The Massignano Eocene-Oligocene golden spike section revisited

Caroline A. Van Mourik[1] and Henk Brinkhuis[2]
[1]*Department of Geology and Geochemistry, Stockholm University, SE-106 91 Stockholm, Sweden*
email: Caroline.vanMourik@geo.su.se (corresponding author)
[2]*Laboratory of Palaeobotany and Palynology, Utrecht University, Budapestlaan 4, 3584 CD, Utrecht, The Netherlands*
email: H.Brinkhuis@bio.uu.nl

ABSTRACT: In common practice, the Eocene/Oligocene (E/O) boundary is linked to the Oi-1 $\delta^{18}O$ benthic isotope event, reflecting the oldest phase of major Antarctic glaciation, calibrated against magnetosubchron C13n. Yet, the IUGS-ratified, current E/O Global Stratigraphic Section and Point (GSSP) at the pelagic Massignano quarry section, central Italy, occurs within the older magnetosubchron C13r. To extend the Massignano record further into the early Oligocene, to include the critical C13n episode missing in the surface section, a core was drilled in the direct vicinity of the quarry section. First correlations between the core and the quarry section have recently been proposed. In this paper, we use high-resolution organic-walled dinoflagellate cyst (dinocyst) analysis to significantly improve correlation between the two sections.

In addition, we build on earlier studies, and demonstrate that the current E/O GSSP criterion, which is based on the local extinction of the tropical planktonic foraminifera genus *Hantkenina* represents an isolated event that is not suitable for global correlation.

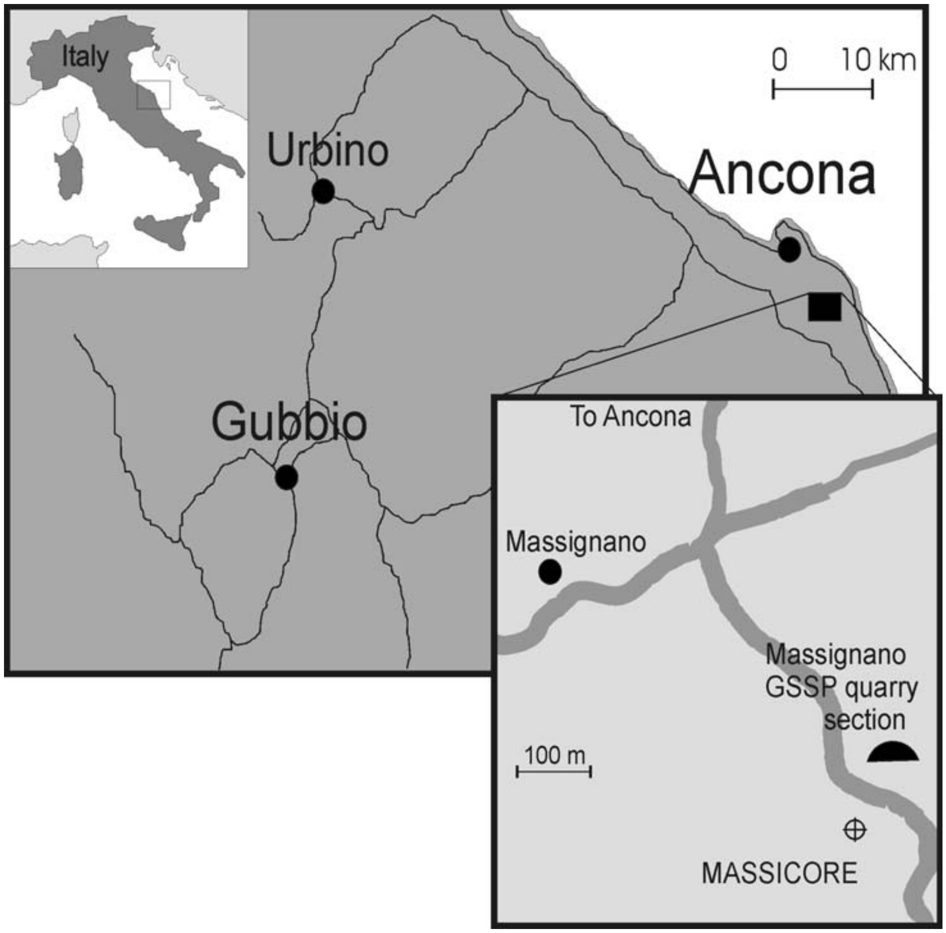
Instead, we argue that selection of the Oi-1 event be the main criterion for the determinating the E/O boundary, and that this provides a much better basis for global correlation, Moreover, the Oi-1 is also related to the TA4.3/4.4 third order sequence boundary and the last occurrence of the dinocyst *Areosphaeridium diktyoplokum*. Selection of this slightly younger criterion would place the upper boundary of the classic Priabonian Stage back in the latest Eocene, and the base of the Rupelian Stage in the earliest Oligocene. Since the proposed correlative Oi-1 event level is not represented in the surface (quarry) section, but only resides in the cored section at Massignano, a new GSSP site should be selected, for example in one of the other central Italian sections that does span C13n.

INTRODUCTION

The 23 meter thick succession of calcareous pelagic sediments exposed in the Massignano quarry near Ancona, central Italy (text-fig. 1), have been ratified as the 'Global Stratigraphic Section and Point' (GSSP) for the Eocene/Oligocene (E/O) boundary (Premoli Silva and Jenkins 1993). The GSSP level at meter 19 (text-fig. 2) was chosen to match the last occurrence (LO) of planktonic foraminifers belonging to the (sub)tropical genus *Hantkenina*. At Massignano, the latter is the single bioevent associated with the boundary proper; other bioevents, summarized in e.g., Nocci et al. (1988) and Brinkhuis and Visscher (1995) are more or less evenly spread over the entire succession. The global application of the *Hantkenina*-criterion for recognition of the E/O boundary, dated at ~33,7 Ma,(Berggren et al. 1995; Lanci et al. 1996) is problematic at best, as many studies have shown the event to be extremely diachronous over the globe. The apparently gradual cooling during the latter part of the Eocene (e.g., Zachos et al. 2001) caused this group to vanish from high to low latitudes in a step-wise pattern. Moreover, it has been demonstrated that (1) the extinction of the hantkeninids does not correlate to the prominent $\delta^{18}O$ shift in benthic foraminifers found around the globe (e.g., Brinkhuis and Visscher 1995; Zachos et al. 2001), and (2) that the E/O GSSP correlates to the middle part of the classic Late Eocene Priabonian Type section (Brinkhuis 1994; Brinkhuis and Visscher 1995). The $\delta^{18}O$, or 'Oi-1' event (e.g., Miller et al. 1991) postdates the GSSP by some 400 kyr, dated as ~33,3 Ma. The Oi-1 event is widely regarded to reflect the onset of major Antarctic glaciation (e.g., Zachos et al. 2001), and is also associated with a marked fall of global eustatic sea level (i.e., the TA4.3/4.4 sequence boundary of Haq et al. 1987). In common paleoceanographic practice, the Oi-1 event has been equated to the E/O boundary, and the hantkeninid event discarded. At Massignano, the LO of the hantkeninids falls in magnetosubchron C13r, while the Oi-1 event is calibrated against the younger C13n. Again unfortunately, the Massignano quarry section does not include sediments representing this critical Subchron C13n, as only about 4 meters of the lowermost Oligocene is exposed at the GSSP site (text-fig. 2). As a result, only indirect correlation from the GSSP section to other, more extended but distant, central Italian pelagic sections allows characterisation of C13n times (e.g., Bice and Montanari 1988: Parisi et al. 1988).

In order to extend the lower Oligocene record in the Massignano area and to promote further high-resolution stratigraphic and paleoecological studies at Massignano, the so-called Massicore (text-fig. 1) was drilled about 110m south of the stratotype section (text-fig. 1; Montanari et al. 1994; Lanci et al. 1996). The E/O GSSP has been correlated to the Massicore, at a coredepth of 19.22m in the 39.4m long core, using biotite-rich layers (Lanci et al. 1996). The additional 15 meters of lower Oligocene strata, now including subchron C13n, from the Massicore make it possible to elucidate the early Oligocene history in the Massignano E/O boundary area and to enhance worldwide correlation to the E/O GSSP.

Organic-walled dinoflagellate cysts (dinocysts) are abundant throughout the upper Eocene and lower Oligocene sediments of Italy, and represent the sole biostratigraphic tool to confidently correlate the pelagic sections of central Italy (e.g., Brinkhuis



TEXT-FIGURE 1
Location of the Massicore drillhole and the Massignano quarry section.

and Biffi 1993; Wilpshaar et al. 1996) to the platform sections in the Priabona area, northeast Italy (Brinkhuis 1994; Brinkhuis and Visscher 1995). In this paper, we aim to (1) enhance the stratigraphic correlation between the Massicore and the Massignano quarry section by means of high-resolution dinocyst analysis, and to (2) evaluate the possibilities of global correlation of the E/O boundary sensu current GSSP.

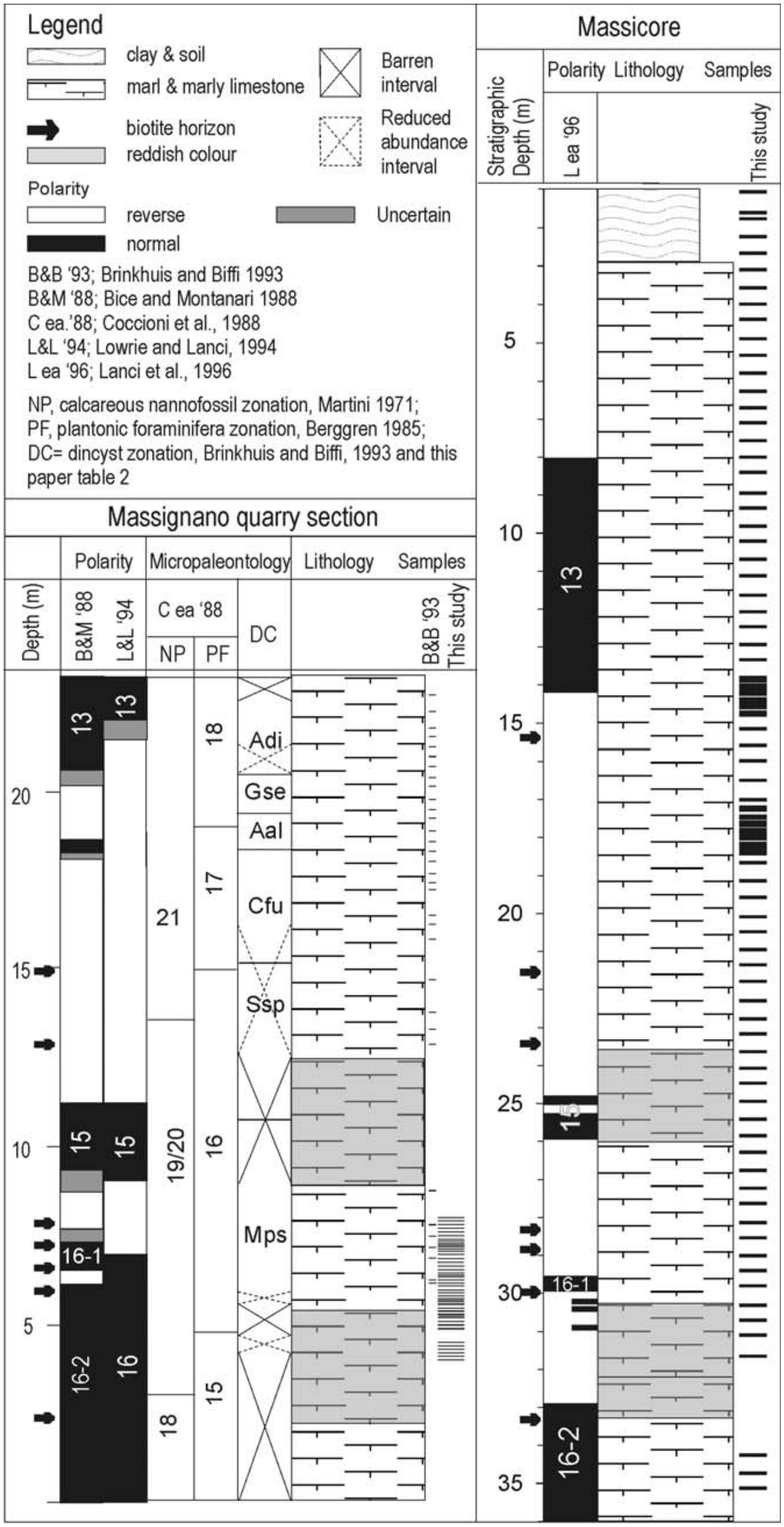
MATERIAL

The upper Eocene to lower Oligocene sediments in the Massignano area consist of reddish and greenish-grey (lower upper Eocene) to greenish-grey pelagic marly limestones and calcareous marls (uppermost Eocene – lower Oligocene, see Alvarez and Montanari 1988; Montanari et al. 1994). Several thin biotite-bearing layers of volcanic origin occur at various stratigraphic levels (Alvarez and Montanari 1988) and are useful for lithostratigraphic correlation. The Massicore was drilled about 110m south of the Massignano quarry GSSP section (text-fig. 1; Montanari et al. 1994). The core is ~39.4m long, with a diameter of 10 cm. The total core recovery was 94.6%, of which 72.7% was recovered intact (Lanci et al. 1996). Due to a consistent 27^{o} dip of the Massicore (Lanci et al. 1996) , the stratigraphic depth correlating to the core depths are used in this study. The Massicore shows lithological features that are identical to the Massignano quarry section, with two distinct reddish intervals in the lower part and several biotite-rich layers (text-fig. 2). Lanci et al. (1996) used four biotite-rich layers for the correlation of the two sections, while two additional biotite horizons were recorded by Montanari (pers. comm., 2003). Although the total number of recognized biotite horizons differs slightly between the successions, still a straightforward linear regression of six of the biotite layers is possible (text-fig. 2).

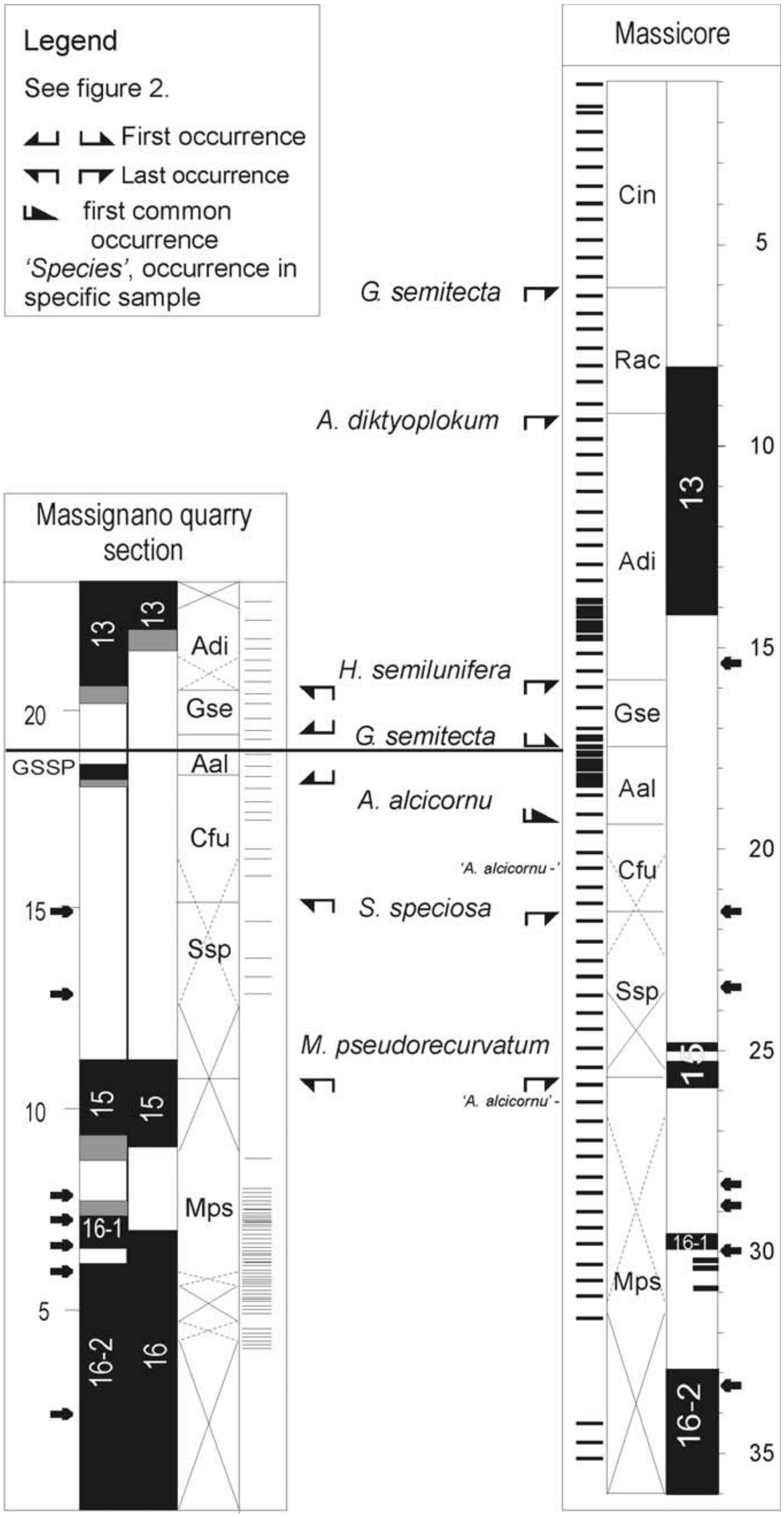
In this study, a total of 140 'new' samples are examined; 94 samples of the Massicore (between 39.42m and 1.15m) and 46 additional samples from the Massignano quarry section (between 4.00m and 8.00m). The additional samples from the Massignano quarry section were combined with 33 samples, from 6.3-22.8m, that have previously been examined by Brinkhuis and Biffi (1993). For location of the samples, see text-figure 2.

Magnetostratigraphy and age assessment

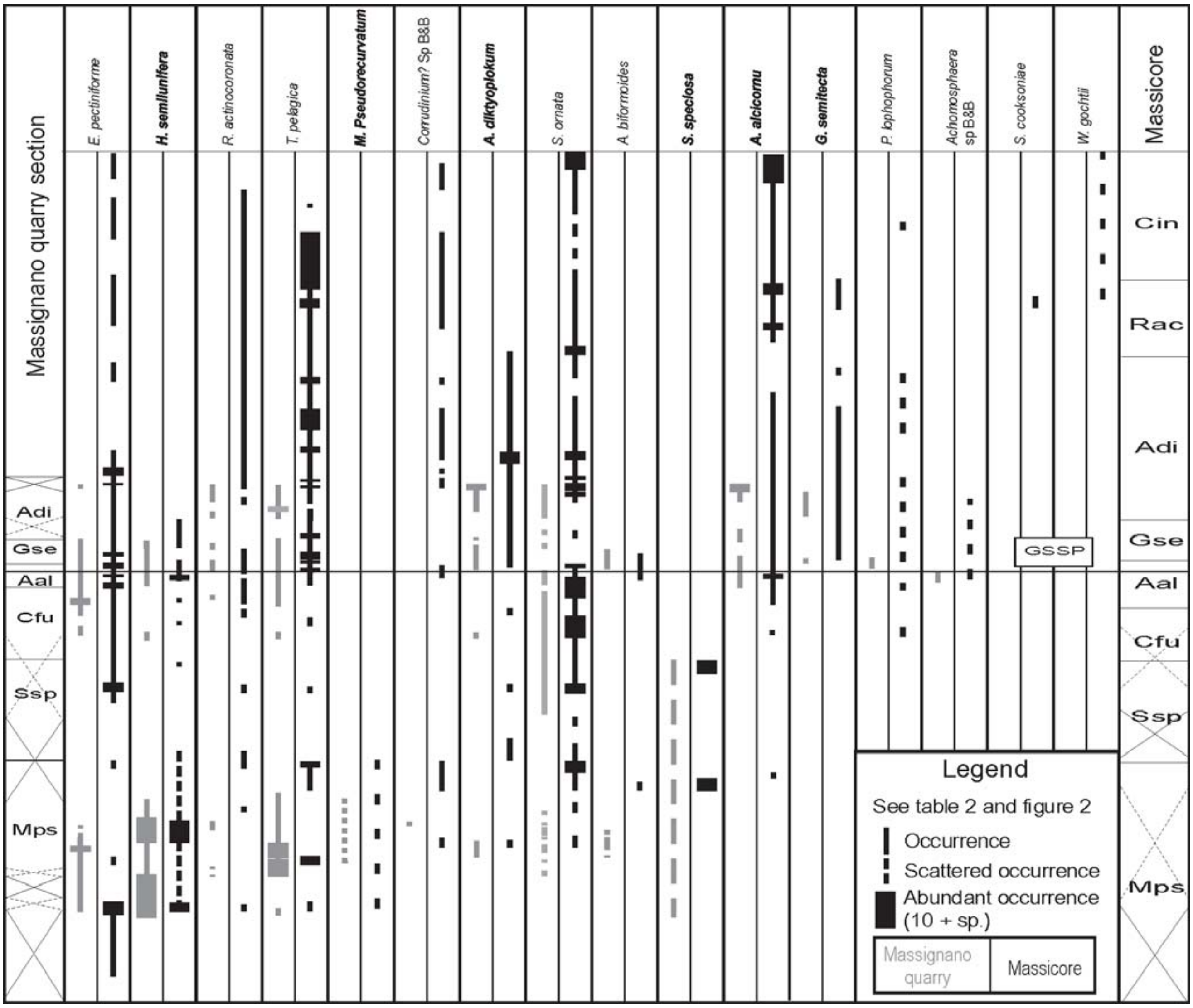
Bio- and magnetostratigraphic information for the Massignano quarry section is summarized in Brinkhuis and Biffi (1993), and indicated in text-figure 2. The GSSP E/O boundary has an estimated age of 33.7±0.5 Ma (Berggren et al. 1995; Lanci et al. 1996), while subchron C13n occurred between 33.545 to 33.058 Ma (Berggren et al. 1995). Lanci et al. (1996) performed a magnetostratigraphic analysis of the Massicore. According to these authors, the characteristic remanent magnetization (ChRM) directions of the Massicore clearly display opposite polarities, but the scatter is large in both polarity groups. The scatter was attributed to disoriented samples, and the signal was



TEXT-FIGURE 2
Correlation of the Massicore with the Massignano quarry section (Montanari, pers comm.). The samples used for the present study are Massicore samples 39.42 to 1.15 and Massignano quarry section 4.00 to 8.00. Massignano samples 6.30 to 22.80 are from Brinkhuis and Biffi (1993).



TEXT-FIGURE 3
Dinocyst zone dividing events for the Massignano quarry section and the Massicore, the zone boundaries are placed at mid-positions between critical samples dividing the zones.



TEXT-FIGURE 4
The relative occurrences of the stratigraphic important events for the Massignano quarry section and the Massicore.

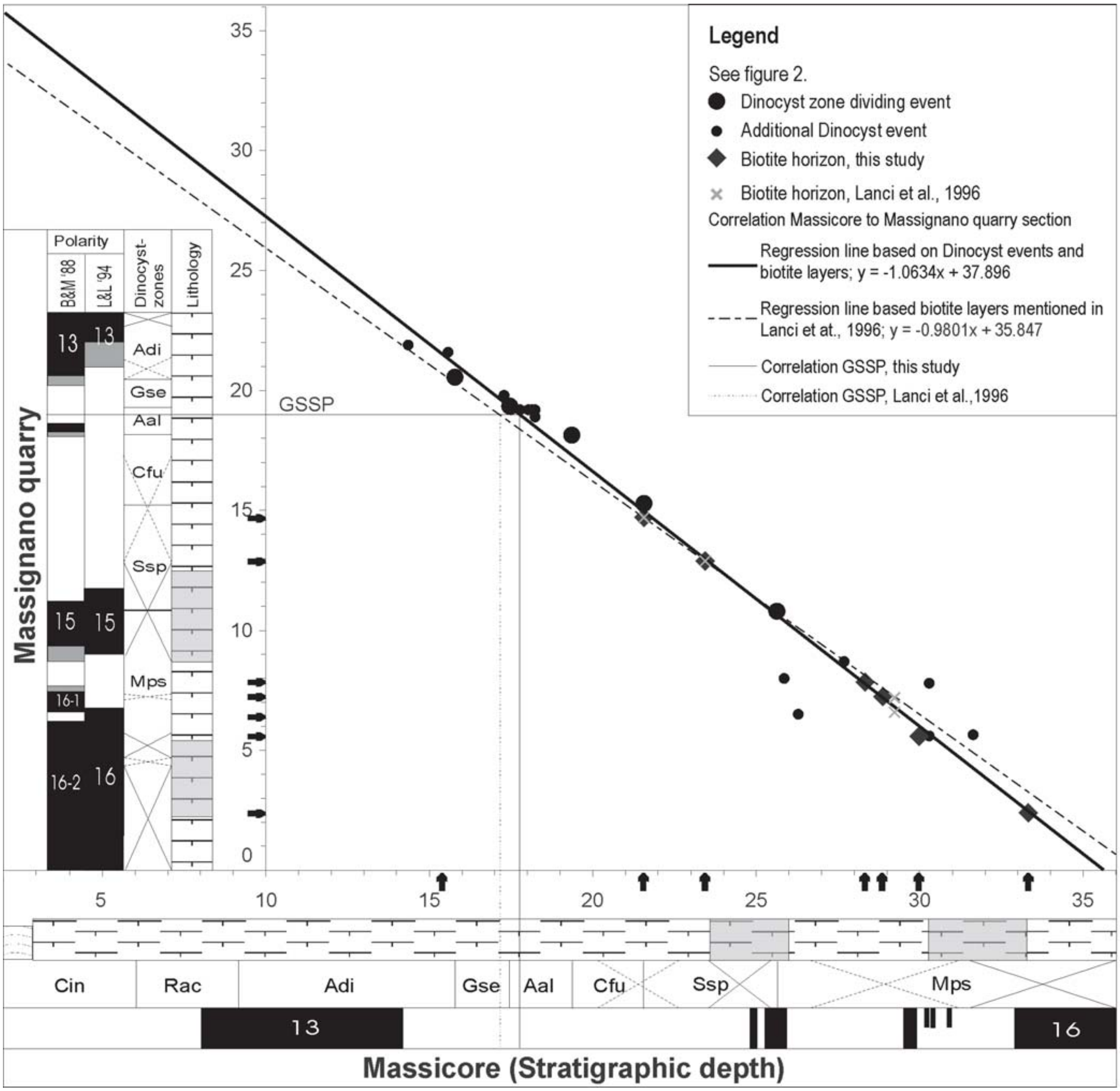
cleaned. The obtained polarity sequence was correlated to Chrons C12r through C16n-2n (Lanci et al. 1996, text-fig 2). Unfortunately, the correlation between the two successions on the basis of magnetic polarity reversals is uncertain (text-fig. 2; see also discussions in Lanci et al. 1996).

METHODS

All samples were processed using standard palynological techniques (cf. Brinkhuis and Biffi 1993; van Mourik et al. 2001) and two slides of each sample were prepared. The samples were counted in two steps. Firstly a minimum of 100 palynomorphs, where possible, were counted and the palynomorphs were grouped into six categories: bisaccate pollen, other pollen and spores, organic inner walls of foraminifera (foram linings), other palynomorphs (prasinophyte algae and acritarchs), indeterminable dinocysts, and determinable dinocysts. The determinable dinocysts were generally counted at the species level. This was then followed by a count of at least 200 dinocysts. The remainder of the slides were scanned for additional (rare) taxa. Dinocyst taxonomy follows that cited in Brinkhuis and Biffi (1993) and Williams et al. (1998). A species list with some remarks is provided in the Taxonomic Appendix. All material is stored at the Laboratory of Palaeobotany and Palynology, Utrecht University, Utrecht, the Netherlands.

RESULTS

Similar to the Massignano quarry samples, Massicore samples contain reasonably preserved palynological assemblages, notably in samples between 1.02m (MC 1.15) to 16m (MC 22.99), and around 10.50m (MC29) (Table 1). In general, the samples are dominated by dinocysts and to a lesser degree by bisaccate pollen, but in the lower non-productive part an increase of prasinophyte algae occurs (Table 1). The additional Massignano quarry samples are generally dominated by dinocysts and prasinophyte algae (Table 1). A dominance of bisaccate pollen in the uppermost meter of the Massicore coincides with the presence of loose soil, indicating that these samples are not useful for quantitative palynological studies of the sediment. Samples containing <20 dinocysts are



TEXT-FIGURE 5
Linear correlation of the Massicore with the Massignano GSSP quarry section by means of biotite-rich layers, dinocyst zone markers and additional dinocyst events (depth quarry =((depth core/-0.92)+37,33) ±0.1).

categorised as barren, while intervals with samples containing <80 dinocysts are listed as 'reduced abundance intervals' (RAI) in text-figures 3 and onward.

The dinocyst zonation of Brinkhuis and Biffi (1993) and their "suite of successive qualitative events" were used as the basis for the stratigraphic interpretation of the dinocyst distribution in the Massicore. The oldest zone recognized in the Massicore is the *Melitasphaeridium pseudorecurvatum* (Mps) Zone, the youngest the *Corrudinium incompositum* (Cin) Zone, which is the base is defined by the last occurrence (LO) of *Glaphyrocysta semitecta* (text-fig. 3). The zonal and interzonal succession of events of Brinkhuis and Biffi (1993) allows a good correlation with the overlapping part of the Massignano quarry section (text-fig. 3). The only apparent discrepancy between the two sequences is the position of the first occurrence (FO) of *Achomosphaera alcicornu*. Two scattered occurrences of *A. alcicornu* are recorded before a first consistent occurrence (FCO; text-fig. 3) in the Massicore sequence. The equivalent intervals in the Massignano quarry section are barren, or RAI, which makes it likely that these 'early' occurrences were initially not picked up in this section. Thus, the base of the *Achomosphaera alcicornu* (Aal) Zone is here redefined, as the FCO of *A. alcicornu*.

TABLE 1
Palynomorph counts from the Massicore and the Massignano quarry.

		Massicore counts							
		till at least 100 palynomorphs							till at least 200 dinocysts
Samples	**Stratgraphic depth**	Bisaccate pollen	Dinocysts	Foram linings	Indeterminabel dinocysts	Pollen & sporen	Other Palynomorphs	**Total Palynomorphs**	**Total dincysts**
MC 1.15	1.02	84.2%	11.7%	*	0.8%	*	3.3%	120	230
MC 1.77	1.58	75.9%	12.1%	*	2.6%	5.2%	4.3%	116	162
MC 1.95	1.74	25.6%	52.1%	*	9.1%	11.6%	1.7%	121	168
MC 2.47	2.20	24.2%	44.4%	*	6.5%	10.5%	14.5%	124	151
MC 2.97	2.65	37.8%	49.3%	2.0%	6.1%	4.1%	0.7%	148	214
MC 3.47	3.09	52.4%	34.9%	*	4.0%	4.8%	4.0%	126	221
MC 3.97	3.54	19.3%	61.3%		8.4%	5.9%	5.0%	119	219
MC 4.47	3.98	9.0%	79.1%		5.2%	6.0%	0.7%	134	217
MC 4.92	4.38	10.6%	77.3%	*	6.4%	4.3%	1.4%	141	212
MC 5.50	4.90	11.4%	67.5%	0.8%	8.9%	10.6%	0.8%	123	191
MC 5.98	5.33	4.2%	73.9%		5.9%	7.6%	8.4%	119	228
MC 6.50	5.79	10.8%	80.0%	0.8%	4.6%	0.8%	3.1%	130	227
MC 7.03	6.26	43.9%	40.7%	1.6%	4.1%	3.3%	6.5%	123	248
MC 7.52	6.70	27.3%	64.5%		4.1%	3.3%	0.8%	121	230
MC 7.98	7.11	17.6%	60.8%	1.6%	5.6%	8.0%	6.4%	125	209
MC 8.52	7.59	12.8%	73.6%	0.8%	4.0%	4.8%	4.0%	125	228
MC 8.98	8.00	18.7%	65.7%	1.5%	5.2%	7.5%	1.5%	134	237
MC 9.43	8.40	10.1%	79.0%	0.8%	5.9%	3.4%	0.8%	119	221
MC 10.06	8.96	6.2%	80.8%	3.1%	6.2%	3.8%		130	214
MC 10.50	9.36	44.4%	42.5%	*	3.9%	6.5%	2.6%	153	246
MC 11.01	9.81	40.3%	48.5%	0.7%	4.5%	0.7%	5.2%	134	248
MC 11.48	10.23	38.5%	53.1%	1.5%	3.1%	3.8%	*	130	231
MC 11.98	10.67	45.2%	41.8%	2.1%	4.8%	4.8%	1.4%	146	236
MC 12.50	11.14	26.2%	59.2%		6.2%	6.9%	1.5%	130	233
MC 13.07	11.65	8.7%	83.3%		4.3%	3.6%		138	250
MC 13.53	12.06	42.0%	48.3%		3.5%	4.2%	2.1%	143	275
MC 14.00	12.47	11.2%	79.0%		4.9%	4.2%	0.7%	143	236
MC 14.52	12.94	4.6%	89.3%		3.1%	0.8%	2.3%	131	232
MC 14.97	13.34	29.0%	65.6%		3.8%	0.8%	0.8%	131	250
MC 15.50	13.81	50.3%	40.8%	*	4.1%	2.7%	2.0%	147	226
MC 15.60	13.90	68.5%	27.4%		3.2%	0.8%	*	124	237
MC 15.70	13.99	32.4%	53.5%	1.2%	4.7%	3.5%	4.7%	170	244
MC 15.80	14.08	11.0%	83.9%		1.7%	1.7%	1.7%	118	228
MC 15.90	14.17	42.1%	51.4%	0.7%	2.9%	1.4%	1.4%	140	242
MC 16.00	14.26	15.8%	77.4%	*	2.7%	2.7%	1.4%	146	259
MC 16.10	14.35	52.1%	38.2%	*	3.0%	1.2%	5.5%	165	262
MC 16.20	14.43	53.6%	38.4%	0.7%	3.6%	2.9%	0.7%	138	252
MC 16.30	14.52	57.0%	41.3%		1.7%			121	236
MC 16.40	14.61	9.2%	77.5%	*	3.3%	5.8%	4.2%	120	238
MC 16.53	14.73	9.3%	82.1%		2.1%	0.7%	5.7%	140	221
MC 16.62	14.81	24.6%	68.0%		1.1%	1.7%	4.6%	175	242
MC 16.99	15.14	59.2%	30.8%		1.5%	4.6%	3.8%	130	229
MC 17.47	15.57	29.9%	59.0%		3.7%	2.2%	5.2%	134	102
MC 17.95	15.99	28.1%	62.3%		2.1%	1.4%	6.2%	146	221
MC 18.50	16.48	5.3%	80.9%		2.3%	0.8%	10.7%	131	220
MC 19.07	16.99	48.2%	25.9%		3.0%	1.8%	21.1%	166	233
MC 19.30	17.20	32.1%	45.5%		3.6%	3.6%	15.2%	165	232
MC 19.41	17.29	12.0%	63.3%		3.3%	2.0%	19.3%	150	240
MC 19.55	17.42	28.8%	47.7%		5.3%	3.0%	15.2%	132	233
MC 19.63	17.49	34.8%	39.3%		5.2%	2.2%	18.5%	135	190
MC 19.75	17.60	26.2%	54.6%		5.5%	1.1%	12.6%	183	260
MC 19.85	17.69	53.8%	27.3%	*	3.8%	3.0%	12.1%	132	214
MC 19.95	17.78	47.5%	18.0%	*	2.9%	1.4%	30.2%	139	241
MC 20.07	17.88	42.6%	43.4%		4.4%	2.9%	6.6%	136	237
MC 20.15	17.95	20.2%	53.5%	*	3.5%	6.1%	16.7%	114	226
MC 20.23	18.02	44.1%	40.0%	0.7%	3.4%	6.2%	5.5%	145	232
MC 20.35	18.13	39.4%	45.7%	*	3.1%	3.9%	7.9%	127	230
MC 20.47	18.24	36.7%	26.7%	0.8%	2.5%	10.0%	23.3%	120	225
MC 20.52	18.28	17.4%	44.0%	*	1.8%	10.1%	26.6%	109	264
MC 20.57	18.33	13.9%	59.9%		4.3%	3.2%	18.7%	187	121

	Massignano quarry counts							
Samples N = this study M = Brinkhuis & Biffi 1993	Bisaccate pollen	Dinocysts	Foram linings	Indeterminabel dinocysts	Pollen & sporen	Other Palynomorphs	**Total Palynomorphs**	**Total dincysts**
M22.80	21.0%	63.0%		16.0%			100	99
M22.20	70.0%	20.0%		8.0%	2.0%		100	103
M21.90	16.1%	77.4%				6.5%	93	97
M21.60	34.0%	57.0%		7.0%	1.0%	1.0%	100	100
M21.30		*					**	**
M21.00		*					**	**
M20.70		*					**	**
M20.40	22.0%	55.0%	1.0%	3.0%	2.0%	17.0%	100	99
M20.10	52.0%	25.0%		9.0%	4.0%	10.0%	100	101
M19.80	71.0%	13.0%		7.0%	4.0%	5.0%	100	100
M19.50	52.0%	35.0%		8.0%	0.0%	5.0%	100	100
M19.20	41.3%	21.2%		7.7%	3.8%	26.0%	104	100
M18.90	55.0%	15.0%	1.0%	10.0%	10.0%	9.0%	100	100
M18.60	9.0%	86.0%		4.0%		1.0%	100	100
M18.30	57.0%	26.0%		7.0%	4.0%	6.0%	100	98
M18.00	12.0%	80.0%		4.0%		4.0%	100	102
M17.70	17.6%	75.5%		1.0%	2.0%	3.9%	102	99
M17.40	38.8%	38.8%		7.1%	4.1%	11.2%	98	101
M17.10		*					**	**
M16.50		*					**	**
M16.80								
M15.90		*					**	**
M14.70		*					**	
M13.80								**
M13.20		*					**	**
M12.90		*					**	**
M8.70	12.0%	6.0%		5.0%		77.0%	100	100
M8.10	3.0%	19.0%		6.0%		72.0%	100	100
N8.00	8.8%	9.8%		2.9%		78.4%	102	125
N7.90	4.2%	45.8%		8.3%		41.7%	24	**
N7.80	5.0%	32.0%		5.0%		58.0%	100	85
M7.80	11.0%	26.0%		3.0%		60.0%	100	99
N7.70								
N7.60	4.5%	33.9%		4.5%		57.1%	112	117
N7.50	2.0%	20.0%		7.0%		71.0%	100	146
M7.50		*				**	**	**
N7.40	3.0%	20.0%		2.0%		75.0%	100	100
N7.35		32.0%		10.0%		58.0%	100	66
N7.30		10.0%		1.0%		89.0%	100	46
N7.20	2.0%	11.0%				87.0%	100	100
M7.20	7.0%	20.0%		6.0%		67.0%	100	94
N7.15	14.0%	36.0%		5.0%		45.0%	100	130
N7.10	4.0%	26.3%		4.0%		65.7%	99	40
N7.00	3.0%	34.0%		6.0%		57.0%	100	92
N6.90		21.0%				79.0%	100	96
M6.90	6.0%	72.0%		1.0%	1.0%	20.0%	100	100
N6.80	2.0%	51.0%		2.0%		45.0%	100	137
N6.70		70.0%				30.0%	100	146
N6.60		70.0%				30.0%	100	130
N6.50		84.0%		1.0%		15.0%	100	130
N6.45	2.0%	18.0%				80.0%	100	160
N6.40	1.9%	5.7%		2.9%		89.5%	105	108
N6.30	4.0%	15.0%		3.0%	1.0%	77.0%	100	82
M6.30		*						**
N6.20	1.0%	16.0%		4.0%		79.0%	100	104
N6.10	5.0%	30.0%		1.0%	1.0%	63.0%	100	150
N6.00	4.0%	49.0%		5.0%	1.0%	41.0%	100	88
N5.90	2.0%	55.0%			1.0%	42.0%	100	167
N5.80		72.0%				28.0%	100	150
N5.70		24.0%		2.0%		74.0%	100	135

TABLE 1, *continued.*
Palynomorph counts from the Massicore and the Massigano quarry.

Samples	Stratgraphic depth	Massicore counts: till at least 100 palynomorphs							Massicore counts: till at least 200 dinocysts
		Bisaccate pollen	Dinocysts	Foram linings	Indeterminabel dinocysts	Pollen & sporen	Other Palynomorphs	Total Palynomorphs	Total dincysts
MC 20.67	18.42	12.8%	67.5%	1.7%	0.9%	2.6%	14.5%	117	263
MC 20.95	18.67	50.0%	21.8%	0.8%		8.1%	19.4%	124	146
MC 21.48	19.14	16.0%	63.9%		4.1%	8.3%	7.7%	169	112
MC 21.98	19.58	5.5%	76.0%		2.1%	3.4%	13.0%	146	194
MC 22.52	20.07	15.9%	69.0%		4.4%	1.8%	8.8%	113	229
MC 22.99	20.48	2.5%	82.5%	1.3%	3.8%	2.5%	7.5%	80	51
MC 23.53	20.97	*	*	*		*		**	**
MC 23.94	21.33	13.3%	50.0%		6.7%	3.3%	26.7%	30	**
MC 24.45	21.78	3.6%	73.2%		7.1%	6.3%	9.8%	112	80
MC 25.01	22.28	*	*			*		**	**
MC 25.56	22.77	17.4%	46.1%		5.2%	2.6%	28.7%	115	187
MC 26.01	23.17	11.1%	77.8%		7.4%	3.7%		27	21
MC 26.50	23.61	*	*					**	**
MC 26.99	24.05	4.5%	63.6%		18.2%		13.6%	22	**
MC 27.43	24.44	*	*		*			**	**
MC 27.99	24.94	*	*		*			**	**
MC 28.51	25.40	4.6%	88.1%		3.7%		3.7%	109	96
MC 29.01	25.85	5.0%	31.3%		2.5%		61.3%	80	222
MC 29.50	26.28	4.9%	50.6%		2.5%		42.0%	81	101
MC 30.02	26.75	1.7%	61.9%		5.9%		30.5%	118	159
MC 30.53	27.20	13.3%	66.7%		6.7%		13.3%	30	20
MC 30.99	27.61	3.4%	31.5%	1.1%	4.5%		59.6%	89	36
MC 31.55	28.11	9.8%	52.9%		3.9%	*	33.3%	51	85
MC 31.99	28.50	1.0%	74.5%		6.1%		18.4%	98	72
MC 32.55	29.00	1.2%	67.1%		8.2%	1.2%	22.4%	85	55
MC 32.99	29.39	4.8%	61.9%		11.9%		21.4%	42	26
MC 33.44	29.80	3.2%	69.9%		8.6%		18.3%	93	99
MC 33.99	30.29		*		*		*	**	**
MC 34.45	30.69	*			*			**	
MC 34.89	31.09								
MC 35.50	31.63	2.9%	50.0%		2.9%	0.7%	43.5%	138	211
MC 38.44	34.25	*	*					**	**
MC 38.95	34.70	*	*		*		*	**	**
MC 39.42	35.12	*	*				*	**	**

Samples N = this study M = Brinkhuis & Biffi 1993	Massignano quarry counts: Bisaccate pollen	Dinocysts	Foram linings	Indeterminabel dinocysts	Pollen & sporen	Other Palynomorphs	Total Palynomorphs	Total dincysts
N5.65	1.0%	41.0%		4.0%	1.0%	53.0%	100	135
N5.60	3.6%	23.2%		3.6%	0.9%	68.8%	112	140
N5.50	11.0%	9.0%		1.0%		79.0%	100	50
N5.40		*					**	**
N5.30		55.0%		3.0%		42.0%	100	57
N5.25								
N5.20								
N5.10		*			*		**	**
N5.00		*					**	**
N4.90	1.0%	39.0%		5.0%		55.0%	100	31
N4.80				*		*	**	
N4.70								
N4.60								
N4.50	1.0%	19.8%		3.0%	1.0%	75.2%	101	76
N4.40	*	33.3%		4.2%		62.5%	24	6
N4.30	2.0%	36.6%			2.0%	59.4%	101	86
N4.20		6.0%				94.0%	100	7
N4.10		43.9%		7.3%	7.3%	41.5%	41	18
N4.00	1.0%	5.0%				94.0%	100	23

* present but not included in the counts
** less than 20 species counted

The relative occurrences of the 'additional dinocyst events' for the Massignano quarry section (including the additional samples from this study) are plotted next to the results from the Massicore in text-figure 4. The expanded dataset is consistent with the initially proposed dinocyst succession.

Combining our new Massignano records with the dinocyst distribution across magneto-subchron C13n known from other central Italian sections (Brinkhuis and Biffi 1993) would place the base of C13n at the Massignano quarry section exactly *between* the base as proposed by Bice and Montanari (1988; Montanari (pers comm. 1998)) and Lowrie and Lanci (1994; text-fig. 3). In the Massicore, the predicted base of C13n should occur around 15.90 m. This is confirmed by the LO of *A. diktyoplokum* (calibrated against the middle of C13n at the other central Italian sections, cf. Brinkhuis and Biffi 1993) at 9.1m. This indicates that the magnetostratigraphic interpretation of the Massicore as proposed by Lanci et al. (1996) is incorrect.

DISCUSSION

When plotting the dinocyst distribution of all Massignano quarry samples next to the Massicore samples using the correlation of Lanci et al. (1996), most events are recorded slightly earlier in the Massicore (text-fig. 4). However, only four biotite horizons, used for correlation, were recognized in the study of Lanci et al. (1996). In the present study, two additional biotite horizons, as recently recognized by Montanari (pers. comm., 2003) are added here (text-fig. 3). Correlation of the complete set of biotite-rich horizons, in combination with the dinocyst record now leads to a new, almost perfect linear correlation (text-fig. 5). This aspect now resolves the above-mentioned discrepancies; remaining small differences are attributed to the equivalents of barren of reduced abundance intervals. The extrapolation of the Massignano quarry E/O GSSP horizon to the Massicore places the boundary at 19.95 meter in the core (17.77m stratigraphic depth), some 75cm higher than previous correlations (Lanci et al. 1996).

TABLE 2
Comparison "composite suite events" Brinkhuis and Biffi (1993) with this study.

Brinkhuis and Biffi, 1993				This study		
Massignano quarry / Monte Cagnero (Type section for Dinocyst zones)				Massignano quarry	Massicore	
	Thickness zones and number of samples	Dinocyst events	Dinocyst zones		Dinocyst events	Thickness zones and number of samples
Monte Cagnero	Thickness 3+ m 11 Samples	LCO *Enneadocysta pectiforme* 'O' Svalbardella cooksoniae LO *Corrudinium incompositum*	Cin		(CO *E. pectiforme*) (O *C. incompositum*)	Thickness 5+ m 7 Samples
Monte Cagnero	Thickness ± 4 m 4 Samples	**LO *Glaphyrocysta semitecta*** FO *Wezeliella gochtii* (Remark)	Rac		**LO *G. semitecta*** FO *W.gochtii* 'O' *S. cooksoniae*	Thickness ± 3 m 7 Samples
Monte Cagnero / Massignano section	Thickness ± 3 m 4 Samples 3+ m, 7 samples	**LO *Areosphaeridium diktyoplokum*** AO *Thalassiphora pelagica (Remark)* FCO *Glaphyrocysta semitecta*	Adi		**LO *A. diktyoplokum*** AO *Th. pelagica* FCO *G. semitecta*	Thickness ± 6,5 m 24 Samples
Massignano section	Thickness ± 1,2 m 4 Samples	**LO *Hemiplacophora semilunifera*** (FO *Stoveracysta?* sp. B&B)* LO *Achilleodinium biformoides* **FO *Glaphyrocysta semitecta***	Gse		**LO *H. semilunifera*** LO *A. biformoides* **FO *G. semitecta***	Thickness ± 1,6 m 6 Samples
Massignano section	Thickness ± 1,2 m 4 Samples	AO bisaccate pollen ** 'FO' *Achilleodinium biformoides* FO Pentadinium lophophorum FO *Achomosphaera* sp. B&B **FO *Achomosphaera alcicornu***	Aal		FCO *P. lophophorum* 'FCO' *A. biformoides* AO bisaccate pollen ** FO *Achomosphaera* sp. B&B **FCO *A. alcicornu***	Thickness ± 1,9 m 14 Samples
Massignano section	Thickness ± 2,9 m 7 Samples	FO *Reticulatosphaera actinocoronata*	Cfu		FO *P. lophophorum*	Thickness ± 2,2 m 5 Samples
Massignano section	Thickness ± 4,5 m 4 Samples	**LO *Schematophora speciosa*** (FO *Stoveracysta* sp.2 B&B) * (FO *Stoveracysta* sp.1 B&B) *	Ssp		**LO *S.speciosa***	Thickness ± 4 m 9 Samples
Massignano section	Thickness 5+ m 7 Samples	**LO *Melitasphaeridium pseudorecurvatum*** AO Prasinophyte algae ** FO Stoveracysta ornata FO *Corrudinium?* sp. B&B	Mps	Thickness 5,5+ m 46 samples FO *Corrudinium?* sp. B&B 'FO' *A. biformoides* FO *R. actinocoronata* FO *Stoveracysta ornata*	**LO *M. pseudorecurvatum*** AO Prasinophyte algae ** 'FO'*A.alcicornu* 'FO' *A. biformoides* FO *S. ornata* FO *Corrudinium?* sp. B&B FO *R. actinocoronata*	Thickness 9,5+ m 17 Samples

FO = First Occurrence	FCO = First Commom Occurrence	' = Scattered occurrence	* = grouped as S. ornata
LO = Last Occurrence	LCO = Last Commom Occurrence	**Species**, zone deviding species	** palynological, non dinocyst event
O = Occurrence	AO = Abundant Occurrence		

This study, in-line with previous results from e.g., Brinkhuis (1994), Stover and Hardenbol (1994), Brinkhuis and Visscher (1995) and Vandenberghe et al. (2003), demonstrates that in the Northern Hemisphere the LO of *Areosphaeridium diktyoplokum* is consistently associated with the ~mid subchron C13n and the Oi-1 event. Moreover, we also confirm that no global dinocyst event is associated with the local extinction of the hantkeninids. While *A. diktyoplokum* is not known to consistently occur in the Southern Hemisphere, recent studies of the Southern Hemisphere Eocene (e.g., Sluijs et al. 2003) have shown that species morphologically closely related to *A. diktyoplokum*, namely *Enneadocysta partridgei* and *Enneadocysta* sp. A of Brinkhuis et al. (2003), all have virtually identical ranges. Thus, the extinction of this complex of dinocysts may well be regarded to represent the E/O junction.

In summary, it appears that the synchroneity between occurrence of the Oi-1 event, the TA4.3/4.4 third order sequence boundary and the LO of *A. diktyoplokum* would represent a much better criterion for global correlation of the E/O boundary. If this concept were applied, this would reinstate the top of the classic Priabonian Stage to the Eocene, and it would place the base of the Rupelian Stage in the earliest Oligocene, correlative to the transgressive phase of cycle TA4.4.

CONCLUSION

The palynological analysis of the expanded Massicore, and additional Massignano quarry samples, has augmented biostratigraphic resolution, resulting in a more refined correlation between the two successions. An improved "composite suite of successive qualitative and quantitative dinocyst events" is provided in Table 2, next to the zonation of Brinkhuis and Biffi (1993). The Cfu/Aal zone boundary is here redefined as the FCO of *A. alcicornu*.

Note that the new correlation of the Massicore with the Massignano quarry section is slightly different than the correlation as proposed by Lanci et al. (1996). The E/O GSSP occurs in the Massicore at meter 17.77 stratigraphic depth and 19.95m core depth, as opposed to 19.2m by Lanci et al. (1996).

This study, which builds upon and further validates the propositions made by Brinkhuis and Visscher (1995), demonstrates that the synchronous occurrence of the Oi-1 event, the TA4.3/4.4 sequence boundary and the LO of *A. diktyoplokum* are better suited as criteria for global correlation of the E/O boundary, than the extinction of the hantkeninids. If this concept is accepted, it would place the top of the classic Priabonian Stage to the Eocene, and it would place the base of the Rupelian Stage in the earliest Oligocene, correlative to the transgressive phase of cycle TA4.4. The age of this proposed level (~33,3 Ma) is ~400 kyr younger than the current ratified E/O GSSP.

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TAXONOMIC APPENDIX

Alphabetical list for the dinoflagellate cysts identified in this study. The dinocyst taxonomy follows Williams et al. (1998).

Achilleodinium biformoides (Eisenack 1954) emend. EATON 1976
Achomosphaera alcicornu (Eisenack 1954) DAVEY and WILLIAMS 1966
Achomosphaera sp. of BRINKHUIS and BIFFI 1993
Areoligera semicirculata (Morgenroth 1966) STOVER and EVITT 1978
Areosphaeridium diktyoplokum (Klumpp 1953) emend. STOVER and WILLIAMS 1995
Batiacasphaera compta DRUGG 1970
Caligodinium amiculum DRUGG 1970
Cannosphaeropsis/Nematosphaeropsis spp. Deflandre and Cookson 1955 / WETZEL 1933
Cerebrocysta spp. Bujak in BUJAK ET AL. 1980
Charlesdowniea clathrata (Eisenack 1938) LENTIN and VOZZHENNIKOVA 1989
Chiropteridium mespilanum (Maier) LENTIN and WILLIAMS 1973
Cleistosphaeridium spp. EATON ET AL 2001
Cooksonidium capricornum Cookson and Eisenack 1965) emend. STOVER and WILLIAMS. 1995
Cordosphaeridium cantharellus (Brosius 1963) GOCHT 1969
Cordosphaeridium fibrospinosum DAVEY and WILLIAMS 1966
Cordosphaeridium funiculatum MORGENROTH 1966
Cordosphaeridium inodes (Klumpp 1953) Eisenack 1963; emend. Morgenroth 1968; emend. SARJEANT 1981
Cordosphaeridium minimum (Morgenroth 1966) BENEDEK 1972
Corrudinium incompositum (Drugg 1970) STOVER and EVITT 1978
Corrudinium? sp. of BRINKHUIS and BIFFI 1993
Cribroperidinium guiseppei (Morgenroth 1966) HELENES 1984
Dapsilidinium spp. BUJAK ET AL. 1980
Deflandrea spp. Eisenack 1938; emend. Williams and Downie 1966; emend. LENTIN and WILLIAMS 1976
Dinopterygium cladoides sensu Morgenroth 1966
Diphyes colligerum (Deflandre and Cookson 1955); emend. GOODMAN and WITMER 1985
Distatodinium craterum EATON 1976
Distatodinium ellipticum (Cookson 1965) EATON 1976
Distatodinium tenerum (Benedek 1972) Eaton 1976; emend. BENEDEK and SARJEANT 1981
Enneadocysta pectiniforme (Gerlach 1961) emend. STOVER and WILLIAMS 1995
Eocladopyxis tesselata LIENGJARERN ET AL. 1980
Fibrocysta spp. STOVER and EVITT 1978
Gelatia inflata BUJAK 1984
Glaphyrocysta intricata (Eaton 1971) STOVER and EVITT 1978
Glaphyrocysta priabonensis BRINKHUIS 1994
Glaphyrocysta semitecta (Bujak in Bujak et al. 1980) LENTIN and WILLIAMS 1981
Glaphyrocysta spp. (pars) STOVER and EVITT 1978
Glaphyrocysta texta (Bujak 1976) STOVER and EVITT 1978
Hemiplacophora semilunifera COOKSON and EISENACK 1965
Heteraulacacysta campanula DRUGG and LOEBLICH 1967
Heteraulacacysta? leptalea EATON 1976
Histiocysta spp. DAVEY 1969
Homotryblium spp. DAVEY and WILLIAMS 1966
Hystrichokolpoma spp. KLUMPP 1953
Hystrichokolpoma sp of BIFFI and MANUM 1988
Hystrichosphaeropsis sp. of BRINKHUIS and BIFFI 1993
Hystrichosphaeropsis rectangularis Bujak in BUJAK ET AL. 1980
Impagidinium brevisulcatum MICHOUX 1985
Impagidinium cf. *aculeatum* (Wall 1967), LENTIN and WILLIAMS 1981
Impagidinium cf *brevisulcatum* of BRINKHUIS and BIFFI 1993
Impagidinium dispertitum (Cookson and Eisenack 1965) STOVER and EVITT 1978
Impagidinium maculatum (Cookson and Eisenack 1965) STOVER and EVITT 1978
Impagidinium pallidum BUJAK 1984
Impagidinium sp. of BRINKHUIS and BIFFI 1993
Impagidinium velorum BUJAK 1984
Lejeunecysta tenella (Morgenroth 1966) WILSON and CLOWES 1980
Lentinia serrata Bujak in BUJAK ET AL. 1980
Lingulodinium spp. WALL 1967
Melitasphaeridium pseudorecurvatum (Morgenroth 1966) BUJAK ET AL. 1980
Operculodinium spp. WALL 1967
Palaeocystodinium golzowense ALBERTI 1961
Pentadinium goniferum EDWARDS 1982
Pentadinium laticinctum Gerlach 1961; emend. BENEDEK ET AL. 1982
Pentadinium lophophorum Benedek 1972, emend. BENEDEK ET AL. 1982
Phthanoperidinium spp. DRUGG and LOEBLICH JR. 1967
Reticulatosphaera actinocoronata (Benedek 1972) emend. BUJAK and MATSUOKA 1986
Rhombodinium porosum BUJAK 1979
Rottnestia borussica (Eisenack 1954) COOKSON and EISENACK 1961
Samlandia spp. EISENACK 1954
Schematophora speciosa Deflandre and Cookson 1955, emend. STOVER 1975
Spiniferites sp.1 of VAN MOURIK ET AL. 2001
Spiniferites spp. MANTELL 1850
Stoveracysta ornata (Cookson and Eisenack 1965) CLOWES 1985
Remark: The original data set from BRINKHUIS and BIFFI 1993 was used, but all *Stoveracysta* species are grouped under *Stoveracysta ornata.*
Svalbardella cooksoniae MANUM 1960
Tectatodinium pellitum Wall 1967 emend. HEAD 1994
Tectatodinium sp.1 of BRINKHUIS and BIFFI 1993
Tectatodinium sp.2 of BRINKHUIS and BIFFI 1993
Thalassiphora? sp. of BRINKHUIS and BIFFI 1993
Thalassiphora patula (Williams and Downie 1966) STOVER and EVITT 1978
Thalassiphora pelagica (Eisenack 1954) Eisenack and Gocht 1960; emend. BENEDEK and GOCHT 1981
Thalassiphora succincta MORGENROTH 1966
Thalassiphora velata (Deflandre and Cookson 1955); EISENACK and GOCHT 1960
Turbiosphaera spp. ARCHANGELSKY 1969
Wetzeliella gochtii COSTA and DOWNIE 1976

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APPENDIX 1

Range chart for the Massicore quarry.

Dinocyst zones	Samples	Stratigraphic depth (Core depth * Cos27°)	TOTAL DINOCYSTS COUNTED	*Impagidinium dispertitum*	*Spiniferites* spp.	*Enneadocysta pectiniforme*	*Impagidinium* sp. of Brinkhuis and Biffi '93	*Impagidinium brevisulcatum*	*Lingulodinium* spp.	*Nematosphaeropsis/Cannosphaeropsis* spp.	*Spiniferites pseudofurcatus*	*Cleistosphaeridium* spp.	*Impagidinium* cf. *aculeatum*	*Operculodinium microtrianum*	*Reticulatosphaera actinocoronata*	*Thalassiphora pelagica*	*Operculodinium* cf. *hirsutum*	*Cordosphaeridium cantharellum*	*Thalassiphora succincta*	*Phthanoperidinium multispinum*	*Hemiplacophora semilunifera*	*Thalassiphora delicata*	*Melitasphaeridium pseudorecurvatum*	*Impagidinium velorum*	*Stoveracysta ornata*	*Corrudinium*? sp. of Brinkhuis and Biffi '93	*Diphyes colligerum*	*Cribroperidinium guiseppei*	*Operculodinium tiara*	*Dapsilidinium* spp.	*Phthanoperidinium comatum*	*Areosphaeridium diktyoplokus*
Cin	MC 1.15	1.02	230	*	27.0%	0.9%	0.4%		2.2%	*	6.1%	4.3%												6.5%	9.6%			0.4%	0.4%			
	MC 1.77	1.58	162	0.6%	11.1%	2.5%	0.6%		0.6%	1.2%	6.2%	23.5%	0.6%											1.2%	8.0%	3.7%			2.5%			
	MC 1.95	1.74	168		29.2%		23.2%		0.6%	0.6%	0.6%	6.5%	2.4%											7.1%	1.2%	3.6%			1.2%	0.6%		
	MC 2.47	2.20	151	2.6%	27.8%		3.3%		0.7%	0.7%		20.5%		1.3%										2.0%	0.7%	2.6%			2.0%			
	MC 2.97	2.65	214	0.9%	44.4%	0.5%	13.6%		2.3%	1.4%		11.2%	2.3%	0.9%	0.5%									2.8%	0.5%				0.9%	0.5%		
	MC 3.47	3.09	221	2.3%	45.2%	1.4%	9.0%		0.9%	2.7%	0.5%	4.5%	3.2%	1.4%	0.9%	*								1.8%	1.8%					1.8%		
	MC 3.97	3.54	219	1.8%	47.0%	1.8%	0.9%		3.7%	2.3%	0.5%	17.4%	1.4%	2.7%	0.9%		1.4%							2.7%					2.7%	0.5%		
	MC 4.47	3.98	217	0.5%	41.5%	0.5%	9.7%		2.8%	1.8%		4.6%	4.1%	0.5%	1.4%		0.9%	0.5%						13.4%	1.8%				2.8%	0.9%	0.9%	
	MC 4.92	4.38	212	0.5%	37.3%		22.6%		2.4%	1.4%		1.9%	4.2%	0.9%	0.5%	5.7%	1.4%							2.4%		0.9%			2.4%	0.5%		
	MC 5.50	4.90	191	0.5%	31.9%		21.5%		0.5%	3.1%	1.0%	11.0%	4.2%	2.1%	0.5%	5.2%								2.1%	0.5%	0.5%			1.0%			
	MC 5.98	5.33	228	0.9%	46.5%		12.7%		2.6%	1.3%	1.8%	1.8%	3.5%		0.4%	8.8%	0.9%	0.4%						1.3%		0.9%			1.3%			
	MC 6.50	5.79	227		58.1%	0.4%	2.2%		3.1%	1.3%	1.3%	4.0%	0.4%	1.3%	*	4.8%	0.9%	0.4%						2.2%	0.4%	0.4%			3.5%	1.8%		
Rac	MC 7.03	6.26	248	0.8%	40.7%	0.4%	2.4%		2.0%	2.8%	8.1%	5.2%	0.8%	0.8%		9.7%	1.2%	2.0%						1.2%	0.4%	1.2%			1.2%	0.4%		
	MC 7.52	6.70	230	0.9%	47.4%	0.4%	7.4%		0.9%	3.5%	6.5%	2.6%	3.0%		0.4%	0.4%	1.3%	0.4%						3.0%	0.4%				0.9%	0.4%		
	MC 7.98	7.11	209	0.5%	53.6%	*	0.5%		0.5%	1.0%	1.0%	2.4%	0.5%	2.4%	*	5.3%	2.4%	*						1.4%	1.4%	0.5%			4.8%			
	MC 8.52	7.59	228	0.4%	62.7%	0.4%	3.1%		0.4%	2.2%	0.4%	2.2%	0.4%	3.1%	0.4%	*	1.3%							2.2%	0.4%	0.4%			0.9%			
	MC 8.98	8.00	237		34.2%		1.7%		3.0%	*	21.1%	5.5%	0.4%	5.1%	1.3%	1.3%	*							1.3%	0.4%	1.3%			2.5%	0.4%	1.3%	
	MC 9.43	8.40	221	2.3%	38.9%		5.9%		2.3%	1.8%	0.9%	5.4%	1.8%	2.7%	1.4%	0.9%	0.9%							2.3%	1.8%				1.8%	0.9%		
	MC 10.06	8.96	214	2.3%	36.4%		9.3%		1.4%	1.9%		13.1%	0.5%	2.3%	1.9%	0.9%	0.9%							0.9%	9.3%				2.3%	1.4%		
Adi	MC 10.50	9.36	246	0.4%	41.1%	2.0%	1.6%		2.8%	0.8%	0.4%	0.8%	0.4%	2.0%	3.3%	1.6%			*					2.0%	1.6%				4.1%	2.0%		2.0%
	MC 11.01	9.81	248	0.8%	37.9%	*	1.2%		2.0%	1.6%	1.6%	3.2%		1.2%	1.2%	*	1.2%		0.4%					3.6%	0.4%				2.8%	0.8%	0.4%	0.4%
	MC 11.48	10.23	231	1.3%	32.0%		3.0%		2.2%	1.3%		1.3%	0.4%		0.9%	4.8%	0.4%							0.9%		0.4%			2.6%			0.9%
	MC 11.98	10.67	236		35.2%					0.4%	2.1%	2.5%		0.4%	0.8%	1.3%	0.8%												3.0%			0.8%
	MC 12.50	11.14	233	1.3%	46.4%		10.3%		0.9%	1.7%	0.4%	2.1%	9.0%	0.4%	2.1%									2.6%	0.9%		0.4%		1.3%	0.4%	0.4%	
	MC 13.07	11.65	250	0.4%	55.2%		2.0%	0.8%	1.2%	2.8%		2.8%	0.4%		1.6%	6.4%	1.6%							1.2%	3.2%	0.4%	1.2%		*	*		2.4%
	MC 13.53	12.06	275	0.7%	42.2%		5.1%	2.2%	0.4%	1.5%		1.1%	0.7%	0.4%	0.4%	6.5%	*							0.7%	3.3%	1.1%	0.4%	2.5%	1.1%			0.4%
	MC 14.00	12.47	236	0.4%	51.7%		8.1%		3.0%	3.4%	0.4%	0.4%	3.0%	0.8%	0.8%	*	0.4%		0.4%					1.7%	0.8%	0.8%	0.8%	0.4%	1.3%	1.3%	0.8%	0.8%
	MC 14.52	12.94	232	1.7%	40.5%	1.7%	6.0%		0.4%	3.9%		5.6%	1.3%	1.7%		4.3%	*							2.2%	4.3%	1.7%			1.3%			
	MC 14.97	13.34	250	0.8%	30.4%	14.8%	0.8%	1.2%		0.4%	0.4%	10.4%		4.8%		2.8%	1.2%		0.4%					2.0%	2.0%	2.8%		0.8%	2.0%	0.4%		7.2%
	MC 15.50	13.81	226		43.4%	8.0%	3.1%		0.4%	2.2%	0.4%	5.3%	0.4%	1.3%	2.2%	0.9%			0.4%					0.4%	3.1%			*	2.7%	0.9%		
	MC 15.60	13.90	235	0.4%	43.4%	0.9%	2.1%		0.4%	0.9%		10.2%	1.7%	4.3%		1.7%	1.7%		1.7%					2.6%	3.8%	0.4%		0.9%	1.7%	0.9%		*
	MC 15.70	13.99	244	1.2%	42.2%		3.7%		0.4%	2.0%	1.2%	8.2%	2.5%	0.8%	0.4%	2.9%	4.1%		2.0%					1.2%	2.9%				2.5%	0.4%		1.6%
	MC 15.80	14.08	228	*	35.5%	0.4%	4.8%		1.8%	2.2%	2.6%	11.0%	1.3%	3.5%	1.8%	5.7%	2.6%		2.6%					2.2%	3.1%			0.4%	1.3%			1.8%
	MC 15.90	14.17	240	1.3%	29.6%	0.4%	1.7%		2.1%	2.9%	1.7%	15.0%	0.4%	7.9%	0.8%	2.5%	3.3%		*					1.7%	7.9%	0.4%		0.8%	1.7%	0.8%	0.4%	0.4%
	MC 16.00	14.26	257	2.3%	37.7%	1.6%	4.7%		0.8%	2.3%	3.1%	7.4%	1.9%	4.3%	0.4%	2.3%	0.8%	0.4%	0.8%					2.7%	1.9%			0.4%	0.4%	0.8%		0.4%
	MC 16.10	14.35	259		33.2%	5.4%	6.6%		0.4%	1.5%	0.8%	7.7%	1.5%	3.5%	0.8%	4.6%	*		0.4%					0.8%	1.9%	0.4%		3.1%	4.2%	1.5%	0.8%	0.4%
	MC 16.20	14.43	252	0.8%	41.3%	2.4%	8.7%		1.2%	4.0%	2.4%	2.4%	2.8%	10.3%	1.6%	1.2%	0.4%		*					2.0%	4.8%				4.4%	0.8%		0.4%
	MC 16.30	14.52	236	0.8%	53.8%	1.3%	5.5%		0.8%	1.7%	0.8%	2.5%	1.3%	4.7%	0.8%	2.5%	1.3%		0.4%					2.1%	0.8%			1.3%	4.2%			0.4%
	MC 16.40	14.61	238	2.1%	41.6%	0.8%	18.1%		0.8%	4.6%	0.8%	2.5%	0.8%	3.4%		0.8%	0.8%		*					2.9%	7.1%			0.4%	3.8%			0.4%
	MC 16.53	14.73	219	0.9%	34.2%	0.9%	11.4%		1.4%	7.8%	1.4%	7.8%	1.4%	5.9%		1.4%	2.3%		*	0.5%				1.4%	4.1%			1.4%	7.8%		0.5%	
	MC 16.62	14.81	242	0.8%	40.5%		6.2%			7.4%	1.7%	5.8%	1.2%	0.8%		2.1%	0.4%		0.8%					0.8%	10.3%				8.7%	0.4%	0.4%	*
	MC 16.99	15.14	229	3.1%	45.0%	0.9%	15.7%		0.9%	8.3%	1.7%	1.7%		2.2%	0.4%									2.2%					3.5%			
	MC 17.47	15.57	102	2.9%	34.3%		19.6%		1.0%	9.8%	2.0%	6.9%	2.0%	2.0%		2.0%								1.0%					2.9%		1.0%	1.0%
Gse	MC 17.95	15.99	221		38.5%		14.9%		2.3%	1.4%	6.8%	6.8%		0.9%		0.9%					0.5%			3.2%					3.2%			
	MC 18.50	16.48	220	0.5%	61.4%		5.0%	0.5%	1.4%	2.7%	3.2%	5.9%		0.9%		5.9%			0.5%		1.4%			0.5%	1.8%				0.9%		0.5%	1.4%
	MC 19.07	16.99	233	0.4%	46.4%	1.3%	6.0%		1.7%	5.2%	4.7%	4.7%		2.1%	1.3%	3.0%	0.4%		0.4%		1.3%			1.7%					3.0%		2.1%	
	MC 19.30	17.20	232	1.7%	34.9%	10.3%	5.2%		0.9%	2.6%	7.3%	3.0%		3.0%	1.7%	8.2%			0.4%					2.2%				0.9%	5.6%			2.6%
	MC 19.41	17.29	240	6.7%	27.9%	5.0%	15.0%		1.3%	10.4%	5.4%	2.1%		2.5%		3.3%								3.3%				0.4%	4.2%	0.8%		
	MC 19.55	17.42	233	1.7%	26.6%		20.6%		0.4%	7.3%	6.4%	4.7%	2.1%	3.4%	1.7%	3.4%	0.9%		0.4%					6.4%				1.3%	3.4%	0.4%		2.1%
Aal	MC 19.63	17.49	190	1.1%	20.0%		16.3%		1.1%	15.3%		12.6%		5.3%		5.8%			*					4.2%					8.9%		0.5%	3.2%
	MC 19.75	17.60	260	2.3%	41.2%	1.5%	8.8%			5.4%	3.5%	5.0%		3.8%	1.9%	*	1.9%		0.8%		1.5%			1.9%			0.4%	1.9%	5.8%			
	MC 19.85	17.69	214	3.3%	30.4%	17.8%	4.7%			1.4%	3.3%	3.3%	2.8%	1.4%	1.4%		0.9%		0.9%		0.5%			3.7%		0.9%		3.7%	6.1%	0.9%		
	MC 19.95	17.78	234	1.7%	37.6%	16.2%	3.0%		0.4%	1.7%	0.4%	1.7%	1.3%	3.8%	0.4%	2.1%			0.9%		2.1%			4.3%		1.3%	*		2.6%	1.3%		
	MC 20.07	17.88	236	1.3%	45.8%	7.2%	3.0%			1.7%	0.8%	3.0%	3.0%	0.8%	0.4%	10.6%	0.4%		0.8%		1.3%	*		0.4%	4.7%	*			3.0%			
	MC 20.15	17.95	225	1.8%	46.7%	3.6%	2.7%		0.4%	1.8%	12.0%	1.8%	1.8%	1.3%		1.8%	0.4%				2.2%	*		2.2%	3.1%	*			1.3%	0.4%		
	MC 20.23	18.02	232	1.3%	42.7%	18.1%	1.3%	*	1.3%	3.9%	1.3%	3.4%	1.3%	3.0%	*	2.2%	0.4%	0.4%	0.4%		1.3%			0.4%	1.3%	0.4%		0.4%	1.3%	0.4%		
	MC 20.35	18.13	230	1.3%	38.7%		4.8%		1.3%	6.1%	11.7%	2.2%	1.3%	1.7%	0.4%	3.5%			*		5.2%	*		1.7%	2.2%		*		3.0%			
	MC 20.47	18.24	225	6.2%	34.2%	9.8%	1.3%	0.4%	0.4%	0.4%	3.6%	12.4%	1.8%						*		1.3%			1.8%	12.4%		0.4%		1.3%	0.4%		
	MC 20.52	18.28	264	1.1%	39.0%	2.3%	11.7%	0.8%	3.0%	4.2%		4.5%	4.5%	8.7%	1.1%							0.4%		1.9%	5.3%				1.5%		1.1%	
	MC 20.57	18.33	121		31.4%	5.0%	9.9%	0.8%	9.1%	5.8%	2.5%	3.3%	5.0%	4.1%	0.8%		1.7%					0.8%		5.0%	9.1%					0.8%	0.8%	
	MC 20.67	18.42	262		59.5%	0.4%	9.2%	0.4%	0.8%	4.6%	1.9%	1.1%	5.3%	0.4%		0.4%	0.8%							1.9%	1.5%							
	MC 20.95	18.67	146	2.7%	11.0%	18.5%	4.1%	1.4%	0.7%	4.8%	3.4%	1.4%	1.4%	7.5%	4.1%		2.7%		*		0.7%	3.4%		1.4%	9.6%						0.7%	
	MC 21.48	19.14	112	3.6%	47.3%	0.9%	5.4%		0.9%	8.9%		0.9%	1.8%	4.5%	1.8%							0.9%		3.6%	8.0%		0.9%					
Cfu	MC 21.98	19.58	194	1.0%	51.5%		8.8%			6.2%	1.0%	3.1%	1.0%	10.8%	2.1%									2.6%	1.5%					0.5%		0.5%
	MC 22.52	20.07	229	0.4%	45.4%	3.9%	6.1%	0.4%	0.4%	3.1%	1.7%	7.0%	1.3%	7.0%		3.1%					0.4%	0.9%		0.4%	10.5%				1.3%			
	MC 22.99	20.48	51	2.0%	31.4%	3.9%	11.8%			3.9%		2.0%	2.0%	3.9%											21.6%					2.0%		
	MC 23.53	20.97	**		*																				*							
	MC 23.94	21.33	**		*	*	*			*															*							
Ssp	MC 24.45	21.78	79	3.8%	24.1%		3.8%	1.3%	1.3%	1.3%		5.1%		1.3%				2.5%			1.3%				6.3%					1.3%		
	MC 25.01	22.28	**		*																				*							
	MC 25.56	22.77	187	5.3%	27.3%	7.0%	5.9%	1.6%		1.1%	3.2%	3.7%		8.0%	0.5%	1.1%	0.5%	0.5%						0.5%	24.1%						0.5%	0.5%
	MC 26.01	23.17	21		23.8%	23.8%	23.8%				9.5%	9.5%	4.8%	4.8%																		
	MC 26.50	23.61	**		*													*														
	MC 26.99	24.05	**		*							*		*											*							
	MC 27.43	24.44	**		*																											
	MC 27.99	24.94	**				*					*					*								*							*
	MC 28.51	25.40	96		42.7%		5.2%			16.7%	5.2%	1.0%		12.5%	2.1%		1.0%	1.0%			3.1%	1.0%			3.1%							1.0%
Mps	MC 29.01	25.85	222	5.4%	21.6%	0.9%	7.2%			2.7%	5.0%	1.8%	4.1%	6.3%	1.4%	7.2%					0.9%	18.0%	0.5%	0.9%	5.9%	2.7%			0.5%	0.5%		
	MC 29.50	26.28	101		41.6%		5.0%			1.0%		4.0%	3.0%	8.9%				1.0%			1.0%	6.9%		1.0%	5.9%	4.0%						
	MC 30.02	26.75	159	1.9%	11.9%		1.3%				1.3%	15.7%	3.1%	3.1%		0.6%	0.6%	3.1%	0.6%		1.3%	1.3%		0.6%	3.8%	0.6%		#####				
	MC 30.53	27.20	20		40.0%			5.0%				15.0%	5.0%									5.0%		5.0%								
	MC 30.99	27.61	36	2.8%	66.7%			2.8%				8.3%			2.8%							2.8%						5.6%				
	MC 31.55	28.11	85	2.4%	42.4%		8.2%	4.7%		4.7%		3.5%	4.7%					1.2%			20.0%	2.4%	1.2%	1.2%								
	MC 31.99	28.50	72		59.7%		9.7%			13.9%		1.4%	2.8%	5.6%							2.8%	0.0%	1.4%					1.4%				
	MC 32.55	29.00	55		21.8%		5.5%			14.5%	7.3%	10.9%		3.6%			1.8%				20.0%	7.3%			3.6%							3.6%
	MC 32.99	29.39	26	7.7%	50.0%		7.7%			11.5%		3.8%		3.8%			7.7%					7.7%										
	MC 33.44	29.80	99	5.1%	30.3%	2.0%		2.0%		4.0%	9.1%	22.2%	1.0%	4.0%		8.1%	1.0%					3.0%						1.0%	3.0%	1.0%	3.0%	
	MC 33.99	30.29	**		*		*				*			*						*	*	*		*	*	*	*					
	MC 34.45	30.69	0																													
	MC 34.89	31.09	0																													
	MC 35.50	31.63	211	1.4%	33.6%	40.3%	2.4%		0.5%	1.4%	0.9%	0.9%	2.4%	3.8%	0.9%	0.5%	0.9%	0.5%	0.5%	0.5%	6.2%	0.5%	1.9%									
	MC 38.44	34.25	**			*	*	*																								
	MC 38.95	34.70	**		*																											
	MC 39.42	35.12	**	*																												

* present but not included in the counts.

** Lesser than 20 species per sample.

APPENDIX 1, *continued*.
Range chart for the Massicore quarry.

Dinocyst zones	Samples	Stratigraphic depth (Core depth * Cos27°)	TOTAL DINOCYSTS COUNTED	*Cordosphaeridium minimum*	*Escharisphaeridia* sp.	*Hystrichokolpoma* spp.	*Corrudinium incompositum*	*Deflandrea phosphoritica* & spp.	*Distatodinium craterum*	*Homotryblium* spp.	*Operculodinium* sp. of Brinkhuis and Biffi '93	*Glaphyrocysta intricata*	*Achilleodinium biformoides*	*Schematophora speciosa*	*Hystrichosphaeropsis* sp. of Brinkhuis and Biffi '93	*Achomosphaera alcicornu*	*Heteraulacocysta? leptalea*	*Cerebrocysta* spp.	*Samlandia* spp.	*Areosphaeridium michoudii*	*Cordosphaeridium funiculatum*	*Pentadinium laticinctum*	*Pentadinium lophophorum*	*Glaphyrocysta pirabonensis*	*Hystrichosphaeropsis rectangularis*	*Rottnestia borussica*	*Fibrocysta* spp.	*Dinopterygium cladoides*	*Deflandrea granulata*	*Distatodinium ellipticum*	*Spiniferites* sp. of van Mourik et al. 2001	*Thalassiphora?* sp. of Brinkhuis and Biffi '93	*Achomosphaera* sp. of Brinkhuis and Biffi '93
Cin	MC 1.15	1.02	230	*		0.4%	0.4%	27.0%		1.7%						4.8%		0.4%	1.3%			0.4%							4.3%	0.4%			
	MC 1.77	1.58	162							0.6%	0.6%					32.1%		0.6%				0.6%											
	MC 1.95	1.74	168				0.6%	1.8%		0.6%						17.9%											0.6%		1.2%				
	MC 2.47	2.20	151				1.3%	2.0%		0.7%	0.7%					19.2%			1.3%			0.7%							2.0%	0.7%			
	MC 2.97	2.65	214	*			*	0.5%	0.9%	0.9%	2.3%					2.8%		0.5%	0.9%			*			*				2.3%		2.3%		
	MC 3.47	3.09	221	1.4%		3.2%	5.4%	1.8%			3.6%								0.9%			*			1.4%			0.5%	1.4%				
	MC 3.97	3.54	219				1.4%	0.9%		0.5%						0.5%			1.4%			4.6%			0.5%	0.5%	1.4%		0.5%				
	MC 4.47	3.98	217	0.5%			2.3%	0.9%		0.5%						0.9%			1.8%				0.5%			*	0.9%		0.5%	0.9%			
	MC 4.92	4.38	212	0.5%		1.9%	6.6%			0.9%						0.5%										0.5%	0.9%			0.9%			
	MC 5.50	4.90	191			0.5%	1.0%	1.0%								1.0%			0.5%			1.6%			1.0%					0.5%			
	MC 5.98	5.33	228	1.8%			2.2%	0.9%											0.4%			0.4%			1.3%					0.9%			
	MC 6.50	5.79	227	0.9%			1.3%	0.4%		0.4%						3.1%			1.3%			*			0.9%	*			*	1.3%			
Rac	MC 7.03	6.26	248	1.2%		*	*	*	0.4%	0.4%						7.3%			0.8%						1.6%					3.2%			
	MC 7.52	6.70	230	0.4%			3.5%	3.0%		0.9%						5.2%	*		0.4%			1.7%							1.7%	1.7%			
	MC 7.98	7.11	209	1.0%			1.9%	3.3%		1.4%						1.0%	0.5%		*			1.9%			0.5%	*			5.3%	1.0%			
	MC 8.52	7.59	226	0.9%			7.0%	1.3%		0.4%						1.3%	0.9%		1.3%			0.9%							0.4%	1.8%			
	MC 8.98	8.00	237	4.6%		0.8%	1.7%	0.8%	*	*						8.0%	*		*									0.8%	*	1.7%			
	MC 9.43	8.40	221	2.3%			1.4%	3.2%	0.5%	0.9%						4.1%			1.4%						0.9%		1.4%		5.4%	3.2%			
	MC 10.06	8.96	214	4.7%			1.9%	0.5%	0.5%	0.5%												0.5%							5.6%				
Adi	MC 10.50	9.36	246	3.3%		1.6%	0.4%	6.9%	0.8%	0.4%										0.4%		1.2%			0.8%				2.0%	1.6%	2.0%		
	MC 11.01	9.81	248	1.2%		0.4%	7.3%	4.4%		2.8%		0.4%							*			0.4%	0.4%			0.8%		2.0%	3.2%	0.4%	0.8%		
	MC 11.48	10.23	231	0.4%			3.9%	22.1%		0.4%															*	0.4%			16.9%				
	MC 11.98	10.67	236				3.0%	23.3%		4.2%						0.8%				0.4%					0.8%	0.4%			18.6%	0.4%		*	
	MC 12.50	11.14	233			0.4%	4.3%	2.6%									0.4%			0.4%			0.4%		0.9%	0.9%			2.1%	*			
	MC 13.07	11.65	250	1.2%		0.4%	1.6%	1.2%	0.4%							0.8%	*			0.4%						*			2.8%	0.4%	0.8%		
	MC 13.53	12.06	275	1.1%		0.4%	3.3%	4.7%				0.4%				0.4%	1.1%			0.7%					0.4%				7.6%	*	*	0.7%	
	MC 14.00	12.47	236	1.7%			0.8%	3.4%	0.4%			0.4%					0.8%			0.4%		0.4%	0.4%			0.4%			3.0%	2.5%			
	MC 14.52	12.94	232			*	16.8%	1.3%				0.9%				0.9%						0.4%			*				0.4%	*			
	MC 14.97	13.34	250			0.8%	0.8%	1.2%								4.8%	0.4%					*				1.2%			2.0%	2.0%	0.4%		
	MC 15.50	13.81	226	*		*	2.7%	5.3%	0.4%							7.5%	1.8%					0.4%					*		1.3%	3.1%	*		
	MC 15.60	13.90	235	1.3%		0.9%	1.3%	6.4%		1.3%						4.3%	0.4%												1.7%	2.1%		0.4%	
	MC 15.70	13.99	244	0.4%		0.4%	*	7.4%								2.9%				0.4%		0.8%						0.8%	2.9%	0.8%	0.8%	0.4%	
	MC 15.80	14.08	228	0.9%		*	0.9%	3.5%		0.4%						1.3%						1.3%	0.4%						0.4%	2.2%	3.5%		
	MC 15.90	14.17	240	0.4%		0.4%	0.8%	6.3%		0.8%						0.8%				*		*	0.4%	0.4%		0.4%		1.3%	2.9%	0.8%	0.4%		
	MC 16.00	14.26	257	0.4%		0.4%	2.7%	5.8%		1.2%						1.6%				0.4%		0.8%	1.6%	0.8%				0.4%	3.1%	1.6%			
	MC 16.10	14.35	259	1.2%		1.5%	1.2%	6.6%		1.9%	0.8%					1.9%	*			*				0.4%					1.9%	1.2%			
	MC 16.20	14.43	252	0.4%		0.4%	0.8%	0.4%		1.2%										0.4%		0.8%						0.4%	0.8%	0.4%	1.6%	0.4%	
	MC 16.30	14.52	236	0.8%			0.8%	1.3%	0.4%	0.8%	0.8%					0.8%				*		0.8%						0.4%	1.3%	0.8%			
	MC 16.40	14.61	238	0.4%		1.3%	0.4%	*		0.8%	0.8%					1.3%				0.4%		0.4%	*		0.4%					*			
	MC 16.53	14.73	219			0.5%	*	*		1.8%	2.3%					0.9%				0.5%			*		*				*	0.9%	0.5%	0.5%	
	MC 16.62	14.81	242					*		0.8%	0.8%					1.7%			0.8%	0.4%		0.4%	0.4%						1.7%	0.4%		0.4%	
	MC 16.99	15.14	229	0.4%		0.4%	1.7%	0.4%		0.4%	4.4%					0.4%			0.4%			*	*						0.9%	3.1%		0.4%	0.4%
	MC 17.47	15.57	102			1.0%	1.0%				4.9%								1.0%			1.0%											
Gse	MC 17.95	15.99	221				5.9%			1.4%	4.5%					0.5%						0.9%								0.5%	6.3%		0.9%
	MC 18.50	16.48	220				0.5%				1.4%									1.8%					0.9%					1.4%			
	MC 19.07	16.99	233	1.7%			3.0%	0.4%			3.0%					0.9%			0.4%			0.4%	*		0.4%					2.6%		0.9%	
	MC 19.30	17.20	232			0.9%	0.9%	0.4%		0.9%						0.9%			*			0.9%	0.4%		0.9%				*	0.4%		0.4%	0.9%
	MC 19.41	17.29	240			0.8%	0.4%	0.8%					0.8%			2.9%			0.8%			0.8%	1.7%		0.4%					0.4%			
	MC 19.55	17.42	233			0.9%	0.9%	0.4%			0.4%					0.9%					0.4%				0.4%					0.4%		0.4%	
Aal	MC 19.63	17.49	190			1.1%	0.5%	0.5%								2.1%					0.5%	0.5%			0.5%								
	MC 19.75	17.60	260	0.4%			0.8%	1.5%		0.4%	0.8%	0.0%	0.4%			0.4%			0.4%			1.2%	1.5%		0.8%	0.4%					2.3%		0.4%
	MC 19.85	17.69	214	0.9%		1.4%	1.9%	0.5%				0.5%	0.9%			2.3%					0.5%	0.5%			0.9%	0.9%		0.5%				0.5%	0.5%
	MC 19.95	17.78	234	*		2.1%	0.4%	3.8%				1.7%	0.4%			1.7%			0.9%		*	0.9%			*			0.9%	2.6%			*	
	MC 20.07	17.88	236	0.4%		1.3%	0.4%	1.3%								0.8%	*		0.4%			1.3%	0.8%			0.8%			1.7%	0.8%			
	MC 20.15	17.95	225	0.4%		1.3%	0.9%	0.4%				1.3%	*			2.7%	0.4%		0.4%				0.4%		0.9%	0.4%					0.4%		2.7%
	MC 20.23	18.02	232			0.4%		1.7%		0.9%			*			1.3%		0.4%			0.4%	*	0.4%		0.4%	0.9%	*		0.9%			0.4%	2.2%
	MC 20.35	18.13	230				0.4%	1.7%			0.4%		0.4%			6.1%	0.4%					0.4%			0.4%	0.4%			1.3%	*	*	0.4%	1.7%
	MC 20.47	18.24	225				*	3.1%			0.9%					*	1.8%		0.4%		0.9%	0.4%			0.4%				2.2%		*	0.4%	*
	MC 20.52	18.28	264	0.4%	0.8%	0.4%	2.3%	2.3%		0.8%		0.4%					0.4%												1.1%				
	MC 20.57	18.33	121					1.7%		1.7%									0.8%														
	MC 20.67	18.42	262		0.4%			5.7%				0.4%				0.8%	0.4%		0.4%		2.3%	0.4%							0.8%	0.4%			
	MC 20.95	18.67	146			0.7%			1.4%	2.7%						0.7%	0.7%				2.1%	2.1%	0.7%			1.4%	0.7%	7.5%					
	MC 21.48	19.14	112				2.7%	0.9%			3.6%					0.9%						0.9%		0.9%		0.9%							
Cfu	MC 21.98	19.58	194		0.5%		1.5%	3.1%		0.5%	1.5%	0.5%	0.0%						0.5%		0.5%				0.5%								
	MC 22.52	20.07	229	0.9%		0.9%	1.7%	2.2%				0.4%												0.4%									
	MC 22.99	20.48	51		2.0%	2.0%	2.0%			2.0%						5.9%							2.0%										
	MC 23.53	20.97	**																														
	MC 23.94	21.33	**																														
Ssp	MC 24.45	21.78	79		2.5%					3.8%				38.0%					1.3%			1.3%											
	MC 25.01	22.28	**																														
	MC 25.56	22.77	187	1.1%		2.1%				2.1%	0.5%	1.1%							0.5%	0.5%	0.5%												
	MC 26.01	23.17	21																														
	MC 26.50	23.61	**																														
	MC 26.99	24.05	**															*															
	MC 27.43	24.44	**																														
	MC 27.99	24.94	**		*												*																
	MC 28.51	25.40	96							1.0%	3.1%																						
Mps	MC 29.01	25.85	222					4.5%	0.5%	0.9%					0.5%		0.5%																
	MC 29.50	26.28	101			1.0%		5.0%	2.0%	2.0%		1.0%			4.0%	2.0%																	
	MC 30.02	26.75	159			0.6%		9.4%		1.3%	0.6%	1.9%	2.5%	6.3%	0.6%																		
	MC 30.53	27.20	20		10.0%		5.0%		10.0%																								
	MC 30.99	27.61	36		2.8%		2.8%	2.8%																									
	MC 31.55	28.11	85		1.2%	2.4%																											
	MC 31.99	28.50	72	1.4%																													
	MC 32.55	29.00	55																														
	MC 32.99	29.39	26																														
	MC 33.44	29.80	99																														
	MC 33.99	30.29	**																														
	MC 34.45	30.69	0																														
	MC 34.89	31.09	0																														
	MC 35.50	31.63	211																														
	MC 38.44	34.25	**																														
	MC 38.95	34.70	**																														
	MC 39.42	35.12	**																														

* present but not included in the counts.
** Lesser than 20 species per sample.

APPENDIX 1, *continued.*
Range chart for the Massicore quarry.

Dinocyst zones	Samples	Stratigraphic depth (Core depth * Cos27°)	TOTAL DINOCYSTS COUNTED	*Deflandrea tenerum*	*Thalassiphora velata*	*Pentadinium goniferum*	*Heteraulacocysta campanula*	*Areoligera semicirculata*	*Tectatodinium* sp.1 of Brinkhuis and Biffi '93	*Lentinia serrata*	*Turbiosphaera* spp.	*Tectatodinium* sp.2 of Brinkhuis and Biffi '93	*Glaphyrocysta semitecta*	*Charlesdownia clathrata*	*Tectatodinium pellitum*	*Lejeunecysta* spp.	*Areosphaeridium ebdonii*	*Hystrichokolpoma* sp. of Biffi and Manum 1988	*Gelata inflata*	*Histiocysta* spp.	*Palaeocystodinium golzowense*	*Svalbardella cooksoniae*	*Wetzeliella gochtii*	TOTAL DINOCYSTS COUNTED
Cin	MC 1.15	1.02	230																	0.9%			*	230
	MC 1.77	1.58	162																	3.1%				162
	MC 1.95	1.74	168																0.6%					168
	MC 2.47	2.20	151		0.7%										2.0%			2.0%	1.3%		0.7%		0.7%	151
	MC 2.97	2.65	214									1.9%						1.4%	0.5%					214
	MC 3.47	3.09	221								*	2.3%							0.9%				*	221
	MC 3.97	3.54	219			0.5%																		219
	MC 4.47	3.98	217									1.4%							0.5%				*	217
	MC 4.92	4.38	212								0.5%	0.9%							0.5%		0.5%		*	212
	MC 5.50	4.90	191		3.7%							1.0%							0.5%	0.5%	1.0%			191
	MC 5.98	5.33	228			0.4%						5.3%							1.3%					228
	MC 6.50	5.79	227									1.8%							0.4%		1.3%			227
Rac	MC 7.03	6.26	248										*							3.2%	0.4%			248
	MC 7.52	6.70	230								*		0.4%						0.4%		0.4%		*	230
	MC 7.98	7.11	209			0.5%			0.5%	0.5%		1.0%	0.5%						1.0%		*	0.5%		209
	MC 8.52	7.59	228						0.4%	0.9%		1.3%												228
	MC 8.98	8.00	237									0.8%							*					237
	MC 9.43	8.40	221		*	*	0.5%		1.8%	0.9%								0.5%						221
	MC 10.06	8.96	214							0.5%		*							0.5%					214
Adi	MC 10.50	9.36	246		*		0.4%			1.6%		1.6%		0.4%	0.8%	0.4%				4.1%				246
	MC 11.01	9.81	248				1.6%			2.8%		8.9%	0.4%		0.4%				0.4%					248
	MC 11.48	10.23	231												2.6%			0.9%						231
	MC 11.98	10.67	236						0.4%															236
	MC 12.50	11.14	233						1.3%	1.3%		3.0%		*				1.3%						233
	MC 13.07	11.65	250						*	4.0%		1.2%	0.4%					0.8%						250
	MC 13.53	12.06	275						0.4%	3.6%		1.5%	2.9%	*				0.4%						275
	MC 14.00	12.47	236						0.4%	1.7%			*					1.3%						236
	MC 14.52	12.94	232			*			0.4%	1.3%			*	0.4%			0.4%							232
	MC 14.97	13.34	250						0.4%				0.4%	*										250
	MC 15.50	13.81	226						0.9%		0.4%	0.9%	*	*										226
	MC 15.60	13.90	235										0.4%			*								235
	MC 15.70	13.99	244			*			0.4%			*	1.2%											244
	MC 15.80	14.08	228			0.4%							*	*										228
	MC 15.90	14.17	240										*											240
	MC 16.00	14.26	257						0.4%			0.4%	1.2%											257
	MC 16.10	14.35	259						0.4%				1.2%		0.4%									259
	MC 16.20	14.43	252			*			0.4%				*											252
	MC 16.30	14.52	236		0.4%	*							3.0%											236
	MC 16.40	14.61	238						1.7%				*											238
	MC 16.53	14.73	219										*											219
	MC 16.62	14.81	242						2.1%	0.4%			1.2%											242
	MC 16.99	15.14	229			0.4%							0.4%											229
	MC 17.47	15.57	102			1.0%			1.0%				1.0%											102
Gse	MC 17.95	15.99	221																					221
	MC 18.50	16.48	220										*											220
	MC 19.07	16.99	233											0.4%										233
	MC 19.30	17.20	232									0.4%	1.3%											232
	MC 19.41	17.29	240					0.4%				0.4%	0.8%											240
	MC 19.55	17.42	233								0.4%	0.4%	0.4%											233
Aal	MC 19.63	17.49	190																					190
	MC 19.75	17.60	260		0.4%							0.4%												260
	MC 19.85	17.69	214																					214
	MC 19.95	17.78	234				1.3%		*	*	0.4%													234
	MC 20.07	17.88	236				0.4%	0.8%	0.4%	*														236
	MC 20.15	17.95	225				0.4%		0.9%	0.4%														225
	MC 20.23	18.02	232				0.0%	3.0%																232
	MC 20.35	18.13	230		*	*	0.4%																	230
	MC 20.47	18.24	225	0.9%																				225
	MC 20.52	18.28	264																					264
	MC 20.57	18.33	121																					121
	MC 20.67	18.42	262																					262
	MC 20.95	18.67	146																					146
	MC 21.48	19.14	112																					112
Cfu	MC 21.98	19.58	194																					194
	MC 22.52	20.07	229																					229
	MC 22.99	20.48	51																					51
	MC 23.53	20.97	**																					**
	MC 23.94	21.33	**																					**
Ssp	MC 24.45	21.78	79																					79
	MC 25.01	22.28	**																					**
	MC 25.56	22.77	187																					187
	MC 26.01	23.17	21																					21
	MC 26.50	23.61	**																					**
	MC 26.99	24.05	**																					**
	MC 27.43	24.44	**																					**
	MC 27.99	24.94	**																					**
	MC 28.51	25.40	96																					96
Mps	MC 29.01	25.85	222																					222
	MC 29.50	26.28	101																					101
	MC 30.02	26.75	159																					159
	MC 30.53	27.20	20																					20
	MC 30.99	27.61	36																					36
	MC 31.55	28.11	85																					85
	MC 31.99	28.50	72																					72
	MC 32.55	29.00	55																					55
	MC 32.99	29.39	26																					26
	MC 33.44	29.80	99																					99
	MC 33.99	30.29	**																					**
	MC 34.45	30.69	0																					
	MC 34.89	31.09	0																					
	MC 35.50	31.63	211																					211
	MC 38.44	34.25	**																					**
	MC 38.95	34.70	**																					**
	MC 39.42	35.12	**																					**

* present but not included in the counts.
** Lesser than 20 species per sample.

APPENDIX 2
Range chart for Massignano quarry.

Dinocyst zones	Samples	TOTAL DINOCYSTS COUNTED	*Enneadocysta pectiniforme*	*Nematosphaeropsis/Cannosphaeropsis* spp.	*Operculodinium/Impletosphaeridium* cpx (pars.)	*Spiniferites/Achomosphaera* spp. (pars.)	*Cleistosphaeridium ancyrea*	*Thalassiphora pelagica*	*Homotryblium plectilum*	*Samlandia chlamydophora*	*Hemiplacophora semilunifera*	*Impagidinium brevisulcatum*	*Escharisphaeridea* sp. of Brinkhuis and Biffi '93	*Schematophora speciosa*	*Cordosphaeridium fibrospinosum*	*Eocladopyxis tesselata*	*Cooksonidium capricornum*	*Spiniferites pseudofurcatus*	*Impagidinium* sp. of Brinkhuis and Biffi '93	*Stoveracysta ornata*	*Thalassiphora? sp. B&B*	*Impagidinium velorum*	*Cribroperidinium* spp.	*Operculodinium* cf. *hirsutum*	*Distatodinium ellipticum*	*Reticulatosphaera actinocoronata*	*Dapsilidinium pastielsii*	*Impagidinium maculatum*	*Diphyes colligerum*	*Impagidinium* cf. *brevisulcatum* of Brinkhuis and Bi
	M22.80	100	2.0%	1.0%	18.0%	14.0%	8.0%	5.0%										1.0%							2.0%	2.0%				
	M22.20	103		2.9%	31.1%	14.6%	1.0%	7.8%										1.9%	1.0%	1.0%	1.0%				1.0%	*				
	M21.90	97		2.1%	6.2%	25.8%	*	41.2%										2.1%	*		*	1.0%			*					
Adi	M21.60	100		6.0%	14.0%	48.0%	5.0%	1.0%	*	*								3.0%	8.0%		4.0%	3.0%			*	1.0%	*			
	M21.30	**				*	*											*							*					
	M21.00	**			*		*												*											
	M20.70	**		*	*	*	*											*	*			*			*					
	M20.40	100	3.0%		12.0%	40.0%	12.0%	3.0%		1.0%	18.0%	*						2.0%	*		*				*					
Gse	M20.10	100	2.0%	1.0%	5.0%	23.0%	5.0%	1.0%			21.0%	1.0%						6.0%	3.0%		*	*	1.0%			3.0%		1.0%		
	M19.80	100	2.0%		3.0%	11.0%	10.0%	2.0%			*	2.0%						5.0%	17.0%		*	*								
	M19.50	100	15.0%	2.0%	5.0%	25.0%	4.0%	8.0%			1.0%	*						9.0%	9.0%		1.0%	1.0%	*		*	1.0%				
	M19.20	100	6.0%	4.0%	28.0%	28.0%	*	*	1.0%	*	1.0%		1.0%					1.0%	1.0%		*	3.0%	6.0%		*	*			2.0%	
Aal	M18.90	100	2.0%	3.0%	10.0%	27.0%	1.0%	9.0%		1.0%	1.0%							13.0%	5.0%		1.0%	*								
	M18.60	100	1.0%	7.0%	26.0%	33.0%	11.0%				3.0%	*						2.0%	6.0%		1.0%	1.0%			*					
	M18.30	98	*	2.0%	17.3%	46.9%	1.0%	1.0%	1.0%			*	1.0%					1.0%	1.0%			*								
	M18.00	102	1.0%	2.0%	11.8%	60.8%	2.0%	*	2.9%			*	1.0%					2.0%	2.9%		1.0%	2.0%	*		*	2.0%	*		*	
	M17.70	99	40.4%	*	7.1%	23.2%		5.1%	*	*		*	*					1.0%		*	*		*		*				*	
	M17.40	101	4.0%	3.0%	7.9%	41.6%	3.0%		1.0%									1.0%	4.0%	18.8%								1.0%		
Cfu	M17.10	**			*	*	*											*												
	M16.50	**				*	*												*		*									
	M16.20	68	7.4%	2.9%	8.8%	25.0%	4.4%	5.9%		1.5%	1.5%		2.9%						14.7%	1.5%		*	1.5%							
	M15.90	**	*		*	*	*						*					*												
	M14.70	**			*	*	*		*					*				*		*										
Ssp	M13.80	**		*	*	*	*							*					*	*										
	M13.20	**			*	*	*					*						*												
	M12.90	**			*	*	*						*						*											
	M8.70	100		7.0%	21.0%	19.0%	3.0%	3.0%			9.0%	2.0%	1.0%					*	2.0%		1.0%	2.0%	1.0%		1.0%			2.0%		
	M8.10	100		2.0%	22.0%	19.0%	11.0%	4.0%			2.0%	1.0%	17.0%	1.0%						1.0%		1.0%					1.0%			1.0%
	N8.00	124			16.1%	12.9%	32.3%	1.6%			8.1%	2.4%	1.6%	0.0%				8.9%				1.6%				0.8%			0.8%	0.8%
	N7.80	86	1.2%	7.0%	8.1%	18.6%	4.7%	4.7%			27.9%			1.2%	1.2%			11.6%	1.2%						2.3%	1.2%				
	M7.80	99		9.1%	12.1%	23.2%	7.1%	1.0%			24.2%		4.0%					3.0%		*		1.0%			1.0%					
	N7.60	117		4.3%	2.6%	8.5%	6.8%	4.3%			44.4%	1.7%	6.8%					6.8%	0.9%	2.6%		6.0%		0.9%						
	N7.50	146		2.1%	6.8%	17.1%	2.1%	*	*	*	51.4%	*	3.4%	*	*			2.7%	4.1%	1.4%		4.1%			*					
	M7.50	**				*	*	*			*	*	*					*				*						*		
	N7.40	99		2.0%	12.1%	14.1%	3.0%	2.0%	3.0%		25.3%		6.1%	10.1%				1.0%	3.0%	7.1%		3.0%								1.0%
	N7.35	67	1.5%	1.5%	11.9%	16.4%	7.5%				37.3%	1.5%	4.5%	6.0%		1.5%		6.0%		3.0%										
	N7.30	47	4.3%	4.3%		23.4%					48.9%		8.5%					8.5%												
	N7.20	101	6.9%	5.0%	6.9%	23.8%	7.9%	1.0%			26.7%	1.0%	3.0%	1.0%				2.0%	2.0%	1.0%					2.0%				1.0%	
	M7.20	94	1.1%	7.4%	8.5%	23.4%		*			39.4%	*	1.1%	*					2.1%	*		1.1%			*		1.1%	*	1.1%	
	N7.15	130	3.8%	2.3%	5.4%	18.5%	0.8%	3.8%	*		46.2%	1.5%	3.1%						9.2%			0.8%			3.1%					
	N7.10	40	10.0%	2.5%	7.5%	32.5%	12.5%	7.5%			5.0%	2.5%		2.5%				2.5%				2.5%								
	N7.00	93	15.1%	6.5%	9.7%	21.5%	7.5%	12.9%			1.1%	1.1%	5.4%	4.3%		4.3%		1.1%	3.2%		1.1%			1.1%			1.1%			
	N6.90	97	16.5%	1.0%	9.3%	9.3%	11.3%	10.3%	*		*	4.1%		7.2%				6.2%	*	3.1%		10.3%					*		1.0%	
Mps	M6.90	100		1.0%	14.0%	12.0%	12.0%	43.0%	1.0%		6.0%	1.0%						3.0%				2.0%							1.0%	
	N6.80	136	4.4%	1.5%	5.9%	5.9%	29.4%	5.1%			7.4%	0.7%		5.1%				23.5%		1.5%	0.7%	5.1%		1.5%						
	N6.70	147		2.0%	4.8%	4.8%	18.4%	52.4%	0.7%					2.7%				3.4%		0.7%		1.4%		2.0%						
	N6.60	130			6.9%	3.1%	55.4%	3.8%	0.8%		2.3%							17.7%				0.8%		0.8%						
	N6.50	129	0.8%		3.9%	3.1%	47.3%	19.4%	*									7.8%				0.8%		2.3%						
	N6.45	160	*	1.3%	6.9%	18.8%	44.4%	7.5%			3.1%	*		2.5%				7.5%				2.5%		0.6%					0.6%	
	N6.40	108	0.9%	0.9%	6.5%	13.0%	41.7%	2.8%	*	*				7.4%		0.9%		1.9%	0.9%			3.7%		3.7%	1.9%		1.9%		*	
	N6.30	82			4.9%	12.2%	34.1%	7.3%			2.4%	2.4%		12.2%				7.3%		*		1.2%	1.2%	3.7%						
	M6.30	**	*		*	*	*	*				*						*							*					
	N6.20	104		1.9%	1.9%	12.5%	35.6%	22.1%			2.9%	1.0%		1.0%				3.8%	1.9%		1.9%	1.0%	1.0%	3.8%			1.0%		*	
	N6.10	154	2.6%	2.6%	1.3%	5.2%	3.2%	75.3%			0.0%	0.6%		0.6%		2.6%		0.6%	0.6%			1.3%	*		*	*				
	N6.00	93	5.4%		1.1%	6.5%	22.6%	43.0%			1.1%					5.4%		8.6%					1.1%	3.2%						
	N5.90	170	1.8%	1.2%	1.2%	6.0%	25.3%	41.2%			0.6%					1.8%		18.1%	0.6%					0.6%	0.6%					
	N5.80	150	*	0.7%	2.7%	4.0%	33.3%	33.3%				0.7%		0.7%		*		23.3%			*	*		0.7%						
	N5.70	137	1.5%	2.9%	2.2%	11.7%	21.9%	40.1%	0.7%		0.7%	0.7%		*	0.7%	1.5%		6.6%	0.7%	*	0.7%	*	2.9%			0.7%			0.7%	
	N5.65	137	1.5%	0.7%	2.9%	10.2%	59.9%	3.6%	*		1.5%			1.5%	*	1.5%		10.9%	2.2%	*			1.5%		*	0.7%	0.7%	0.7%	*	*
	N5.60	140	*	2.9%	2.9%	2.9%	50.0%	12.9%			9.3%	*	0.7%			*		13.6%	1.4%	1.4%	*	0.7%	0.7%	0.7%						
	N4.50	83	9.6%		2.4%	1.2%	1.2%				72.3%		1.2%			9.6%	2.4%													
	N4.30	90	5.6%	4.4%	2.2%	16.7%	1.1%	3.3%	1.1%	1.1%	38.9%	3.3%	1.1%	2.2%	2.2%	5.6%	11.1%													

* present but not included in the counts.
** Lesser than 20 species per sample.

APPENDIX 2, *continued.*
Range chart for Massignano quarry.

Dinocyst zones	Samples	TOTAL DINOCYSTS COUNTED	*Hystrichokolpoma rigaudiae*	*Impagidinium dispertitum*	*Hystrichosphaeropsis? sp. of Brinkhuis and Biffi '93*	*Cordosphaeridium cantharellum*	*Lingulodinium spp.*	*Pentadinium laticinctum*	*Thalassiphora velata*	*Operculodinium tiara*	*Deflandrea cf. heterophlycta*	*Impagidinium cf. aculeatum of Brinkhuis and Biffi '93*	*Operculodinium microtrainum*	*Thalassiphora patula*	*Homotryblium pallidum*	*Deflandrea leptodermata/arcuata cpx*	*Thalassiphora succincta*	*Melitasphaeridium pseudorecurvatum*	*Glaphyrocysta pribonensis*	*Fibrocysta axialis*	*Areosphaeridium diktyoplokum*	*Achilleodinium biformoides*	*Rottnestia borussica*	*Deflandrea phosphoritica cpx*	*Hystrichokolpoma cinctum*	*Glaphyrocysta intricata*	*Corrudinium incompositum*	*Homotryblium sp. of Brinkhuis and Biffi '93*	*Corrudinium? sp. of Brinkhuis and Biffi '93*	*Rhombodinium porosum*	*Hystrichokolpoma salacia*
Adi	M22.80	100	1.0%				7.0%	2.0%	1.0%	4.0%					1.0%		1.0%				14.0%			4.0%							
	M22.20	103	1.9%	1.9%			1.9%	1.0%	*	1.9%	2.9%		*		*	2.9%	*				*			17.5%	1.0%						
	M21.90	97		2.1%			6.2%	1.0%		*	*					3.1%					1.0%			*			2.1%				
	M21.60	100	1.0%	3.0%				1.0%	*	*						*								*			1.0%				
	M21.30	**																													
	M21.00	**								*														*							
	M20.70	**		*			*		*				*																		
Gse	M20.40	100	1.0%	3.0%			*														*										
	M20.10	100	1.0%	4.0%			*	1.0%				*		1.0%		1.0%								6.0%			1.0%				
	M19.80	100		5.0%							1.0%		*								*	2.0%	1.0%	35.0%			*				
	M19.50	100	*	*	1.0%		1.0%		*	*				*							4.0%	2.0%		1.0%			1.0%				
Aal	M19.20	100	1.0%	4.0%	*	*	*	1.0%	*		*		1.0%			*	1.0%			*	*	2.0%	2.0%	2.0%			1.0%				*
	M18.90	100		1.0%		*	*	1.0%					1.0%	*		4.0%							1.0%	4.0%							
	M18.60	100		1.0%	*		*	*				1.0%	*			*								*	*		2.0%				
	M18.30	98		2.0%	1.0%		3.1%	1.0%				*				5.1%								4.1%		1.0%					
Cfu	M18.00	102	1.0%	1.0%	*		1.0%	*			*		*				*								*						*
	M17.70	99		1.0%		*	*		*		3.0%					2.0%							*	5.1%			1.0%				*
	M17.40	101		6.9%							*					3.0%							1.0%	3.0%							
	M17.10	**																						*							
	M16.50	**																													
	M16.20	68	1.5%																		2.9%			5.9%	*						
	M15.90	**	*																												
Ssp	M14.70	**																													
	M13.80	**									*		*										*								
	M13.20	**	*	*																*											
	M12.90	**					*									*															
Mps	M8.70	100	*	2.0%		*	1.0%			4.0%		7.0%				10.0%		1.0%							*		1.0%				
	M8.10	100		4.0%			1.0%		*	5.0%	2.0%													4.0%				1.0%			
	N8.00	124	0.8%	0.8%			3.2%			1.6%	1.6%													1.6%						0.8%	0.8%
	N7.80	86								2.3%			1.2%		1.2%								1.2%	2.3%						1.2%	
	M7.80	99		2.0%						5.1%	2.0%	2.0%																1.0%	2.0%		
	N7.60	117		1.7%	0.9%																							0.9%			
	N7.50	146		*			0.7%			*					0.7%		*					1.4%	0.7%			0.7%	0.7%				
	M7.50	**		*										*				*													
	N7.40	99		*				1.0%									3.0%	1.0%				*		2.0%							
	N7.35	67																					1.5%								
	N7.30	47								2.1%																					
	N7.20	101		1.0%			1.0%										1.0%					5.9%									
	M7.20	94		1.1%			1.1%			*					1.1%	1.1%		1.1%				8.5%									
	N7.15	130		*			0.8%															0.8%									
	N7.10	40		2.5%								2.5%									5.0%	2.5%									
	N7.00	93		1.1%																	2.2%										
	N6.90	97	*	1.0%									*					1.0%			4.1%	1.0%		*	2.1%	1.0%					
	M6.90	100																			4.0%										
	N6.80	136		1.5%																		*	0.7%								
	N6.70	147					0.7%														6.1%										
	N6.60	130																			8.5%										
	N6.50	129		1.6%			2.3%						0.8%							0.8%	8.5%	0.8%									
	N6.45	160		1.9%			1.9%			*				0.6%						*											
	N6.40	108	*	0.9%			0.9%			2.8%					0.9%		4.6%	0.9%	0.9%												
	N6.30	82	1.2%				8.5%	1.2%																							
	M6.30	**												*	*	*															
	N6.20	104	1.0%	1.0%			2.9%			*			1.9%	*																	
	N6.10	154		0.6%	1.3%		0.6%			0.6%	*	*																			
	N6.00	93		2.2%																											
	N5.90	170		1.2%		*		*																							
	N5.80	150	0.7%	0.0%			*	*																							
	N5.70	137	1.5%	1.5%	*	*																									
	N5.65	137																													
	N5.60	140																													
	N4.50	83																													
	N4.30	90																													

* present but not included in the counts.
** Lesser than 20 species per sample.

APPENDIX 2, *continued*.
Range chart for Massignano quarry.

Dinocyst zones	Samples	TOTAL DINOCYSTS COUNTED	*Enneadocysta arcuatum*	*Cordosphaeridium inodes*	*Stoveracysta* sp.1 of Brinkhuis and Biffi '93	*Phthanoperidinium comatum*	*Stoveracysta* sp.2 of Brinkhuis and Biffi '93	*Cordosphaeridium minimum*	*Distatodinium craterum*	*Cordosphaeridium funiculatum*	*Chiropteridium mespilanum*	*Deflandrea granulata*	*Dinopterygium cladoides*	*Glaphyrocysta* sp. of Brinkhuis and Biffi '93	*Heteraulacocysta? leptalea*	*Heteraulacocysta campanula*	*Glaphyrocysta texta*	*Achomosphaera alcicornu*	*Caligodinium amiculum*	*Achomosphaera* sp. of Brinkhuis and Biffi '93	*Tectatodinium pellitum*	*Pentadinium lophophorum*	*Turbiosphaera* spp.	*Hystrichokolpoma* sp of Biffi and Manum 1988	*Glaphyrocysta semitecta*	*Tectatodinium* sp.1 of Brinkhuis and Biffi '93	*Charlesdowniea clathrata*	*Homotryblium aculeatum*	*Stoveracysta?* sp. of Brinkhuis and Biffi '93	*Cleistosphaeridium placacantha*	*Impagidinium pallidum*	*Areoligera semicirculata*	*Tectatodinium* sp.2 of Brinkhuis and Biffi '93	TOTAL DINOCYSTS COUNTED
Adi	M22.80	100			1.0%													11.0%						*										100
	M22.20	103																*							3.9%									103
	M21.90	97				1.0%	1.0%										*								4.1%	*			*			*	*	97
	M21.60	100			*		*		*			*	1.0%	*											*									100
	M21.30	**							*																	*								**
	M21.00	**																								*					*			**
	M20.70	**					*		*									*			*													**
Gse	M20.40	100																*						1.0%		1.0%				3.0%				100
	M20.10	100			1.0%		3.0%																			5.0%			3.0%					100
	M19.80	100		1.0%									*								2.0%					1.0%								100
	M19.50	100								1.0%	*		1.0%				1.0%	1.0%				1.0%		1.0%	2.0%	1.0%	*	*						100
Aal	M19.20	100						*		*		1.0%		*			*	*		2.0%	*	*	*											100
	M18.90	100					3.0%					1.0%			*			6.0%		5.0%														100
	M18.60	100					*	*				1.0%	2.0%			*		1.0%	1.0%															100
	M18.30	98								*		7.1%	1.0%	1.0%				1.0%																98
Cfu	M18.00	102			2.9%	*	*			2.0%		1.0%	*		*		*																	102
	M17.70	99		*	3.0%		1.0%	*		*		7.1%	*	*	*	*																		99
	M17.40	101			*				*	1.0%	*																							101
	M17.10	**			*																													**
	M16.50	**			*																													**
	M16.20	68			10.3%			1.5%																										68
	M15.90	**			*																													**
Ssp	M14.70	**																																**
	M13.80	**				*	*																											**
	M13.20	**			*																													**
	M12.90	**			*																													**
Mps	M8.70	100		*																														100
	M8.10	100																																100
	N8.00	124	0.8%																															124
	N7.80	86																																86
	M7.80	99																																99
	N7.60	117																																117
	N7.50	146																																146
	M7.50	**																																**
	N7.40	99																																99
	N7.35	67																																67
	N7.30	47																																47
	N7.20	101																																101
	M7.20	94																																94
	N7.15	130																																130
	N7.10	40																																40
	N7.00	93																																93
	N6.90	97																																97
	M6.90	100																																100
	N6.80	136																																136
	N6.70	147																																147
	N6.60	130																																130
	N6.50	129																																129
	N6.45	160																																160
	N6.40	108																																108
	N6.30	82																																82
	M6.30	**																																**
	N6.20	104																																104
	N6.10	154																																154
	N6.00	93																																93
	N5.90	170																																170
	N5.80	150																																150
	N5.70	137																																137
	N5.65	137																																137
	N5.60	140																																140
	N4.50	83																																83
	N4.30	90																																90

* present but not included in the counts.
** Lesser than 20 species per sample.