

PARTE II

Nannoplancton calcareo e nannofossili calcarei: tassonomia e biostratigrafia

OUTLINE

- **caratteristiche morfologiche e terminologia**
- **biostratigrafia e schemi biostratigrafici**
- **utilità della biostratigrafia a nannofossili: esempi applicativi**

ALCUNE DEFINIZIONI

BIOSTRATIGRAFIA

SETTORE DELLA STRATIGRAFIA CHE SI OCCUPA DELLO STUDIO DELLA DISTRIBUZIONE NEL TEMPO DEI FOSSILI

CLASSIFICAZIONE BIOSTRATIGRAFICA

l'organizzazione delle rocce in unità (unità biostratigrafiche) sulla base del loro contenuto in fossili

UNITA' BIOSTRATIGRAFICA (BIO-ZONA)

Pacco di sedimenti (corpi di rocce) caratterizzati da un peculiare contenuto in fossili che consente di differenziarli da quelli contigui

UNITÀ FONDAMENTALE	➡	BIO-ZONA
UNITÀ DI RANGO SUPERIORE:	➡	SUPERZONA
UNITÀ DI RANGO INFERIORE:	➡	SOTTOZONA

BIO-ORIZZONTI

- ✓ Servono a definire le unità biostratigrafiche (bio-zone)
- ✓ comparse/estinzioni controllate dall'evoluzione organica (che sono per definizione sempre sincroni)
- ✓ o dall'evoluzione ambientale

EVENTI OMOTASSICI:

eventi che si ripetono nello stesso ordine stratigrafico in successioni diverse e lontane

TIPI DI BIO-ORIZZONTI

Uso degli acronimi

FAD-LAD: comparse/estinzioni controllate dall'evoluzione organica(sono per definizione sempre sincroni)

TUTTI GLI ALTRI TIPI DI BIORIZZONTI SONO CONTROLLATI DALL'EVOLUZIONE AMBIENTALE

FO-LO (LO-HO)

prima presenza-ultima presenza di un *taxon* in una successione

BIO-ORIZZONTI NEL GIURASSICO INFERIORE E MEDIO DELLA BIOPROVINCIA TETIDEA

From MATTIOLI, E. & ERBA, E. (1999) –
Synthesis of calcareous nannofossil events in
tethyan Lower and Middle Jurassic successions.
Riv. Ital. Paleont. Strat., Milano, vol. 105 (3), pp.
343-376.

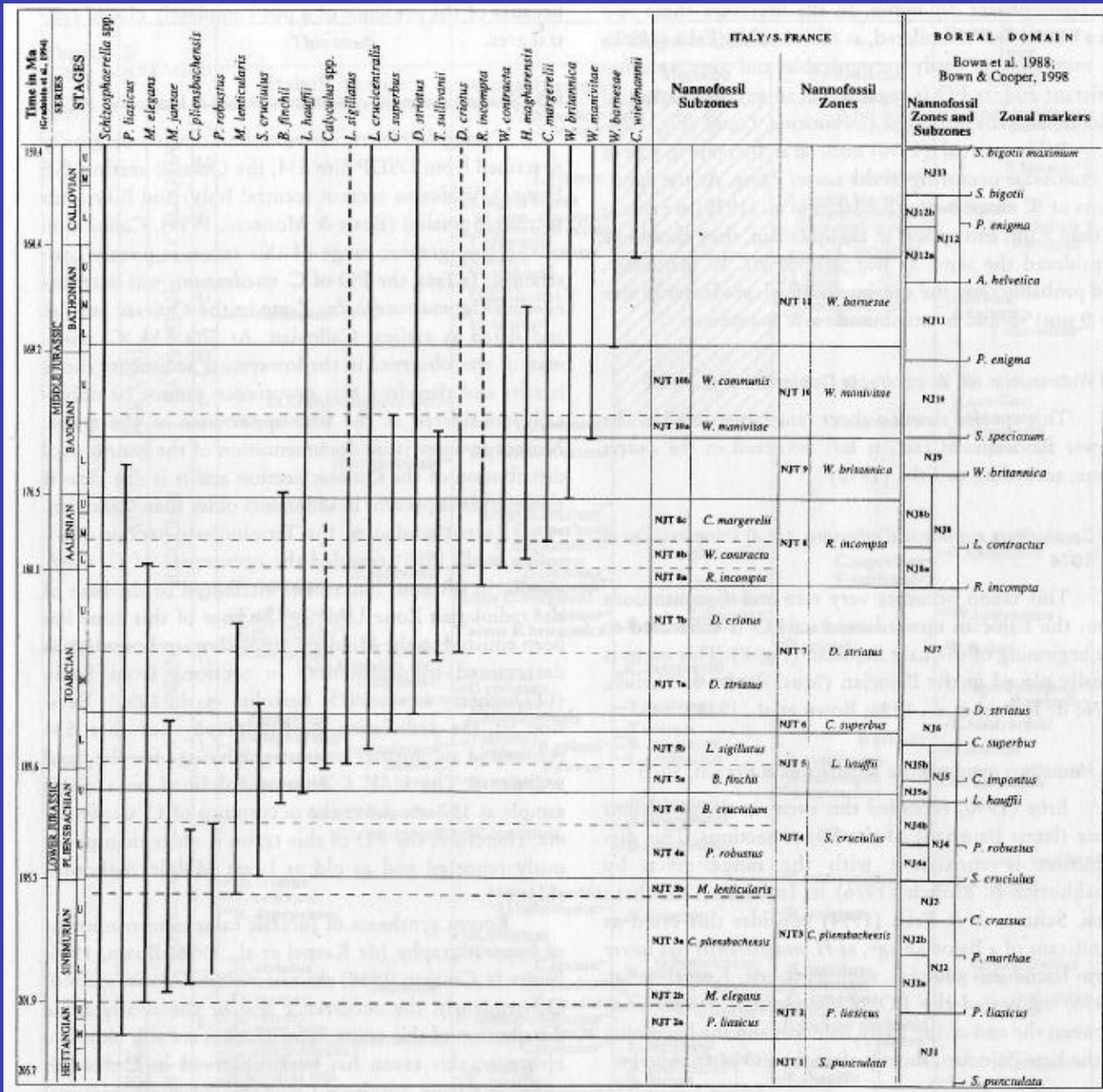


Fig. 12 - Biozonation scheme proposed for Italy and Southern France (Mediterranean Province) compared to the scheme proposed by Bown et al. (1988) and Bown & Cooper (1998) for the Boreal Realm. Time scale after Gradstein et al. (1994).

BIOZONE ED EVENTI DEL GIURASSICO INFERIORE E MEDIO DELLA BIOPROVINCIA TETIDEA

Time in Ma	SERIES STAGES	This study		de Kaenel et al., 1996			Bown & Cooper, 1998
		Italy/S. France	Portugal (Bergen)	Morocco (Dr. Kaenel)	Switzerland (Dr. Kaenel)	Boreal	
159.4	CALLOVIAN	U	A. helvetica S. hexum		A. helvetica S. hexum	S. bigotii maximum A. helvetica	
		M	L. velatus		L. velatus	S. hexum	
		L	S. bigotii bigotii S. spec. speciosum S. speciosum octum I. expansus S. hexum V. stradneri		S. bigotii bigotii S. spec. speciosum S. speciosum octum I. expansus S. hexum V. stradneri	S. bigotii S. speciosum P. enigma	
164.4	BATHONIAN	U	A. rahlia A. decussatus A. harrisoni H. cuvillieri		A. rahlia A. decussatus A. harrisoni H. cuvillieri	S. hexum A. helvetica T. shawensis	
		M	LCO Discorhabdus spp.			H. cuvillieri T. shawensis C. margerelii P. enigma	
		L	W. barnesae	T. shawensis			
169.2	BAJOCIAN	U	H. magharensis	S. speciosum octum		C. superbus S. speciosum	
		M	C. superbus T. sullivanii	A. helvetica Acme B. striatum C. superbus C. magharensis C. spec. speciosum D. constans T. sullivanii acme C. margerelii T. tiziense acme E. britannica	C. magharensis D. constans C. superbus T. tiziense	C. superbus S. speciosum	
		L	W. manivatae W. aff. manivatae W. aff. contracta W. communis W. britannica		E. britannica P. grassiei	W. britannica P. grassiei	
176.5	AALENIAN	U	T. patulus LCO Biscutum spp. L. sigillatus L. umbriensis	P. enigma D. constans T. sullivanii C. magharensis	C. margerelii B. prinsiif T. sullivanii	C. impontus/cavus B. prinsiif L. contractus	
		M	C. margerelii H. magharensis	T. tiziense R. incompta L. velatus B. prinsiif	T. tiziense R. incompta L. contractus	T. tiziense	
		L	W. contracta P. poulnabroncei P. liasicus C. cavus	R. incompta P. cavus		R. incompta	
180.1	TOARCIAN	U	"small" Calyculus C. cantaluppii	W. fossacinta	W. fossacinta A. depravatus B. intermedium	A. depravatus	
		M	D. criotus T. sullivanii B. depravatus	acme L. hauffii O. hamiltoniae	acme L. hauffii B. criotum	B. intermedium D. criotus	
		L	D. striatus W. colacicchii D. ignotus C. superbus C. cantaluppii C. poulnabroncei C. sigillatus C. calyculus spp. B. aff. B. hauffii B. hauffii L. primigenius	M. jansae P. liasicus distinctus S. finchii C. primolus A. atavus L. hauffii P. liasicus liasicus B. profundum D. novus L. hauffii P. dubia S. finchii	O. hamiltoniae B. striatum D. constans C. superbus L. sigillatus P. liasicus distinctus C. jansae	O. hamiltoniae D. striatus B. finchii C. superbus	
189.6	PLIENSCHACHIAN	U	B. novum P. robustus C. plienschachensis	Lotharingius spp. C. plienschachensis	C. granulatus C. plienschachensis	C. plienschachensis P. robustus	
		M	B. aff. B. dubium S. orbiculus S. cruciulus C. crassus M. lenticularis	S. genphyron B. prinsiif S. cruciulus P. cavus S. procarium C. granulatus	S. cruciulus	S. cruciulus M. lenticularis	
		L			P. robustus O. hamiltoniae C. crassus		
195.3	SINEMURIAN	U				P. marthaer	
		M	C. plienschachensis M. jansae			C. plienschachensis M. elegans	
		L	"small" Crepidolithus P. liasicus C. crassus ? T. patulus			P. liasicus	
201.9	HETTANGIAN	U				S. punctulata	
		L				P. triassica	
205.7							

From MATTIOLI, E. & ERBA, E. (1999) –
Synthesis of calcareous nannofossil events in
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Riv. Ital. Paleont. Strat., Milano, vol. 105 (3), pp.
343-376.

GIURASSICO p.p.

Italy/S France Mattioli et al., in prep.	Portugal Bergen, in prep.	BOREAL NF ZONES Bown et al., 1988		NANNOFOSSIL EVENTS		BOREAL AMM. ZONES	AGE	
				Secondary events	Zonal events			
		NJ12	NJ12a	▲ <i>S. hexum</i>	▲ <i>A. helvetica</i>	discus	BATHONIAN	
	▲ <i>S. hexum</i>	NJ11		▼ <i>T. shawensis</i>		aspidoides		
	▲ <i>H. cuvillieri</i>							hodsoni
						morrisi		
						subcontractus		
						progracilis		
▲ <i>W. barnesae</i>	▼ <i>T. shawensis</i>	NJ10		▲ <i>H. cuvillieri</i> , ▲ <i>T. shawensis</i> ,	▲ <i>P. enigma</i>	tenuiplicatus	BAJOCIAN	
▼ <i>C. magharensis</i>	▼ <i>S. spec. octum</i>				▲ <i>C. margerelli</i> , ▲ <i>S. spec. octum</i>			zigzag
▼ <i>L. contractus</i>	▼ <i>D. striatus acme</i>							parkinsoni
▼ <i>C. superbus</i>	▼ <i>C. superbus</i>			▲ <i>C. superbus</i>	▲ <i>S. speciosum</i>	garantiana		
	▼ <i>S. speciosum</i>			▼ <i>D. constans</i>		subfurcatum		
	▼ <i>D. constans</i>					humphriesianum		
▲ <i>W. manivillae</i>	▲ <i>T. tiziense</i>	NJ9				sauezi	AALENIAN	
▲ <i>W. britannica</i>	▲ <i>W. britannica acme</i>	NJ8	NJ8b	▲ <i>P. grassei</i>		laeviuscula		
					▼ <i>B. prinsii</i> , ▼ <i>C. imponentus</i>	▲ <i>L. contractus</i>		discites
▲ <i>C. margerelli</i>	▲ <i>D. constans</i>		NJ8a	▲ <i>Trisc. sp.</i>	▲ <i>R. incompta</i>	concaum	TOARCIAN	
▲ <i>C. magharensis</i>	▲ <i>T. sullivanii</i>			▲ <i>B. intermedium</i>		murchisonae		
▲ <i>L. contractus</i>	▲ <i>T. tiziense</i>					opalinum		
▲ <i>R. incompta</i>	▲ <i>B. prinsii</i>					levesquei	PLIENSBACh.	
▲ <i>D. criotus</i>	▲ <i>R. incompta</i>					thouarsense		
	▲ <i>L. hauffii acme</i>	NJ7		▼ <i>L. hauffii acme</i>		variabilis		
▲ <i>D. striatus</i>	▲ <i>D. striatus</i>			▼ <i>D. criotus</i>	▲ <i>D. striatus</i>	bifrons		
▲ <i>C. superbus</i>	▲ <i>C. superbus</i>	NJ6		▼ <i>O. hamiltoniae</i>		falciferum		
▲ <i>L. sigillatus</i>	▲ <i>C. primulus</i>			▼ <i>B. finchii</i>	▲ <i>C. superbus</i>	tenuicostatum		
▲ <i>L. hauffii</i>	▲ <i>L. hauffii</i>	NJ5	NJ5b	▲ <i>C. primulus</i>	▲ <i>C. imponentus</i>	spinatum	SINEMURIAN	
▲ <i>B. finchii</i>	▲ <i>B. novum</i>			▲ <i>L. sigillatus</i>		margaritatus		
	▲ <i>L. ?barozii</i>		NJ5a	▲ <i>B. finchii</i>	▲ <i>L. hauffii</i>	davoei		
▲ <i>B. novum</i>	▲ <i>C. plienschach.</i>	NJ4	NJ4b	▲ <i>C. plienschachensis</i>	▲ <i>P. robustus</i>	ibex		
▲ <i>B. aff. B. dubium</i>	▲ <i>B. prinsii</i>		NJ4a		▲ <i>S. cruciulus</i>	jamesoni		
▼ <i>?C. plienschachensis</i>	▲ <i>S. cruciulus</i>					raricostatum		
	▲ <i>C. granulatus</i>	NJ3				oxynoyum	HETTANGIAN	
	▲ <i>C. crassus</i>			▲ <i>O. hamiltoniae</i>	▲ <i>C. crassus</i>	obtusum		
		NJ2	NJ2b	▲ <i>P. robustus</i>	▲ <i>P. marthae</i>	turneri		
▲ <i>C. plienschach.</i>	no data			▲ <i>C. plienschachensis</i>		semicostatum		
▲ <i>M. jansae</i>			NJ2a	▲ <i>M. elegans</i>	▲ <i>P. liasicus</i>	bucklandi		
▲ <i>M. elegans</i>						angulata		
▲ <i>P. liasicus</i>		NJ1			▲ <i>S. punctulata</i>	liasicus	HETTANGIAN	
				▲ <i>P. triassica</i>		planorbis		

Fig. 4.1 Hettangian to Bathonian biostratigraphic zones and events.

GIURASSICO p.p.-Berriasiano

MAGNETO-STRATIGRAPHY	TETHYAN NF ZONES Bralower et al., 1989		BOREAL NF ZONES Bown et al., 1988		NANNOFOSSIL EVENTS		BOREAL AMM. ZONES	AGE						
					Secondary events	Zonal events								
M18	NJK	NJKd <small>FO N. steinmanni</small>	NJ18		▲ <i>N. steinmannii minor</i> *		lamplughi	PORTLANDIAN	VOLGIAN	BERRIASSIAN				
M19		NJKc <small>FO B. latiflor</small>			?	▲ <i>C. curvillieri</i>					preplicomphalus			
		NJKb <small>FO U. granulosa</small>				▼ <i>C. mexicana minor</i> , <i>P. beckmannii</i> *					primitivus			
		NJKa									oppressus			
M20	NJ20	FO H. chianfa	NJ17	NJ17b	?	▼ <i>W. britannica</i> decline	anguliformis	BOLONIAN	VOLGIAN	TITHONIAN				
						?	▼ <i>E. gallicus</i>				▲ <i>S. atmetos</i> ▼	kerberus		
M21		FO		NJ17a	▲ <i>H. chianfa</i> , <i>H. noeliae</i> , <i>P. senaria</i> *	▲ <i>S. bigotii</i> ▼	okusensis	BOLONIAN	VOLGIAN	TITHONIAN				
		FO			?	▼ <i>A. cylindricus</i>	glaucolithus							
M22		FO C. max/min		NJ19b	▲ <i>Nannoconus</i> *		albani	BOLONIAN	VOLGIAN	TITHONIAN				
		FO Z. embergeri		NJ16b	▲ <i>C. mex. max.</i> *	▲ <i>S. atmetos</i> ▲	fittoni							
				NJ16a	▲ <i>C. mex. minor</i> *	▲ <i>A. harrisonii</i> ▲	rotunda	BOLONIAN	VOLGIAN	TITHONIAN				
				NJ15b	▲ <i>Z. embergeri</i> *		pallasioides							
	NJ19	NJ19a	NJ15	NJ15a			pectinatus	KIMMERIDGIAN	VOLGIAN	TITHONIAN				
													hudlestoni	
												▲ <i>C. conicus</i>	▲ <i>S. brevispinus</i> ▲	wheatleyensis
												▼ <i>C. perforata</i>		scitulus
					▲ <i>F. multicolonnatus</i> *		elegans	KIMMERIDGIAN	VOLGIAN	TITHONIAN				
					▼ <i>D. striatus</i>	▼ <i>L. crucicentralis</i> ▼	autissiodorensis							
							eudoxus	KIMMERIDGIAN	VOLGIAN	TITHONIAN				
							mutabilis							
							cymodoce	KIMMERIDGIAN	VOLGIAN	TITHONIAN				
							baylei							
							rosenkrantzi	KIMMERIDGIAN	VOLGIAN	TITHONIAN				
							regulare							
							serratum	KIMMERIDGIAN	VOLGIAN	TITHONIAN				
							glosense							
							tenuiserratum	KIMMERIDGIAN	VOLGIAN	TITHONIAN				
							densiplicatum							
							cordatum	KIMMERIDGIAN	VOLGIAN	TITHONIAN				
							mariae							
							lamberti	KIMMERIDGIAN	VOLGIAN	TITHONIAN				
							athleta							
							coronatum	KIMMERIDGIAN	VOLGIAN	TITHONIAN				
							jason							
							calloviense	KIMMERIDGIAN	VOLGIAN	TITHONIAN				
							macrocephalus							
								KIMMERIDGIAN	VOLGIAN	TITHONIAN				
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BIO-ORIZZONTI NEL CRETACEO

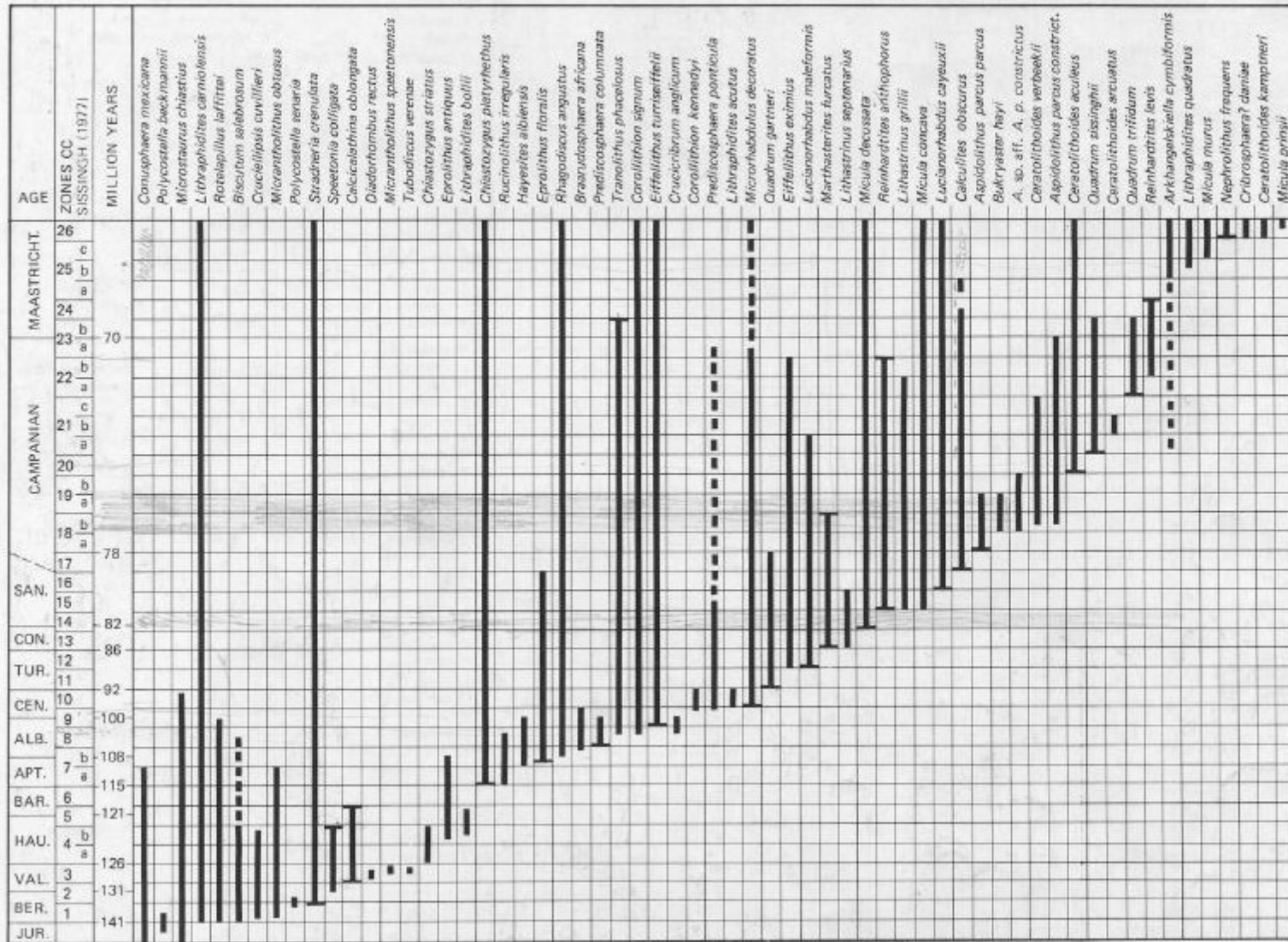


Fig. 7. Ranges of Cretaceous markers and a few other calcareous nanofossils

BERRIASIANO-HAUTERIVIANO

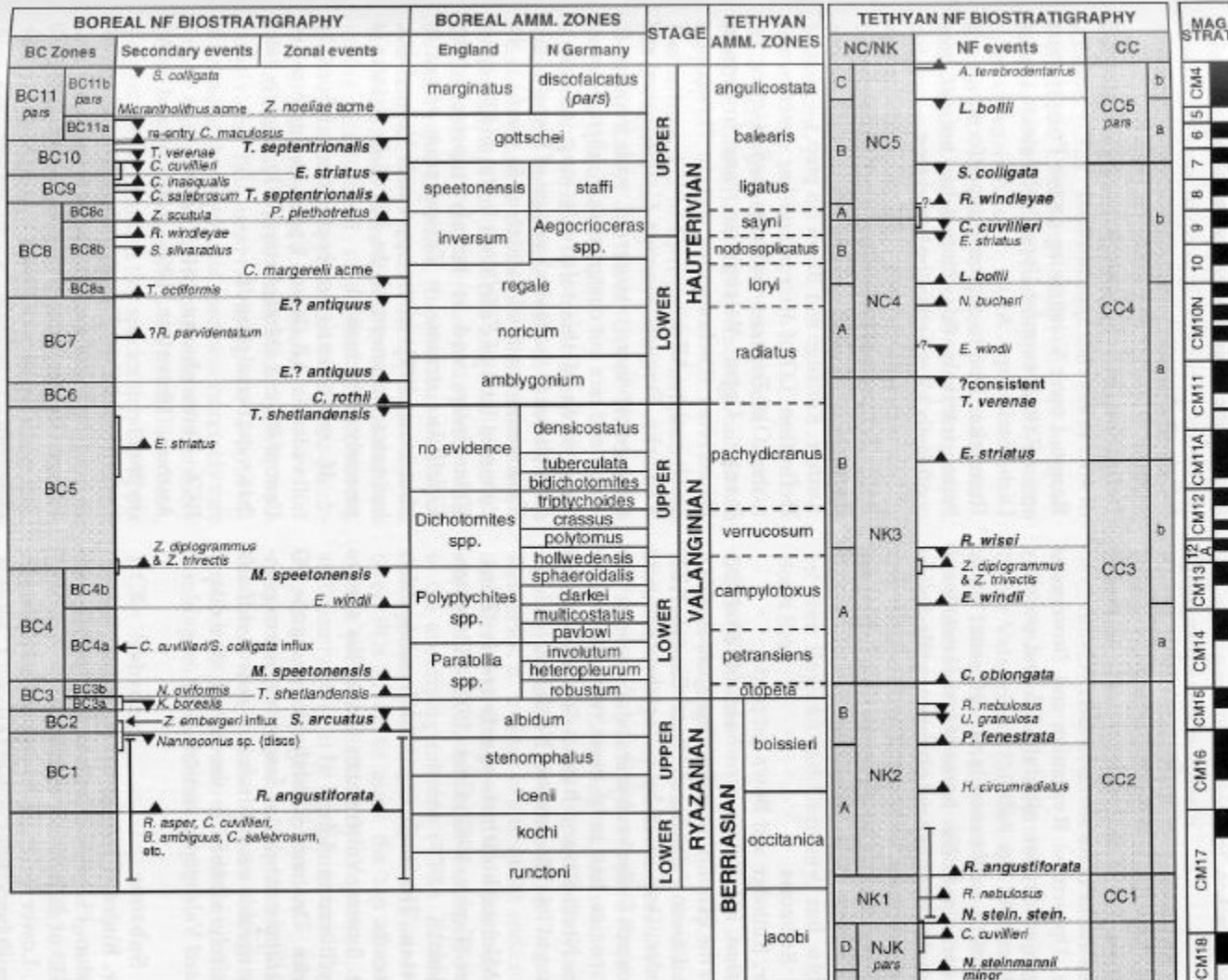


Fig. 5.1 Neocomian nannofossil biostratigraphy. Boreal BC zones after Rutledge and Bown (in prep.); all events are calibrated to the boreal cephalopod zonation scheme. Tethyan NC zones after Roth (1978, 1983) with subdivisions after Bralower (1987) and Bralower et al. (1993). NK zones after Bralower et al. (1989). CC zones after Sissingh (1977, 1978) with modifications by Perch-Nielsen (1979a, 1985a) and Applegate and Bergen (1988). Most events are calibrated against ammonite zones (predominantly using Bergen, 1984). Correlation between the boreal and tethyan biostratigraphies is made via ammonite zone correlations, based largely on Rawson (1995). The magnetostratigraphic scale is not well calibrated with the cephalopod stratigraphy and is included as a guide only, based on Bralower (1987), Bralower et al. (1989) and Cecca et al. (1994).

BARREMIANO-ALBIANO

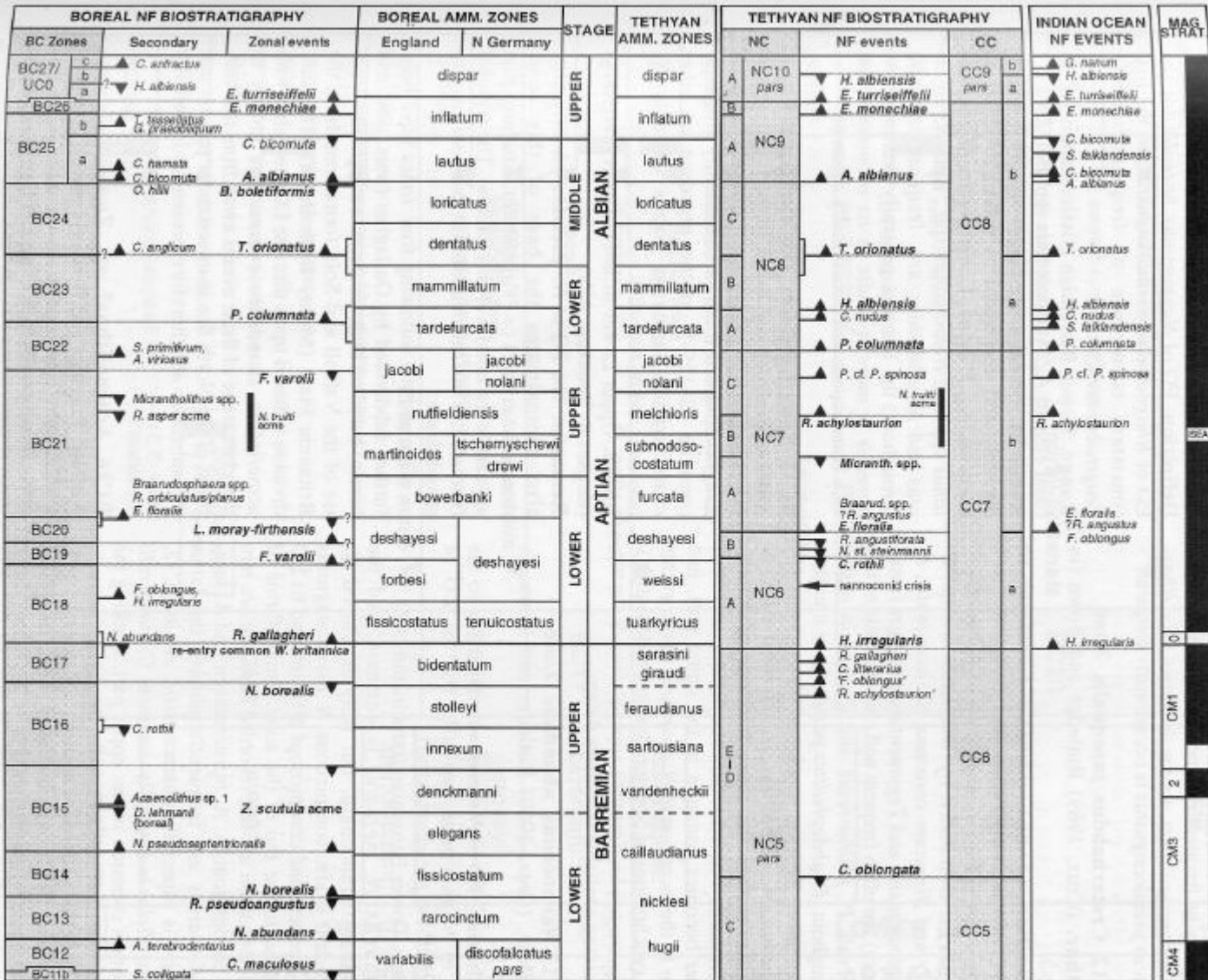


Fig. 5.2 Barremian-Albian nannofossil biostratigraphy. Boreal BC zones after Rutledge and Bown (in prep.). Albian events also based on Crux (1991), Burnett in Gale et al. (1996) and Jeremiaš (1996). Most events are calibrated to the boreal cephalopod zones. See also Fig. 5.1 caption.

ALBIANO p.p.-CENOMANIANO

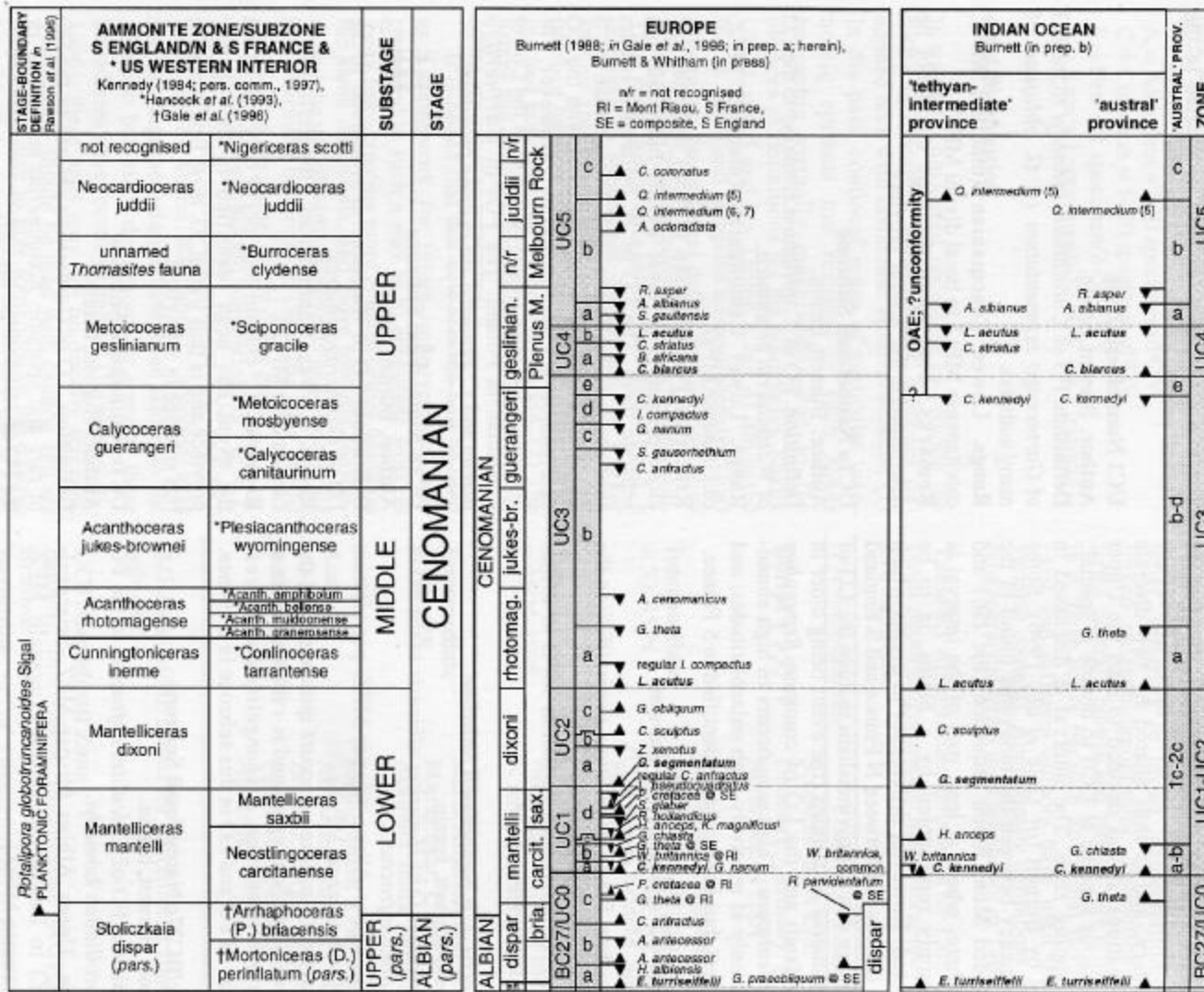


Fig. 6.2 Comparison of uppermost Albian to Upper Cenomanian biozonations with new data which has been correlated with macrofossil zones. Stages appear in quotation marks because no precise correlation of nannofossil data with the stages was attempted by the original authors.

CONIACIANO-SANTONIANO

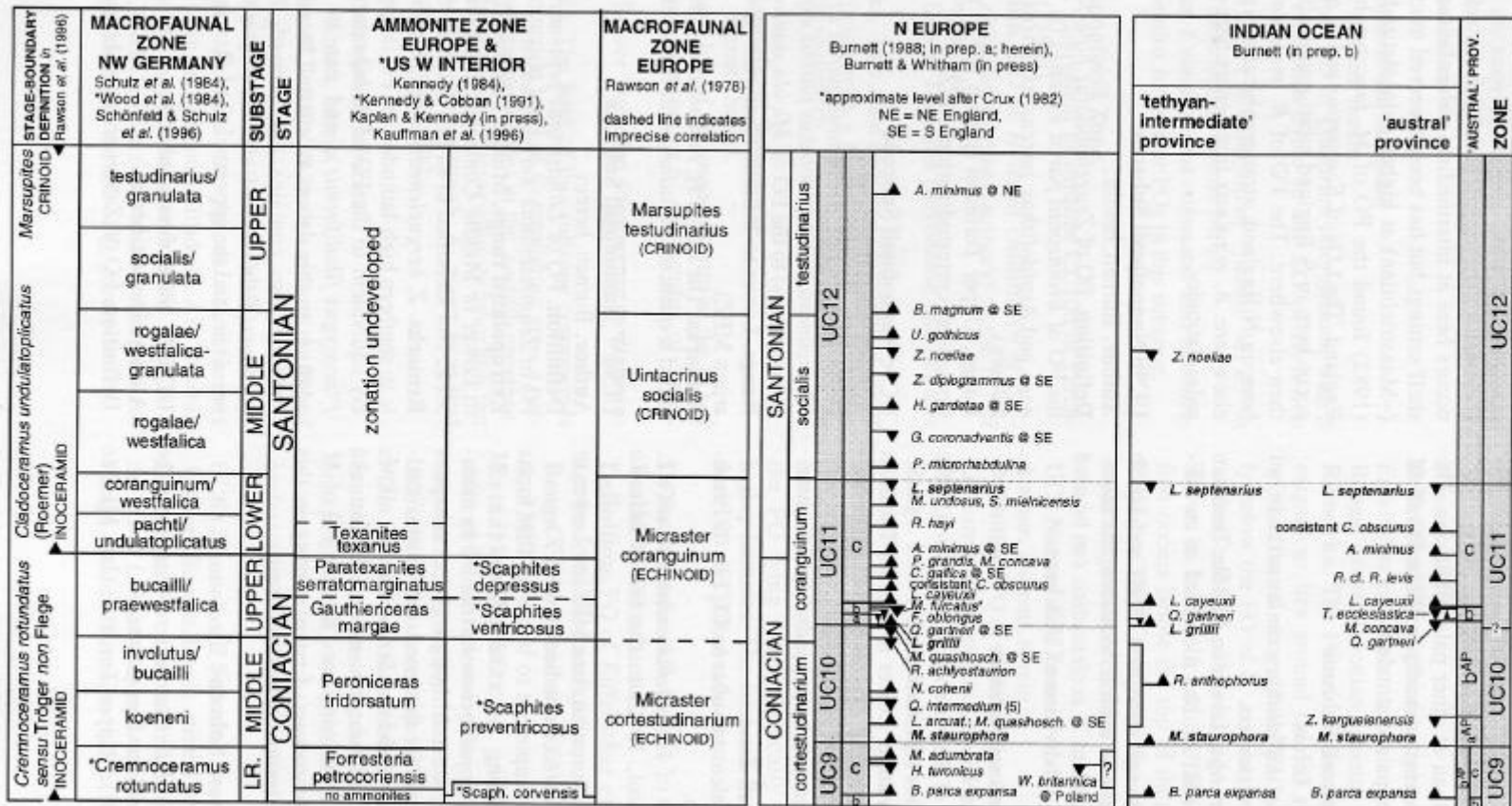


Fig. 6.4 Comparison of Coniacian to Santonian biozonations with new data which has been correlated with microfossil zones. Stages appear in quotation marks because no precise correlation of nannofossil data with the stages was attempted by the original authors.

CAMPANIANO p.p.-MAASTRICHTIANO

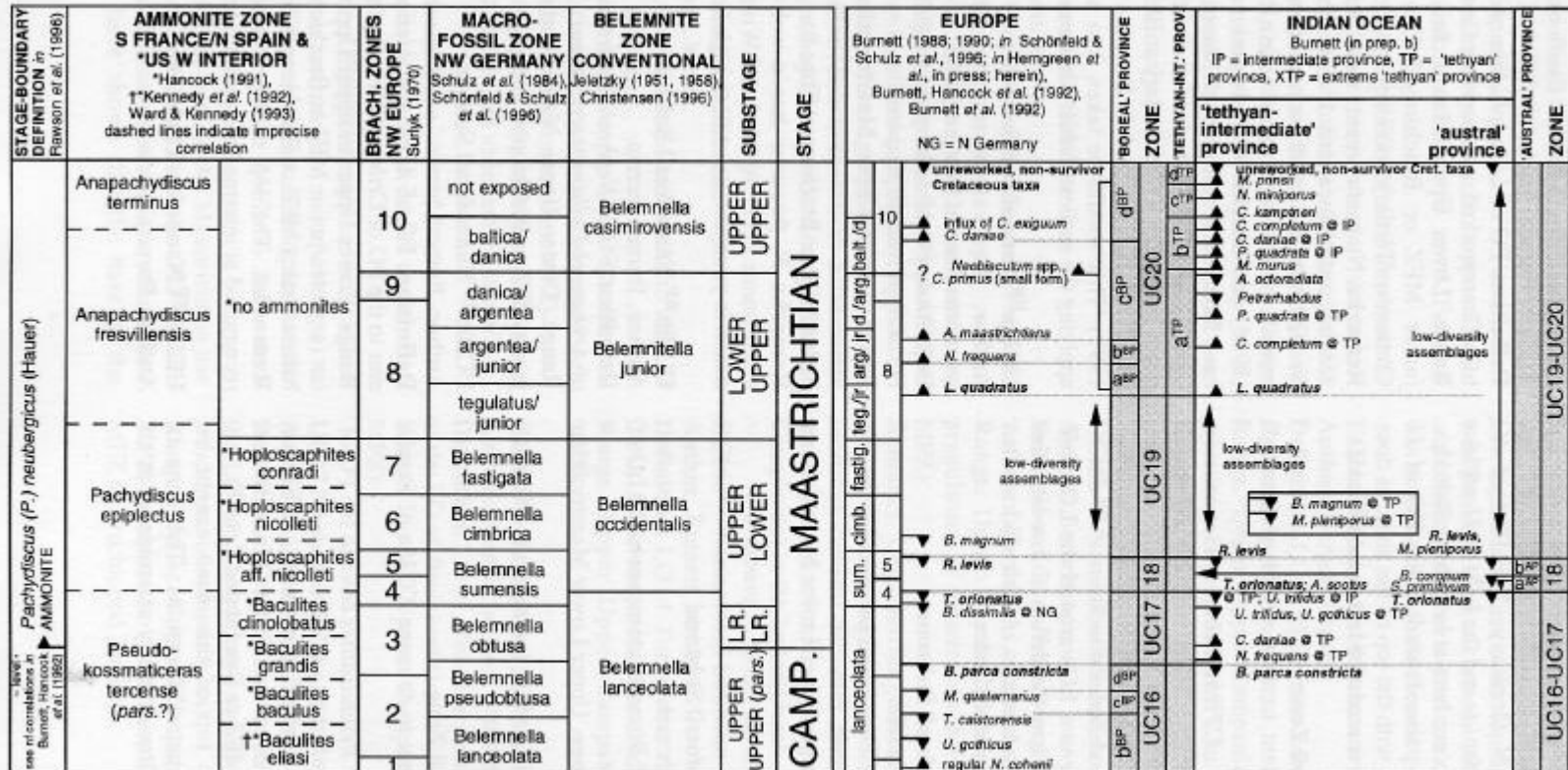


Fig. 6.6 Comparison of uppermost Campanian-Maastrichtian biozonations with new data which has been correlated with macrofossil zones. Stages appear in quotation marks because no precise correlation of nanofossil data with the stages was attempted by the original authors.

BIOSTRATIGRAFIA A MICROFOSSILI CALCAREI NELLA SUCCESSIONE UMBRO-MARCHIGIANA (PREMOLI SILVA & SLITER, 1995)

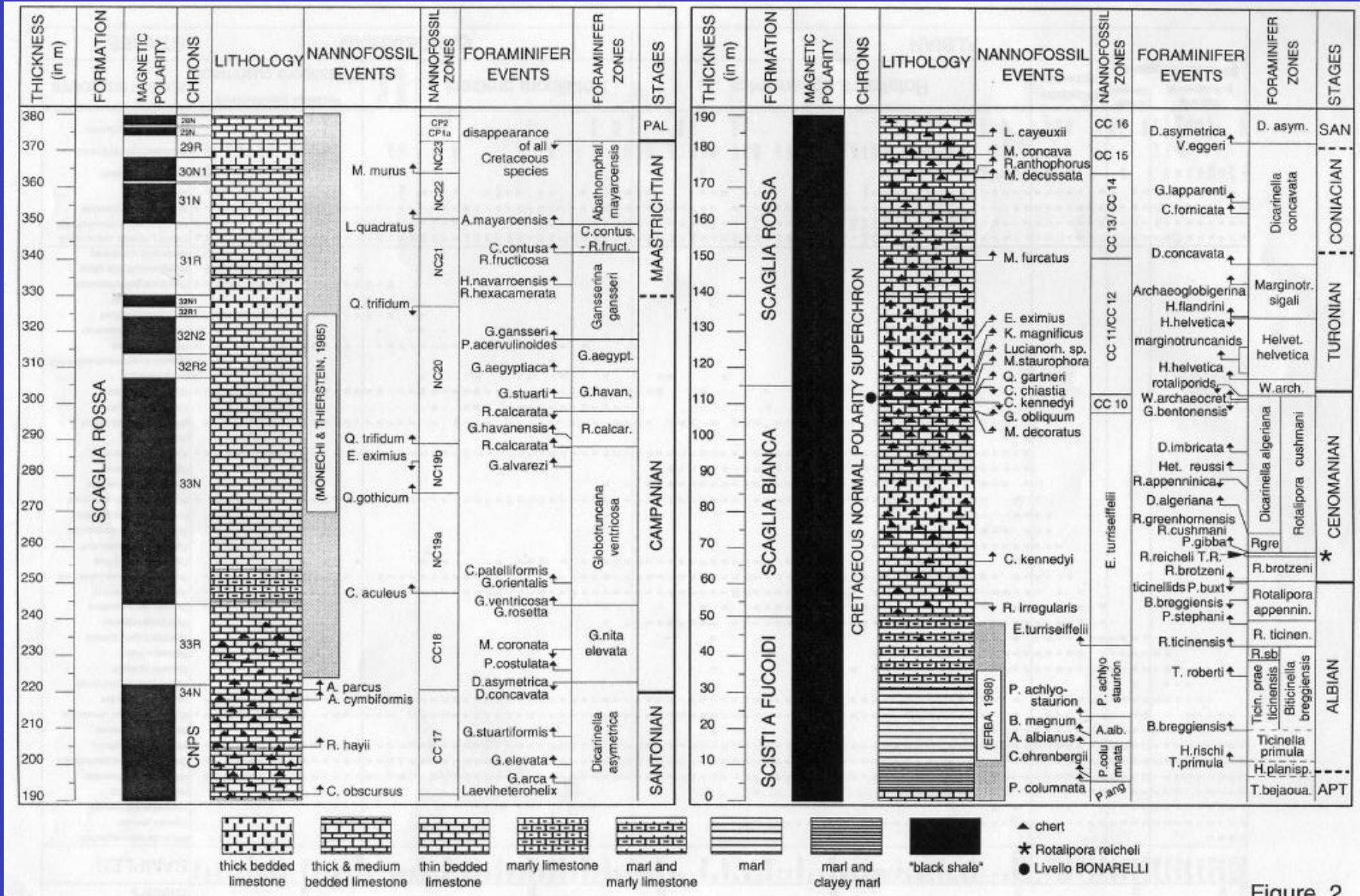


Figure 2