

## RESEARCH ARTICLE

THE EVOLUTIONARY LINEAGES OF THE MAASTRICHTIAN PLANKTIC FORAMINIFERA GENUS *Plummerita* IN THE TETHYS

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## ARTICLE DETAILS

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## ABSTRACT

Five phylogenetic lineages were observed by present author in the eleven Tethyan Maastrichtian planktic foraminiferal species of the genus *Plummerita*. These lineages help to define the major faunal changes from the species throughout of three groups of the *Plummerita*. The first group (*P. haggagae* group) belongs to the four-chambered volition (4-ch) with axially pointed spine-like prolongation evolved to another species of five-chambered volition (5-ch) (*P. hantkeninoides* group), to another species of six-chambered volition (6-ch) (*P. reicheli* group). The five lineages are: (1) The *Plummerita elkefensis* (4-ch) to *P. hantkeninoides* (5-ch), (2) *P. haggagae* (4-ch) to *P. costata* (5-ch) to *P. spainica* (6-ch), (3) *P. inflata* (5-ch) to *P. tunisica* (6-ch) (4) *P. kelleriae* (5-ch) to *P. caribbeanica* (6-ch), (5) *P. premolisilvae* (5-ch) to *P. reicheli* (6-ch). Unfortunately, most of these lineage are uncompleted from four to five to six-chamber volition, while only one of them is completed (no. 2). In spite of this uncompleted lineages situation, it seems that we must await further study to complete these lineages by another unknown taxa.

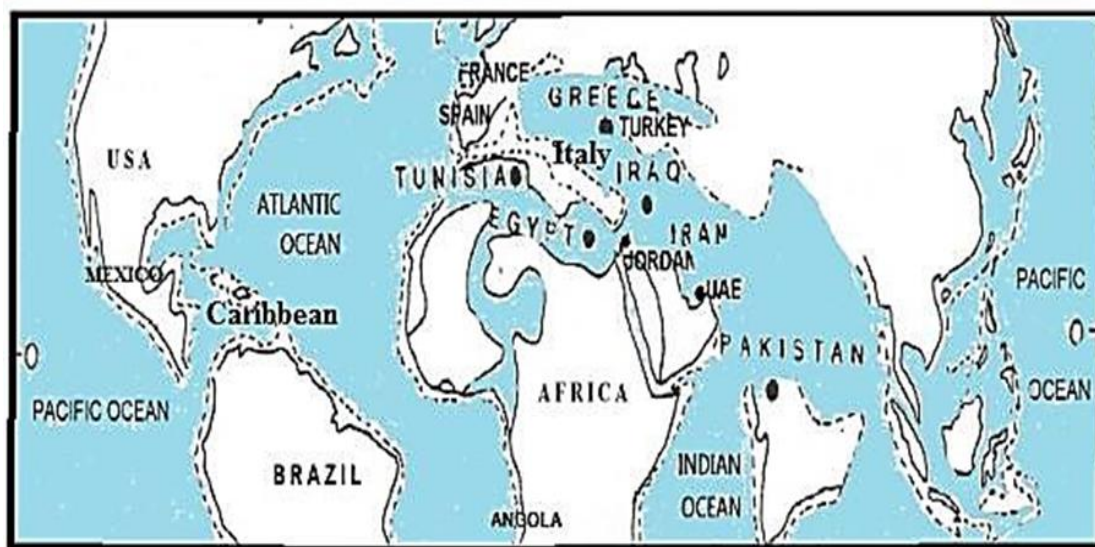
## KEYWORDS

Lineages, Planktic foraminifera, *Plummerita*, Maastrichtian, Tethys

## 1. INTRODUCTION

The Maastrichtian planktic foraminiferal genus *Plummerita* with its eleven species have three groups, according to its number chambers of the last whorl: *Plummerita haggagae* group, *P. hantkeninoides* group and *P. reicheli* group. The first one is of the four-chambered volition with axially pointed spine-like prolongation, which includes, so far, two species: *P. haggagae* and *P. elkefensis*. The second group is of the five-chambered volition,

includes six species: *P. costata*, *P. hantkeninoides*, *P. hodaie*, *P. inflata*, *P. kelleriae*, *P. premolisilvae*. The third group with six-chambered volition, includes four species: *P. caribbeanica*, *P. reicheli*, *P. spainica* and *P. tunisica*. Five proposed lineages between the species in these three groups of the genus *Plummerita*. This assemblage is distributed in many countries in the Tethys (Figure 1).



**Figure 1:** The Maastrichtian paleogeographic map showing the connected seas from west Atlantic Ocean (Caribbean) to east Atlantic (Spain, Italy) via the Mediterranean Sea (Tunisia, Egypt), as well as Iraq and Iran (Solakius et al., 1990).

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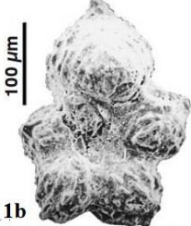

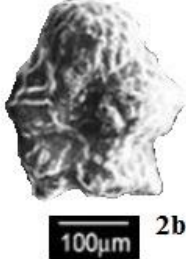



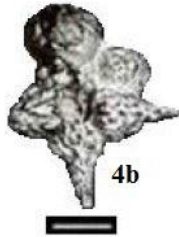





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**Table 1.** Fig. 1a. *Plummerita elkefensis*, 1b. *P. hantkeninoides*; 2a. *P. haggagae*, 2b. *P. costata*; 2c. *P. spainica*; 3b. *P. inflata*, 3c. *P. tunisica*; 4b. *P. spainica*, 4c. *P. caribbeanica*; 5b. *P. premolisilvae*, 5c. *P. reicheli* (scale bar= 100µm). The empty boxes are the specimens not identified until now.

Table 1: showing the different trends of the Maastrichtian <i>Plummerita</i> members.		
		
		
		
		
		

## 2. SYSTEMATIC PALEONTOLOGY

The diagnostic Maastrichtian planktonic foraminiferal species of the genus *Plummerita* have spine-like prolongation of ultimate and penultimate chambers of the last whorl. These assemblage includes three main groups according to the number chambers of the last whorl: four-chamber volution (*P. haggagae* group), five-chamber volution (*P. hantkeninoides* group) and six-chamber volution (*P. reicheli* group) (Plate 1). The taxonomy followed here is that of (Loeblich and Tappan, 1988).

Order Foraminiferida Eichwald, 1830

Suborder Globigerinina Delage & Hérouard, 1896

Superfamily Globotruncanacea Brotzen, 1942

Family Rugoglobigerinidae Subbotina, 1959

Genus *Plummerita* Brönnimann, 1952

Type species: *Rugoglobigerina* (*Plummerella*) *hantkeninoides* *hantkeninoides* Brönnimann, 1952

I. *Plummerita haggagae* group: includes, so far, two species: *P. elkefensis* and *P. haggagae*.

I.1. *Plummerita elkefensis* Anan & Orabi, 2022, p. 183, figure 4. D, E) (Plate 1, figure 1a) (= *Plummerita hantkeninoides* (Brönnimann). Samir, 2002 p. 24, pl. 1, fig. 5; *Plummerita hantkeninoides* (Brönnimann) - Keller, 2005, 17 p. 741, pl. 16.4)

Remarks: It is distinguished by its radially elongated chambers with axially spine-like prolongation in linear pattern rugose surface in all four chambers in the last whorl with low trochoidal volution. It was recorded, so far, from Egypt and Tunisia.

I.2. *Plummerita haggagae* Anan, 2008, p. 249, pl. 1, figs. 2, 3 (Plate 1, figure 2a) (= *Plummerita hantkeninoides* (Brönnimann) - Ziko et al,1993, p. 143, fig. 4. 10, 11; Keller, 2003, p. 81, fig. 8 (non figs. 9, 10), Galal,2004, p. 246, fig. 7.4; Obaidalla et al, 2017, p. 67, fig. 18.K (non J); Bamerni et al., 2021, p. 8, pl. 1, figs. 5-8).

Remarks: It differs from *P. elkefensis* by its three spine-like prolongation of the last fourth inflated chamber, but without spine-like prolongation of

the last fourth inflated chamber. It was recorded, so far, from Egypt and Iraq.

II. The second *Plummerita hantkeninoides* group includes, so far, six species: *P. costata*, *P. hantkeninoides*, *P. hodaie*, *P. inflata*, *P. kelleriae*, *P. premolisilvae*.

II. 3. *Plummerita costata* (Brönnimann, 1952) (Plate 1, figure 2a) (= *Rugoglobigerina* (*Plummerella*) *hantkeninoides costata* Brönnimann, 1952, p. 40, pl. 3, figs. 4-6, text-fig. 18a-c.; *Plummerita costata* (Brönnimann) – Anan, 2012, p. 594, pl. 1, fig. 2).

Remarks: *P. costata* is distinguished by its five-chambered volition, with axially pointed spine-like prolongation for the four penultimate chambers, but without spine-like prolongation of the last inflated chamber. It was recorded from Trinidad, Italy, Egypt and Iran.

II. 4. *Plummerita hantkeninoides* (Brönnimann, 1952) (Plate 1, figure 1b) (= *Rugoglobigerina* (*Plummerella*) *h. hantkeninoides* Brönnimann, 1952, p. 37, pl. 3, figs. 1-3, text-fig. 1a-k; *Plummerita hantkeninoides* (Brönnimann) – Arz et al, 2001, p. 224, pl. 1, fig. 7).

Remarks: It is characterized by the last five-chambered volition, radially elongated with axially spine-like prolongation of linear pattern rugose surface for all the five chambers in the last whorl. It was recorded from Trinidad, Mexico, Italy, Tunisia and Egypt.

II.5. *Plummerita hodaie* Anan, 2022, p. 183, Fig. 4A (= *Plummerita inflata* (Brönnimann). Anan, 2012, p. 594, pl. 1, fig. 3).

Remarks: It is closely related to *P. inflata* (pl. 1, figure 6), but differs by the position of its larger fourth chamber than the last fifth chamber, and its third chamber exists perpendicular along the vertical line to the last fifth chamber in the final whorl of the test. Unfortunately, no four-chamber or six-chamber volition specimens, so far, were recorded for it to complete the lineage including this species. It was, so far, confined to Egypt.

II.6. *Plummerita inflata* (Brönnimann, 1952) (= *Rugoglobigerina* (*Plummerella*) *hantkeninoides inflata* Brönnimann, 1952, p. 40, pl. 3, figs. 7-9, text-fig. 19a-m; *Plummerita* sp. Kassab, 1975, p. 350, pl. 2, fig. 5; *Plummerita inflata* (Brönnimann). Anan, 2012, p. 594, pl. 1, fig. 3) (Plate 1, figure 3b).

Remarks: It is characterized by axially pointed spine-like prolongations of the first three chambers, but strongly inflated shapes without spines for the last two chambers in the last whorl. It was recorded from Trinidad, Iraq and Egypt.

II.7. *Plummerita kelleriae* Anan & Orabi, 2022, p. 183, Figure 4. B (= *Plummerita hantkeninoides* Keller et al, 2003, p. 279, pl. 2, fig. 14) (Plate 1, figure 4b).

Remarks: It differs from *P. inflata* and *P. hodaie* by its first three radially elongate chambers with axially spine-like prolongation, while the last penultimate and ultimate chambers are inflated without spines. It was recorded from Egypt.

II.8. *Plummerita premolisilvae* Anan & Orabi, 2022, p. 183, Figure 4. C (= *Plummerita hantkeninoides* (Brönnimann) – Coccioni & Premoli Silva, 2015, p. 59, pl. 3, fig. 15 (non figs. 12-14, 16). (Plate 1, figure 5b).

Remarks: This species has closely related to *P. inflata* and *P. kelleriae*, but differs from it by its only first two radially elongate chambers with axially spine-like prolongation, while the last third, fourth and fifth last chambers are inflated without spines. It was recorded, so far, from Italy.

III. The third *Plummerita reicheli* group includes for species: *Plummerita caribbeanica*, *P.*

*reicheli*, *P. spainica* and *P. tunisica*.

III.9. *Plummerita caribbeanica* Anan, 2023, p. 26, pl. 1, fig. 5 (= *Rugoglobigerina* cf. *reicheli* or *Plummerita* cf. *hantkeninoides*-Robaszynski et al., 1983/4, p. 187, p. 286, pl. 50, fig. 6) (Plate 1, figure 4c).

Remarks: It is characterized by a tubulospine first three chambers of the six-chamber volition of the last whorl. This new was recorded from Puerto Rico, Caribbean region.

III.10. *Plummerita reicheli* (Brönnimann, 1952) (= *Rugoglobigerina* r. *reicheli* Brönnimann, 1952, p. 168, pl. 3 (3), figs. 10-12) (Plate 1, figure 5c).

Remarks: This species has closely resembles the chamber's arrangement of the last whorl of *P. premolisilvae* (Pl. 1, fig. 8), but with six-chamber volition instead of five-chamber only. It was recorded from Trinidad, Egypt and Iraq.

III.11. *Plummerita spainica* Anan, 2023, p. 25, pl. 1, fig. 7 (= *Plummerita hantkeninoides* (Brönnimann) – Gilabert et al., 2021, p. 6, fig. 3L) (Plate 1, figure 2c).

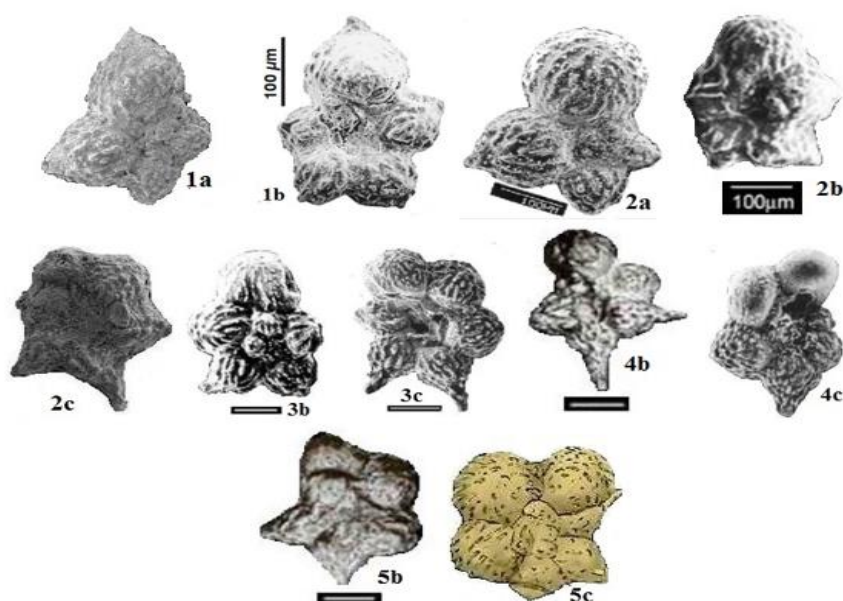
Remarks: This species has closely related to *P. costata* (Brönnimann), but differs by its six-chamber volition than five-chamber volition of the latter. It most probably developed from *P. costata* (Plate 1, figure 3). *P. spainica*, so far, was confined to Spain.

III.12. *Plummerita tunisica* Anan, 2023, p. 25, pl. 1, fig. 3 (= *Plummerita hantkeninoides* (Brönnimann) – Keller, 2012, p. 26, figure. 4.2, non figs. 4.1,3) (Plate 1, figure 3c).

Remarks: This species has closely related to *P. inflata* (Brönnimann) but differs from it by its last six-chamber in the final whorl, and most probably developed from it (Plate 1, fig. 6). It is, so far, confined to Tunisia.

## Plate 1

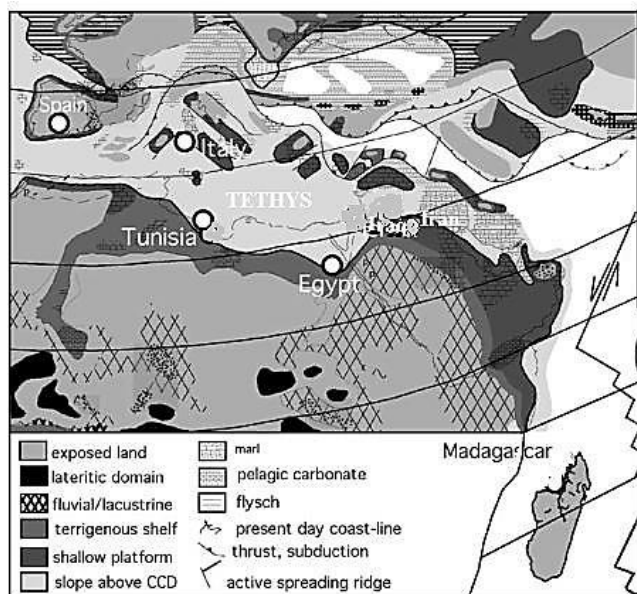
Fig. 1a. *Plummerita elkefensis* Anan & Orabi, 2022; 1b. *P. hantkeninoides* (Brönnimann, 1952); 2a. *P. haggagae* Anan, 2008; 2b. *P. costata* (Brönnimann, 1952); 2c. *P. spainica* Anan, 2023; 3b. *P. inflata* (Brönnimann, 1952); 3c. *P. tunisica* Anan, 2023; 4b. *P. kelleriae* Anan & Orabi, 2022; 4c. *P. caribbeanica* Anan, 2023; 5b. *P. premolisilvae* Anan & Orabi, 2022; 5c. *P. reicheli* (Brönnimann, 1952).





### 3. PALEO GEOGRAPHY

All the identified species of Brönnimann (1952): *Plummerita hantkeninoides*, *P. costata*, *P. inflata* and *P. reicheli* were originally identified from Trinidad, and some of them are also recorded from other countries, e.g. Mexico, Italy, Tunisia, Egypt, Iraq and Iran. Other identified species of *Plummerita* were recorded from Caribbean (*P. caribbeana*), Spain (*P. spainica*), Italy (*P. premolisilvae*), Tunisia (*P. elkefensis* and *P. tunisica*), Egypt (*P. elkefensis*, *P. haggagae*, *P. hodaie* and *P. kelleriae*), and Iraq (*P. haggagae*) (Figure 2).



**Figure 2:** The Maastrichtian paleogeographic map of the Northern Tethys (Spain and Italy) and Southern Tethys (Tunisia, Egypt, Iraq and Iran) (Keller, 2005).

### 4. PALEOENVIRONMENT

According to many authors the planktonic foraminiferal *Plummerita* spp. are mostly representing a warm stratigraphic interval water environment which have radiations of its tests, and deep marine, outer shelf-upper bathyal environment, 200-400 m, and represents the Latest Maastrichtian Warming Event (LMWE) (Frerichs, 1971; Abramovich and Keller, 2002; Keller, 2003; Gilbert et al., 2021). An abrupt global warming of 3-4°C occurred near the end of the Maastrichtian at 65.45-65.10 Ma. During the warm event, the relative abundance of a large number of species decreased, including tropical-subtropical affiliated species, whereas typical mid-latitude species retained high abundances.

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