ISPRA Istituto Superiore per la Protezione e la Ricerca Ambientale
SERVIZIO GEOLOGICO D'ITALIA
Dipartimento Difesa del Suolo

SAPIENZA UNIVERSITÀ DI ROMA

ORDINE DEI GEOLOGI DEL LAZIO

Biostratigrafia: Eocene

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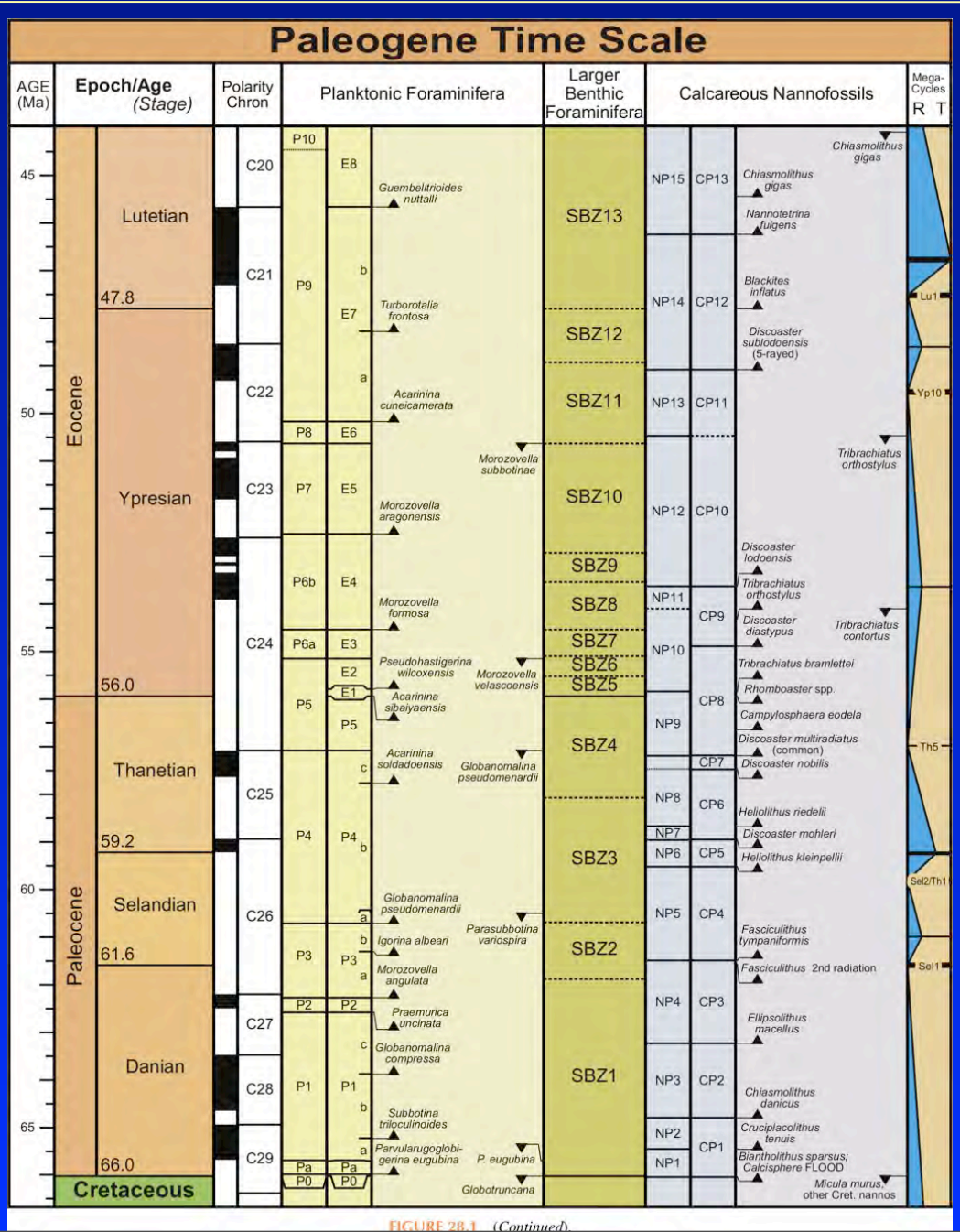
Outline

- SBZ in the Eocene
- Diversity and paleoclimate
- Decline of Paleogene LF

SBZ in the Eocene



Vandenberghe et al. (2012)

SBZ in the Eocene

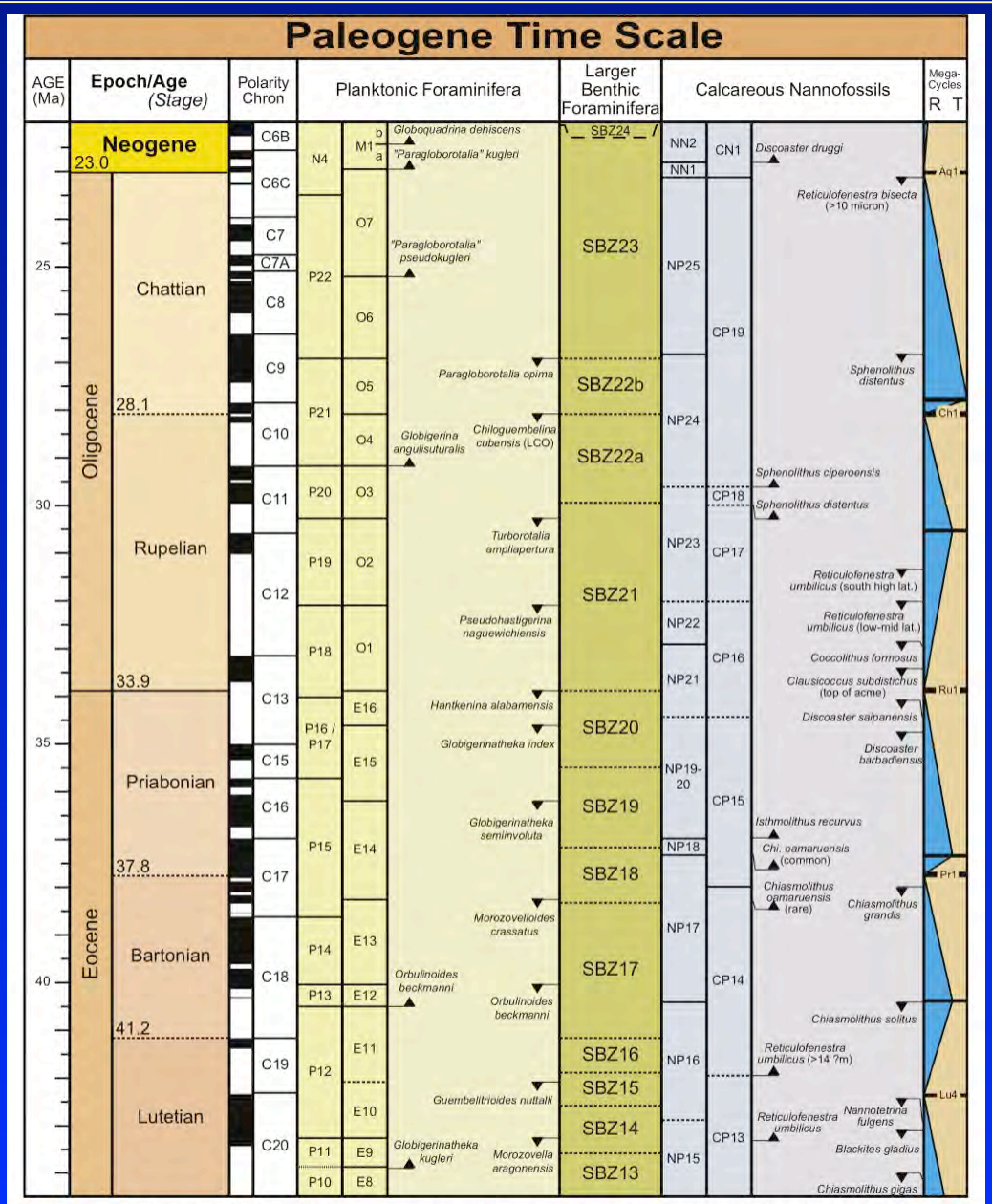


FIGURE 28.1 **Paleogene stratigraphic subdivisions, geomagnetic polarity scale, zonations of planktonic foraminifera, larger benthic foraminifera and calcareous nannofossils, and main trends in eustatic sea level**. Planktonic foraminiferal stratigraphy is modified from Wade *et al.* (2011), Tethyan zonation of larger benthic foraminifera is modified from Serra-Kiel *et al.* (1998), and the calcareous nannofossil stratigraphy is modified from tables in the Pacific Equatorial Age Transect (PEAT) program (Pälike *et al.*, 2010) with assistance of Paul Bown. The main Paleogene transgressive–regressive trends are

Vandenberghe et al. (2012)

SBZ in the Eocene

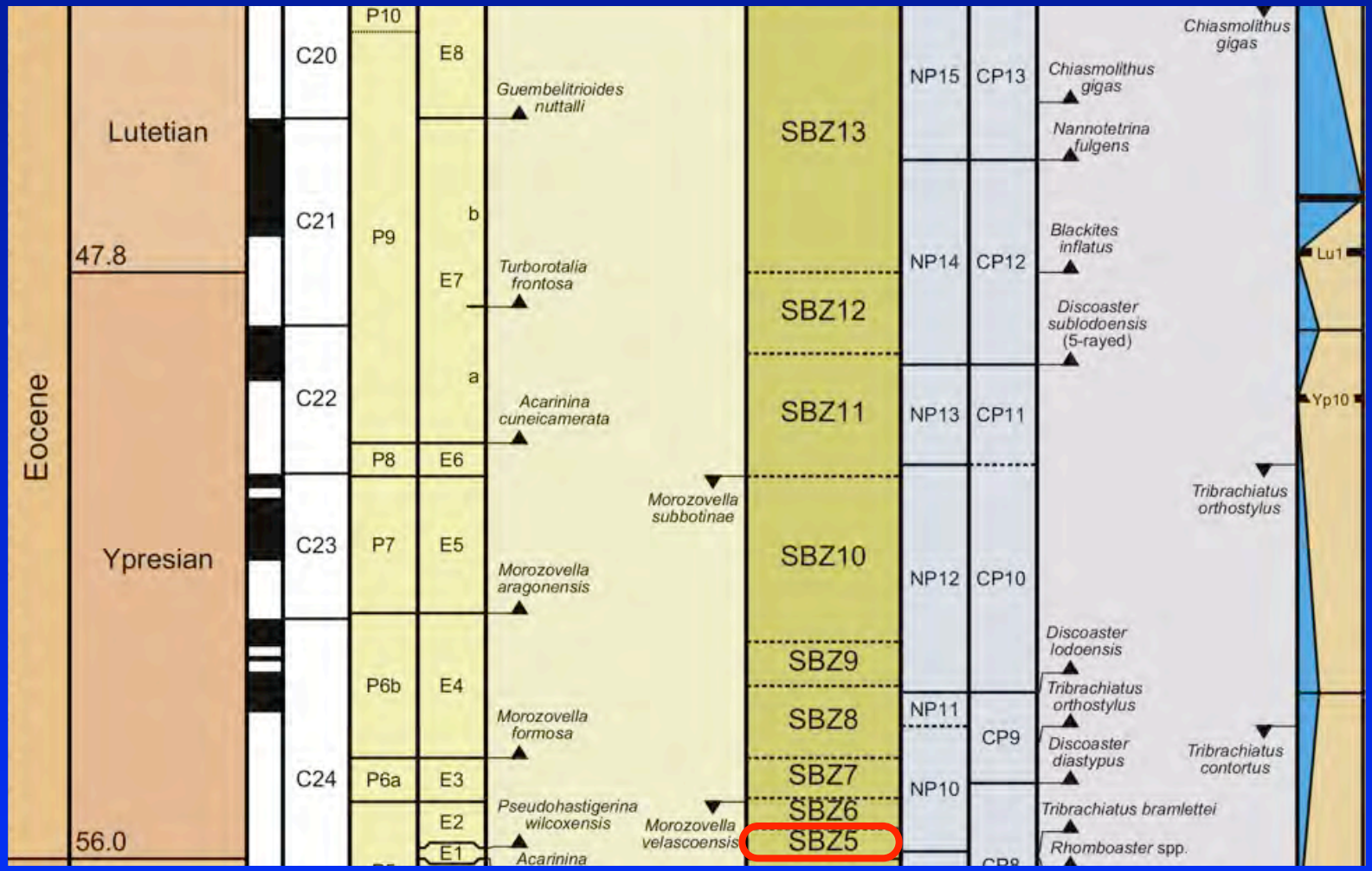
	Stage	Zonation	Larger Benthic Foraminifera
	Aquitanian	SBZ 24	*Miogypsina gr. gunteri / tani*
Oligocene	Chattian	SBZ 23	*Miogypsinoides, Lepidocyclinids, Nummulites bouillci*
		SBZ 22 ? b	*Lepidocyclinids, Nummulites vascus* — *Cycloclypeus*
	Rupelian	SBZ 22 ? a	*N. fichteli, N. bouillei* — *Bullalveolina*
		SBZ 21	*Nummulites vascus, N. fichteli*
Eocene	Priabonian	SBZ 20	*Nummulites retiatus, Heterostegina gracilis*
		SBZ 19	*Nummulites fabianii, N. garnieri, Discocyclina pratti minor*
	Bartonian	SBZ 18	*Nummulites biedai, N. cyrenaicus*
		SBZ 17	*Alveolina elongata, A. fragilis, A. fusiformis, Discocyclina pulcra baconica Nummulites perforatus, N. brogniarti, N. biarritzensis*
	Lutetian	SBZ 16	*Nummulites herbi, N. aturicus, Assilina gigantea, Discocyclina pulcra balatonica*
		SBZ 15	*Alveolina prorrecta, Nummulites millecaput, N. travertensis*
		SBZ 14	*Alveolina munieri, Nummulites beneharnensis, N. boussaci, Assilina spira spira*
		SBZ 13	*Alveolina stipes, Nummulites laevigatus, N. uranensis*
	Ypresian — Cuisian	SBZ 12	*Alveolina violae, N. manfredi, N. campesinus, N. caupennensis, Assilina major, A. cuvillieri*
		SBZ 11	*Alveolina cremae, A. dainellii, Nummulites praelaevigatus, N. nitidus, N. archiaci, Assilina laxispira*
		SBZ 10	*Alveolina schwageri, A. indicatrix, Nummulites burdigalensis burdigalensis, N. planulatus, Assilina placentula, Discocyclina archiaci archiaci*
	Ypresian — Ilerdian	SBZ 9	*Alveolina trempina, Nummulites involutus, Assilina adrianensis*
		SBZ 8	*Alveolina corbarica, Nummulites exilis, N. atacicus, Assilina leymeriei*
		SBZ 7	*Alveolina moussoulensis, Nummulites praecursor, N. carcasonensis*
		SBZ 6	*Alveolina ellipsoidalis, A. pasticillata, Nummulites minervensis*
		SBZ 5	*Orbitolites gracilis, Alveolina vredenburgi, Nummulites gamardensis*
Paleocene	Thanetian	SBZ 4	*Glomalveolina levis, Nummulites catari, Assilina yvettae*
	Selandian	SBZ 3	*Glomalveolina primaeva, Fallotella alavensis, Miscellanea yvettae*
		SBZ 2	*Miscellanea globularis, Ornatononion minutus, Paralockhartia eos, Lockhartia akbari*
	Danian	SBZ 1	*Bangiana hanseni, Laffitteina bibensis*

FIGURE 28.8 Paleogene zonation of larger benthic foraminifera with selected taxa.

Vandenberghe et al. (2012)

SBZ in the Eocene

Base of the Eocene: appearance of *Alveolina* s.s.: SBZ 5



SBZ in the Eocene

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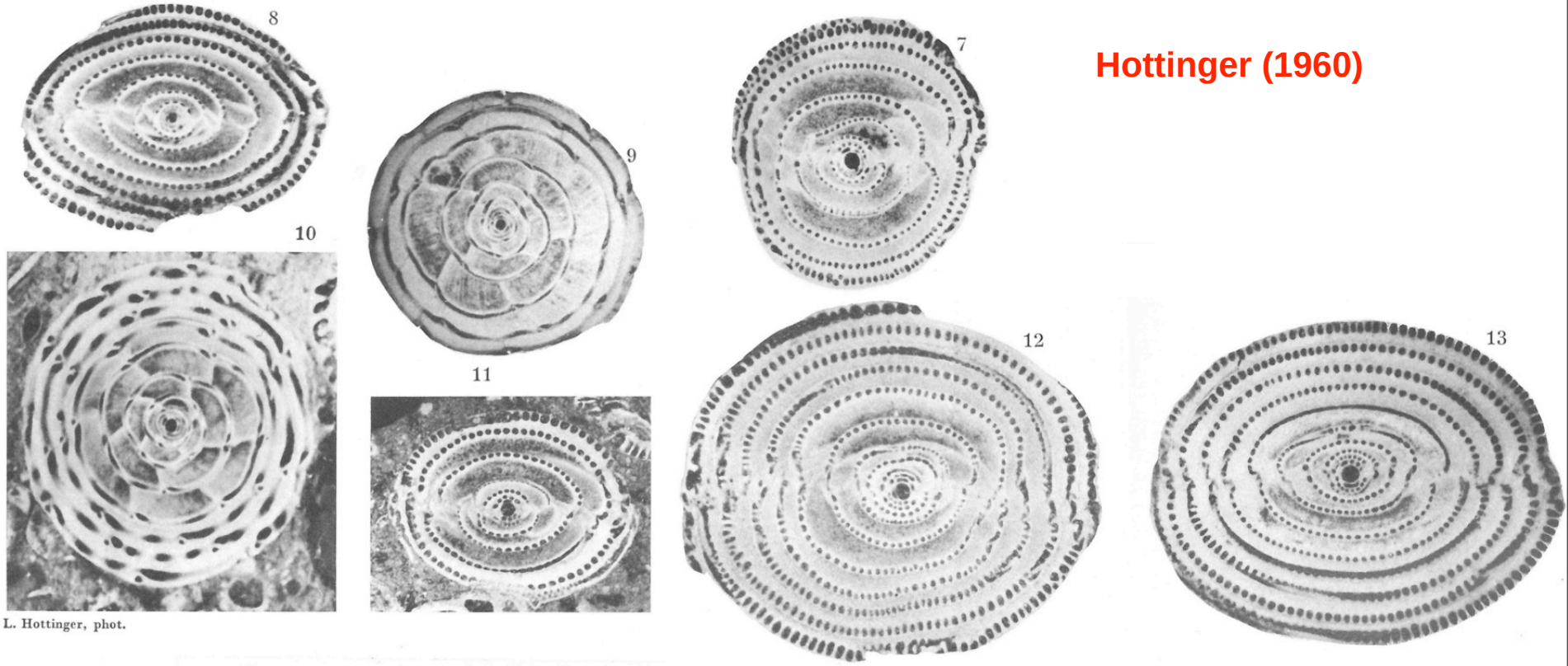
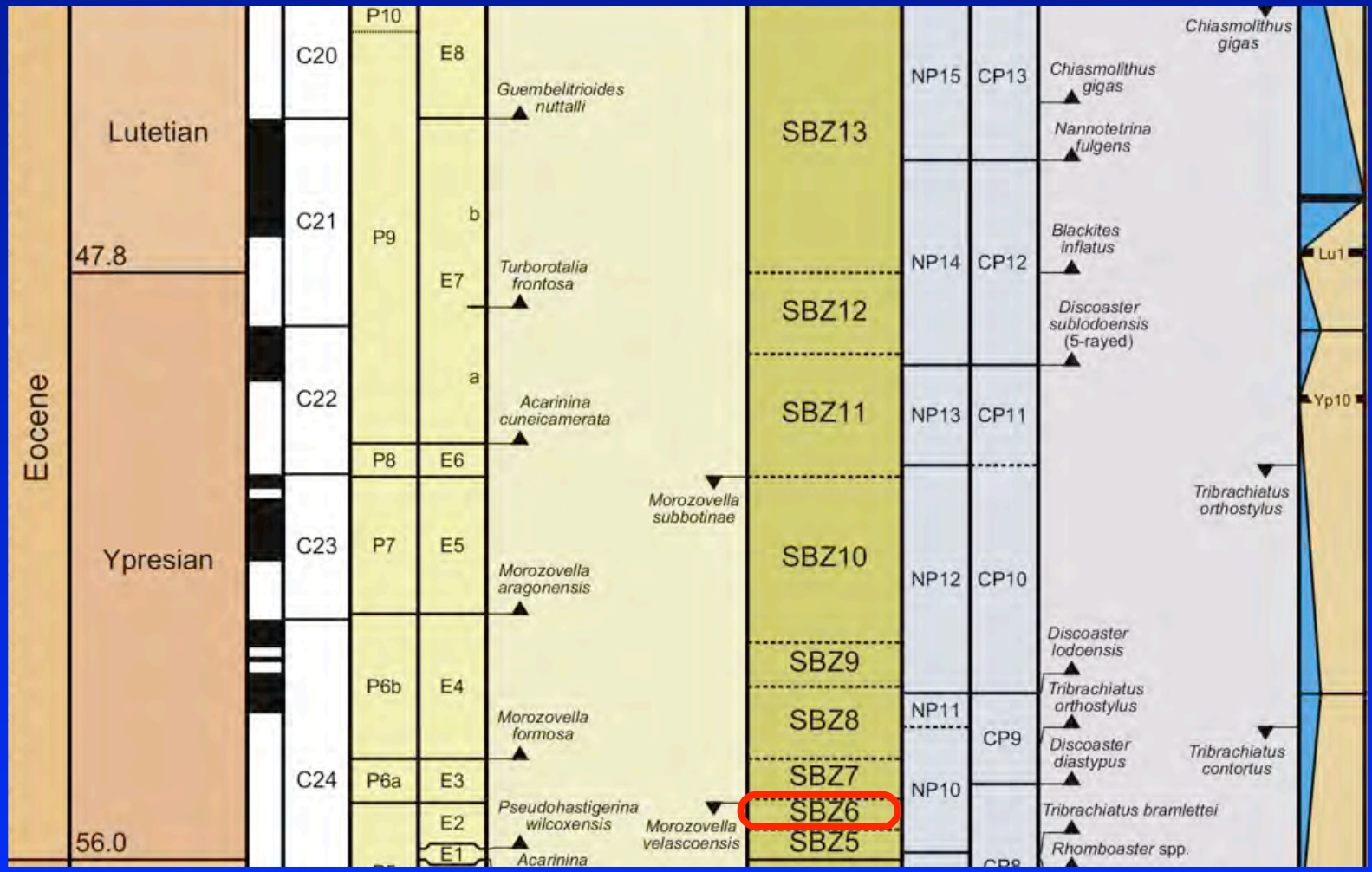


Hottinger (1960)

Alveolina avellana avellana

SBZ in the Eocene

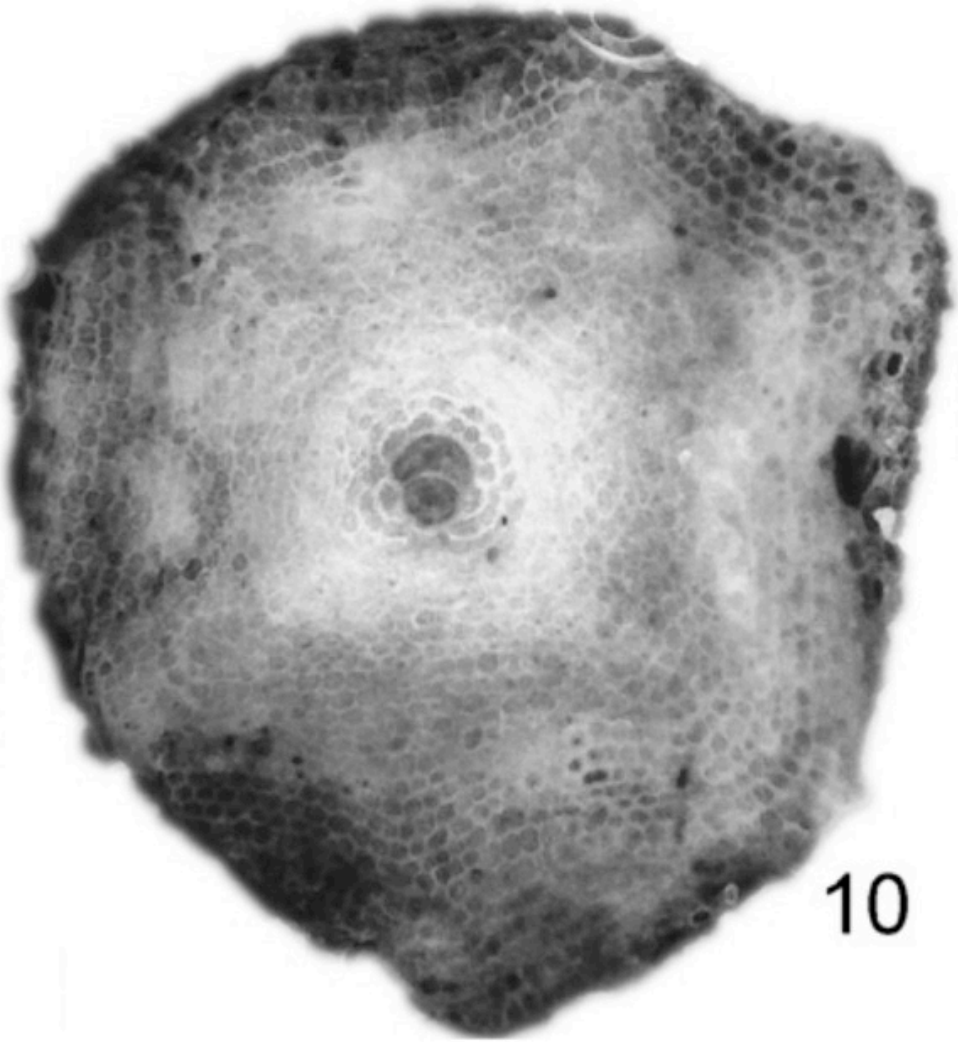
Appearance of *Asterocyclina*: SBZ 6

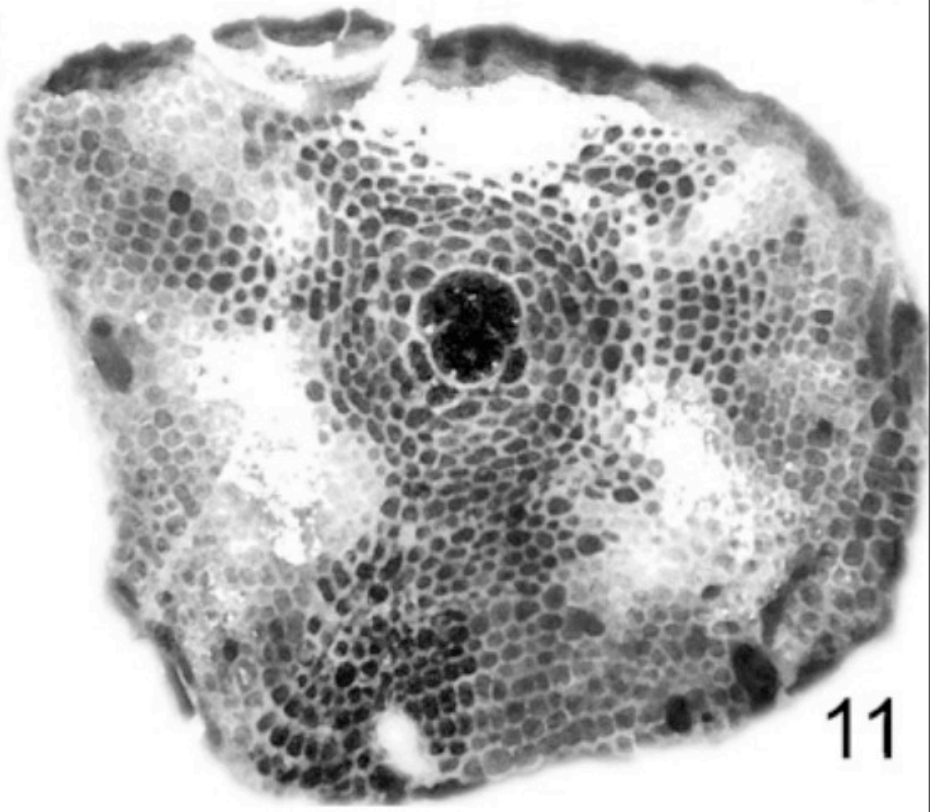


SBZ in the Eocene

Appearance of *Asterocyclina*: SBZ 6

Less & O'Kovacs (2009)

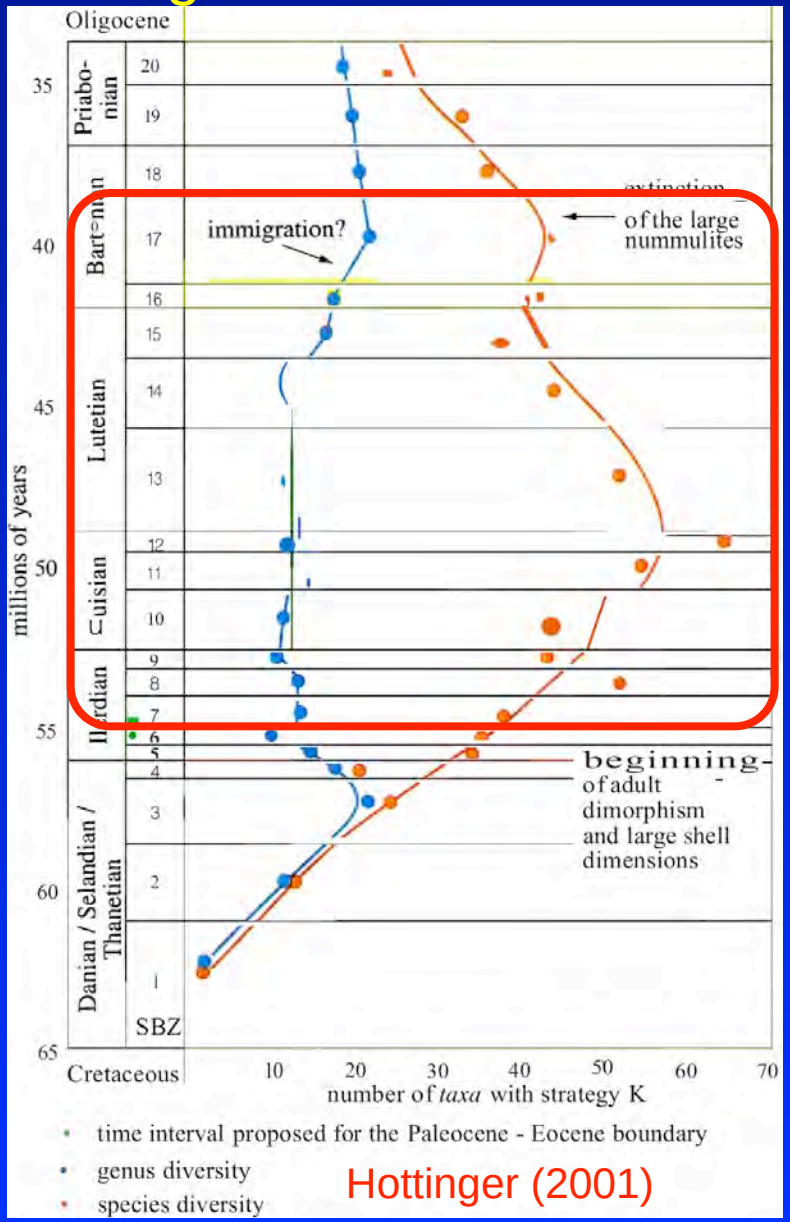




Asterocyclina taramellii

SBZ in the Eocene

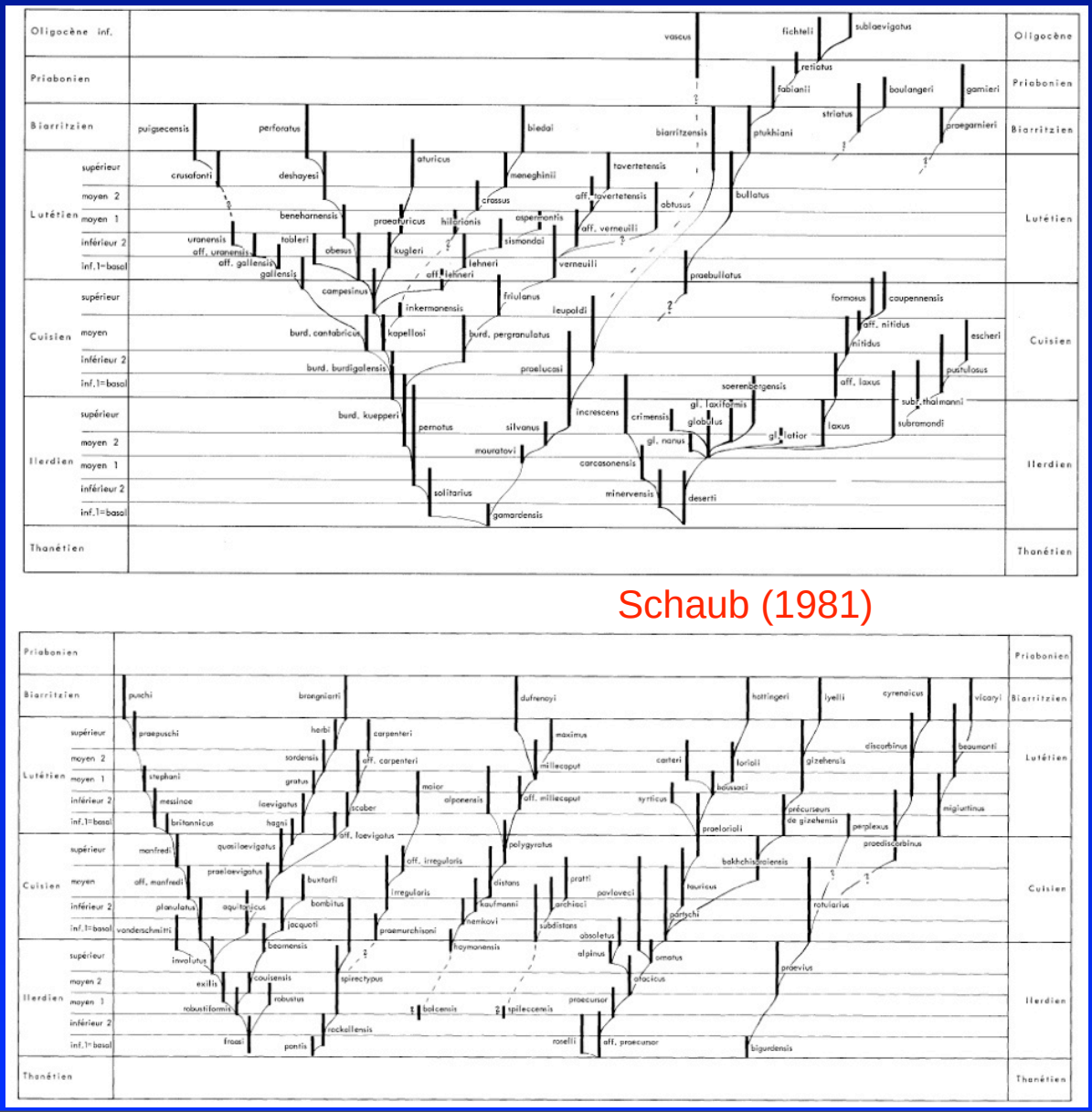
A long interlude: SBZ 7-17



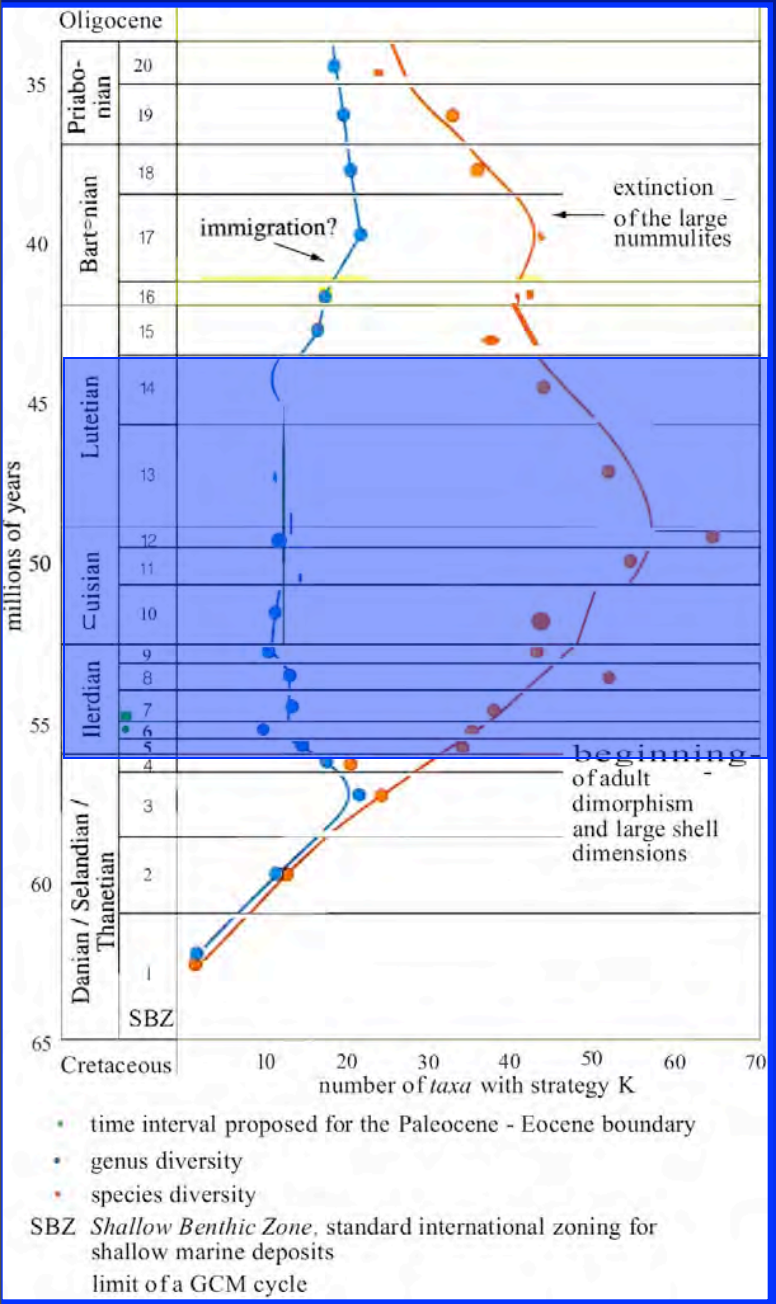
Hottinger (2001)

SBZ in the Eocene

A long interlude: SBZ 8-17



Diversity and paleoclimate



From genera radiation to species radiation

From Paleocene to Early-Middle Eocene: specific biodiversity increases.

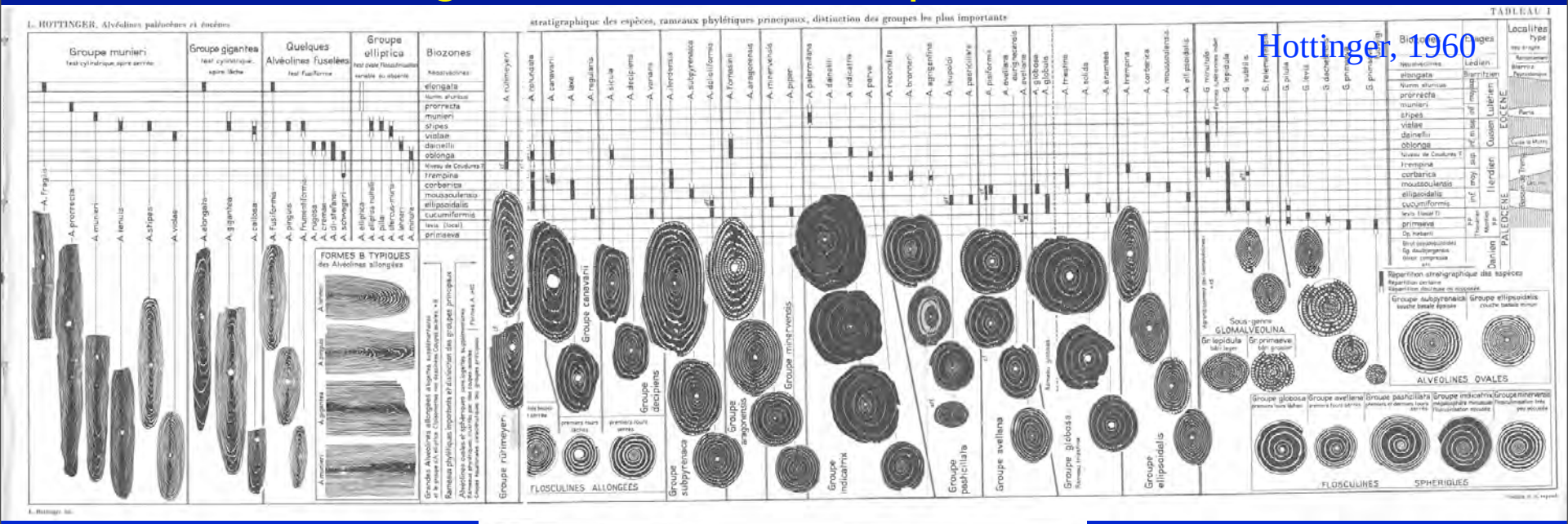
Global Community Maturation: Phases in a Cycle for K-strategist Foraminifera

PERIOD	PHASE	PRINCIPAL TENDENCIES	SALIENT ASPECTS[a]
Event at the Eocene-Oligocene boundary			Extinction of the planktonic foraminifera and of the orthophragminiforms Survival of the neritic benthos K strategist
Priabonian	3 (?)	Success of the competition	Appearance of new genera *(Spiroclypeus?)* together with the older ones
Late Bartonian	2 (?)	Progress of the competition	Insurgence of new genera; *Operculina alpina* dominates New competitors: *Pellatispira, Biplanispira, Heterostegina*
Lower Bartonian (Biarritzian)	5	Removal of competitors	Diminution of species diversity, increase of specific endemism; frequent monospecific endemism of species of large size
Lutetian, Cuisian, Upper Ilerdian	4	Size increase	Parallel evolution of diversified evolutionary lines; development of odd pairs; classes of over 10 cm size reached
Lower Ilerdian	3	Complete success	Diversification of the successful genera of different species; success of *Alveolina, Orbitolites, Assilina, Nummulites*, orthophragminiforms
Upper Paleocene	2	Experimentation of new life strategies	Increase in generic diversity and reduction of endemism; about 40 species of smaller size with complex structure
Lower Paleocene	1	Preparation of K strategy	No phenotypic response or no K strategy (?) No larger form No complex structure (?)
Event at the Cretaceous-Tertiary boundary			Extinction of the K strategist form; survival of the deep benthos and, in shallow waters, of *Laffitteina*

[a] Question marks indicate uncertain aspects.

Diversity and paleoclimate

From genera radiation to species radiation



Hottinger, 1960

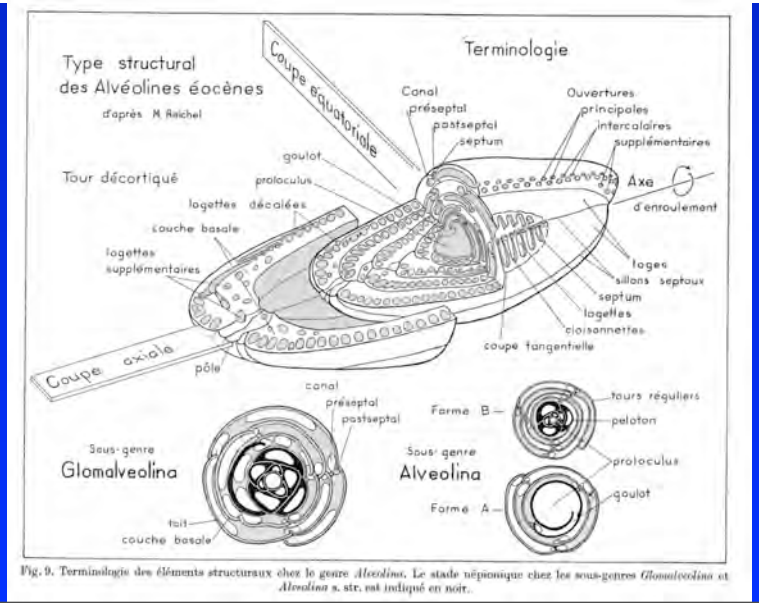
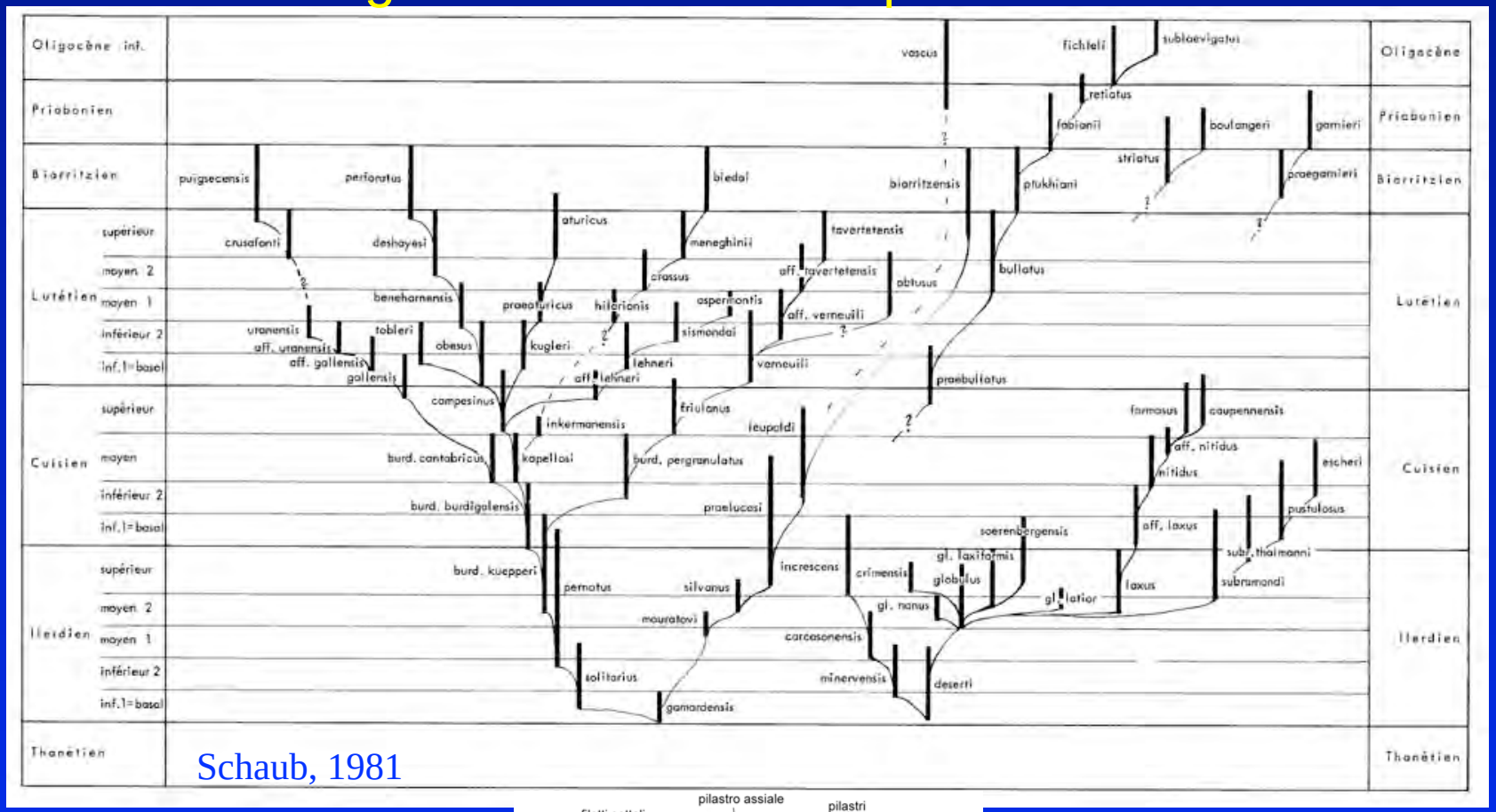


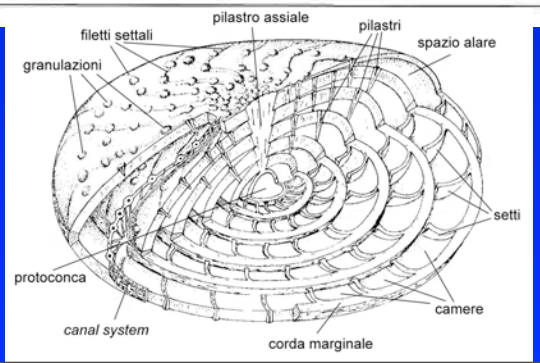
Fig. 9. Terminologie des éléments structuraux chez le genre *Alveolina*. Le stade néanique chez les sous-genres *Glomalveolina* et *Alveolina* s. str. est indiqué en noir.

Diversity and paleoclimate

From genera radiation to species radiation

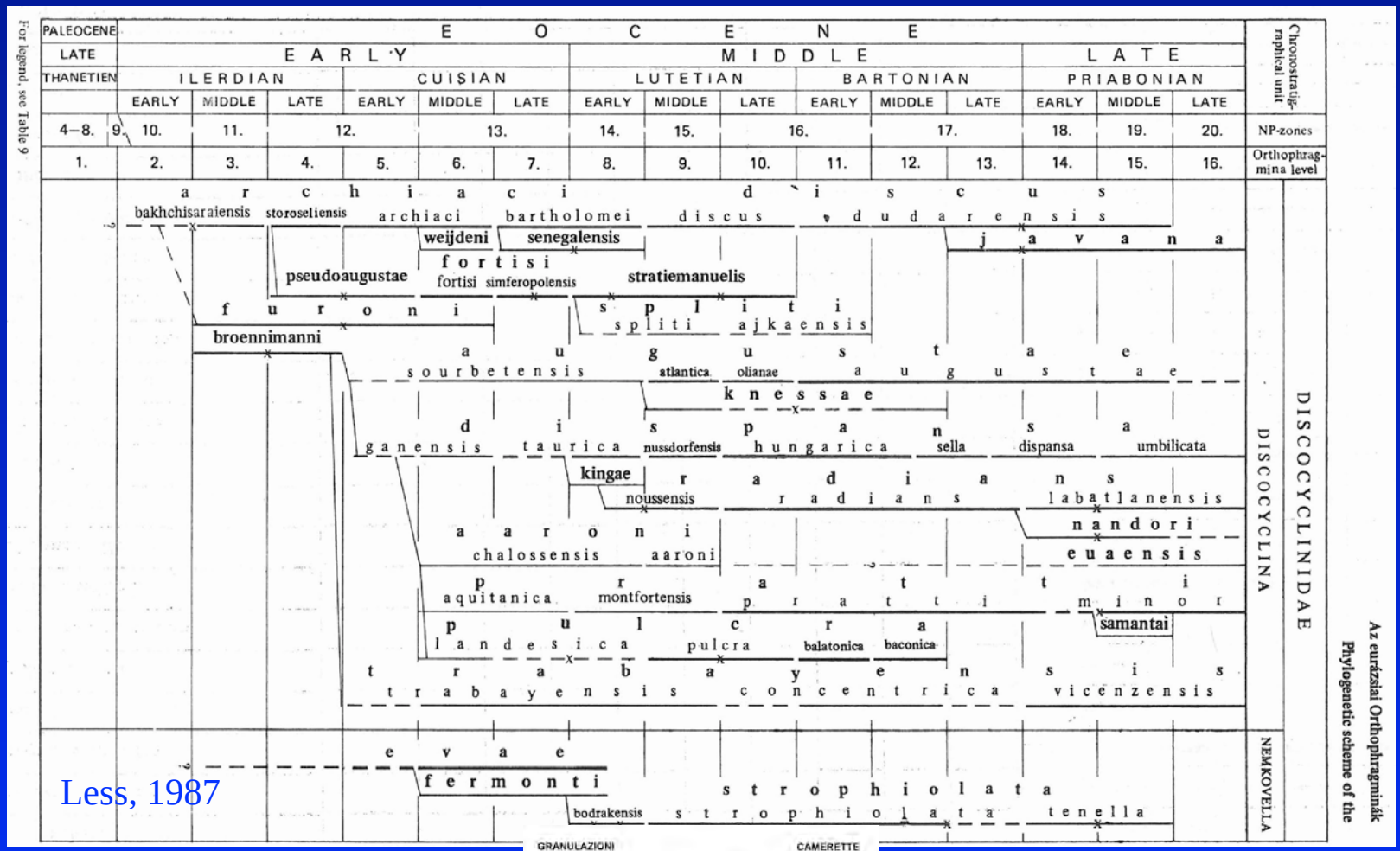


Schaub, 1981

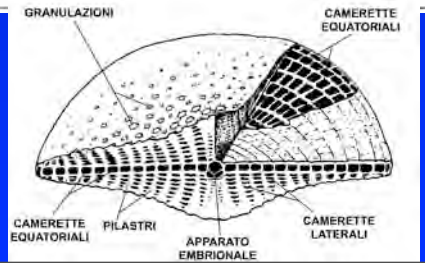


Diversity and paleoclimate

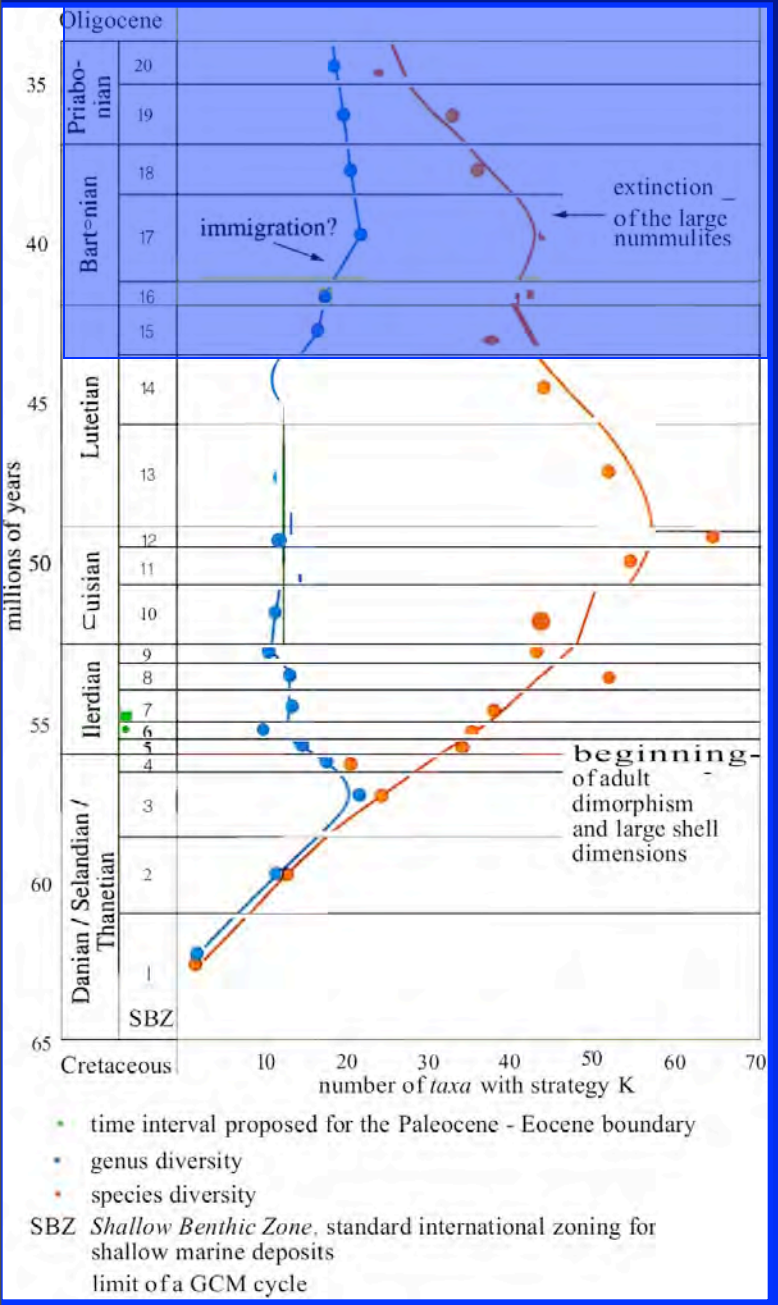
From genera radiation to species radiation



Less, 1987



Diversity and paleoclimate



Reduction and decline of LBF

From Middle Eocene on:
specific biodiversity decrease .

Global Community Maturation: Phases in a Cycle for K-strategist Foraminifera

PERIOD	PHASE	PRINCIPAL TENDENCIES	SALIENT ASPECTS[a]
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Reduction and decline of LBF

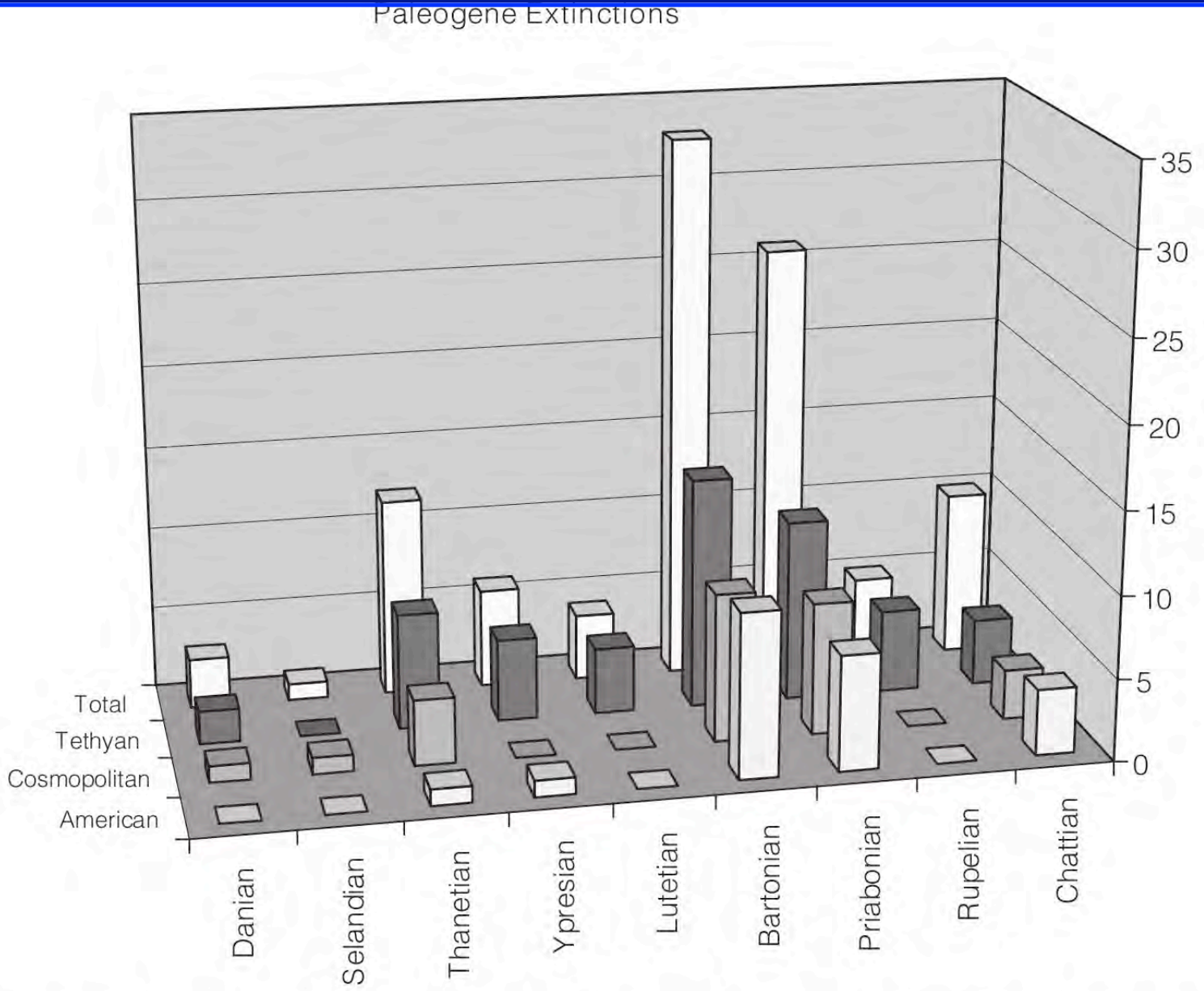
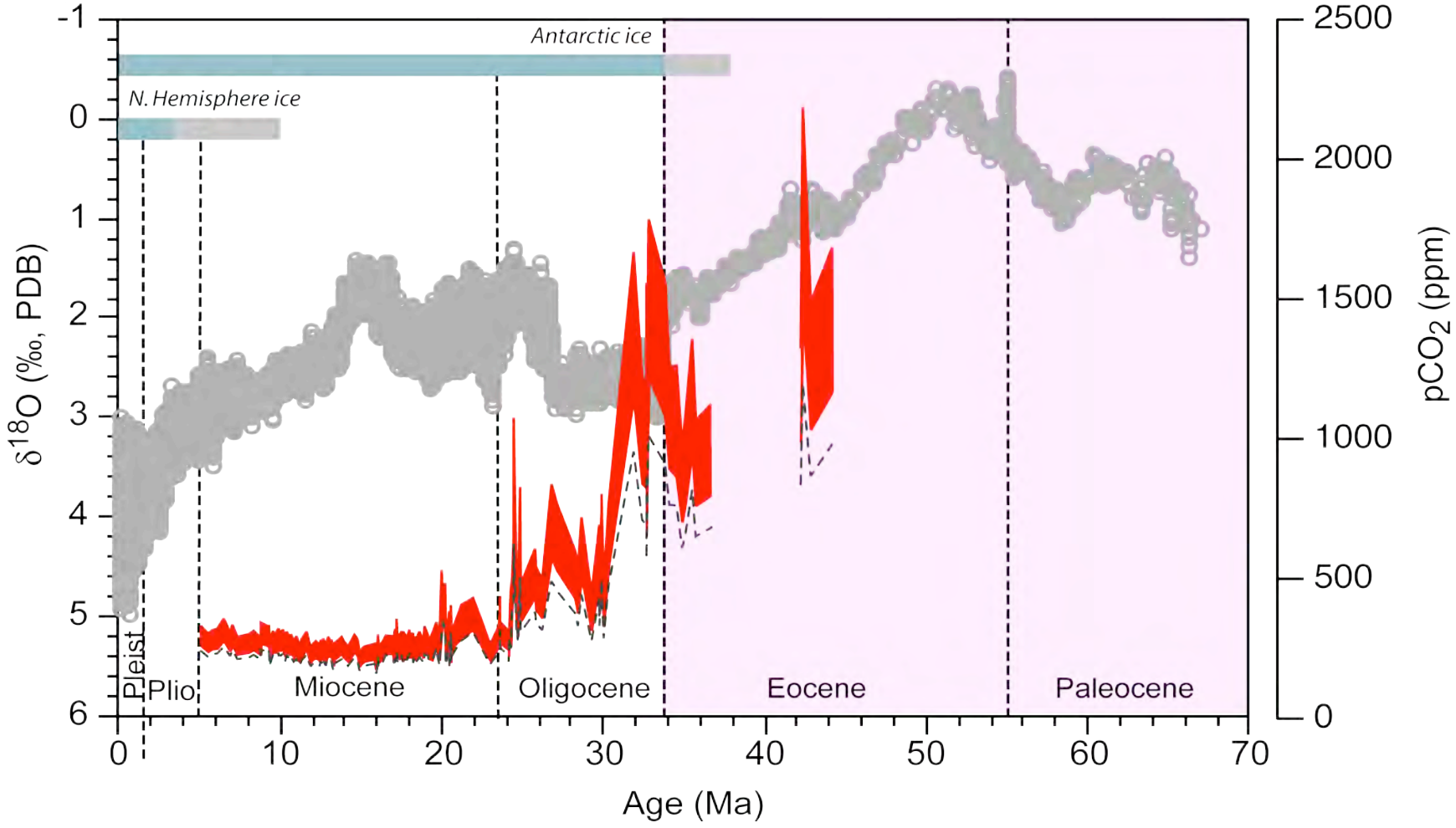
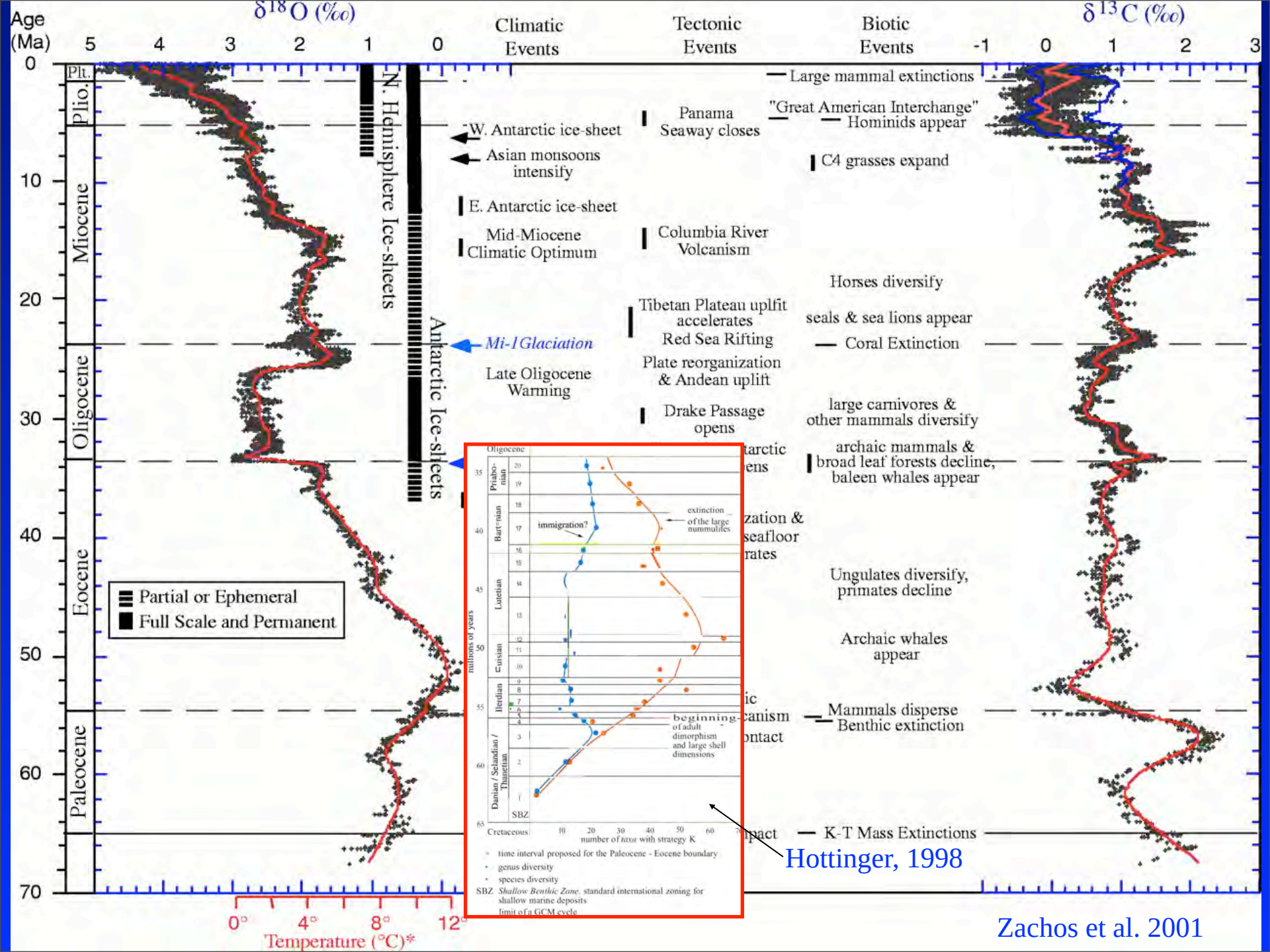
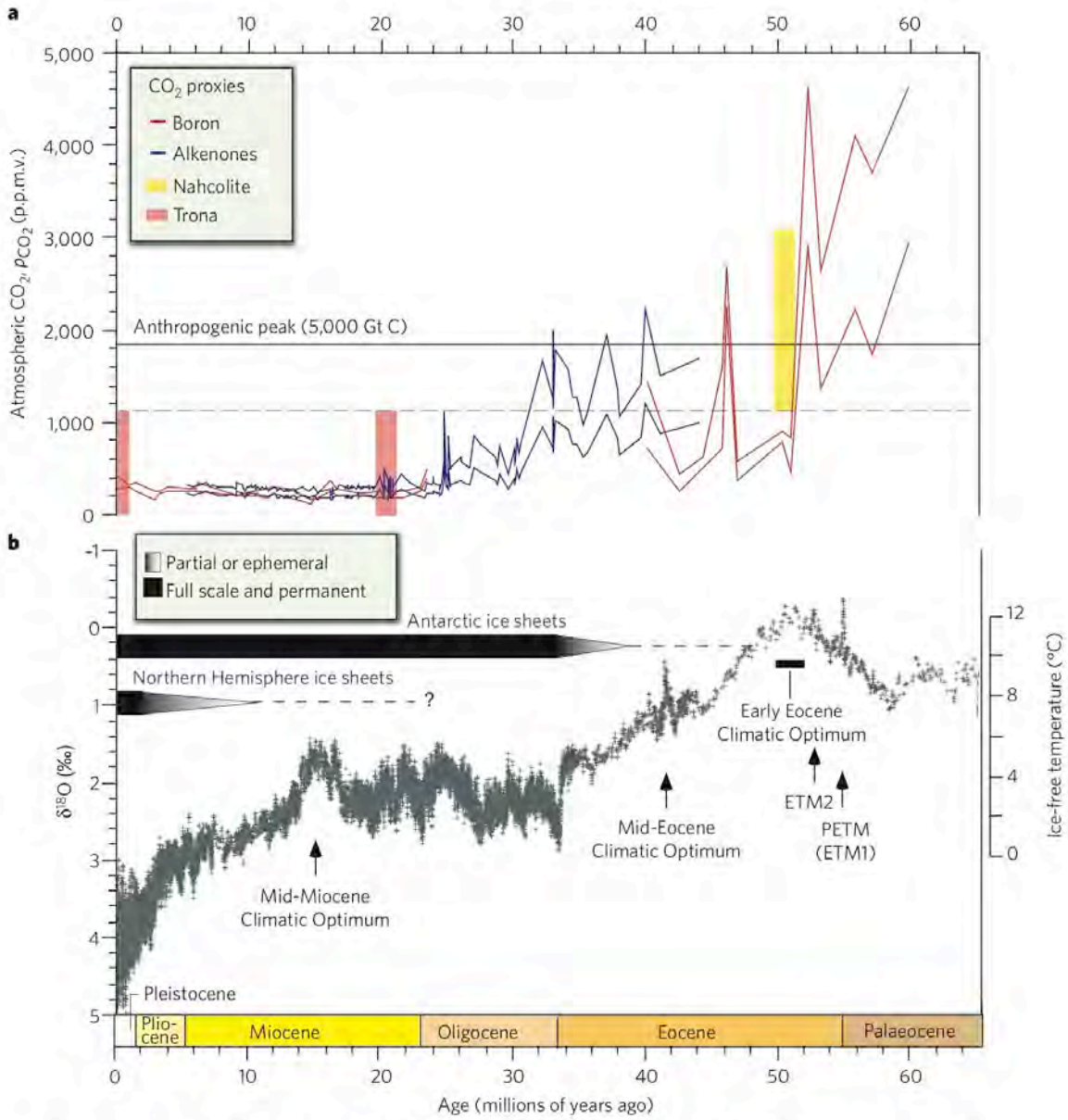


Figure 6.33. The number of larger foraminifera genera becoming extinct at the top of each Palaeogene stage boundary.

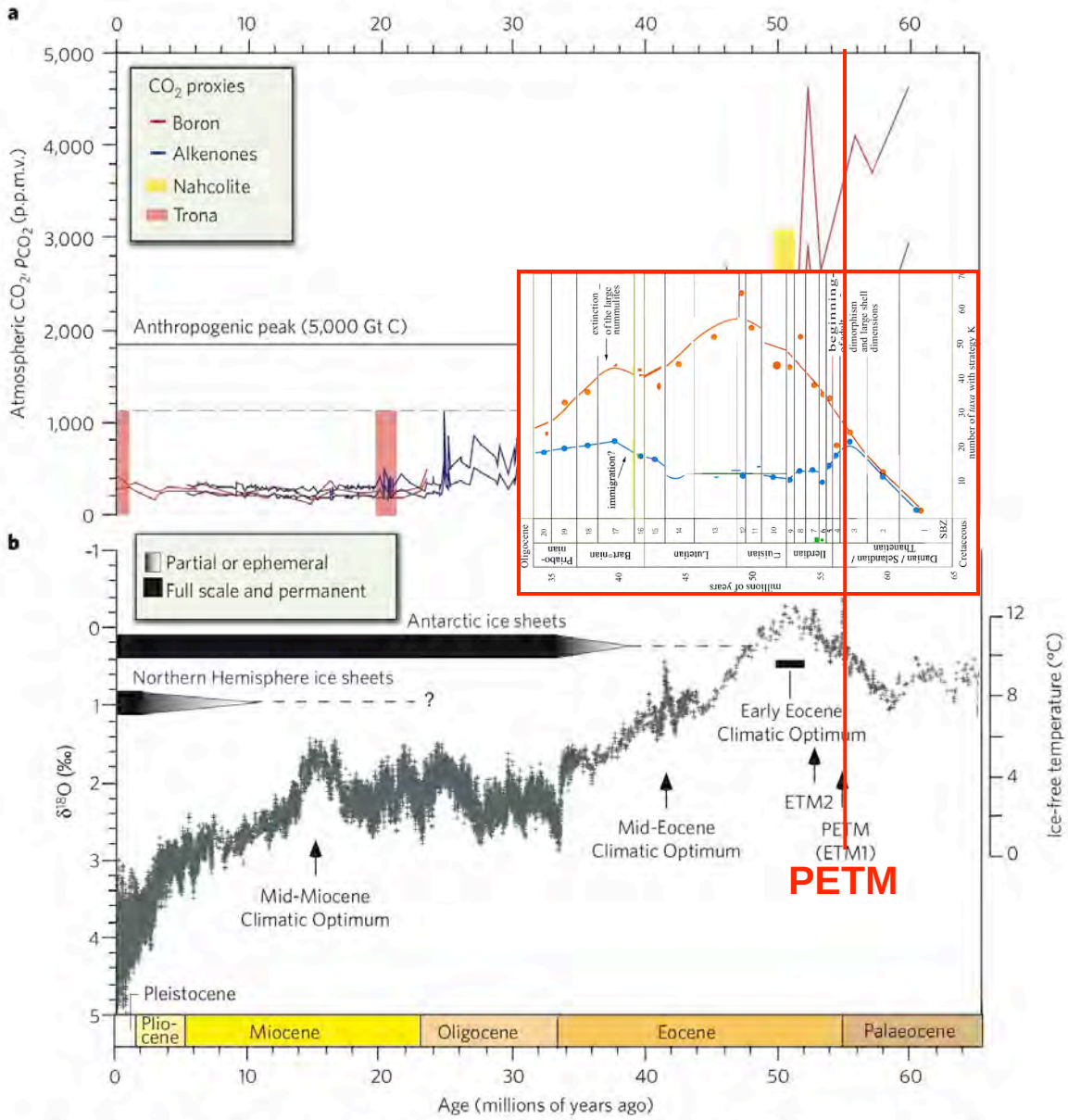
CO_2 concentrations and climate during Cenozoic




Age (Ma)
δ18O (‰)
Climatic Events
Tectonic Events
Biotic Events
δ13C (‰)
Plio.
Miocene
Oligocene
Eocene
Paleocene
N. Hemisphere Ice-sheets
Antarctic Ice-sheets
W. Antarctic ice-sheet
Asian monsoons intensify
E. Antarctic ice-sheet
Mid-Miocene Climatic Optimum
Mi-1 Glaciation
Late Oligocene Warming
Panama Seaway closes
Columbia River Volcanism
Tibetan Plateau uplift accelerates
Red Sea Rifting
Plate reorganization & Andean uplift
Drake Passage opens
Large mammal extinctions
"Great American Interchange"
Hominids appear
C4 grasses expand
Horses diversify
seals & sea lions appear
Coral Extinction
large carnivores & other mammals diversify
archaic mammals & broad leaf forests decline, baleen whales appear
Ungulates diversify, primates decline
Archaic whales appear
Mammals disperse
Benthic extinction
K-T Mass Extinctions
Partial or Ephemeral
Full Scale and Permanent
Temperature (°C)*
Hottinger, 1998
Zachos et al. 2001



Evolution of atmospheric CO2 levels and global climate over the past 65 Ma. a) Cenozoic pCO2 for the period 0 to 65 Ma ago; b) The climate for the same period, mainly reconstructed by means of ∂18O. After Zachos et al., 2008, Nature, 451, pp. 279-283.



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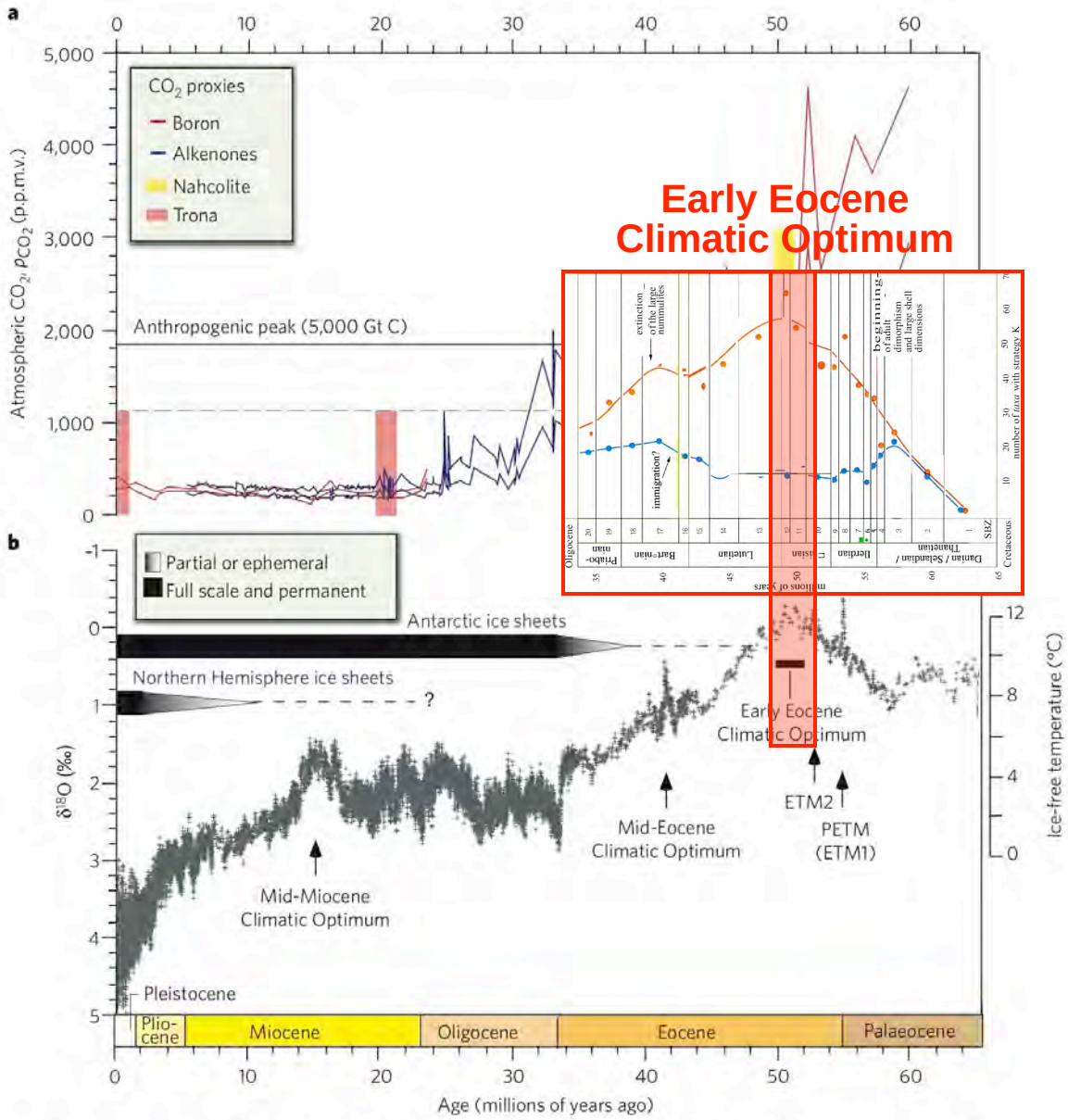

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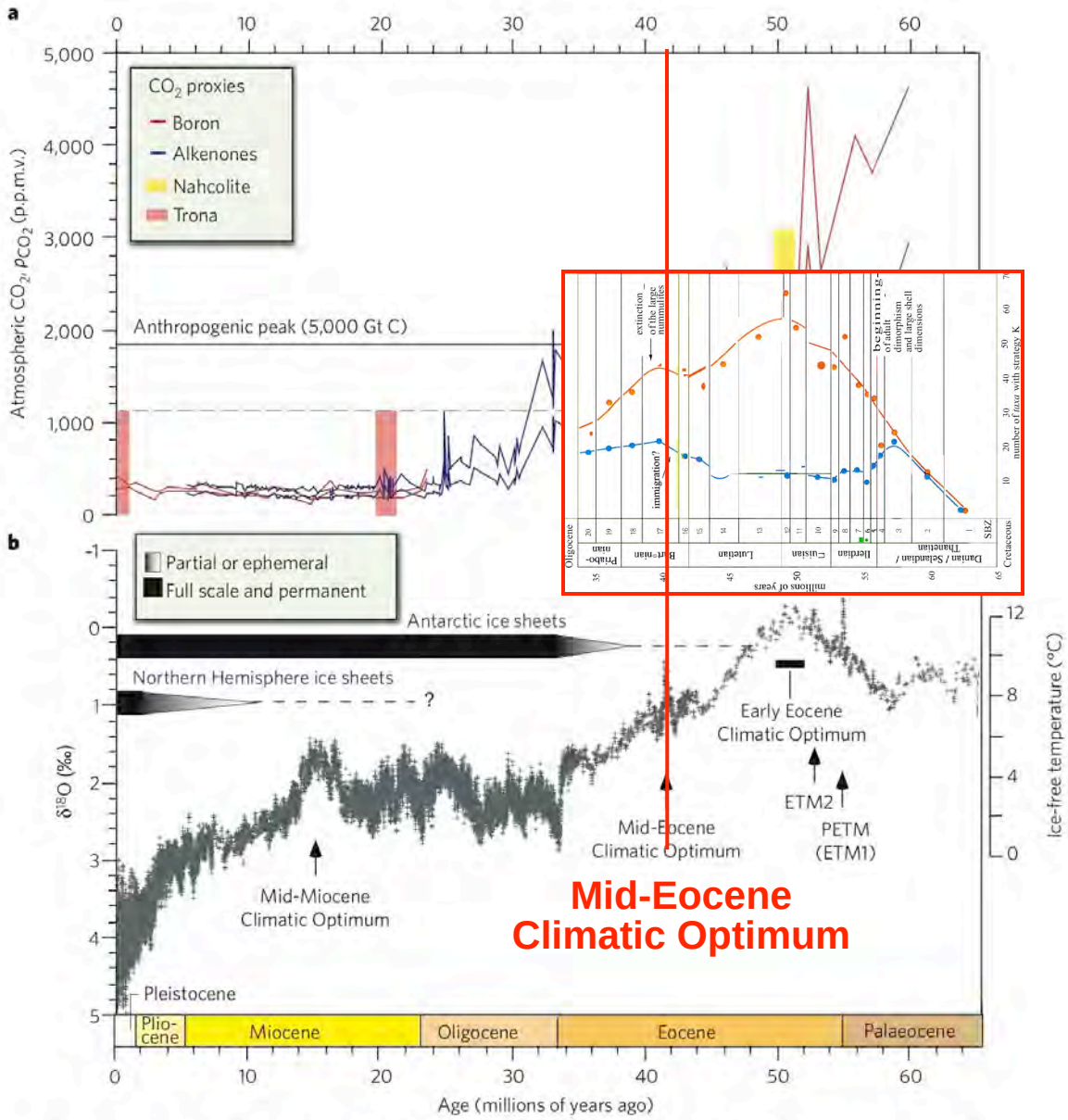

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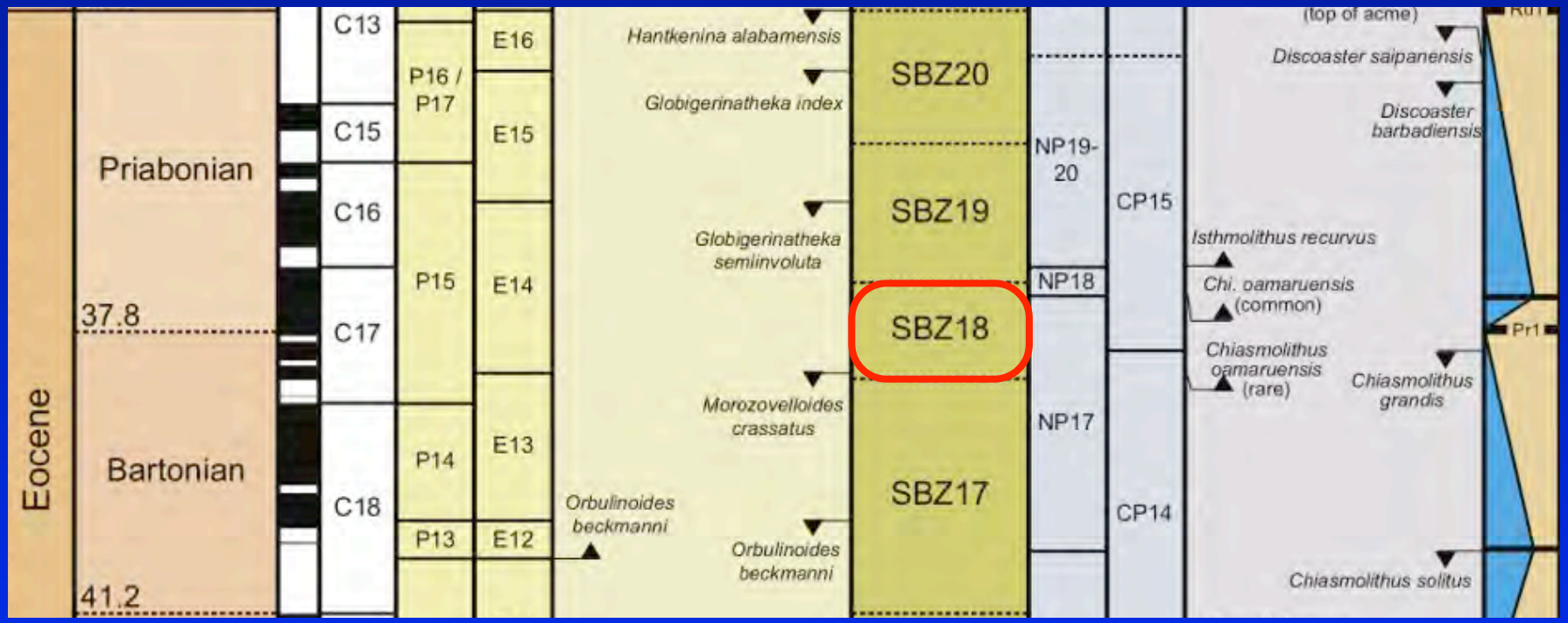
Decline of Paleogene LF

Extinction of large *Assilina* and *Alveolina* s.s.
Appearance of *Heterostegina*: SBZ 18



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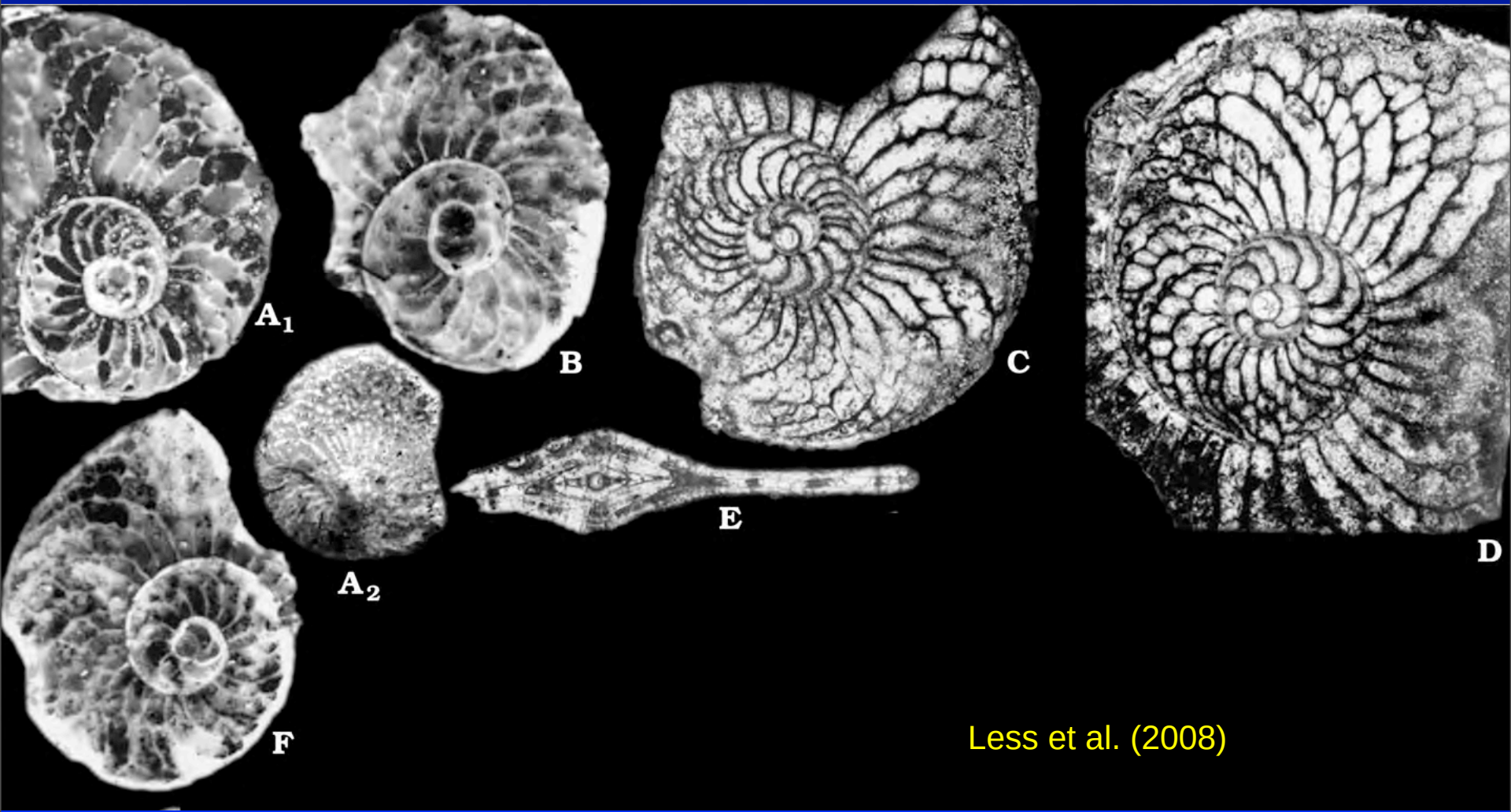
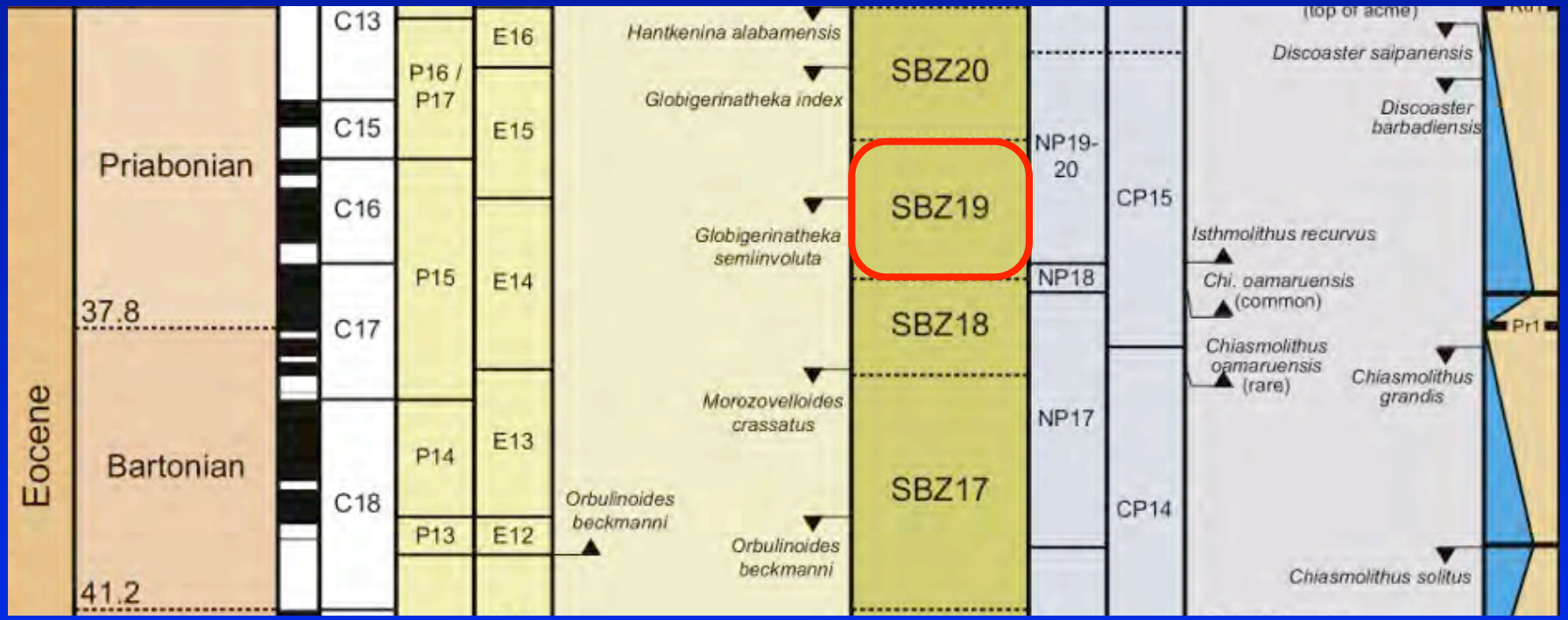


Less et al. (2008)

Heterostegina armenica armenica

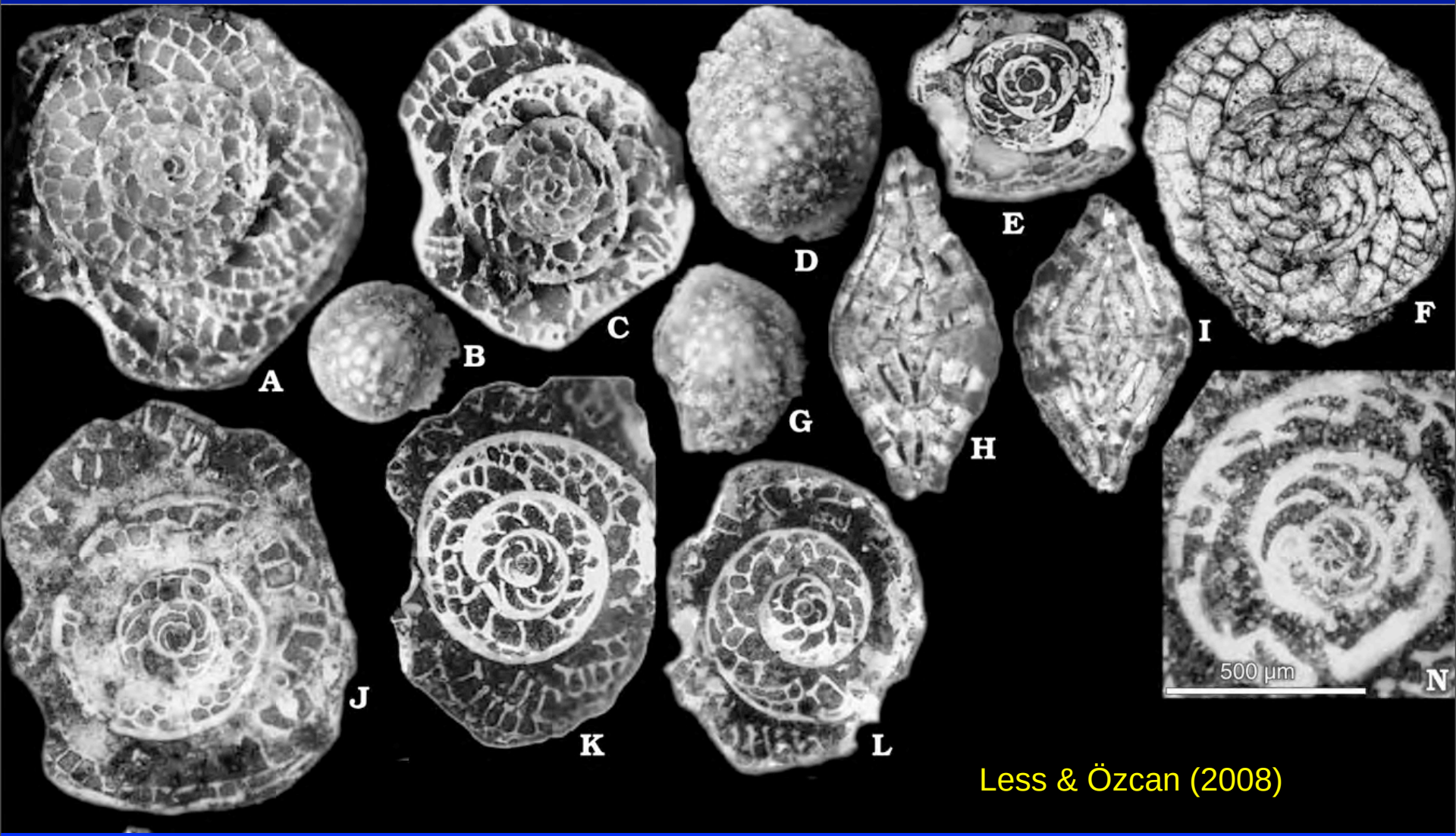
Decline of Paleogene LF

Extinction of larger *Nummulites*.
Appearance of *Spiroclypeus*: SBZ 19



Decline of Paleogene LF

Extinction of larger *Nummulites*.
Appearance of *Spiroclypeus*: SBZ 19



Less & Özcan (2008)

Spiroclypeus sirottii

Decline of Paleogene LF

Extinction of orthophragminae.
Appearance of *Nummulites fichteli* and *N. vascus*: SBZ 21