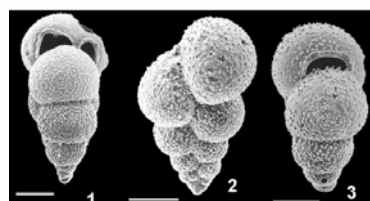
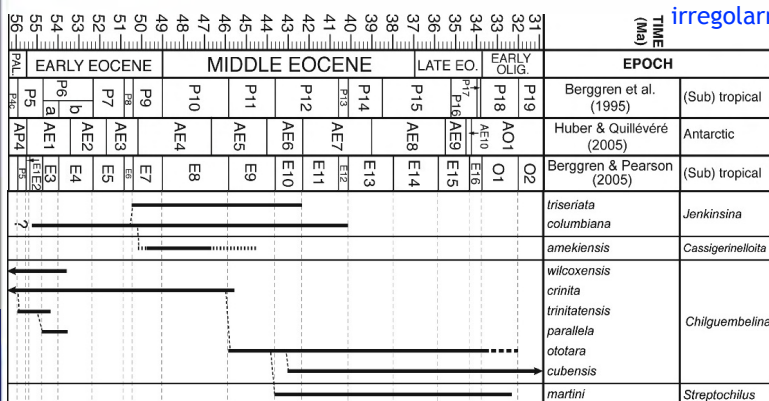




Generi con parete non spinosa

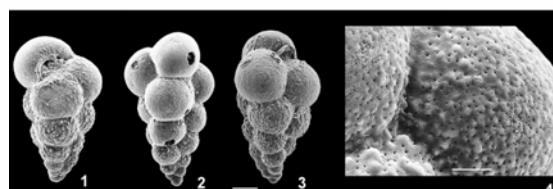
- Liscia, sottile, microperforata
- Pori minori di 1µm in diametro e irregolarmente distribuiti sulla superficie



Chilguembelina trinitatensis

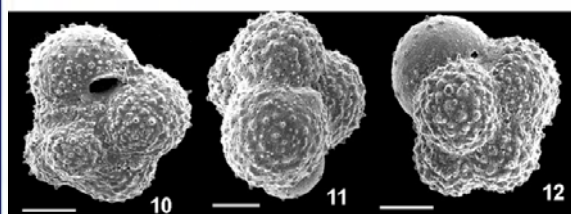


Streptochilus martini



Jenkinsina triseriata

Pearson et al 2006 49



Cassigerinelloita amekiensis

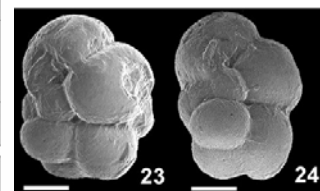
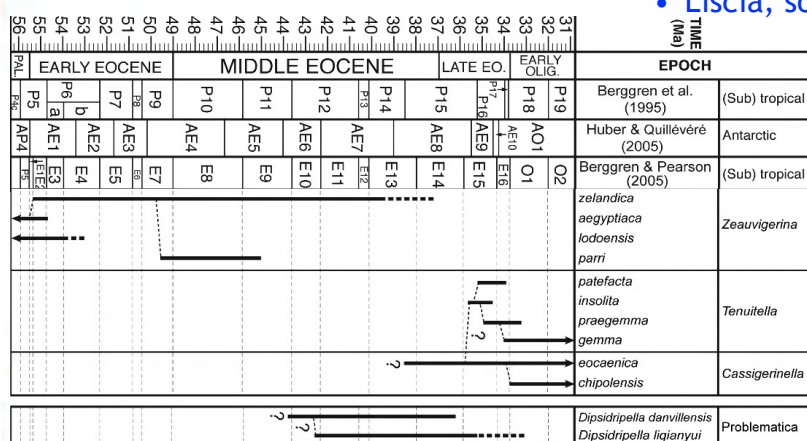
Camere che sia aggiungono in serie di 3



Generi con parete non spinosa

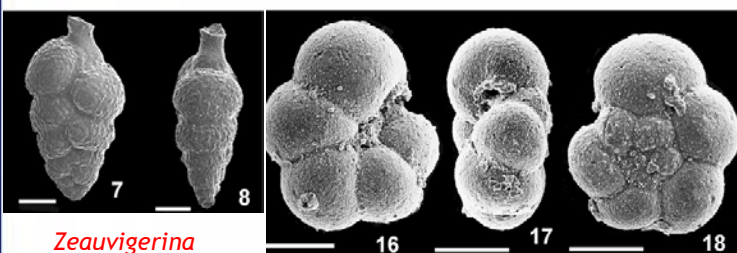
- Liscia, sottile, microperforata

Pori minori di 1µm in diametro e irregolarmente distribuiti sulla superficie



Cassigerinella chipolensis

da biseriale a planispirale

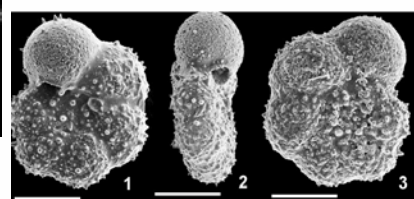


Zeauvigerina

da biseriale a uniseriale

Tenuitella gemma

trocospirale basso



Dipsidripella

Pearson et al 2006 50



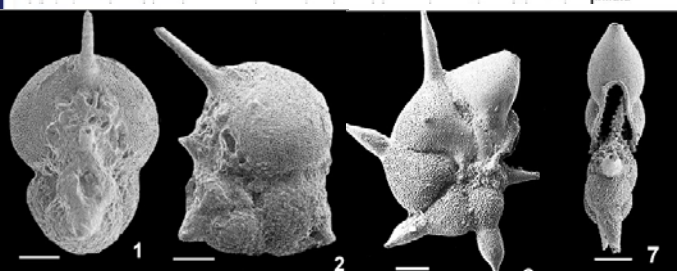
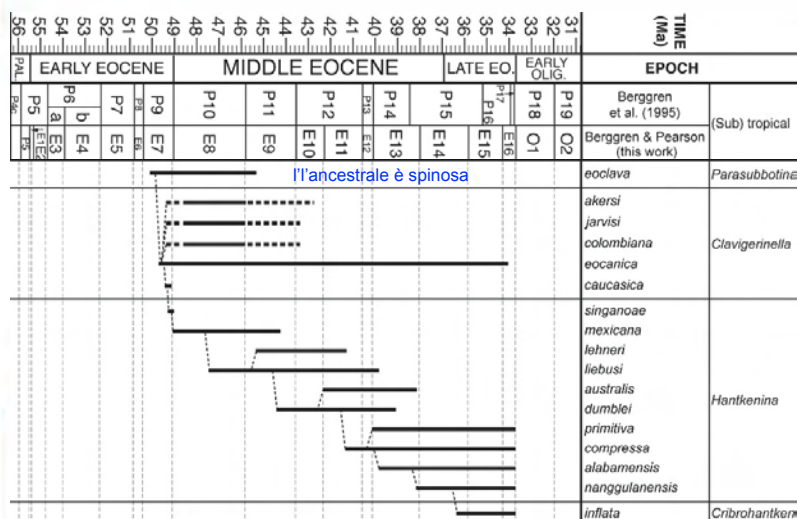


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Generi con parete non spinosa



Cribrohantkenina inflata

Hantkenina dumblei

- liscia

tipo *Clavigerinella*:
struttura densamente
perforata con una fitta
cancellatura data da rilievi
che determinano una
superficie liscia dovuta
all'aggiunta uniforme di
lamelle calcitiche



Clavigerinella eocanica

Clavigerinella evolve dalla spinosa
Parasubbotina eoclava, perde le spine e dà
origine alle hantkenine che non possiedono
spine

subtipo *Hantkenina*: stadi ancestrali
come *Clavigerinella*, stadio adulto con
parete liscia per successiva aggiunta di
lamelle calcitiche

Pearson et al 2006

51

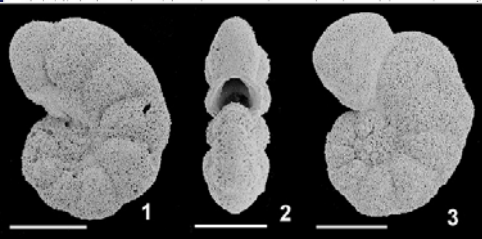
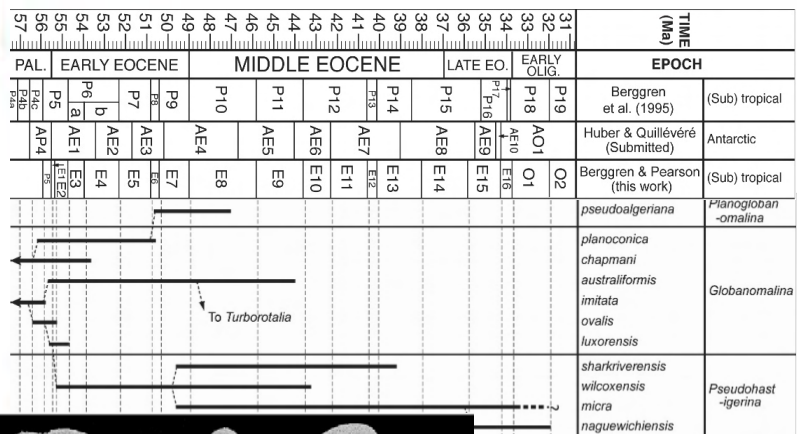


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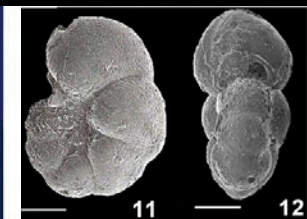


Generi con parete non spinosa



Planoglobanomalina pseudoalgeriana

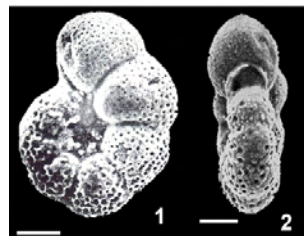
da asimmetrica a planispirale



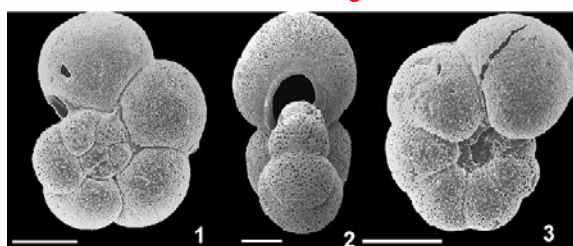
Pseudohastigerina micra

- Liscia

Piccole pustule confinate
nell'area ombelicale e
intorno all'apertura



Pseudohastigerina naguewichiensis



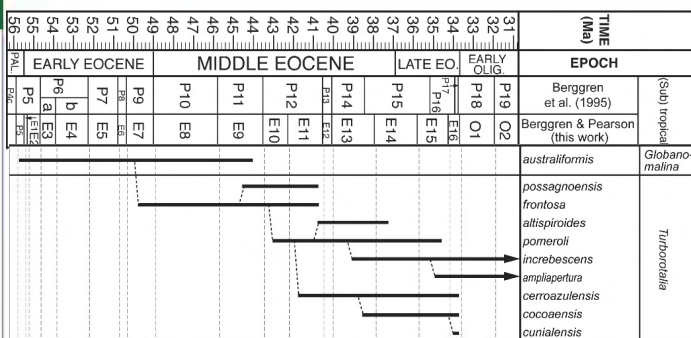
Globanomalina luxorensis Pearson et al 2006

52

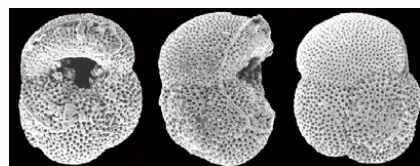


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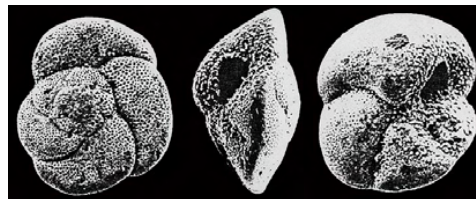
• Liscia
tipo *Turborotalia*: deriva da *Globanomalina* (liscia); *T. frontosa* è cancellata. Aggiunta di lamelle calcitiche nel corso dell'evoluzione



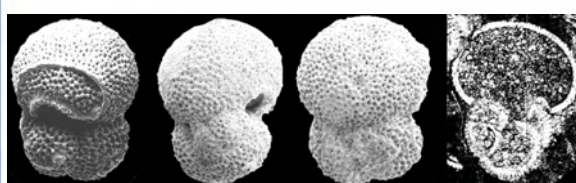
Turborotalia ampliapertura



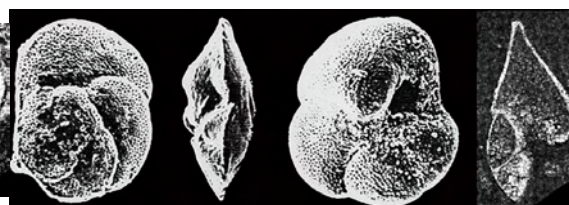
Turborotalia cerroazulensis



Turborotalia cocoaensis



Turborotalia frontosa

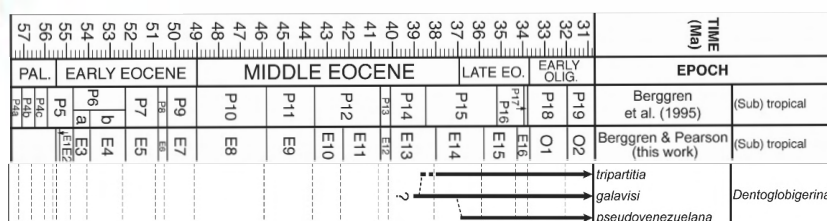


Turborotalia cunialensis Pearson et al 2006 53

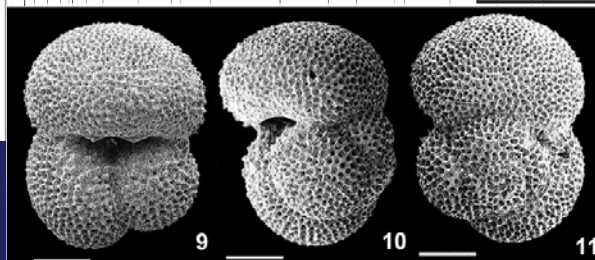


Generi con prete non spinosa

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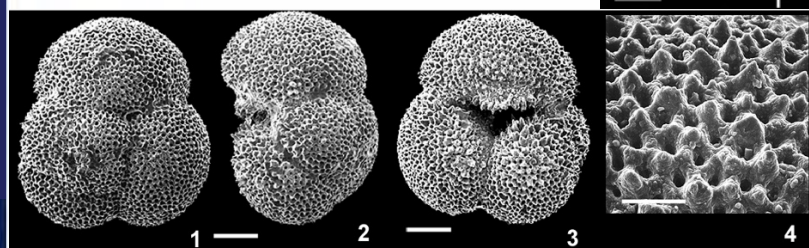
• Cancellata
tipo *Globoquadrina*: pori abbastanza regolari e pustule di vario tipo; pustule più grandi intorno all'apertura.



Dentoglobigerina tripartita



Dentoglobigerina galavisi



Dentoglobigerina pseudovenezuelana



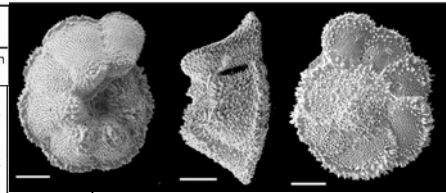
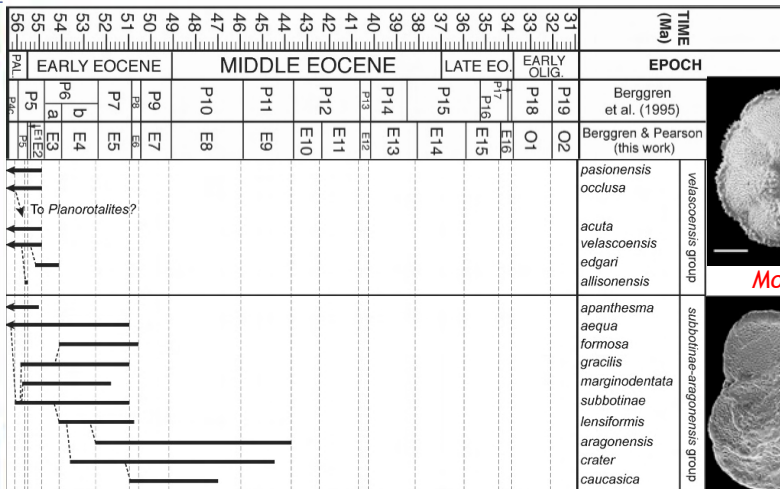
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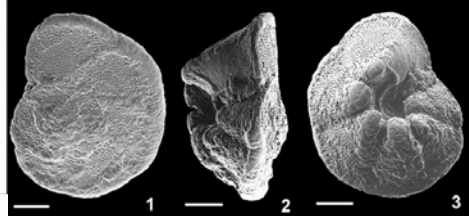


Generi con parete non spinosa

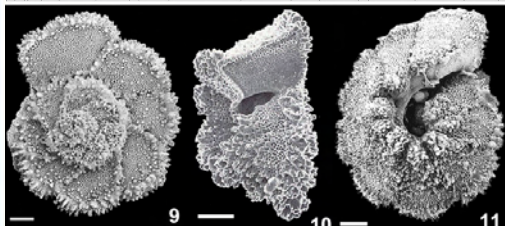
• Muricata



Morozovella velascoensis

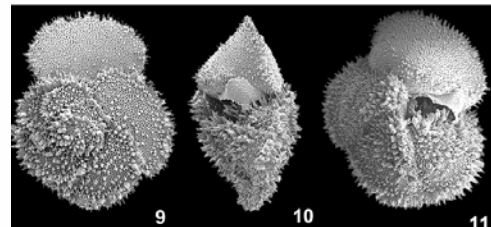


Morozovella aragonensis



Morozovella caucasica

Muricae concentrate intorno all'area ombelicale e alla periferia a formare una distinta e continua muricocarena



Morozovella gracilis Pearson et al 2006

55



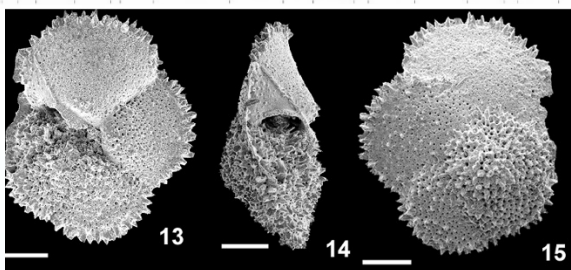
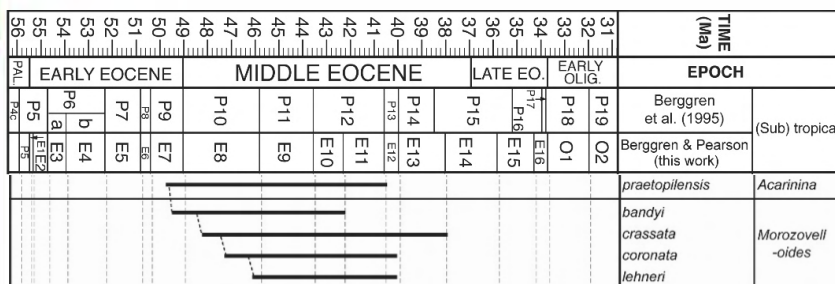
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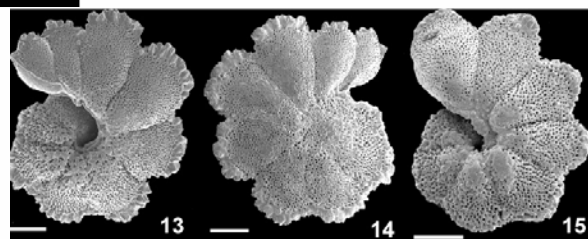
Generi con parete non spinosa

• Muricata



Morozovelloides crassatus

Muricae concentrate intorno all'area ombelicale e alla periferia a formare una discontinua muricocarena



Morozovelloides lehneri

Pearson et al 2006

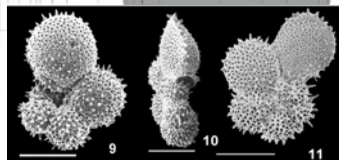
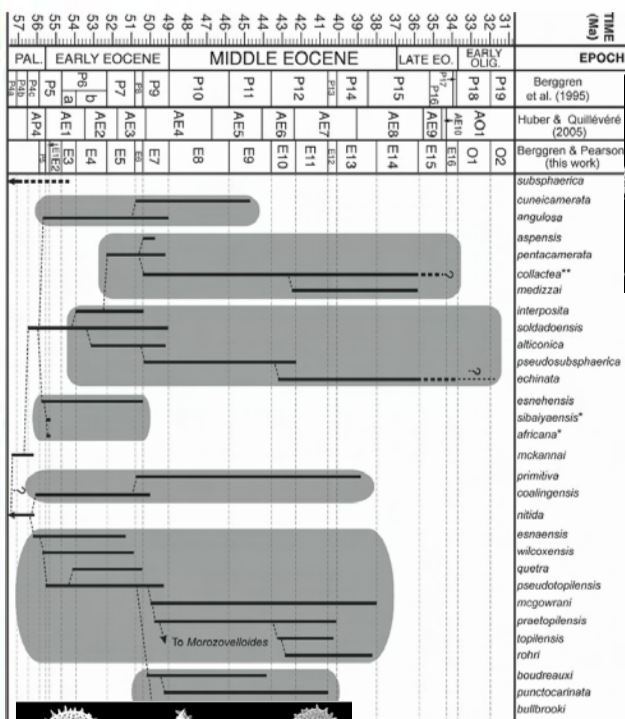
56



Generi con parete non spinosa

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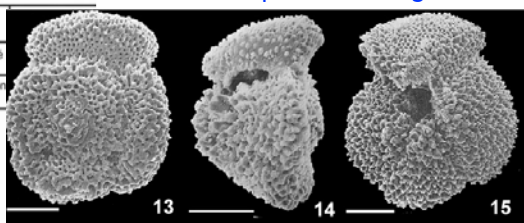
UNIVERSITÀ DEGLI STUDI DI MILANO
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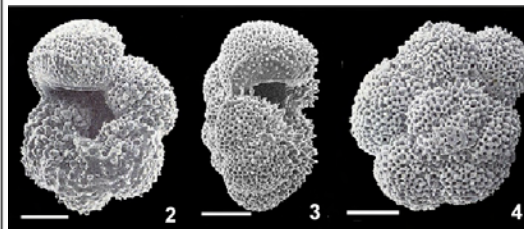
Acarinina africana

• Muricata

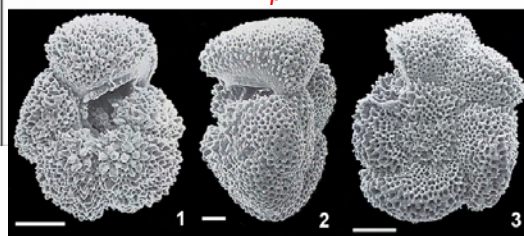
Muricae a coprire l'intero guscio



Acarinina bullbroki



Acarinina aspensis



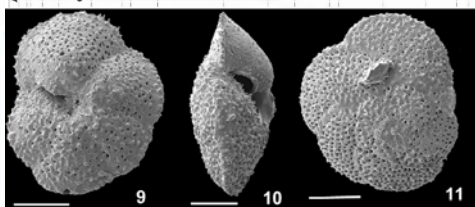
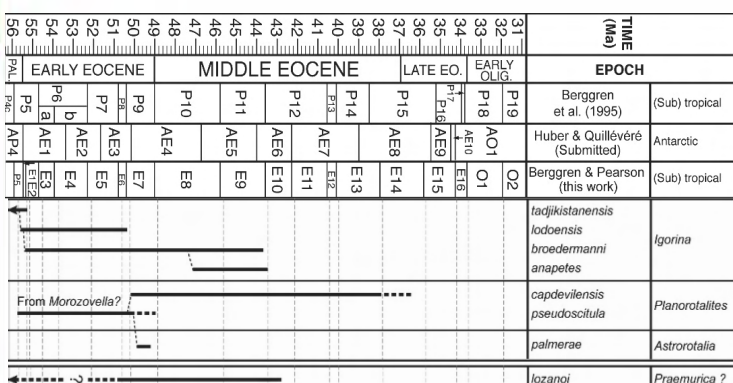
Acarinina cuneicamerata

Pearson et al 2006 57

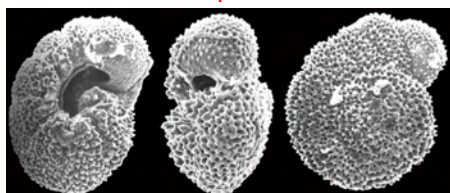
Generi con parete non spinosa

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Planorotalites pseudoscitula

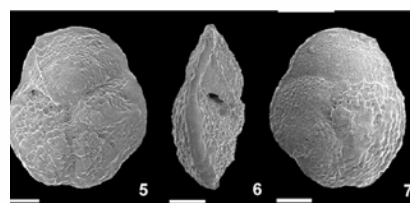


"Igorina" *brodermanni*

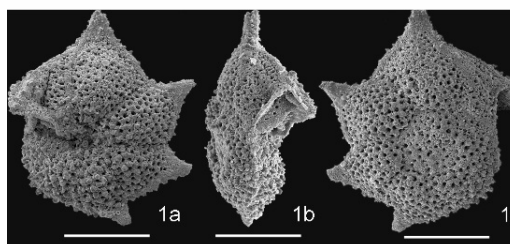
• Muricata

subtipo *Planorotalites*: pustule fuse a formare parete cancellata su parte della superficie.

Igorina è fortemente pustulosa. *Astrorotalia* è debolmente muricata.



Planorotalites capdevillensis



Astrorotalia palmerae

Pearson et al 2006 58

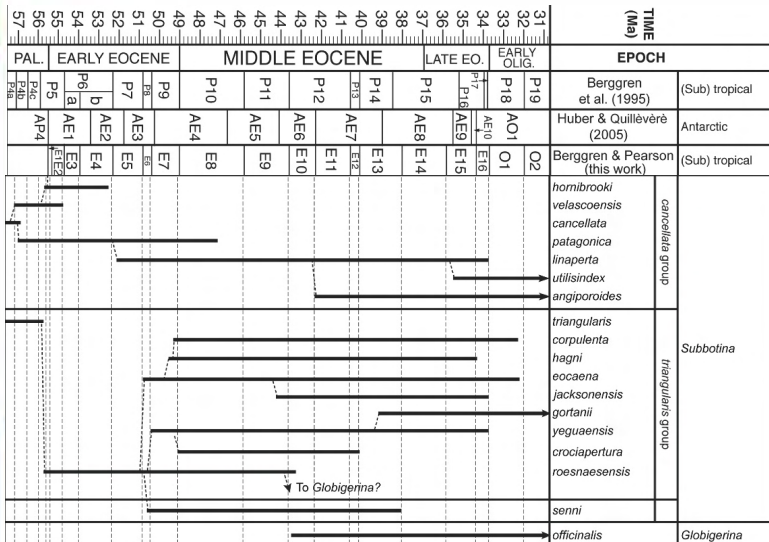


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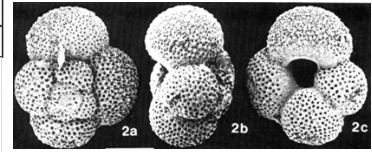
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Generi con parete spinosa



- liscia

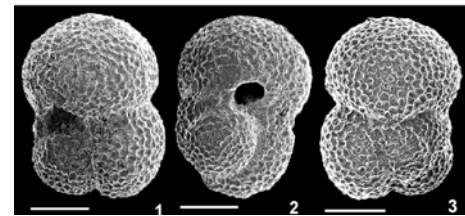


★ *Globigerina officialis*

- Cancellata



Subbotina crociapertura



Subbotina patagonica

Pearson et al 2006 59

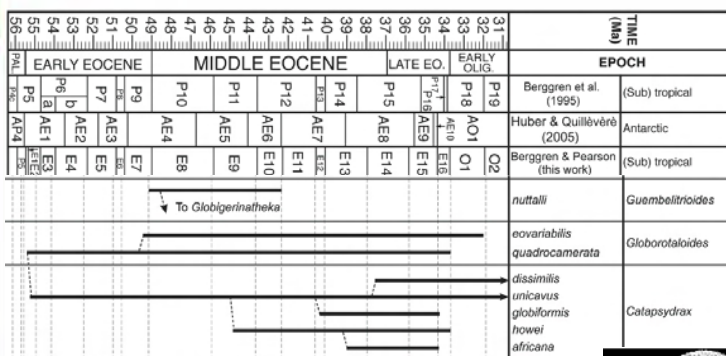


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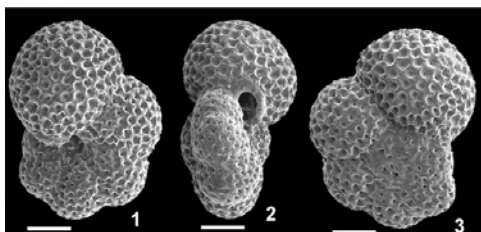


Generi con parete spinosa

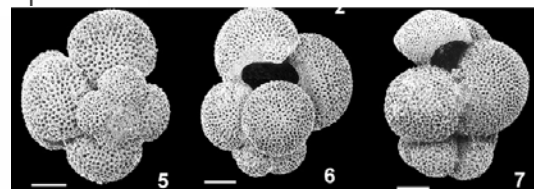


- Cancellata

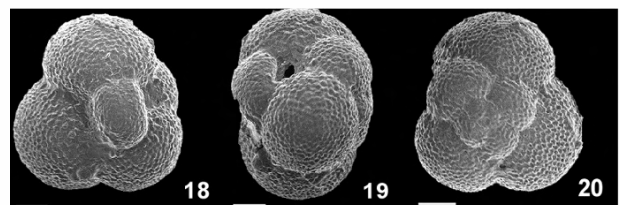
tipo *sacculifer*: pori
egualmente distribuiti,
struttura cancellata e
simmetrica (a favo). Spine
all'intersezione delle creste
poligonali.



Globorotaloides eovariabilis



Guembelitrioides nuttalli



Catapsydrax dissimilis

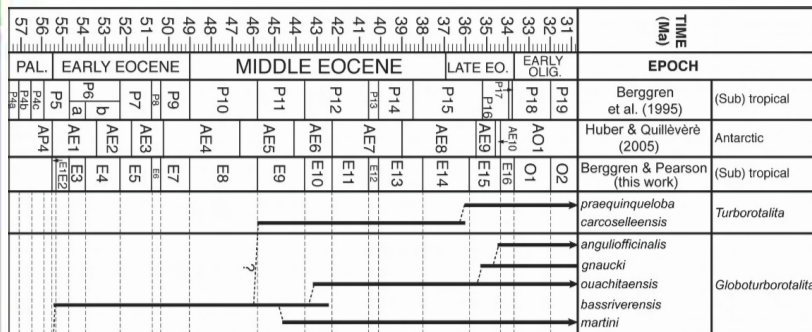
Pearson et al 2006 60



Generi con parete spinosa

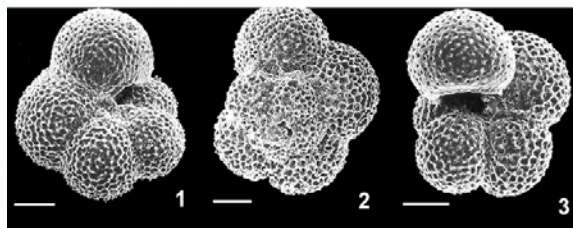
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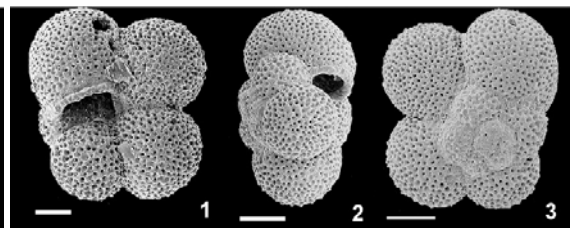


• Cancellata

tipo *Turborotalita*: parete cancellata che diventa liscia per aggiunta di lamelle addizionali.



Globoturborotalita angulioffinalis



Turborotalita praequineloba

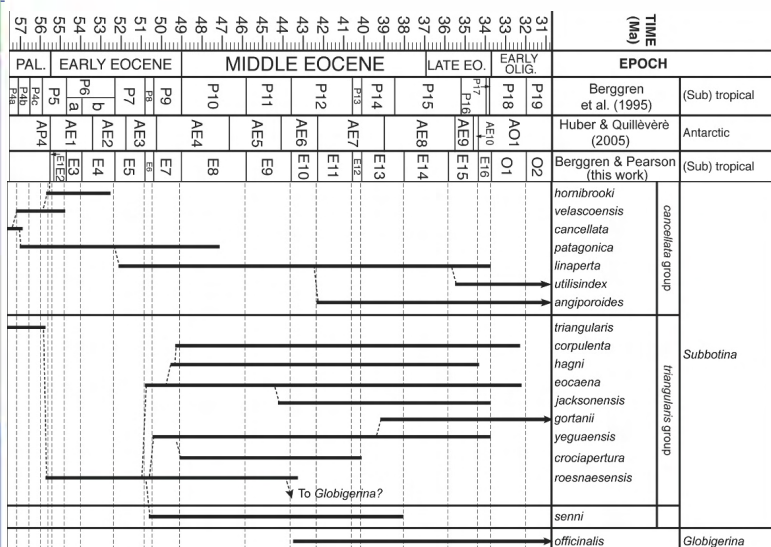
Pearson et al 2006 61



Generi con parete spinosa

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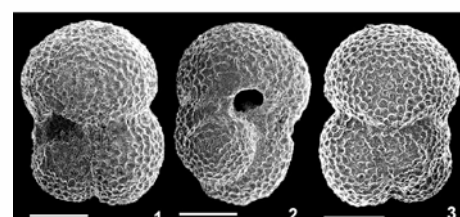
• Cancellata

tipo *sacculifer*: pori egualmente distribuiti, struttura cancellata fortemente simmetrica (a favo).

tipo *ruber*: struttura cancellata può essere simmetrica in alcune parti e asimmetrica in altre. Spine all'intersezione dei poligoni.



Subbotina crociapertura



Subbotina patagonica

Pearson et al 2006 62

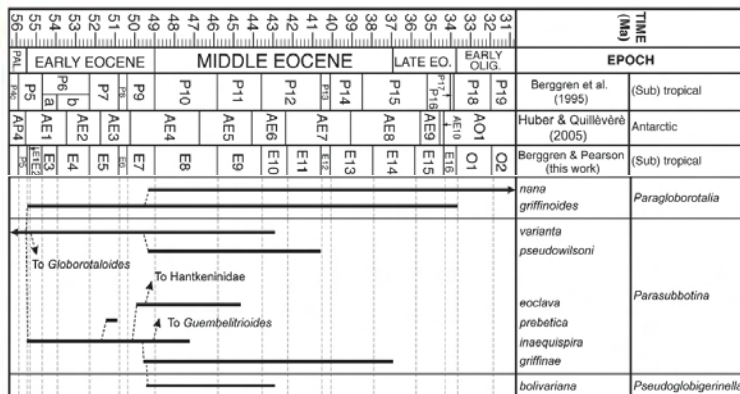


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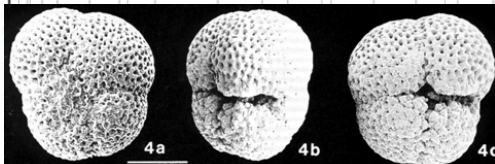


Generi con parete spinosa

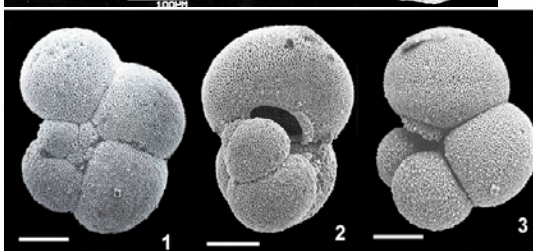


• Cancellata

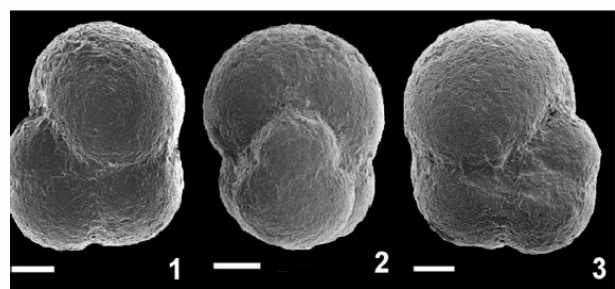
tipo *Clavigerinella*: struttura densamente perforata con una fitta cancellatura data da rilievi che determinano una superficie liscia dovuta all'aggiunta uniforme di lamelle calcitiche.



Paragloborotalia nana



Parasubbotina griffinae



Pseudoglobigerinella bolivariana

Pearson et al 2006 63

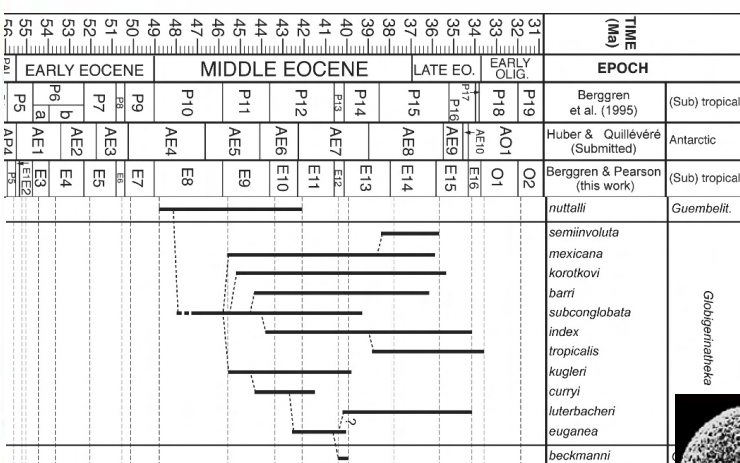


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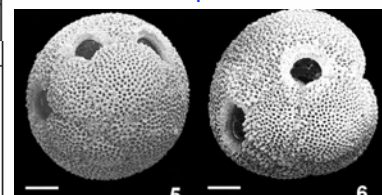


Generi con parete spinosa

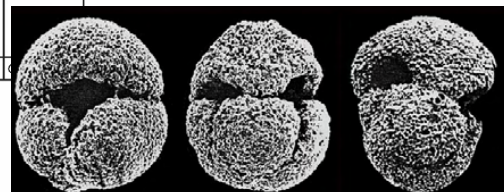


• Cancellata

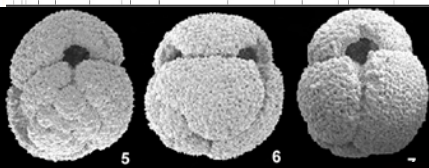
creste disposte in poligoni più o meno regolari o esagonali, possono essere presenti anche pseudospine corte e tozze o ispessimenti esterni



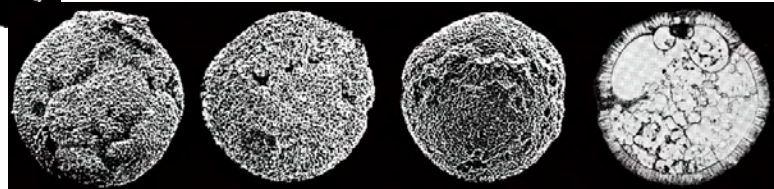
Globigerinatheka semiinvoluta



Globigerinatheka index



Globigerinatheka korotkovi



Orbulinoides beckmanni

Pearson et al 2006 64



Biostratigrafia e biozonazione

EOCENE TIME SCALE

Berggren and Pearson 2005

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TIME (Ma)	CHRONS	POLARITY	EPOCH	AGE	CALCAREOUS NANNOPLANKTON		PLANKTONIC FORAMINIFERA			
					Martini (1971)	Bukry (1973, 1975)	Berggren et al. (1995)		Berggren and Pearson (this work)	
31	C12n		OLIGOCENE	EARLY RUPELIAN	NP21	CP16	P19	<i>T. ampliapertura</i> IZ	O2	<i>T. ampliapertura</i> IZ
32	C12r						P18	<i>Ch. cubensis-Pseudohastigerina</i> spp. IZ	O1	<i>P. nagewichiensis</i> IZ
33	C13n							<i>T. cerroazulensis</i> IZ	E16	<i>H. alabamensis</i> IZ
34	C13r						P17	<i>T. cunialensis / Cr. inflata</i> CRZ	E15	<i>G. index</i> IZ
35	C14n		LATE PRIABONIAN	NP19-20	CP15	P15		<i>Po. semiinvoluta</i> IZ	E14	<i>G. semiinvoluta</i> IZ
36	C15n									
37	C16n									
38	C17n									
39	C18n		MIDDLE BARTONIAN	NP17	CP14	P14		<i>Tr. rohri - M. spinulosa</i> PRZ	E13	<i>M. crassata</i> IZ
40	C18r									
41	C19r									
42	C20n									
43	C20n		LUTETIAN	NP16	CP13	P12		<i>M. lehneri</i> PRZ	E11	<i>M. lehneri</i> PRZ
44	C20r								E10	<i>A. topilensis</i> PRZ
45	C21n							<i>Gb. kugleri / M. aragonensis</i> CRZ	E9	<i>G. kugleri / M. aragonensis</i> CRZ
46	C21r									
47	C21n		EARLY YPRESIAN	NP15	CP12	P11		<i>H. nuttalli</i> IZ	E8	<i>G. nuttalli</i> IZ
48	C21r									
49	C22n									
50	C22r									
51	C23n		NP13	CP11	P9	P7		<i>Pt. palmerae - H. nuttalli</i> IZ	E7	<i>A. cuneicamerata</i> IZ
52	C23r									
53	C24n									
54	C24r									
55	C24r		PALEOCENE	LATE	NP9	CP8	P5	<i>M. velascoensis</i> IZ	E1	<i>M. marginodentata</i> PRZ
56	C25n									

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Biostratigrafia e biozonazione

Definizione delle zone ed eventi marker

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TIME (Ma)	CHRONS	POLARITY	EPOCH	AGE	PLANKTONIC FORAMINIFERA	EVENTS
41	C18r		MIDDLE	E11	<i>M. lehneri</i> PRZ	
42	C19r				<i>A. topilensis</i> PRZ	Guembilitrioides nuttalli (~41.4)
43	C20n				<i>G. kugleri / M. aragonensis</i> CRZ	Morozovella aragonensis (42.6)
44	C20r				<i>G. nuttalli</i> LOZ	Globigerinatheka kugleri (~43.4)
45	C21n		EARLY	E8	<i>G. nuttalli</i> LOZ	
46	C21r				<i>T. frontosa</i> LOSZ	Guembilitrioides nuttalli (45.5)
47	C21r				<i>T. frontosa</i> LOSZ	
48	C22n				<i>T. frontosa</i> LOSZ	Turborotalia frontosa (48.6)
49	C22r		E7a	A. cuneicamerata LOSZ		
50	C22r				<i>A. cuneicamerata</i> LOSZ	
51	C23n				<i>A. pentacamerata</i> PRZ	Acarinina cuneicamerata (50.3)
52	C23r				<i>M. aragonensis / M. subbotinae</i> CRZ	Morozovella subbotinae (50.8)
53	C24n		E4	M. formosa LOZ		
54	C24r				<i>M. formosa</i> LOZ	Morozovella aragonensis (52.3)
55	C24r				<i>M. marginodentata</i> PRZ	Morozovella formosa (54.4)
56	C24r				<i>M. velascoensis</i> IZ	Morozovella velascoensis (54.9)

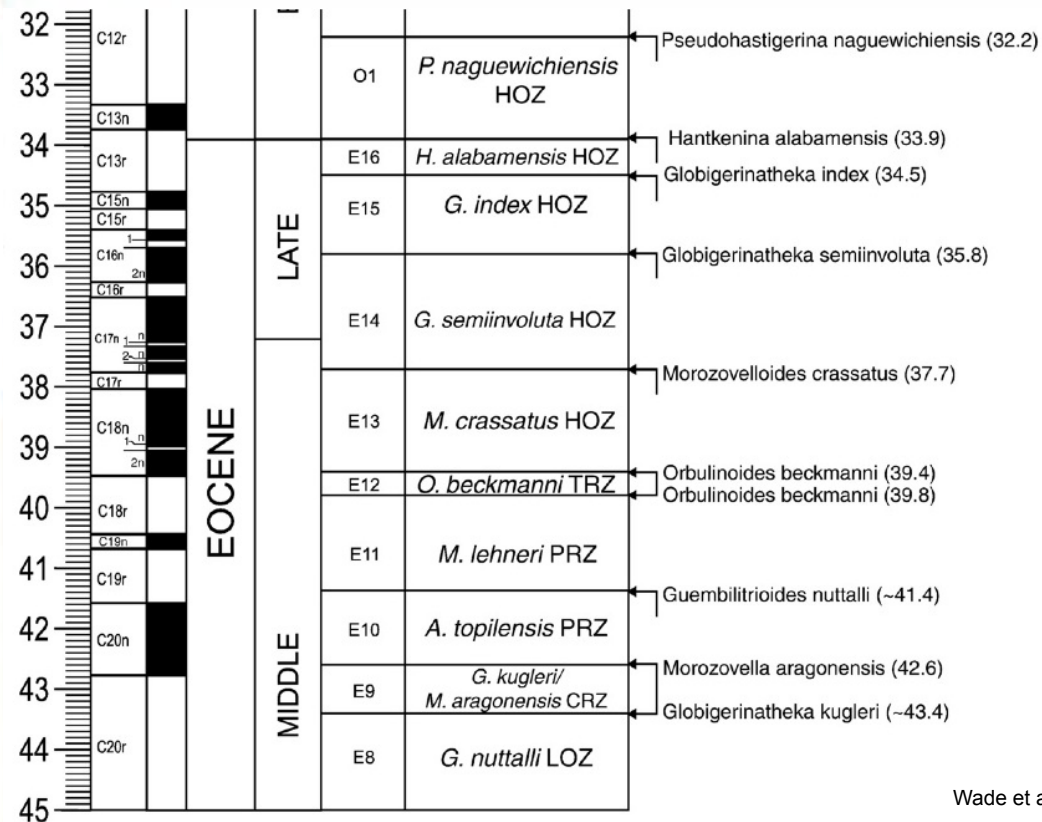
Wade et al 2011

66



Biostratigrafia e biozonazione

Definizione delle zone ed eventi marker



Wade et al 2011 67



Biostratigrafia e biozonazione

OLIGOCENE TIME SCALE Berggren & Pearson 2005

TIME (Ma)	CHRONOS	POLARITY	EPOCH	AGE	CALCAREOUS NANNOPLANKTON		PLANKTONIC FORAMINIFERA			
					Martini (1971)	Bukry (1973-1975)	Berggren et al. (1995)		Berggren and Pearson (this work)	
23	C6Bn 1-2n		MIOCENE	EARLY AQUITANIAN	NN2	CN1	M1b	<i>Gt. kugleri</i> / <i>Gq. dehiscens</i> CRZ	not studied	
24	C6Cn 1-2n				NN1		M1a	<i>Gd. primordius</i> PRZ		
25	C6Cr		LATE CHATTIAN	CHATTIAN	NP25	CP19	P22	<i>Gl. ciperoensis</i> PRZ	O6	<i>G. ciperoensis</i> PRZ
26	C7n 1-2n									
27	C8r									
28	C9n									
29	C10n		EARLY RUPELIAN	RUPELIAN	NP24	CP18	P21	<i>Gl. angulatusuturalis</i> / <i>Pg. opima</i> s.s. ISZ	O5	<i>P. opima</i> HOZ
30	C11n									
31	C12n									
32	C12r									
33	C13n		LATE PRIABONIAN	PRIABONIAN	NP21	CP16	P18	<i>Ch. cubensis</i> - <i>Pseudohastigerina</i> spp. IZ	O1	<i>P. nagewichiensis</i> HOZ
34	C13r									
35	C15n									
36	C16n									
37	C17n		LATE PRIABONIAN	PRIABONIAN	NP18	CP15	P15	<i>Po. semiinvoluta</i> IZ	E14	<i>G. semiinvoluta</i> HOZ
38	C17r									
39	C18n									
40	C19n									

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OLIGOCENE: distribuzione delle specie

Spezzaferri 1994

NB-La tassonomia dei foraminiferi planctonici dell'Oligocene è attualmente in revisione da parte del Paleogene Working Group. Un Atlante simile a quelli del Paleocene ed Eocene è in preparazione.

Stratigraphic Ranges of Oligocene Planktonic Foraminifera (after Spezzafini, 1994)	OLIGOCENE					
	RUPELIAN		CHATTIAN		Zones	Age
	P18- P19	P20	P21	P22		
pseudohastigerinids			a	b		23.03
Globorotaloides permixtus						
Subbotina portanii						
"Globigerina" venezuelana						
Globorotaloides suteri						
Dentoglobigerina globularis						
Dentoglobigerina barroemouensis						
"Globigerina" viparitia						
"Globigerina" praedapfi						
Globoquadrina praetexticensis						
"Globigerina" rotii						
Dentoglobigerina galavisi						
Globorotaloides variabilis						
Chiloguembellina cubensis						
Tenuitella clemenciae						
Tenuitella neoclemenciae						
Paragloboborotalia stokesii						
Cassigernella chipolensis						
Paragloboborotalia nana						
Tenuitella gemma						
Catapaydrax dissimilis						
Turborotalia ampliapertura						
Globigerina officinalis						
Dentoglobigerina larmei						
Catapaydrax martinii						
Catapaydrax unicus						
"Globigerina" euapertura						
Globoturbotalita ovachtaensis						
Globoturbotalita ovachtaensis gna						
"Globigerina" sellii						
Subbotina angiporoides						
Globorotaloides testungosa						
"Globigerina" tapuriensis						
Paragloboborotalia opima opima						
Tenuitellina angustumbilicata						
Tenuitellina praestainforthi						
Globigerina proebuloides						
Globigerinella obesa						
Globoturbatalita ciperoensis						
Subbotina praeturtilina						
Tenuitella munda						
Globoturbatalita anguliefficialis						
Globoturbatalita angulituralis						
Globoturbatalita woodi						
Globigerina proebuloides occlusa						
Globoturbatalita brazeri						
Globoturbatalita labocrassata						
Globoturbatalita ciperoensis foriasi						
Cassigernella globulosa						
Globigerinita gluinata						
Paragloboborotalia semivera						
Protietella navazuelensis						
Globoturbatalita atmanensis						
Globigerinita uvula						
Globigerinoides primordius						
Paragloboborotalia pseudokugleri						
Paragloboborotalia birnageae						
Levatorella proluxa						
Streptochilus pristinum						
Dentoglobigerina allispina globosa						
Globigerina earnei						
"Globigerina" binaiensis						
Globorotaloides stainforthi						
Globoquadrina dehiscentis						

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OLIGOCENE: distribuzione delle specie

Paragloborotalia lineage (Spezzaferri 1994)

Age	Zones	Evolution of <i>P. kugleri</i> group (modified from Spezzaferri 1991)		
MIOCENE	N4	↓	extinction of the <i>P. kugleri</i> group	
		←	decreasing abundance of the <i>P. kugleri</i> group	
		←	<i>P. kugleri</i> with markedly arched sutures also on umbilical side	→
		←	diversification level of the genus <i>Globigerinoides</i>	
		←	biconvex specimens of <i>P. kugleri</i>	
		←	<i>P. kugleri</i> (150-250µm)	
OLIGOCENE	P22	↑	<i>P. kugleri</i> (40-150µm), <i>P. pseudokugleri</i> / <i>P. kugleri</i> transition (150-250µm)	↗
		←	<i>P. pseudokugleri</i> / <i>P. kugleri</i> transition (40-150µm), <i>P. pseudokugleri</i> (150-250µm)	
		←	<i>P. pseudokugleri</i> (40-150µm) ancestral form of <i>P. pseudokugleri</i> (150-250µm)	
		↑	ancestral form of <i>P. pseudokugleri</i> (40-150µm)	

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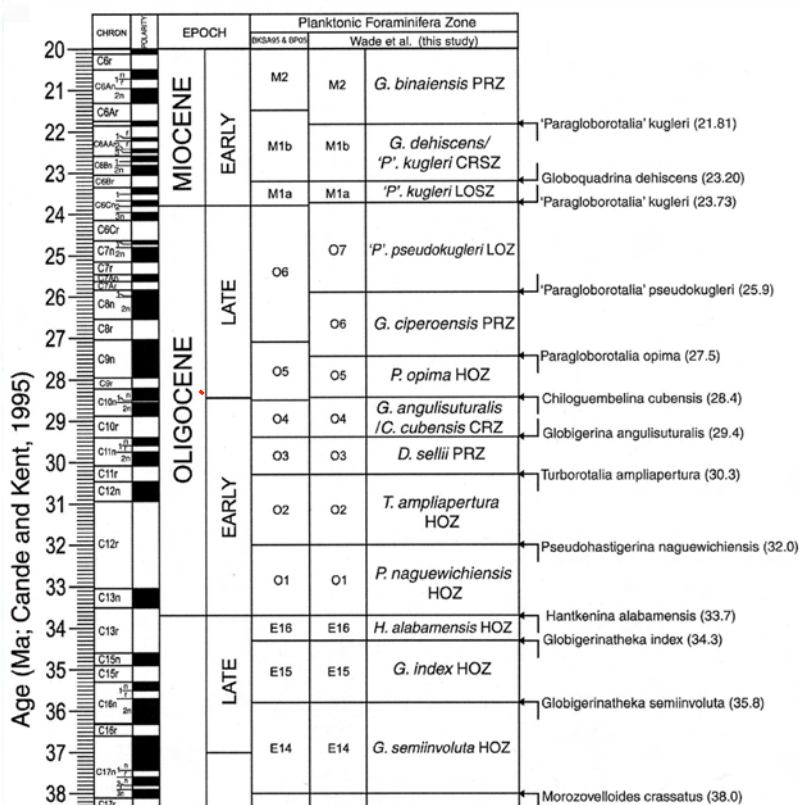


Biostratigrafia e biozonazione

Definizione delle zone ed eventi marker

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Chiloquembelina extinction

Wade et al 2011

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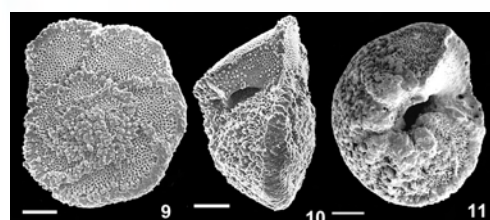
top Paleocene - Eocene inferiore

Zone P5-E5

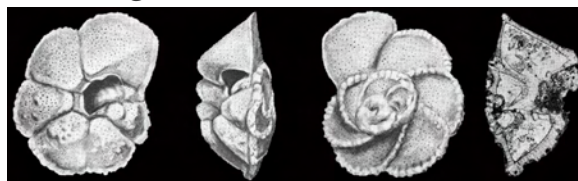
- Evoluzione del gruppo *Morozovella aragonensis*

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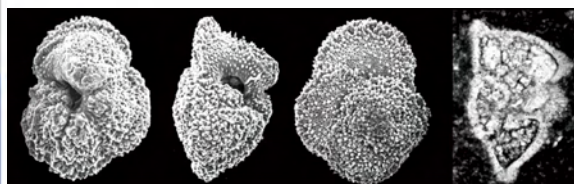
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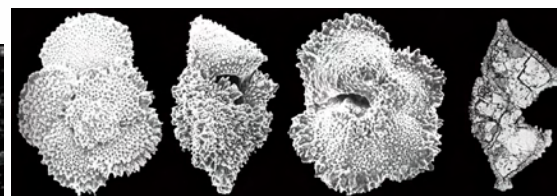
Morozovella aragonensis



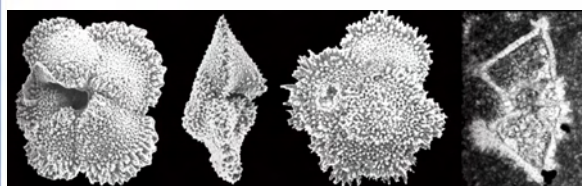
Morozovella formosa



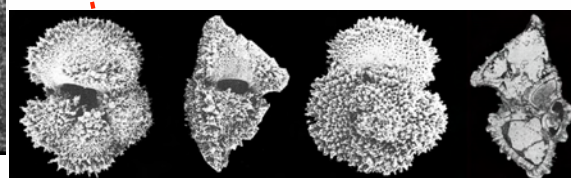
Morozovella lensiformis



Morozovella gracilis



Morozovella marginodentata



Morozovella subbotinae

72



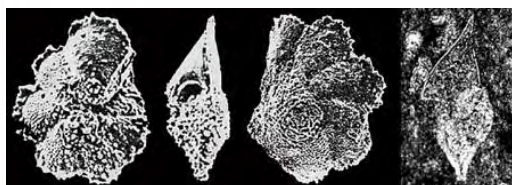
Eocene medio

Zone E7-E12

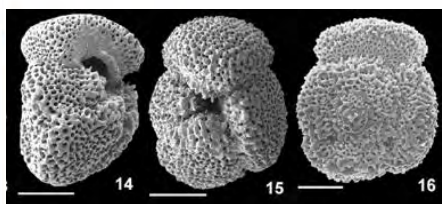
- Associazione tipica

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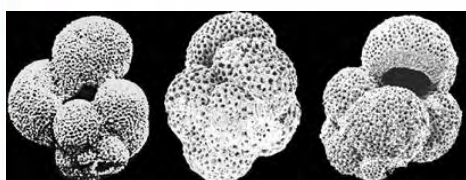
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Morozovelloides lehneri



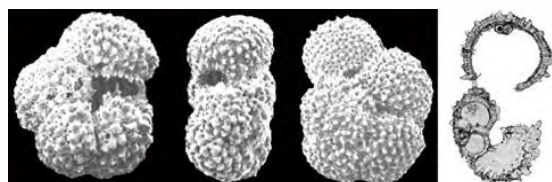
Acarinina bullbrookii



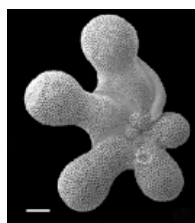
Guembeltrioides nuttalli=higginsii



Acarinina topilensis



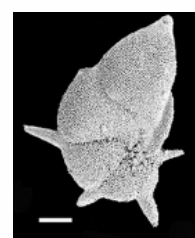
Acarinina rohri



Clavigerinella akersi



Clavigerinella eocanica



Hankenina dumblei

73

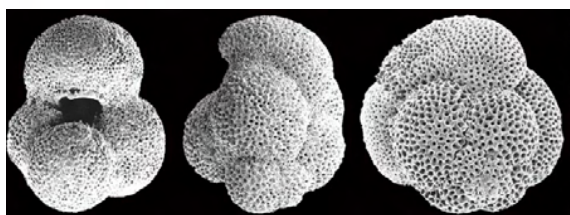


Eocene medio

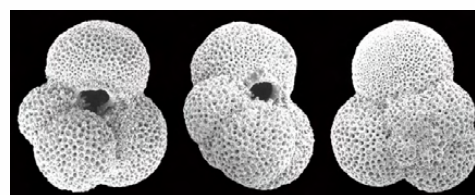
Zone E5-E13

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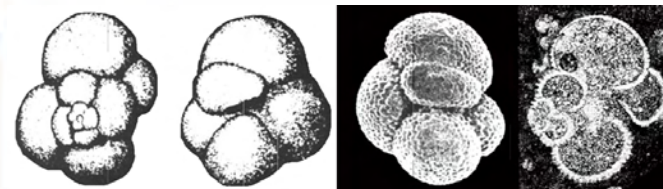
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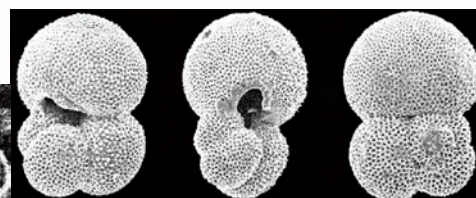
Subbotina gortanii



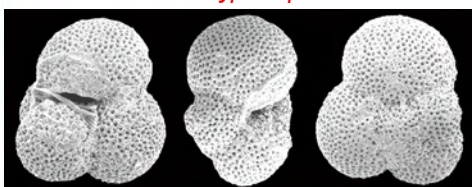
Subbotina eocaena



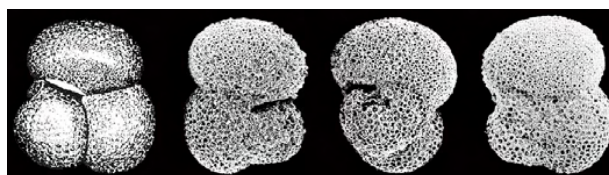
Subbotina cryptomphala



Subbotina cruciapertura



Subbotina eocaenica



Subbotina linaperta

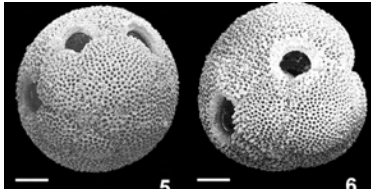
74



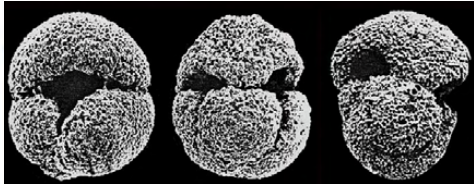
Eocene medio - superiore

Zone E8-E16

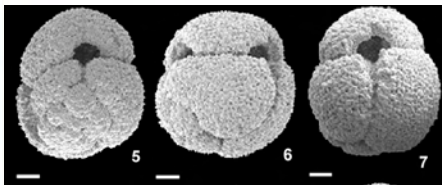
- Evoluzione *Globigerinatheka*



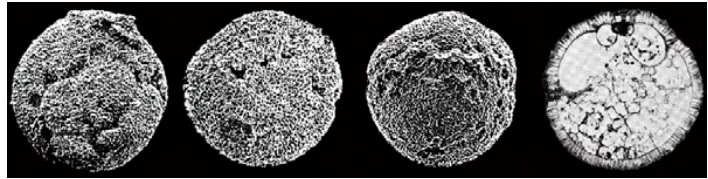
Globigerinatheka semiinvoluta



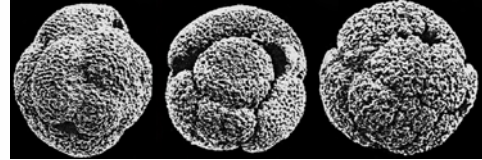
Globigerinatheka index



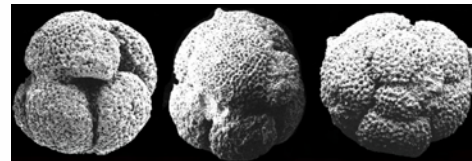
Globigerinatheka korotkovi



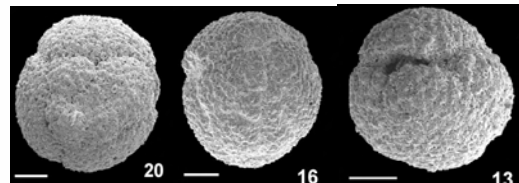
Orbulinoides beckmanni



Globigerinatheka euganea



Globigerinatheka curryi



Globigerinatheka subconglobata

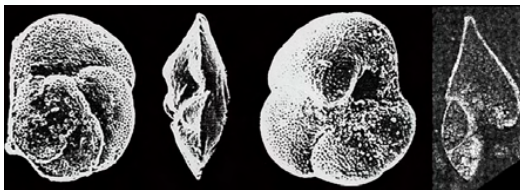
75



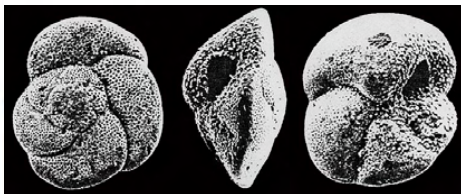
Eocene medio - superiore

Zone E7-E16

- Evoluzione *Turborotalia*



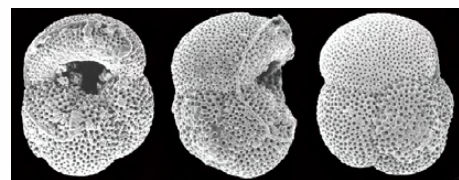
Turborotalia cunialensis



Turborotalia cocoaensis



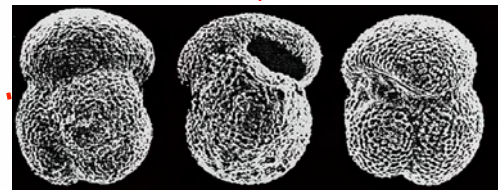
Turborotalia cerroazulensis



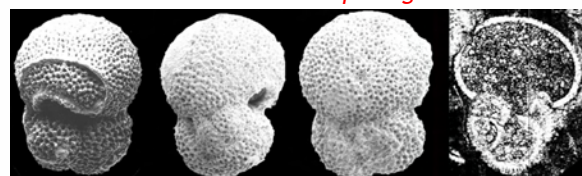
Turborotalia ampliapertura



Turborotalia pomeroli



Turborotalia possagnoensis



Turborotalia frontosa

76





Eocene superiore

Zone E14-E15-E16

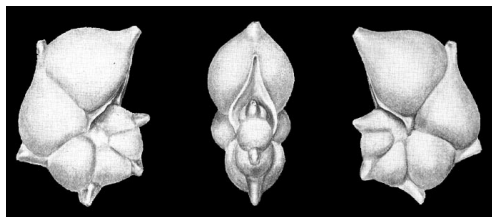
- maggiori estinzioni

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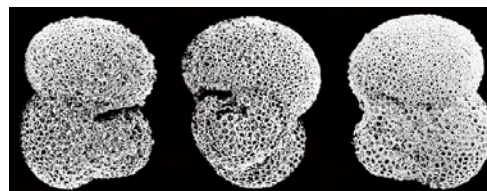
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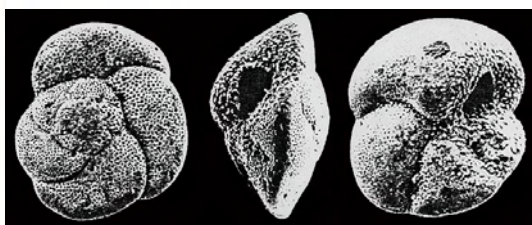
Pseudohastigerina
> 125 microns



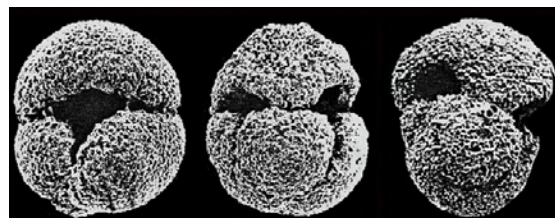
Hantkenina and Cribrohantkenina



Subbotina



Turborotalia



Globigerinatheka

77



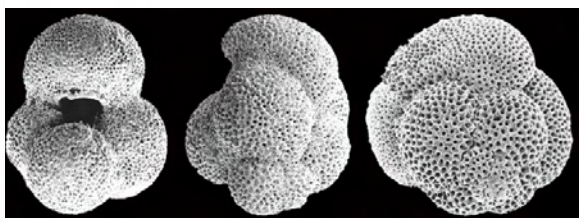
base Oligocene

Zona O1

- Taxa dell'Eocene che ritroviamo anche nell'Oligocene

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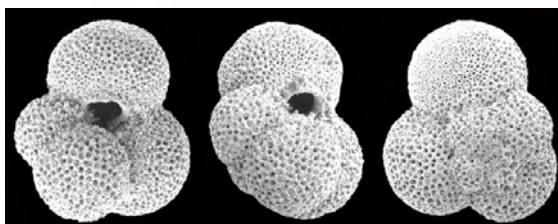
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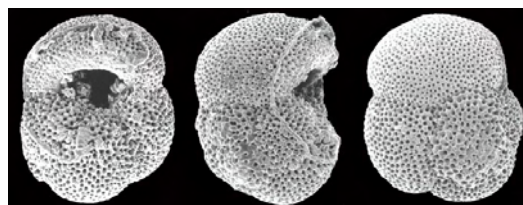
Subbotina gortanii



Chiloguembelina



Subbotina eocaena



Turborotalia ampliapertura

78

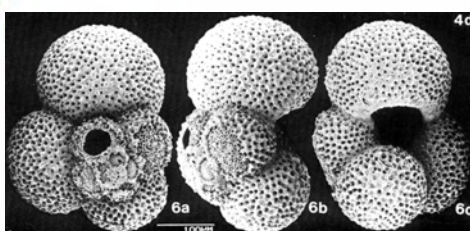


Oligocene inferiore

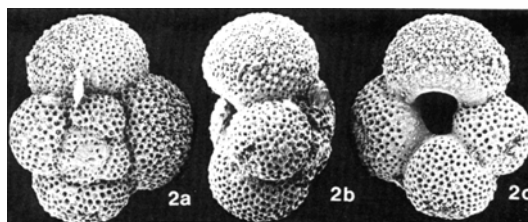
Zone 01- 02- 03- 04

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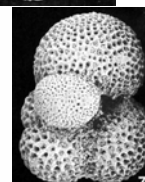
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Dipartimento di Scienze della Terra "A. Desio"



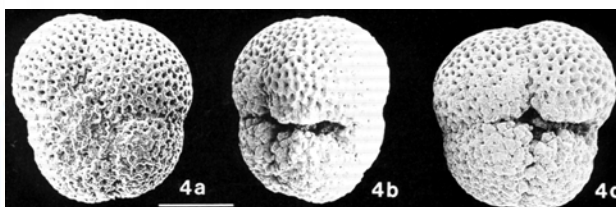
Globigerina praebulloides



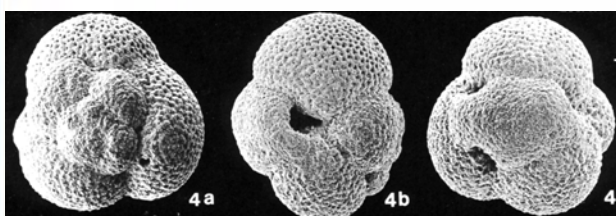
Globigerina officinalis



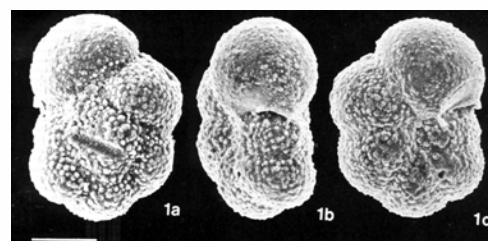
Catapsydrax martini



Paragloborotalia nana



Catapsydrax dissimilis



Tenuitella gemma
specie più fredde

79

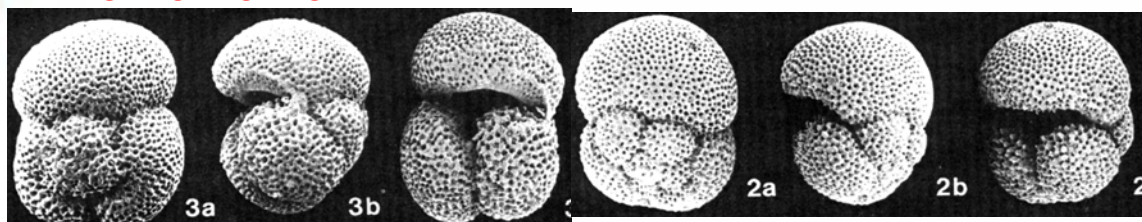


Oligocene inferiore

Zone 01- 02- 03- 04

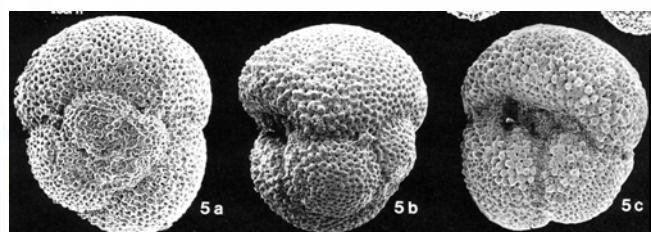
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UNIVERSITÀ DEGLI STUDI DI MILANO
Facoltà di Scienze e Tecnologie
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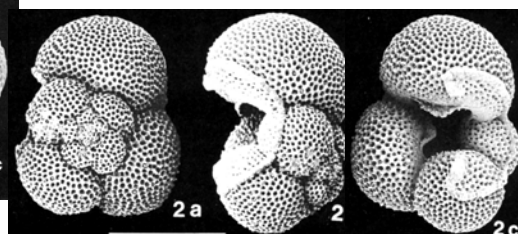


"Globoquadrina" tapuriensis

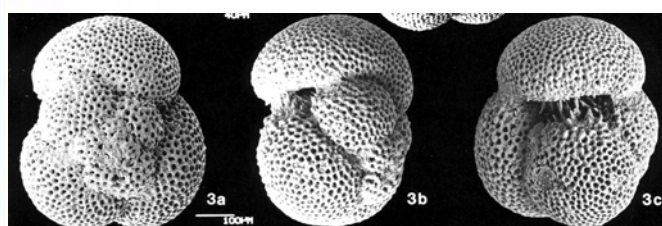
"Globoquadrina" tripartita



"Globoquadrina" sellii



Dentoglobigerina globularis



"Globigerina" venezuelana

specie più calde

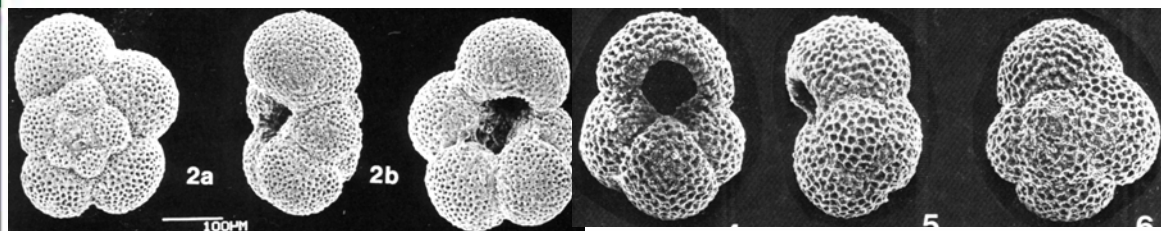
80



Oligocene medio

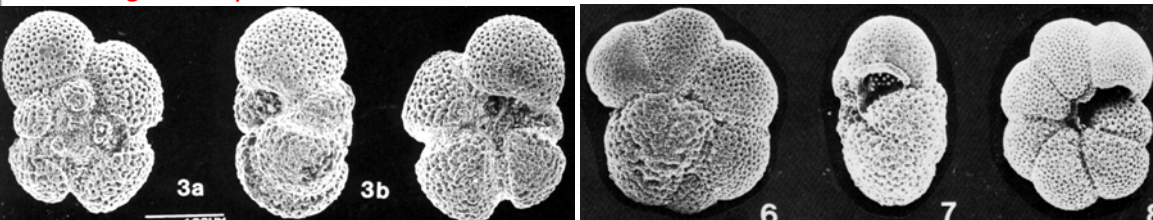
Zone 04- 05

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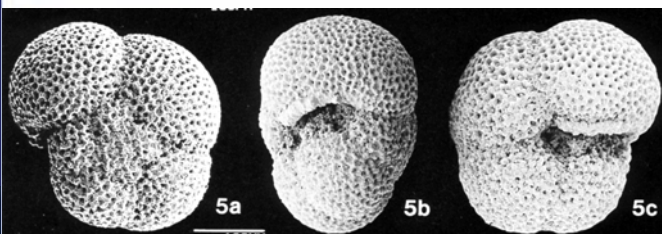
Globigerina ciperoensis

Globoturborotalita woodi



Globigerina angulisuturalis

Paragloborotalia siakensis



Paragloborotalia opima

aumento delle
specie più calde

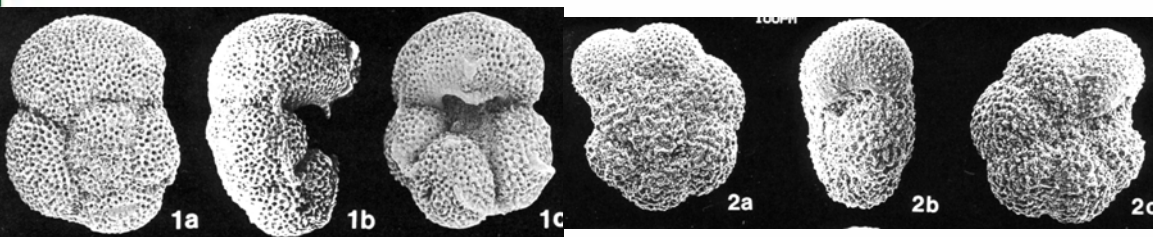
81



Oligocene superiore

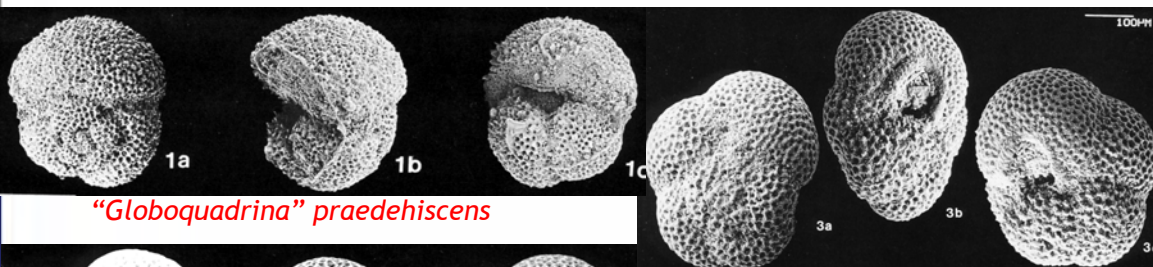
Zona 06

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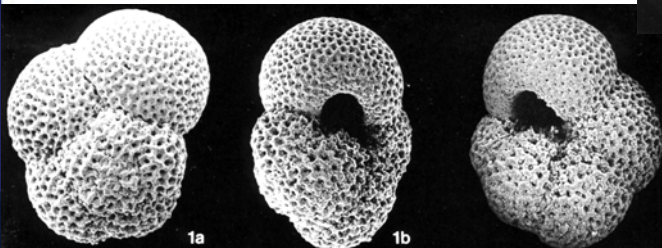
Dentoglobigerina baroemoenensis

"Paragloborotalia" pseudokugleri



"Globoquadrina" praedehiscens

Paragloborotalia acrostoma



Paragloborotalia semivera

aumento delle
specie più calde

82

