

## RESEARCH ARTICLE

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

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## ARTICLE DETAILS

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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.

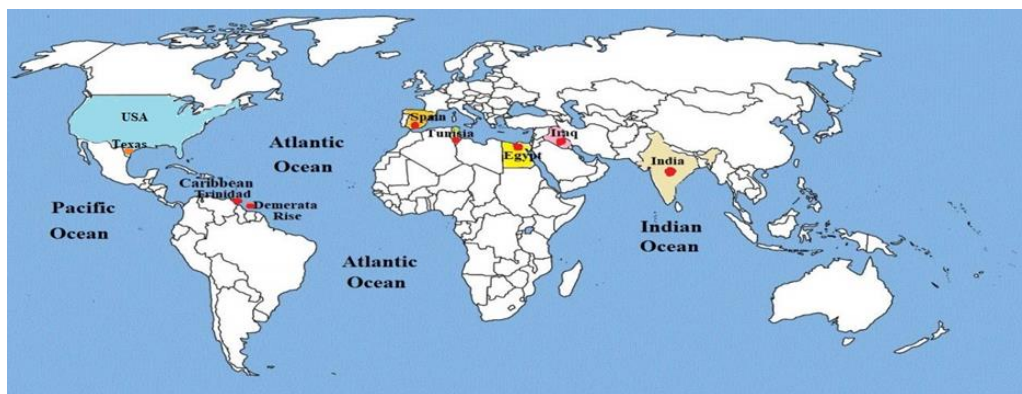
## KEYWORDS

*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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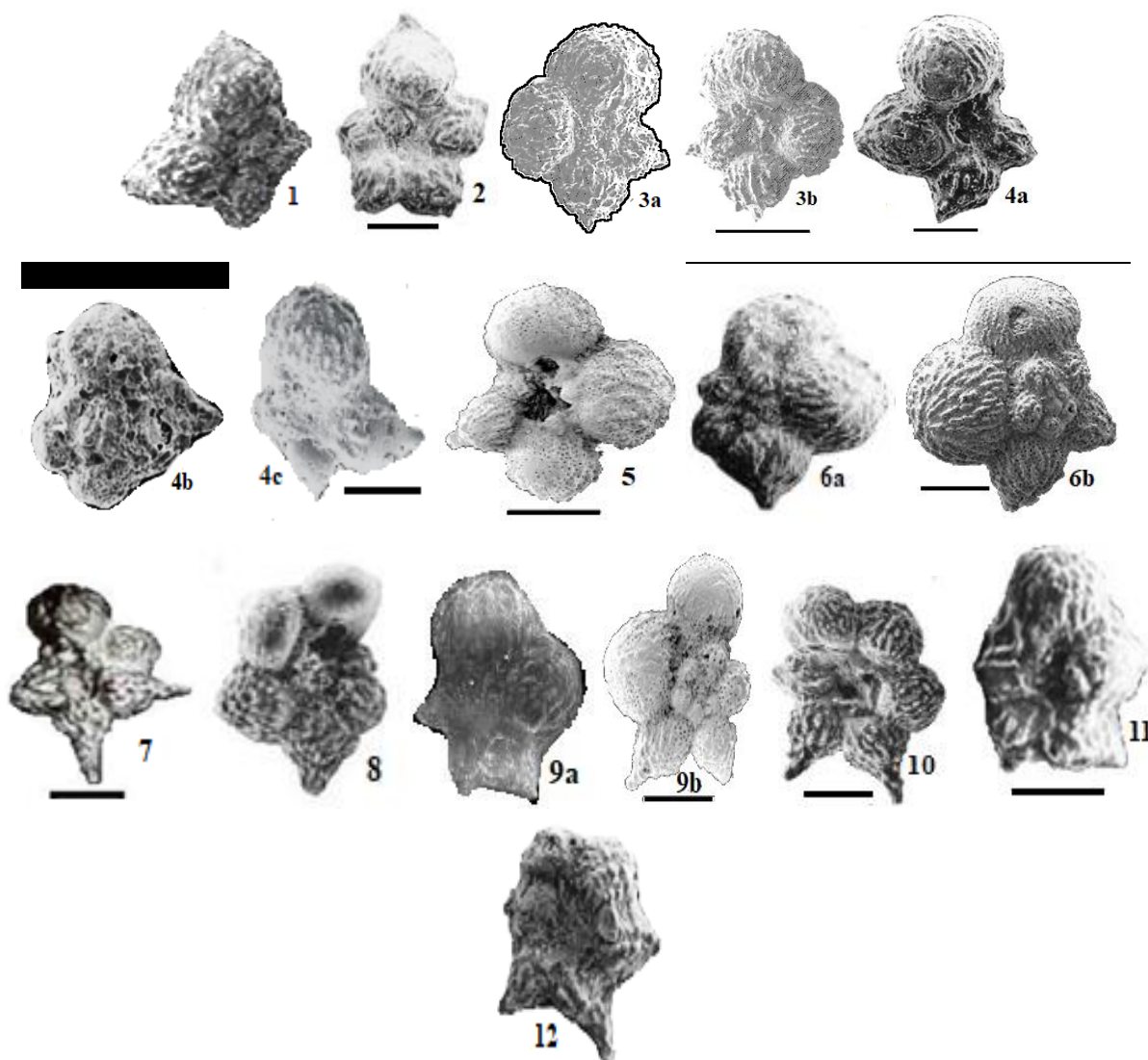
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(1988) is followed here. Two groups of the Maastrichtian genus *Plummerita* were produced by Brönnimann (1952) from Trinidad: *P. hantkeninoides* group (with last five-chambered volition (5ch): *P. hantkeninoides*, *P. costata* and *P. inflata*), and *P. reicheli* group (with last six-chambered volition (6ch): *P. reicheli*, *P. pustulata* and *P.*

hexacamerala), and later on many localities in the Northern and Southern Tethys. The third *P. elkefensis* group (with last four-chambered volition (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  $\mu\text{m}$ ):** 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. *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*  $\rightarrow$  *P. hantkeninoides* is presented in (Pl. 1, figs. 1  $\rightarrow$  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*  $\rightarrow$  *P. haggagae* is presented in (Pl. 1, figs. 3  $\rightarrow$  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 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. hodaie*, but differs by its axially pointed spine-like prolongations of the second chamber than the third one of the latter.

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

Remarks: The evolutionary lineage: *Plummerita salimi* → *P. hodaie* is presented in (Pl. 1, figs. 5 → 46). *P. hodaie* 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. caribbeana* by its first three chambers of the five-chamber evolution, than six-chamber evolution of the last whorl of the latter. It is, so far, confined to Egypt (Anan & Orabi (2022)).

***Plummerita caribbeana* Anan, 2023**, p. 26, pl. 1, fig. 3.

Remarks: It is recorded from Puerto Rico, Caribbean region (Robaszynski et al., 1983/4). The evolutionary lineage: *P. kellerae* → *P. caribbeana* 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. PALEO GEOGRAPHY**

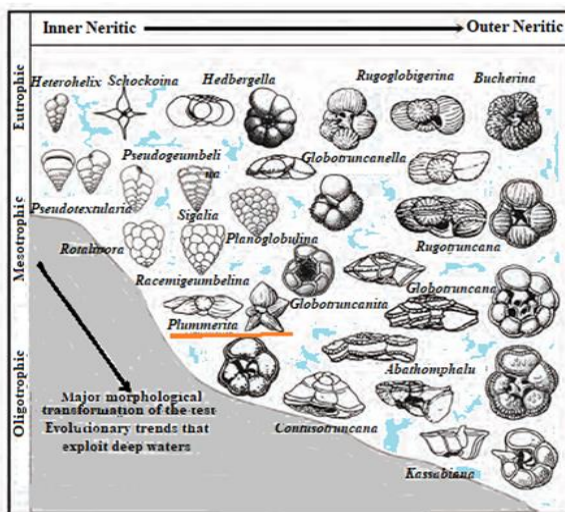
The identified species of Brönnimann (1952): *Plummerita hantkeninoides* group and *P. reicheli* group were originally identified from Trinidad, and later from many countries in the Northern and Southern Tethys. *Plummerita elkefensis* group is recorded from USA, Caribbean, Tunisia, Egypt, Iraq and India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