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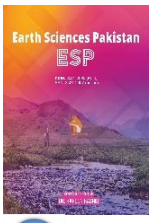

RESEARCH ARTICLE

SIX TETHYAN EVOLUTIONARY LINEAGES OF THE LATE MAASTRICHTIAN PLANKTIC FORAMINIFERAL SPECIES OF PLUMMERITA

Haidar Salim Anan*

Emeritus, former Vice President of Al Azhar University-Gaza, P. O. Box 1126, Palestine.
**Corresponding Author Email: profanan@gmail.com*

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ABSTRACT

Twelve latest Maastrichtian planktic foraminiferal species of the genus Plummerita in the Late Maastrichtian P. hantkeninoides Range Zone are recorded and illustrated from the Northern and Southern Tethys (USA, Caribbean, Trinidad, Spain, Tunisia, Egypt, Iraq and India). Six planktic foraminiferal evolutionary lineages in the assemblage were produced by gradualistic evolutionary trends which observed within this assemblage. These trends are: (1) Plummerita elkefensis Anan & Orabi → P. hantkeninoides (Brönnimann), (2) P. safaae Anan, n. sp. → P. haggagae Anan, (3) P. salimi Anan, n. sp. → P. hodae Anan, (4) P. kellerae Anan & Orabi → P. caribbeanica Anan, (5) P. inflata (Brönnimann) → P. tunisica Anan, (6) P. costata (Brönnimann) → P. spainica Anan. Two of the recorded species is treated here as new: Plummerita safaae and P. salimi. These lineages help to define the major faunal changes in the Late Maastrichtian warm water Gene Pool.

KEYWORDS

Plummerita, Planktic foraminifera, Maastrichtian, Lineages,

1. INTRODUCTION

The latest Maastrichtian members of the genus Plummerita (with last spine-like prolongation of the ultimate or penultimate of two, three, four or five-chambered volution test), have an extensive distribution in the Northern and Southern Tethys, particularly in: USA, Caribbean region (Puerto Rico), Trinidad, Demerara Rise (ODP Hole 1259C), Spain, Tunisia, Egypt, Iraq and India (Figure 1).

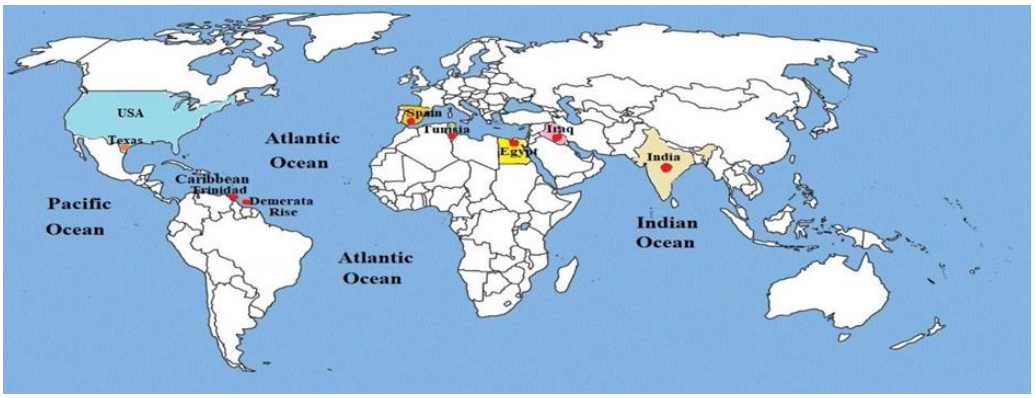

Figure 1: Geographic distribution of the Plummerita species in different localities in the Tethys.

The Plummerita species caught the attention of a great numbers of researchers, i.e. Said & Kenawy (1956), Galal (2004); Keller (2002, 2005, 2012), Anan (2008), Mukhopadhyay (2008), Al-Mutwali & Ibrahim (2019), Bamerni et al., 2021; Anan & Orabi, 2022; Anan (2023). Anan (2008) presented a Plummerita haggagae of last four chambers volution from Gabal Duwi, Red Sea coast of Egypt, as well as Um Sohryngkew River section, Meghalaya of India by Mukhopadhyay (2008), and Bekhme Area, NE Iraq by Al-Mutwali & Ibrahim (2019), and also Per Fat section, Duhok of NE Iraq by Bamerni et al. (2021). Anan & Orabi (2022) presented P. elkefensis from Tunisia, while P. hodae and P. kellerae from Egypt. Later on, Anan (2023) added P. caribbeanica from Puerto Rico, Caribbean region, and P. tunisica from Tunisia. In this study two species are believed here to be new: Plummerita safaae Anan and P. salimi Anan.

2. MATERIAL OF STUDY

Rich and well-preserved five Late Maastrichtian Plummerita species were erected originally from Trinidad, and later from many localities in the Northern Tethys (Spain, Italy) and Southern Tethys (Tunisia, Egypt, Iraq, Iran, and India).

3. TAXONOMY

With its modern taxonomical consideration, following the Code of Zoological Nomenclature (CZN), the classification of Loeblich & Tappan

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(1988) is followed here. Two groups of the Maastrichtian genus Plummerita were produced by Brönnimann (1952) from Trinidad: P. hantkeninoides group (with last five-chambered volution (5ch): P. hantkeninoides, P. costata and P. inflata), and P. reicheli group (with last six-chambered volition (6ch): P. reicheli, P. pustulata and P. hexacamerata), and later on many localities in the Northern and Southern Tethys. The third P. elkefensis group (with last four-chambered volution (4ch): P. elkefensis, P. safaae and P. haggagae) is presented in this study. Six planktic foraminiferal evolutionary lineages were produced by gradualistic evolutionary trends which observed in this study. The twelve recorded Plummerita species are shown in Plate 1.

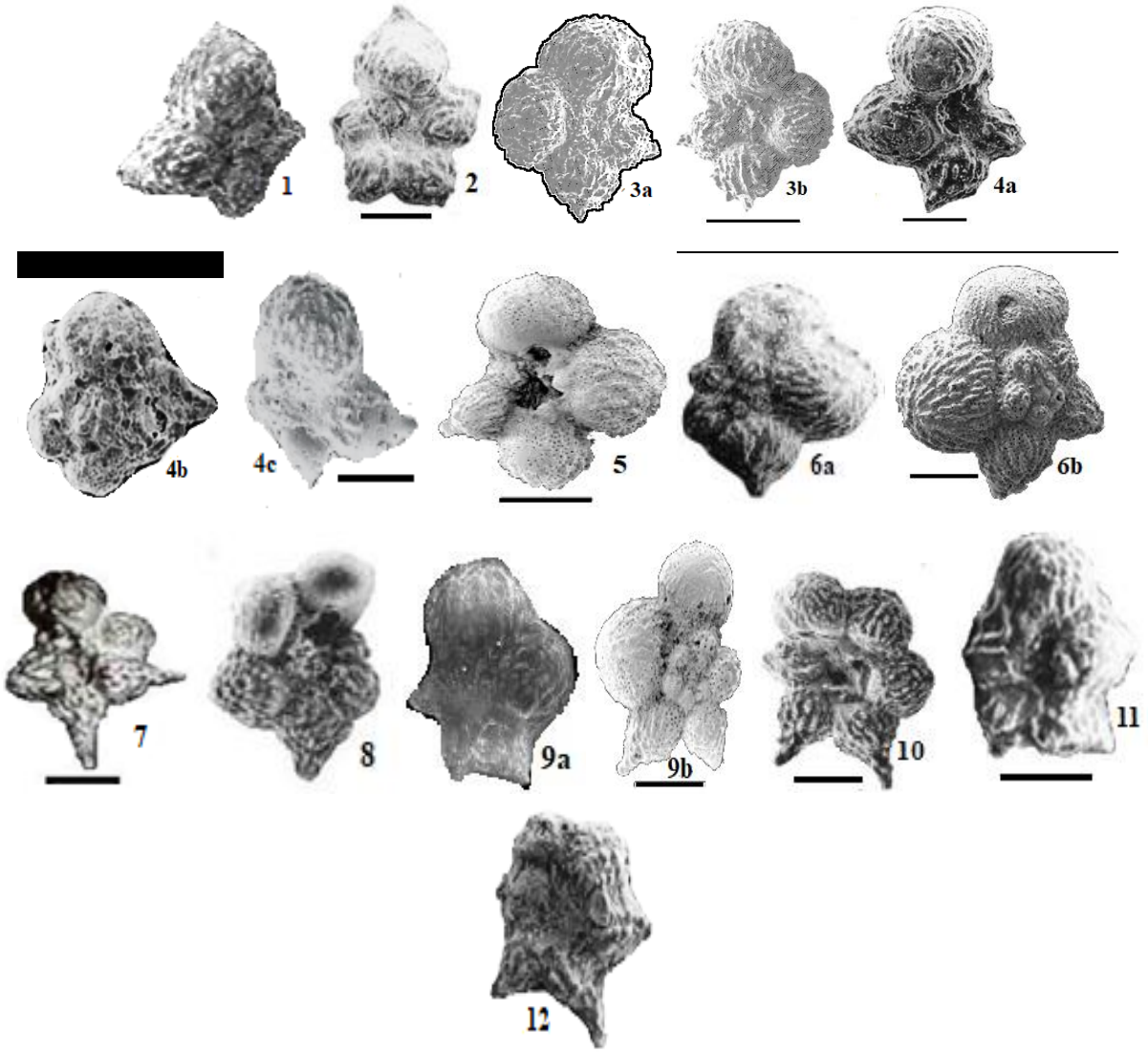

Plate 1 (Scale bars 100 µm): Figure 1. Plummerita elkefensis Anan & Orabi (2022) from Tunisia, 2. P. hantkeninoides (Brönnimann, 1952) from Trinidad, 3a, b. P. safaae Anan, n. sp. from Demerara Rise (ODP Hole 1259C), east of Trinidad, 4a-c. P. haggagae Anan (2008), a. from Egypt, b. from India, c. from Iraq, 5. 5. P. salimi Anan, n. sp. from Egypt, 6a, b. P. hodae Anan, in Anan & Orabi (2022), a. from Egypt, b. from Texas, USA, 7. P. kellerae Anan & Orabi (2022) from Egypt, 8. P. caribbeanica Anan (2023) from Puerto Rico of Caribbean, 9a, b. P. inflata (Brönnimann, 1952), a. from Trinidad, b. from Egypt, 10. P. tunisica Anan (2023) from Tunisia, 11. P. costata (Brönnimann, 1952) from Trinidad, 12. P. spainica Anan (2023) from Spain.

Order Foraminiferida Eichwald, 1830

Suborder Globigerinina Delage and Hérouard, 1896

Genus Plummerita Brönnimann, 1952

Type species: Rugoglobigerina (Plummerella) hantkeninoides subspecies hantkeninoides Brönnimann, 1952.

Plummerita elkefensis Anan & Orabi, 2022, p. 183, fig. 4. D.

Remarks: The planktic foraminiferal evolutionary lineage: Plummerita elkefensis→ P. hantkeninoides is presented in (Pl. 1, figs. 1 → 2). It is, so far, confined to Tunisia (Keller, 2005).

Plummerita hantkeninoides (Brönnimann, 1952)

Remarks: It was recorded from Trinidad (Brönnimann, 1952), and later from Mexico (Arz et al, 2001), Italy (Coccioni & Premoli Silva, 2015), Tunisia (Salaj, 1996), Egypt (Anan, 2012), Palestine (Almogi-Labin et al., 1990) and Iran (Darvishzad et al., 2007).

3a, b. Plummerita safaae Anan, n. sp. [=Plummerita hantkeninoides (Brönnimann) - Georgescu, 2016, p. 221], Atlantic Ocean.

Etymology: after Dr. Safaa Sharabi, Petroleum Consultant, Egypt.

Age: Latest Maastrichtian Plummerita hantkeninoides Zone.

Diagnosis: This species is distinguished by its four chambered volition, with axially pointed spine-like prolongation for only two penultimate chambers, without spine like prolongation of the last third and fourth inflated chambers.

Remarks: P. safaae with only two spine-like prolongation of the last four inflated chamber, which differs from P. haggagae with three spine-like prolongation of the last four inflated chamber, and from four inflated chamber of P. elkefensis with four spine-like prolongations.

Plummerita haggagae Anan, 2008, p. 249, pl. 1, figs. 2, 3.

Remarks: P. haggagae is recorded, so far, from Egypt (Anan, 2008), Iraq (Al-Mutwali & Ibrahim, 2019, p. 21, pl. 4, fig. 2; Bamerni et al., 2021, p. 8, pl. 1, figs. 5-7) and India (Mukhopadhyay, 2008). The evolutionary lineage: Plummerita safaae→ P. haggagae is presented in (Pl. 1, figs. 3 → 4).

Plummerita salimi Anan, n. sp. [=P. hantkeninoides (Brönnimann) - Keller, 2002, p. 81, pl. 2, fig. 9].

Etymology: after my late father, Salim Anan, Gaza, Palestine.

Age: Latest Maastrichtian Plummerita hantkeninoides Zone.

Diagnosis: The only second chamber in the last whorl of this species is yields axially pointed spine-like prolongations, while the other last three chambers are strongly inflated shape without spines. It is also distinguished by its more inflated fourth chamber, than the fifth chamber of the last whorl.

Remarks: This species is closely related with P. hodae, but differs by its axially pointed spine-like prolongations of the second chamber than the third one of the latter.

a, b. Plummerita hodae Anan, 2022, p. 183, fig. 4A.

Remarks: The evolutionary lineage: Plummerita salimi→ P. hodae is presented in (Pl. 1, figs. 5 → 46). P. hodae is recorded, so far, from Egypt (Anan, 2012) and USA (Keller et al., 2009).

Plummerita kellerae Anan & Orabi (2022), p. 183, fig. 4 B.

Remarks: It differs from P. caribbeanica by its first three chambers of the five-chamber volution, than six-chamber volution of the last whorl of the latter. It is, so far, confined to Egypt (Anan & Orabi (2022).

Plummerita caribbeanica Anan, 2023, p. 26, pl. 1, fig. 5.

Remarks: It is recorded from Puerto Rico, Caribbean region (Robaszynski et al., 1983/4). The evolutionary lineage: P. kellerae →P. caribbeanica is presented in (Pl. 1, figs. 7 → 8).

a, b. Plummerita inflata (Brönnimann, 1952), p. 40, pl. 3, figs. 7-9, text-fig. 19a.

Remarks: It was recorded from Trinidad (Brönnimann, 1952), and later on from Tunisia (Salaj, 1996), Egypt (Keller, 2002) and Iraq (Kassab, 1975).

Plummerita tunisica Anan, 2023, p. 25, pl. 1, fig. 3.

Remarks: It is, so far, confined to Tunisia (Keller, 2012). The evolutionary lineage: Plummerita inflata →P. tunisica is presented in (Pl. 1, figs. 9 → 10).

Plummerita costata (Brönnimann, 1952),

Remarks: It is recoded from Trinidad (Brönnimann, 1952), and later on from Tunisia (Salaj, 1996), Egypt (El-Sabbagh, 2007), Iran (Darvishzad et al, 2007) and Italy (Coccioni & Premoli Silva, 2015).

Plummerita spainica Anan (2023), p. 26, pl. 1, fig. 7a-c.

Remarks: It is recorded from Spain (Gilabert et al., 2021). The evolutionary lineage: Plummerita costata → P. spainica is presented in (Pl. 1, figs. 11 → 12).

4. Paleogeography

The identified species of Brönnimann (1952): Plummerita hantkeninoides group and P. reicheli group were originally identified from Trinidad, and later from many countries in the Northern and Southern Tethys. Plummerita elkefensis group is recorded from USA, Caribbean, Tunisia, Egypt, Iraq and India (Figure 2).

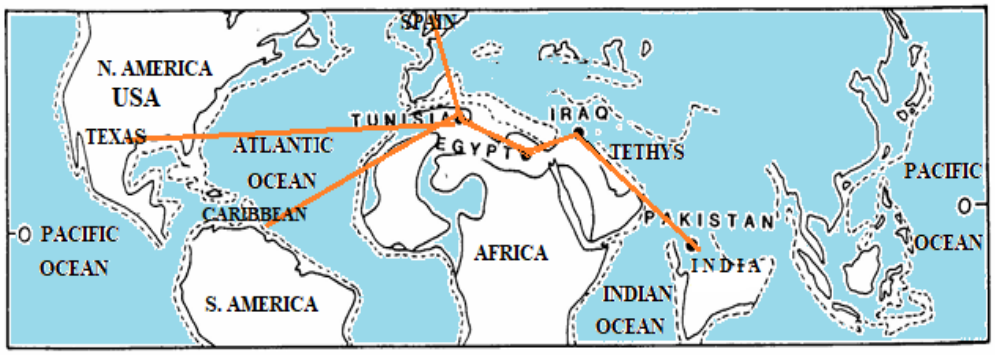

Figure 2: The Late Maastrichtian paleogeographic map showing the distribution of the Plummerita species in different six Tethyan localities: USA, Caribbean, Spain, Tunisia, Egypt, Iraq and India (after Solakius et al., 1990; with some modifications).

5. Paleoenvironment

According to many authors, i.e. Frerichs (1971), Keller (2002), Boudagher-Fadel (2015), Coccioni & Premoli Silva (2015), Gilabert et al. (2021), the planktonic foraminiferal Plummerita spp. are mostly representing a warm stratigraphic interval water environment which have radiations of its tests, and open deep marine neritic environment (~200 m), and represents the Latest Maastrichtian Warming Event, LMWE (Figures 3, 4).

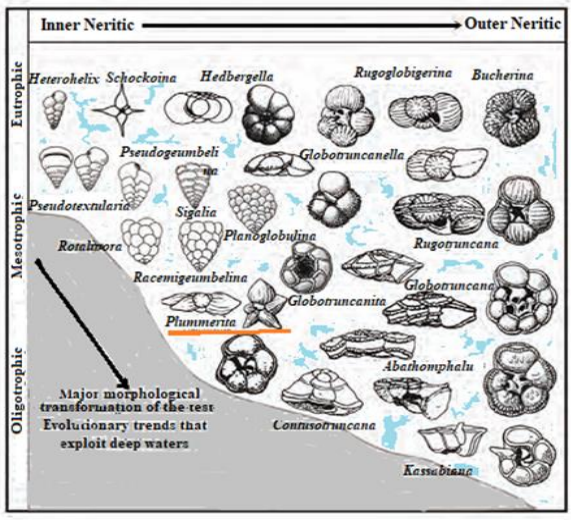

Figure 3: The distribution of the Late Cretaceous planktonic foraminiferal genera in the neritic environment, including the genus Plummerita (after Boudagher-Fadel, 2015).

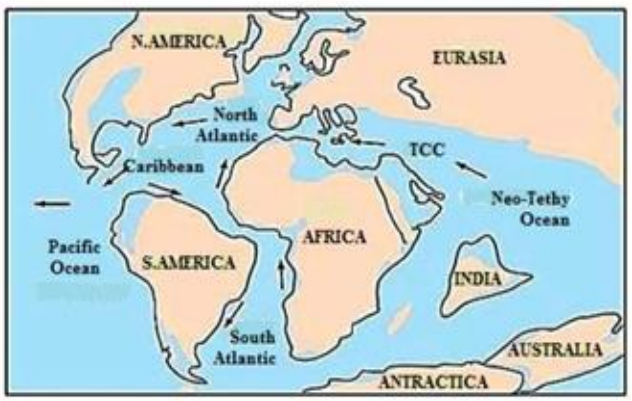

Figure 4: Paleogeography of the Neo-Tethys Ocean during the Maastrichtian showing the flow direction of the Tethyan Circum global Current (TCC) from east to west (after Abed, 2013).

6. Conclusion

The present study deals with the recording of twelve identified species of the calcareous Globigerinid foraminifer's genus Plummerita were originally erected from many localities in the Tethys: North and South America, Europe, Africa and Asia. The Tethyan realm had been connected with the Atlantic Ocean from west to the Indo-Pacific Ocean in the east, via Mediterranean Sea, which crossing the Middle East region during the Maastrichtian time. Environmental conditions of the identified species represent warm stratigraphic interval water neritic environment (~200m).

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