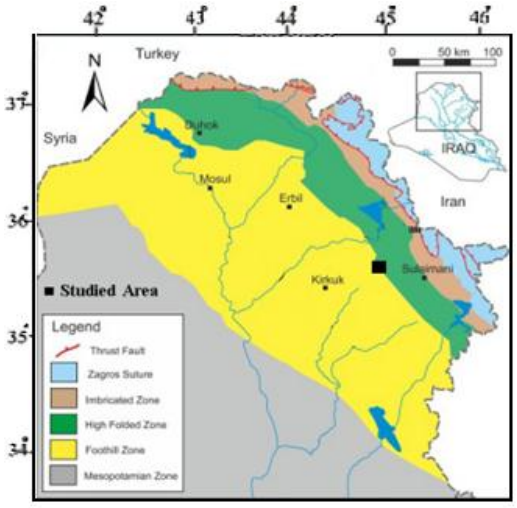

Figure 1: Tectonic Map of NE Iraq shows the location of the studied section (Source: http://www.geoexpro.com).

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The underlying contact is unconformable with Pilaspi Formation, while the overlying is conformable with Injana Formation. Lithologically, Fat'ha Formation mainly consists of marl, marly limestone, claystone, gypsum, sandstone, marly sandstone, and conglomerate (Bellen *et al*., 1959; in Jassim and Goff, 2006; Figure 2).

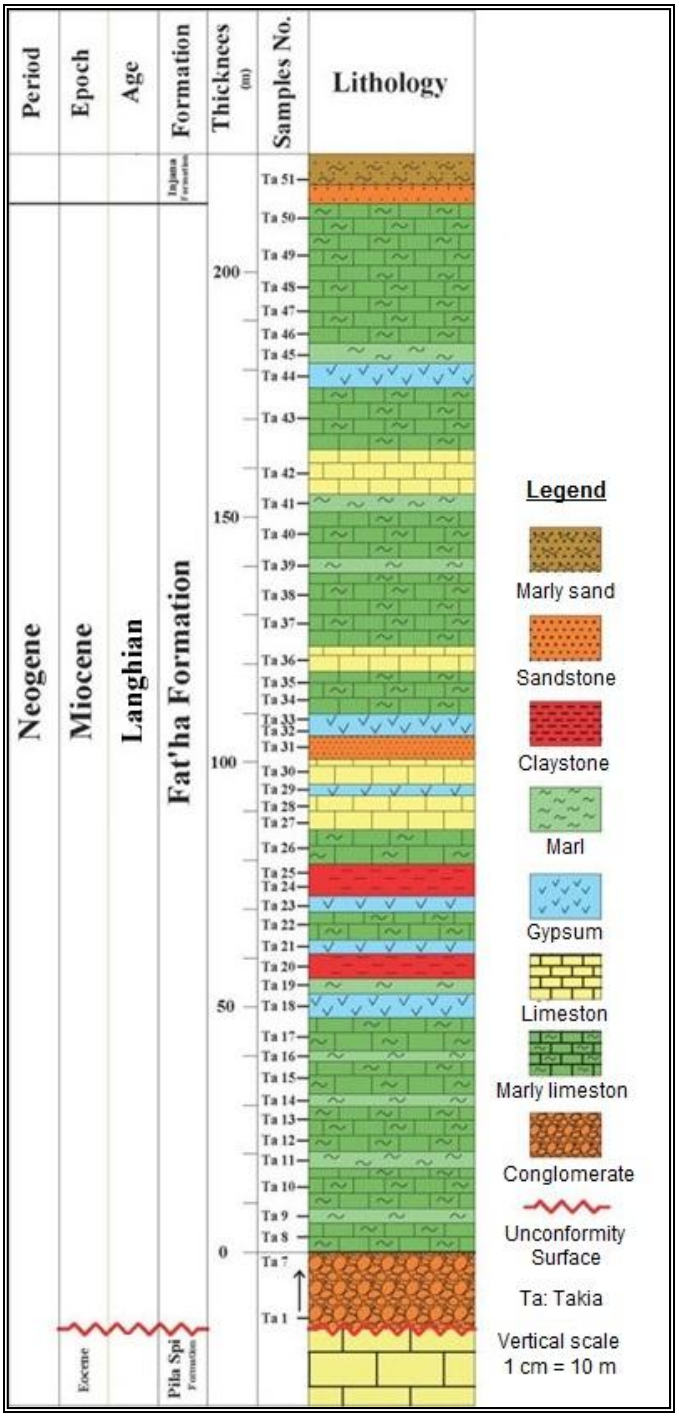

Figure 2: Stratigraphic column of the Fat'ha Formation in the Takia area, Darbandi Bazian Anticline, Sulaimaniyah city.

PREVIOUS STUDIES

The previous studies that related to the Fat'ha Formation ostracods are as mentioned below:

1. Khalaf (1984) studied the Middle Miocene Ostracods from many locations in Iraq.
2. Khalaf (1993a) studied some new ostracod species of the genera *Cytherella* and *Cytherelloidea* from the Middle Miocene of North Iraq.
3. Khalaf and Kharofa (2002) studied the paleontology of ostracods in the Fat`ha Formation in the Hammam al-Alil area, northern Iraq.
4. Hawramy and Khalaf (2012) studied the ostracod of the Fatha Formation (Middle Miocene) From (Darbandikhan, Aghjalar) sections Sulaimaniah area, Northeastern Iraq.
5. Hawramy and Ali (2018) mentioned a new Middle Miocene ostracods from Kurdistan Region, Northeastern Iraq.
6. Issa (2016) studied the ostracods and charophytes as indicators of environmental variables in the marshland area of Southern Iraq.
7. Al-Hadithi and Aziz (2019) studied the paleoecology and statistical study of ostracoda, Fat'ha Formation (Middle Miocene) from Bazian Anticline, Al-Sulaymaniyah area, Kurdistan Region. Iraq.
8. Al-Shareefi *et al*. (2022) Studied the nanobiostratigraphy and ostracoda paleoecology of the Fat'ha Formation in Bashiqa Anticline, Northeastern Iraq.
9. Ghafor and Ahmad (2021) studied the stratigraphy of Oligocene-Early Miocene successions in the Sangaw area, Kurdistan Region, NE-Iraq.

Aims of Study

1. View a detailed system description and taxonomic study of the ostracoda in the Fat'ha Formation in the studied area.
2. Describe a new species of ostracods in the Fat'ha Formation.

MATERIALS AND METHODS

Fifty-one rock samples were taken from the Fat′ha Formation. Each sample taken was 250 gm and processed according to Moore and Pitrat (1961). The picked ostracod specimens include well-preserved and crushed carapaces and valves.

REPOSITORY

All the figured specimens were deposited at the Geology Department of Mosul University under a prefix.
MO.MM.Ft.F.B.Su.
Mo: Mosul University.
MM: Middle Miocene
Ft. F: Fat'ha Formation.
B: Darbandi Bazian Anticline

- **Systematic Description**

The classification of ostracods in the present study followed that of Morkhoven (1963), Hartmann and Puri (1974), and Horne *et al*. (2002).

Phylum:	Arthropoda	Siebold and Stannius, 1845 in Ellis and Messina 1952
Subphylum:	Crustacea	Pennant, 1777 in Ellis and Messina 1952 in Ellis and Messina 1952
Class:	Ostracoda	Latreille, 1806 in Ellis and Messina 1952
Order:	Podocopida	Muller, 1896 in Ellis and Messina 1952
Suborder:	Podocopa	Sars, 1866 in Ellis and Messina 1952
Superfamily:	Cytheracea	Baird, 1850 in Ellis and Messina 1952
Family:	Cytherellidae	Baird, 1850 in Ellis and Messina 1952
Genus:	*Schneiderella*	Stancheva, 1974 in Ellis and Messina 1952
Type species:	*Cythereis dromas*	Schneider, 1939 in Ellis and Messina 1952

- ***Schneiderella takensis* sp. nov.** (Figure 3a – d)

– **Derivation of name:** From first described occurrence in Takia village, Darbandi Bazian anticline northeastern Iraq.

– **Diagnosis:** A species of *Schneiderella*, characterized by a carapace that is swollen posteriorly and has well developed ventrolateral alae structure and distinct anterior and posterior cardinal angles.

– **Holotype**: Carapace, MO.MM.Ft.F.B.Su. (1.1) (Figure 3a).

– **Paratype:** Three carapaces, MO.MM.Ft.F.B.Su. (1.2 – 1.4) (Figure 3b – d).

– **Type locality and Horizon:** Fat'ha Formation. (Middle Miocene) Darbandi Bazian anticline, Takia area, NE Iraq, Sample no. Ta. 9.

– **Materials:** 6 specimens.

– **Dimension (mm):** Length (L): 0.72, Height (H): 0.30, Width (W): 0.35, L/ H: 2.4

– **Description:** The carapace sub rhomboidal is shaped in the lateral view, Maximum length sites are above the middle and the greatest height locates at the anterior cardinal angle. The dorsal margin is sub-straight, Ventral Margin is slightly convex. Anterior is broadly rounded, relatively to the carapace, and slightly oblique downward. The posterior is narrow, slightly drawn backward, and has a small concavity in the dorsal part, while it sloping or curved in the ventral part. Both anterior and posterior cardinal angles are presence, a rounded eye tubercle, the presence of a vertical groove starting behind the eye tubercle and ending above the ventral margin, carapace moderately calcified. The entire outer surface is covered with slight reticulate ornamentation. The left valve is larger than the right valve, the overlapping occurs along the anterior and posterior margins.

– **Remarks:** the present species is differing from *Schneiderella* aff. *oertlii* (Guha, 1967b), which was originally described by Guha (1967b). But the latter differs in being more elongated and narrower. Also species differing *Schneiderella unispinata* (Khalaf, 1993a) in the form of the distinctive posterior, which is narrower in the current species while being wide in *S. unispinata*. Also, species similar to *Schneiderella* sp. 1 (Hawramy and Khalaf, 2012) in the dorsal margin which is slightly convex to straight, and more faint ornamented.

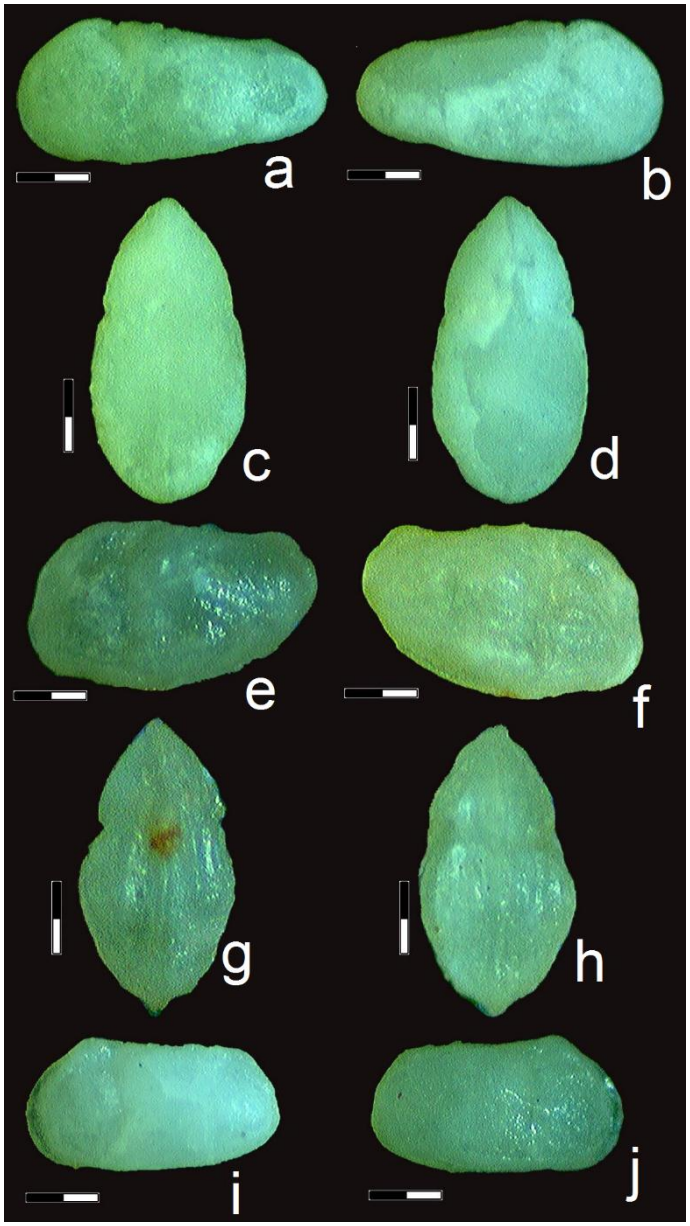

Figure 3: (1 bar = 200 μm).

(a – d) *Schneiderella takensis* sp.nov.

a) Holotype, external carapace, Left valve, MO.MM.Ft.F.B.Su.1.1.
b) Paratype, external carapace, right valve, MO.MM.Ft.F.B.Su.1.2.
c) Paratype, external carapace, ventral view, MO.MM.Ft.F.B.Su.1.3.
d) Paratype, external carapace, dorsal view, MO.MM.Ft.F.B.Su.1.4.

(e – h) *Schneiderella bazensis* sp.nov.

e) Holotype, external carapace, left valve, MO.MM.Ft.F.B.Su.1.5.
f) Paratype, external carapace, right valve, MO.MM.Ft.F.B.Su.1.6.
g) Paratype, external carapace, ventral view, MO.MM.Ft.F.B.Su.1.7.
h) Paratype, external carapace, dorsal view, MO.MM.Ft.F.B.Su.1.8.

(i and j) *Sulcostocythere takensis* sp.nov.

i) Holotype, external carapace, left valve, MO.MM.Ft.F.B.Su.1.9.
j) Paratype, external carapace, right valve, MO.MM.Ft.F.B.Su.1.10.

- ***Schneiderella bazensis* sp. nov.** (Figure 3e – h)

– **Derivation of name:** From first described occurrence in the Takia village, Darbandi Bazian anticline Northeastern Iraq.

– **Diagnosis:** A species with strong ventrolateral inflation, a strongly reticulate surface, in which the merged reticular muri form subparallel costae.

– **Holotype:** Carapace, MO.MM.Ft.F.B.Su. (1.5) (Figure 3e).

– **Paratype:** Three carapaces, MO.MM.Ft.F.B.Su. (1.6 – 1.8) (Figure 3f – h).

– **Type locality and Horizon:** Fat'ha Formation (Middle Miocene), Darbandi Bazian anticline, Takia area, NE. Iraq, Sample no. Ta. 9.

– **Materials:** 8 specimens.

– **Dimension** (mm)**:** L: 0.53, H: 0.30, W: 0.35, L/H: 1.76

– **Description:** The carapace is sub rhomboidal in the lateral view. The maximum length is located in the middle and the greatest rise is at the front. The dorsal margin is straight and concave before the end and slope and ends high. The ventral margin is bent upwards towards the rear. The anterior is wide and curvy and tilted toward the ventral edge. The posterior is narrow and elevated and contains a concave at the end, the ocular node is clear. The outer surface contains an adrenal groove that begins from the ventral edge and ends at the dorsal edge, the left valve is larger than the right valve and the overlap is evident around the ventral edge, the surface ornamented with reticules.

– **Remarks**: The present species is differing from *Schneiderella unispinata* (Khalaf, 1993a) in the form of the distinctive posterior, which is narrower in the current species while being wide in *Schneiderella unispinata* (Khalaf, 1993a) which the posteroventral margin is slightly drawn out towards the dorsal.

Genus:	*Sulcostocythere*	(Benson and Maddocks, 1964)
Type species:	*Sulcostocythere knysnaensis*	(Benson and Maddocks, 1964)

- ***Sulcostocythere takensis* sp. nov.** (Fig.3i and j, and Fig.4a and b)

– **Derivation of name:** From first described occurrence in Takia village, Darbandi Bazian anticline North-Eastern Iraq.

– **Diagnosis:** A *Sulcostocythere* species, with elongate, contains an eye tubercle on the surface; the anterior contains a thin edge.

– **Holotype:** Carapace, MO.MM.Ft.F.B.Su. (1.9) (Fig.3i).

– **Paratype:** Three carapaces, MO.MM.Ft.F.B.Su. (1.10 – 1.12) (Fig.3j, and Fig.4a and b).

– **Type locality and Horizon:** Fat'ha Formation (Middle Miocene) Darbandi Bazian anticline, Takia area, NE. Iraq, Sample no. Ta. 9.

– **Materials:**16 specimens.

– **Dimension** (mm)**:** L: 0.63, H: 0.30, W: 0.31, L/H: 2.1

– **Description:** Carapace sub quadrate in the lateral view, maximum h

– eight passes through the anterior cardinal angle, the greatest length locates below the middle. The dorsal margin sub-straight joins the anterior and posterior with a rounded angle. The ventral margin is slightly convex, merging with the anterior and the posterior with a rounded angle. The anterior is broad and slightly tilted toward the ventral margin. Posterior is narrow, rounded in the middle, and slightly concaved at the ventral part. There is a vertical groove that starts directly behind the eye tubercle and ends below the middle, the eye tubercle is weakly presence, the posterior half is more bulging than the anterior half, and the anterior and posterior cardinal angles are rounded. The outer surface is covered with very fine pits or small pores. The left valve is slightly larger than the right, with an overlapping presence at the anterior.

– **Remarks:** The present species fairly resembles *Sulcostocythere danakilensis* (Gramann, 1975) in the posterior and anterior but differs in the shape of the eye tubercle which is distinct, rounded, and elongated. Also, the species distinguished from *Sulcostocythere* sp. 1 (Hawramy and Khalaf, 2012) by its posteroventral margin.

- ***Sulcostocythere bazensis* sp. nov.** (Figure 4c – f)

– **Derivation of name:** From first described occurrence in Takia village, Darbandi Bazian anticline northeastern Iraq.

– **Diagnosis:** A *Sulcostocythere* species, with elongate, sub rhomboidal, and whose lateral surface is covered with finely pitted reticules.

– **Holotype:** Carapace, MO.MM.Ft.F.B.Su. (1.13) (Figure 4c).

– **Paratype:** Three carapaces, MO.MM.Ft.F.B.Su. (1.14 – 1.16) (Figure 4d – f).

– **Type locality and Horizon**: Fat'ha Formation (Middle Miocene) Darbandi Bazian anticline, Takia area, NE. Iraq, Sample no. Ta. 9.

– **Materials:** 21 specimens.

– **Dimension (mm):** L: 0.54, H: 0.31, W: 0.25, L/H: 1.74

– **Description:** The carapace is elongated and sub-rectangular in the lateral view, maximum height passes through the eyespot and the greatest length locate below the middle. Dorsal margin sub-straight. The ventral margin sinuous joins the posterior with a rounded angle. The anterior is wide and obliquely rounded downward. Posterior narrow and sub-truncated, have a small slighted curve behind the posterior cardinal angle. The eye tubercle is presence, there is a curved thin ridge that starts below the middle near the anterior and ends behind the middle. The outer surface is covered with faint reticulations. The left valve is slightly larger than the right valve, which appears through the dorsal margin.

– **Remarks:** The present species is differing from *Sulcostocythere knysnaensis* (El-waer, 1988) in having longer and less height carapace and the shape of the posterior.

Genus	*Neomonoceratina*	Kingma, 1948 in Ellis and Messina 1952
Type species:	*Neomonoceratina columbiformis*	Kingma, 1948 in Ellis and Messina 1952

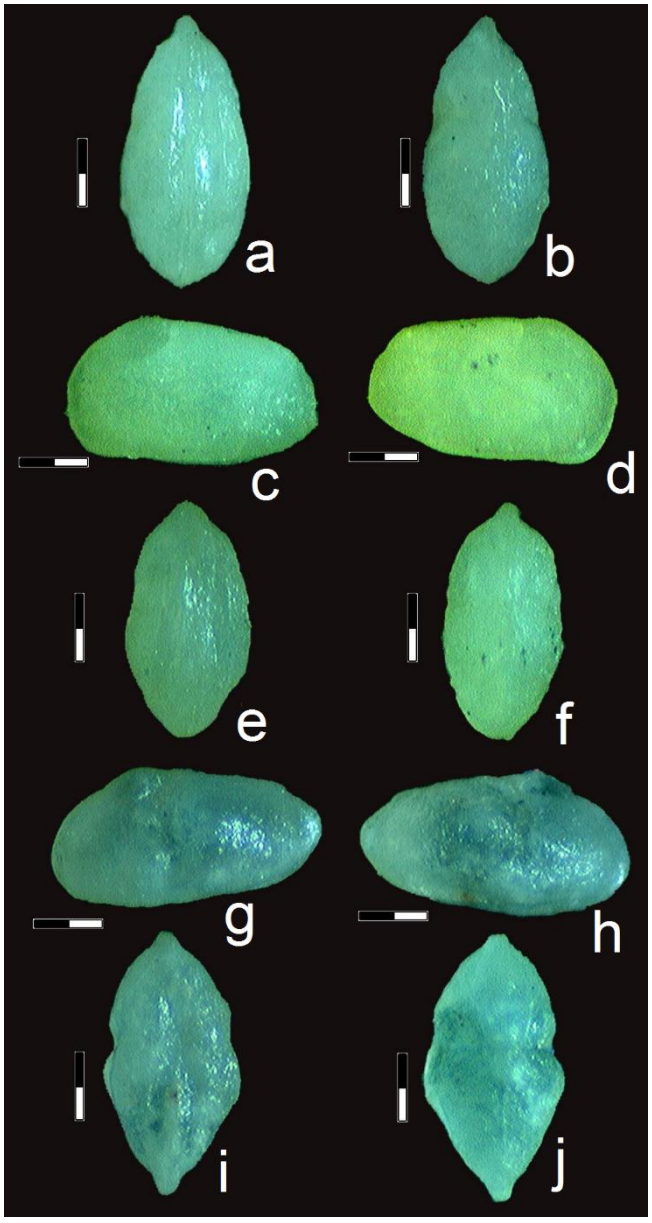

Figure 4: (1 bar = 200 μm)

(a and b) *Sulcostocythere takensis* sp.nov.

a) Paratype, external carapace, ventral view, MO.MM.Ft.F.B.Su.1.11.
b) Paratype, external carapace, dorsal view, MO.MM.Ft.F.B.Su.1.12.

(c – f) *Sulcostocythere bazensis* sp.nov.

c) Holotype, external carapace, left valve, MO.MM.Ft.F.B.Su.1.13.
d) Paratype, external carapace, right valve, MO.MM.Ft.F.B.Su.1.14.
e) Paratype, external carapace, ventral view, MO.MM.Ft.F.B.Su.1.15.
f) Paratype, external carapace, dorsal view, MO.MM.Ft.F.B.Su.1.16.

(g – j) *Neomonoceratina takensis* sp.nov.

g) Holotype, external carapace, left valve, MO.MM.Ft.F.B.Su.1.17.
h) Paratype, external carapace, right valve, MO.MM.Ft.F.B.Su.1.18.
i) Paratype, external carapace, ventral view, MO.MM.Ft.F.B.Su.1.19.
j) Paratype, external carapace, dorsal view, MO.MM.Ft.F.B.Su.1.20.

- ***Neomonoceratina takensis* sp. nov.** (Figure 4g – j)

– **Derivation of name:** From first described occurrence in Takia village, Darbandi Bazian anticline North-Eastern Iraq.

– **Diagnosis:** Carapace typical of *Neomonoceratina*, moderately and rather equally inflated laterally, with weakly marked main ribs A faint rib runs downwards from the eye tubercle and parallels the anterior margin. Another rib occurs in the posterodorsal part of the carapace parallelly to the margin of the two ribs on the ventral side, the internal one is longer, intercostal areas, mostly in the upper part of the carapace, indistinctly and obliquely ribbed.

– **Holotype:** Carapace, MO.MM.Ft.F.B.Su. (1.17) (Fig.4g).

– **Paratype**: Three carapaces, MO.MM.Ft.F.B.Su. (1.18 – 1.20) (Fig.4h – j).

– **Type locality and Horizon:** Fat'ha Formation (Middle Miocene) Darbandi Bazian anticline, Takia area, NE-Iraq, Sample no. Ta. 50.

– **Materials:** 7 specimens.

– **Dimension (mm):** L: 0.60, H: 0.31, W: 0.25, L/H: 1.93

– **Description:** Carapace sub ovate in the lateral view, maximum height and length locate at the middle narrowly rounded anteriorly, while provided with a short sub-dorsal, caudal process posteriorly; anterior and posterior margins slightly thickened. Dorsal and ventral margins are somewhat coinciding posteriorly, the latter being a little concave in the middle. Eye tubercle weakly marked, with a faint rib crossing it, then running downwards and disappearing above the middle rib. The anterior cardinal angle is poorly developed. Lateral inflation, equal and moderate, in its lower part, is bounded by a faint lateroventral rib and sharply ended posteriorly. A similar but longer rib occurs between the fanner rib and the ventral margin. Median rib long, extending from the anterior margin up to the posterior part of the carapace and continuing over the sulcus. Another, the bent rib runs closely to the posterodorsal margin In front of the upper part of the sulcus there is small, tubercle-like valve inflation. The surface of the carapace, especially its lower part, is almost smooth; the upper part of the carapace is generally faintly and obliquely ribbed.

– **Remarks:** The present species is distinguished from *Neomonoceratina miocaenica*, (El-waer, 1988) by its more elevated anteromarginal rim and distinct eye tuberculate surface. Also, it differs from *Neomonoceratina iniqua* (Whatley and Quanhong, 1987 in Al-Hakari, 2011) in the shape of the dorsal margin and posterior. Species is differing from *Neomonoceratina porocostata* Howe and Mckenzie (1989) (Mohammed and Keyser, 2012). in the details of ornamentation and shape of the posterior which is very slightly curved. *Neomonoceratina delicata* is similar to those described by Ishizaki and Kato (1976) (Issa, 2016) from the Quaternary of Japan. They are however more equally inflated and somewhat different in the details of ornamentation. Also, the species is similar to *Neomonoceratina keiji* Szczechura (1988) (Szczechura and Abd-Elshafy, 1988) but it's differing in the dorsal margin which it's a slightly curved and distinct anterodorsal marginal angle. This species also distinguished from *Neomonomceratina interiecta* Bonaduce *et al*. (1988) (Safak and Nurlu, 2018) from the middle – Late Miocene in Turkey by having a narrower posterior margin.

CONCLUSION

Five new ostracod species belonging to three genera from the Fat'ha Formation (Middle Miocene) in the Takia area, Darbandi Bazian anticline, Sulaimanya city, Kurdistan Region, Northeastern Iraq. These species are *Schneiderella takensis* sp. nov., *Schneiderella bazensis* sp. nov., *Sulcostocythere takensis* sp. nov., *Sulcostocythere bazeansis* sp. nov., and *Neomonoceratina takensis* sp. nov.

The Miocene ostracods from Iraq show great affinities with the Mediterranean and Indopacific Bioprovince. Thus, based on the comparison at the generic level and the similarities between Iraqi genera and the adjacent areas, Iraq and Iran represents an intermediate zone located between the Mediterranean Tethyan and the Indopacific Tethyan parts.

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