

Planktonic foraminifers from the Palestinian Judea Group (Cretaceous) and their biostratigraphic significance

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ABSTRACT

Twenty-three species of the Late Cretaceous planktonic foraminifera have been recorded. Stereoscan photographs or camera lucida drawings have also been provided. These foraminifers suggest that the age of the Judea Group at its type locality (Jerusalem) extends up to the early Campanian.

INTRODUCTION

The present study records the planktonic foraminifera from a calcareous rock sample collected from the outcrop of the Judea Group near Al-Sakhra Mosque in Jerusalem, Palestine (Fig. 1). This sample provides further evidence for the age of the Judea Group at its type locality.

The first formal definition for the Judea unit was given by Ball & Ball (1953) who treated it as a formation. It includes all the marine succession of limestone and dolomite overlying the Early Cretaceous Kurnub Sandstone (= Hatira Formation), and underlying the Santonian–Middle Campanian Chalks of the Menuha Formation. The Judea unit is characterized by its fossiliferous calcareous facies. According to Picard (1938), the Judea 'Limestone' is mainly Cenomanian–Turonian in age, but also includes locally rocks of Coniacian and even Santonian age. Ball & Ball (1953), however, restricted it to Cenomanian and Turonian age (*cf.* Bentor (1959), and Dubertret *et al.* (1963)).

Recently, several authors such as Bartove (1967), Flexer (1968), Bartove & Steinitz (1977) and Flexer *et al.* (1986), considered the Judea as a group of Albian (or Cenomanian)–Coniacian age (Fig. 2).

The Judea Group is recognized in Palestine, Jordan, Lebanon, Syria and northern Iraq. In Palestine, it is widespread and its exposures extend almost continuously from the north to the south of the country. Its thickness varies from 290 m to 1100 m, with a tendency to increase towards the north (Fig. 3).

SYSTEMATIC PALEONTOLOGY

A total of 23 species of the Cretaceous planktonic foraminifera are here identified.

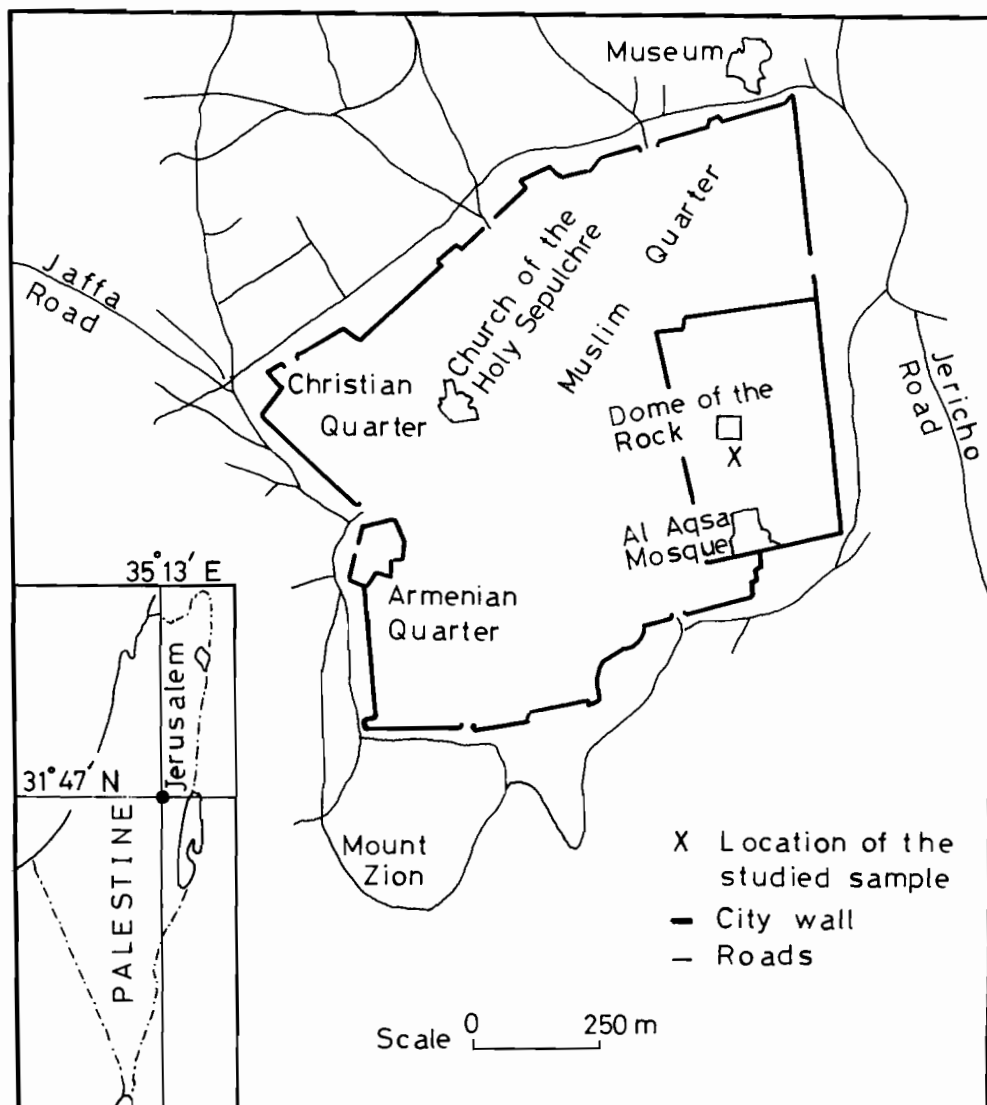


Fig. 1. Map of the Old City of Jerusalem showing the location of the studied sample.

Stereoscan photographs or camera lucida drawings are also provided. These species are listed below with reference to the original description and the changes in the names of genera, whenever possible. Also given is the stratigraphical range of each species as recorded by previous workers. The illustrated specimens are deposited in the Department of Geology, University of Sana', Sana', Yemen Arab Republic.

Heterohelix complanata (Marie)

(Pl. 1, Fig. 1)

1941 *Guembelina complanata* Marie, p 184, Pl. 28, Fig. 27.

1969 *Heterohelix* sp. cf. *H. complanata* (Marie), Stenestad, p 657, Pl. 1, Figs 8, 11, 12; Pl. 3, Fig. 1; Fig. 11a-d.

Age	P A L E S T I N E					SYRIA
	P	A	L	E	S	
Cenomanian	Ball & Ball (1953)	Bentor (1959)	Bartove (1967)	Bartove & Steinitz (1977)	Flexer et al. (1986)	Dubertret et al. (1963)
		Menuha Formation			MOUNT SCOPUS GROUP	Gatrane Formation
						Soukhne Formation
Turonian			JUDEA GROUP	JUDEA GROUP		Judea Formation
		Judea Formation	Eteq Formation Gerofit Formation Ora Formation	Zihor Formation Gerofit Formation Ora Formation	A D O H G V H C D F	Judea Formation
Albian						Base not Exposed
						Hathira Formation
Early Cretaceous						

Fig. 2. Historical review of stratigraphic nomenclature and age assignment of the Judea Group in Palestine and adjacent regions.

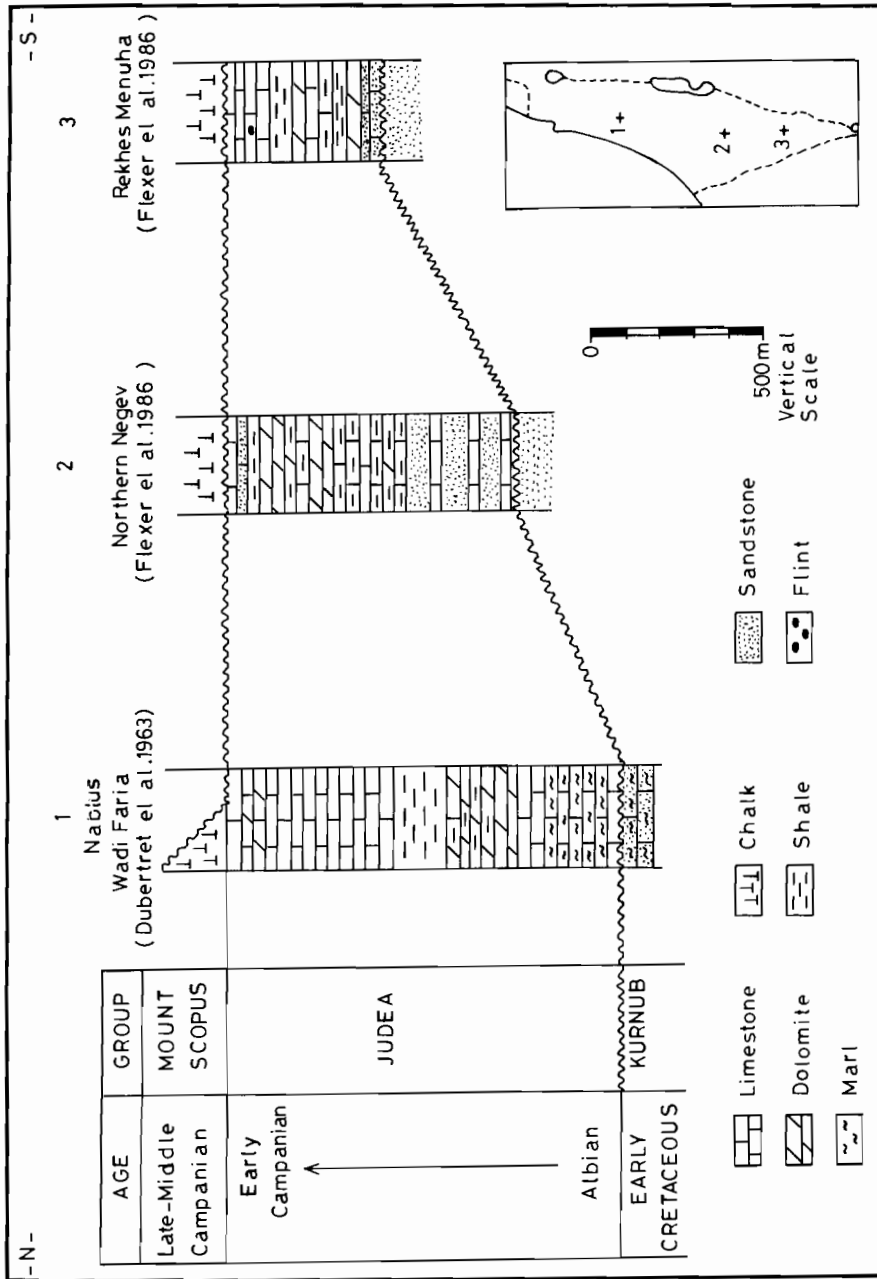


Fig. 3. N-S stratigraphic cross section showing variation in thickness of Judea Group in Palestine. Horizontal distance not to scale. Datum plane top of Judea Group. Age modified according to results of the present study.

Stratigraphical range:

Campanian–Maastrichtian (El-Nakhal & El-Naggar 1981).

Heterohelix globulosa (Ehrenberg)

(Pl. 1, Fig. 2)

1840 *Textularia globulosa* Ehrenberg, p 135, Pl. 4, Fig. 4B.

1929 *Guembelina globulosa* (Ehrenberg), White, p 36, Pl. 4, Fig. 10.

1966 *Heterohelix globulosa* (Ehrenberg), Salaj & Samuel, p 224, Pl. 37, Fig. 18.

Stratigraphical range:

Coniacian–Maastrichtian (El-Nakhal & El-Naggar 1981).

Heterohelix inflata El-Nakhal

(Pl. 1, Fig. 3)

1983 *Heterohelix inflata* El-Nakhal, p 16, Pl. 1, Figs 1, 2.

Stratigraphical range:

Cenomanian–Campanian (El-Nakhal 1983).

Heterohelix moremani (Cushman)

(Pl. 1, Fig. 4)

1938 *Guembelina moremani* Cushman (pars), p 10, Pl. 2, Figs 1, 2; non Fig. 3.

1967 *Heterohelix moremani* (Cushman), Pessagno (pars), p 260, Pl. 89, Figs 1, 2; non Pl. 48, Figs 10, 11.

Stratigraphical range:

El-Nakhal & El-Naggar (1981) restricted the range of *H. moremani* (Cushman) to the Cenomanian–Turonian. However, Pessagno (1967) expanded its lower range to the Albian, and Brown (1969) extended its upper range to the early Campanian. Accordingly, the stratigraphical range of the present species is accepted as Albian–early Campanian.

Heterohelix papula (Belford)

(Pl. 1, Fig. 5)

1960 *Guembelina papula* Belford, p 57, Pl. 15, Figs 6–9; Fig. 3 (1–6).

1981 *Heterohelix papula* (Belford), El-Nakhal & El-Naggar, p 76, Pl. 2, Figs 13, 15.

Stratigraphical range:

Coniacian–Maastrichtian (El-Nakhal & El-Naggar 1981).

Heterohelix plummerae (Loetterle)

(Pl. 1, Fig. 6)

1937 *Guembelina plummerae* Loetterle, p 33, Pl. 5, Figs 1, 2.

1959 *Pseudotextularia plummerae* (Loetterle), Ayala-Castanares, p 19, Pl. 1, Figs 7–9.

1981 *Heterohelix plummerae* (Loetterle), El-Nakhal & El-Naggar, p 77, Pl. 2, Figs 1–3.

Stratigraphical range:

Coniacian–Maastrichtian (El-Nakhal & El-Naggar 1981).



Plate 1 (Fig. 1 is a camera lucida drawing, all other figures are stereoscan photographs):

- Fig. 1: *Heterohelix complanata* (Marie), $\times 149$.
 Fig. 2: *Heterohelix globulosa* (Ehrenberg), $\times 225$.
 Fig. 3: *Heterohelix inflata* El-Nakhal, $\times 190$.
 Fig. 4: *Heterohelix moremani* (Cushman), $\times 180$.
 Fig. 5: *Heterohelix papula* (Belford), $\times 123$.
 Fig. 6: *Heterohelix plummerae* (Loetterle), $\times 123$.
 Fig. 7: *Heterohelix pseudotessera* (Cushman), $\times 212$.
 Fig. 8: *Heterohelix pulchra* (Brotzen), $\times 228$.
 Fig. 9: *Heterohelix ultimatimida* (White), $\times 190$.
 Fig. 10: *Gublerina reniformis* (Marie), $\times 216$.
 Fig. 11: *Globigerinelloides asperum* (Ehrenberg), $\times 190$.
 Fig. 12: *Globigerinelloides alvarezzi* (Eternod-Olvera), $\times 328$.

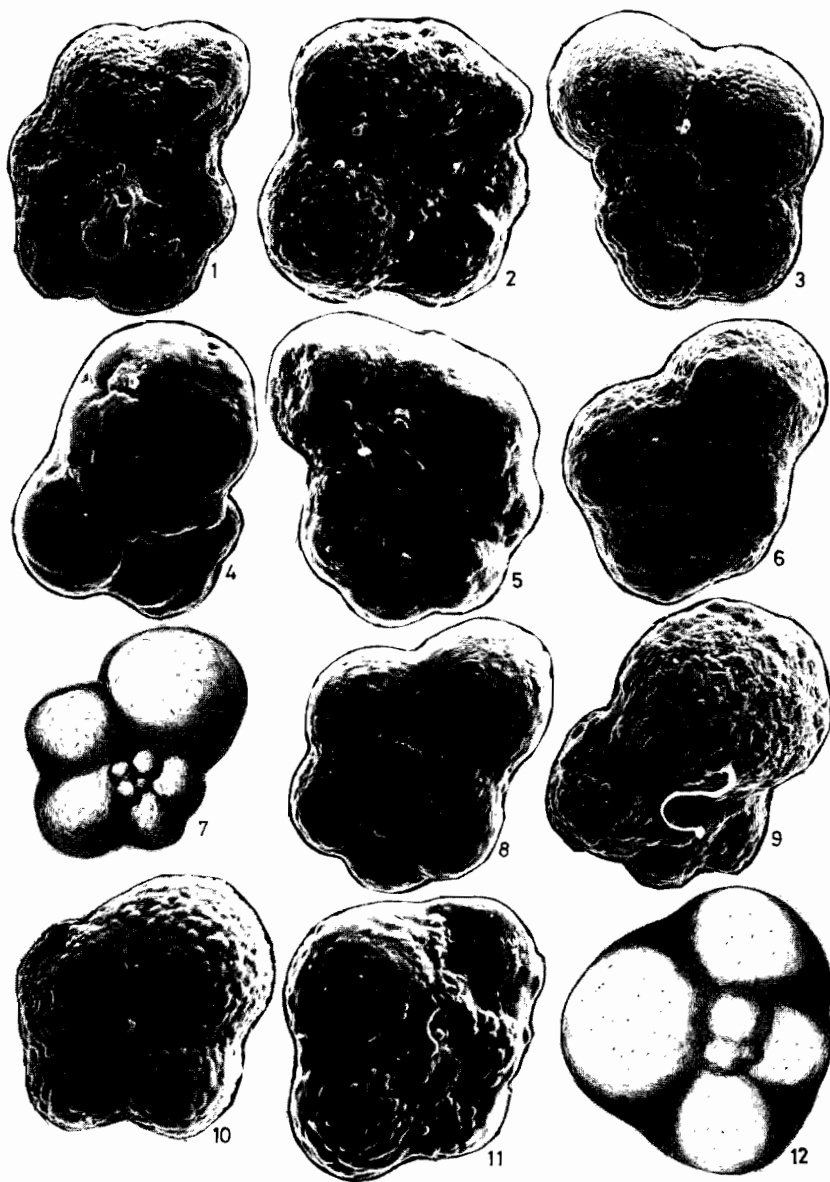


Plate 2 (Figs 7 & 12 are camera lucida drawings, all other figures are stereoscan photographs):

Fig. 1: *Globigerinelloides prairiehillensis* Pessagno, $\times 136$.

Fig. 2: *Globigerinelloides volutus* (White), $\times 243$.

Fig. 3: *Hedbergella delrioensis* (Carsey), $\times 136$.

Fig. 4: *Hedbergella macrocephala* El-Nakhal, $\times 187$.

Fig. 5: *Hedbergella planispira* (Tappan), $\times 340$.

Fig. 6: *Hedbergella* sp. cf. *H. submacrocephala* El-Nakhal, $\times 141$.

Fig. 7: *Hedbergella submacrocephala* El-Nakhal, $\times 141$.

Fig. 8: *Hedbergella trocoideaformis* El-Nakhal, $\times 154$.

Fig. 9: *Rugoglobigerina macrocephala* Brönnimann, $\times 220$.

Fig. 10: *Rugoglobigerina rugosa* (Plummer), $\times 169$.

Fig. 11: *Trinitella* sp. cf. *T. scotti* Brönnimann, $\times 179$.

Fig. 12: *Archaeoglobigerina bashai* El-Nakhal & El-Naggar, $\times 150$.

Heterohelix pseudotessera (Cushman)

(Pl. 1, Fig. 7)

1938 *Guembelina pseudotessera* Cushman, p 14, Pl. 2, Figs 19–21.

1968 *Heterohelix pseudotessera* (Cushman), Barr, p 142, Pl. 1, Figs 12, 13.

Stratigraphical range:

Coniacian–Maastrichtian (El-Nakhal & El-Naggar 1981).

Heterohelix pulchra (Brotzen)

(Pl. 1, Fig. 8)

1936 *Guembelina pulchra* Brotzen, p 121, Pl. 9, Figs 2, 3.

1970 *Heterohelix pulchra* (Brotzen), Eicher & Worstell, p 296, Pl. 8, Figs 9, 10.

Stratigraphical range:

Cenomanian–Senonian (El-Nakhal & El-Naggar 1981).

Heterohelix ultimatumida (White)

(Pl. 1, Fig. 9)

1929 *Guembelina ultimatumida* White, p 39, Pl. 4, Fig. 113.

1961 *Heterohelix ultimatumida* (White), Said & Kerdany, p 332, Pl. 2, Fig. 2.

Stratigraphical range:

Campanian–Maastrichtian (El-Nakhal & El-Naggar 1981).

Gublerina reniformis (Marie)

(Pl. 1, Fig. 10)

1941 *Ventilabrella reniformis* Marie, p 264, Pl. 28, Fig. 27.

1969 *Gublerina reniformis* (Marie), Brown, p 59, Pl. 2, Fig. 6; Pl. 4, Figs 3, 4.

Stratigraphical range:

Coniacian–Maastrichtian (El-Nakhal & El-Naggar 1985).

Globigerinelloides alvarezii (Eternod Olvera)

(Pl. 1, Fig. 12)

1959 *Planomalina alvarezii* Eternod Olvera, p 91, Pl. 4, Figs 5–7.

1968 *Globigerinelloides alvarezii* (Eternod Olvera), Sliter, p 98, Pl. 15, Figs 1, 2.

Stratigraphical range:

Coniacian–Maastrichtian (El-Naggar & El-Nakhal 1982).

Globigerinelloides asperum (Ehrenberg)

(Pl. 1, Fig. 11)

1854 *Phanerostomum asperum* Ehrenberg, p 23, Pl. 30, Figs 26a, b.

1928 *Globigerina aspera* (Ehrenberg), Franke, p 192, Pl. 18, Fig. 10.

1929 *Globigerinella aspera* (Ehrenberg), Carman, p 315, Pl. 34, Fig. 6.

1963 *Planomalina (Globigerinelloides) aspera aspera* (Ehrenberg), van Hinte, p 97, Pl. 12, Fig. 2.

1965 *Globigerinelloides aspera* (Ehrenberg), Takayanagi, p 201, Pl. 20, Fig. 9.

Stratigraphical range:

Coniacian–Maastrichtian (El-Naggar & El-Nakhal 1982).

Globigerinelloides prairiehillensis Pessagno

(Pl. 2, Fig. 1)

1967 *Globigerinelloides prairiehillensis* Pessagno, p 277, Pl. 60, Figs 2, 3; Pl. 83, Fig. 1; Pl. 90, Figs 1–4; Pl. 97, Figs 3, 4.

Stratigraphical range:

Santonian–Maastrichtian (Fondecave 1975).

Globigerinelloides volutus (White)

(Pl. 2, Fig. 2)

1928 *Globigerina voluta* White, p 197, Pl. 28, Fig. 5.

1962 *Globigerinella voluta* (White), Herm, p 51, Pl. 3, Fig. 7.

1973 *Globigerinelloides volutus* (White), Smith & Pessagno (pars), p 41, Pl. 16, Figs 1, 2; non Figs 3, 4.

Stratigraphical range:

Campanian–Maastrichtian (El-Naggar & El-Nakhal 1982).

Hedbergella delrioensis (Carsey)

(Pl. 2, Fig. 3)

1926 *Globigerina cretacea* d'Orbigny var. *delrioensis* Carsey, p 43 (not illustrated).

1961 *Hedbergella delrioensis* (Carsey), Loeblich & Tappan, p 275, Pl. 2, Figs 11–13.

Stratigraphical range:

El-Naggar & El-Nakhal (1984) considered the range of the present species as Late Albian–Turonian. However, Pessagno (1967) expanded its upper range to the Campanian. Accordingly, the range of *H. delrioensis* (Carsey) is accepted to be Late Albian–Campanian.

Hedbergella macrocephala El-Nakhal

(Pl. 2, Fig. 4)

1983 *Hedbergella macrocephala* El-Nakhal, p 12, Pl. 1, Figs 6–8.

Stratigraphical range:

Cenomanian (El-Nakhal 1983).

Hedbergella planispira (Tappan)

(Pl. 2, Fig. 5)

1940 *Globigerina planispira* Tappan, p 122, Pl. 19, Fig. 12.

1957 *Praeglobotruncana planispira* (Tappan), Bolli *et al.*, p 40, Pl. 9, Fig. 3.

1961 *Hedbergella planispira* (Tappan), Loeblich & Tappan, p 276, Pl. 5, Figs 4–10.

Stratigraphical range:

El-Naggar & El-Nakhal (1984) considered the range of *H. planispira* (Tappan) as Albian–Turonian. However, some authors such as Takayanagi (1965) and Douglas (1969) expanded its range to the Campanian, and others e.g. Olsson (1964) and Barr (1968) expanded it to the Maastrichtian. Accordingly, the range of the present species is accepted to be Albian–Campanian, ? Maastrichtian.

Hedbergella submacrocephala El-Nakhal
(Pl. 2, Fig. 7)

1983 *Hedbergella submacrocephala* El-Nakhal, p 13, Pl. 1, Figs 9–11.

Stratigraphical range:

Cenomanian (El-Nakhal 1983).

Hedbergella trocoideaformis El-Nakhal
(Pl. 2, Fig. 8)

1966 *Hedbergella trocoidea* (Gandolfi), Marianos & Zingula, p 336, Pl. 37, Fig. 8.

1969 *Hedbergella* sp. Douglas, p 169, Pl. 9, Fig. 5.

1971 *Hedbergella* sp. Belford & Scheibnerova', p 336, Pl. 1, Figs 15–17.

1979 *Hedbergella yezoana* Takayanagi & Iwamoto, Frerichs, p 167, Pl. 3, Figs 7–9.

1983 *Hedbergella* sp. Belford, p 15, Pl. 5, Figs 17–19.

1983 *Hedbergella trocoideaformis* El-Nakhal, p 14, Pl. 1, Figs 3–5.

1984 *Hedbergella trocoidea* (Gandolfi), El-Naggar & El-Nakhal, p 109, Pl. 2, Figs 7–9.

Previous records:

H. trocoideaformis was first described by El-Nakhal (1983) from the Cenomanian–Turonian of Kuwait. It was previously recorded as *H. trocoidea* from the upper Albian of California (Marianos & Zingula 1966), the Cenomanian–Turonian of Kuwait (El-Naggar & El-Nakhal 1984), and as *H. yezoana* from the probable Coniacian–Campanian of Wyoming, U.S.A. (Frerichs 1979). Also, it was recorded as *Hedbergella* sp. from the Campanian–Maastrichtian of northern California (Douglas 1969), the Turonian of Western Australia (Belford & Scheibnerova' 1971) and the probable Coniacian of Western Australia (Belford 1983).

Stratigraphical range:

The analysis of the above mentioned records shows that the range of *H. trocoideaformis* El-Nakhal, and its synonyms is Late Albian–Maastrichtian.

Rugoglobigerina macrocephala Brönnimann
(Pl. 2, Fig. 9)

1952 *Rugoglobigerina (Rugoglobigerina) macrocephala macrocephala* Brönnimann, p 23, Pl. 2, Figs 10–12; Fig. 8.

Stratigraphical range:

Campanian–Maastrichtian (El-Nakhal & El-Naggar 1984).

Rugoglobigerina rugosa (Plummer)
(Pl. 2, Fig. 10)

1927 *Globigerina rugosa* Plummer, p 38, Pl. 2, Figs 10a–d.

1952 *Rugoglobigerina (Rugoglobigerina) rugosa rugosa* (Plummer), Brönnimann (pars), p 28, Figs 12a–i; non 11, 13.

Stratigraphical range:

Campanian–Maastrichtian (El-Nakhal & El-Naggar 1984).

Trinitella sp. cf. *T. scotti* Brönnimann
(Pl. 2, Fig. 11)

1952 *Trinitella scotti* Brönnimann, p 57, Pl. 4, Figs 4–6, 30.

Remarks:

In the present study, the genus *Trititella* Brönnimann is represented by few specimens which are referred to as *T. sp. cf. T. scotti* Brönnimann. This form is differentiated from *T. scotti* Brönnimann by its quadriglobular outline, more closely coiled test, and by its 4–4.5 chambers in the last whorl which increase more rapidly in size as added. *T. scotti* has a subcircular outline, 5–6 chambers in the last whorl which increase gradually in size as added. If more material becomes available, the present form will be formally named and described.

Stratigraphical range:

Maastrichtian (Brönnimann 1952).

Archaeoglobigerina bashai (El-Nakhal & El-Naggar)

(Pl. 2, Fig. 12)

1984 *Rugoglobigerina* (*Archaeoglobigerina*) *bashai* El-Nakhal & El-Naggar, p 155, Pl. 1, Figs 1–3.

Stratigraphical range:

Cenomanian–Turonian (El-Nakhal & El-Naggar 1984).

BIOSTRATIGRAPHIC SIGNIFICANCE OF THE RECORDED FAUNA

The concurrent presence of *Heterohelix moremani* (last occurrence base Campanian), and *Heterohelix complanata*, *H. ultimatimida*, *Globigerinelloides volutus*, *Rugoglobigerina macrocephala* and *R. rugosa* (first occurrence base Campanian), suggests an early Campanian age. Accordingly, the upper range of the Judea Group in its type locality (Jerusalem) extends up to the early Campanian, and its age in Palestine becomes Albian–early Campanian.

Similarly, the stratigraphical ranges of *Hedbergella macrocephala* El-Nakhal and *Hedbergella submacrocephala* El-Nakhal, which were recorded from the Cenomanian of Kuwait, and *Archaeoglobigerina bashai* El-Nakhal & El-Naggar, which was recorded from the Cenomanian–Turonian of Kuwait, extend up to the early Campanian.

Again, the occurrence of *Trititella sp. cf. T. scotti* Brönnimann within the present assemblage, indicates that the genus *Trititella* Brönnimann is not restricted to the Maastrichtian but occurs also in the lower Campanian.

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دراسة عن
وجود فورامينيفرا هائمة في صخور القدس (العصر الطباشيري) بفلسطين وأهميتها الطباقية الحيوية

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خلاصة

تم التعرف في الدراسة الحالية على ٢٣ نوعاً من الفورامينيفرا الهائمة التابعة للعصر الطباشيري المتأخر ، وقد صُورت هذه الأنواع ، ويدل وجود هذه المجموعة من الأحافير على أن عمر صخور القدس في فلسطين يمتد إلى العصر الكمباني المبكر .