

Planktonic Foraminiferal Biostratigraphy of Tanjero Formation (Late Maastrichtian) in Bekhme Area, Northeastern Iraq

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ABSTRACT

The biostratigraphy of Tanjero Formation has been investigated within a well-exposed section at the northern limb of Perat anticline, Bekhme area, Northeastern Iraq. The studied section consists mainly of marl, marly limestone, and sandstone. The formation conformably overlies Shiranish Formation (Late Campanian-Maastrichtian) and it is overlain unconformably by the Kolosh Formation (Paleocene). The samples of the section under investigation yielded rich and well diversified planktonic foraminiferal taxa, where 69 planktonic species belonging to 21 genera have been recognized. The detailed foraminiferal investigation permits the recognition of four well defined zones. These are from older at the base:

4. *Plummerita hantkeninoides* Total Range Zone.
3. *Pseudoguembelina palpebra* Partial Range Zone.
2. *Pseudoguembelina hariaensis* Interval Zone.
1. *Racemiguembelina fructicosa* Interval Zone.

The Planktonic zones were correlated with other zonal schemes in- and outside Iraq. They are considered to be of Late Maastrichtian age.

Keywords: biostratigraphy, Tanjero, Perat, Maastrichtian, foraminifera.

الطباقية الحياتية للفورامينيفرا الطافية لتكوين تانجيرو (الماسترختيان المتأخر) في منطقة بخمة، شمال
شرق العراق

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الملخص

تم دراسة الطباقية الحياتية للمكشوف السطحي لتكوين تانجيرو في الجهة الشمالية لطية بيرات، منطقة بخمة، شمال شرقي العراق. تتألف صخرية التكوين من صخور المارل والحجر الجيري المارلي والحجر الجيري والحجر الرملي. يحد تكوين تانجيرو من الأسفل تكوين شرانش (الكامبانيان المتأخر-الماسترختيان) بشكل متوافق طباقياً، ويعلوه تكوين كولوش (الباليوسين) بشكل غير متوافق طباقياً. يتميز تكوين تانجيرو بكونه غنياً بحشود الفورامنيفرا الطافية المحفوظة بشكل جيد حيث تم تشخيص 69 نوعاً تعود الى 21 جنساً وحددت مدياتها الزمنية، واعتماداً عليها تم تحديد أربعة انطقة حياتية هي من الأقدم في الأسفل:

4. *Plummerita hantkeninoides* Total Range Zone.

3. *Pseudoguembelina palpebra* Partial Range Zone.

2. *Pseudoguembelina hariaensis* Interval Zone.

1. *Racemiguembelina fruticosa* Interval Zone.

تم مضاهاة هذه الانطقة الحياتية مع الانطقة الحياتية لدراسات داخل العراق وخارجه وحدد على أساس ذلك عمر تكوين تانجيرو في مقطع الدراسة بكونه يمثل عمر الماسترختيان المتأخر.

الكلمات الدالة: الانطقة، تكوين، تانجيرو، الفورامنيفرا، الماسترختيان، بيرات.

INTRODUCTION

The studied section is located at the northern limb of Perat anticline 45 km northeast of Aqra city. The Tanjero Formation was first defined by (Dunnington, 1952 in Bellen et al.1959) from the highly folded zone of northern Iraq, its type section located at Sirwan vally, 2 km to the south of Kani Karweshkan village, near Halabja town (Fig.1), on the right bank of Sirwan River (upstream of the Diassa River). It attains a thickness of m. comprises two divisions; the lower division represents pelagic marl, and occasional beds of argillaceous limestone with siltstone beds in the upper part (Bellen et al.1959), whereas, the upper division comprises silty marl, sandstone, conglomerate and sandy or silty organic detrital limestone interfingering with the Aqra limestone Formation. The thickness of the Tanjero Formation is highly variable, with a maximum thickness of about 2000 m between Rawanduz and Chwarta (Jassim and Goff, 2006). Abdel-Kireem (1986 a) suggests removal of the word "clastic" from the name of the formation and to place its lower part within the Shiranish Formation, and during his study, Abdel-Kireem (1986 b) subdivided the formation into three units according to the microfacies and lithofacies.

Karim (2004, 2006) and Karim and Surdasy (2005 a,b, 2006) investigated the basin analysis, paleocurrent, tectonic history and sequence stratigraphy of the Tanjero Formation; they indicated an unconformity in the lower part of Tanjero Formation which was represented by about 500 m of boulder and gravel conglomerate. They mentioned that this conglomerate was deposited during sea-level fall (lowstand system tract). On the bases of the identified planktonic foraminiferal assemblages Sharbazheri et al. (2009) recorded five biozones (CF5-CF1) from the uppermost part of Tanjero Formation in the Sirwan valley (Sulaimani Region, NE Iraq).

The Tanjero Formation extends into southeast Iran where it was referred to as the Maastrichtian flysch by Kent et al. (1952, in Jassim and Goff, 2006). In Turkey, the Cretaceous part of the Germav Formation is equivalent to the Tanjero Formation (Buday, 1980).

The purpose of this paper is to record the planktonic species and establishing the biostratigraphic zones and correlating them with their equivalent biozones in- and outside Iraq in order to determine the age of the studied section.

LITHOSTRATIGRAPHY AND CONTACT BOUNDARIES

Tanjero Formation in the studied section is about 230 m thick, its lower part mainly consists of alternation of grey marl, marl siltstone with dark grey shale and thin beds of pale grey marly limestone beds, while its upper part consists of alternation of dark grey shale or marl with olive green sandstone beds. The description of lithological constituent is shown in Fig. (2).

The lower contact of the Tanjero Formation is gradational and conformable with Shiranish Formation (Late Campanian -Early Maastrichtian), while its upper contact is unconformable with Kolosh Formation (Paleocene) (Figs.3&4).

MATERIALS AND METHODS

Fifty-six rock samples were collected at (2-4) m intervals along the studied section. About 30 g of each sample was weighed, crushed, and boiled for (10 – 30) hours, washed over 230 mesh sieve with tap water, dried and size-sorted using a set of sieves (40, 60, 80, 100, 120 mesh), then ultrasonically agitated for (10 – 30) minutes, all specimens were picked and mounted on microslides for identification under binocular microscope.

BIOSTRATIGRAPHY

The investigation of foraminiferal assemblages within the studied section revealed that planktonic species are abundant in general within all the sequences of Tanjero Formation. Planktonic foraminifera have been used for biostratigraphic analysis for the studied section, their systematic study enabled the authors to identify sixty-nine planktonic species belonging to eighteen genera (Fig.5). The identified planktonic foraminiferal biozones were correlated with their equivalent standard biozones in other regions of the world (Figs.6&7). Furthermore, these biozones have been correlated locally with previous studies in Iraq. The studied section can be subdivided into four biozones, these biozones are described below starting from older to younger.

1- *Racemiguembelina fruticosa* Interval Zone (CF4) :

Definition: This zone was introduced by Li and Keller (1998 a and b). It represents the stratigraphic range of the index species *Racemiguembelina fruticosea* (Egger) which precedes the appearance of *Pseudoguembelina hariaensis* Nederbragt.

Age: Early Late Maastrichtian.

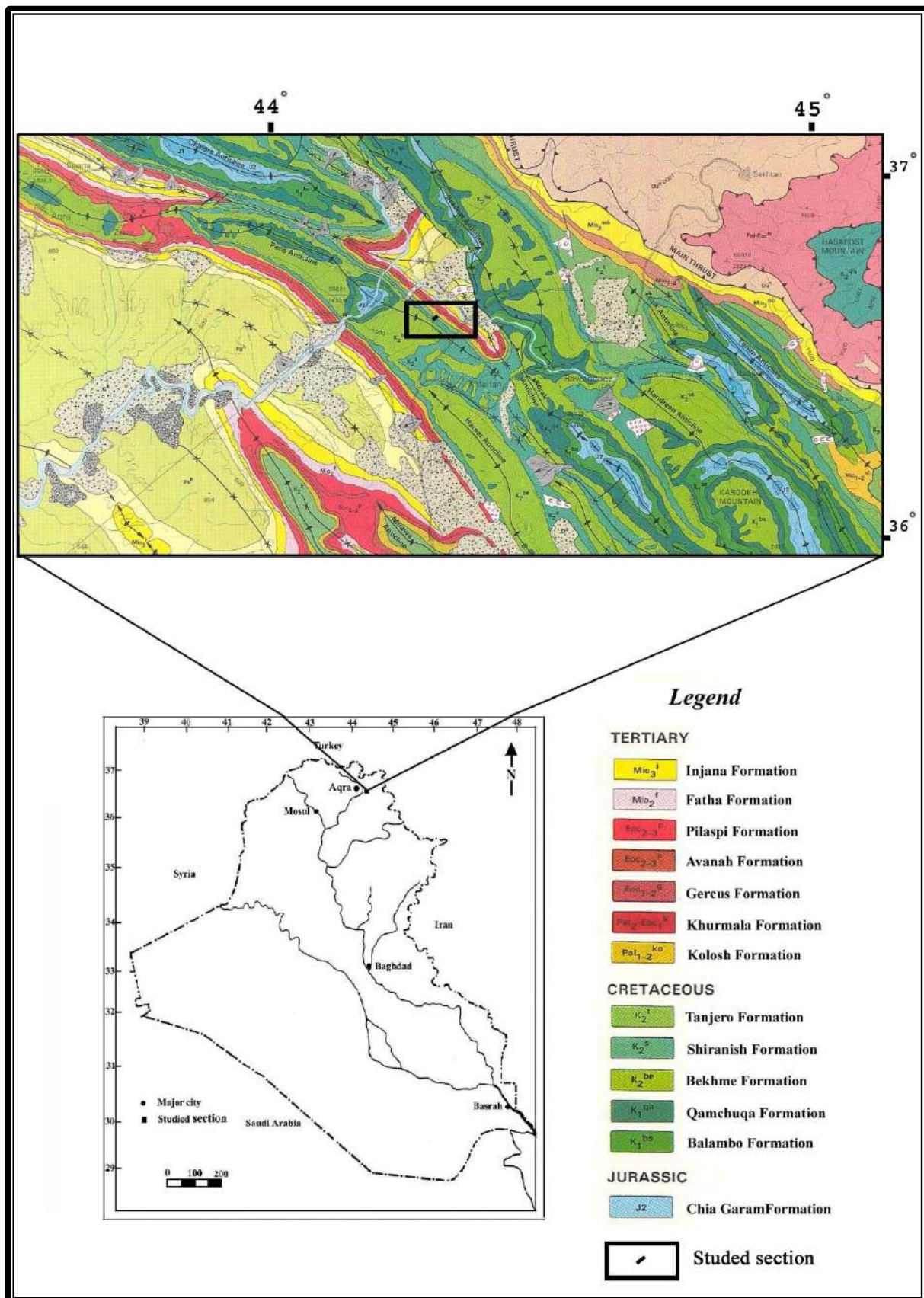


Fig.1: Location map of the studied section.

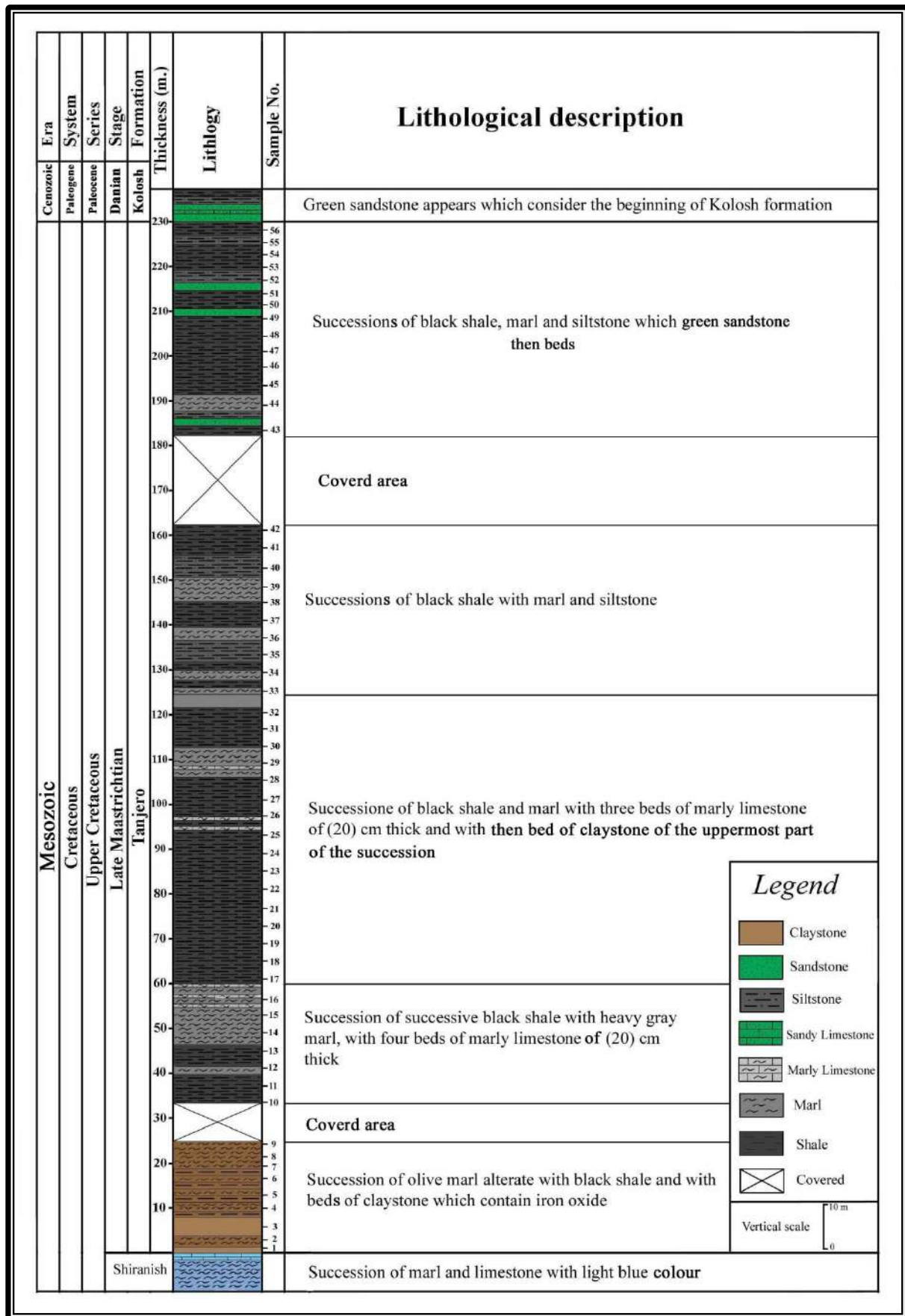


Fig.2: Lithologic description of Tanjero Formation in the studied section.

Boundaries: The lower boundary of this zone is marked by the first appearance of *Racemiguembelina fructicosa* (Egger), whereas its upper boundary is marked by the first appearance of *Pseudoguembelina hariaensis* Nederbragt.

Thickness: 85m that represented by the samples (1–23).

Correlation and Age Determination: This zone is apparently equivalent to *Racemiguembelina fructicosa* Zone which is described by (Li *et al.*, 1999), (Darvishzad and Abdolulipour, 2008), (Rostami *et al.*, 2009) of Early Late Maastrichtian age, and correlated to the upper part of *Globotruncana contusa* – *Racemiguembelina fructicosa* Zone of (Premoli Silva *et al.*, 1998), (Arenillas *et al.*, 2006), and (Keller *et al.*, 2011).

Locally in Iraq, this zone is correlated with *Racemiguembelina fructicosa* Zone of (Sharbazheri, 2008) and (Al-Doori, 2010) which considered it of Early Late Maastrichtian age.

2- *Pseudoguembelina hariaensis* Interval Zone (CF3) :

Definition: This zone was originally defined by Li and Killer (1998a). The Interval zone which is represented by the stratigraphic range of the index species *Pseudoguembelina hariaensis* Nederbragt between its first appearance and the last appearance of *Gansserina gansseri* (Bolli)

Age: middle Late Maastrichtian

Boundaries: The lower boundary of this zone is marked by the first appearance of *Pseudoguembelina hariaensis* Nederbragt, whereas its upper boundary is marked by the last appearance of *Gansserina gansseri* (Bolli).

Thickness: 70m represented by the samples (24 – 40).

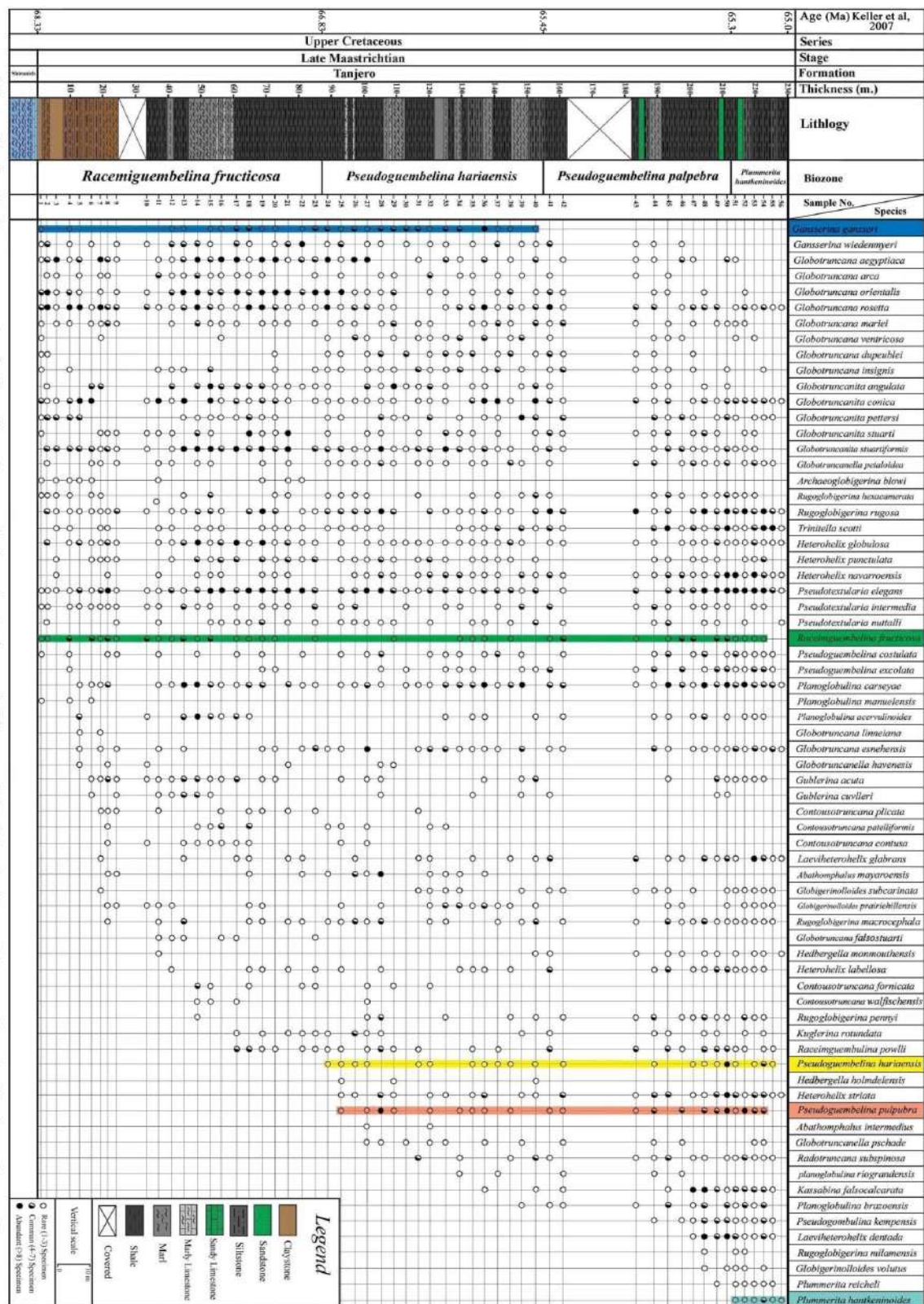
Correlation and Age Determination: The present zone is equivalent to the *Pseudoguembelina hariaensis* Zone which is described by (Li *et al.*, 1999), (El-Sabbagh *et al.*, 2004), (Keller *et al.*, 2009), (Arenillas, *et al.*, 2006) and (Darvishzad *et al.*, 2007), they considered it to be of middle Late Maastrichtian age.

Locally in Iraq, the zone is correlated with *Pseudoguembelina hariaensis* Zone of (Shanbazheri, 2008) which assigned it to the middle Late Maastrichtian age.

3- *Pseudoguembelina palpebra* Partial range Zone (CF2) :

Definition: This zone was defined by Li and Keller (1998 a and b), it represents the partial range of *Pseudoguembelina palpebra* Bronnimann and Brown between the last appearance of *Gansserina gansseri* (Bolli) and the first appearance of *Plummerita hantkeninoides* (Bronnimann).

Fig3: Geological ranges and relative abundance of planktonic foraminifera and its biostratigraphic zonation in Tanjero Formation.



Stages	Kassab, 1979 N-Iraq		Stages	Hamoudi, 2000 Ja-13 N-Iraq		Stages	AL-Mutwali & Al-Jouboury, 2005 NW-Iraq		Stages	Sharhazheri, 2008 NE-Iraq		Stages	Al-Doury, 2010 N-Iraq		Bameri, 2010 N-Iraq		Stages	Present study, 2013 N-Iraq	
Early Maastrichtian	<i>Globotruncana fornicata - stuartiformis-elevata-rosetta-ventricosa</i>		Early Maastrichtian	<i>Globotruncanella havanensis</i>		Early Maastrichtian	<i>Globotruncanella aegyptiaca</i> <i>Globotruncanella havanensis-Rosita fornicata</i>		Late Maastrichtian	<i>Plummeria hantkenioides</i> <i>Pseudoguembelina palpebra</i> <i>Pseudoguembelina hantkenioides</i> <i>Racemiguembelina fructicosa</i> <i>Pseudotextularia intermedia</i> <i>Contusotruncana contusa</i> <i>Gansserina gansseri</i>		Late Campanian	<i>Globotruncana aegyptiaca</i>		Late Campanian	<i>Globotruncana aegyptiaca</i>	Late Campanian	<i>Plummeria hantkenioides</i> <i>Pseudoguembelina palpebra</i> <i>Pseudoguembelina hantkenioides</i> <i>Abathomphalus mayaroensis</i> <i>Racemiguembelina fructicosa</i> <i>Planoglobulina acervuloides</i> <i>Contusotruncana contusa</i> <i>Gansserina gansseri</i>	
Middle Maastrichtian	<i>Globotruncana contusa-duwi-esnehensis</i>		Late Maastrichtian	<i>Gansserina gansseri</i>		Late Maastrichtian	<i>Gansserina gansseri</i>		Early Maastrichtian	<i>Gansserina gansseri</i>		Early Maastrichtian	<i>Gansserina gansseri</i>		Early Maastrichtian	<i>Gansserina gansseri</i>	Early Maastrichtian	<i>Plummeria hantkenioides</i> <i>Pseudoguembelina palpebra</i> <i>Pseudoguembelina hantkenioides</i> <i>Racemiguembelina fructicosa</i>	
Late Maastrichtian	<i>Globotruncana falsoculcarata</i>	<i>Abathomphalus mayaroensis</i>																	
	<i>Globotruncana gansseri-bahijae</i> <i>Gibberina cuvieri</i>																		
	<i>Globotruncana arca-tricarinata subcircummodifer</i>																		



Not Studied

Legend:

Fig4 : Correlation chart of planktonic foraminifera biostratigraphic zones with other studies inside Iraq.

Stages		Robaszynski et al, 1984 General	Caron, 1985 General	Robaszynski et al, 2000 General	Stages		Li et al, 1999, and Li & Keller, 1998 Tunisia	El. Sabbagh et al, 2004 Egypt	Darvishzad et al, 2007 Iran	Sari, 2006 Turkey	Keller et al, 2009 India	Keller et al, 2011 Krishna- Godavari Basin	Present Study, 2013 N-Iraq
Maastrichtian					Maastrichtian		Early		Late				
<i>Gansserina gansseri</i>		<i>Gansserina gansseri</i>	<i>Gansserina gansseri</i>	<i>Gansserina gansseri</i>	<i>Plummeria reicheli</i>	<i>Abathomphalus mayaroensis</i>	<i>Globotruncana linneiana</i>	<i>Contusotruncana contusa</i>	<i>Globotruncana stuarti</i>	<i>Pseudotextularia intermedia</i>	<i>Planoglobulina acervulinoides</i>	<i>Rugoglobigerina scotti</i>	<i>Gansserina gansseri</i>
												</	



Not Studied

Legend:

Figs : Correlation chart of planktonic foraminifera biostratigraphic zones with other studies outside Iraq.

Age: Late Maastrichtian

Boundaries: The lower boundary of this zone is marked by the last appearance of *Gansserina gansseri* (Bolli), whereas its upper boundary is marked by the first appearance of *Plummerita hantkeninoides* (Bronnimann).

Thickness: 58m that represented by the samples (41–50).

Correlation and Age Determination: The present zone is equivalent to the *Pseudoguembelina palpebra* Zone of (Li *et al.*, 1999), (Darvishzad *et al.*, 2007) and (El-Sabbagh *et al.*, 2004) who considered it of Late Maastrichtian age.

Locally in Iraq, this Zone is correlated with *Pseudoguembelina palpebra* Zone of (Sharbazheri, 2008) and (Al-Doori, 2010) who assigned to the Latest Maastrichtian.

4- *Plummerita hantkeninoides* Total range Zone (CF1):

Definition: This zone was introduced by (Pardo *et al.*, 1996), which is defined by the total range of the nominate taxon.

Age: Latest Maastrichtian.

Boundaries: The lower boundary of this zone is marked by the first appearance of *Plummerita hantkeninoides* (Bronnimann), while its upper boundary is marked by its last appearance.

Thickness: 17 m represented by the samples (51-56).

Correlation and Age Determination: *Plummerita hantkeninoides* is easily identified within the uppermost part of Late Maastrichtian, the range of this excellent marker species spans the youngest 300 kyr of the Maastrichtian below the Cretaceous / Paleogene boundary (Keller *et al.*, 2002). This zone marks the uppermost Cretaceous biozone, and its top marks the K/Pg boundary. The upper limit of this zone coincides with the mass extinction of large tropical–subtropical taxa. The present zone is equivalent to the *Plummerita hantkeninoides* Zone (CF1) which is described by (Li *et al.*, 1999), (Darvishzad *et al.*, 2007); they considered it of Latest Maastrichtian age. This zone is also correlated with the upper part of *Abathomphalus mayaroensis* Zone of (Robaszynski *et al.*, 1984) (Caron, 1985), (Premoli Silva *et al.*, 1998) (Chacon *et al.*, 2005) of Late Maastrichtian age.

In Iraq, this zone is equivalent to the upper part of *Kassabiana falsocalcarata* Zone of (Kassab *et al.*, 1986) of Late Maastrichtian age, it is equivalent to the upper part of *Abathomphalus mayaroensis* zone of (Bamerni, 2010), it is also correlated with *Plummerita hantkeninoides* Zone which is described by (Sharbazheri, 2008) of Latest Maastrichtian age.

CONCLUSION

Planktonic foraminiferal investigation of the Upper Cretaceous Tanjero Formation in Bekhme area, northern Iraq yielded 69 species that belong to 18 genera. According to their stratigraphic range, the formation is divided into four zones. The distribution of faunal sequence and the correlation between these zones and other zonal schemes in- and outside Iraq reveals a Late Maastrichtian age for the Tanjero Formation.

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PLATE 1

Fig. 1: *Heterohelix globulosa* (Ehrenberg). Sample No. 49.

Fig. 2: *Heterohelix labellosa* Nederbragt. Sample No. 25.

Fig. 3: *Heterohelix striata* (Ehrenberg). Sample No. 51.

Fig. 4: *Laeviheterohelix dantata* (Stenestad). Sample No. 50.

Fig. 5: *Laeviheterohelix glabrans* (Cushman). Sample No. 50.

Fig. 6: *Planoglobulina acervulinoides* (Egger). Sample No. 14.

Fig. 7: *Planoglobulina brazoensis* Martin. Sample No. 50.

Fig. 8: *Planoglobulina carseyae* Plummer. Sample No. 49.

Fig. 9: *Pseudotextularia intermedia* Deklasz. Sample No. 27.

Fig. 10: *Racemiguembelina fructicosa*(Egger). Sample No. 10.

Fig. 11: *Gublerina cuvillieri* Kikoine. Sample No. 14.

Fig. 12: *Pseudoguembelina costulata* (Cushman). Sample No. 51.

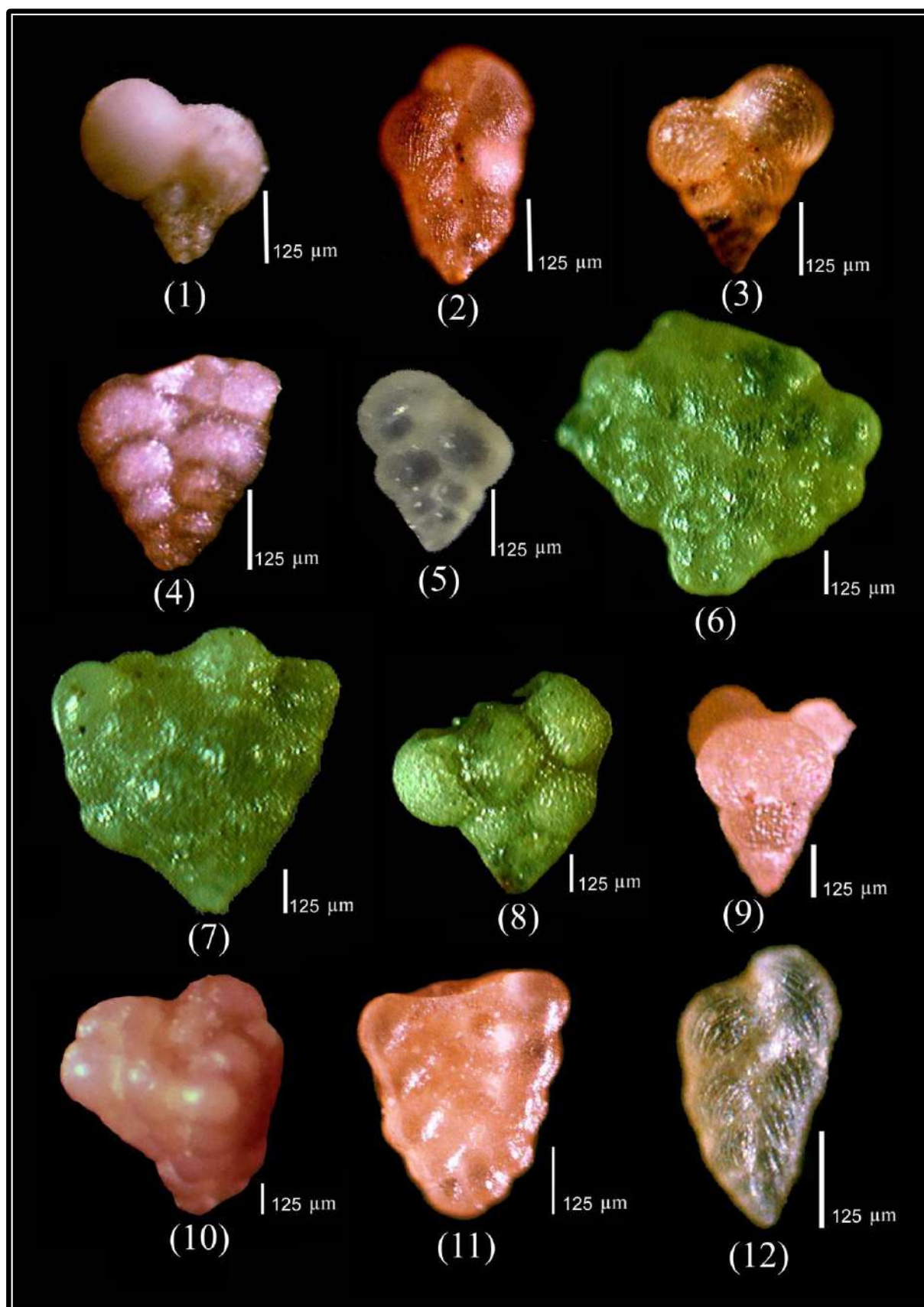
PLATE 1

PLATE 2

Fig. 1: *Pseudoguembelina hariaensis* Nederbragt. Sample No. 35.

Fig. 2: *Pseudoguembelina palpebra* Brönnimann & Brown. Sample No. 48.

Fig. 3a: *Globigerinelloides subcarinata* Bronnimann. Umbilical side. sample No. 51.

Fig. 3b: *Globigerinelloides subcarinata* Bronnimann. Spiral side. sample No. 51.

Fig. 4a: *Gansserina gansseri* (Bolli). Spiral side. Sample No. 17.

Fig. 4b: *Gansserina gansseri* (Bolli). Side view. Sample No. 17.

Fig. 4c: *Gansserina gansseri* (Bolli). Umbilical side. Sample No. 17.

Fig. 5a: *Globotruncana aegyptiaca* Nakkady. Spiral side. Sample No. 14.

Fig. 5b: *Globotruncana aegyptiaca* Nakkady. Side view Sample No. 14.

Fig. 5c: *Globotruncana aegyptiaca* Nakkady. Umbilical side. Sample No. 14.

Fig. 6a: *Globotruncana dupeublei* Caron *et al.*. Spiral side. Sample No. 28.

Fig. 6b: *Globotruncana dupeublei* Caron *et al.*. Side view. Sample No. 28.

Fig. 6c: *Globotruncana dupeublei* Caron *et al.*. Umbilical side. Sample No. 28.

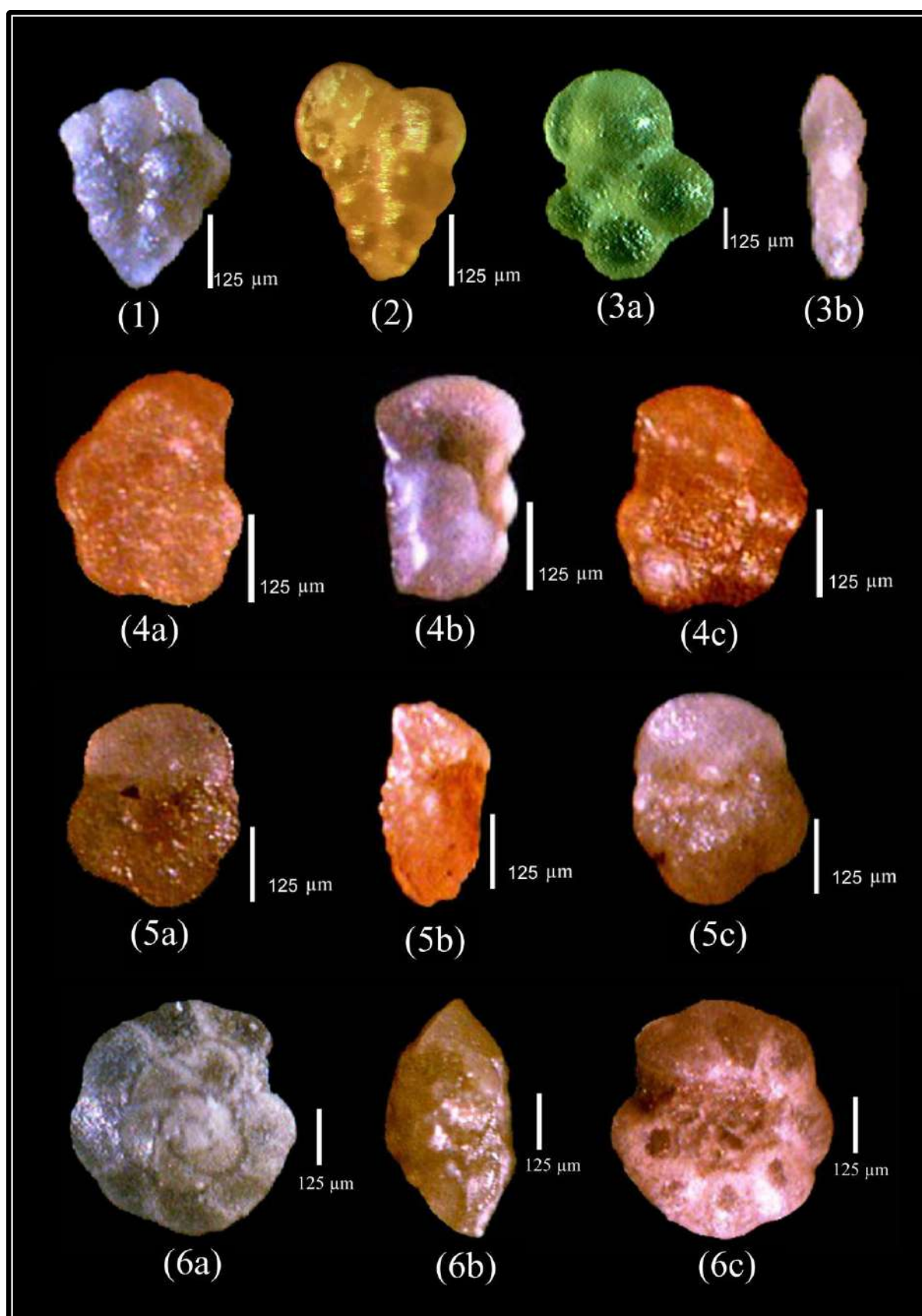
PLATE 2

PLATE 3

Fig. 1a: *Globotruncana rosetta* (Carsey). Spiral side. Sample No. 36.

Fig. 1b: *Globotruncana rosetta* (Carsey). Side view. Sample No. 36.

Fig. 1c: *Globotruncana rosetta* (Carsey). Umbilical side. Sample No. 36.

Fig. 2a: *Globotruncanita angulata* (Tilev). Spiral side. Sample No. 6.

Fig. 2b: *Globotruncanita angulata* (Tilev). Side view. Sample No. 6.

Fig. 2c: *Globotruncanita angulata* (Tilev). Umbilical side. Sample No. 6.

Fig. 3a: *Globotruncanita conica* (White). Spiral side. Sample No. 27.

Fig. 3b: *Globotruncanita conica* (White). Side view. Sample No. 27.

Fig. 3c: *Globotruncanita conica* (White). Umbilical side. Sample No. 27.

Fig. 4a: *Globotruncanita stuarti* (de Lapparent). Spiral side. Sample No. 18.

Fig. 4b: *Globotruncanita stuarti* (de Lapparent). Side view. Sample No. 18.

Fig. 4c: *Globotruncanita stuarti* (de Lapparent). Umbilical side. Sample No. 18.

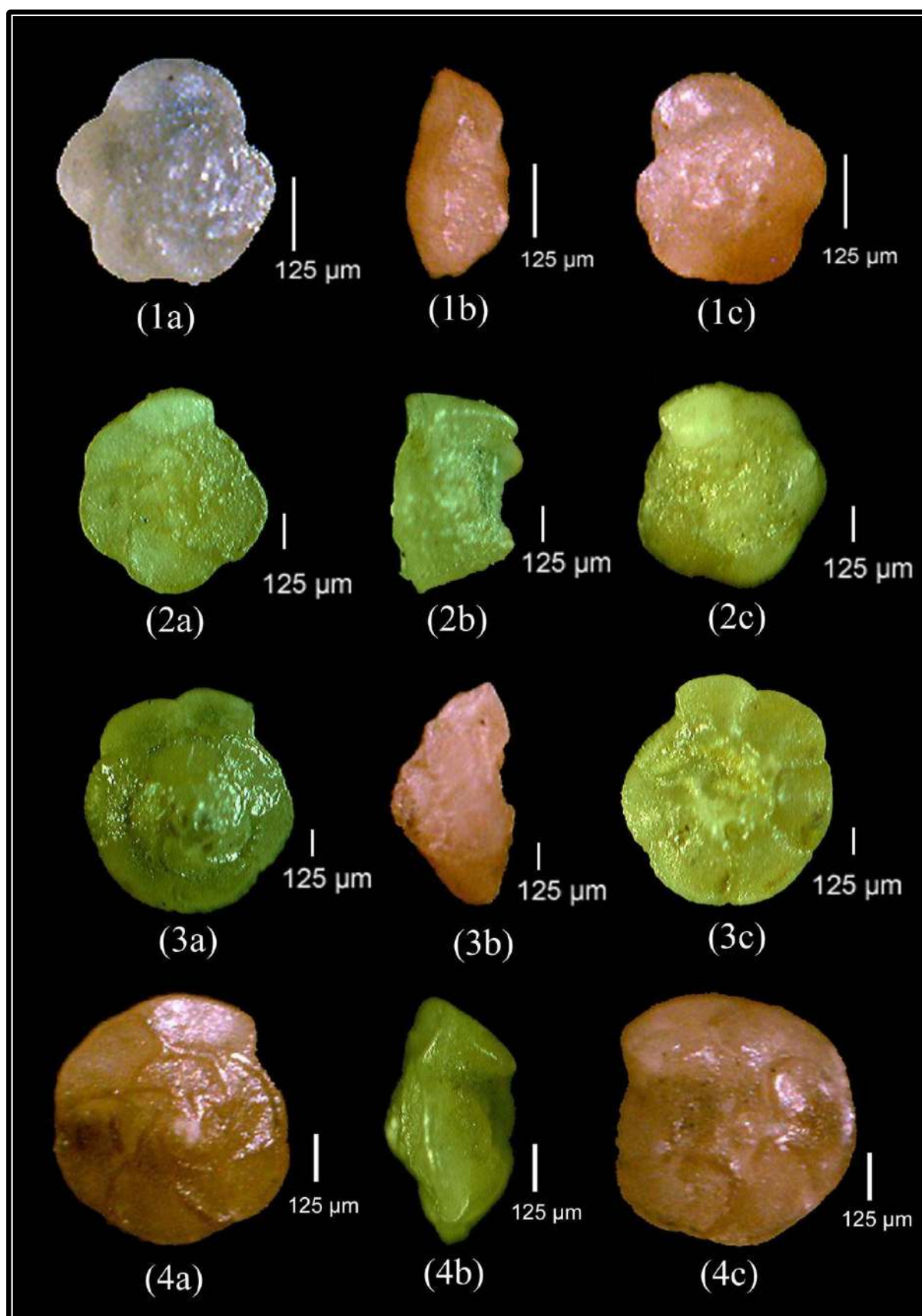
PLATE 3

PLATE 4

Fig. 1a: *Abathomphalus mayaroensis* (Bolli). Spiral side. Sample No. 28.

Fig. 1b: *Abathomphalus mayaroensis* (Bolli). Side view. Sample No. 28.

Fig. 1c: *Abathomphalus mayaroensis* (Bolli). Umbilical side. Sample No. 28.

Fig. 2a: *Plummerita hantkeninoides* (Bronnimann). Spiral side. Sample No. 52.

Fig. 2a: *Plummerita hantkeninoides* (Bronnimann). Side view. Sample No. 52.

Fig. 2a: *Plummerita hantkeninoides* (Bronnimann). Umbilical side. Sample No. 52.

Fig. 3a: *Rugoglobigerina macrocephala* Brönnimann. Spiral side. Sample No. 48.

Fig. 3b: *Rugoglobigerina macrocephala* Brönnimann. Spiral side. Sample No. 48.

Fig. 3c: *Rugoglobigerina macrocephala* Brönnimann. Umbilical side. Sample No. 48.

Fig. 4a: *Rugoglobigerina rugosa* (Plummer). Spiral side. Sample No. 47.

Fig. 4b: *Rugoglobigerina rugosa* (Plummer). Side view. Sample No. 47.

Fig. 4c: *Rugoglobigerina rugosa* (Plummer). Umbilical side. Sample No. 47.

PLATE 4