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Untersuchungen zur Sedimentation und Ökologie von Coccolithophoriden im Bereich der Kanarischen Inseln: Saisonale Flussmuster und Karbonatexport

Dissertation zur Erlangung des Doktorgrades
der Naturwissenschaften
am Fachbereich Geowissenschaften
der Universität Bremen

vorgelegt von
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Kurzfassung

Als einer der Hauptprimär- und Karbonatproduzenten in den Oberflächengewässern um die Kanarischen Inseln wurden Coccolithophoridengemeinschaften aus Sedimentfallen bearbeitet, um ihre Verwertbarkeit als Indikator für Produktivität und Exportproduktion von den oberflächennahen Bereichen zum Meeresboden abzuschätzen. Die Coccolithophoridenflüsse entlang eines Gradienten von der hochproduktiven NW afrikanischen Küstenregion zur oligotrophen subtropischen Gyre zeigen eine enge Koppelung mit den biologischen Produktionszyklen im Oberflächenwasser, gebunden an die großräumige ozeanische und atmosphärische Zirkulation der Region. Die höchsten Exportflüsse wurden jeweils im Frühjahr (Februar-März) aufgezeichnet, etwa einen Monat nach der Winterphytoplanktonblüte. In den übrigen Monaten des Jahres waren die Coccolithenflüsse eher gering, aber durchgängig vorhanden. Während die Flussraten an den beiden ozeanischen Stationen nördlich der Inseln La Palma und Gran Canaria vergleichbar hoch waren, wurden an der auftriebsbeeinflussten Station östlich von Lanzarote/ Fuerteventura deutlich höhere Coccolithophoridenflüsse aufgezeichnet. Anhand von Satellitendaten (CSCZ) zu Phytoplankton-Pigmentkonzentrationen (u. a. Chlorophyll a) im Oberflächenwasser konnten nährstoffreiche Auftriebsfilamente an mehreren Stellen entlang der Küste sowie Auftriebseffekte entlang der östlichsten Inseln Lanzarote und Fuerteventura als mögliche Quellen für eine erhöhte Zufuhr an Nährstoffen und Biomasse für die küstennahen Bereiche angenommen werden. Ein starker Einfluss an lateral advektiertem Material wurde in den tieferen Sedimentfallen (3000-3700 m) an den beiden ozeanischen Stationen LP und ESTOC verzeichnet. Als mögliches Liefergebiet der Partikel wurde der küstennahe Bereich nordöstlich des Kanarenbeckens diskutiert.

Mit Hilfe artspezifischer Karbonatgewichte wurde der gewichtsbilanzierte Anteil des Coccolithenkarbonats am Gesamtkarbonatexport bestimmt und somit die Bedeutung der Coccolithophoriden als wichtige Karbonatproduzenten in dieser Region aufgezeigt. Der Anteil des Coccolithenkarbonats betrug an allen Stationen entlang des Gradienten etwa 33%.

Durchschnittliche holozäne Akkumulationsraten von Coccolithen und (Coccolithen-) Karbonat, bestimmt aus Oberflächensedimenten an den drei Fallenstationen, stimmen generell mit den Exportflüssen der unteren Sedimentfallen in der oligotrophen Region überein. An der küstennahen Station ist eine hohe Diskrepanz zwischen den Coccolithenflüssen in der Falle (700 m) und deren Akkumulation im Sediment auf einen verstärkten Einfluss von Umlagerungs- und Transportprozessen in der Schelfregion zurückzuführen.

Trotz der überraschend guten Übereinstimmung der Coccolithophoridengemeinschaften an allen Stationen, konnten wichtige Trends in der Artenzusammensetzung entlang des Produktivitätsgradienten aufgezeigt werden. Die höchsten Anteile an der Gemeinschaft hatten durchweg die drei Arten *Emiliania huxleyi*, *Florisphaera profunda* und *Gephyrocapsa ericsonii* (zusammen etwa 60-80%). Eine Präferenz für höhere Nährstoffgehalte und/oder niedrige Oberflächenwassertemperaturen wird für alle Arten der Gattung *Gephyrocapsa*, speziell für *G. ericsonii* und *G. oceanica* angenommen, da sie ihre höchsten relativen Anteile an der durch nährstoffreiche Auftriebswässer beeinflussten Station aufweisen. Im Gegensatz dazu zeigen die Arten *F. profunda* und *C. leptoporus* mit ihren höchsten Anteilen an den beiden ozeanischen Stationen eine Affinität zu den eher stabilen, oligotrophen Bedingungen der subtropischen Gyre.

Danksagung

Herr Prof. Dr. Rüdiger Henrich hat die vorliegende Dissertation ermöglicht und betreut. Für seine freundliche Unterstützung und Ermunterung, besonders in der Endphase der Arbeit, möchte ich mich an dieser Stelle bedanken. Herrn Prof. Dr. Gerold Wefer danke ich für die Übernahme des Zweitgutachtens.

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Die vorliegende Arbeit wurde im Rahmen des europäischen MAST-III Projektes CANIGO (Canary Islands Azores Gibraltar Observations), Subprojekt 3 (Particle Flux and Paleoceanography in the Eastern Boundary Current System) angefertigt und finanziell gefördert.

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2. Manuskript 2: 57

   Baumann, K.-H., Sprengel, C., subm. Morphological variations of various coccolith species in a sediment trap north of the Canary Islands. Journal of Nannoplankton Research.

3. Manuskript 3: 75

   Sprengel, C., Baumann, K.-H., Henderiks, J., Henrich, R., Neuer, S., subm. Modern coccolithophore and carbonate sedimentation along a produktivity gradient in the Canary Islands region: Seasonal export production and surface accumulation rates. Deep-Sea Research II.

4. Manuskript 4: 109
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Teil I – Einleitung

1. Einführung in die Thematik

Die Ozeane nehmen über den Kohlenstoffkreislauf durch eine Vielzahl biogeochemischer Austausch- und Transportprozesse eine bedeutende Rolle im globalen Klimageschehen ein. Neben physikalischen Parametern wie Wassertemperatur und ozeanische Zirkulation bestimmt die biologische Produktivität marinen Phytoplanktons in den oberen Wasserschichten maßgeblich den Austausch von Kohlendioxid (CO_2) zwischen Ozean und Atmosphäre und stellt somit einen wichtigen Faktor im Klimasystem dar (Broecker, 1982; Berger und Keir, 1984). Es wird angenommen, dass atmosphärisches CO_2 – ein wichtiges Treibhausgas – durch die Absorption der Wärmeabstrahlung von der Erdoberfläche in hohem Maße den globalen Wärmehaushalt beeinflusst (Trenberth et al., 1996). Ein enger Zusammenhang wurde ebenfalls zwischen CO_2-Konzentrationsveränderungen im Ozean und den Oberflächenwassertemperaturen nachgewiesen (Berger und Wefer, 1992).

Im Oberflächenwasser lebende Primärproduzenten benötigen CO_2 für den Aufbau organischer Substanz. Durch die sogenannte "biologische Pumpe", d. h. den Export gelösten und partikulären organischen Materials aus der photischen Zone in tiefere Bereiche des Ozeans, wird dem Oberflächenwasser, und somit auch der Atmosphäre, CO_2 entzogen (Broecker, 1982; Berger et al., 1989). Die Karbonatproduktion planktischer Organismen hingegen wirkt diesem Mechanismus durch die Freisetzung von CO_2 entgegen. Schwankungen im CO_2-Gehalt der Atmosphäre werden unter anderem mit Änderungen in der Effektivität dieser biologischen Pumpe erklärt. So hat man vermutet, dass deutlich niedrigere CO_2-Gehalte der Atmosphäre während der Glazialzeiten im Vergleich zu mittleren holozänen Werten auf signifikante Veränderungen der biologischen Produktivität zurückgeführt werden können (Barnola et al., 1987; Sarnthein et al., 1988; Martin, 1990). Die Effizienz der biologischen Pumpe, d. h. in welchem Maße biogene Partikel in die Tiefsee exportiert, im Sediment akkumuliert und somit langfristig dem Kohlenstoffkreislauf entzogen werden, wird durch die Höhe der Primärproduktion, durch den Anteil des Exportflusses sowie durch das Verhältnis von organischem zu karbonatischem Kohlenstoff in absinkenden biogenen Partikeln bestimmt (Berger und Keir, 1984). In einigen Studien an Coccolithophoridenblüten wurde versucht, die Rolle dieser Organismen als eine CO_2-Quelle oder -Senke abzuschätzen. Aufgrund der bis jetzt jedoch nur sehr lückenhaften Aufzeichnungen, konnten hierüber noch keine genauen Aussagen getroffen werden (Robertson, et al., 1994; Tyrrell und Taylor, 1995).

Partikelfluss-Studien haben zum Ziel, ein detailliertes Verständnis über die Kontrollmechanismen zeitlich und räumlich variierender Flüsse von Kohlenstoff und assoziierten Elementen im Ozean zu erlangen sowie zugehörige Austauschprozesse mit der Atmosphäre und dem Ozeanboden zu bewerten (Honjo, 1996; Fischer und Wefer, 1996). Zeitserien-Sedimentfallen sind entwickelt worden, um den Partikelfluss als Bindeglied zwischen der biologischen Produktion im oberen Ozean und der Akkumulation im Sediment von der euphotischen Zone bis zur Tiefsee zu quantifizieren. Exportflüsse liefern nicht nur Informationen für das Verständnis heutiger klimatischer Veränderungen, sondern können auch zur Kalibrierung von Paläoproduktivitätsabschätzungen verwendet werden, die auf Proxies wie z. B. organischem Kohlenstoffgehalt in den Sedimenten (Müller und Suess, 1979), Karbonatakkumulationsraten (u.a. Brummer und van Eijden, 1992; Rühlemann et al., 1999), Biomarkern (u.a. Brassel et al., 1986, Marlowe et al., 1990) oder der Quantifizierung von Mikrofossilgemeinschaften und -häufigkeiten (u.a. Beaufort et al., 1994; Thomas et al., 1995) basieren.

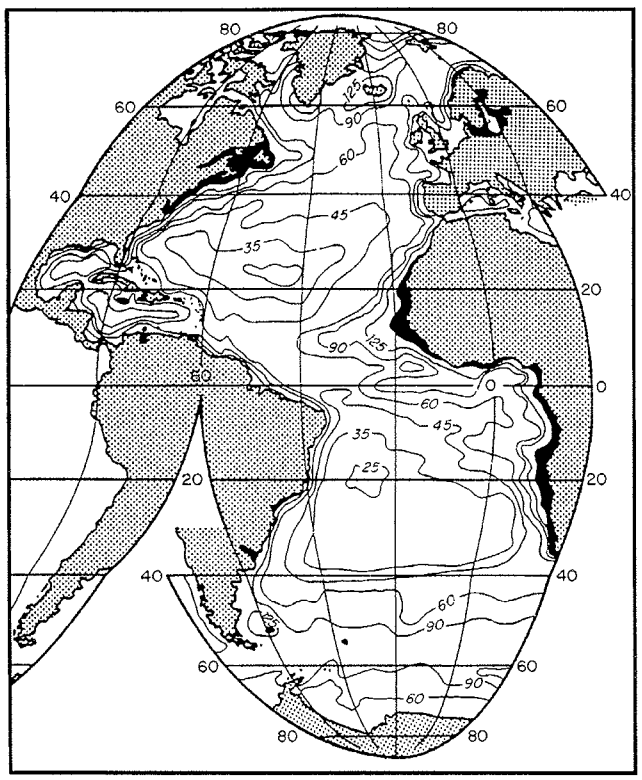

Abb. 1. Primärproduktion im Atlantik in g C m^{-2} a^{-1} (Berger et al., 1989; Fig. 11)

Im atlantischen Ozean zeichnen sich die Küstenauftriebsgebiete vor Westafrika (NW Afrika, Benguela-Region), die äquatoriale Divergenzzone und die Subpolargebiete durch eine hohe Primär- und Exportproduktion aus (Berger, 1989; Abb. 1). Dieses generelle Muster spiegelt sich ebenso in der Karbonatkonzentration/-produktion im Oberflächenwasser wider (Milliman, 1993). Zusammen mit Diatomeen, Dinoflagellaten und Silikoflagellaten bilden Coccolithophoriden die Hauptprimärproduzenten in der euphotischen Zone und tragen durch die Ausbildung eines kalzitischen Außenskelettes erheblich zum Karbonatexport und zur Akkumulation karbonatischer Sedimente bei. In einigen Regionen, z. B. in den oligotrophen Niedrigproduktionsgebieten, stellen Coccolithophoriden vermutlich die Hauptkarbonatproduzenten dar,

während ihr Beitrag zum Karbonatfluss in den nährstoffreichen Auftriebsregionen geringer zu sein scheint. Neuere Abschätzungen gehen davon aus, dass etwa 40-60% der globalen Kalziumkarbonatproduktion über Coccolithophoriden stattfindet (Wollast, 1994). Neben ihrer Bedeutung für den globalen Kohlenstoffkreislauf können rezente Coccolithophoridenarten und -gemeinschaften wichtige Informationen für palökologische und paläozeanographische Rekonstruktionen aus Sedimenten liefern.

Im Rahmen des interdisziplinären europäischen MAST-III Projektes CANIGO (Canary Islands Azores Gibraltar Observations) wurden im Subprojekt "Particle flux and paleoceanography in the Eastern Boundary Current System" umfassende Sedimentfallenstudien im Bereich nördlich der Kanarischen Inseln durchgeführt. Das Gebiet umfasst einen Gradienten von der hochproduktiven NW afrikanischen Küstenregion zum oligotrophen, niedrigproduktiven Bereich der subtropischen nordatlantischen Gyre. Die Region bietet somit die Möglichkeit, Exportflüsse und ihre Steuerungsmechanismen in Abhängigkeit verschiedener Produktivitätsregime direkt miteinander zu vergleichen. Im Rahmen der vorliegenden Dissertation wurden umfangreiche Untersuchungen zur Sedimentation und Ökologie von Coccolithophoriden durchgeführt, um diese Organismen anhand bestimmter Umweltparameter in dieser Region zu charakterisieren und ein detailliertes Verständnis für die komplexen Produktions-, Transport- und Ablagerungsprozesse dieser Planktongruppe zu erlangen.

2. Grundlagen zur Biologie und Ökologie rezenter Coccolithophoriden

2.1. Biologie

Coccolithophoriden sind marine einzellige Algen der Klasse Prymnesiophyceae Hibbert 1976, Stamm Haptophyta. Charakteristisch für diese Gruppe ist die Ausbildung kalzifizierter Plättchen (Coccolithen), die eine zumeist verschachtelt angeordnete, zusammengesetzte äußere Zellwandbedeckung (Coccosphäre) formen. Diese Außenskelette haben im allgemeinen ein gutes fossiles Erhaltungspotential, vorwiegend als einzelne Coccolithen oder seltener als gesamte Coccosphären. Von der Zelle können zwei Typen von Coccolithen produziert werden, die sich durch ihre morphologische Ausprägung, der Art ihrer Entstehung und dem Zeitpunkt ihrer Genese innerhalb des Lebenszyklus der Alge unterscheiden (Bown und Young, 1998).

Holococcolithen besitzen eine relativ einfache Struktur aus zahlreichen, etwa 0,1 µm großen rhomboedrischen Kalzitkristallen. Basierend auf Ergebnissen einiger weniger Kulturversuche wird vermutet, dass sie extrazellulär zwischen der Zellmembran und einer äußeren organischen Haut gebildet werden (Rowson et al., 1986). Ihre Diversität in rezenten Cocco-

lithophoridengemeinschaften ist sehr hoch (Kleijne, 1991; Jordan und Chamberlain, 1997). Aufgrund ihrer fragilen Struktur haben sie jedoch nur ein geringes Erhaltungspotential und sind daher fossil kaum überliefert. Im Rahmen der vorliegenden Arbeit wurden nur vereinzelt Holococcolithen in Sedimentfallenproben identifiziert, obwohl im Untersuchungsgebiet zahlreiche Arten in den Planktongemeinschaften auftreten (Abrantes et al., subm.; Sprengel, unpubl. Daten). Heterococcolithen wachsen intrazellulär im Zytoplasma, in den Golgi-Vesikeln, und werden dann durch die Zellwand sezerniert. Es handelt sich um überwiegend runde bis elliptische, seltener polygonale Scheiben oder Ringe, die aus einem radial angeordneten Gefüge verschiedenartiger Kristalleinheiten bestehen (Teil IV – Fototafeln). Einen Überblick über die Ergebnisse der verschiedenen Studien und methodischen Ansätze an Coccolithophoriden-Kulturen und isolierten Coccolithen geben Westbroeck et al. (1989), Young (1989) und Pienaar (1994).

Einige Coccolithophoriden produzieren keine Coccolithen, sondern werden lediglich von einer Schicht organischer Plättchen bedeckt oder sind "nackt". Diese Coccosphären treten auch bei Arten auf, die normalerweise ein kalzitisches Außenskelett bilden, wie z. B. *Emiliania huxleyi*. Es wird angenommen, dass den unterschiedlichen Zelltypen verschiedene Lebensphasen zugrunde liegen; dieses konnte jedoch noch nicht zweifelsfrei geklärt werden (Klaveness, 1972; Pienaar, 1994). Im Zuge umfangreicher Planktonstudien wurden in den letzten Jahren häufiger Coccolithophoriden beobachtet, die ein kombiniertes Holococcolithen/ Heterococcolithen-Skelett besitzen oder deren Coccosphären aus verschiedenen Heterococcolithen zusammengesetzt sind (Alcober und Jordan, 1997; Cros et al., 2000; Sprengel und Young, 2000; Cortés, 2000). Diese Kombinationszellen einiger Arten deuten höchstwahrscheinlich auf alternierende Lebenszyklen hin, wobei die verschiedenen Stadien unterschiedliche Coccolithen-Typen hervorbringen. Ein bekanntes Beispiel hierfür ist die Art *Coccolithus pelagicus*, deren motile oder Schwärmerphase Holococcolithen bildet, während Zellen mit Heterococcolithen typisch für eine Ruhephase sind, eventuell vergleichbar mit einem Zystenstadium, wie z. B. bei kalkigen Dinoflagellaten (Parke und Adams, 1960; Kleijne, 1991).

Die genaue Funktion von Coccolithen ist bis heute nur unzureichend bekannt. Von Young (1994) wurde unter anderem Schutz vor mechanischer, bakterieller und/oder chemischer Zerstörung der Zellmembran, Auftriebsregulation, Lichtzuführung oder -reflexion sowie Kalzifikation zur Unterstützung der Photosynthese (durch intrazelluläre Freisetzung von CO_2 über die Karbonatsynthese) diskutiert. So wird z. B. für *Florisphaera profunda* eine Lichtbrechung an den Coccolithen in die Zelle angenommen, die ein Leben dieser Art in der lichtlimitierten tiefen photischen Zone ermöglicht. Als Sekundäreffekt führt u. a. die hohe Anzahl

von Coccolithen einiger blütenbildender Arten, wie z. B. *Emiliania huxleyi* oder *Gephyrocapsa oceanica*, zu einer Reflexion des Sonnenlichtes, und somit zum verstärkten Rückstrahlungsvermögen der Wasseroberfläche, sowie zu einer Erhöhung der Oberflächenwassertemperatur (u. a. Holligan et al., 1993). Die erhöhte Produktion von Coccolithen pro Zelle könnte eine Anpassung dieser Arten an oberflächennahe, lichtdurchflutete Habitate darstellen. Aufgrund morphologischer und ökologischer Analysen verschiedener Arten und Artengruppen kommt Young (1994) zu dem Ergebnis, dass die Formenvielfalt der Coccolithen und die unterschiedliche Nutzung ökologischer Nischen nicht nur auf einen einzigen Parameter oder eine feste bestimmte Kombination von Eigenschaften zurückgeführt werden kann. Vielmehr wird angenommen, dass verschiedenartig gestaltete Coccolithen Anpassungsmechanismen an unterschiedliche Habitate darstellen und dabei mehrere und unterschiedliche Funktionen erfüllen können.

2.2. Ökologie und biogeographische Verbreitung

Rezente Coccolithophoriden haben eine weltweite ozeanische Verbreitung und nehmen einen bedeutenden Anteil der Phytoplanktongemeinschaften in nahezu allen marinen Regionen ein (Jordan und Chamberlain, 1997). Als photosynthetisierende Organismen leben sie in der euphotischen Zone, die in den höheren Breiten auf die oberen 20-30 m der Wassersäule beschränkt sein kann, in den Subtropen allerdings bis auf 120 m hinunterreichen kann. Im Gegensatz zu den meisten anderen Phytoplanktongruppen erreichen Coccolithophoridengemeinschaften ihre höchste Diversität in warmen, oligotrophen Niedrigproduktionsgebieten, wie z. B. den subtropischen zentralen Gyren (Winter et al., 1994). Die Populationsdichte in diesen Regionen ist durch geringe Reproduktionsraten relativ niedrig. Eutrophe Bedingungen, verursacht durch Auftrieb nährstoffreicher Zwischenwässer oder tiefe saisonale Durchmischung der oberen Wasserschichten, können oft großdimensionale Planktonblüten mit hohen Zellzahlen hervorbringen, die zumeist von wenigen Arten dominiert werden (u. a. Mitchell-Innes und Winter, 1987; Giraudeau et al., 1993; Brown und Yoder, 1994).

Coccolithophoriden zeigen bestimmte biogeographische Verbreitungsmuster, die weitgefasste, latitudinale Provinzen umfassen (Abb. 2). Diese Bereiche werden im allgemeinen eher durch Variationen in den Gemeinschaften als durch endemisch auftretende Arten charakterisiert. Als wichtigsten Faktor für die Abgrenzung der biogeographischen Zonierung wurden ursprünglich die Oberflächenwassertemperaturen angenommen (McIntyre und Bé, 1967; Okada und Honjo, 1973). In neueren Arbeiten werden jedoch zunehmend unterschiedliche Kombinationen verschiedener Parameter, wie z. B. Temperatur-, Nährstoffverteilung und Stratifizierung

der Wassersäule herangezogen (Winter et al., 1994; Brand, 1994). Diese wiederum sind an großräumige dynamische Strukturen der ozeanischen Zirkulation, wie z. B. Divergenzzonen, ozeanische Fronten oder zentralozeanische Gyren gebunden. Obwohl für die verschiedenen Florenzonen bestimmte Arten oder Artenvergesellschaftungen typisch sind (Tab. 1), stellen die Verteilungsmuster kein statisches Gebilde dar. So haben Untersuchungen in verschiedenen Regionen gezeigt, dass sich in Abhängigkeit bestimmter physikalisch-ozeanographischer Parameter und verschiedener Überlebensstrategien bestimmter Arten (K- und r-selektierte Arten) charakteristische Coccolithophoridenvergesellschaftungen ausbilden können (siehe Winter et al., 1994 und Young, 1994 im Überblick).

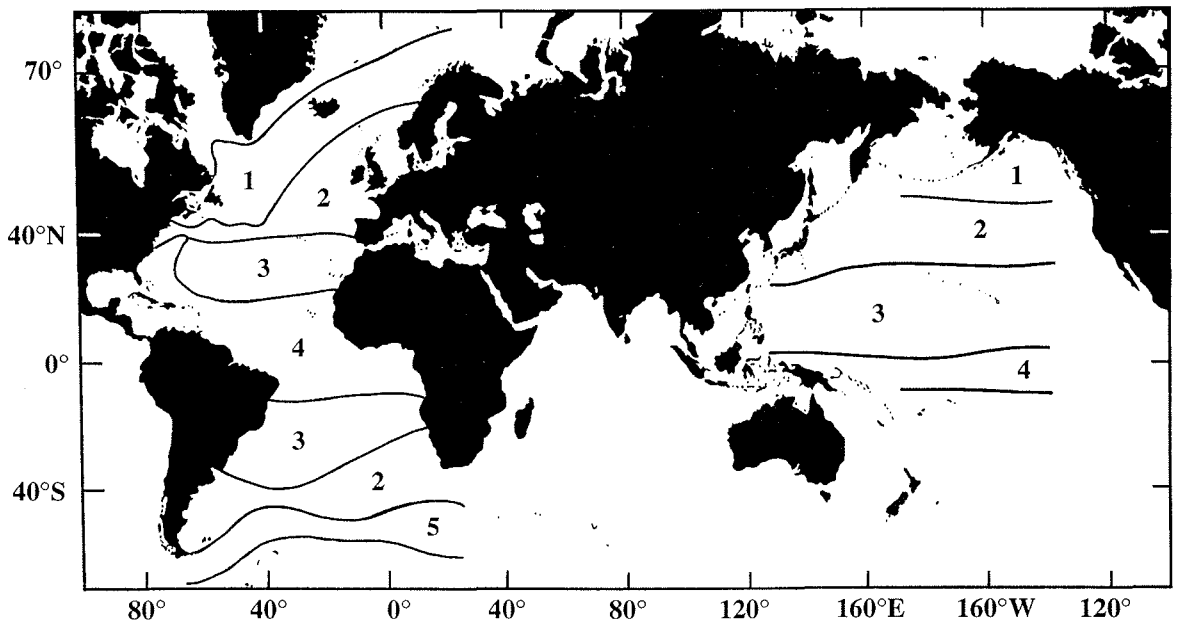

Abb. 2. Biogeographische Zonierung von Coccolithophoriden im Atlantik und Pazifik (nach McIntyre & Bé, 1967 und Okada & Honjo, 1973). 1 = subarktisch, 2 = gemäßigt, 3 = subtropisch, 4 = tropisch, 5 = subantarktisch.

2.3. Übergang von der Lebend- zur Sedimentgemeinschaft

Durch die Bildung eines kalzitischen Außenskelettes und der weltweiten ozeanischen Verbreitung sind Coccolithophoriden erheblich am Aufbau karbonatischer Schelf- und Tiefseesedimente beteiligt (Bramlette, 1958; Berger, 1976; Milliman, 1993). In Sedimenten die oberhalb der Kalzitkompensationstiefe abgelagert wurden, können Coccolithophoriden- bzw. Coccolithengemeinschaften für paläozeanographische und paläoklimatische Rekonstruktionen herangezogen werden (Molfino und McIntyre, 1990; Giraudeau, 1992; Beaufort et al., 1997; Lototskaya, 1999; Kinkel et al., 2000). Eine der wichtigsten Voraussetzungen für die Verwendung von Coccolithengemeinschaften als Indikator (Proxy) für Paläo-Umweltbedingungen ist

Tab. 1. Charakteristische Arten und Artenvergesellschaftungen der biogeographischen Coccolithophoriden-Zonen in Abbildung 2 (nach Jordan & Chamberlain, 1997 und Winter et al., 1994).

Biogeographische Zone	Charakteristische Arten / Artenvergesellschaftungen
(1) Subarktisch	*Emiliania huxleyi, Coccolithus pelagicus, Calciopappus caudatus, Algirosphaera* spp., *Papposphaera* spp.
(2) Gemäßigt	*Emiliania huxleyi, Gephyrocapsa muellerae, Calcidiscus leptoporus, Helicospaera* spp.
(3) Subtropisch	Holococcolithophoriden, *Discosphaera tubifera, Rhabdosphaera* spp., *Syracospaera* spp., *Umbellosphaera* spp., *Pontosphaera* spp., *Florisphaera profunda, Gladiolithus flabellatus*
(4) Tropisch	*Emiliania huxleyi, Gephyrocapsa oceanica, Reticulofenestra sessilis, Umbellosphaera* spp., *Calcidiscus leptoporus*
(5) Subantarktisch	*Papposphaera* spp.

eine genaue Kenntnis über die heutigen ökologischen Präferenzen der verschiedenen Arten (s. o.). Ein weiterer wichtiger Aspekt ist hierbei die Tatsache, dass Coccolithophoriden während des Absinkens zum Meeresboden durch eine Vielzahl von Prozessen, wie z. B. Zerfall der Coccosphären und Fragmentierung fragiler Arten durch Zooplankton-Fraß oder selektive Lösung verändert werden können. So werden zumeist nicht die ursprünglichen Artenverhältnisse und Quantitäten der Lebendgemeinschaft, sondern je nach Einfluss verschiedener Faktoren stark veränderte oder reduzierte Vergesellschaftungen im Sediment akkumuliert (Andruleit, 1995). Trotzdem haben diverse Studien in unterschiedlichen Regionen gezeigt, dass mit Hilfe von Coccolithophoridengemeinschaften wichtige Aussagen über Wassermassenverteilung, Temperaturregime und Nährstoffverhältnisse im Oberflächenwasser getroffen werden können (u. a. Samtleben und Schröder, 1992; Andruleit, 1997; Baumann et al., 1999).

Durch ihre geringe Größe von nur wenigen µm haben Coccosphären und Coccolithen ein zu geringes eigenes Sinkpotential (wenige cm-dm/Tag), um nach dem Absterben der Zelle frei durch die Wassersäule zum Meeresboden zu gelangen (Honjo, 1976). Der Übergang von der Plankton-Lebendgemeinschaft (Biozönose) zur Sedimentgemeinschaft (Thanatozönose) hängt somit unter anderem von einer effektiven Einbindung in größere, schneller absinkende Partikel wie z. B. Kotballen zooplanktischer Organismen oder amorphe Aggregate ('marine snow') ab (u. a. Knauer et al., 1984; Pilskaln und Honjo, 1987; Asper, 1987). Hierbei erhöhen sich nicht nur die Sinkgeschwindigkeiten (ø100-300 m/Tag; Steinmetz, 1994) sondern es ist auch stärkerer Schutz vor bakterieller und/oder chemischer Auflösung der Coccolithen während des Absinkprozesses gegeben (Roth et al., 1975; Honjo, 1976; Samtleben et al., 1995).

Die größten Veränderungen in der Zusammensetzung der Gemeinschaften finden einerseits in den oberen Wasserschichten durch biologische Vorgänge (Remineralisation, Aggregation, selektive Lösung) und andererseits an der Grenzfläche Wasser-Sediment durch chemisch-biologische sowie physikalische Abbau- und Umlagerungsprozesse statt (Steinmetz, 1994; Roth, 1994). Bei Paläorekonstruktionen müssen somit in verstärktem Maße Erhaltungs- und Transportprozesse berücksichtigt werden.

3. Zielsetzungen der vorgelegten Studie

Die vorliegende Dissertation fokussiert sich auf die Erforschung der Ökologie, der Überlieferung und der Sedimentationsprozesse rezenter Coccolithophoridengemeinschaften in den Gewässern um die Kanaren. Es wurden Berechnungen des Gesamtcoccolithenflusses aus Sedimentfallenproben für unterschiedliche ozeanische Regime erstellt und biometrische Analysen bestimmter Arten durchgeführt, die wesentlich zu einem besseren Verständnis möglicher Steuerungsmechanismen der Coccolithophoridenproduktion und -akkumulation beitragen. Die der Arbeit zugrunde liegenden methodischen und wissenschaftlichen Ansätze werden im Folgenden anhand der schematischen Darstellung in Abbildung 3 näher erläutert.

Mit Hilfe von Planktonproben aus der photischen Zone lassen sich Aussagen über die Tiefenverteilung verschiedener Coccolithophoridenarten und deren Bezug zu den regulierenden physikalisch-ozeanographischen Parametern, wie z. B. Nährstoff- und Temperaturverteilungen (hier: Jahresgang mittlerer monatlicher Oberflächenwassertemperaturen; Abb. 3, oben) treffen. Ozeanische Interpretationen sind allerdings durch eine hohe Variabilität und Dynamik lebender Gemeinschaften stark eingeschränkt, da umfassende räumliche und zeitliche Zusammenhänge nur mit einem sehr dichten, kontinuierlichen Probennetz erfasst werden können. So wurden bisher nur von einigen wenigen Bearbeitern Planktonverteilungen mit der Verbreitung von Gemeinschaften in Oberflächensedimenten verglichen (McIntyre und Bé, 1967; Honjo und Okada, 1974; Roth und Coulbourn, 1982; Samtleben und Schröder, 1992; Baumann et al., 2000).

Die kontinuierliche Aufzeichnung der Sinkgemeinschaften mit Hilfe von Zeitserien-Sedimentfallen ermöglichen die Quantifizierung von Exportflüssen (Coccolithophoriden, Karbonat) als Bindeglied zwischen der Produktion im Oberflächenwasser und der Akkumulation im Sediment. Über einen längeren Zeitraum, meist ein Jahresgang, können Erkenntnisse zum saisonalen Auftreten der Gemeinschaft oder einzelner Arten und somit auch indirekt Rückschlüsse auf ihr Vorkommen in der photischen Zone gewonnen werden. In offen-ozeanischen

Bereichen kann die Exportproduktion ein integriertes saisonales Signal der Produktion und Artenvergesellschaftung in den überlagernden Wasserschichten widerspiegeln (Haidar et al., 2000). Einen weiteren wichtigen Aspekt bei der Untersuchung von Coccolithophoridenflüssen bildet die Möglichkeit, den anteiligen Karbonatexport aus der photischen Zone in das geologische Archiv zu quantifizieren um die Bedeutung dieser kalzifizierenden Organismen im Kohlenstoffbudget genauer als bisher abschätzen zu können (vgl. Broerse, 2000). Interannuelle Aufzeichnungen von Exportflüssen können am ehesten mit den über einen längeren Zeitraum gemittelten Gemeinschaften und der Karbonatakkumulation in den Oberflächensedimenten verglichen werden.

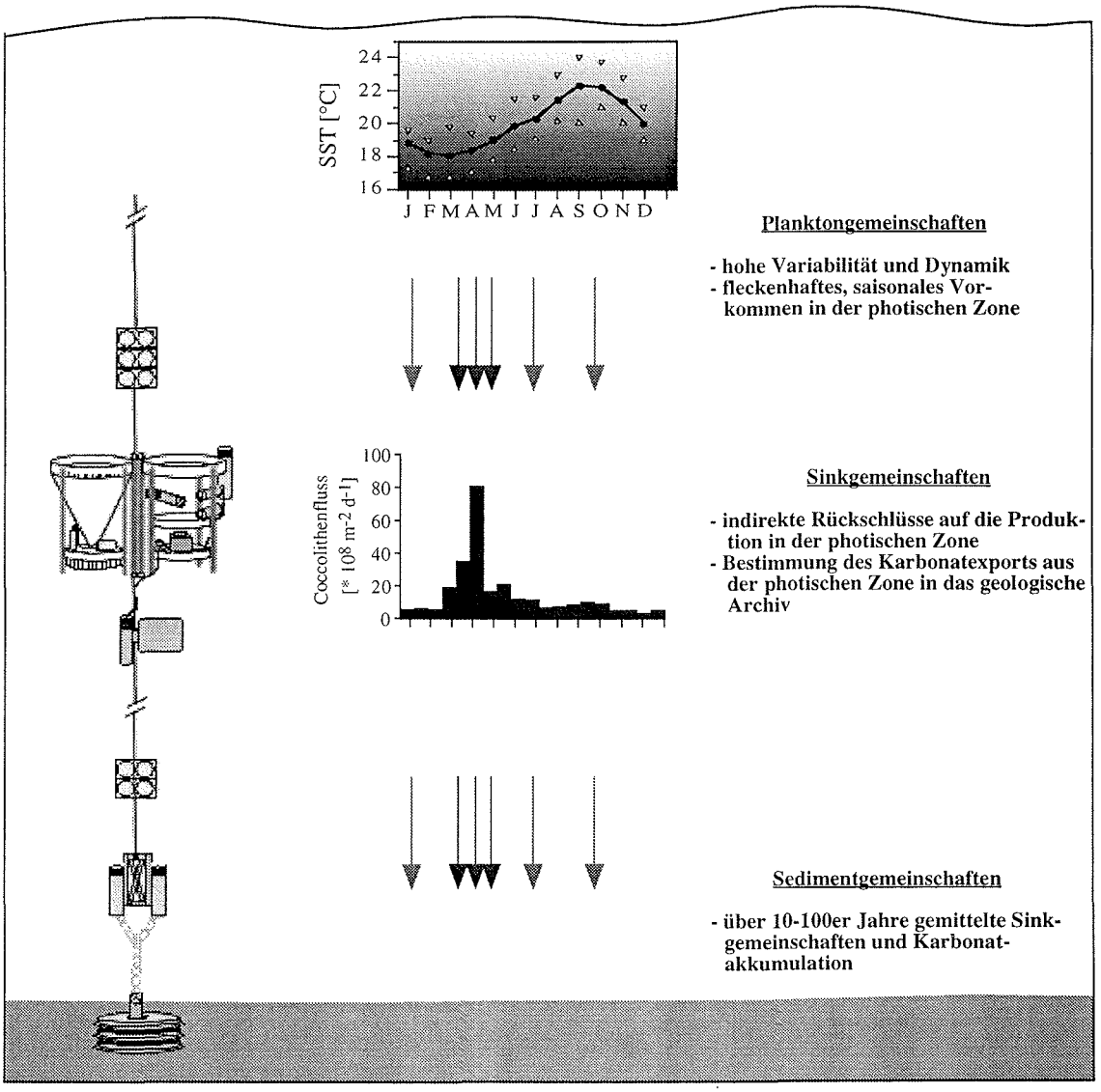

Abb. 3. Schematischer Schnitt durch die Wassersäule mit einer Darstellung der unterschiedlichen Untersuchungsansätze bezüglich der verschiedenen Coccolithophoridengemeinschaften von der Produktion in der photischen Zone bis zur Einbettung im Sediment (Erläuterungen siehe im Text).

4. Untersuchungsgebiet

Ergänzend zu den im zweiten Teil der Arbeit vorgestellten Manuskripten wird in diesem Kapitel ein zusammenfassender Überblick der Hydrographie des Arbeitsgebietes und den daraus resultierenden biologischen Produktionscharakteristika gegeben. Die im Rahmen der vorliegenden Studie bearbeiteten Verankerungsstationen liegen entlang eines Ost-West-Transektes nördlich und westlich der Kanarischen Inseln bei etwa 29°N. Die genauen Positionensangaben, Verankerungstiefen und Verankerungszeiträume sind in Kapitel 5 (Material und Methodik) aufgelistet sowie den Manuskripten 1 und 3 (Teil II dieser Arbeit) zu entnehmen.

4.1. Ozeanische und atmosphärische Zirkulation

Die Kanarischen Inseln befinden sich etwa 100-600 km westlich der marokkanischen Küste auf etwa 28° nördlicher Breite (Abb. 4). Mit ihrer zonalen Erstreckung von etwa 13°-18°W im östlichen Randgebiet des subtropischen Nordatlantiks umfassen sie den Übergangsbereich von der hochproduktiven nordwestafrikanischen Küstenregion zum offen-ozeanischen Bereich der oligotrophen nordatlantischen Zentral-Gyre. Die großräumige ozeanographische Situation im Kanarenbecken wird durch das Rezirkulationssystem des subtropischen Wirbels und küstennahe Auftriebsprozesse bestimmt. Der Kanarenstrom, ein wichtiger Teil des östlichen Grenzstromsystems der zentralozeanischen Gyre, wird von dem aus nordwestlicher Richtung kommenden Azorenstrom gespeist und fließt weiter südwestwärts entlang des nordwestafrikanischen Schelfs (Stramma und Siedler, 1988; Mittelstaedt, 1991). Er zeigt eine saisonale Variabilität mit jeweils stärkeren Strömungen nahe des Kontinentalrandes im Sommer sowie westlich der Inseln Lanzarote und Fuerteventura im Winter (Stramma und Siedler, 1988). Zwischen 25° und 20°N spaltet sich der Kanarenstrom allmählich vom Kontinentalrand ab und speist mit seinen Ausläufern den Nordäquatorialstrom bei etwa 10°-12°N. Die durchmischte Deckschicht (bis ca. 200 m) wird im gesamten Kanarenbecken bis in eine Tiefe von etwa 600 m von südwärts gerichtetem nordatlantischem Zentralwasser unterlagert. Überwiegend in den tieferen Bereichen entlang des afrikanischen Schelfs strömt zwischen 600 m und 1100 m niedrigsalines, nährstoffreicheres antarktisches Zwischenwasser nach Norden. Die höchsten Salinitäten charakterisieren nördlich und östlich der Inseln in etwa 800-1400 m Wassertiefe südwärts gerichtetes Mittelmeerwasser. Die tiefsten Bereiche der Kanarenregion werden von nordatlantischem Tiefenwasser durchströmt (Mittelstaedt, 1991; Knoll et al., 1999; Hernández-Guerra et al., 1999; B. Lenz, Univ. Kiel, pers. Mitt. 1999).

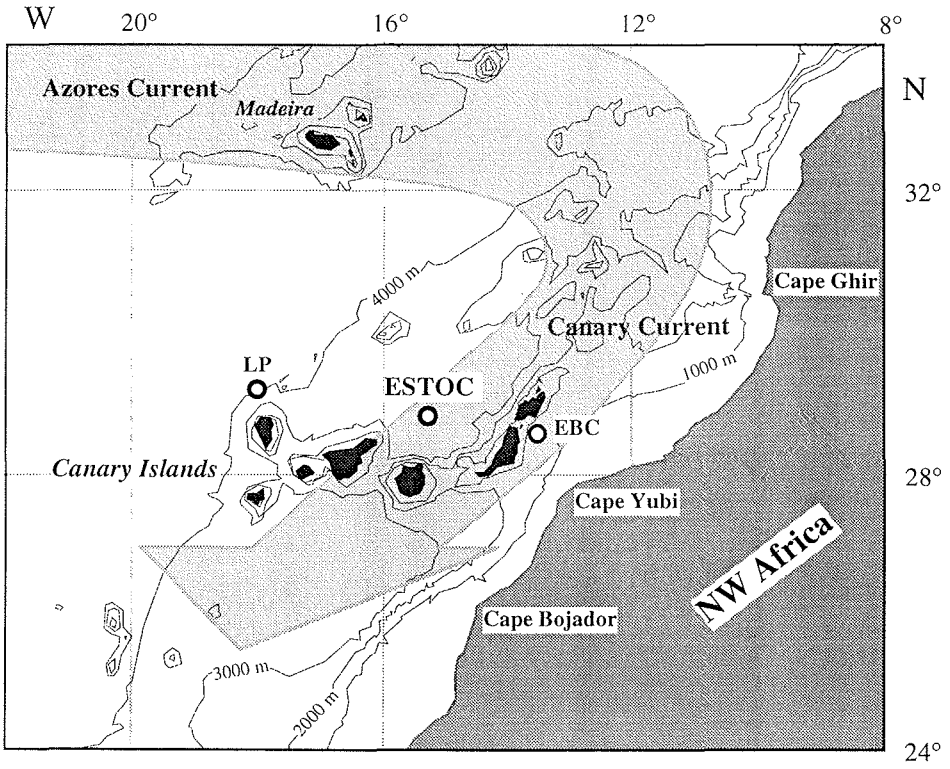

Abb. 4. Übersichtskarte des Untersuchungsgebietes mit Lage der bearbeiteten Sedimentfallenverankerungen und der Oberflächenströmung (nach Stramma & Siedler, 1988 und Mittelstaedt, 1991).

Die enge Kopplung der ozeanischen Zirkulation mit den vorherrschenden meridionalen Passatwinden zeigt sich in einem etwa 50-70 km breiten Küstenstreifen, der nahezu ganzjährig durch den Auftrieb kalter Zwischenwässer aus dem Bereich des nordatlantischen Zentralwassers gekennzeichnet ist, deutlich erkennbar anhand der niedrigen Temperaturen in Abb. 5 (Mittelstaedt, 1991; Nykjaer und Van Camp, 1994; Barton et al., 1998). Bedingt durch saisonale Veränderungen in der Orientierung und Stärke der Passatwinde zeigen sich in bestimmten Bereichen entlang der Küste saisonal verstärkte Auftriebssignale. Nördlich 25°N ist der Auftrieb am stärksten während der Sommer- und Herbstmonate, einhergehend mit der höchsten Intensität des Nordost-Passates (Wooster et al., 1976; Van Camp et al., 1991; Barton et al., 1998). Die Grenze zwischen dem kalten, nährstoffreichen Auftriebswasser und dem wärmeren, nährstoffarmen Wasser des offenen Ozeans ist häufig unregelmäßig. Entlang der Küste bilden sich saisonal an mehreren Positionen, wie z. B. Cape Ghir (31°N), Cape Jubi (28°N) und Cape Bojador (26°N) regelmäßig Auftriebsfilamente, die mehrere hundert Kilometer aus dem Schelfbereich westwärts driften können und somit einen wichtigen Transportmechanismus für Nährstoffe und Biomasse in Richtung des offenen Ozeans darstellen (Abb. 6) (Nykjaer und Van Camp; 1994; Davenport et al., 1999; Rodríguez et al., 1999).

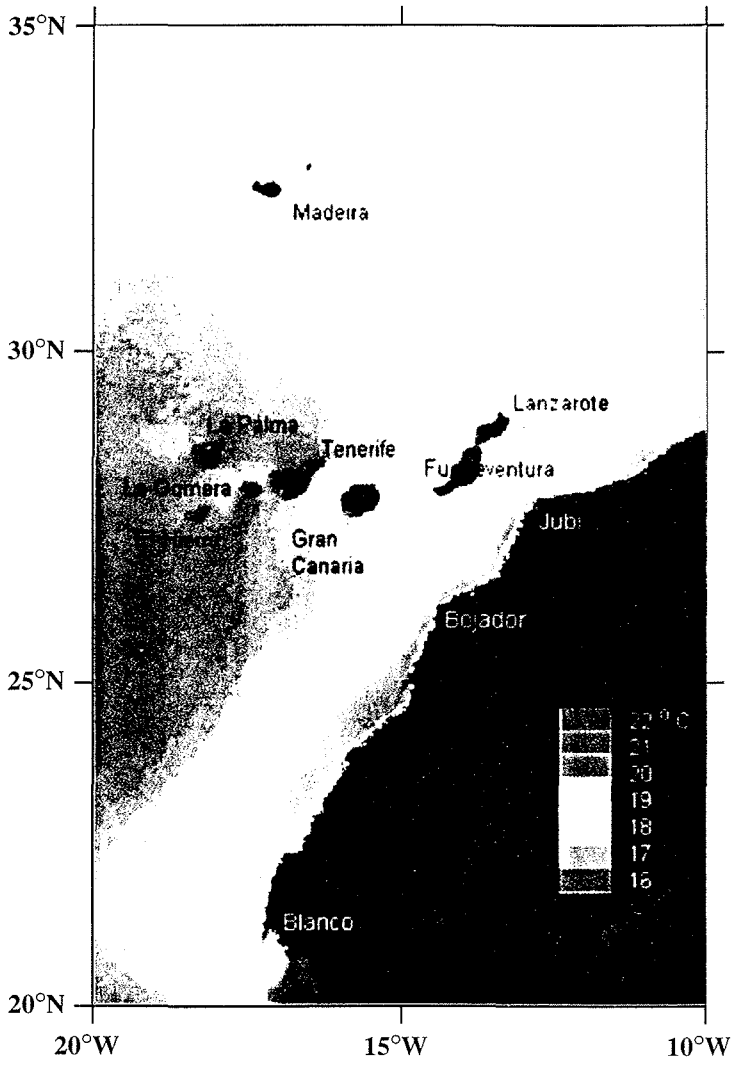

Abb. 5. Mittlere Oberflächenwassertemperaturen von 1981-1999 im Bereich der Kanarischen Inseln (nach Barton et al., 1998; Fig. 1).

4.2. Primärproduktion und Partikelflüsse

Die Zusammenhänge zwischen den atmosphärischen und hydrographischen Merkmalen und den Produktionscharakteristika der Kanarenregion sind in den letzten Jahrzehnten intensiv untersucht worden (siehe Barton et al., 1998 im Überblick). Mit Hilfe von Satellitenbildern (Coastal Zone Color Scanner Daten) wurden charakteristische Phytoplanktonpigmentverteilungen im Oberflächenwasser identifiziert, die eine enge Beziehung der biologischen Produktivität mit den regulierenden physikalisch-ozeanographischen Parametern (u.a. Temperatur, Nährstoffe, Stratifizierung) erkennen lassen (u.a. Hernández-Guerra et al., 1999; Arístegui et al, 1997; Davenport et al., 1999). Aufgrund ihrer zonalen Erstreckung bilden die Kanarischen Inseln eine Art Hindernis für den relativ schwachen (<10 cm s^{-1}; Neuer et al., 1997), südwestwärts fließenden Kanarenstrom, deutlich erkennbar an den höheren Oberflächenwassertemperaturen in den Schatten stromabwärts der äußeren fünf Inseln (Abb. 5). Die beiden östlichsten Inseln Fuerteventura und Lanzarote bilden wiederum durch ihre Lage parallel

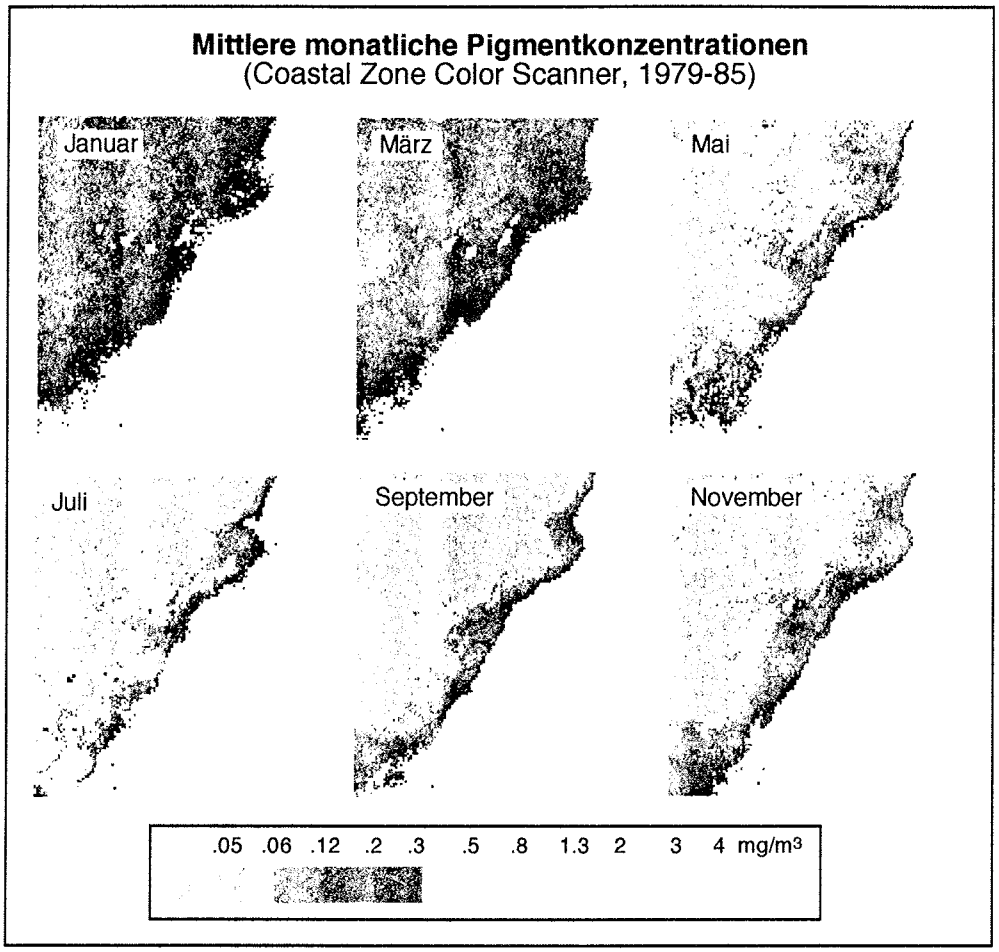

Abb. 6. Saisonale Entwicklung von Pigmentkonzentrationen im Oberflächenwasser in der Kanarenregion (CZCS Daten; http://me-www.jrc.it/me-website/contents/shared_utilities/frames/archive_ocean.htm).

zur marokkanischen Küste eine natürliche Barriere für den westwärts gerichteten Transport nährstoffreicher Auftriebswässer. Aufgrund dieser Effekte lässt sich die Region nördlich und südlich der Inseln in jeweils zwei Bereiche unterteilen, und zwar einen östlichen, vom Küstenauftrieb beeinflussten und einen westlichen, vom Küstenauftrieb unbeeinflussten Teil (Barton et al., 1998). Die im Rahmen der vorliegenden Dissertation bearbeiteten Sedimentfallen wurden im nördlichen, stromaufwärts gelegenen Bereich des Kanarenbeckens und östlich der Inseln Lanzarote und Fuerteventura verankert (siehe Kap. 5 – Material und Methodik). Im folgenden wird hier kurz auf die Besonderheiten dieser Regionen eingegangen.

Im nördlichen, offen-ozeanischen Bereich des subtropischen Wirbels wird die biologische Produktion in den oberen Wasserschichten hauptsächlich durch den episodischen Eintrag von Nährstoffen aus tieferen Bereichen in die euphotische Zone kontrolliert. Während der meisten Zeit des Jahres sind die Oberflächenwässer aufgrund einer stabilen Thermokline nährstoffabgereichert, resultierend in geringen Primärproduktionsraten und einer geringen Phytoplank-

tonbiomasse (Barton et al., 1998). Bedingt durch eine relativ kurze Phase der strömungs- und windinduzierten Durchmischung der oberen Wasserschichten im Herbst/Winter entwickelt sich zumeist gegen Ende der Wintermonate bzw. im Frühjahr eine nicht sehr stark ausgeprägte Phytoplanktonblüte, vergleichbar mit der nährstofflimitierten Herbstblüte in den gemäßigten Breiten (Abb. 6) (Arístegui et al, 1997). Der Bereich zwischen den östlichsten Inseln und der Küste wird zusätzlich von nährstoffreichen Auftriebswässern oder westwärts driftenden Auftriebsfilamenten beeinflusst (s. o.), die eine erhöhte Produktion, besonders während der Hauptauftriebszeit, zur Folge haben.

Der enge Zusammenhang zwischen der Primärproduktion in der euphotischen Zone und der Partikelsedimentation spiegelt sich in einer ausgeprägten Saisonalität der (Coccolithophoriden-) Exportflüsse sowohl an den zwei ozeanischen Fallenstationen LP und ESTOC als auch an der küstennahen Lokation EBC wider (Neuer et al., 1997; Teil II – Manuskript 1 und 3, diese Arbeit). Die Hauptanteile des absinkenden partikulären Materials bilden Karbonatpartikel (30-66%), lithogene Komponenten (26-55%) und zu einem geringeren Teil Opal (2-5%) (Neuer et al., 1997; Freudenthal et al., subm.). Der durchweg hohe Anteil der lithogenen Fraktion weist auf einen signifikanten Einfluss von Staubeintrag aus dem angrenzenden NW afrikanischen Küstengebiet und der Sahara hin (siehe Ratmeyer, 1996 im Überblick).

5. Material und Methodik

Die geographischen Positionen und Grunddaten der bearbeiteten Sedimentfallen sind in Tabelle 2a zusammengestellt. Die Verankerungen CI 1-7 (ESTOC) wurden nördlich von Gran Canaria, die Verankerung LP1 nördlich von La Palma und die Falle EBC 2-1 östlich der Inseln Lanzarote und Fuerteventura ausgebracht. Alle Sedimentfallen sind vom Typ Kiel SMT 230/234, mit einer Fangfläche von 0,5 m^2 und 20 Probenbehältern. In der Tabelle 2b sind zusätzlich die Lokationen der im Manuskript 3 zum Vergleich herangezogenen holozänen Oberflächensedimente aufgeführt (Henderiks et al., subm.; Freudenthal et al., subm.).

5.1. Aufbereitung und Untersuchung der Sedimentfallenproben

Vor dem Ausbringen der Sedimentfallen wurden alle Probenbehälter mit Quecksilberchlorid ($HgCl_2$) in einer NaCl-Lösung versetzt, um einen mikrobiellen Abbau der gefangenen Partikel zu vermeiden. Nach der Bergung der Verankerungen wurden die Proben abermals mit $HgCl_2$ vergiftet und bei 4°C gelagert. In einem ersten Bearbeitungsschritt wurden alle Proben nass

Tab. 2. Beschreibung aller bearbeiteten Sedimentfallen (**a**) und der im Rahmen der Arbeiten zu Manuskript 3 (s. Teil II dieser Arbeit) verwendeten holozänen Sedimente (**b**).

a)

Verankerung (Station / Nr.)	Geographische Position Breite	Länge	Wassertiefe [m]	Fallentiefe [m]	Fangperiode	Probenanzahl
CI 3	29°09.1'N	15°26.5'W	3606	3086	12.04.93 - 07.06.94	19
CI 4	29°09.6'N	15°26.7'W	3625	923	09.06.94 - 02.09.94	10
				3070	09.06.94 - 02.09.94	10
CI 5	29°08.67'N	15°28.7'W	3625	976	05.09.94 - 12.11.95	20
CI 6	29°09.1'N	15°28.1'W	3618	976	17.11.95 - 21.12.96	20
				3062	17.11.95 - 01.12.96	19
CI 7	29°11.0'N	15°27.0'W	3610	750	23.12.96 - 15.09.97	19
				3000	23.12.96 - 15.09.97	19
LP 1	29°45.73'N	17°57.26'W	4327	900	06.01.97 - 15.09.97	18
				3700	06.01.97 - 15.09.97	18
EBC 2-1	28°42.49'N	13°09.34'W	996	700	02.01.97 - 29.09.97	20

b)

Gerät / Station	Verankerung	Geographische Position Breite	Länge	Wassertiefe [m]
GKG / GeoB 4242-4	LP	29°40.9'N	17°53.4'W	4292
SL / GeoB 4242-5		29°40.5'N	17°53.3'W	4286
MUC / GeoB 4301-1	CI (ESTOC)	29°09.0'N	15°30.0'W	3614
SL / GeoB 4241-11		29°10.0'N	15°27.1'W	3609
MUC / GeoB 4234-1	EBC	28°53.4'N	13°13.6'W	1360
SL / GeoB 4240-2		28°53.3'N	13°13.5'W	1358

gesiebt (>1 mm) und sorgfältig gewaschen. Die <1 mm Fraktion wurde in kleinere Teilproben (1/5, 1/25, 1/125) geteilt. Standardanalysen (u.a. organische Kohlenstoff-, Karbonat-, biogene Opalgehalte) wurden am gefriergetrockneten Material durchgeführt (Fischer und Wefer, 1991; Neuer et al., 1997).

Für die Untersuchung der Coccolithophoridengemeinschaften erfolgte die Probenaufbereitung gemäß des Schemas in Abbildung 7. Nach dem Teil - und Filtervorgang wurden die Proben für die Bearbeitung am Rasterelektronenmikroskop (REM) vorbereitet. Dazu wurde ein ca. 0,5 cm^2 großes Teilstück des Filters auf einen Aluminiumträger geklebt und unter Hochvakuum mit einer Gold/Palladium-Schicht bedampft. Die REM Untersuchungen wurden am Zeiss DMS 940A des Fachgebietes Sedimentologie/Paläozeanographie durchgeführt. Die Anzahl der Coccolithen und Coccosphären wurde entlang zufällig gewählter, abgemessener Spuren auf

dem Filter ausgezählt (mind. 300 Coccolithen) und dann mit Hilfe folgender Formel in durchschnittliche Coccolithen-/Coccosphärenflüsse (Individuen m^{-2} d^{-1}) umgerechnet:

(1) Coccolithen-/Coccosphärenfluss = F x C x S / A x D x O

wobei **F** = effektive Filtrationsfläche (mm^2), **C** = Anzahl der gezählten Coccolithen/Coccosphären, **S** = Splitfaktor, **A** = abgesuchter Filterbereich (mm^2), **D** = Sammelintervall der Probe (Tage) und **O** = Fläche der Sedimentfallenöffnung (m^2) angibt.

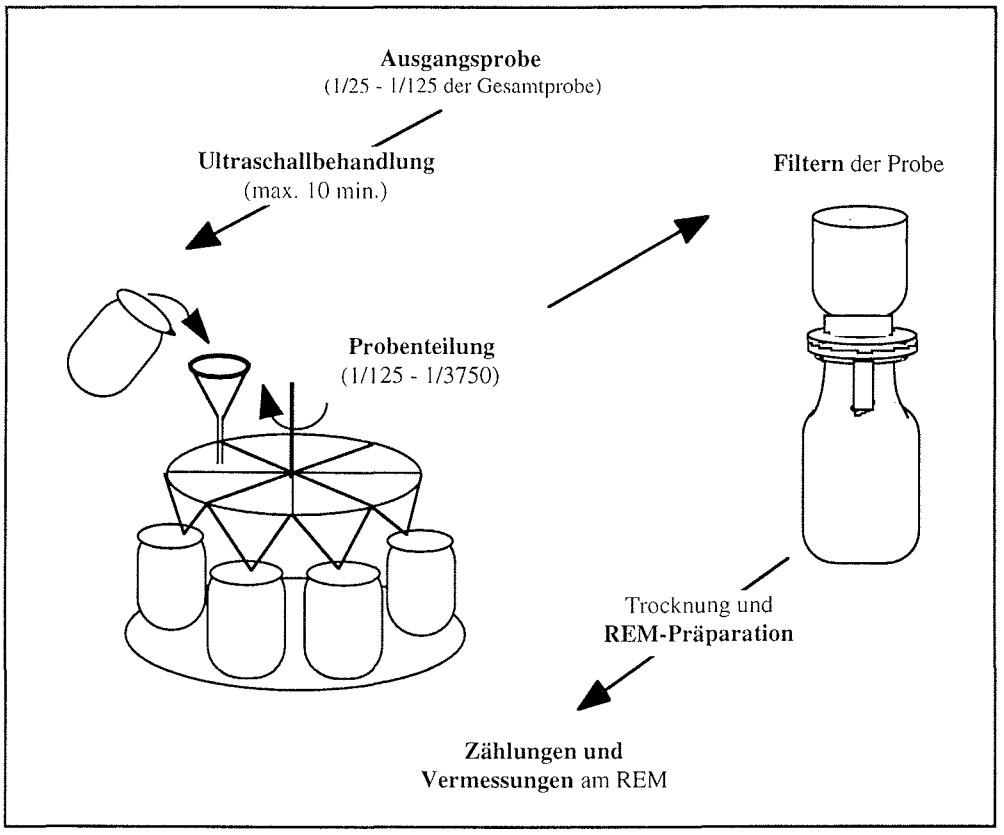

Abb. 7. Schematische Darstellung der Sedimentfallen-Probenaufbereitung für Coccolithophoridenuntersuchungen (modifiziert nach Andruleit, 1996).

5.2. Biometrische Analysen und Berechnung von Coccolithenkarbonat

Biometrische Vermessungen ausgewählter Arten wurden direkt am REM Bildschirm mit Hilfe einer integrierten Messeinheit bei 5000- oder 10.000-facher Vergrößerung durchgeführt. Die ermittelten biometrischen Daten bilden sowohl die Grundlage für eine Diskussion der morphologischen Variabilität einzelner Arten und Artengruppen im Vergleich mit ökologischen Parametern (siehe Teil II – Manuskript 2) als auch eine wichtige Basis für die Abschätzung des Coccolithenkarbonatanteils in den Sedimentfallenproben.

Für die Bestimmung des gewichtsbilanzierten Coccolithenkarbonats wurden Längenvermessungen an den 8 häufigsten und größten Coccolithenarten vorgenommen (siehe Teil II – Manuskript 1). Mit Hilfe folgender Formel nach Young und Ziveri (2000) wurden für diese Arten spezifische Karbonatgewichte (in pg) berechnet:

$$(2) \quad \mathbf{m = 2{,}7 \times k_s \times l^3}$$

wobei $\mathbf{k_s}$ = artspezifischer Umrissfaktor (Tab. 2 in Young und Ziveri, 2000) und **l** = Coccolithenlänge bzw. -durchmesser (µm). Der Faktor 2,7 gibt die spezifische Dichte von Kalzit an (pg μm^{-3}).

Für alle weiteren, untergeordneten Arten und Artengruppen wurden spezifische Karbonatgewichte aus Literaturdaten übernommen (siehe Teil II – Manuskript 1). Coccolithen intakter Zellen wurden ebenso in die Karbonatberechnungen mit einbezogen. Die durchschnittliche Anzahl von Coccolithen pro Coccosphäre für verschiedene Arten entstammt den Literaturangaben verschiedener Autoren aus Untersuchungen in unterschiedlichen Regionen. Zur Berechnung der Coccolithenkarbonatflüsse wurden die Karbonatgewichte mit den jeweiligen Coccolithenflüssen (siehe Formel 1) multipliziert.

6. Darstellung der Ergebnisse in Einzelpublikationen

Die im Rahmen der vorliegenden Dissertation erzielten Ergebnisse sind in insgesamt 4 Manuskripten zusammengefasst. Das erste und vierte Manuskript sind bereits bei *Marine Micropaleontology* erschienen und die Manuskripte 2 und 3 sind bei *Journal of Nannoplankton Research* und *Deep-Sea Research II* zur Veröffentlichung eingereicht. Die Arbeiten behandeln unterschiedliche, z. T. auf einander aufbauende Themenkomplexe, deren Aspekte an dieser Stelle bezüglich der jeweiligen Fragestellungen kurz erläutert werden.

Manuskript 1:

Sprengel, C., Baumann, K.-H., Neuer, S., 2000. Seasonal and interannual variation of coccolithophore fluxes and species composition in sediment traps north of Gran Canaria (29°N 15°W). Marine Micropaleontology 39, 157-178.

In dieser Publikation werden sowohl saisonale als auch interannuelle Variationen (1993-1996) von Coccolithophoridenflüssen in Sedimentfallen der europäischen Zeitserien-Verankerungsstation ESTOC (European Sation for Time-series in the Ocean, Canary Islands), ca. 100 km nördlich von Gran Canaria, analysiert. Die Coccolithengesamtflüsse und die Arten-

vergesellschaftung in verschiedenen Wassertiefen (1000 m, 3000 m) werden in Abhängigkeit zu den biologischen Produktionszyklen im Oberflächenwasser und den Transportprozessen innerhalb der Wassersäule diskutiert. Über den gewichtsbilanzierten Anteil des Coccolithenkarbonats am Gesamtkarbonatfluss wird die Bedeutung der Coccolithophoriden als einer der Hauptkarbonatproduzenten in dieser Region herausgestellt.

Manuskript 2:

Baumann, K.-H., Sprengel, C., subm. Morphological variations of various coccolith species in a sediment trap north of Gran Canaria. (Journal of Nannoplankton Research, eingereicht)

An 8 ausgewählten Coccolithophoridenarten in Sedimentfallenproben einer Zeitserie der ESTOC-Station (1996, 1000 m) wurden biometrische Analysen, und zwar Größenbestimmungen (u. a. Länge, Breite, Durchmesser) und eine Charakterisierung morphologischer Besonderheiten (z. B. Brückenwinkel, Porenweite, Elementanzahl) durchgeführt. Anhand der detailliert beschriebenen morphologischen Variationen innerhalb einer Art oder Gattung wird diskutiert, ob diese unterschiedlichen Ausprägungen von ökologischen Faktoren, z. B. Temperatur, Nährstoffen und/oder Konkurrenzdruck abhängig sein können (= Ökophänotypen) oder ob es sich bei den Variationen um "echte" genetische Ausprägungen, und somit um verschiedene Genotypen handelt. Des Weiteren bilden die Längen- und Größenvermessungen die Basis für eine genauere Abschätzung der artspezifischen Karbonatgewichte und somit der Coccolithenkarbonatberechnungen (vergleichende Ergebnisse in den Manuskripten 1 und 3).

Manuskript 3:

Sprengel, C., Baumann, K.-H., Henderiks, J., Henrich, R., Neuer, S., subm. Modern coccolithophore and carbonate sedimentation along a productivity gradient in the Canary Islands region: Seasonal export production and surface accumulation rates. (Deep-Sea Research Part II, eingereicht)

Aufbauend auf den Ergebnissen der Arbeiten zu Manuskript 1 wurden die Coccolithophoridenflüsse und -gemeinschaften in unterschiedlichen Wassertiefen an drei Sedimentfallenstationen entlang eines Produktivitätsgradienten von der hochproduktiven, auftriebsbeeinflussten NW afrikanischen Küstenregion zum offen-ozeanischen Bereich der oligotrophen subtropischen Gyre untersucht. Durch die Synchronisation aller Sedimentfallen ist ein genauer zeitlicher und regionaler Vergleich der Proben innerhalb des Verankerungszeitraumes (Januar bis September 1997) möglich. Die Variabilität der Exportflüsse und die unterschiedliche Zusammensetzung der Gemeinschaften entlang des Transektes wird im Hinblick auf die verschiedenen Produktivitätsbedingungen im Oberflächenwasser diskutiert. Der Vergleich der Flüsse in

den unterschiedlichen Wassertiefen im Zusammenhang mit der ozeanischen Zirkulation ermöglicht eine Abschätzung des relativ "ungestörten" versus lateral beeinflussten Transportes sowie eine Ansprache möglicher Herkunftsgebiete der absinkenden Partikel. Durch den Vergleich der rezenten Exportflüsse mit den holozänen Akkumulationsraten im Sediment an den drei Fallenstationen wird geprüft, in welchen Maße Erhaltungs- und Transportprozesse Einfluss auf die Sedimentation und Akkumulation von Coccolithophoriden in der Kanarenregion haben und inwieweit sich die heutige Situation auf die geologische Vergangenheit übertragen lässt.

Manuskript 4:

Bairbakhish, A.N., Bollmann, J., Sprengel, C., Thierstein, H.R., 1999. Disintegration of aggregates and coccospheres in sediment trap samples. Marine Micropaleontology 37, 219-223.

Sedimentfallenproben enthalten häufig größere Aggregate und/oder Kotballen, die u. a. eine sehr hohe Anzahl von Coccolithen enthalten. Für eine genaue Quantifizierung der Coccolithenflüsse in z. T. sehr kleinen Teilproben ist es notwendig, diese Aggregate aufzulösen und alle darin enthaltenen Partikel vor einer weiteren Behandlung der Proben in gleichmäßige Suspension zu bringen. Lockere Aggregate lassen sich in den meisten Fällen mit einer 5- bis 10-minütigen Ultraschallbehandlung auflösen, ohne dass eine mechanische Zerstörung der Coccolithen stattfindet. Im Rahmen dieser Studie wurde ein kombiniertes chemisch-mechanisches Verfahren an diversen Sedimentfallenproben (ESTOC – Kanarische Inseln; ALOHA – Hawaii) getestet.

7. Literatur

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Teil II – Veröffentlichungen und Manuskripte

1. Seasonal and interannual variation of coccolithophore fluxes and species composition in sediment traps north of Gran Canaria (29°N 15°W)

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Abstract

Coccolithophore flux variations in sediment traps of the time-series station ESTOC (European Station for Time-series in the Ocean, Canary Islands), located 60 nm north of Gran Canaria, were recorded from April 1993 to December 1996. The 20 cup particle traps were deployed at 1000 m and 3000 m below sea surface, and sampling intervals ranged from 8 days to three weeks.

Coccolith and coccosphere fluxes at both trap depths were characterized by a strong seasonality. At 1000 m, maximum coccolith fluxes were reached during spring from March to April 1995 and from February to March 1996. Highest coccolith fluxes of 4538 x 10^6 coccoliths m^{-2} d^{-1} occurred at the beginning of March 1996, whereas lowest values of 19.8 x 10^6 coccoliths m^{-2} d^{-1} were recorded in June 1994. Total coccosphere fluxes were constantly low during most of the investigated time interval and showed only high values during the main sedimentation phases from January to March 1995 (up to 6.2 x 10^6 spheres m^{-2} d^{-1}), and in March 1996 (36.4 x 10^6 spheres m^{-2} d^{-1}). At 3000 m water depth, the sedimentation pattern was rather similar to the pattern observed at 1000 m. Maximum coccolith and coccosphere fluxes were also reached during spring time in February 1994 (8200 x 10^6 and 15.6 x 10^6 m^{-2} d^{-1}, respectively) and in March 1996 (8114 x 10^6 and 32.3 x 10^6 m^{-2} d^{-1}, respectively). However, total coccolith flux peaks at 3000 m were about 2-4 times higher compared to the upper traps, probably due to horizontal advection from phytoplankton material from north of the study site. This effect also influenced the coccolith-$CaCO_3$ flux estimates. Mean calculated coccolith-$CaCO_3$ fluxes ranged between 3.9 mg m^{-2} d^{-1} for the upper traps (1995/96), and 9.9 mg m^{-2} d^{-1} for the lower traps (1996). Coccoliths contributed for about 8-78% of the measured total $CaCO_3$ fluxes (< 1 mm fraction), with a mean contribution of 33.4% in the upper, and 41.4% in the lower traps.

The coccolithophore assemblages were dominated by *Emiliania huxleyi*, *Florisphaera profunda*, and *Gephyrocapsa ericsonii* during the entire sampling period, whereas all other species together generally contributed less than 40% to the total assemblages. Variability of species compositions at either trap depth was very low, indicating similar seasonal flux patterns of the different species.

Keywords: coccolithophore flux; species composition; coccolith-carbonate flux; Canary Islands

1. Introduction

Coccolithophores are a major group within the modern marine phytoplankton. Their cell surfaces are covered by minute external calcite scales (coccoliths) which form an important part of fine-grained deep-sea sediments and, therefore, are extensively used in paleontologic and paleoceanographic studies (e.g., Crux and van Heck, 1989; Winter and Siesser, 1994). Recently, coccolithophores have gained increased attention as they play a unique role in the global carbon cycle with effects on both, the biological and the carbonate pump. Also their optical (albedo - masses of detached coccoliths substantially reflect incoming light) and biochemical (dimethylsulfide - which acts as a source molecule for cloud nucleation) effects they are likely to produce additional feedback to climate change (Westbroek et al., 1993).

The basic understanding of modern ecological affinities of the species is essential for palaeoecological studies using coccolith assemblages in marine sediments. Increasing information is available on the distribution of living coccolithophores from studies of plankton samples (e.g., McIntyre and Bé, 1967; Okada and Honjo, 1973; Honjo and Okada, 1974; Kleijne, 1991; Giraudeau et al., 1993; Ziveri et al., 1995a), especially in the North Atlantic (e.g., Okada and McIntyre, 1979; Knappertsbusch and Brummer, 1995; Samtleben et al., 1995; Baumann et al., 1997). In addition, satellite imagery has demonstrated that coccolithophore blooms, especially of *Emiliania huxleyi*, are a common feature in the North Atlantic (e.g., Holligan et al., 1983, 1993; Balch et al., 1993; Brown and Yoder, 1994). As a result of such work the broad scale biogeography and ecology of coccolithophores is reasonably well known (e.g., Winter et al., 1994; Young et al., 1994). However, the detailed ecology of many species is still very poorly known - with the result that palaeoecological applications are restricted.

In addition, the processes involved in transformation of living communities in the surface water into coccolith assemblages in the underlying sediment are still poorly understood. It is obvious that assemblages in sediments are reduced by selective destruction and/or dissolution (e.g., Schneidermann, 1977; Samtleben et al., 1995). Sediment trapping is the primary technique for measuring export fluxes. It has been shown that the settling of biogenic material is directly related to surface production and reflects the seasonality of that production (Deuser et al., 1981). So it also can provide invaluable information on the seasonal variations in abundance and composition of plankton assemblages - especially mineralised plankton with short life spans, such as coccolithophores. This has been demonstrated by various recent investigations of time-series sediment traps, which have reported seasonally variable coccolithophore fluxes (Samtleben and Bickert, 1990; Steinmetz, 1991; Ziveri et al., 1995b; Andruleit, 1997; Broerse et al., in press).

Within the MAST III funded CANIGO (Canary Islands Azores Gibraltar Observation) subproject "Particle flux and paleoceanography in the Eastern Boundary Current System", particle flux studies are being carried out at mooring stations along a zonal transect at about 29° N. Among the main goals of this subproject are to quantify the influence of environmental variability on the magnitude and composition of seasonal and interannual particle flux in the Canary region, and to study the modification of particulate matter in the water column. In the present study, settling coccolithophore assemblages from multi-year moored sediment traps at 1000 m and 3000 m water depth from 60 nm north of Gran Canaria were investigated in order to obtain insight in the interannual variation of coccolithophore export. This study focuses on determination of the vertical fluxes of the different coccolithophore species at various depths and on assessment of the coccolith-carbonate flux relative to the total carbonate flux.

2. Oceanographic setting and general production characteristics

The Canary Islands are located 60 to 350 nm west of the Northwest African coast at a latitude of 27-28°N (Fig. 1). The region, located in the Eastern Boundary Current regime of the subtropical North Atlantic gyre, is part of the recirculation system linking the Gulf Stream, via the Azores Current and Canary Current, with the North Equatorial Current. A branch of the Azores Current flows to the west of the islands, whereas another branch crosses the Canary archipelago and joins the southward flowing Canary Current along the Northwest African Coast (e.g., Stramma and Siedler, 1988; Fig. 1). Along that coast, upwelling and related currents interact with the Canary Current. Coastal upwelling is restricted to the shelf area, and, north of about 25°N, mainly occurs during late summer and early fall (Speth and Detlefsen, 1982; van Camp et al., 1991). Surface waters in the area of the mooring location are not directly influenced by upwelling filaments, although filaments of cold, nutrient-rich water can be advected far westwards south of the islands (Nykjaer and van Camp, 1994). Thus, the islands are situated in a transition zone between more productive, relatively nutrient-rich waters to the east along the North African continent, and more oligotrophic waters of the North Atlantic gyre to the west.

The monthly averaged sea-surface temperatures (SSTs) for the period 1981-1991 (Fig. 2a) show a "normal" seasonality with minimum SSTs (16.8°C) in February and March, and maximum SSTs (up to 24.0°C) in September. Higher monthly averaged pigment concentrations compared to ambient levels in the surrounding water, as observed by Coastal Zone Colour Scanner images, were only recorded for the period January to March (Fig. 2b). Maximum particle fluxes recorded at ESTOC were closely related to the period of lowest SSTs and highest

pigment concentration in the usually oligotrophic surface waters of the studied region (Neuer et al., 1997). The most likely source region of material arriving the sediment traps north of Gran Canaria was identified to be a 100 km x 100 km area to the northeast of the ESTOC station, probably influenced by lateral input of particles from a higher productive secondary source region further to the NW African coast (Neuer et al., 1997; Davenport et al., 1999).

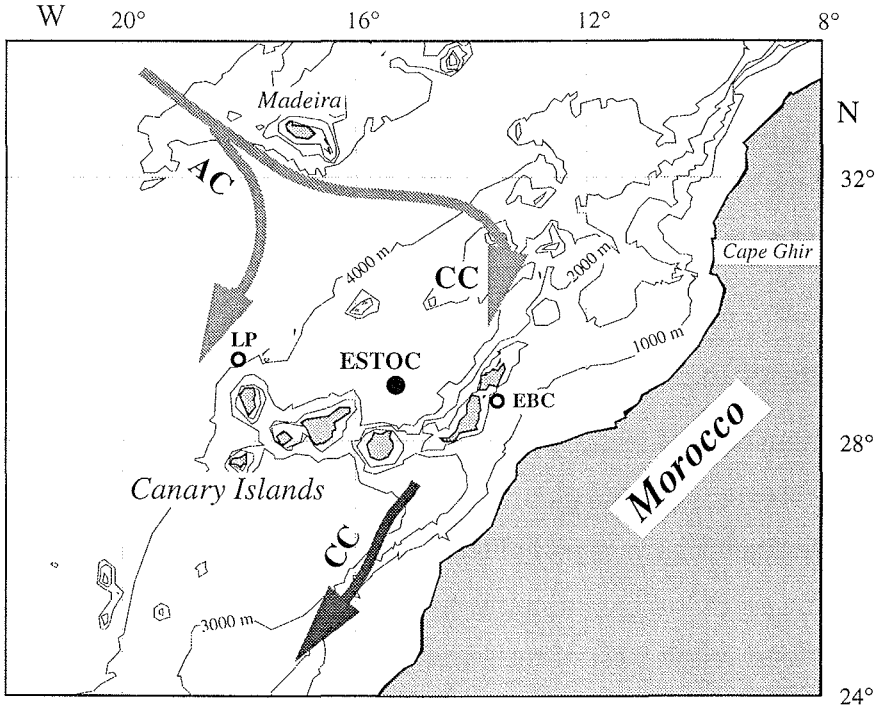


Fig. 1. Map of the Canary Islands region with surface current pattern (AC = Azores Current, CC = Canary Current) and location of the ESTOC moorings. In addition, other mooring stations to be investigated within the CANIGO project along a zonal transect from the African shelf to the outer oligotrophic ocean of the Canary archipelago are indicated (LP = La Palma, EBC = Eastern Boundary Current).

3. Materials and Methods

For this study, a total of 98 samples from six time-series sediment traps of four deployments with varying lengths and sampling intervals were investigated at ESTOC (Table 1, Fig. 1). The cone-shaped particle traps of the Kiel type (Aquatec) with 20 cups and a collection area of 0.5 m^2 were moored at approximately 1000 m and 3000 m below sea surface. Water depth at the ESTOC position is about 3600 m. The individual sampling intervals of the moorings ranged from one to three weeks (except for sample 19, mooring CI 3: 52 days). The sampling cups were poisoned with mercury chloride prior to and after deployment.

Initial sample processing was carried out by the marine geology group at Bremen University (Neuer et al., 1997). For coccolithophore analysis, aliquots of each sample (usually 1/25 or

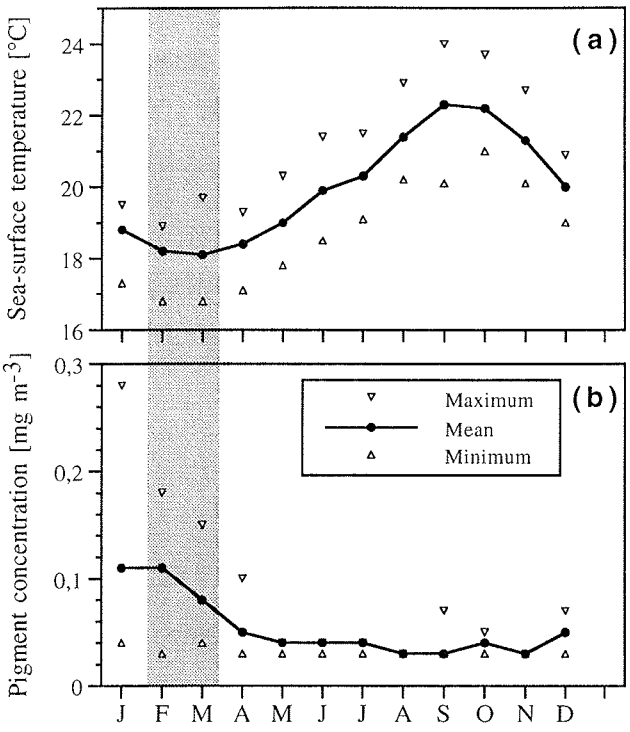


Fig. 2. Monthly averaged data from the Coastal Zone Colour Scanner (CZCS) and the Advanced Very High Resolution Radiometer (AVHRR) database (supplied by the European Commission Joint Research Centre, Ispra, Italy) for **(a)** sea-surface temperatures (for the period 1981-1991), and **(b)** pigment concentrations (for the period 1979-1985) at 29°N, 15°44'W. Dark shaded area indicate period of highest particle fluxes recorded at ESTOC.

1/125 of the < 1 mm fraction) were provided. These aliquots were wet split further by means of an electrical rotary sample divider (Fritsch, Laborette 27) using tap water as the split medium. Studied aliquots ranged between 1/250 and 1/3750, depending on particle content of the source material. The samples were placed in an ultrasonic bath (35 kHz) for 5 to 10 minutes to disintegrate small pellets and aggregates, and then filtered onto polycarbonate membrane filters (Schleicher & Schuell™ 47mm diameter, 0.45 µm pore size) using a vacuum pump. Immediately after filtration, filters were rinsed carefully with tap water to prevent crystallisation of salt. The filters were dried at 45°C for at least 12 hours. For coccolith analysis with the scanning electron microscope (SEM), a randomly chosen small section of the dried filter (approx. 0.6 cm^2) was fixed on an aluminium stub and sputtered with gold/palladium.

Table 1. Location of the ESTOC moorings (CI3-6), trap depths and sampling intervals. Samples were not available from the upper trap of mooring CI3 and from the lower trap of mooring CI5 due to technical failure.

Mooring	Position	Water depth (m)	Trap depths (m)	Deployment interval	No. of samples
CI 3	29°09.1'N 15°26.5'W	3606	3086	12.04.93 - 07.06.94	19
CI 4	29°09.6'N 15°26.7'W	3625	923	09.06.94 - 02.09.94	10
			3070	09.06.94 - 02.09.94	10
CI 5	29°08.67'N 15°28.7'W	3625	976	05.09.94 - 12.11.95	20
CI 6	29°09.1'N 15°28.1'W	3618	976	17.11.95 - 21.12.96	20
			3062	17.11.95 - 21.12.96	19

The SEM examination was carried out using a Zeiss DMS 940A, usually at 10 kV accelerating voltage. The numbers of coccoliths and coccospheres were counted on measured transects generally at a magnification of 3000 to 5000x, depending on particle density on the filter. Between 450 and 750 coccoliths were counted per sample. Identification generally followed the taxonomy of Jordan and Kleijne (1994) and Jordan and Green (1994). A list of all recorded species isgiven in Jordan et al. (this vol.).

The taxonomic counts were then converted into daily fluxes of coccoliths m^{-2}. The average coccolith flux during a specific time period (sampling interval) was calculated using the following equation:

$$\text{Coccolith flux (no. of coccoliths } m^{-2}\ d^{-1}) = F \times C \times S / A \times D \times O$$

with F = effective filtration area (mm^2), C = number of coccoliths counted, S = split factor, A = investigated filter area (mm^2), D = sampling interval (d), and O = area of the trap aperture (m^2).

Coccosphere fluxes where calculated using the same equation, with C = number of coccospheres counted. Fecal pellets and aggregates were of minor importance and, thus, not hindering any of the sample preparations. Preservation of coccoliths was found to be very good at both trap depths.

Coccolith-carbonate fluxes were calculated on the basis of averaged individual coccolith-carbonate estimates (Table 2), and then compared to the total carbonate content of the <1 mm fraction. Coccosphere fluxes were first converted into coccolith fluxes and then transformed into coccolith-carbonate fluxes. During counting, the number of coccoliths per coccosphere of different species was estimated by multiplying the counted coccoliths on the visible half of the coccosphere by two. The errors in coccolith-carbonate calculations are substantial, particularly since a single mean carbonate value does not account for the size variations of most common species (e.g., Samtleben, 1980; Young and Westbroek, 1991; Baumann, 1995; Knappertsbusch et al., 1997). Nevertheless, the calculated coccolith-carbonate flux data seem very reasonable in comparison to the total carbonate flux values (Table 4). So we believe they are a good approximation of the real coccolith-carbonate flux.

Table 2. Used coccolith carbonate weights for individual species and mean coccolith length of selected species based on size measurements carried out within this study (+ indicates 'no size measurements on ESTOC trap samples').

Species	Coccolith carbonate (pg)	Mean length (μm)	Reference
C. leptoporus	91.1	7.5	calculated after Young & Ziveri (2000)
C. pelagicus	99.5	+	Young & Ziveri (2000)
D. tubifera	1.5	+	Young & Ziveri (2000)
E. huxleyi	2.1	3.4	calculated after Young & Ziveri (2000)
F. profunda	1.6	2.7	calculated after Young & Ziveri (2000)
G. ericsonii	0.9	1.9	calculated after Young & Ziveri (2000)
G. muellerae	6.3	3.6	calculated after Young & Ziveri (2000)
G. oceanica	15.9	4.9	calculated after Young & Ziveri (2000)
H. carteri	142.8	+	Beaufort & Heussner (1999)
O. fragilis	96.8	+	Young & Ziveri (2000)
Pontosphaera spp.	68.0	+	Beaufort & Heussner (1999), averaged
R. clavigera	67.5	+	Young & Ziveri (2000)
Syracosphaera spp.	12.1	+	Beaufort & Heussner (1999)
S. pulchra	16.0	+	Knappertsbusch & Brummer (1995)
U. sibogae var. *foliosa*	38.6	6.2	calculated after Young & Ziveri (2000)
U. sibogae var. *sibogae*	12.6	4.4	calculated after Young & Ziveri (2000)
U. tenuis	8.7	+	Young & Ziveri (2000)
Others	8.0	+	Honjo (1976)

4. Results

4.1. Coccolithophore fluxes

In general, coccolith and coccosphere fluxes at both trap depths are characterized by strong seasonality and, at the upper trap level, also by a high interannual variability during the sampling period (Fig. 3). At 1000 m water depth, coccolith flux peaks were sampled each spring, March to April 1995 and February to March 1996. The highest coccolith flux values were recorded in the beginning of March 1996 (4538 x 10^6 coccoliths m^{-2} d^{-1}) and lowest values occurred in June 1994 (19.8 x 10^6 coccoliths m^{-2} d^{-1}). At the beginning of the sampling period, coccolith fluxes were low but relatively constant (between 20 and 371 x 10^6 coccoliths m^{-2} d^{-1}). Starting in December 1994, fluxes increased steadily and reached a maximum of 1758 x 10^6 coccoliths m^{-2} d^{-1} in March/April 1995. After the maximum, coccolith fluxes declined rapidly in April 1995 and were low until the end of 1995, except for slightly higher values in August and December 1995. The second prominent flux peak in the beginning of March 1996 was about 2.5 times higher than in spring 1995. Mean coccolith fluxes in 1995 and 1996 were 524 x 10^6 and 727 x 10^6 coccoliths m^{-2} d^{-1}, respectively.

Total coccosphere fluxes at 1000 m were constantly low during most of the investigated time interval and only showed higher values during the main sedimentation phases, from January

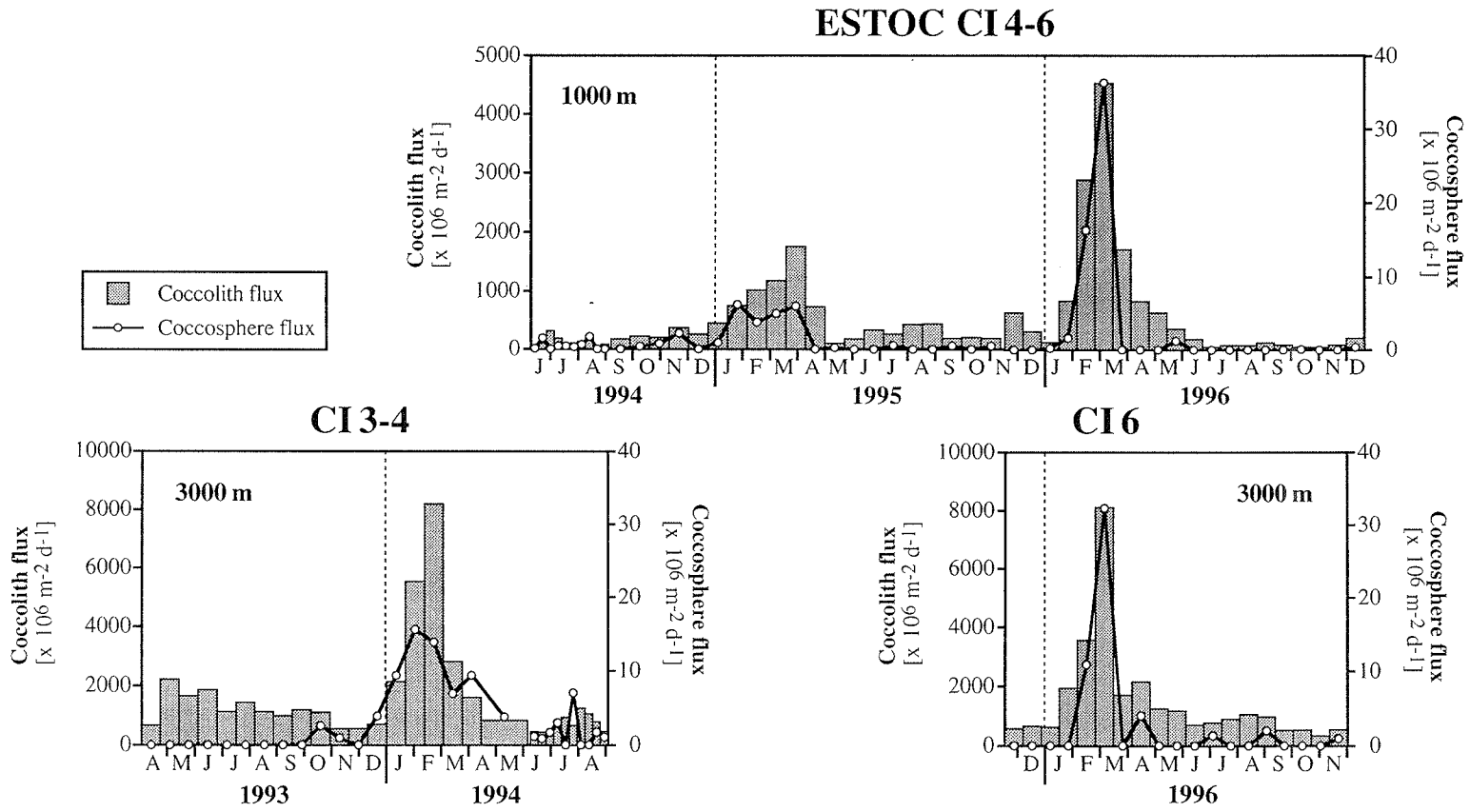


Fig. 3. Seasonal and interannual total coccolith (bars) and coccosphere (line) fluxes at 1000 m and 3000 m water depth of the investigated ESTOC moorings CI4-6 (upper traps) and CI3, CI4 and CI6 (lower traps). Due to technical failure, no data are available for the upper trap of CI3 and for the lower trap of CI5.

to March 1995 (up to 6.2 x 10^6 coccospheres m^{-2} d^{-1}) and in February/March 1996 (36.4 x 10^6 coccospheres m^{-2} d^{-1}).

At 3000 m water depth, the sedimentation pattern appeared similar to the pattern observed at the upper trap level. Maximum coccolith and coccosphere fluxes also showed high seasonality, with marked peaks during spring in February 1994 (8200 x 10^6 and 15.6 x 10^6 m^{-2} d^{-1}, respectively) and in March 1996 (8114 x 10^6 and 32.3 x 10^6 m^{-2} d^{-1}, respectively). No data are available from the 3000 m trap from the beginning of September 1994 to mid-November 1995 due to technical failure. However, it is highly probable that, in accordance to the seasonal trend, coccolith and coccosphere fluxes also reached their peaks in spring 1995 during the hiatus. The prominent coccolith flux peak in March 1996 occurred simultaneously with the maximum coccolith flux values observed at the 1000 m trap. Coccolith fluxes were approximately two times higher at the lower traps compared to the upper ones. This notable increase of fluxes with depth indicates the importance of lateral advection of particulate matter to the mooring location as already described by Neuer et al. (1997).

4.2. Seasonal species fluxes and species composition

Examination of all sediment trap samples reveal a highly diverse coccolithophore assemblage. A total of 56 heterococcolithophore and 7 holococcolithophore species were identified, these are listed, with full taxonomic citations, in Jordan et al. (this vol.). Most of the counted specimens are single coccoliths, whereas coccospheres are of minor importance. The preservation of both intact coccospheres and single coccoliths was very good in the two trap depths. Significant dissolution of coccoliths was not even observed in the lower trap samples.

The coccosphere counts were dominated by *Emiliania huxleyi* (one-layered) and *Gephyrocapsa ericsonii*. Intact coccospheres of *Gephyrocapsa oceanica*, *Gephyrocapsa muellerae*, *Umbilicosphaera sibogae*, and *Algirosphaera oryza* occurred in lower abundances. The seasonal coccolith flux pattern as described above was mainly determined by the three most abundant species *E. huxleyi*, *Florisphaera profunda*, and *G. ericsonii* (Fig. 4, 5; Plate I). *E. huxleyi* dominated the coccolith assemblage during most of the investigated time interval with relative abundances of 26-52% in the upper trap and 10-53% in the lower ones. *F. profunda* (0.5-39% and 5-25%, respectively) and *G. ericsonii* (3-29% and 4-13%, respectively) also contributed considerably to the settling assemblages. *Algirosphaera* spp. occurred sporadically with abundances over 10% of the total community (Fig. 6). The seasonal changes in relative abundances of different species at 3000 m were distinctly lower than in the 1000 m trap.

At 1000 m, coccolith fluxes of these species started to increase in December 1994 and, simultaneously, reached maximum values in March/April 1995 (Fig. 4; Table 3a). After the maximum, coccolith fluxes declined rapidly and were relatively low until January 1996, except for slightly higher values in August/September 1995. The deep-photic layer species *F. profunda* showed another distinct flux peak in November 1995. The second marked coccolith flux peak in February/March 1996 was also reached simultaneously and fluxes were about two times higher than in spring 1995. The seasonal coccolith flux pattern of *G. oceanica* showed maximum

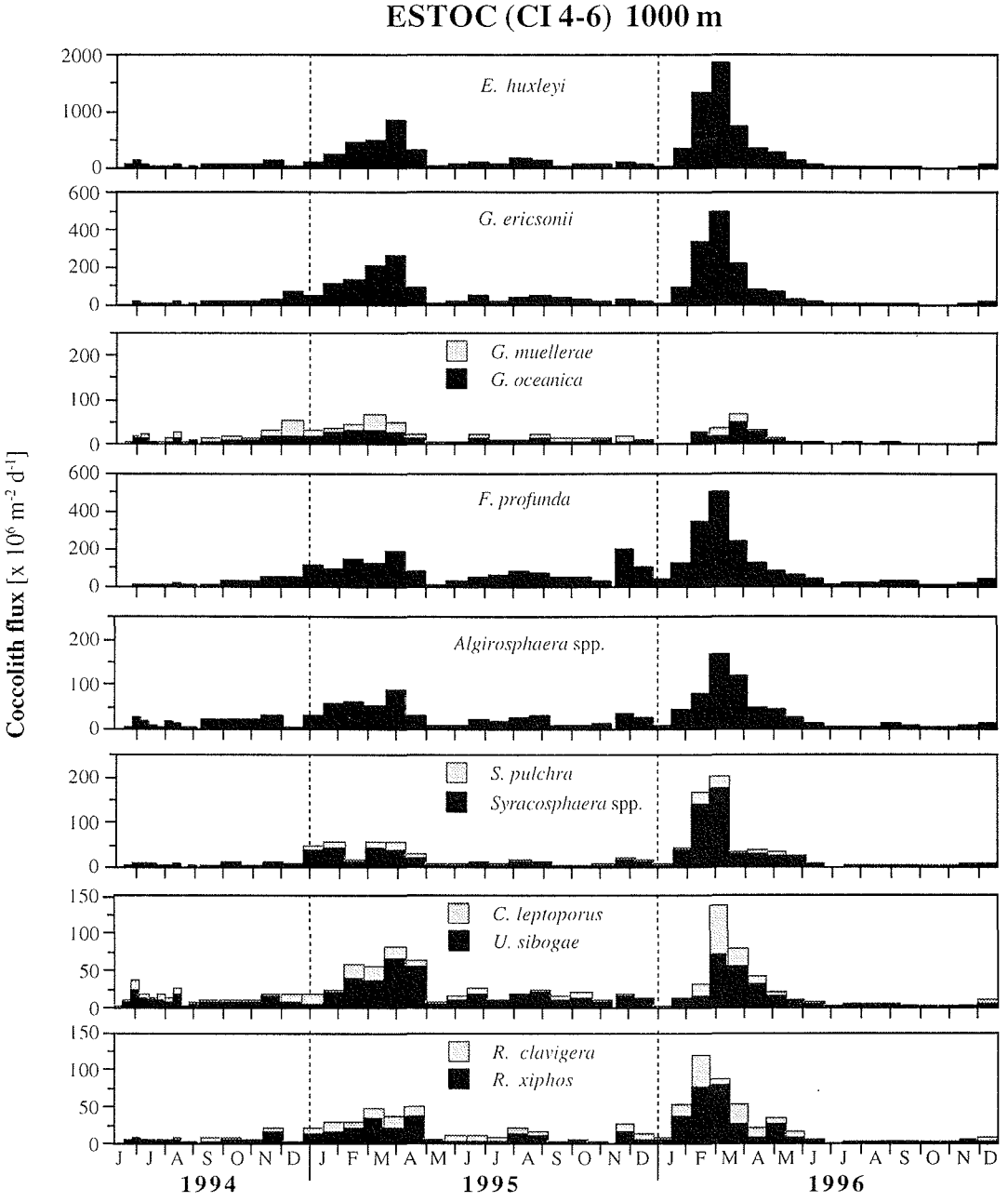


Fig. 4. Seasonal variations of coccolith fluxes for distinct coccolithophore species recorded at 1000 m water depth of the ESTOC moorings CI4-6.

Table 3a. Flux data of figured species in ESTOC upper sediment trap samples.

Sample No.	Sampling interval (days)	Total coccoliths	*Algirosphaera* spp.	*C. leptoporus*	*E. huxleyi*	*F. profunda*	*G. ericsonii*	*G. muellerae*	*G. oceanica*	*R. clavigera*	*R. xiphos*	*S. pulchra*	*Syracosphaera* spp.	*Umbellosphaera* spp.	*U. sibogae*	Other heterococcoliths	Total holococcoliths
		(x 10^6 coccoliths m^{-2} d^{-1})															
Cl4o (923 m):																	
1	8.6	19,8	1,4	2,2	8.6	0,1	0.8	0,8	1,5	0,0	0,8	0,3	0,4	0,4	1,4	1,0	0,4
2	8.6	104.7	4.3	4,3	56,0	0,6	3,7	3,0	2,7	0,0	5,5	4,0	1,5	1,8	7,9	4,9	4,6
3	8.6	313.9	25,1	11,4	145,0	10,3	18,3	5,7	14,8	0,0	9,1	8,0	2,3	1,1	25,1	20,5	17,1
4	8,6	188,2	17,8	6,8	60,9	9,7	13,5	10,6	14,0	1,7	5,1	4,2	3,4	6,3	12,7	10,6	11,0
5	8,6	99,4	6,5	4,1	37,4	5,0	7,4	4,3	4,3	0,0	4,8	3,0	4,1	1,5	10,7	4,6	1,5
6	8.6	103,5	5,5	6,7	44,7	1,8	5,5	1,8	4,3	0,9	4,0	3,0	2,4	3,7	11,6	4,3	3,3
7	8,6	129,7	15,9	4,1	43,8	11,4	6,3	6,0	8,6	1,0	4,1	1,3	2,5	4,4	8,6	9,2	2,5
8	8,6	236,6	12,3	7,0	76,1	16,4	21,7	13,5	14,1	3,5	4,7	2,9	7,6	10,0	19,9	19,9	7,0
9	8.6	47,4	3,7	1,2	12,3	3,8	3,4	2,6	2,5	0,4	1,7	1,2	1,0	4,3	3,3	2,6	3,4
19	8.6	84,2	5,8	2,3	28,4	7,0	6,5	4,6	4,4	1,1	2,2	1,6	2,3	4,3	5,8	5,3	2,5
Cl5m (976 m):																	
1	19	179,1	20,3	2,3	61,2	10,7	19,5	9,2	7,3	5,7	2,7	1,5	4,2	7,7	9,2	13,0	4,6
2	22	222,2	20,2	4,0	77,9	22,4	22,4	9,9	8,8	1,8	5,5	2,9	9,9	8,8	7,7	15,1	4,8
3	22	205,5	23,0	1,9	72,5	31,4	15,1	5,7	9,4	3,0	4,2	1,1	3,8	10,6	8,7	14,4	0,8
4	22	371,8	30,9	2,9	127,8	51,4	24,2	15,4	17,6	5,1	15,4	4,4	9,6	14,0	15,4	31,6	5,9
5	22	261,6	2,8	10,1	26,4	52,8	74,7	34,2	20,2	1,1	1,7	1,1	6,7	6,7	9,5	13,5	0,0
6	22	454,0	29,1	12,3	94,3	108,4	48,5	15,9	17,6	8,8	13,2	9,7	39,7	22,0	6,2	25,6	2,6
7	22	755,0	55,8	3,7	254,2	95,5	117,8	9,9	27,3	13,6	17,4	11,2	44,6	22,3	21,1	50,8	9,9
8	22	1021,0	59,5	20,5	444,5	148,8	132,0	14,9	33,5	7,4	22,3	3,7	14,9	14,9	39,1	61,4	3,7
9	22	1182,8	52,1	19,8	498,4	119,0	213,2	34,7	32,2	12,4	34,7	12,4	44,6	9,9	37,2	59,5	2,5
10	22	1758,5	89,3	17,9	845,0	181,5	258,9	23,8	26,8	17,9	20,8	14,9	41,7	20,8	65,5	104,1	29,8
11	22	737,7	28,5	7,4	303,8	75,6	96,7	11,2	13,6	13,6	38,4	7,4	22,3	13,6	57,0	32,2	16,1
12	22	102,6	9,4	1,3	37,7	7,2	8,3	1,6	3,1	1,6	3,4	1,1	5,6	3,8	7,0	10,1	1,3
13	22	184,5	9,4	3,5	70,5	25,2	15,4	2,8	4,7	6,9	3,1	2,5	4,7	7,2	12,0	13,9	2,5
14	22	338,2	22,0	5,7	98,9	49,1	49,1	9,4	16,4	6,9	3,8	3,8	7,6	9,4	20,2	27,1	8,8
15	22	266,7	16,0	1,7	81,6	62,8	17,1	4,4	7,7	5,0	4,4	2,2	4,4	8,3	10,5	34,2	6,6
16	22	432,9	26,4	1,8	161,3	82,9	35,3	5,3	6,2	7,9	13,2	5,3	13,2	13,2	18,5	37,0	5,3
17	22	440,8	28,2	3,5	152,5	73,2	52,9	7,9	15,9	7,1	10,6	7,9	7,1	8,8	22,0	39,7	3,5
18	22	194,4	6.4	5,5	42,2	47,6	42,6	7,9	7,4	3,0	1,0	0,0	3,0	7,4	10,4	8,4	1,5
19	22	207.4	8,8	9,3	52,5	43,6	29.4	8,3	7,8	2,9	2,9	2,5	2,9	9,3	12,7	11,3	2,9
20	18	193,9	13,4	2,8	69,3	31,4	16,2	3,2	11,5	2,3	1,8	3,7	5,1	10,6	7,4	14,8	0,5
Cl6m (976 m):																	
1	26	496,5	32,1	2,8	90.6	195.4	26,4	10,4	7.6	12,3	16,0	1,9	17,9	11,3	17,0	43,4	11,3
2	20	318,7	24,2	2,6	67.4	100.1	17.0	2,6	8,5	7,2	7,2	3,9	13,1	9,8	10,5	40,6	3,9
3	20	133.0	9.6	0.5	35.1	36.7	11.2	0.5	3.5	3,7	5,4	1,4	5,6	4,9	1,4	12,2	1,4
4	20	844,3	40,9	1,6	343,6	117,8	91.6	1,6	1,6	16,4	37,6	1,6	40,9	13,1	11,5	121,1	3,3
5	20	2891,2	76,4	16,4	1331,0	349,1	338.2	0,0	27,3	43,6	76,4	27,3	141,8	38,2	16,4	403,7	5,5
6	20	4537.7	167.3	65,4	1854.3	501.8	494.5	14,5	21.8	7,3	80.0	29,1	174,5	50,9	72,7	923,5	80,0
7	20	1724,5	117.8	22,9	723,2	242,2	216.0	16,4	52,4	26,2	26,2	6,5	29.5	22,9	55,6	166,9	0,0
8	20	841,2	49,1	11,5	340,4	117,8	80,2	3,3	29,5	13,1	8,2	6,5	32,7	14,7	31,1	96,6	6,5
9	20	644,2	44,2	4,9	273,7	77,3	73,6	2,5	11,0	8,6	25,8	6,1	27,0	9,8	16,0	50,3	13,5
10	20	362,0	27.6	1,2	129,5	59,5	33,7	1,2	5,5	6,7	9,8	4,9	22,1	9,8	9,8	36,2	4,3
11	20	189,1	11,8	1,6	70,0	32,4	17,0	1,3	3,6	2,6	2,6	2,0	7,9	9,5	5,6	16,4	4,9
12	20	49,9	3,4	1,8	18,1	10,3	3,6	1,1	2,2	0,4	0,4	0,5	1,0	1,1	1,2	3,5	1,4
13a	20	83.8	2,1	0,7	38,1	11,5	5,7	0,8	3,6	1,5	1,3	1,1	2,3	3,3	3,9	7,7	0,2
14	20	75,7	2,7	1,6	27,2	12,5	5,5	0,7	2,5	1,9	0,6	2,5	2,7	3,6	3,0	5,8	2,8
15	20	123,3	12,0	2,0	38,0	21,8	8,2	1,1	4,5	2,4	2,2	1,3	4,5	4,7	3,6	11,3	5,6
16	20	88,1	9,9	0.6	21,8	22,2	5,5	0,4	2,8	1,7	2,7	1,2	2,2	2,1	2,2	10,8	2,2
17	20	50,8	4,0	0,5	14,5	11,2	2,4	0,5	0,8	1,2	1,5	0,7	2,0	1,7	1,3	7,2	1,3
18	20	43,7	4,1	0,8	14,0	6,9	1,7	0,5	1,2	1,3	1,8	1,6	1,9	1,6	1,0	4,3	0,9
19	20	89,4	6,4	1,1	23,0	17,2	6.3	0,8	1,5	2,2	4,5	1,1	6,4	3,0	2,5	9,1	4,4
20	20	207,0	14,3	3,7	68,3	42,5	15,5	2,5	4,1	4,5	4,1	3,3	7,0	6,5	6,5	21,7	2,5

Table 3b. Flux data of figured species in ESTOC lower sediment trap samples.

Sample No.	Sampling interval (days)	Total coccoliths	*Algirosphaera* spp.	*C. leptoporus*	*E. huxleyi*	*F. profunda*	*G. ericsonii*	*G. muellerae*	*G. oceanica*	*R. clavigera*	*R. xiphos*	*S. pulchra*	*Syracosphaera* spp.	*Umbellosphaera* spp.	*U. sibogae*	Other heterococcoliths	Total holococcoliths
		(x 10^6 coccoliths m^{-2} d^{-1})															
CI3u (3086 m):																	
1	21	676,3	21,8	12,5	283,6	93,5	56,1	9,3	35,8	9,3	7,8	12,5	31,2	24,9	31,2	42,1	4,7
2	21	2216,7	72,7	24,2	900,5	384,5	97,0	34,6	65,8	10,4	41,6	34,6	83,1	107,4	110,8	197,4	52,0
3	21	1664,2	84,1	23,4	621,7	243,1	130,9	11,7	58,4	11,7	32,7	39,7	65,4	98,2	60,8	147,3	35,1
4	21	1874,6	102,8	23,4	808,7	247,8	173,0	37,4	88,8	42,1	32,7	37,4	46,7	74,8	60,8	93,5	4,7
5	21	1133,6	49,1	4,7	444,1	191,7	65,4	23,4	53,8	4,7	7,0	18,7	16,4	58,4	67,8	114,5	14,0
6	21	1432,8	67,8	21,0	549,3	217,4	88,8	16,4	23,4	21,0	42,1	9,3	35,1	98,2	81,8	137,9	23,4
7	21	1126,6	72,5	25,7	458,1	156,6	74,8	11,7	30,4	23,4	25,7	18,7	14,0	49,1	53,8	102,8	9,3
8	21	991,1	56,1	18,7	366,5	172,0	61,7	9,3	28,0	9,3	20,6	9,3	24,3	52,4	56,1	102,8	3,7
9	21	1189,7	53,8	14,0	446,4	261,8	70,1	14,0	16,4	14,0	16,4	16,4	28,0	53,8	53,8	123,9	7,0
10	21	1111,8	44,2	15,6	363,7	226,0	93,5	10,4	28,6	5,2	33,8	26,0	23,4	49,4	52,0	111,7	28,6
11	21	544,1	29,9	5,6	169,2	113,1	42,1	2,8	16,8	10,3	8,4	11,2	20,6	21,5	24,3	58,9	9,3
12	21	563,1	31,2	12,5	173,5	127,8	43,6	3,1	11,4	12,5	8,3	9,3	19,7	23,9	29,1	50,9	6,2
13	21	699,3	47,7	8,8	269,8	97,4	79,9	7,8	29,2	6,8	12,7	5,8	16,6	34,1	32,1	50,6	0,0
14	21	2136,4	84,1	32,7	799,4	406,7	285,2	14,0	32,7	18,7	32,7	18,7	121,5	107,5	28,0	154,3	0,0
15	21	5533,0	374,1	70,1	2221,0	865,0	568,9	15,6	116,9	77,9	54,6	46,8	233,8	124,7	140,3	600,1	23,4
16	21	8200,0	498,6	138,5	3975,3	803,4	997,3	27,7	83,1	55,4	55,4	69,3	540,2	152,4	138,5	637,2	27,7
17	21	2811,8	173,1	41,6	1322,8	297,8	332,4	6,9	83,1	34,6	6,9	6,9	166,2	55,4	103,9	173,1	6,9
18	21	1601,9	77,9	15,6	825,9	193,2	158,9	12,5	56,1	3,1	15,6	18,7	53,0	28,0	28,0	106,0	9,3
19	52	833,2	42,8	11,3	431,7	66,7	51,6	15,1	37,8	3,8	12,6	8,8	23,9	16,4	23,9	78,0	8,8
CI4u (3070 m):																	
1	8,6	457,8	41,1	11,4	186,1	32,0	29,7	33,1	22,8	4,6	3,4	4,6	4,6	13,7	29,7	34,2	6,8
2	8,6	428,0	33,8	8,5	159,8	42,3	36,4	19,5	15,2	4,2	17,8	4,2	11,0	11,0	21,1	35,5	7,6
3	8,6	373,0	20,3	9,3	156,5	20,3	24,5	26,2	25,4	2,5	10,1	6,8	6,8	10,1	19,5	27,1	7,6
4	8,6	796,2	33,5	12,2	321,2	86,8	73,1	35,0	39,6	9,1	19,8	9,1	13,7	16,7	42,6	65,5	18,3
5	8,6	945,0	51,9	22,6	354,1	74,4	85,7	36,1	47,4	4,5	81,2	20,3	15,8	24,8	47,4	45,1	33,8
6	8,6	663,9	43,7	9,9	341,1	45,1	36,6	22,6	28,2	9,9	8,5	8,5	7,0	22,6	26,8	45,1	8,5
7	8,6	1247,6	92,7	33,7	539,5	89,9	123,6	45,0	64,6	11,2	16,9	28,1	11,2	33,7	75,9	64,6	16,9
8	8,6	1058,2	83,0	19,2	442,9	95,8	95,8	46,8	34,1	14,9	17,0	8,5	6,4	40,5	61,7	78,8	12,8
9	8,6	792,0	36,9	21,1	331,9	72,0	68,5	38,6	38,6	8,8	19,3	8,8	14,0	33,4	38,6	47,4	14,0
10	8,6	464,3	28,3	6,5	165,3	34,8	31,5	40,2	18,5	5,4	8,7	5,4	6,5	14,1	33,7	55,5	9,8
CI6u (3062 m):																	
1	26	446,2	28,0	7,0	115,4	100,0	26,6	7,0	21,7	6,3	15,4	8,4	7,0	18,9	23,1	52,5	9,1
2	20	660,7	54,0	8,8	221,9	140,4	39,3	10,8	17,7	11,8	6,9	10,8	9,8	24,5	29,5	63,8	10,8
3	20	630,3	37,3	4,9	184,6	160,0	42,2	6,9	12,8	16,7	19,6	11,8	24,5	11,8	27,5	57,9	11,8
4	20	1940,5	124,3	19,6	674,1	428,7	186,5	13,1	36,0	39,3	62,2	16,4	45,8	49,1	49,1	166,9	29,5
5	20	3562,2	130,9	49,1	1352,9	616,4	321,9	60,0	43,6	76,4	81,8	16,4	120,0	92,7	92,7	431,0	76,4
6	20	8114,0	436,4	32,3	2941,7	1276,9	872,8	32,3	48,5	80,8	290,9	48,5	307,1	177,8	242,4	1228,4	97,0
7	20	1711,4	62,2	29,5	520,3	320,7	199,6	26,2	49,1	26,2	62,2	6,5	62,2	42,5	55,6	229,1	19,6
8	20	2152,0	139,1	36,8	756,9	454,1	220,9	28,6	36,8	20,5	40,9	24,5	61,4	53,2	61,4	196,4	20,5
9	20	1259,0	76,1	14,7	434,4	213,5	137,4	2,5	34,4	14,7	66,3	12,3	51,5	24,5	34,4	120,3	22,1
10	20	1182,4	71,6	14,3	396,9	265,9	100,2	16,4	45,0	10,2	24,5	16,4	49,1	40,9	14,3	96,1	20,5
11	20	703,7	65,5	4,1	222,3	155,5	66,8	15,0	12,3	6,8	19,1	4,1	28,6	20,5	21,8	54,6	6,8
12	20	778,7	45,0	8,2	267,3	147,3	81,8	8,2	39,5	25,9	16,4	8,2	23,2	25,9	9,5	54,6	17,7
13	20	904,2	57,3	2,0	343,7	104,3	108,4	6,1	34,8	14,3	32,7	18,4	36,8	32,7	36,8	61,4	14,3
14	20	1069,2	70,9	10,9	340,9	204,6	95,5	13,6	38,2	30,0	46,4	13,6	38,2	40,9	24,5	84,6	16,4
15	20	981,9	69,6	10,2	349,8	192,3	75,7	12,3	32,7	8,2	28,6	2,0	28,6	30,7	30,7	98,2	12,3
16	20	524,2	48,1	5,9	175,7	110,9	29,5	3,9	19,6	13,7	13,7	9,8	12,8	13,7	25,5	35,3	5,9
17	20	534,0	49,1	3,9	182,6	97,2	42,2	6,9	20,6	6,9	13,7	4,9	22,6	13,7	14,7	48,1	6,9
18	20	339,7	28,5	2,9	119,1	70,9	21,2	4,4	8,8	9,5	8,0	3,7	5,1	11,0	15,3	27,0	4,4
19	20	544,8	26,5	4,9	203,2	125,7	25,5	8,8	22,6	10,8	14,7	10,8	8,8	15,7	21,6	39,3	5,9

values in February 1995 and at the end of March 1996, but also smaller peaks were observed in summer 1994 and 1995. Coccolith fluxes of the less frequent species all displayed similar trends with maximum values in spring 1995 and 1996 (Fig. 4), except for those of *G. muellerae,* which showed distinct peaks in December 1994 and March 1995. Most of the coccolithophore species encountered (listed in Jordan et al., this vol.) only occurred in very small numbers and, therefore, contributed insignificantly to the total coccolithophore flux.

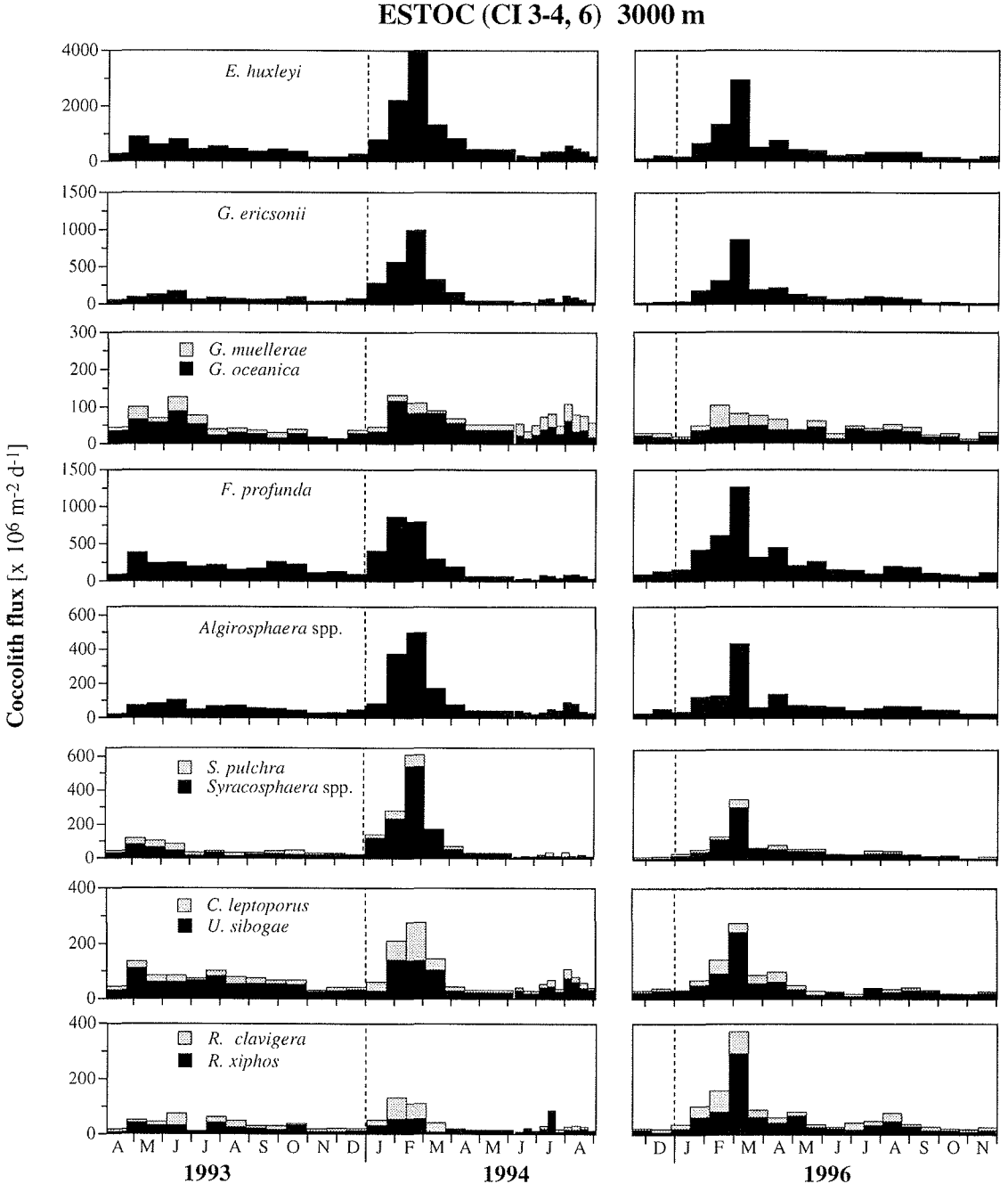


Fig. 5. Seasonal variations of coccolith fluxes for distinct coccolithophore species recorded at 3000 m water depth of the ESTOC moorings CI3, CI4 and CI6. Note the different scale compared to the 1000 m traps (Fig. 4.).

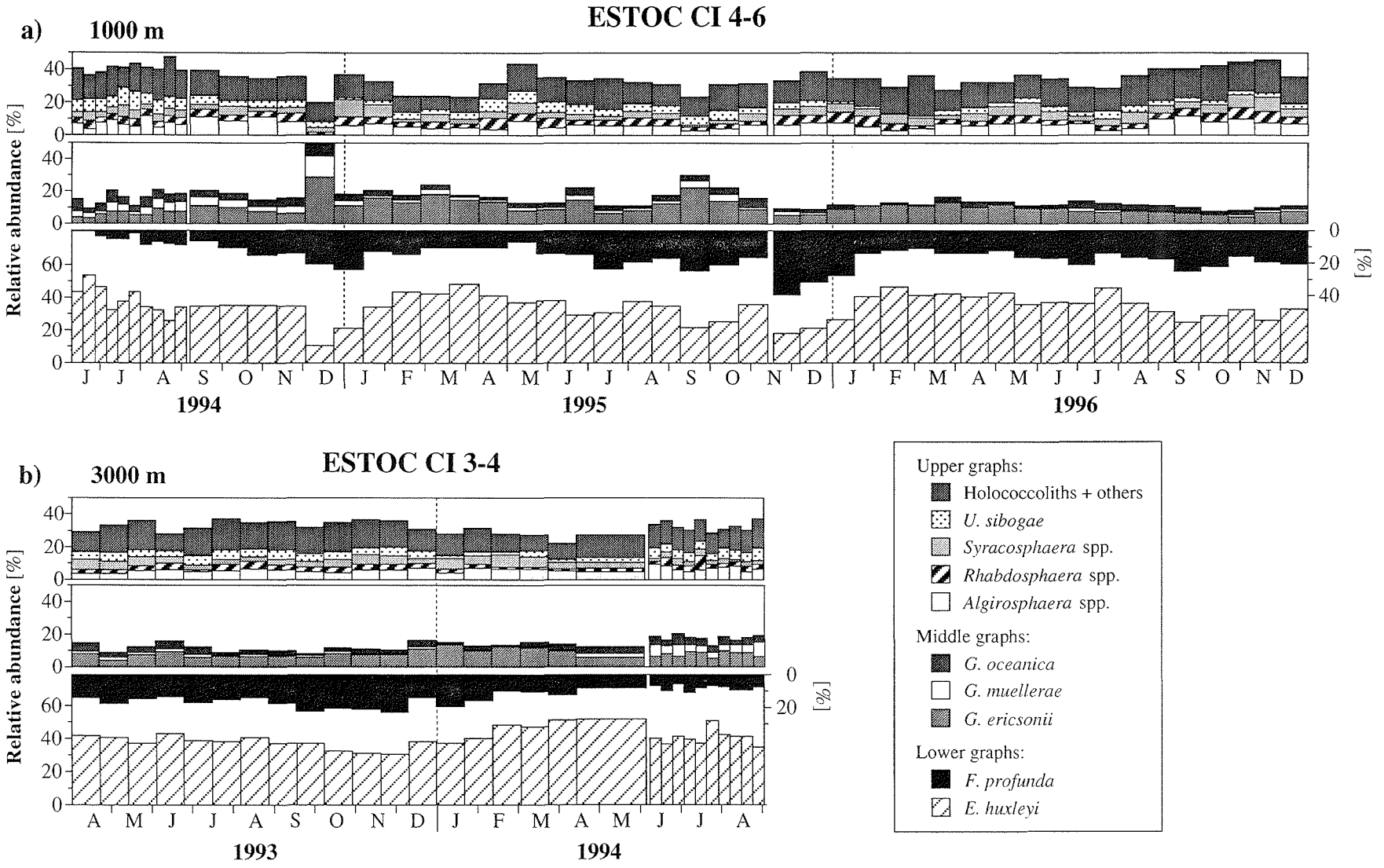


Fig. 6. Relative abundances of coccoliths from the most frequent coccolithophore species at 1000 m (a) and 3000 m (b) water depth. Data for the lower trap of the mooring CI6 are not shown, due to similar seasonal variations. Note the grouped legend, according to the order of the graphs.

Similarly at 3000 m only a few species were the main contributors to the overall coccolithophore flux (Fig 5; Table 3b). Coccolith fluxes of the most abundant species *E. huxleyi*, *F. profunda*, and *G. ericsonii* all display similar seasonal trends with distinct peaks in spring 1994 and spring 1996. Additionally, fluxes of *G. muellerae* and *G. oceanica* showed higher values in early summer 1993 and in summer 1994. *Algirosphaera* spp. demonstrated marked peaks in February 1994, July 1994 and February/March 1996.

4.3. Coccolith-$CaCO_3$ fluxes

Calculated coccolith-$CaCO_3$ fluxes varied significantly, between 0.4 and 29.4 mg m^{-2} d^{-1} in the upper traps, and between 2.4 and 48.7 mg m^{-2} d^{-1} in the lower ones (Table 4). In Fig. 7 measured $CaCO_3$ fluxes (<1 mm fraction) of the two trap depths are compared with the calculated coccolith-$CaCO_3$ flux estimates. At 1000 m water depth, the mean calculated coccolith-$CaCO_3$ flux is 3.9 mg m^{-2} d^{-1} in 1995/96, and, on average, contributed 33.4% to the measured total carbonate flux. Variation in the relative amount is high, varying between 8.0% and 72.8%. At 3000 m water depth, mean calculated coccolith-$CaCO_3$ flux is 9.9 mg m^{-2} d^{-1} in 1996. The contribution of the coccolith-$CaCO_3$ fluxes to the total carbonate fluxes varied between 17.8 and 66.8%, with an average contribution of 41.4%.

As expected, calculated coccolith-carbonate fluxes were lower than the measured carbonate fluxes of the <1 mm fraction, except for one value in the lower trap CI6 in May 1996. Here, coccolith-$CaCO_3$ flux was higher than the total $CaCO_3$ flux. This is presumably a calculation artifact, but still indicative of a high proportion of coccoliths in the low carbonate content of the sample.

5. Discussion

5.1. Seasonal variation of coccolithophore fluxes

The present sediment trap study at ESTOC from April 1993 to November 1996 reveal strong seasonal variations of coccolithophore fluxes with maximum values occurring in late winter/ early spring. During recurrent annual cycles, coccolithophore fluxes exhibit distinct changes reflecting the variability of upper ocean conditions (hydrography, pigment concentration) and consequently the seasonality of phytoplankton development in surface waters of the studied area. The observed coccolith flux pattern corresponds well with the seasonal pattern of total particle and carbonate flux recorded during the same mooring periods (Neuer et al., 1997; Fig. 7).

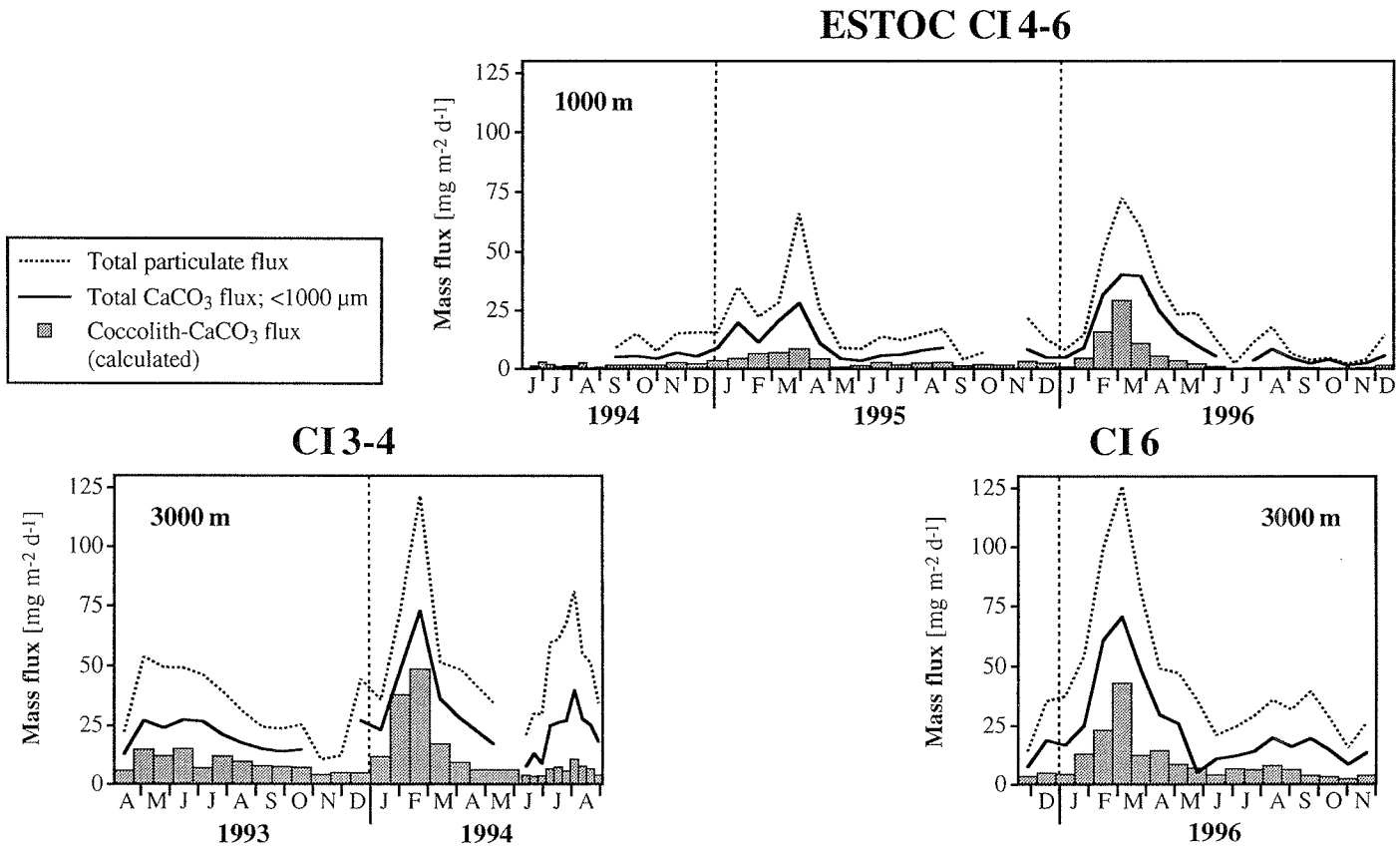


Fig. 7. Comparison of total particle, total carbonate (< 1 mm fraction) and calculated coccolith-carbonate fluxes at 1000 m and 3000 m water depth of the investigated ESTOC moorings CI4-6 (upper traps) and CI3, CI4 and CI6 (lower traps).

Table 4. Total carbonate fluxes (< 1 mm) and coccolith-carbonate fluxes (calculated) in mg m^{-2} d^{-1} of the ESTOC moorings CI3-6 (+ indicates 'no data').

Upper traps					Lower traps				
Mooring/ sample	Closing date	$CaCO_3$ flux (<1 mm)	Coccolith-$CaCO_3$ flux	% of $CaCO_3$ flux (<1 mm)	Mooring/ sample	Closing date	$CaCO_3$ flux (<1 mm)	Coccolith-$CaCO_3$ flux	% of $CaCO_3$ flux (<1 mm)
CI4o					CI3u				
1	17.06.94	+	0,4	+	1	23.04.93	13,0	6,0	46,2
2	26.06.94	+	1,3	+	2	14.05.93	27,1	14,8	54,6
3	04.07.94	10,2	2,9	28,8	3	04.06.93	24,0	12,1	50,5
4	13.07.94	7,1	1,8	25,7	4	25.06.93	27,5	15,1	54,8
5	21.07.94	+	1,0	+	4	16.07.93	26,8	6,9	25,7
6	30.07.94	+	1,2	+	6	06.08.93	21,1	12,0	56,7
7	07.08.94	+	1,2	+	7	27.08.93	17,6	9,6	54,6
8	16.08.94	+	2,6	+	8	17.09.93	15,1	7,9	52,3
9	24.08.94	+	0,4	+	9	08.10.93	13,9	7,4	53,5
10	02.09.94	+	0,7	+	10	29.10.93	14,8	7,1	48,2
CI5m					11	19.11.93	+	4,2	+
1	24.09.94	5,4	1,7	30,7	12	10.12.93	+	5,0	+
2	16.10.94	5,9	1,7	29,3	13	31.12.93	27,1	4,8	17,8
3	07.11.94	4,7	1,8	37,3	14	21.01.94	23,2	11,9	51,2
4	29.11.94	7,4	3,0	40,5	15	11.02.94	48,7	38,0	78,0
5	21.12.94	5,8	2,3	39,4	16	04.03.94	72,9	48,7	66,8
6	12.01.95	9,6	3,9	40,5	17	25.03.94	36,4	17,2	47,4
7	03.02.95	21,3	4,8	22,5	18	15.04.94	28,2	9,4	33,3
8	25.02.95	12,3	7,0	57,1	19	07.06.94	16,7	6,2	37,3
9	19.03.95	22,2	7,6	34,1	CI4u				
10	10.04.95	30,3	9,3	30,6	1	17.06.94	7,6	3,8	50,1
11	02.05.95	11,8	4,7	39,8	2	26.06.94	13,1	3,5	26,4
12	24.05.95	4,9	0,8	16,7	3	04.07.94	8,9	3,6	40,7
13	15.06.95	3,9	1,7	42,5	4	13.07.94	24,9	6,7	26,8
14	07.07.95	6,2	3,1	49,6	5	21.07.94	26,3	7,2	27,5
15	29.07.95	6,7	1,9	27,7	6	30.07.94	27,2	5,7	20,9
16	20.08.95	8,6	2,8	32,5	7	07.08.94	39,8	10,7	27,0
17	11.09.95	9,8	3,0	30,9	8	16.08.94	28,0	7,7	27,6
18	03.10.95	+	1,5	+	9	24.08.94	25,2	6,6	26,4
19	25.10.95	+	2,1	+	10	02.09.94	18,2	3,9	21,5
20	12.11.95	+	1,7	+	CI6u				
CI6m					1	07.12.95	7,6	3,6	46,9
1	07.12.95	8,4	3,3	39,2	2	27.12.95	18,9	5,1	26,8
2	27.12.95	5,0	2,5	50,1	3	16.01.96	16,9	4,5	26,7
3	16.01.96	5,0	0,9	18,3	4	05.02.96	25,3	13,2	52,1
4	05.02.96	9,2	4,7	51,2	5	25.02.96	60,8	23,3	38,3
5	25.02.96	31,8	16,0	50,3	6	16.03.96	70,7	43,1	60,9
6	16.03.96	40,4	29,4	72,8	7	05.04.96	48,6	12,6	25,9
7	05.04.96	39,9	11,0	27,5	8	25.04.96	29,9	14,6	48,9
8	25.04.96	24,9	5,7	22,8	9	15.05.96	26,1	8,7	33,4
9	15.05.96	15,6	3,7	23,6	10	04.06.96	5,2	7,0	135,4
10	04.06.96	10,2	2,3	22,5	11	24.06.96	11,1	4,2	37,9
11	24.06.96	5,5	1,2	21,1	12	14.07.96	12,3	6,8	55,3
12	14.07.96	+	0,5	+	13	03.08.96	14,2	6,5	45,5
13	03.08.96	3,7	0,7	19,4	14	23.08.96	20,0	8,1	40,6
14	23.08.96	8,5	0,7	8,0	15	12.09.96	16,2	6,4	39,2
15	12.09.96	4,8	0,9	19,5	16	02.10.96	19,8	4,0	20,1
16	02.10.96	2,3	0,7	30,5	17	22.10.96	14,8	3,4	23,0
17	22.10.96	4,1	0,5	11,3	18	11.11.96	8,6	2,4	27,5
18	11.11.96	1,5	0,4	27,6	19	01.12.96	13,7	3,9	28,3
19	01.12.96	2,5	0,7	28,8					
20	21.12.96	5,8	1,5	26,0					

A comparison of coccolithophore fluxes and mass fluxes recorded at ESTOC (Fig. 3, 7) with historic CZCS derived pigment data (Fig. 2) shows that flux maxima generally occurred about one month after maximum pigment concentration was observed in surface waters of that region (see also Neuer et. al., 1997; Davenport et al., 1999). Although there is a deficiency of detailed seasonal biological studies in the Canary Islands region, reported mean primary production and chlorophyll values are generally low throughout the year (e.g., Arístegui et al.,

1989). Relatively high surface chlorophyll values are only observed from January to March, coinciding with the period of lowest SSTs resulting from deep mixing of the surface layer due to intensified wind stress (Fig. 2). The enhancement of chlorophyll is the result of nutrient enrichment of previously nutrient-depleted surface waters. A weak late-winter bloom, comparable to the autumn blooms of temperate seas, is apparent in the region during January and February, decreasing gradually towards spring and summer (e. g., Braun et al., 1985). This general pattern of primary production in surface waters of the studied region is well aligned to the observed seasonality of total coccolithophore fluxes which exhibit high values during spring, decreasing towards summer and autumn.

Previous studies reported the rapid transfer of primary productivity signals in the euphotic zone to the deep sea resulting in corresponding deep ocean particle flux maxima in about 3000 m water depth after only brief delays of few weeks to 1.5 month (e.g., Deuser et al., 1990; Asper et al., 1992; Newton et al., 1994). However, sinking particles are strongly influenced by advection and diffusion owing to horizontal currents and sinking speeds of the different particles itself (Siegel et al., 1990). In addition, trap efficiency is mainly influenced by currents in the vicinity of the sediment traps (Baker et al., 1988; Gust et al., 1992). Assuming a mean particle sinking rate of 100 m d^{-1} and an average current speed of 5-10 cm s^{-1} derived from current meter measurements from depth 20 m below the traps of the moorings CI 3 and CI 4, Neuer et al. (1997) presume a 100 km x 100 km primary source area directly to the NE of ESTOC for the particles collected with the 1000 m sediment traps. Relative trap efficiency is most probably not reduced due to the usually low current speeds in the vicinity of the traps (Baker et al., 1988; Neuer et al., 1997).

Comparing total coccolithophore fluxes of the 1000 m and 3000 m traps, we found a notable increase of fluxes with depth and a simultaneous reaching of maximum flux peaks at both trap depths in March 1996. This observation indicates relatively rapid sinking of particles through the water column. However, Neuer et al. (1997) propose that the source region of the 3000 m trap encompasses regions of higher production closer to the African shelf west off Cape Ghir, far to the north of the station (see also Davenport et al., in press; see Fig. 1). The authors speculate that the more rapidly sinking particles from the primary source region for the 1000 m trap may interact with the matter being advected laterally, resulting in the temporal coincidence of the two flux peaks (see also Siegel et al., 1990). The source region of the deep trap must form plankton populations that are similar to the open ocean populations encountered in the ESTOC region, since the composition of the particulate material in the two trap depths is similar.

5.2. Variability of the settling assemblages

Surprisingly little variation can be observed in the species composition of the coccolithophore assemblages at either trap depth. Indeed the absolute fluxes of the different species all show comparable seasonal patterns (Fig. 4-5). Sinking assemblages at both depths are dominated by *E. huxleyi* (generally >30%), with only *F. profunda* and gephyrocapsids (mainly *G. ericsonii*) contributing significantly to the assemblages. All other species exhibited maximum relative abundances <10% (Fig. 6).

The ratio of *E. huxleyi* to *F. profunda* is significantly variable from 85:1 to 1:2. A seasonal trend of increased abundances of the deep-dwelling species *F. profunda* in winter and clearly dominating *E. huxleyi* in spring to summer was also recorded in the subtropical North Atlantic (Broerse et al., in press). This variation is probably a result of varying nutrient supply to the upper euphotic zone where the majority of coccolithophores reside. The nutrient availability is controlled by the depth of the nutricline, which can be monitored by the abundance of *F. profunda* (Molfino and McIntyre, 1990). Together with *Gladiolithus flabellatus*, this is the only species that is restricted to the light-limited, lower euphotic zone (~60 to ~180 m water depth) of the tropical and subtropical oceans (Okada and Honjo, 1973; Winter et al., 1994). According to the model of Molfino and McIntyre (1990), high relative abundances of *F. profunda* are associated with a deep nutricline and deep thermocline, whereas low relative abundances are characteristic for a shallow nutricline and thermocline. This model has been used to interpret strong changes in *F. profunda* abundances in Quaternary sediments for reconstruction of past changes in the thermocline dynamics, in the equatorial Atlantic (Molfino and McIntyre, 1990; Bassinot et al., 1997), northwestern Pacific (Ahagon et al., 1993) and the Indian Ocean (Okada and Matsuoka, 1996).

Although the hypothesis of Molfino and McIntyre (1990) was applied to the equatorial Atlantic, the present findings are in accordance with it, since the relative abundances of *F. profunda* are highest before the maximum of *E. huxleyi* occurred. The period of strongest near-surface stratification in the study area occurs in summer when insolation, but also wind forcing are strongest. Convection due to surface cooling aided by wind stirring during winter is sufficient to destroy the seasonal stratification from November on. The time of maximum penetration of the surface mixed layer is March to April (Barton, 1994). Thus, maximum fluxes of *E. huxleyi* and highest coccolithophore production in the upper euphotic zone of the Canary Islands region is observed after the seasonal stratification breaks down in winter. Although increased coccolithophore production in open ocean conditions is generally associated with waters which have been depleted in nutrients and become increasingly stratified, the fluxes of *E. huxleyi* as

well as of all other species can well be coupled to seasonal surface processes in the studied region. Generally, this is also in very good accordance to sediment trap data at 34°N 21°W (Broerse et al., in press), where highest coccolith fluxes were also observed from January to March.

In addition, the pattern of relative abundances of the individual species recorded at 3000 m is very similar to that described for the upper trap (Fig. 6). Even proportions of fragile specimens, such as of holococcolithophores, are comparable to their frequencies in the upper part of the water column. In addition, coccoliths were preserved excellently and, hence, must have been transported rapidly through the water column and/or protected against corrosion within pellets or scavenged aggregates. Both mechanisms have been found to be important for the Canary Islands region (Fischer et al., 1996; Neuer et al., 1997). The excellent correspondence of the coccolithophore composition at both trap depths also indicate that continuous advection of phytoplankton material from a similar source region occurred. Laterally transported, reworked material from the shelf and upper slope of the NW-African margin which probably have another composition can therefore be neglected.

5.3. Coccolithophore-$CaCO_3$ flux estimates

Although coccoliths are believed to be a prominent contributor to open ocean carbonate fluxes and, thus, play an important role in the global carbon cycle, their quantification has long been problematic. Averaged coccolith-$CaCO_3$ masses have been used earlier (Honjo, 1976; Samtleben and Bickert, 1990; Steinmetz, 1991). However, converting coccolith abundances into species-specific $CaCO_3$ flux estimates becomes more and more a routine analysis, since much more accurate estimates of the volume and mass of single coccolith species have recently been made (Knappertsbusch and Brummer, 1995; Beaufort and Heussner, 1999; Young and Ziveri, 2000).

Calculated coccolith-$CaCO_3$ fluxes in the present study account for about 8 to 78% of the measured total $CaCO_3$ fluxes (<1 mm) with a mean contribution of 33.4% for the upper traps and 41.4% for the lower ones (Fig. 7). Unfortunately, so far there has been no information on the contribution of other organismal groups to the biogenic flux at ESTOC. Studies on planktonic foraminifers are in progress, and will be published elsewhere (H. Meggers, pers. comm., 1998). However, preliminary observations on the nature of the particulate matter in the traps indicate that coccolithophores constitute a dominant part of this material (Neuer et al., 1997). The same holds true for other coccolith studies from sediment traps in the northern Atlantic Ocean, with

estimated coccolithophore contribution to the total carbonate flux between about 20-65% (Honjo, 1986; Broerse et al., 2000). In other areas of the Atlantic Ocean, such as the western equatorial Atlantic (Steinmetz 1991), the eastern south Atlantic (Cepek and Wefer, subm.), and the Arctic North Atlantic (Samtleben and Bickert, 1990) this contribution seems to be of minor importance (generally <10%). This probably indicates differences in surface water productivity, with higher coccolithophore fluxes and associated coccolith-$CaCO_3$ fluxes occurring in more productive areas, but may also to be due in part to different methodologies used for carbonate quantification. Nevertheless, regional variations in terms of absolute mean coccolith-$CaCO_3$ fluxes seem rather low. The present fluxes were in the order of 3.9 and 9.9 mg coccolith-calcite m^{-2} d^{-1}. This is close to other values, ranging from about 1-2 mg m^{-2} d^{-1} in the equatorial and subarctic Atlantic (Samtleben and Bickert, 1990; Steinmetz, 1991) to 6-14 mg m^{-2} d^{-1} in the temperate North Atlantic (Broerse et al., 2000; Beaufort and Heussner, 1999).

As stated above, the mean contribution of the coccolith-$CaCO_3$ fluxes to the total measured $CaCO_3$ fluxes was slightly lower in the upper traps in comparison to the deeper traps (Fig. 7). This is in good accordance with the coccolith flux data discussed above. Similar observations have already been made for other locations (see discussion above; Steinmetz, 1991; Andruleit, 1997). Thus, significant modification of the coccolith-$CaCO_3$ flux by calcite dissolution, apparently does not occur. This allows us to approximate the contribution of individual coccolith species to the coccolith-$CaCO_3$ flux. Generally, the annual coccolith-$CaCO_3$ flux is dominated on the one hand by small-sized coccoliths and nannoliths, such as *E. huxleyi*, *Gephyrocapsa* spp., and *F. profunda* on the other hand by the larger, but less dominant species *Calcidiscus leptoporus* and *Umbilicosphaera sibogae* (Fig. 8). Within the former group, the dominating species in terms of absolute coccolith flux, *E. huxleyi* and *Gephyrocapsa* spp. (especially *G. ericsonii*), contribute significantly to the calculated coccolith-$CaCO_3$ flux, although they are less significant in terms of species-specific $CaCO_3$ mass. Mainly during periods of flux maxima, *E. huxleyi* and *Gephyrocapsa* spp. together contribute up to 30% to the coccolith-$CaCO_3$ flux, whereas *C. leptoporus* and *U. sibogae* are also main contributors during periods of lowest coccolith-$CaCO_3$ fluxes. This reflects the lower seasonality of the latter species (Fig. 4, 5) and differences in coccolith size, with *C. leptoporus* having a > 40-times the carbonate content of *E. huxleyi* (see Table 2). This is in good agreement to other findings of the temperate Atlantic (Broerse et al., in press), whereas coccolith-$CaCO_3$ fluxes in subpolar regions were found to be dominated by only one species, the massive *Coccolithus pelagicus* (Samtleben and Bickert, 1990; Andruleit, 1997).

In addition, most of the coccolith-carbonate material sinks rapidly within a short period of time. At 1000 m, pulse-like flux maxima in early spring are in the order of 16-30 mg m^{-2} d^{-1} (1996) and at 3000 m up to 49 mg m^{-2} d^{-1} (1993, 1996) within a two months interval. In 1996, the annual coccolith-carbonate flux was 1.6 g m^{-2} at 1000 m and 3.6 g m^{-2} at 3000 m. The pulse-like fluxes are close to estimates of about 42 mg coccolith-calcite m^{-2} d^{-1} during a *S. pulchra* pulse in the temperate North Atlantic (Knappertsbusch and Brummer, 1995). Other data on coccolith-$CaCO_3$ production in near-surface waters of the North Atlantic originate from satellite imagery. Accordingly, coccolith-$CaCO_3$ production during blooms of *E. huxleyi* could reach >100 mg m^{-2} d^{-1} (Brown and Yoder, 1994), 2-3 times the values of the observed flux maxima. For the Canary Islands region, two-thirds of the annual coccolith sedimentation in terms of individual coccoliths and in terms of coccolith-$CaCO_3$ occurred during a short, two month, interval. Together with the above mentioned previous findings this clearly indicates a general pulse-like, relatively episodic nature of coccolith sedimentation, at least for the North Atlantic.

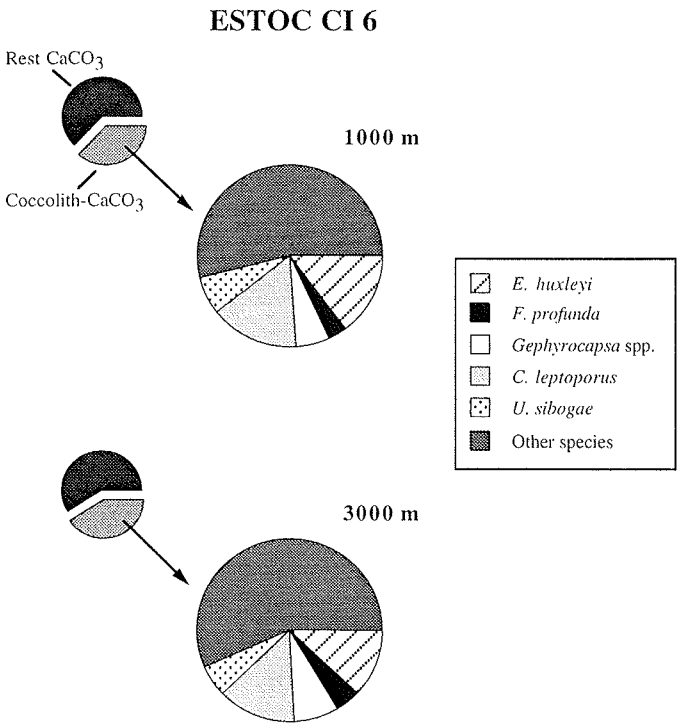
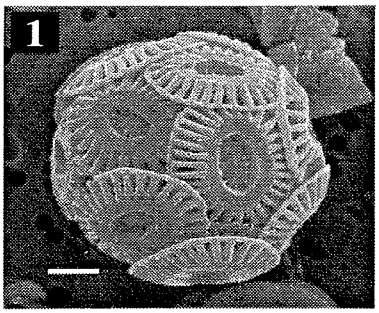


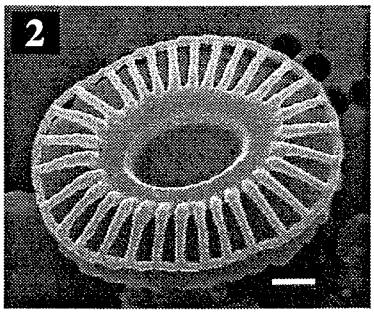
Fig. 8. Contribution of the annual coccolith-carbonate flux to the annual total carbonate flux (small pies) and percentage of single species and species groups to the coccolith-carbonate flux (large pies) of the ESTOC mooring CI6 (1000m, 3000m).

6. Conclusions

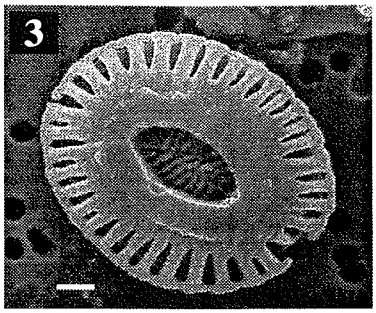
(1) Strong seasonal changes in coccolithophore fluxes with maxima in late winter/early spring were recorded in a multi-year sediment trap study at ESTOC-station 60 nm north of Gran Canaria from April 1993 to November 1996. During recurrent annual cycles, coccolithophore fluxes exhibit distinct changes reflecting the variability in upper ocean conditions and consequently the seasonality of phytoplankton development in surface waters.



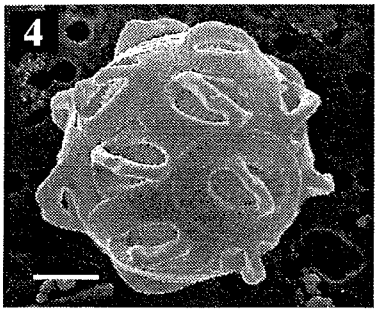
E. huxleyi bar = 1 µm



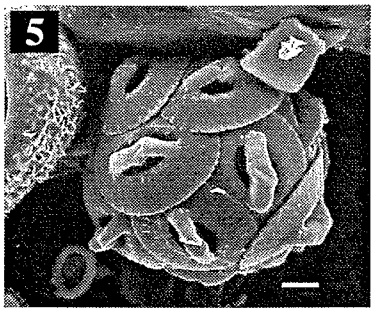
bar = 0.5 µm



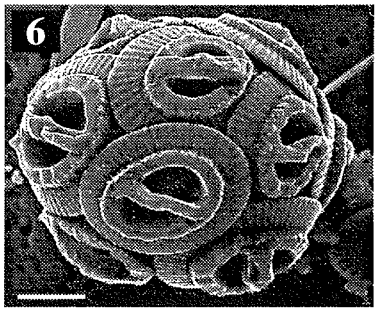
bar = 0.5 µm



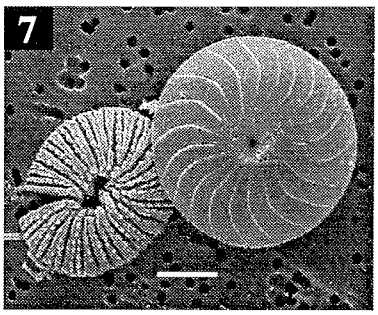
G. ericsonii bar = 1 µm



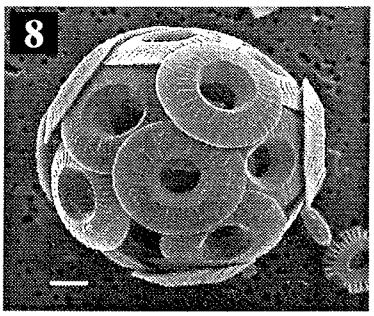
G. muellerae bar = 1 µm



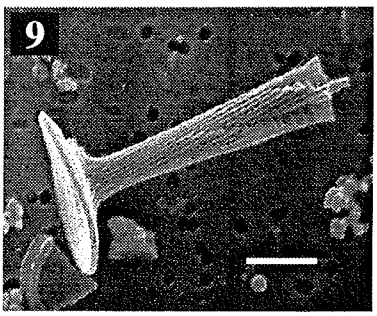
G. oceanica bar = 2 µm



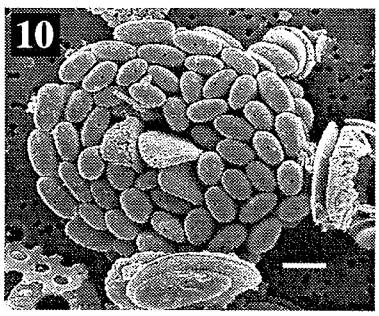
U. tenuis, C. leptoporus bar = 2 µm



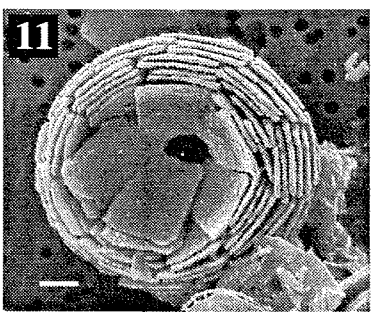
U. sibogae var. *foliosa* bar = 2 µm



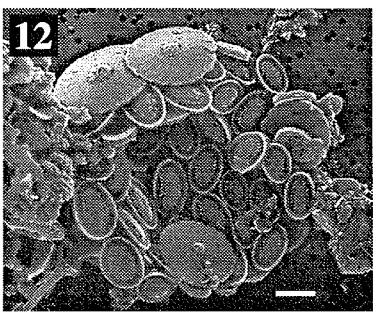
R. clavigera bar = 2 µm



A. robusta bar = 2 µm



F. profunda bar = 1 µm



S. anthos bar = 2 µm

Plate I

1. *Emiliania huxleyi*, intact coccosphere (CI5, 1000 m, Feb. 1995).
2. *E. huxleyi*, distal view of coccolith, type B (Young and Westbroek, 1991) (CI4, 3000 m, Aug. 1994).
3. *E. huxleyi*, distal view of over-calcified coccolith, type A (Young and Westbroek, 1991) (CI4, 3000 m, Aug. 1994).
4. *Gephyrocapsa ericsonii*, well preserved coccosphere (CI5, 1000 m, Jan./Feb. 1995).
5. *Gephyrocapsa muellerae*, intact coccosphere (CI5, 1000 m, Sept. 1995).
6. *Gephyrocapsa oceanica*, intact coccosphere (CI6, 1000 m, Jan./Feb. 1996).

Plate I (continued)

7. *Umbellosphaera tenuis* (left) and *Calcidiscus leptoporus* (right), distal view of coccoliths (CI5, 1000 m, July 1995).
8. *Umbilicosphaera sibogae* var. *foliosa*, intact coccosphere (CI6, 1000 m, Feb./March 1996).
9. *Rhabdosphaera clavigera* var. *clavigera*, rhabdolith in profile (CI4, 3000 m, Aug. 1994).
10. *Algirosphaera robusta*, coccosphere with partly corroded circum-flagellar rhabdoliths (CI6, 3000 m, Sept. 1996).
11. *Florisphaera profunda*, coccosphere with overlapping nannoliths (CI5, 1000 m, Oct. 1995).
12. *Syracosphaera anthos*, collapsed dimorphic coccosphere (CI6, 1000 m, Jan. 1996).

(2) Coccolithophore export production was closely related to both total mass fluxes and the $CaCO_3$ fluxes. At 1000 m, maximum coccolith fluxes of 4538 x 10^6 coccoliths m^{-2} d^{-1} occurred at the beginning of March 1996, whereas lowest values of 19.84 x 10^6 coccoliths m^{-2} d^{-1} are recorded in June 1994. At 3000 m water depth, the sedimentation pattern was rather similar to the pattern observed at 1000 m. Maximum coccolith fluxes were again reached during spring, in February 1994 (8200 x 10^6 coccoliths m^{-2} d^{-1}) and in March 1996 (8114 x 10^6 coccoliths m^{-2} d^{-1}).

(3) Generally, total coccolith flux peaks at 3000 m were about 2-4 times higher than in the upper part of the water column. This is probably the product of horizontal advection of phytoplankton blooms close to the upwelling region north of the study area.

(4) Total coccosphere fluxes at both trap depths were constantly low during most of the investigated time interval and only showed higher values during the main sedimentation phases in January/February 1994 (3000 m), from January to March 1995 (1000 m), and in March 1996 (1000 m, 3000 m).

(5) The coccolithophore assemblages at both trap depths were dominated by *E. huxleyi*, *F. profunda*, and *G. ericsonii*. All other species generally contributed <10% to the assemblage. Variation in the species composition at either trap depth was very low, reflecting similar seasonal flux patterns of the different species during the entire sampling period.

(6) Mean coccolith-carbonate fluxes ranged between 3.9 mg m^{-2} d^{-1} for the upper traps, and 9.9 mg m^{-2} d^{-1} for the lower ones. Calculated coccolith-$CaCO_3$ fluxes in the present study, therefore, account for up to 78% of the measured total $CaCO_3$ fluxes with a mean contribution to the total $CaCO_3$ flux of 33.4% in the upper traps and 41.4% in the lower ones.

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2. Morphological variations of various coccolith species in a sediment trap north of the Canary Islands

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Abstract

Biometrical analyses were performed on nearly 3200 specimens of distinct coccolith species of the time-series station ESTOC (European Station for Time-series in the Ocean, Canary Islands). Originally started for calculation of modern species-specific carbonate fluxes, this study was further intensified both to improve our knowledge of the morphological variability for each of the investigated species and to check the seasonal size-variations of the various species. Besides the dominant taxa *Emiliania huxleyi* and *Florisphaera profunda*, intensive measurements of various parameters have been made on *Calcidiscus leptoporus*, *Gephyrocapsa* spp., *Helicosphaera carteri*, *Syracosphaera pulchra*, and *Umbilicosphaera sibogae*. Generally, the species are unimodally distributed with respect to length/diameter and show only slight seasonal variation.

1. Introduction

Changes in the morphology of microfossil hard parts, as the basis for taxonomic identification, are most commonly used for reconstructions of evolutionary patterns and processes, especially within coccolithophores (e.g., Samtleben, 1980; Young, 1990; Wei, 1992; Baumann, 1995; Kameo and Takayama, 1999). However, for the interpretation of the evolutionary development it is important to know the present morphological variability as well as the biogeographical distribution of the species. At the moment, this has been worked out only for very few abundant coccolithophore species/genera, such as *Emiliania huxleyi* (Young and Westbroek, 1991), *Gephyrocapsa* spp. (Bollmann, 1997), and *Calcidiscus leptoporus* (Knappertsbusch et al., 1997). Changes in morphology through time do not necessarily indicate evolution. Size can be controlled genotypically, as has been shown to be important within *Emiliania huxleyi*, but may also reflect ecological conditions within other species (Young and Westbroek, 1991; Baumann, 1995; Knappertsbusch et al., 1997). The overall morphology of many species often varies with size,

and strong size variation is evident in both living and fossil samples (Young and Westbroek, 1991). Study of size variation in living oceanic coccolithophore species is therefore a prerequisite both to improve our knowledge of the morphological range of the species and to apply this knowledge to paleontological and paleoceanographical studies.

In the present study, samples from a year-round moored sediment trap (CI6m) at 1000 m water depth from 60 nm north of Gran Canaria (Fig. 1) were investigated in order to measure the morphological variation of distinct coccolith species. This study was originally started for a more exact determination of modern species-specific carbonate fluxes (Sprengel et al., 2000), by using mean lengths data of various species in a formula given by Young and Ziveri (2000). Besides providing information on the seasonal succession of species, sediment trapping also gives the opportunity to study seasonal variation in morphology of coccoliths. Therefore, this aspect has been much intensified in the latter part of the work.

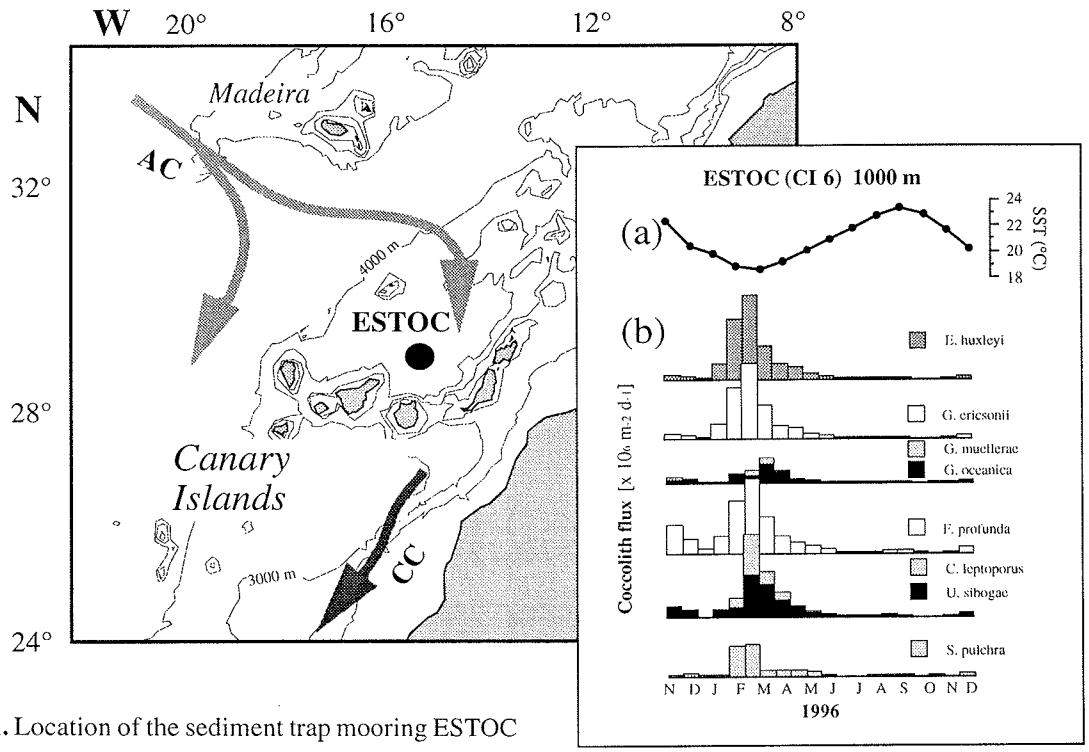

Fig. 1. Location of the sediment trap mooring ESTOC (CI 6m) and main surface water currents (AC – Azores Current, CC – Canary Current). Additional data on the right side include (a) monthly mean sea-surface temperature (SST) for the sediment trap mooring location (29.1° N, 15.5°W) for the period November 1995 to December 1996, and (b) the coccolith flux data (not in scale!) of the investigated species (from Sprengel et al., 2000).

The mooring is located in the Eastern Boundary Current regime of the subtropical North Atlantic gyre. This is a transition zone between relatively nutrient-rich waters along the North African continent to the east and more oligotrophic waters of the North Atlantic gyre to the west and, thus, seems to be well-suited to look into the above mentioned problems. The monthly

averaged sea-surface temperatures (SSTs) for 1996 show a "normal" North Atlantic seasonality with minimum SSTs (18.6°C) in February and Marc, and maximum SSTs (up to 23.5°C) in September (Fig. 1). Maximum coccolith fluxes recorded at ESTOC are closely related to the period of lowest SSTs and highest pigment concentration (Sprengel et al., 2000). Highest fluxes of >4500 x 10^6 coccoliths $m^{-2}d^{-1}$ were observed in late winter/early spring whereas lowest values of <20 x 10^6 coccoliths $m^{-2}d^{-1}$ generally occurred during summer months (Sprengel et al., 2000; Fig. 1). *Emiliania huxleyi*, *Florisphaera profunda*, and *Gephyrocapsa ericsonii* dominated the coccolithophore assemblages, whereas all other species generally contributed <10% to the community. Variation in the relative species composition was low, reflecting similar seasonal flux patterns of the different species during the entire sampling period.

Besides the most abundant species *E. huxleyi* and *F. profunda* we have selected *Gephyrocapsa* spp., *Calcidiscus leptoporus*, *Umbilicosphaera sibogae*, *Helicosphaera carteri*, and *Syracosphaera pulchra*, displaying an overview of styles of the main morphological variations of coccoliths. Basic aims of this study are: (1) to measure (and numerically classify) the morphological variability for each of the investigated species and (2) to check the seasonal distribution of the morphological varieties. This study was conducted in conjunction with the EU-funded TMR-project CODENET, which, among other tasks, aims to study coccolith morphology and determine ecophenotypic and genotypic variability of distinct species.

2. Materials and Methods

For this study, 16 of the 20 samples from the time-series sediment trap CI6m were chosen, which all were already counted for coccolith content (Sprengel et al., 2000). The individual sampling intervals of the mooring is about three weeks. For coccolithophore analysis, aliquots of each sample were wet split by means of an electrical rotary sample divider (Fritsch, Laborette 27) using tap water as the split medium. The samples were filtered onto polycarbonate membrane filters (Schleicher & Schuell™ 47 mm diameter, 0.45 µm pore size) using a vacuum pump. Thereby a monolayer of all sediment particles was created which was than investigated under the scanning electron microscope (for more details see Sprengel et al., 2000).

Measurements were made using a Zeiss DMS 940A scanning electron microscope (SEM). For all species distal shield length and width, or the diameter of the distal shield of about 30 to 50 randomly chosen specimens were measured. In addition, various other parameters were measured or counted, such as the size of the central area (*C. leptoporus*, *E. huxleyi*, *Gephyrocapsa* spp., *U. sibogae*) and the number of distal shield elements (*C. leptoporus*, *E. huxleyi*, *U. sibogae*).

All measurements were made directly on the TV-screen at a magnification of 5,000 or 10,000x by using an internal Zeiss measuring system, leading to a resolution on the micrographs of about 0.1-0.2 µm. It was tried to measure coccoliths in different areas of the SEM-mounts by moving from one measured specimen to the next unmeasured specimen.

3. Results and Discussion

3.1 Variability of the species

Coccospheres of ***Calcidiscus leptoporus*** (Murray and Blackman, 1898) Loeblich and Tappan, 1978 consists of tightly interlocked coccoliths. These placoliths are mostly circular or slightly elliptical in plan view, with the distal shields displaying dextrally imbricated and sigmoidally shaped sutures. *C. leptoporus* is known to have a holococcolith stage (*C. leptoporus* f. *rigidus*) in its life cycle (Kleijne, 1991).

The morphology of a total of 328 individual coccoliths of *C. leptoporus* group into three indistinct clusters of <5.0 µm, 5.0 to ~8.5 µm, and >8.5 µm (Fig. 2). Overall, the diameters of the distal shield range from 3.9 µm to 11.5 µm, and the number of elements from 15 to 34 (Table 1). However, the majority of measurements are between 6.0 µm to 8.0µm, and 18 to 28 distal shield elements. In addition, a strong correlation (r^2 = 0.677) of the coccolith diameter and the number of elements is obvious, whereas the width of the central area is less clear

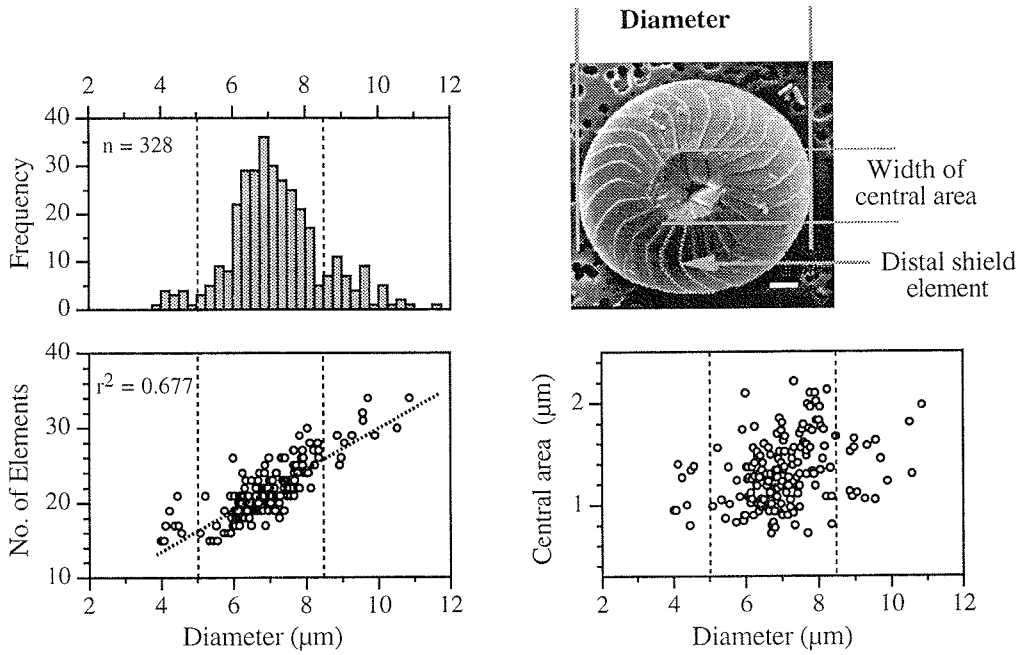

Fig. 2. Scatter plots and frequency distribution (of the coccolith diameter – at 0.25 µm intervals) of all *C. leptoporus* coccoliths measured. Measured parameters are indicated in SEM-picture.

correlated to the coccolith diameter (Fig. 2).

In total, our data confirm several previous observations of *C. leptoporus* morphology (e.g. McIntyre and Bé, 1967; Bartolini, 1970; Baumann, 1990; Kleijne, 1993; Knappertsbusch et al., 1997). In particular the clustering of the coccolith measurements into three different morphotypes with minimum overlap at 5 µm and 8 µm by Knappertsbusch et al. (1997) is very similar to our finding. The authors have not found any correlation between these morphotypes and single environmental parameters. Nevertheless, Knappertsbusch et al. (1997) also showed, that individual assemblage plots may differ significantly from different regions, with either large, intermediate or small coccoliths dominating. Thus, the strong dominance in frequency of coccoliths of the intermediate morphotypes in samples of CI6m is not surprising.

Emiliania huxleyi (Lohmann, 1902) Hay and Mohler, 1967 in Hay et al., 1967 forms spherical coccospheres consisting of less than 10 to up to more than 50 partially interlocked placoliths. These oval placoliths typically are formed of T-shaped elements and have an elliptical central area. Young and Westbroek (1991) distinguished between different varieties of *E. huxleyi* (types A, B, C, and var. *corona*) although they stated that biometric analyses do not separate these types easily. *Emiliania huxleyi* in general is the most abundant living coccolithophore and has extremely broad ecological affinities, occurring in all of the main oceanic conditions. Large-scale blooms which mainly consist of *E. huxleyi,* are regularly observed during early summer in the northern North Atlantic (e.g., Holligan et al., 1993; Brown and Yoder, 1994). This species is easy to maintain in culture and has been subject to intensive studies, combining observations from culture and oceanic populations (e.g. Watabe and Wilbur, 1966; Westbroek et al., 1989; Young and Westbroek, 1991; Westbroek et al., 1993; Young 1994).

The morphology of a total of 803 individual coccoliths of *E. huxleyi* show a clear unimodal distribution with a maximum centered at 3.3 µm (Fig. 3). Overall, distal shield lengths are 2.4 to 4.4 µm, the widths are 2.0 to 3.6 µm, and the number of T-shaped elements range between 22 and 40 (Table 1). Length and width of the distal shield are extremely well correlated ($r^2 = 0.93$) and a good correlation also exists between the length of the distal shield and both numbers of radial elements and size of the central area ($r^2 = 0.68$ and $r^2 = 0.548$ respectively). Varieties as given by Young and Westbroek (1991) have not been distinguished here. However, since most of the coccoliths had a grill of curved rods in the central area (see SEM-picture in Fig. 3), the majority of the measured specimens are probably type A coccoliths. A few specimens with delicate rays and open (dissolved?) central area or with remains of a tiny plate indicate that forms of *E. huxleyi* type C also occur.

Despite an increasing base of knowledge on *Emiliania huxleyi*, we still know little about its variability in coccolith morphology. The types of variation observed in the present study indicate that genotypic variation, as has been described by Young and Westbroek (1991) for *E. huxleyi* as a whole, is not obvious. The population in this area seems to be morphologically relatively homogeneous, a finding that have been made for other regions as well, especially in the North Atlantic (Young, 1994).

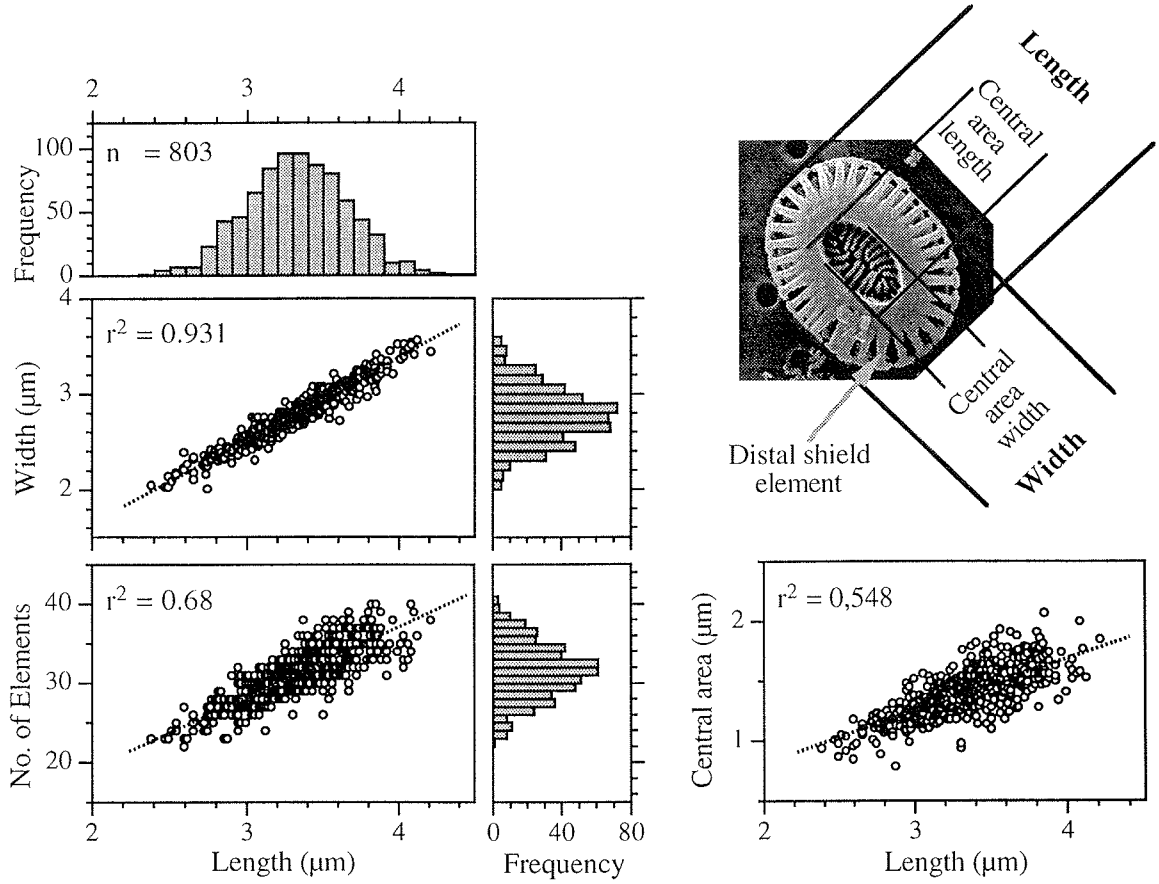

Fig. 3: Coccolith size variation data and frequency distributions (at 0,25 µm intervals) of various parameter measured in *E. huxleyi*. Measured parameters are indicated in SEM-picture of this species (representing a type A variety).

Florisphaera profunda Okada and Honjo, 1973 forms subspherical coccospheres with overlapping flat coccoliths (nannoliths), forming a rosette when looking in top view. Each single nannolith is a polygonal plate without any ornamentation. Generally, two varieties of *F. profunda* (var. *profunda* and var. *elongata*) could be distinguished. Together with a few other species it is the main contributor to the so-called deep-water assemblage (~60 to ~180 m water depth) of low- to mid-latitudes (Okada and Honjo, 1973; Nishida, 1979; Reid, 1980). In sediment assemblages this species has often been overlooked. However, recently *F. profunda* has gained

Table 1. Statistics of the morphological variability of the selected coccolith species of CI6m. Note that in a first phase of the study only measurements of length/diameter have been made, resulting in different counts per parameter.

		Counts	Minimum	Maximum	Mean	St. Deviation
C. leptoporus	Diameter (µm)	328	3.97	11.55	7.21	1.27
	No. of elements	159	15	34	21.72	3.89
	Pore width (µm)	173	0.08	2.21	1.32	0.34
E. huxleyi	Length (µm)	803	2.38	4.43	3.33	0.33
	Width (µm)	516	2.01	3.56	2.78	0.29
	No. of elements	512	22	40	31.06	3.56
	Pore length (µm)	516	0.79	2.07	1.40	0.21
F. profunda	Length (µm)	497	1.59	5.95	2.78	0.76
	Width (µm)	393	0.94	3.99	1.83	0.48
G. ericsonii	Length (µm)	122	1.44	2.94	1.97	0.23
	Width (µm)	62	1.18	2.34	1.58	0.18
	Pore length (µm)	62	0.65	1.47	1.04	0.15
	Bridge angle (°)	62	20	55	34.29	7.96
G. muellerae	Length (µm)	62	2.94	3.82	3.45	0.24
	Width (µm)	43	2.42	3.16	2.88	0.21
	Pore length (µm)	43	1.2	1.92	1.68	0.20
	Bridge angle (°)	43	13	33	21.50	6.01
G. oceanica	Length (µm)	81	3.94	5.91	4.99	0.50
	Width (µm)	71	3.25	5.15	4.27	0.47
	Pore length (µm)	71	1.74	3.34	2.46	0.35
	Bridge angle (°)	71	45	81	64.27	7.82
H. carteri	Length (µm)	223	4.75	12.84	9.13	1.44
	Width (µm)	100	4.93	7.91	5.95	0.73
S. pulchra	Length (µm)	484	3.88	8.42	5.87	0.70
	Width (µm)	282	2.75	6.28	4.15	0.58
U. sibogae var. *foliosa*	Diameter (µm)	452	2.91	5.99	4.42	0.49
	Central area (µm)	263	1.77	3.57	2.58	0.29
	Pore size (µm)	357	1.02	2.83	1.70	0.25
	No. of elements	99	17	33	27.88	2.71
U. sibogae var. *sibogae*	Diameter (µm)	118	4.43	6.97	5.93	0.44
	Central area (µm)	95	1.59	3.30	2.61	0.30
	Pore size (µm)	99	0.81	2.18	1.54	0.29
	No. of elements	50	22	35	31.70	2.38

increasing attention, since it was shown to be a useful paleoproductivity indicator (e.g. Molfino and McIntyre, 1990; Ahagon et al., 1993; Bassinot et al., 1997) . The nutrient availability is controlled by the depth of the nutricline, which can be monitored by the abundance of *F. profunda* (Molfino and McIntyre, 1990).

The length and the width of the nannoliths are easily measurable morphometrical patterns in *F. profunda*. Therefore, and due to the high relative abundance in settling assemblages of the

Canary Islands, 496 specimen have been measured in the present study. The distribution shows a unimodal pattern with a maximum centered at about 2.8 µm (Fig. 4). Overall, coccolith lengths are 1.6 to 5.9 µm, the maximum widths are 0.9 to 4.0 µm (Table 1). Obviously, there is a great variability in the scatterplot (Fig. 4), especially of coccoliths >3.5 µm in length. Thus, a rather low correlation exists between the length and the width of the coccoliths, resulting in a correlation coefficient of only $r^2 = 0{,}269$. Possibly this is due to the fact that both varieties of *F. profunda* are present in the investigated samples, with var. *elongata* forming larger coccoliths (e.g. Reid, 1980).

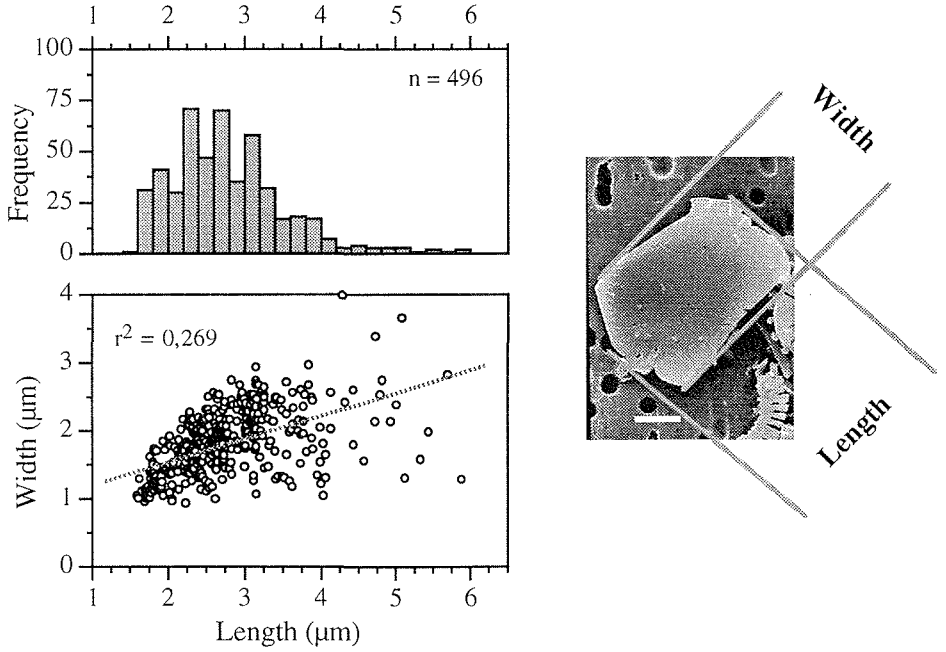

Fig. 4. Coccolith size variation data of all measured *F. profunda*.

The presented results of the study of morphological variation in *F. profunda* are rather preliminary, but give a first impression of the size-variability of this species. Their increased value as a proxy for nutrients could possibly advance to study the morphological diversity of the whole population.

All extant species of the genus ***Gephyrocapsa*** Kamptner, 1943 build spherical coccospheres of oval placoliths with a bridge crossing the central area. The numbers of extant species within the genus is still a point of debate and, besides, has often been confused due to different taxonomic concepts. This is rather surprising, since Bréhéret (1978) and Samtleben (1980) already demonstrated that *Gephyrocapsa* species could relatively easily be distinguished by the combination of morphological parameters such as the placoliths length and bridge angle.

Recently, morphological analysis of Holocene *Gephyrocapsa* assemblages reveal six dominant morphological associations (Bollmann, 1997), which the author described informally, since he reserved judgement on whether these corresponded to discrete species or at least in part to ecophenotypes.

For this study we wished to tested whether the three species of *Gephyrocapsa* (*G. ericsonii* McIntyre and Bé, 1967, *G. muellerae* Bréhéret, 1978, *G. oceanica* Kamptner, 1943), which were distinguished by Sprengel et al. (in press) in the investigated samples, could be separated by morphological measurements. We measured the lengths of 264 specimens and the width, bridge angle and central area size of 136 of these. Overall, lengths and widths of the placoliths are extremely well correlated ($r^2 = 0.995$) and a trimodal distribution pattern can be observed in the length data (Fig. 5). A bivariate plot of length vs. bridge angle clearly seperates the three modes into discrete clusters. These clusters correspond to the above mentioned species. *Gephyrocapsa ericsonii* coccoliths are 1.4 to 2.9 µm long, ≤2.3 µm wide, and have medium-large bridge angles of about 20-55° (Table 1). *G. muellerae* coccoliths are medium-sized, 2.9 to 3.8 µm long and have a typical small bridge angle of 13-33°, whereas large-sized *G. oceanica*

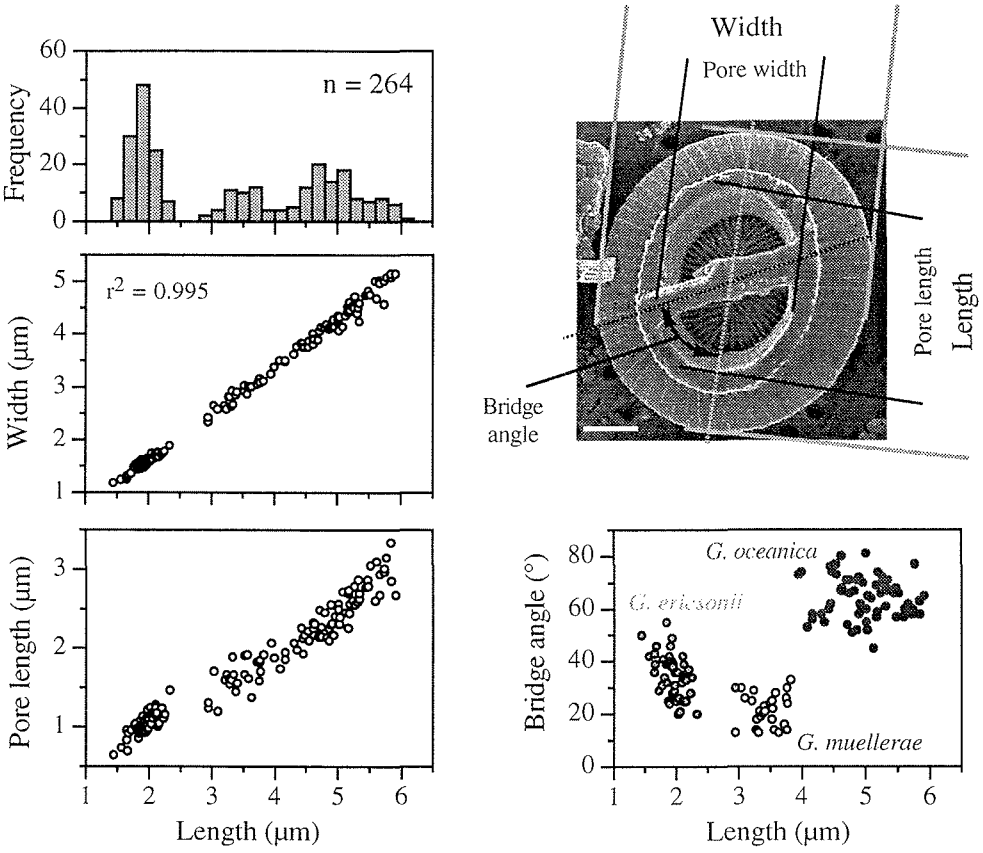

Fig. 5. Coccolith size variation data and frequency distributions (at 0.2 µm intervals) of various parameter measured in *Gephyrocapsa* spp. Measured parameters are indicated in SEM-picture (representing a *G. oceanica*).

are 3.9 µm to 5.9 µm long and have a large bridge angle, generally >50° (Fig. 5).

Thus, our measurements exactly fit into the "traditional" scatterplot-scheme of bridge angle vs. length presented by Samtleben (1980). In addition, although difficult to combine, the observed species could be identical to morphotype associations GM, GC, and GE/GL as introduced by Bollmann (1997), with his ecological interpretation fitting relatively nicely to the observed composition of the *Gephyrocapsa* assemblage.

Helicosphaera carteri (Wallich, 1877) Kamptner, 1954 forms coccospheres with large, elliptical coccoliths (helicoliths) with a helical flange terminated by an expanded wing. Three varieties of *H. carteri* (vars. *carteri*, *hyalina* and *walichii*) are conventionally recognised in the extant nannoplankton based on the helicolith central-area structure (e.g. Young 1998), although it is not clear whether this variation is genotypically controlled. Cros et al. (2000) have found combination coccospheres of *H. carteri* heterococcoliths with the *Syracolithus catilliferus* holococcoliths, from which they infer that the two morphospecies are life cyclephases of a single biological species.

The length of the helicolith is the most easily measurable morphometrical parameter in *Helicosphaera carteri*. Therefore, in the present study data is mainly presented as total coccolith length and width of the coccolith (both including and excluding the wing; Fig. 6) measured on a total of 223 specimen. In general, most coccoliths are between 6.2 µm and 12.2 µm in length and range from 4.4 to 7.9 µm in width. Length and width are relatively well correlated to each

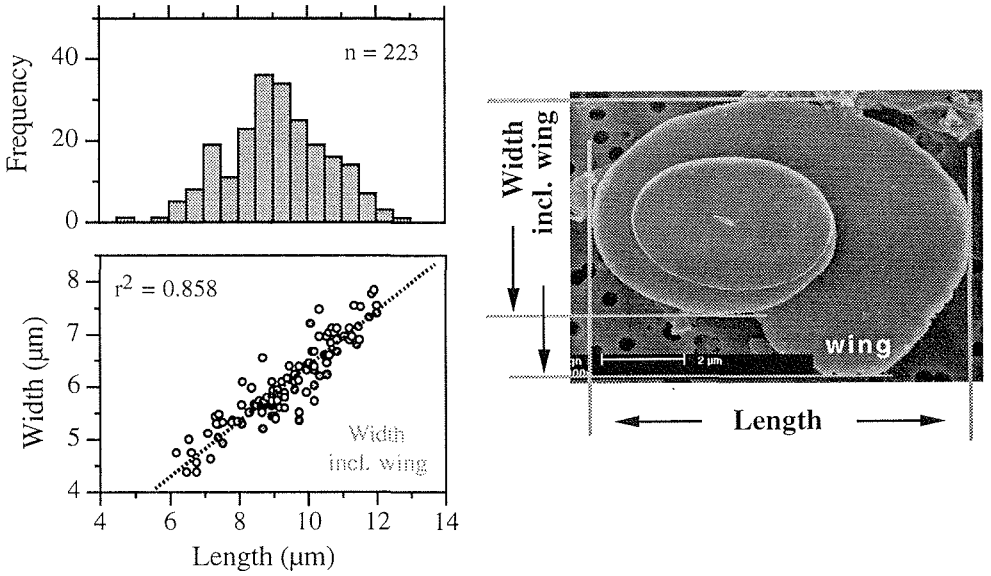

Fig. 6. Scatter plots and frequency distribution (at 0.25 µm intervals) of all *H. carteri* coccoliths measured. Note that specimen shown in SEM-picture has an unusual wide wing.

other (r^2 = 0.586). *H. carteri* seems to be unimodally distributed with respect to coccolith length.

However, since we have not included the central area structure as a morphological feature in this study, different intraspecific varieties have possibly been analysed together. This might be the case even though a conspicuous unimodal frequency distribution was observed. Nevertheless, results are promising to intensify study on the morphological variability of this species.

The coccosphere of ***Syracosphaera pulchra*** Lohmann, 1902 is dithecate, and consists of an endothecal layer of elliptical basin-shaped caneoliths and an exothecal layer of dome-shaped cyrtoliths. The exothecal coccoliths have a very low preservation potential so that we have only measured the endothecal coccoliths. Combination coccospheres occur with both the holococcolithophorid *Calyptrosphaera oblonga* and *Daktylethra pirus*, suggesting that this species may have a particularly complex life cycle (Cros et al., 2000; Geisen et al., pers. comm.).

In our study, we have measured only length and width of the endothecal caneoliths. The measurements on a total of 484 caneoliths show a clear unimodal distribution pattern (Fig. 7). In general, the population was consistently characterized by medium-sized coccoliths, most of them 5-7 µm long and 3.5-5 µm wide. Overall, the length of the caneoliths ranges from 3.9 µm to 8.4 µm, and the width from 2.7 µm to 6.3 µm (Table 1). The lengths and widths are strongly correlated to each other, with a correlation coefficient of r^2 = 0.846 (Fig. 7).

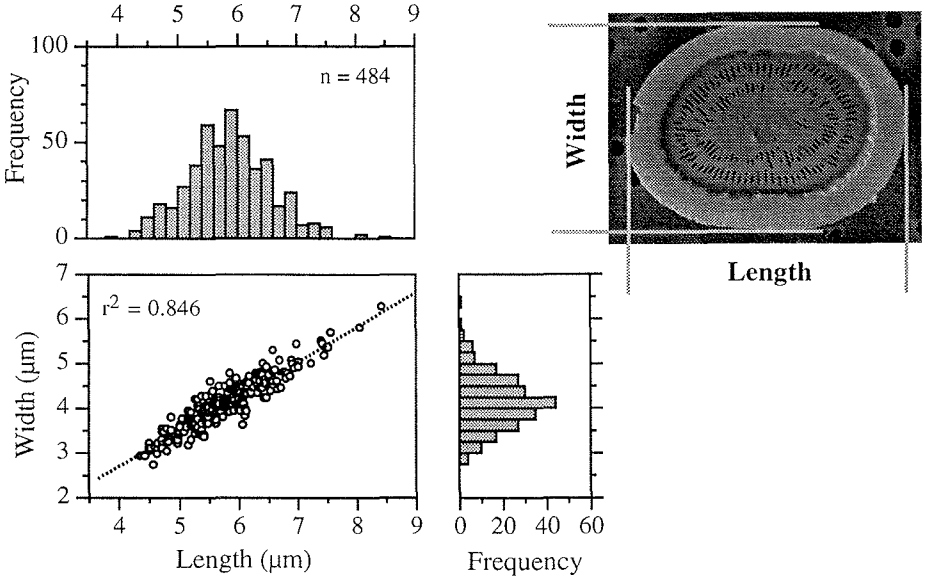

Fig. 7. Scatter plots and frequency distribution (at 0.2 µm intervals for the coccolith length; at 0.25 µm intervals for the coccolith width) of all *S. pulchra* coccoliths measured.

Detailed morphological data on *S. pulchra* does, to our knowledge, not exist so far, although it is the most robust *Syracosphaera* species and is characteristic for temperate to subtropical coccolithophore assemblages (Jordan and Chamberlain, 1997). Therefore, the present study gives a first basis for the morphometrical characterisation of this species.

Umbilicosphaera sibogae Weber-van Bosse, 1901 forms non-motile, spherical coccospheres covered with circular placoliths. It contains two varieties, most probably discrete genotypes, showing distinct variation in coccosphere form: *U. sibogae* var. *sibogae* (Weber-van Bosse, 1901) Gaarder, 1970 forms a large coccosphere with about 40-100 partly interlocked circular placoliths, which have a relatively large central opening. The coccosphere of *U. sibogae* var. *foliosa* (Kamptner, 1963) Okada and McIntyre, 1977 is smaller in diameter and consists of <30 tightly interlocked circular coccoliths with a relatively small central opening. Detailed descriptions of the coccolith morphology are given in Okada and McIntyre (1977) and Kleijne (1993).

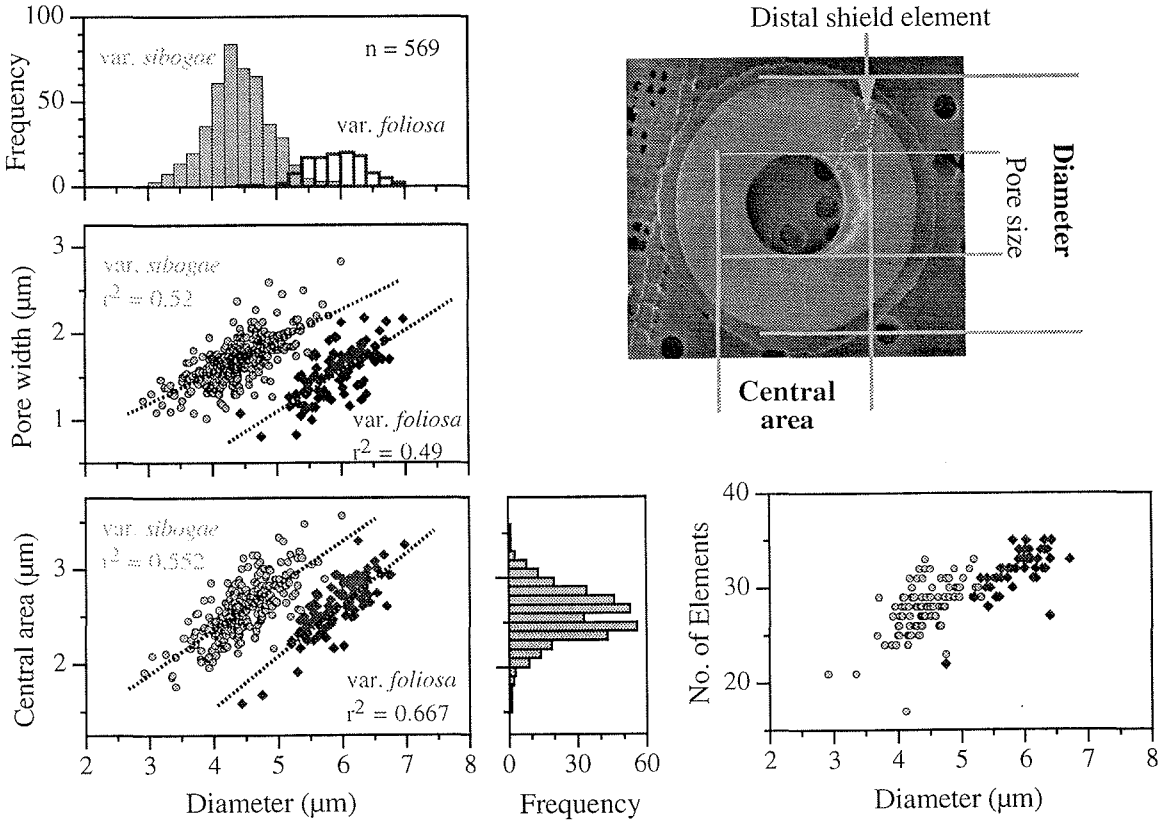

Fig. 8. Scatter plots and frequency distribution (at 0.2 µm intervals for the coccolith diameter; at 0.1 µm intervals for the central area) of all *U. sibogae* coccoliths measured. Measured parameters are indicated in SEM-picture (representing *U. sibogae* var. *sibogae*).

In our study of 569 individual coccoliths the two varieties show distinct variation in coccolith diameter, element numbers, and size both of the central area and the pore (Fig. 8). The distal shield of *U. sibogae* var. *sibogae* is 2.9 µm to 6.0 µm in diameter and consists of 21(17)-33 elements (Table 1). Proximal shields are larger than the distal shields, but have not been measured in our study. The distal shield of *U. sibogae* var. *foliosa* is 4.4 µm to 7.0 µm in diameter, and consists of 26(22)-35 elements. The distribution of each of the varieties is unimodal with peaks centered at 4.4 µm (var. *sibogae*) and, less clear, at about 5.9 µm (var. *foliosa*) respectively. A good correlation of most of the parameters (pore size, width of the central area, number of distal shield elements) exist with the diameter of the distal shield, with correlation coefficients ranging between $r^2 = 0.49$ and $r^2 = 0.667$ (Fig. 8). The absolute range both of the pore size and of the central opening is very similar for both varieties, indicating that the relative proportions with the diameter of the distal shield are smaller for var. *sibogae*.

In general our findings very well fit to previously published morphological data on *U. sibogae* (e.g. Okada and McIntyre, 1977; Kleijne, 1993). Although the morphology of both varieties slightly overlaps, identification usually was never a problem in our samples.

3.2. Seasonal variation of morphological associations

The investigated coccolith species show surprisingly little morphological variation throughout the year, although strong seasonal coccolith fluxes, coinciding with variation in SST, are well illustrated at ESTOC from November 1995 to November 1996 (Sprengel et al., 2000; Fig. 9). In particular, this is the case for the variation in mean length of *E. huxleyi*, which is about 3.3 µm throughout the year. The frequency distribution of the single samples, however, display less clear (unimodal) distribution than that of the total population (Fig. 3). This is probably an artefact of the lower number of measurements in comparison to the total population. However, the maximum range in size of *E. huxleyi* generally exhibits a pulsating pattern of minor variation during bloom phase and slightly wider distribution of lengths in pre- and post-bloom samples. Conspicuous variation in size distribution between single samples of the sediment trap can also be seen in most of the other species, especially in *F. profunda*, without revealing any seasonal pattern. This is in contrast to seasonal trends in species occurrences, with highest relative abundances of the deep-dwelling *F. profunda* in pre- and post-bloom phase and clearly dominating *E. huxleyi* during bloom-phase (Sprengel et al., 2000).

The only noteworthy exceptions seem to be the size variations in *C. leptoporus* and *U. sibogae*. However, although the absolute variation in the diameter of *C. leptoporus* is 1.5 µm

(6.68 µm to 8.18 µm), which is 20% of the size, a clear seasonal pattern is not revealed (Fig. 9). Highest and lowest mean diameters are found in winter samples (November/December 1995 and December 1996 respectively). Whether this is due to the low number of measurements in some of the samples or a real trend remains rather unclear. However, as shown before, three different morphotypes of *C. leptoporus* occur, and their appearance may be environmentally controlled (Knappertsbusch et al., 1997). *Umbilicosphaera sibogae* shows a significant increase in the number of larger coccoliths with increasing total coccolith flux and decreasing temperatures. However, the higher mean lengths are due to the increased numbers of *U. sibogae* var. *foliosa* during the "bloom" samples, whereas this variety is only sparsely present in the pre- and post-bloom samples. This finding corresponds well with observations of Broerse et al. (in press), who showed that var. *foliosa* becomes more abundant in nutrient-enriched (upwelling) regions, whereas var. *sibogae* is thought to be associated with oligotrophic conditions. Nevertheless, very slight morphological variations of both varieties are less the standard deviation (Table 1) and do not display any seasonal trend.

In total, the results of this study suggest that oceanic populations from distinct regions, such as the Canary Islands, are relatively homogeneous with respect to coccolith morphology, probably representing only part of the total genotypic heterogeneity of the investigated species. Thus, the total variation in coccolith morphology of a distinct species can only be identified on a global distribution. Different morphotypes of a species, however, may have distinct ecological adaptation, as is indicated by both varieties of *U. sibogae*. In fact, there is increasing evidence that morphological varieties reflect genotypic rather than ecophenotypic variation (e.g. Young and Westbroek, 1991; Knappertsbusch et al., 1997; Young, pers. comm.), of which the distributions are environmentally controlled.

4. Conclusions

In summary, all investigated coccolith species generally are characterized by a relatively strong correlation of the various parameters measured. They all exhibit a unimodal distribution of lengths/diameters and show only slight morphological variation throughout the year. This is rather surprising, since strong seasonal coccolith fluxes, coinciding with variation in SST, are well illustrated at the trap position north of Gran Canaria. Thus, it is suggested that these populations represent a local part of the total genotypic morphovariability of the species.

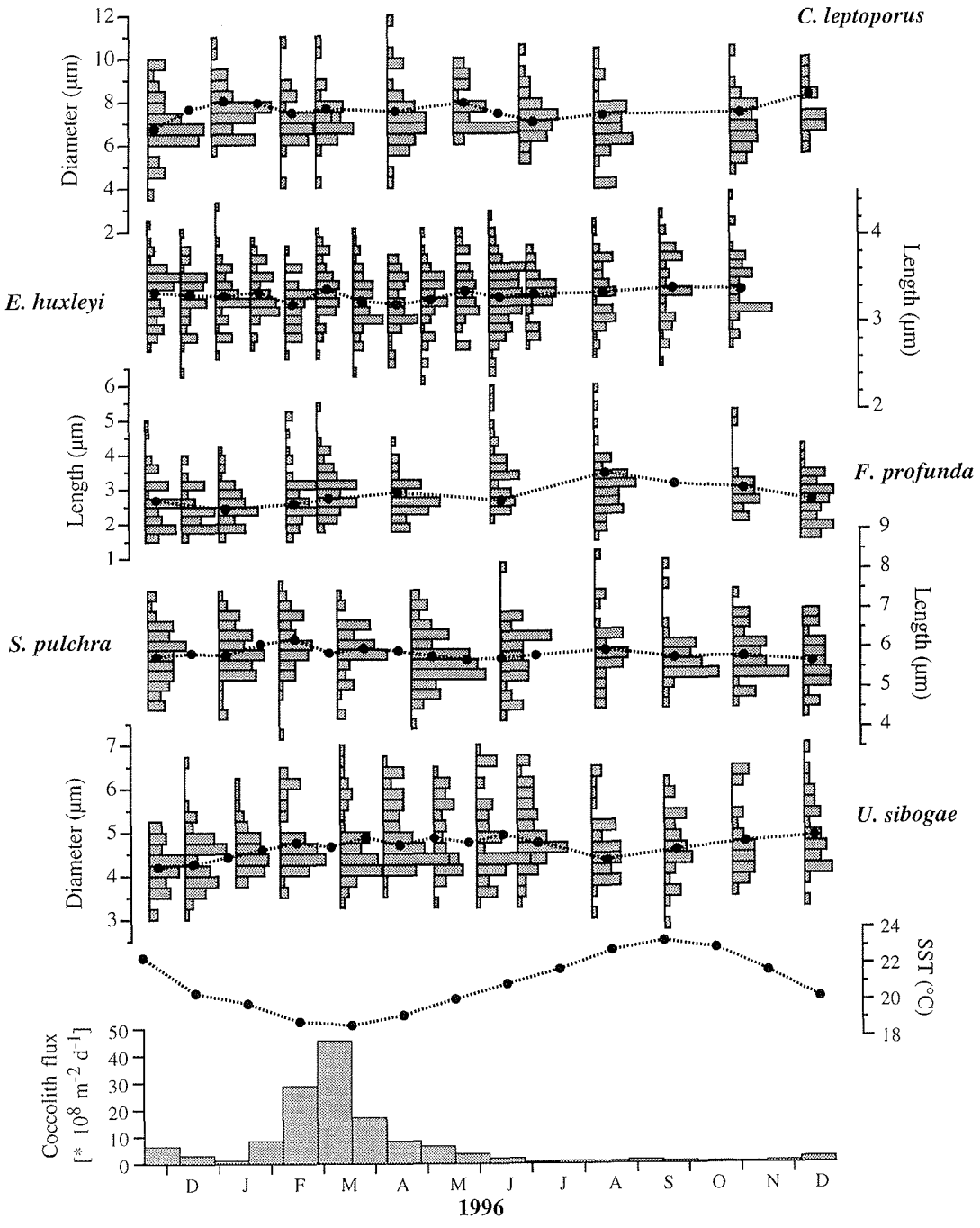

Fig. 9. Comparison of the seasonal size variation data of distinct species together with monthly sea-surface temperature (SST) for the sediment trap mooring location (29.1° N, 15.5°W) for the period November 1995 to December 1996 and the total coccolith flux (from Sprengel et al., 2000).

Acknowledgements

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Eastern Boundary Current System", and has later constituted part of the EU-funded TMR Network Project CODENET (Coccolithophorid Evolutionary Biodiversity and Ecology Network).

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3. Modern coccolithophore and carbonate sedimentation along a productivity gradient in the Canary Islands region: Seasonal export production and surface accumulation rates

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Abstract

Coccolithophores, one of the main primary and carbonate producers in the surface waters of the Canary Islands region, were investigated to quantify coccolith and coccolith-carbonate export fluxes and to determine possible trends in species composition related to different productivity conditions. Present day coccolith and coccolith-carbonate fluxes were compared to the long-term records of coccolith and carbonate accumulation in Holocene sediments underneath the mooring locations. Coccolithophore flux variations in sediment traps at three stations along an E-W transect at approximately 29°N from the upwelling influenced north-west African shelf region to the open ocean were recorded from January to September 1997. Four particle traps were deployed at the oceanic sites LP (900 m, 3700 m) and ESTOC (750 m, 3000 m), and one at the near-coast site EBC (700 m). All traps have been synchronized on a 14-day sampling interval.

Total coccolith fluxes along the studied transect were highly seasonal, with pronounced sedimentation events occurring in February (upper traps) and March (deep traps), related to the winter phytoplankton bloom in surface waters. While total coccolith flux rates and fluxes of different species at the two oceanic sites LP and ESTOC were comparable (mean: 6.4 and 5.4 x 10^8 coccoliths m^{-2} d^{-1}), fluxes increased significantly towards the shallower site EBC (mean: 13.7 x 10^8 coccoliths m^{-2} d^{-1}). This gradient points to increased productivity in surface waters at the near-coast station, probably associated with nutrient-rich upwelling filaments detaching from the coast and/or upwelling effects along the easternmost islands. Additionally, a strong influence of lateral advected, coccolith-rich material was demonstrated for the deeper sediment traps at the two offshore sites, resulting in an increase of mean daily coccolith fluxes by a factor three (LP) and by a factor two (ESTOC), respectively. Estimated annual coccolith-carbonate fluxes along the transect were 2.8 g m^{-2} (EBC) and 1.2-1.3 g m^{-2} (ESTOC, LP) in the upper traps, representing 31-33% of the total annual carbonate flux. The coccolith-carbonate supply was higher in the deeper traps, with 63% at LP and 44% at ESTOC, respectively. Average Holocene coccolith and (coccolith-) carbonate accumulation rates derived from surface samples at the

mooring locations generally confirm the sediment trap results. Discrepancies mainly result from near-bottom and down-slope particle transfer processes, which especially influence the site closer to the shelf. Dissolution processes are likely to affect primarily the deep sediments at the oligotrophic site LP.

The highly diverse subtropical coccolithophore assemblages were quite similar in all sediment trap samples from the three mooring sites, with three species (*Emiliania huxleyi*, *Florisphaera profunda*, *Gephyrocapsa ericsonii*) contributed significantly to the community. Despite the good correspondance between the assemblage compositions along the transect, some trends towards the upwelling influenced site EBC could be observed. Whereas all *Gephyrocapsa* species (mainly *G. ericsonii*) respond positively to higher productivity conditions at the near-coast station, *Calcidiscus leptoporus* and the deep-photic zone species *F. profunda* increased in mean relative abundances towards the two offshore sites pointing to a preference for the more stable, oligotrophic conditions of the subtropical gyre.

Keywords: coccoliths; export fluxes; sediment traps; carbonate; Holocene accumulation; coastal upwelling; N Atlantic; NW Africa; Canary Islands

1. Introduction

Coccolithophores are unicellular algae which constitute a significant component of the marine phytoplankton in present oceans. They are characterized by intracellular formation of minute calcite scales (coccoliths) forming an external cell-wall covering (coccosphere). Coccoliths are important contributors to the carbonate fraction of deep-sea sediments, as they are readily preserved above the calcite compensation depth (CCD) (Berger, 1976; Milliman, 1993). Coccolithophores influence biogeochemical cycles and the global climate system by contributing significantly to the oceanic pumps of organic carbon (via photosynthesis) and carbonate (via calcification) and hence affect the surface ocean CO_2 balance (Westbroek et al., 1993; Brand, 1994). Estimations on the relative contribution of different calcifying organisms (e.g. coccolithophores, foraminifera) to the global calcium carbonate production are few, but it is assumed that about 40-60% of the marine carbonate production is provided by coccoliths (Wollast, 1994).

Coccoliths and coccolith assemblages may provide signals for interpreting global change in the geological record, e.g. palaeoproductivity or past ocean circulation patterns (Baumann et al., 1999; Kinkel et al., 2000). A prerequisite for using coccoliths as biotic proxies for environmental parameters in palaeoceanographic and palaeoecologic studies is a basic understanding of the coccolithophore ecology and the processes involved in transformation of the living communities in surface waters (biocoenoses) into coccolith assemblages in the underlying sediments (thanatocoenoses).

However, although increasing information is available on the distribution of living coccolithophores in present oceans (e.g. McIntyre and Bé, 1967; Okada and Honjo, 1973; Kleijne et al., 1989; Ziveri et al., 1995a; Baumann et al., 1997), there is still a deficiency in the knowledge of transformation and alteration processes influencing coccolithophore assemblages being exported to deeper waters and accumulated on the seafloor. Due to mainly logistic reasons and different time-scales involved (days vs. several hundreds of years), only a limited number of studies are available which directly compare plankton data with surface sediments (McIntyre and Bé, 1967; Samtleben and Schröder, 1992; Baumann et al., 2000). Sediment traps are seen to be a valuable tool to link the dynamics of coccolithophore production in the photic zone, as represented by plankton samples, with the assemblages found in the underlying surface sediments (Samtleben et al., 1995). Recent investigations, in which time-series sediment traps have been used, have reported seasonal and interannual fluctuations in coccolithophore fluxes, including species composition and abundances, as well as the timing and intensity of coccolithophore production periods in different oceanic environments (Samtleben and Bickert, 1990; Steinmetz, 1991; Ziveri et al., 1995b; Andruleit, 1997; Broerse et al., 2000; Sprengel et al., 2000). These data on coccolithophore export production rates also provide an important basis for the estimation of the global budget of carbonate supplied by coccoliths.

Within the CANIGO (Canary Islands Azores Gibraltar Observations) time-series sediment trap experiment north of the Canary Islands in 1997/1998, comprehensive biogeochemical flux studies have been carried out in order to obtain a better insight in the controlling factors of particles sedimenting to the seafloor. Palaeoceanographic important plankton groups (diatoms, calcareous nannoplankton, foraminifera) have been quantitatively determined in order to characterize these organisms as proxies for environmental parameters, that later can be used for palaeoclimatic interpretations of the geological record. The present study focuses on the determination of coccolithophore and coccolith-carbonate export production along an E-W productivity gradient from the highly fertile, upwelling influenced regime along the NW African coast to the low productive area of the subtropical N Atlantic gyre. Our major objectives are: (1) to compare seasonal fluxes and species compositions with the different productivity conditions in surface waters along the transect, (2) to determine the influence of mid- and deep-water processes affecting the coccolithophore export fluxes within the water column, and (3) to test, how present day fluxes of coccoliths and coccolith-carbonate can be related to long-term Holocene accumulation rates in the underlying sediments.

2. Regional setting

2.1. Hydrography

The Canary Islands are located in the eastern subtropical North Atlantic at a latitude of 27-28°N (Fig. 1). The large-scale oceanographic situation in the Canary Basin is characterized by the subtropical gyre recirculation and coastal upwelling processes along the north-west African continent. The easternmost branch of the Azores Current crosses the Canary archipelago and feeds the Canary Current, an essential part of the Eastern Boundary Current System (e.g., Stramma and Siedler, 1988; Fig. 1). The relatively weak Canary Current mainly flows south-westward at the surface along the African shelf, underlain by southward flowing North Atlantic Central Water (NACW, down to 600 m) and northward moving fresh Antarctic Intermediate Water (AAIW, 600-1100 m) (Knoll et al., 1999). Between 25°N and 20°N the Canary Current becomes detached from the continental margin and gradually turns into the wind-driven North Equatorial Current at lower latitudes (Mittelstaedt, 1991). Along the coast upwelling of cool and nutrient-rich subsurface NACW and related offshore currents interact with the Canary Current. The coastal upwelling system off north-west Africa is strongly coupled with the large-scale variations of the trade winds. Correlated with the seasonal shift of the trades, which is related to the migration of the Inter-Tropical Convergence Zone (ITCZ), upwelling exhibits a seasonal signal along the coast. North of 25°N upwelling mainly occurs during late summer and early autumn (Speth and Detlefsen, 1982; van Camp et al., 1991). The primary upwelling zone is confined to the shelf area, but recurrent prominent filaments of cool and pigment-rich water often extend several 100 km off-shore, acting as important transport mechanisms for nutrients and plankton (Nykjaer and van Camp, 1994; Barton et al., 1998; Davenport et al., 1999; Rodríguez et al., 1999). Due to their zonal extension, the Canary Islands represent a barrier for the general south-westward flow of both ocean currents and trade winds, giving rise to a number of mesoscale horizontal and vertical mixing processes in the transition zone between the cool, relatively nutrient-rich waters of the coastal upwelling regime in the east and the warmer, oligotrophic waters of the subtropical North Atlantic gyre in the west (Barton et al., 1998).

2.2. Annual production cycle and particle fluxes

Barton et al. (1998) broadly divided the Canary Islands region into four sub-regions, which show distinct mesoscale variability within their annual production cycles. Accordingly, the mooring site EBC (Eastern Boundary Current) is generally regarded to be affected by the NW

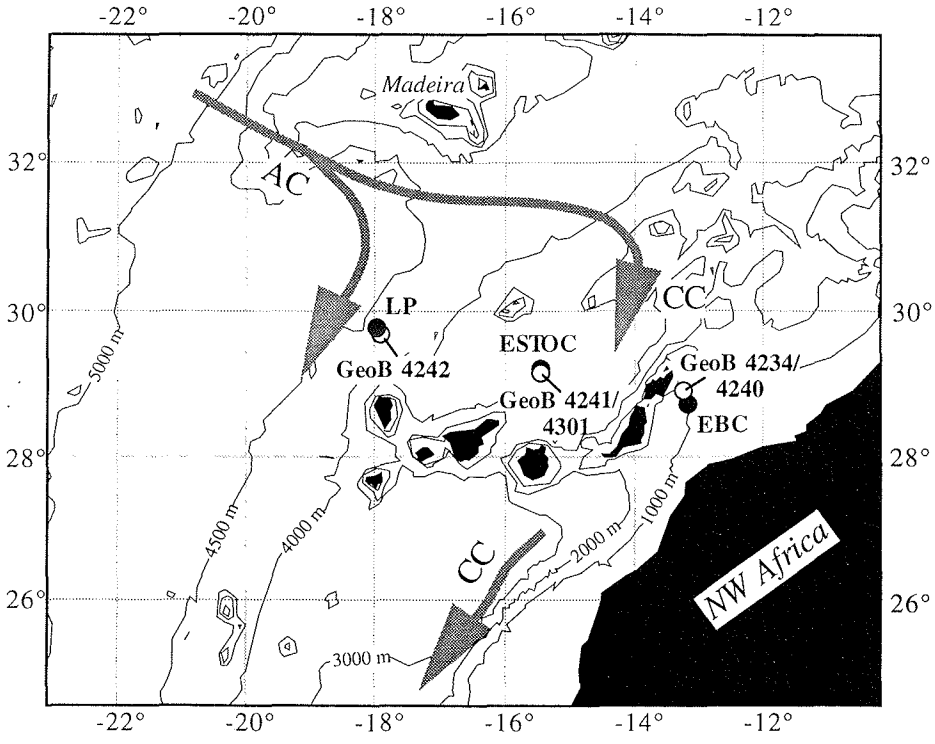

Fig. 1. Map of the Canary Islands region showing the large-scale oceanographic circulation pattern (AC = Azores Current; CC = Canary Current). The locations of the sediment trap arrays LP, ESTOC, and EBC (black circles) and the positions of the sediment samples (open circles) used in this study are indicated.

African coastal upwelling system, whereas the sites ESTOC (European Station for Time-series in the Ocean, Canary Islands) and LP (La Palma) are situated in the more oligotrophic, unaffected waters of the subtropical gyre (Fig. 1). In open ocean regimes, such as central oligotrophic gyres, new biological production within the photic zone is mainly controlled by the episodic supply of inorganic nutrients from subsurface waters to the euphotic layer (Marañón et al., 2000). For the Canary Islands region, Arístegui et al. (1997) described a strong annual rhythm in heating and wind forcing, causing a temporal change from seasonally induced thermocline breakdown after summer stratification during late autumn, or the reverse during spring, when vertical mixing weakens and waters become increasingly stratified towards summer. Figure 2a shows the annual cycle of monthly averaged sea-surface temperatures (SST) at the three mooring sites EBC, ESTOC, and LP during the sediment trap experiment in 1997. Maximum temperature gradient between the near-shore station EBC and the two oceanic sites occurred in August-September, as a result of the increased upwelling of cold subsurface waters along the coast during summer. Mean monthly surface pigment concentrations compiled from Coastal Zone Color Scanner (CZCS) data (Fig. 2b) reveal extremely low values (0.05 mg m^{-3}) at the two offshore sites LP and ESTOC for most of the year, pointing to generally low biological production. A slight enhancement at the end of winter indicates the main production period

during the late winter bloom of phytoplankton in surface waters (see also Davenport et al., 1999). Pigment concentrations at the near-shore station EBC show a higher seasonality with maximum values occurring also during winter, but an additional increase during the summer season which corresponds well with the period of high coastal upwelling activity (see also Barton et al., 1998).

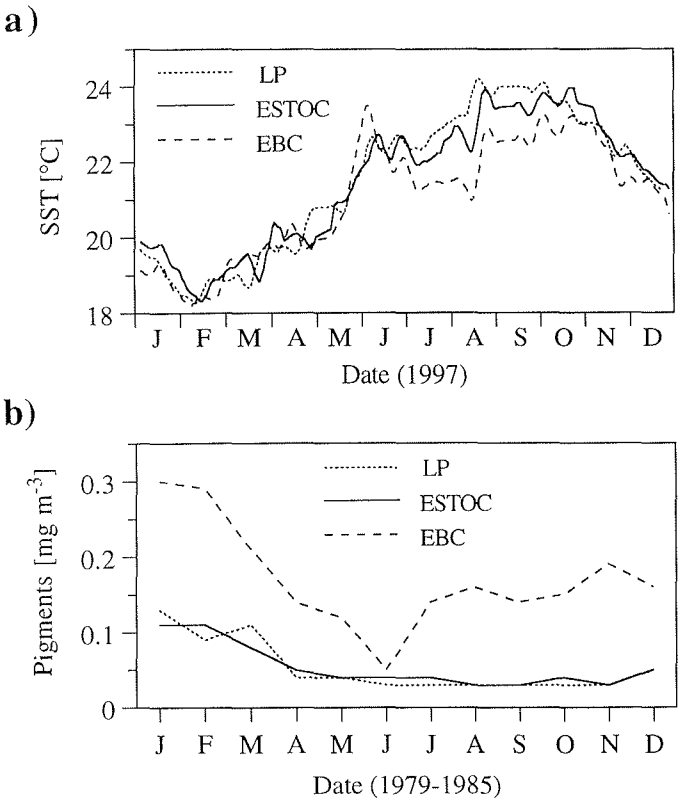

Fig. 2. Annual cycle of (a) sea-surface temperature (SST) for 1997, calculated from the Advanced Very High Resolution Radiometer (AVHRR) data archive, and (b) average monthly phytoplankton pigment concentration derived from Nimbus-7 Coastal Zone Color Scanner (CZCS) data base for the period 1979-1985 at the mooring locations LP, ESTOC, and EBC.

Previous investigations with sediment traps at the time-series station ESTOC north of Gran Canaria reported a close coupling between biological production within the euphotic zone and particle fluxes into the deep ocean in the Canary Islands region (Neuer et al., 1997; Davenport et al., 1999). A multi-year record of coccolithophore fluxes revealed a clear seasonality with recurrent late winter sedimentation events, occurring approximately one month after the winter bloom (Sprengel et al., 2000). Total particulate flux mainly consisted of carbonate and mineral particles, the latter indicative of a high aeolian input from the African desert region (Neuer et al., 1997; Ratmeyer et al., 1999). Additionally, it has been shown that a considerable fraction of deep particle flux in the northern Canary Basin originates by lateral advection (Neuer et al., 1997; Sprengel et al., 2000).

Table 1. Ground data of the sediment trap arrays along the E-W transect (upper part) and related surface sediment samples (lower part; Wefer et al., 1997; Freudenthal et al., subm.) used in this study.

	Mooring		
	LP1	CI7 (ESTOC)	EBC2-1
Position	29°45.73'N 17°57.26'W	29°11.0'N 15°27.0'W	28°42.49'N 13°09.34'W
Water depth (m)	4327	3610	996
Trap depths (m)	900 (LP1o) 3700 (LP1u)	750 (CI7m) 3000 (CI7u)	700
Collection period	06/01/97 - 15/09/97	23/12/96 - 15/09/97	02/01/97 - 29/09/97
No. of studied samples	36	38	19
Collection interval (days)	14	14	14
Station (GeoB no.)	4242-4 / 4242-5	4301-1 / 4241-11	4234-1 / 4240-2
Device	boxcore / gravity core	multicore / gravity core	multicore / gravity core
Position	29°40.9'N / 29°40.5'N 17°53.4'W / 17°53.3'W	29°09.0'N / 29°10.0'N 15°30.0'W / 15°27.1'W	28°53.4'N / 28°53.3'N 13°13.6'W / 13°13.5'W
Water depth (m)	4292 / 4286	3614 / 3609	1360 / 1358

3. Material and methods

3.1. Sediment trap samples

Within this study, a total of 93 samples from five time-series sediment traps were investigated. Cone-shaped, continuous-collecting particle traps of the Kiel type (Aquatec, aperture 0.5 m^2) were deployed at various water depths on three moored vertical arrays along an E-W transect north and east of the Canary Islands (Fig. 1, Table 1). Seafloor depths along the transect range from ~1000 m at the near-shore site EBC, to ~3600 m and 4300 m at the two oceanic sites ESTOC and LP (Table 1). All sediment traps were synchronized on a 14-day sampling interval. Prior to deployment, all sampling cups were filled with 1 ml mercury chloride in a 40‰ density gradient (Suprapur NaCl) to retard microbial activity. After recovery of the moorings, all samples were poisoned again with mercury chloride and stored at 4°C.

First sample processing was carried out by the marine geology group at Bremen University, including removing of zooplankton swimmers (>1 mm fraction), washing, and subsequent wet-splitting of the trap samples into equal fractions. The <1 mm size fraction was analysed according to Fischer and Wefer (1991). Total carbonate content was calculated as the difference between measured total carbon and organic carbon (CHN-analyser, Haereus), assuming that all inorganic carbon was represented by calcium carbonate (Freudenthal et al., subm.).

For coccolithophore analysis, aliquots of each trap sample (usually 1/125 of the <1 mm size fraction) were provided. The sample splits were first ultrasonicated (35 kHz) for 10 to 20 minutes to disintegrate small pellets and aggregates. Afterwards, all subsamples were wet split further by means of an electrical rotary sample divider (Fritsch, Laborette 27) using buffered water (pH 8-9) as split medium (modified after Andruleit, 1996; Sprengel et al., 2000). Studied aliquots ranged between 1/125 and 1/3750, depending on particle content of the original source material. The final sample splits were filtered onto polycarbonate membrane filters (Schleicher & Schuell™ 47 mm diameter, 0.45 µm pore size) using a low-pressure vacuum pump. Immediately after filtration, filters were rinsed carefully with buffered water (pH 8-9) to prevent crystallisation of salt. The filters were oven-dried at 40°C for at least 12 hours. For coccolith analysis with the scanning electron microscope (SEM), a randomly chosen small section of the dried filter (approx. 0.5 cm^2) was fixed on an aluminium stub and sputtered with gold/palladium. SEM examinations were carried out using a Zeiss DMS 940A at Bremen University. The numbers of coccoliths and coccospheres were counted on measured transects generally at a magnification of 3000 to 5000×, depending on particle density on the filter. Between 300 and 780 coccoliths were counted per sample. Identification followed the taxonomy of Jordan and Kleijne (1994) and Jordan and Green (1994). The taxonomic counts per sample were converted into daily fluxes of coccoliths per m^2. Fluxes (total and species specific) were calculated by extrapolating the counted specimens to the total sample and entire effective filtration area, collecting interval and trap aperture area using the following equation:

$$(1) \quad \text{Coccolith flux (no. of coccoliths } m^{-2}\ d^{-1}) = F \times C \times S / A \times D \times O$$

with F = effective filtration area (mm^2), C = number of coccoliths counted, S = split factor, A = investigated filter area (mm^2), D = sampling interval (days), and O = area of the trap aperture (m^2). Coccosphere fluxes were calculated using the same equation, with C = number of coccospheres counted.

3.2. Surface sediment samples

In order to compare present day coccolithophore export fluxes in sediment trap material with long term fluxes in underlying Holocene sediments, surface sediment samples underneath and in proximity of the three mooring sites were investigated (Fig. 1, Table 1). All sediment samples were recovered during R/V *Meteor* cruise 37 in winter 1996/97 (Wefer et al., 1997). Initial sample processing was carried out at the Geological Institute in Zürich (Switzerland).

For a detailed method description see Henderiks et al. (subm.).

Further sample processing for coccolithophore analysis was carried out according to Bollmann et al. (1999). Subsamples of the <38 µm fraction (fine fraction) were weighed and mixed with a weighed amount of polystyrene microbeads (as a tracer), put in suspension with denatured alcohol and sprayed on a cover glass. After drying, the cover glass was mounted on an aluminium stub and sputtered with gold prior to SEM examination. All coccolith analyses were conducted on a Hitachi S2300 SEM at ETHZ (Zürich). All coccoliths and added microbeads in a given field of view were counted with a magnification of 4000 and 6000×. From the ratio between counted and added microbeads, the number of coccoliths per weight dry sediment (no. coccoliths g^{-2}) could be calculated. Identification followed the taxonomy of Jordan and Kleijne (1994) and Perch-Nielsen (1985). Since sedimentation rates are available for the three sediment samples (Henderiks et al., subm.), coccoliths per weight unit were converted into coccolith accumulation rates using the formula:

$$(2) \quad AR_{cocco} = D_{cocco} \times LSR \times DBD$$

where AR_{cocco} = coccolith accumulation rate (no. of coccoliths cm^{-2} ka^{-1}), D_{cocco} = coccolith density (no. of coccoliths per gram sediment), LSR = linear sedimentation rate (cm ka^{-1}), and DBD = sediment dry bulk density (g cm^{-3}).
Average Holocene coccolith accumulation rates were calculated for the uppermost two samples at each site. Sedimentation rates of the Holocene sediments are based on oxygen isotope Age Models (SPECMAP time-scale). For a detailed description of the methods and sample processing see Henderiks et al. (subm.) and references therein.

3.3. Coccolith-carbonate calculations

Coccolith fluxes were converted into coccolith-carbonate fluxes on the basis of mean species specific estimates of coccolith masses (Sprengel et al., 2000). Since there is an extremely wide range of coccolith sizes between coccolithophore species and consequently a great variation in mass estimates (Young and Ziveri, 2000; Ziveri et al., 1999), separate carbonate masses for the most frequent species were used in this study.

Coccoliths from intact cells (coccospheres) were also included in the carbonate estimates, although coccospheres only occurred in very small numbers in all samples. Coccosphere fluxes were first converted into coccolith fluxes and then transformed into coccolith-carbonate mass fluxes. During the counting procedure, the number of coccoliths per coccosphere of different

species was estimated from SEM images. Total coccolith accumulation rates deriving from surface sediments were also converted into coccolith-carbonate accumulation using the same approach as for the sediment trap samples.

4. Results

4.1. Total coccolithophore fluxes in sediment traps

In all trap samples, coccolithophore fluxes (total and species specific) were dominated by single coccoliths. Intact coccospheres were very rare to absent and occurred mainly during times of maximum coccolith sedimentation. Thus, no reliable coccosphere fluxes per species could be calculated and only the total coccosphere flux, besides the coccolith flux, is presented within this study. Both coccospheres and free coccoliths were mostly well preserved in all samples. Even in the deeper part of the water column, species normally affected by corrosion showed no significant signs of dissolution (e.g., etching). However, fragmented or disintegrated coccoliths, which are the result of mechanical breakage, also contributed to a minor extent to the overall coccolithophore flux. Fragmented coccoliths smaller than a half of a specimen were not included in the counts and hence flux calculations.

Total coccolith fluxes (= flux of free coccoliths) showed a clear seasonality at all three mooring sites along the studied transect with marked peaks in spring (Fig. 3, upper graphs). At the upper trap level (700-900 m water depth), maximum coccolith flux values were simultaneously recorded at all stations at the beginning of February 1997. At the start of the mooring period in January 1997, coccolith fluxes showed a clear E–W gradient from 19.3 × 10^8 coccoliths m^{-2} d^{-1} (EBC) to 9.7 × 10^8 (ESTOC) and 2.7 × 10^8 coccoliths m^{-2} d^{-1} (LP), respectively. Coccolith fluxes then rapidly increased and declined within a short time interval of 14 days (= sample 4) at ESTOC and EBC. At the westernmost station LP total coccolith fluxes also rapidly increased in February, but then gradually decreased after the maximum value towards the end of March 1997. Coccolith fluxes remained low at ESTOC and LP until the end of the sampling period in September 1997 (0.5-8 and 0.1-4 × 10^8 coccoliths m^{-2} d^{-1}, respectively). At the easternmost station EBC another signal with moderate coccolith flux values in May and June/July 1997 (up to 18 × 10^8 coccoliths m^{-2} d^{-1}) could be observed. While total coccolith flux rates at the two oceanic sites LP and ESTOC were comparable over the entire experiment (up to 41 and 47 × 10^8 coccoliths m^{-2} d^{-1}, respectively), fluxes were significantly higher at the near-shore site EBC (up to 73 × 10^8 coccoliths m^{-2} d^{-1}). Mean daily coccolith fluxes over the mooring period were 6.4 × 10^8 (LP), 5.4 × 10^8 (ESTOC), and 13.7 × 10^8 coccoliths

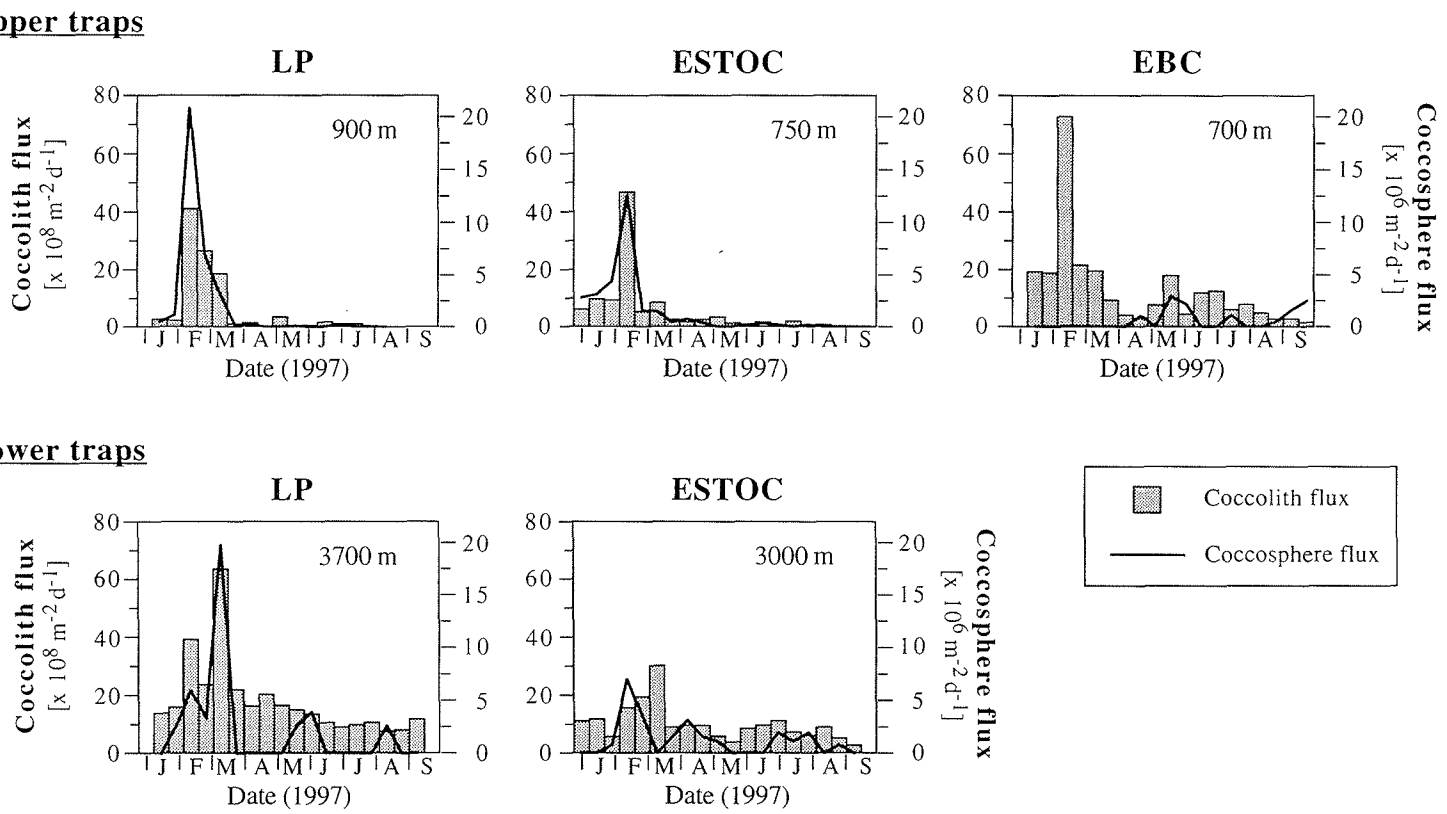

Fig. 3. Seasonal variability of the total coccolith (bars) and coccosphere (line) fluxes in different water depths (upper traps, lower traps) at the three mooring sites along the 29°N transect. Note the different scales for coccolith and coccosphere fluxes.

m^{-2} (EBC). Total coccosphere fluxes in the upper traps were constantly low during most of the investigated time interval and showed only higher values in February (LP, ESTOC) and in May/September (EBC) (Fig. 3, upper graphs).

At the deeper trap level (3000 and 3700 m), the sedimentation pattern appeared similar to the trend observed in the upper traps (Fig. 3, lower graphs). Maximum coccolith fluxes were also reached during spring, approximately one month after the main flux signal in the shallower traps. At the LP mooring site, mean coccolith flux at 3700 m was 18.2×10^8 coccoliths m^{-2} d^{-1}, showing an increase with respect to the 900 m trap by a factor three. Coccolith flux values ranged from 64×10^8 coccoliths m^{-2} d^{-1} (March 1997) to 8×10^8 coccoliths m^{-2} d^{-1} (August 1997). At ESTOC, mean coccolith flux also increased with depth (from 5 to 10×10^8 coccoliths m^{-2} d^{-1}), but the amplitude of seasonal fluctuations was significantly lower at the deeper trap level. Total coccosphere fluxes were also very low in the deeper traps, except of higher values in February 1997, and did not show a clear seasonal trend.

4.2. Species fluxes and settling assemblages

The taxonomic composition of the highly diverse coccolithophore assemblages was quite similar in all investigated trap samples from the three mooring sites. In total, 57 heterococcolithophore and 8 holococcolithophore species have been identified, dominated by only a few taxa throughout the studied period. All species are listed in Abrantes et al. (subm.). Most of the species exhibited comparable seasonal flux patterns as shown in Fig. 4 and 5 for selected taxa.

At the upper trap level (700-900 m), absolute species coccolith fluxes showed highest values at the near-shore site EBC (Fig. 4), inferred by the total coccolith fluxes described above (see Fig. 3). The dominant species at all stations were *Emiliania huxleyi* (mean 29.4-39.8%) and *Florisphaera profunda* (mean 22.2-29.1%) which showed opposing seasonal fluctuations in relative abundance. During times of flux maxima in spring 1997, *E. huxleyi* was found with abundances of 40-55% and *F. profunda* with abundances of 9-18% of the total assemblage. After the flux peaks in February, relative abundance of *F. profunda* increased while *E. huxleyi* showed slightly decreasing values. At the two oceanic sites LP and ESTOC *Gephyrocapsa ericsonii* (mean 7.2 and 8.1%, respectively) and *Algirosphaera* spp. (mean 4.3 and 8.3%, respectively) also contributed significantly to the community (Fig. 4). At the easternmost station EBC the third most abundant species *G. ericsonii* contributed on average 13.2% to the total assemblage, followed by *Algirosphaera* spp. (3.3%) and *Gephyrocapsa oceanica* (3.5%). All other species generally occurred with abundances of <3% or showed only sporadically higher

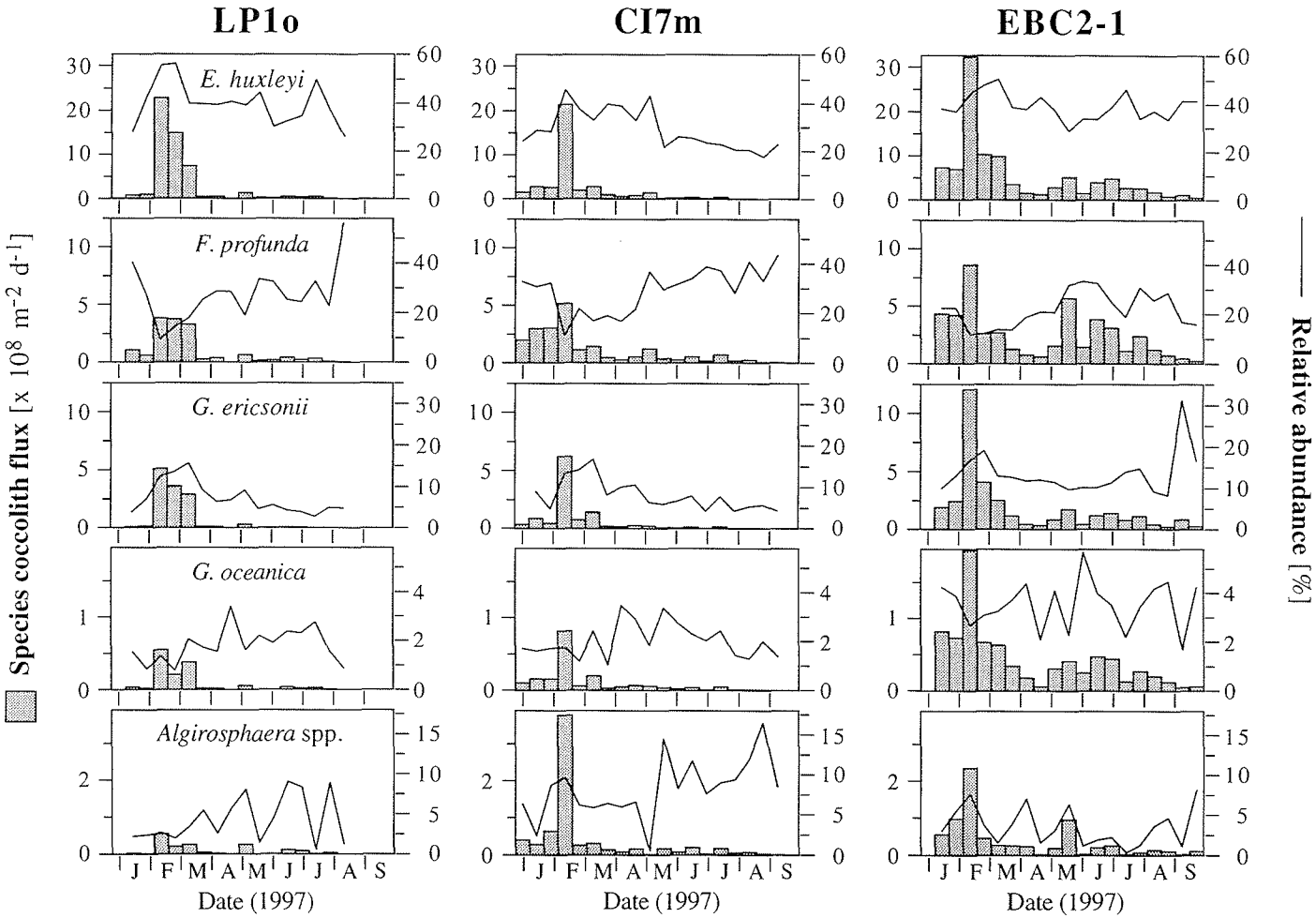

Fig. 4. Seasonal variations of species coccolith fluxes (bars) and relative abundances (line) of selected taxa in upper sediment trap samples of the moorings LP1o (900 m), CI7m (= ESTOC, 750 m), and EBC2-1 (700 m).

values.

At the deeper trap level, coccolith fluxes were also clearly dominated by *E. huxleyi* (mean 31.5-34.1%), followed by *F. profunda* (mean 24.7-26.1%), *G. ericsonii* (mean 5.6-8.1%), and *Algirosphaera* spp. (mean 6.6%) (Fig. 5). Fluxes of these species all displayed similar seasonal flux pattern with marked peaks in March 1997. Only little variation was observed in species composition of the coccolith assemblages at the different trap depths. Seasonal fluctuations in relative abundances of dominant and subordinate species in the deeper traps were lower than in the upper sediment traps.

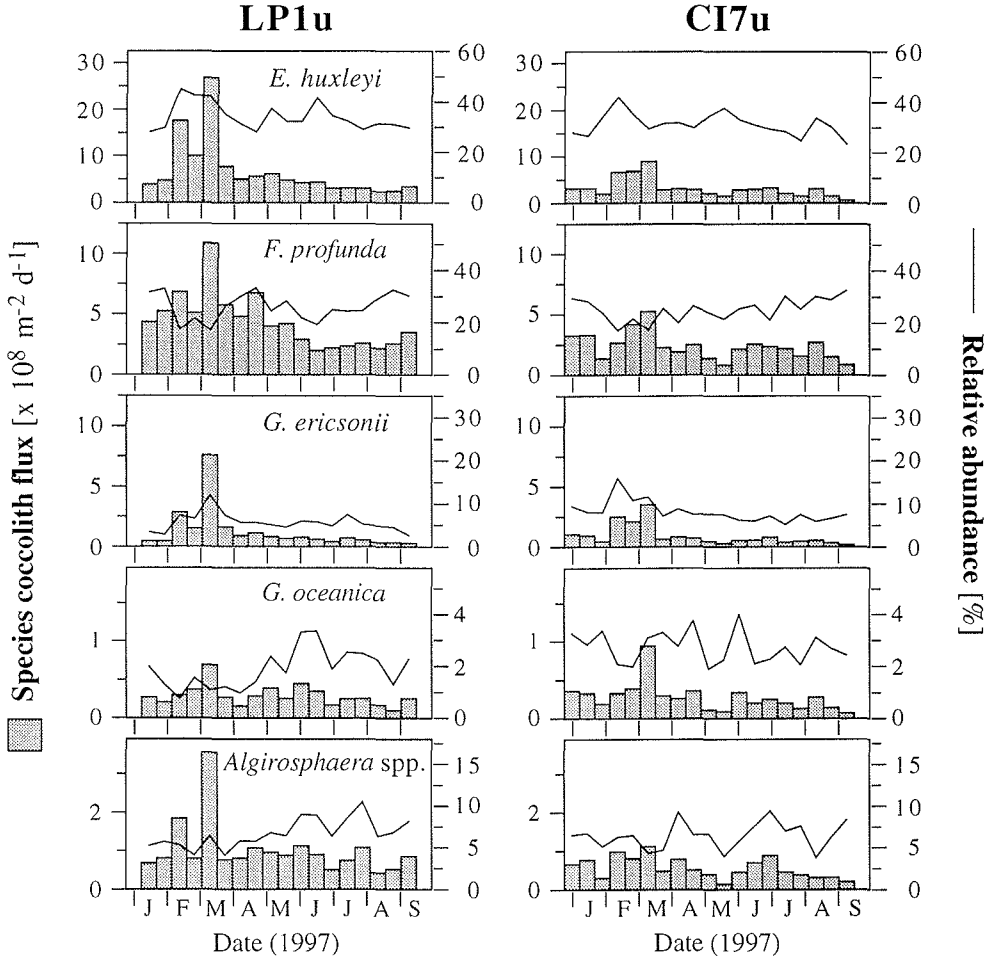

Fig. 5. Seasonal variations of species coccolith fluxes (bars) and relative abundances (line) of selected taxa in lower sediment trap samples of the moorings LP1u (3700 m) and CI7u (= ESTOC, 3000 m).

4.3. Coccolith-carbonate flux estimates and contribution to total biogenic carbonate flux

Coccolith-carbonate fluxes were calculated for all trap samples on the basis of mean species-specific carbonate estimates (Young and Ziveri, 2000; Sprengel et al., 2000) and compared to

the total measured carbonate fluxes (Fig. 6). Total coccolith-carbonate fluxes at the upper trap depths varied significantly over the studied period with highest values of 24.9 mg m^{-2} d^{-1} (LP), 23.8 mg m^{-2} d^{-1} (ESTOC), and 39.4 mg m^{-2} d^{-1} (EBC) occurring during the main sedimentation phase of coccoliths in February 1997 (Fig. 6, upper graphs). A strong gradient between the near-shore location and the two oceanic sites was clearly expressed in the mean daily coccolith-carbonate fluxes which ranged from 7.9 mg m^{-2} at EBC to 3.3 and 3.6 mg m^{-2}, respectively, at ESTOC and LP. The mean contribution of coccolithophores to the total carbonate flux in the upper traps throughout the entire experiment was 32.8% (EBC, range 15-44%), 27.8% (ESTOC, range 8-96%), and 29.5% (LP, range 6-69%).

Coccolith-carbonate fluxes strongly increased with depth at the two off-shore stations (Fig. 6, lower graphs). At ESTOC mean daily coccolith-carbonate flux recorded in the deep particle trap was 7.3 mg m^{-2}, more than twice the flux observed in the upper one. At the westernmost station LP mean coccolith-carbonate flux at 3700 m water depth (13.3 mg m^{-2} d^{-1}) was even four times higher compared to the flux at 900 m. Coccolith carbonate contributed on average 44% (ESTOC, range 24-62%) and 63.4% (LP, range 48-94%) to the total carbonate flux at the deeper trap level.

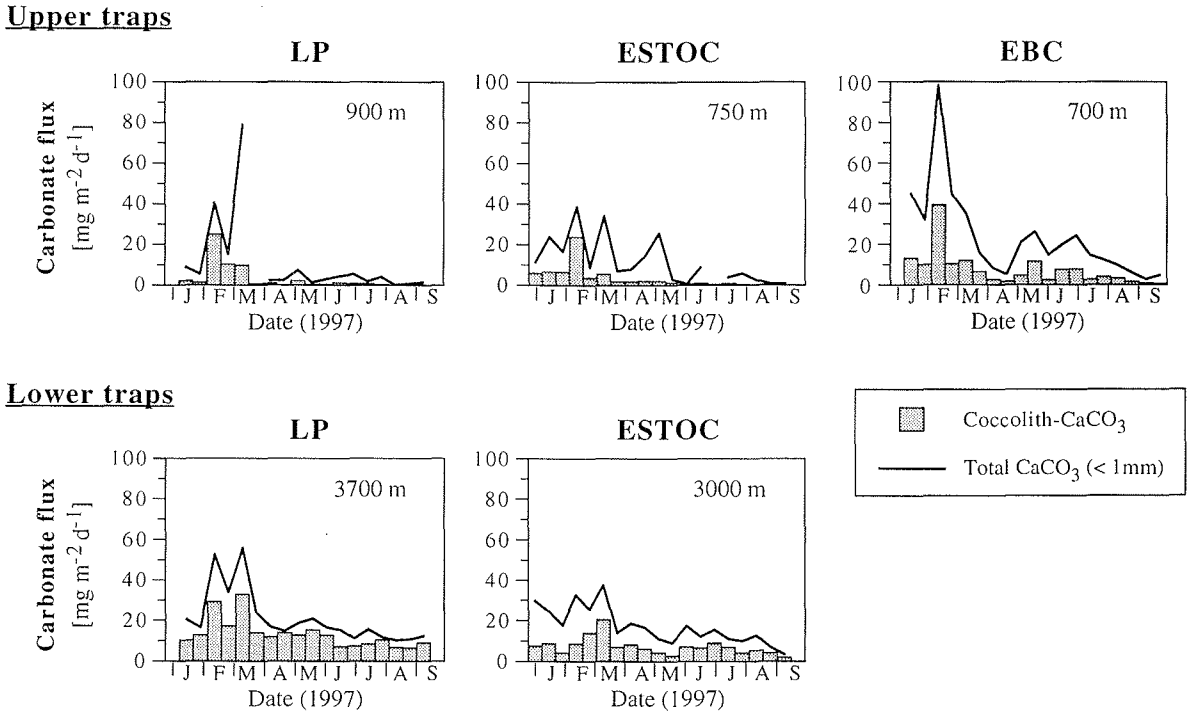

Fig. 6. Seasonal variability of measured total carbonate fluxes of the <1 mm fraction (line) and computed coccolith-carbonate fluxes (bars) in mg m^{-2} d^{-1} at the three mooring sites along the studied transect. Gaps within the line indicate "no data available".

Computed coccolith-carbonate fluxes closely followed total carbonate flux variations at EBC ($r^2 = 0.94$) and in the deep traps at ESTOC and LP ($r^2 = 0.72$ and $r^2 = 0.93$, respectively) pointing to a significant input of coccolithophores to the total biogenic carbonate and generally similar transport mechanisms for the bulk carbonate fraction (Fig. 7). Correlation was lower in the upper traps at ESTOC and LP ($r^2 = 0.61$ and $r^2 = 0.46$, respectively) most probably due to high input of other carbonate particles such as foraminifera tests or detrital carbonate (H. Meggers, University of Bremen, pers. comm. 1999).

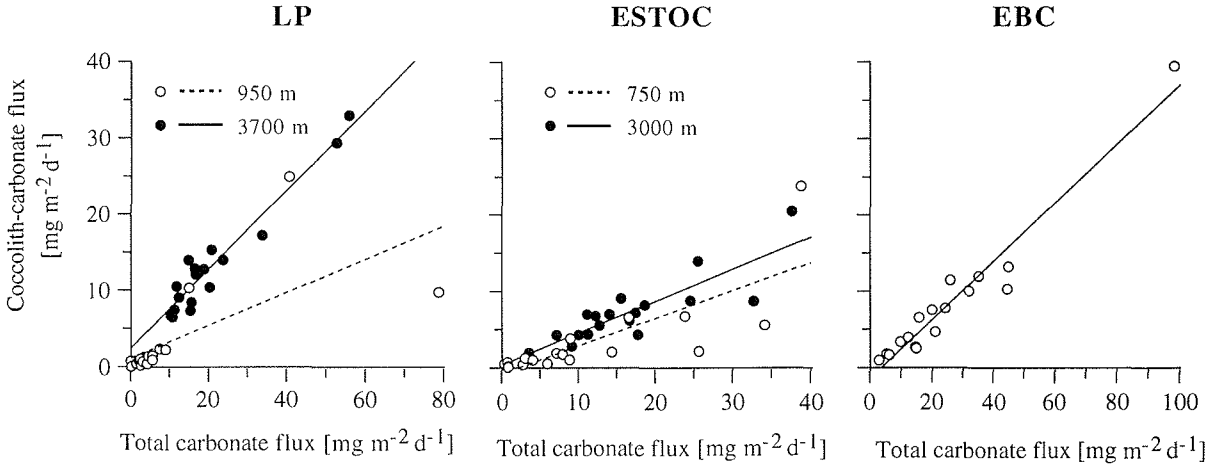

Fig. 7. Linear regressions of coccolith-carbonate vs. total carbonate fluxes in different water depths at each mooring site. Correlation coefficients are for LP: r^2 (950 m) = 0.46 and r^2 (3700 m) = 0.93, for ESTOC: r^2 (750 m) = 0.61 and r^2 (3000 m) = 0.72, and for EBC: r^2 (700 m) = 0.94.

4.4. Coccolith and coccolith-carbonate accumulation rates

Average coccolith accumulation rates calculated from Holocene surface samples in proximity of the sediment trap arrays revealed a strong E-W gradient from 75.2×10^9 coccoliths cm^{-2} ka^{-1} at the near-coast station EBC to 42.4 and 41.8×10^9 coccoliths cm^{-2} ka^{-1} at the oligotrophic sites ESTOC and LP. The same trend was detected within the computed coccolith-carbonate accumulation rate which was highest at EBC (0.78 g cm^{-2} ka^{-1}), decreasing towards ESTOC (0.47 g cm^{-2} ka^{-1}) and LP (0.44 g cm^{-2} ka^{-1}). Coccolith species composition in Holocene sediments and long-term changes within the geological record will be discussed elsewhere (Henderiks, in prep.).

5. Discussion

5.1. Coccolithophore flux variability in comparison with surface water processes

It is well established from various comprehensive time-series sediment trap studies, which have reported seasonally variable coccolithophore fluxes, that coccolithophore export production from the photic zone often exhibits a distinct seasonal cyclicity (e.g., Steinmetz, 1991; Ziveri et al., 1995b; Andruleit, 1997; Broerse et al., 2000; Sprengel et al., 2000). It has been shown that the production and sedimentation of biogenic particles in the ocean are strongly coupled and therefore seasonal flux patterns of biogenic material within the water column usually reflect biological production cycles in the surface waters (Deuser et al., 1981; Honjo, 1982; Steinmetz, 1994). Additionally, variations in the magnitude of biogenic particle fluxes reported from different oceanic sites can be related to different productivity conditions or large-scale surface water biogeochemical provinces (Jickells et al., 1996 and references therein).

Seasonal fluctuations of coccolith fluxes reported within this study can generally be regarded as a reflection of seasonal coccolithophore production changes in surface waters of the studied region. In this part of the oligotrophic subtropical North Atlantic gyre, the annual production cycle is strongly controlled by distinct atmospheric and hydrographic features regulating the supply of inorganic nutrients to the upper euphotic layer and hence new biological production. During most time of the year open oceanic surface waters in the Canary Islands region are nutrient-depleted, resulting in low primary production rates and phytoplankton biomass (Barton et al., 1998). Consequently, the main production period is relatively short, revealing a strongly defined phytoplankton seasonality. Coccolith fluxes in all traps along the studied transect showed a pronounced seasonality with marked sedimentation events in February 1997 and relatively low flux values during the rest of the studied period. By comparing these flux patterns with CZCS data and reported near-surface chlorophyll concentrations in surface waters (Fig. 2, this study; Barton et al., 1998; Davenport et al., 1999), we conclude that the flux peaks in spring are related to the winter phytoplankton „bloom“ in the region. The present findings are in good accordance with the coccolithophore flux pattern described in Sprengel et al. (2000). A multi-year sediment trap study at ESTOC from 1993-1996 also revealed recurrent coccolith flux peaks during spring each year, approximately one month after maximum pigment concentration could be observed in surface waters of the studied region.

The difference in the magnitude of coccolith fluxes between the upper traps of the two oceanic sites (ESTOC, LP) and the near-shore station EBC indicates variation in surface productivity. At the upwelling influenced EBC total coccolith fluxes were about two times

higher compared to the oligotrophic stations LP and ESTOC. This is also apparent in total biogenic mass fluxes (carbonate, total organic carbon) reported by Freudenthal et al. (subm.). In addition to the sedimentation maximum related to the winter bloom signal, coccolith fluxes at EBC are slightly increased during the summer months. Even though the near-coast site is not directly located in the primary upwelling zone, surface waters are frequently influenced by offshore flowing chlorophyll and nutrient-rich filaments originating west of the Islands along the NW African coast (Barton et al., 1998; Davenport et al., 1999; Johnson and Stevens, 2000) and filaments resulting from upwelling off the north-west coast of the island Fuerteventura (Davenport et al., 1999 and references therein). The filaments at the African coast mainly arise during times of maximum upwelling intensity in late summer and thus observed elevated coccolith fluxes at EBC in summer 1997 could be the result of enhanced biological productivity associated with these common offshore phenomena. This is also corroborated by CZCS pigment data shown in figure 2. Higher pigment concentrations at EBC during summer could be the result of both advective transport of phytoplankton biomass from the primary coastal upwelling regime and *in situ* growth of phytoplankton in nutrient-enriched offshore waters.

Mean daily coccolith fluxes in the shallow traps over the mooring period ranged from 6.4 and 5.4 $\times$ 10^8 coccoliths m^{-2}, respectively, at LP and ESTOC to 13.7 $\times$ 10^8 coccoliths m^{-2} at EBC. Sediment trap studies at the subtropical North Atlantic station NABE-34 at 34°N 21°W (Broerse et al., 2000) showed a comparable seasonal coccolithophore flux pattern with marked sedimentation events during late winter/early spring and average flux values of 11.2 $\times$ 10^8 coccoliths m^{-2} d^{-1} at 1000 m water depth. The two times higher coccolith flux observed at NABE-34 (compared to the fairly similar oligotrophic sites LP and ESTOC) could be the result of locally enhanced productivity associated with the nearby frontal region of the Azores Current, interannual variability and/or different trap efficiencies as discussed in Scholten et al. (2000). Similar coccolith fluxes were recorded at the station Bermuda (31°N 64°W) in the western subtropical North Atlantic (14 $\times$ 10^8 coccoliths m^{-2} d^{-1}; Haidar et al., 2000).

5.2. Flux variations within the water column

Total coccolith and carbonate fluxes at LP and ESTOC showed a significant increase towards the deeper traps over the entire experiment. The general seasonal flux pattern with marked sedimentation events during spring did not change essentially with depth, albeit the pattern became less pronounced at ESTOC. Coccolith flux maxima in the deep traps occurred with a time lag of approximately two sampling intervals (= 28 days) compared to the shallow traps.

Steinmetz (1994) described several possible mechanisms affecting flux measurements within the water column. Increasing coccolith flux values at depth observed within this study may result from lateral advective transport of additional material to the mooring sites or from different trapping efficiencies of the shallow and deep traps. Trapping efficiencies are mainly influenced by the speed of ocean currents in the vicinity of the particle traps. As previously discussed in Neuer et al. (1997), no significant hydrodynamic biases were assumed for the ESTOC site due to the low current velocities of 10 to max. 15 cm s^{-1} at the different trap depths. According to Baker et al. (1988), trapping efficiencies are considered to be nearly 100% within this range of current speeds. Scholten et al. (2000) estimated the relative trapping efficiency at ESTOC using the ^{230}Th calibration method and revealed a slightly higher value for the deep particle trap. However, despite the higher efficiency of the deeper trap, corrected particle fluxes showed an enormous increase with depth pointing to an additional allochthonous particle source (Scholten et al., 2000). Further evidence for lateral particle input affecting the deep sediment traps at ESTOC and LP is described by Freudenthal et al. (subm.). The authors observed degradation of organic matter within the investigated trap samples, shown by in increase of the total organic carbon/total nitrogen ratio with depth, but simultaneously relatively constant or even increasing organic carbon fluxes between the shallow and deep traps. For the ESTOC station, lateral advection of particles from a higher productive site closer to the NW African shelf was previously assumed to explain the remarkable increase of coccolith fluxes with depth (Sprengel et al., 2000). During the foregoing mooring period in 1996, total coccolith fluxes at 3000 m water depth were also about two times the flux observed at the upper trap level. Considering a mean south-westward geostrophic flow of the Canary Current (Stramma and Siedler, 1988) and associated features like cyclonic eddies and meanders as reported from a fine resolution model of Johnson and Stevens (2000), we suggest that surface waters located to the north-east of the mooring stations ESTOC and LP are the most probable source location of particles intercepted with the different traps. Near Cape Ghir (approx. 31°N), a recurrent, quasi-permanent large upwelling filament often extends up to 400 km off the NW African coast (Davenport, 1999; Barton, 1998; Nykjaer, 1988). By comparing the seasonal activity of the filament as revealed from CZCS data and ESTOC sediment trap flux data, Davenport et al. (1999) considered this structure a possible source of advected material to the mooring location.

Nevertheless, while discussing likely sources of laterally advected particles to the mooring sites LP and ESTOC, it has to be considered that sediment traps possibly sample material of a large area, the so-called "statistical funnel" above a trap (Deuser et al., 1990). The extension and shape of this area depends on the spatial and temporal oceanic flow field in the vicinity of

the trap, the time and duration of the collection period, and the sinking characteristics of the particles itself (Siegel and Deuser, 1997). Due to these highly variable parameters, sediment traps moored at different depths and/or different locations may sample material from different source regions (Siegel and Deuser, 1997). This may explain the differences in coccolith flux rates observed at LP and ESTOC at the different trap depths. While coccolith fluxes recorded in the upper two traps were fairly similar, flux values in the deep LP trap (3700 m) were significantly higher than the fluxes observed in the deep ESTOC trap (3000 m). Advection of particles from higher productive shelf waters from a relatively large distance to the mooring sites may be supported by a high number of juvenile planktonic foraminifera observed in the deep LP trap (H. Meggers, University of Bremen, pers. comm. 2000), which are often abundant in surface waters of shallow nutrient-rich areas (Hemleben et al., 1989).

5.3. Variations in coccolith settling assemblages along the transect

The coccolith assemblage composition in all investigated sediment trap samples from the three mooring sites was quite similar throughout the entire experiment. Only a few taxa dominated the highly diverse subtropical assemblage over the mooring period, together accounting for about 60-80% of the total community. The species richness was comparable at all trap stations along the transect (Abrantes et al., subm.). Seasonal fluctuations of subordinate species were closely related to the opposing seasonal succession of the most dominant taxa *E. huxleyi* and *F. profunda* (Fig. 4, 5). Highest relative abundances of the deep photic zone species *F. profunda* were recorded during summer and late winter coinciding with lowest abundances of *E. huxleyi*. Increasing proportions of *F. profunda* are presumed to be related to progressive nutrient depletion of the upper photic zone during summer and autumn, while nutrients are still available in the lower part of the euphotic zone (Veldhuis et al., 1993). The present findings are in good accordance with the long-term record of coccolithophore fluxes at the ESTOC station (Sprengel et al., 2000). A comparable seasonal dominance shift of both species has been previously reported from the eastern subtropical NE Atlantic station NABE-34 (Broerse et al., 2000), from the station Bermuda in the subtropical NW Atlantic (Haidar et al., 2000), and from the NW Pacific (Okada, 1994).

Despite the good correspondence between the assemblage compositions at all mooring stations along the studied transect, some trends towards the near-shore site EBC could be observed (Fig. 8). Coccoliths of *G. ericsonii*, *G. oceanica*, and to a lesser extant of *Gephyrocapsa muellerae* (not figured) all displayed highest relative abundances at the easternmost station EBC.

G. ericsonii showed a significant increase from 7% (LP) to 13% (EBC) of the total assemblage. A similar trend was observed in plankton samples of the studied transect, with highest cell densities of *G. ericsonii* occurring at EBC during winter and summer (J. Bollmann, ETH Zürich, pers. comm. 1999). *G. ericsonii* has not yet been studied in detail, but a preference of this species for near-coastal currents with high nutrient contents was previously reported from Winter et al. (1979) in the Gulf of Elat. *G. oceanica* has been interpreted to prefer waters of high fertility and neritic environments (Mitchell-Innes and Winter, 1987; Fincham and Winter, 1989) and has been reported to bloom in upwelling waters of low latitudes (Kleijne et al., 1989). *G. muellerae* is not or only rarely recorded in the studied trap samples at the oligotrophic sites LP and ESTOC (mainly <1%), but occurred with relative abundances of 1-3% at EBC. Jordan (1988) reported a dominance of *G. muellerae* in plankton assemblages north of the Azores Front (32-36°N), but very low numbers south of it. Our results suggests that all *Gephyrocapsa* species, especially *G. ericsonii*, respond positively to higher productivity conditions at the upwelling influenced EBC.

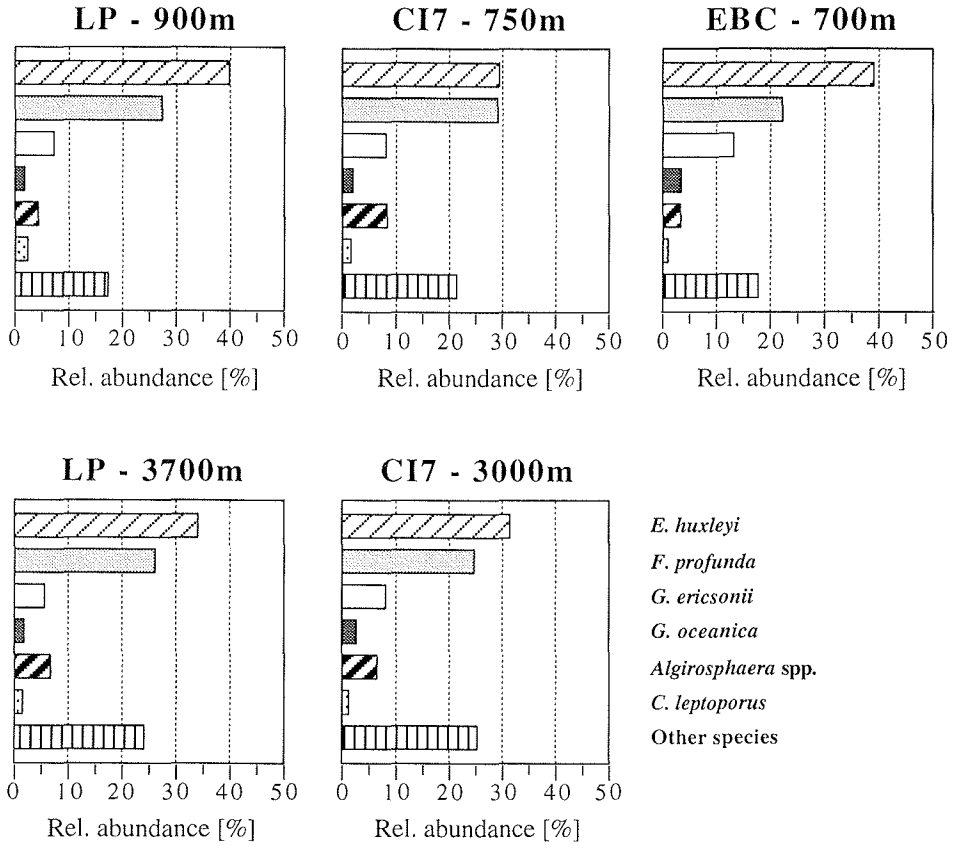

Fig. 8. Contribution (%) of selected species to the coccolith settling assemblages along the studied transect over the entire sediment trap experiment from January to September 1997.

Coccoliths of *F. profunda* showed lowest mean relative abundance of 22% at the easternmost station EBC, compared to 27% (LP) and 29% (ESTOC) at the two oligotrophic sites. *F. profunda* lives almost exclusively within the lower euphotic zone in primarily subtropical and tropical waters (Okada and Honjo, 1973; Okada and McIntyre, 1979). As stated above, highest relative abundances of this species within the seasonal production cycle are related to periods of stable conditions in terms of water column stratification, when surface waters are usually nutrient-depleted and the production of shallow living coccolithophores is reduced (see also Broerse, 2000). Highest absolute coccolith frequencies of *F. profunda* in upper sediment trap samples were recorded at EBC during spring and summer (Fig. 4), which indicates a positive response to nutrient-enrichment at this site. Despite this affinity to higher nutrient conditions, observed increasing relative abundances of *F. profunda* towards the western stations ESTOC and LP point to a preference for the more stable subtropical gyre conditions at the two oligotrophic sites.

Calcidiscus leptoporus generally contributed < 3% to the total coccolith assemblage within this study. *C. leptoporus* has a wide biogeographic distribution in the modern oceans, but only rarely occurrs in the north-west African upwelling environment (Blasco et al., 1980). The distribution pattern of *C. leptoporus* coccoliths in surface sediments from the SW African continental margin reported by Giraudeau (1992) show a progressive increase in abundance offshore of the main upwelling areas, which has been interpreted as an optimal growth of this species within oligotrophic conditions. Our results are in good accordance with the findings of Giraudeau (1992), since *C. leptoporus* slightly increases in relative abundances in offshore direction towards the westernmost mooring station LP. A similar trend was observed in Holocene sediments with slightly increasing abundances of *C. leptoporus* coccoliths further offshore (Henderiks, unpubl. data).

5.4. Coccolith-carbonate supply within the water column

Estimated annual coccolith-carbonate fluxes along the studied transect were 2.8 g m^{-2} (EBC) and 1.2-1.3 g m^{-2} (ESTOC, LP) in the shallow traps, representing 31-33% of the total annual carbonate flux. Coccolith-carbonate fluxes recorded in the deep traps at LP and ESTOC were 4.9 and 2.7 g m^{-2} a^{-1}, respectively, with a contribution of 63% and 44% to the total carbonate flux. Summed coccolith-carbonate fluxes per season of the 1997 mooring period (Table 2) closely reflect the seasonal flux pattern of coccoliths described in chapter 4.1 (Fig. 3). At the two oligotrophic sites LP and ESTOC, the bulk of carbonate formed by coccoliths in the upper

Table 2. Summed coccolith-carbonate fluxes (in g m^{-2}; calculated), percentage of total coccolith-carbonate over the entire experiment, and contribution of coccolith-carbonate to the total carbonate flux per season of the studied mooring period. Winter: 06/01/97-16/03/97 (= 70 days), Spring: 17/03/97-22/06/97 (= 98 days), Summer: 23/06/97-14/09/97 (= 84 days).

Season		Station				
		EBC	CI (ESTOC)		LP	
		700 m	750 m	3000 m	900 m	3700 m
Winter	Coccolith-$CaCO_3$ flux	1.19	0.65	0.79	0.68	1.44
	% of total coccolith-$CaCO_3$	59.5	77.4	43.2	85.0	42.9
	% of total $CaCO_3$	33.4	38.1	40.7	32.8	57.3
Spring	Coccolith-$CaCO_3$ flux	0.52	0.15	0.59	0.09	1.24
	% of total coccolith-$CaCO_3$	26.0	17.9	32.2	11.3	36.9
	% of total $CaCO_3$	33.6	16.0	42.8	27.6	69.6
Summer	Coccolith-$CaCO_3$ flux	0.29	0.04	0.45	0.03	0.68
	% of total coccolith-$CaCO_3$	14.5	4.8	25.6	3.8	20.2
	% of total $CaCO_3$	29.3	18.1	53.4	14.6	67.6

trap samples sedimented over a relatively short time period of 70 days in winter, representing 85% (LP) and 77% (ESTOC) of the total coccolith calcite recorded during the entire experiment. Coccolith-carbonate supply was strongly reduced during spring and summer at both stations. At the upwelling influenced EBC, the differences in coccolith-carbonate fluxes per season were not as high as at the western stations. About 60% of the total coccolith-carbonate export was observed during winter and still 26% and 14%, respectively, during spring and summer 1997. Seasonal coccolith-carbonate fluxes at the deeper trap level showed the same trend as observed in the upper traps, but relatively high values throughout all seasons indicating high lateral input of coccolith-rich material within the deeper part of the water column. The present findings provide further evidence for the episodic nature of coccolith- and hence coccolith-carbonate sedimentation within a short time interval. In regions with relatively low biological production and a strongly defined phytoplankton seasonality, such as subtropical oligotrophic gyres, coccoliths are important carbonate producers for only a limited time of the year (see also discussion above). However, despite their low carbonate masses coccoliths still accounted for about 32% of the total carbonate export within the present study. This is in good accordance with results from the subtropical station NABE-34, where coccoliths contributed 29% to the total annual carbonate flux (Broerse, 2000). Nevertheless, coccolith-carbonate flux calculations can only provide an estimate for the real value due to substantial errors in coccolith volume calculations of around 40-50% (Young and Ziveri, 2000). In addition, errors due to incomplete

breakdown of pellets and aggregates, which often contains large numbers of coccoliths (e.g. Beaufort and Heussner, 1999; Knappertsbusch and Brummer, 1995), as well as exclusion of coccolith fragments from the counts will rather underestimate the coccolith-carbonate fluxes in this study (see also Broerse et al., 2000).

5.5. Export production versus Holocene accumulation rates

A compilation of present day coccolith and coccolith-carbonate fluxes recorded in sediment traps along the 29°N transect and their accumulation rates in Holocene surface sediments at the three mooring sites is presented in Figure 9 and Table 3. For better comparability, coccolith fluxes derived from the nine months lasting trap experiment in 1997 were extrapolated to one year and, accordingly, coccolith accumulation rates were calculated as numbers of coccoliths m^{-2} a^{-1}. For the ESTOC site, results from the previous mooring period in 1996 are also shown (Sprengel et al., 2000). As already discussed above, absolute coccolith frequencies were highly variable along the studied transect and within the water column, pointing to a relative complex interaction of various hydrological and biological mechanisms controlling the production, sedimentation and accumulation of biogenic particles in the studied region. However, despite the slight discrepancies between the present day observations and the estimates of long term geological records, a relatively consistent picture can be drawn from this case study.

The two oligotrophic stations LP and ESTOC closely resemble each other in terms of coccolith and coccolith-carbonate accumulation rates, although the export production was highly variable throughout the trap experiment. In general, coccolith fluxes recorded in the upper traps at both sites are too low to sufficiently explain the coccolith accumulation in the underlying sediments (Fig. 9a). Only due to additional lateral input, sedimentation of coccoliths in the deeper ESTOC trap was significantly increased and thereby broadly reflects the coccolith accumulation rates below. A comparison of two successive moorings in 1996 and 1997 shows the interannual variability of export production and the varying influence of horizontal advection affecting the deeper part of the water column. At the easternmost site LP, the annual coccolith flux at 3700 m water depth was about three times higher than fluxes at 900 m, and still clearly higher than the coccolith accumulation rate in the surface sediment. This discrepancy between the deep particle trap and the surface sediment may be explained by interannual variability in export production and lateral input of additional material, or overall enhanced dissolution of coccoliths at the sediment-water interface and in the sediment. From the observations presented within this study, it can be concluded that the magnitude of laterally advected material is closely related to

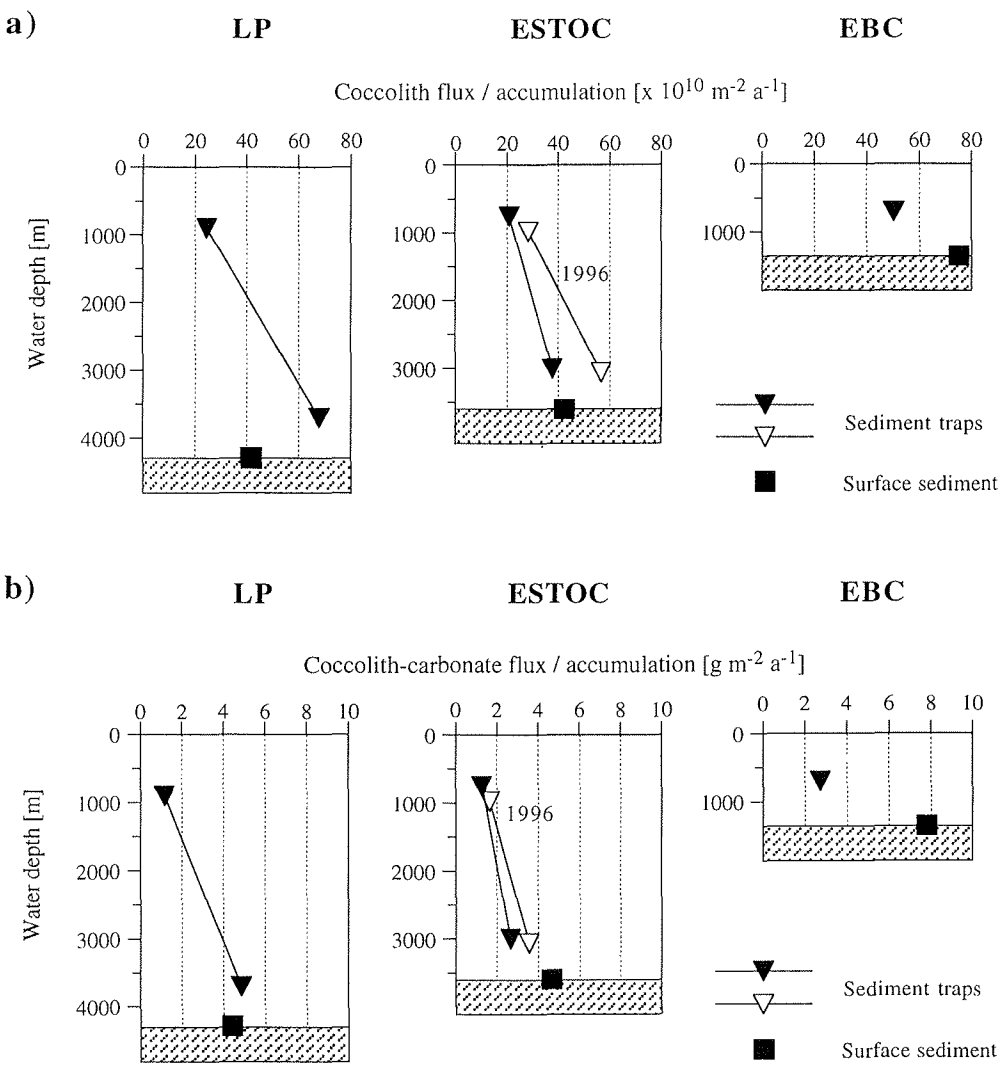

Fig. 9. Comparison of (a) coccolith flux/accumulation (no. × 10^{10} m^{-2} a^{-1}) and (b) coccolith-carbonate flux/ accumulation (g m^{-2} a^{-1}) recorded in sediment traps (solid triangles: 1997, open triangles: 1996) and Holocene sediment samples at the three mooring sites along the studied E-W transect north of the Canary Islands. Data for the 1996 mooring period at the ESTOC station derived from Sprengel et al. (2000).

upper water column productivity and water mass transport. This results in highly variable coccolith frequencies, especially in the deeper part of the water column. It is therefore possible that total coccolith flux observed in the deep LP trap in 1997 was considerably higher than during other years and hence does not provide a characteristic picture of the long term accumulation within the sediment. An indication for enhanced dissolution of coccoliths in the surface sediment at LP could be the different proportion of coccolith-carbonate to the total carbonate in the deep trap and the sediment (Table 3). While coccoliths contributed 63% to the total carbonate flux in the deep trap, coccolith-carbonate accumulation within the Holocene sediment represented only 48% of the total carbonate accumulation. This discrepancy is not evident for the shallower ESTOC site, where the coccolith contribution to the total carbonate

Table 3. Compilation of total coccolith flux/AR, total carbonate and coccolith-carbonate flux/AR, and coccolith contribution to the total carbonate flux/AR discussed within this study.

	LP			ESTOC					EBC	
	Sediment traps		Surface sediment	Sediment traps				Surface sediment	Sediment trap	Surface sediment
	LP1		GeoB 4242	CI7 (1997)		CI6 (1996)		GeoB 4241/4301	EBC2-1	GeoB 4234/4240
Trap depth [m]	900	3700		750	3000	976	3062		700	
Coccolith flux[c] / AR[b] [Ind. x 10^{10} m^{-2} a^{-1}]	24.62	67.88	41.84	20.93	37.6	28.39	56.58	42.43	50.23	75.22
Total $CaCO_3$ flux[a] / AR[b] [g m^{-2} a^{-1}]	3.7	7.7	9.25	3.8	6.0	4.5	8.6	10.91	8.5	30.39
Coccolith-$CaCO_3$ flux[c] / AR[b] [g m^{-2} a^{-1}]	1.16	4.86	4.41	1.27	2.65	1.63	3.55	4.66	2.76	7.79
Coccolith contribution to total $CaCO_3$ flux / AR	31.35%	63.12%	47.68%	33.42%	44.17%	36.22%	41.28%	42.71%	32.47%	25.63%

[a] Freudenthal et al. (subm.)

[b] Henderiks et al. (subm.), AR = accumulation rate (based on oxygen isotope Age Models, SPECMAP time-scales)

[c] this study

flux is similar within the deep particle traps (1996/1997) and the Holocene sediment. A dissolution index based on the ratio of poor/well preserved coccoliths of *E. huxleyi* gives a hint to enhanced carbonate dissolution within the surface sediment at the offshore site LP compared to ESTOC and EBC (Henderiks et al., subm.). Preservation aspects for the most frequent coccolithophore species encountered in the water column, sediment traps, and the Holocene sediments along the studied transect are discussed in Abrantes et al. (subm.). However, assuming that the magnitude and strength of laterally advected matter to the deep traps may vary interannually, we propose that the high input of coccolith-rich material to the deep LP trap in 1997 was rather unusual and that the discrepancy in coccolith concentrations between the trap samples and the sediment is a mixture of (differential) transport and dissolution processes. In addition to likely enhanced dissolution of coccoliths especially at the sediment-water interface, resuspension within near-bottom nepheloid layers may influence and modify the sediment composition at both sites.

At the easternmost site EBC, Holocene coccolith accumulation rate is about 50% higher than the annual coccolith flux observed in the sediment trap above (Fig. 9a). This difference could be explained by intense down-slope particle transfer processes which most probably affect the sedimentation in this near-shore environment. Horizontal advection of resuspended shelf sediments within near-bottom nepheloid layers, which may also become detached and spread along isopycnals, is known to be a common feature along continental slope environments (Heussner et al., 1999; Lampitt et al., 1995; Dickson and McCave, 1986). Near-bottom down-slope mass transport in the studied region is supported by a relative steep gradient in topography (Freudenthal et al., subm.). Accumulation rates of total carbonate at EBC were more than three times higher than the carbonate fluxes recorded in the sediment traps (Table 3). The relatively low contribution of coccoliths to the total carbonate content of the sediment (26%) is assumed to be mainly related to differential transport of coccoliths and relative enrichment of larger carbonate particles, e.g. foraminifera tests and detrital carbonate, which may also be advected from the shelf and upper slope area. Dissolution of coccoliths is presumed to play a minor role in this shallow water environment. As previously reported from Beaufort and Heussner (1999), coccolith sedimentation in margin environments may result mainly from sediment focussing, which means that observed fluxes within the water column and sediment accumulation are significantly higher than it would be expected from the production within the overlying waters.

6. Summary and conclusions

The coccolithophore export production in the Canary Islands region recorded in different water depths along an E-W profile was highly seasonal, with marked sedimentation events in February (upper traps) and March (lower traps) related to the winter phytoplankton bloom in surface waters of the studied area. Total coccolith flux rates and changes in assemblage composition along the transect indicate increased productivity at the upwelling influenced near-coast site EBC. Furthermore, a strong influence of lateral advected material was demonstrated for the deeper sediment traps at the two offshore sites. Average Holocene coccolith and (coccolith-) carbonate accumulation rates derived from surface sediments near the mooring locations generally confirm the sediment trap results. However, the surface sediments seem to be strongly influenced by near-bottom and down-slope particle transfer processes, especially at the site closer to the NW African shelf. Enhanced dissolution of coccoliths within the sediment-water interface was assumed to affect primarily the deeper sediments at the westernmost site LP.

Despite the good correspondence of the coccolith and carbonate data presented within this case study, it can be generally concluded that a quantitative comparison of present day export fluxes and accumulation rates in the underlying sediments is mainly limited by the different time-scales regarded (year vs. several hundreds of years). Seasonal and/or interannual variations in coccolith export production, especially in highly variable margin environments, emphasize the need for long-term observations. Horizontal input from shelf and upper slope waters as well as post-depositional processes may strongly modify export and accumulation rates in these areas.

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Short Communication

Disintegration of aggregates and coccospheres in sediment trap samples

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Abstract

A method for non-destructive disaggregation of coccoliths contained in fecal pellets, marine snow and on coccospheres is described. It consists of repeated chemical oxidation of organic material with (NaClO and H_2O_2) combined with brief periods of ultrasonification. © 1999 Elsevier Science B.V. All rights reserved.

Keywords: sample preparation; fecal pellets; aggregates; sediment trap; coccolithophores

1. Introduction

Sediment trap samples contain a heterogeneous mixture of biogenous material, detrital particles, and aggregates (including fecal pellets). Aggregates often contain, and thus transport vertically, large amounts of biogenous material, such as diatoms and coccolithophores. To quantify the fluxes of coccoliths, it is necessary to disintegrate such aggregates. This has proven difficult, however, because of the mechanical and chemical fragility of aggregates and coccoliths. Gentle mechanical disaggregation under a binocular microscope has been used previously (Knappertsbusch and Brummer, 1995), but this turned out to be very time-consuming and only partially effective in our sample materials. A comprehensive review of preparation techniques for coccoliths proposed so far can be found in Bown (1998).

After considerable experimentation, we have arrived at an efficient procedure which combines chemical and mechanical treatments. The organic matter is oxidized simultaneously with two strong oxidants, sodium hypochloride (NaClO) and hydrogen peroxide (H_2O_2), and the aggregates are mechanically disintegrated by repeated short periods of ultrasonification. Oxidation with dilute sodium hypochloride has previously been used for the extraction of coccoliths from black shales (Eshet, 1996), but in our sediment trap samples that technique left many aggregates intact and led to overgrowth of coccoliths. By adding the pH-balancing oxidant hydrogen peroxide and ultrasonification, both problems were overcome.

2. Treatment

The treatment consists of the following steps.

(1) Exactly 800 μl were extracted from original sediment trap suspensions with a micropipette and placed in a 6 ml glass test tube.

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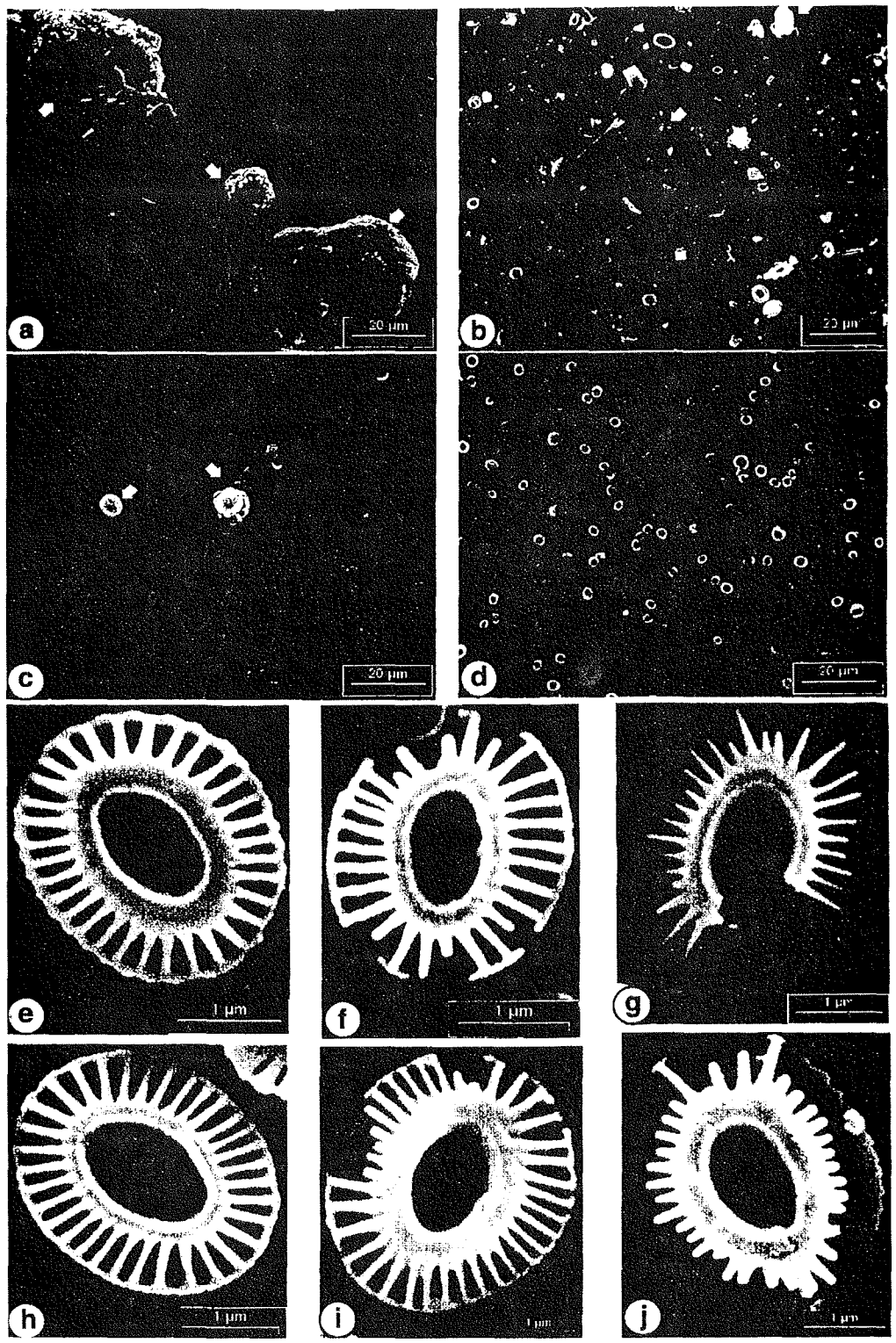
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(2) An equal amount (i.e. 800 μl) of a standard domestic bleach solution (2.8% NaClO, Javelwasser household (Coop®) brand) was added to the flask.

(3) Immediately after step (2) an equal amount (i.e. 800 μl) of 35% H_2O_2 solution was also added to the suspension. This led to moderate bubbling of the suspension, which never rose higher then the lower half of the 6 ml test tube.

(4) The suspension in the tube was then agitated repeatedly in an ultrasonic bath at 50 kHz for 5 s every 10 min and left to react in between for a total treatment period of 30–60 min (treatment period proportional to organic carbon content of the original sample). This was done with several samples in parallel.

(5) To keep the pH of the solutions between 8 and 9 during this process, one to two drops of NaClO (2.8%) solution were added to the test tubes every 10 min. Controls of the pH with indicator paper strips showed that this procedure never let the solution go beyond the 8–9 pH range.

(6) At the end of the treatment period each suspension was poured into a filtration apparatus. To prevent subsequent precipitation of salts, the filter was rinsed with 250 ml of a very dilute solution of ammonia in distilled water (at pH 8).

3. Results

The effectiveness of the method was tested in two sediment trap samples from the Hawaiian Ocean Timeseries (HOT) study in which the coccolith fluxes were determined in treated and untreated splits of the samples. The determined coccolith fluxes increased by 42% in the sample from 800 m depth and by 32% in the sample from 4000 m depth after treatment. Evidently a considerable proportion of coccoliths was contained in aggregates and fecal pellets, which were released into the suspensions of both samples.

The described treatment is based on the enhanced oxidation of organic matter by the combination of sodium hypochloride (pH >9) and hydrogen peroxide (pH <5) while maintaining the pH near 8.5 to prevent solution or overgrowth of coccoliths. The overall reaction is (simplified) as follows: $NaClO + H_2O_2 + C_{org} \Rightarrow NaCl + H_2O + CO_2$ (gas). A treatment time of 30 min (with 3 additions of 1 or 2 drops of NaClO solution) has proven sufficient for trap suspensions containing up to 10% aggregates (>15 μm length). With higher proportions of aggregates, a treatment period of up to 60 min was necessary for dispersion of all aggregates. A shorter treatment period of 30 min already led to the dispersion of coccoliths from all coccospheres.

4. Aggregate disintegration

To arrive at the optimum treatment time, tests were carried out with a sediment trap sample (ALOHA III-4-20) from the JGOFS time-series station north of Hawaii (22°45′N, 158°00′W), collected at 4000 m water depth between March 26, 1995 and April, 12, 1995 by the HOT-Group of the University of Hawaii. The efficiency of disintegration of aggregates (Plate 1, a and b) was evaluated for various concentrations of solutes and ultrasonification periods. These included various mixtures of concentrated (35%) hydrogen peroxide and sodium hypochloride solutions (ranging from 2.8 to 20%) and treatment periods between 15 to 120 min. At the solute concentrations given in the treatment section above, the proportion of aggregates decreased from 40% in the untreated sample to 0% after the 60 min treatment (Table 1).

Plate 1
(a–d) Effectiveness of aggregate (a, b) and coccosphere (c, d) disintegration as observable in scanning electron microscopy. Fecal pellets and aggregates (a) in sediment trap sample ALOHA III-4-20 (see text for further details) are disintegrated into individual coccoliths after treatment (b). Similarly, the coccospheres of an *Emiliania huxleyi* culture sample (c) are disintegrated into coccoliths (d). (e–j) Effects of increasing dissolution on morphology of *Emiliania huxleyi* coccoliths from sediment trap samples ALOHA II-4-15 and III-4-20 as seen in scanning electron microscopy. (e, h) Well preserved, intact coccoliths (preservational morphotype G). (f, i) Slightly etched coccoliths show partially to totally dissolved grid in central area and partially broken off T-bars in distal shield (morphotype E-1). (g, j) Moderately etched coccoliths with empty central areas and most elements in distal shield reduced to inner parts (morphotype E-2).

Table 1
Change in the proportion of coccoliths and aggregates in a trap sample (ALOHA III-4-20) with increasing treatment period (in minutes)

	Aggregates >15 μm		Coccoliths	
	specimens	%	specimens	%
No treatment	198	40	302	60
15 min treatment	22	4	478	96
30 min treatment	12	2	488	98
60 min treatment	0	0	500	100

Table 2
Coccospheres and coccoliths (specimens and percent) in an *E. huxleyi* culture sample before and after treatment

	Coccospheres		Coccoliths	
	specimens	%	specimens	%
No treatment	56	11	444	89
60 min treatment	0	0	500	100

Table 3
Intact versus broken coccoliths (specimens and percent) of an *E. huxleyi* culture sample before and after continuous ultrasonification

	Intact coccoliths		Coccolith fragments	
	specimens	%	specimens	%
No treatment	469	94	31	6
60 min treatment	482	96	18	4

Table 4
Proportions of preservational morphotypes of *E. huxleyi* in a monoclonal culture sample before and after treatment

	Preservational morphotypes (%)			Specimens counted
	G	E-1	E-2	
No treatment	76	18	6	558
45 min treatment	77	18	5	530
90 min treatment	75	24	1	678

5. Coccosphere disintegration

The efficiency of coccosphere disintegration was tested by subjecting suspensions of several monoclonal cultures of *Emiliania huxleyi* to the treatment procedure. All coccospheres became disintegrated within 30–60 min of treatment (Plate 1, c and d; Table 2).

6. Coccolith breakage

To test for fragmentation of individual coccoliths during ultrasonic agitation, a suspension of an *E. huxleyi* culture was continuously sonified for 60 min. The proportion of fragments of less than half of a coccolith changed by less than 2.5% and is within the statistical noise (Table 3). Coccolith breakage therefore is negligible.

7. Dissolution of individual coccoliths

During all our experiments we carefully checked for carbonate dissolution by monitoring relative abundances of three preservational morphotypes of *E. huxleyi*. For describing the observed changes in preservational state we used designations similar to those of Roth and Thierstein (1972). Accordingly, intact specimens of *E. huxleyi* are designated 'type G' and indicate good preservation with perfect coccoliths (Plate 1, e and h). *E. huxleyi* 'type E-1' preservational morphotypes show slight etching and have the central area and/or distal shield margin partially missing (Plate 1, f and i). *E. huxleyi* 'type E-2' are moderately etched morphotypes, showing open central areas and having the T-elements of the distal shield reduced to radial teeth (Plate 1, g and j). In none of our experiments was dissolution high enough to lead to strongly etched morphotypes of *E. huxleyi* 'type E-3', which have both shields partially or totally dissolved and have only the rim left. Such morphotypes ('rings') are known from dissolved sediment samples and were illustrated by McIntyre and McIntyre (1971).

Absence of measurable dissolution effects is evident from the unchanging proportions of various preservational morphotypes of *E. huxleyi* coccoliths in two samples tested. The first sample is from a monoclonal *E. huxleyi* culture (Table 4).

The second sample tested is from a sediment trap (II-4-15, from the JGOFS time-series station ALOHA, collected at 4000 m water depth between

Table 5
Proportions of preservational morphotypes in trap sample ALOHA II-4-15 before and after treatment

	Preservational morphotypes (%)			Specimens counted
	G	E-1	E-2	
No treatment	12	57	31	497
60 min treatment	5	67	28	555

May 13 and May 31, 1994 by the HOT-Group of the University of Hawaii) and did not show any statistically reliable change in the proportions of various preservational morphotypes (Table 5).

8. Discussion

Our treatment using 800 μl each of suspension and two oxidants have proven effective in a study of a total of nearly 50 samples. These consisted of 35 sediment trap samples from the JGOFS time-series stations ALOHA I-III (north of Hawaii) and 2 samples from ESTOC (Canary Islands), whose dry weights in 800 μl of suspension were 0.38–1.77 mg, and of eight samples of various *E. huxleyi* cultures, with dry weights of 0.10–0.26 mg.

It is possible that the amount of sodium hypochloride and hydrogen peroxide may have to be adjusted for samples with organic carbon contents highly different from those used here, either in quality or quantity. The organic carbon contents of the trap and culture samples prepared so far ranged from 30 to 70% (Bairbakhish, unpubl. diploma thesis). This should, however, be done with great caution, because the addition of both oxidants in larger amounts than 800 μl has in our trials sometimes led to more intensive bubbling.

In some treated samples from the ESTOC station which had been poisoned with mercury chloride, coatings of unknown composition have been observed in the SEM. These could be eliminated by extended rinsing after treatment. No coatings were observed in the other samples, which had been poisoned with formaldehyde.

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Teil III – Zusammenfassung und Ausblick

1. Zusammenfassende Darstellung der Ergebnisse

Im folgenden Teil der Dissertation werden die Ergebnisse der vorgestellten Arbeiten bezüglich der jeweiligen Fragestellungen und Aspekte zusammengefasst und abschließend ein kurzer Ausblick auf zukünftige Arbeiten gegeben.

1.1. Saisonale Flussmuster im Vergleich zur Produktivität

Die Untersuchung von Coccolithophoridengemeinschaften in Sedimentfallen entlang eines Produktivitätsgradienten in den Oberflächengewässern nördlich und östlich der Kanarischen Inseln lassen generell einen engen zeitlichen und räumlichen Zusammenhang der Exportflüsse in den tieferen Bereichen der Wassersäule mit der biologischen Produktivität in den oberen Wasserschichten erkennen. Die Coccolithophoridenflüsse an allen drei Fallenstationen unterliegen einer ausgeprägten Saisonalität mit markanten, synchron auftretenden Sedimentationsmaxima jeweils im Frühjahr sowie relativ niedrigen Flüssen während der übrigen Zeit des Jahres. Im Vergleich der Flüsse mit saisonal variierenden Pigmentkonzentrationen (u. a. Chlorophyll a) im Oberflächenwasser zeigt sich, dass die Hauptsedimentationsereignisse in der Regel etwa einen Monat nach der Winterblüte des Phytoplanktons auftreten. Anhand des saisonalen Flussmusters kann indirekt abgeleitet werden, dass die Coccolithophoridenproduktion in der euphotischen Zone einem stark ausgeprägten saisonalen Zyklus unterliegt. Dieser wiederum wird durch bestimmte hydrographische und atmosphärische Parameter (u. a. intensive Passatwinde und hieraus abzuleitender verstärkter Auftrieb) kontrolliert, die u. a. die für die biologische Produktion wichtigen Nährstoff- und Temperaturverteilungen im Oberflächenwasser regulieren. So ist die Phytoplanktonproduktivität in den warmen, oligotrophen, offen-ozeanischen Bereichen der Tropen und Subtropen generell niedrig, da aufgrund einer nahezu permanent entwickelten Thermokline eine dauerhafte Versorgung der oberen Wasserschichten mit Nährstoffen (u. a. Nitrat, Phosphat, Silikat, Eisen; Broerse, 2000) verhindert wird. Erst eine tiefe, saisonale, wind- und strömungsinduzierte Durchmischung der Deckschicht führt zu einer Anreicherung von Nährstoffen und damit zu einem verstärkten Phytoplanktonwachstum in der photischen Zone, resultierend in episodischen Sedimentationsereignissen in der tieferen Wassersäule (vgl. Teil II dieser Arbeit). Die höheren Coccolithophoridenflüsse an der küstennahen Station lassen auf eine höhere Produktivität im Oberflächenwasser schließen, die vermutlich

eng mit westwärts driftenden, nährstoffreichen Auftriebsfilamenten in Zusammenhang steht. Das generelle Sedimentationsmuster mit hohen Flüssen im Frühjahr und relativ niedrigen während der übrigen Zeit des Jahres wird dadurch jedoch nicht beeinflusst.

1.2. Transportprozesse in der Wassersäule

Die vergleichenden Untersuchungen der Exportflüsse in verschieden Wassertiefen haben ergeben, dass die Sinkgemeinschaften in den tieferen Bereichen (3000-3700 m) in hohem Maße von lateralem Partikeltransport beeinflusst werden. So wurden in den tieferen Sedimentfallen der beiden ozeanischen Stationen LP und ESTOC deutlich höhere Coccolithenflüsse bei generell vergleichbaren Sedimentationsmustern beobachtet. Die hohe Konzentration an Coccolithen in den tieferen Sinkstoffproben lässt auf ein höherproduktives Liefergebiet der Partikel NE der beiden Stationen schließen. Hierbei wird die These diskutiert, dass Sedimentfallen in Abhängigkeit des ozeanischen Strömungsumfeldes, der Zeit und Dauer der Verankerung sowie des unterschiedlichen Sinkverhaltens verschiedener Partikel möglicherweise Material unterschiedlicher Herkunftsgebiete sammeln (Siegel und Deuser, 199). Die überraschend gut übereinstimmenden Coccolithophoridengemeinschaften in den unterschiedlichen Fallentiefen geben keine Hinweise auf mögliche Liefergebiete. Die generell gute Erhaltung der Coccolithen in allen Wassertiefen spricht für einen schnellen Transport durch die Wassersäule, überwiegend verpackt in größere Aggregate oder Zooplankton-Kotballen. Die Flussmaxima in den unteren Sedimentfallen treten mit einem zeitlichen Verzug von ca. 28 Tagen auf, was einer geschätzten mittleren Sinkgeschwindigkeit der Partikel von etwa 100 m/Tag entsprechen würde.

1.3. Ökologische Aspekte der Coccolithophoridengemeinschaften

Anhand der aufgezeichneten Coccolithophoridenflüsse im Bereich der Kanarischen Inseln konnte dargelegt werden, dass sich in dieser Region eine hochdiverse Gemeinschaft mit einer saisonal entwickelten vertikalen Arten-Zonierung (s. u.) ausbildet. Insgesamt konnten 57 Heterococcolithen- und 8 Holococcolithenarten identifiziert werden, von denen allerdings nur wenige die Vergesellschaftung dominierten. Variationen in der Gemeinschaft entlang des bearbeiteten Transektes geben einen Hinweise auf unterschiedliche ökologische Präferenzen einzelner Arten.

Die Coccolithengemeinschaft im Sinkbereich wird durch einen starken saisonalen Wechsel in den relativen Anteilen der dominanten Arten *E. huxleyi* und *F. profunda* gekennzeichnet. Dieser Wechsel ist ein Hinweis auf eine gut ausgebildete vertikale Zonierung der Plankton-

Lebendgemeinschaft in Arten-/Artengemeinschaften der oberen und der unteren photischen Zone. Die höchsten relativen Anteile der tieflebenden Art *F. profunda* werden mit den niedrigsten Nährstoffkonzentrationen in der oberen photischen Zone vor und nach einer Blütenphase in Zusammenhang gebracht, einhergehend mit geringen Produktionsraten der dort lebenden Arten. Diese Beobachtung wurde bereits in mehreren subtropischen Regionen gemacht, wo sich aufgrund der geringen Konzentration suspendierter Partikel in der Wassersäule und einer damit verbundenen hohen Eindringtiefe der Sonneneinstrahlung saisonal eine Tiefenzonierung ausbilden kann (u. a. Winter et al., 1994; Haidar et al., 2000; Broerse et al., 2000).

Trotz der relativ geringen Variabilität der Gemeinschaften im Untersuchungsgebiet, konnten wichtigeTrends entlang des Produktivitätsgradienten beobachtet werden. Eine Präferenz für höhere Nährstoffgehalte und/oder niedrige Oberflächenwassertemperaturen wird für alle Arten der Gattung *Gephyrocapsa*, speziell für *G. ericsonii* und *G. oceanica* angenommen, da sie ihre höchsten relativen Anteile an der durch nährstoffreiche Auftriebswässer beeinflussten Station aufweist. Im Gegensatz dazu zeigen die Arten *F. profunda* und *C. leptoporus* eine Affinität zu den eher stabilen, oligotrophen Bedingungen der subtropischen Gyre. Ähnliche Beobachtungen wurden ebenso in den Oberflächensedimenten entlang des Gradienten gemacht (Henderiks et al., in Vorb.).

Biometrische Analysen an 9 ausgewählten Arten in den Sinkgemeinschaften der ESTOC-Station zeigten nur eine relativ geringe morphologische Variabilität während eines Jahreszyklus. Lediglich für eine Art – *U. sibogae* – könnte anhand der Daten eine ökologische Anpassung der verschiedenen Morphotypen (Varietäten) an bestimmte Umweltparameter (u. a. Temperatur- und Nährstoffverteilungen) angenommen werden.

In früheren Studien wurden Coccolithophoriden generell als eine an stabile, oligotrophe Bedingungen angepasste Phytoplanktongruppe angesehen, da sie häufig die Gemeinschaften in Niedrigproduktionsgebieten dominieren und dort ihre höchsten Diversitäten ausbilden (Winter et al., 1994; vgl. Teil I dieser Arbeit). In den letzten Jahrzehnten wurden verstärkt Untersuchungen in höher produktiven Regionen durchgeführt und es wurde beobachtet, dass sich dort saisonal großräumige Blüten bestimmter Arten (z. B. *Emiliania huxleyi*, *Gephyrocapsa oceanica*) entwickeln können (s. Broerse, 2000 im Überblick). In den hochenergetischen primären Auftriebsbereichen äquatorialer Divergenzzonen und entlang der Westküsten der Kontinente wird die Planktongemeinschaft häufig von Diatomeen dominiert (Romero, 1998), während hohe Gehalte an Coccolithophoriden normalerweise außerhalb der Auftriebszentren in Wässern mit niedrigem Silikatgehalt beobachtet werden (u.a. Giraudeau et al., 1993). Anhand vergleichender Untersuchungen an unterschiedlichen Phytoplanktongruppen in der Kanarenregion konnte

aufgezeigt werden, dass die Planktongemeinschaften nahezu ganzjährig von Coccolithophoriden dominiert werden (Abrantes et al., subm.). Des Weiteren nehmen die absoluten Zellzahlen im Plankton (Bollmann, ETHZ, unpubl. Daten) sowie die Exportflüsse in Richtung des höher produktiven Gebietes zu. Ähnliche Beobachtungen wurden von Kinkel (1999) und Baumann et al. (1999) im Auftriebsgebiet des äquatorialen Atlantik gemacht.

1.4. Coccolithen-Karbonatexport und holozäne Akkumulation

Der auf der Basis von artspezifischen Karbonatgewichten berechnete Coccolithenkarbonatfluss betrug an den beiden ozeanischen Stationen ca. 1-1,5 g m^{-2} a^{-1} und an der küstennahen Station 2,8 g m^{-2} a^{-1}, was einem relativen Anteil am Gesamtkarbonatfluss von jeweils etwa 33% entspricht. In den unteren Fallen war der Anteil des Coccolithenkarbonats deutlich höher (40-60%), was auf eine höhere Konzentration von Coccolithen im lateral advektierten Material hindeutet (s. o.). Die Karbonatakkumulation in den Oberflächensedimenten an den oligotrophen Stationen entspricht in etwa den Karbonatflüssen in den unteren Fallen, weicht also deutlich von den Flüssen in den oberen Sedimentfallen ab. An der auftriebsbeeinflussten Station EBC ist die Akkumulation von Coccolithenkarbonat im Sediment ungefähr dreimal so hoch wie der berechnete Exportfluss in der Falle.

Milliman (1993) schätzt auf der Basis von 65 Sedimentfallenstudien den jährlichen Gesamtkarbonatexport auf 2-5 g m^{-2} in den zentral-ozeanischen Gyren und auf 30-40 g m^{-2} in den Hochproduktionsgebieten. Die im Rahmen der vorliegenden Studie ermittelten Werte stimmen generell mit den Abschätzungen von Milliman (1993) überein, obwohl bezüglich der Sedimentdaten, besonders an der küstennahen Station, verstärkt Umlagerungsprozesse mit in die Interpretation einbezogen werden müssen.

2. Ausblick auf zukünftige Arbeiten

Die vorliegende Studie zu ökologischen Aspekten und Sedimentationsprozessen rezenter Coccolithophoridengemeinschaften in der Region um die Kanarischen Inseln zeigt deutlich, dass Partikelflussuntersuchungen mit Hilfe von Zeitserien-Sedimentfallen eine wichtige Verbindung zwischen den klima- und biogeochemisch gesteuerten Prozessen und Ereignissen in den oberflächennahen Wasserschichten und ihrer Aufzeichnung im Sediment darstellen. Sie leisten einen immensen Beitrag zum besseren Verständnis biogeochemischer Zyklen im Ozean und bilden eine wichtige Grundlage für palökologische und paläozeanographische Rekonstruk-

tionen.

Bezogen auf Coccolithophoriden als eine der Hauptprimär- und Karbonatproduzenten in den heutigen Ozeanen sind Ergebnisse zu den ökologischen Präferenzen einzelner Arten und Vergesellschaftungen, biogeographischen Verbreitungsmustern sowie den relativ komplexen Transportprozessen während der Sedimentation und Akkumulation für die Interpretation fossiler Gemeinschaften unerlässlich. Hierbei ist es notwendig, ein möglichst vollständiges zeitlich-räumliches Bild der Lebensweise dieser Organismen zu erlangen, um die im Sediment gespeicherten Informationen besser beurteilen und nutzen zu können. So können mit Hilfe verstärkter Planktonuntersuchungen und Kulturversuche im Vergleich mit Nährstoff- und Temperaturverteilungen sowie physikalisch-ozeanographischen Prozessen die Abhängigkeit der Coccolithophoridengemeinschaften bzw. einzelner Arten von bestimmten Umweltparametern bzw. die Anpassung an bestimmte Habitate festgestellt werden. Saisonale und interannuelle Variationen sowie Unterschiede in den verschiedenen ozeanographischen Regimen können am besten mit zeitgeschalteten Sedimentfallen aufgezeichnet werden. Hierbei ist es notwendig, Partikelflussmessungen in mehreren Wassertiefen durchzuführen, um Veränderungen der Gemeinschaften durch Transport-, Umlagerungs- und chemisch-biologische Abbauprozesse innerhalb der Wassersäule und an der Grenze Wasser-Sediment zu erfassen. Die Bestimmung von Karbonatexportflüssen und den jeweiligen gewichtsbilanzierten Anteilen der verschiedenen Organismen am Karbonatfluss leistet einen wichtigen Beitrag zur Abschätzung des globalen Kohlenstoff- bzw. Karbonatbudgets. Für eine Evaluierung der Ergebnisse verschiedener Bearbeiter und Aufzeichnungen aus unterschiedlichen Regionen sind hierbei gleiche methodische Ansätze unerlässlich.

3. Literatur

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Teil IV – Anhang

1. Taxonomie

Reich: PROTISTA
Stamm: HAPTOPHYTA Cavalier-Smith, 1989
Klasse: PRYMNESIOPHYCEAE Hibbert, 1976
Ordnung: COCCOLITHOPHORALES Schiller, 1926

(A) Heterococcolithophoriden

Familie: **CALCIOSOLENIACEAE** Kamptner, 1937

Gattung: ***ANOPLOSOLENIA*** Deflandre, 1952

A. brasiliensis (Lohmann, 1919) Deflandre, 1952
– Nishida, 1979; Heimdal & Gaarder, 1981; Manton & Oates, 1985

Gattung: ***CALCIOSOLENIA*** Gran, 1912

C. murrayi Gran, 1912
– Nishida, 1979; Manton & Oates, 1985

Familie: **COCCOLITHACEAE** Poche, 1913

Gattung: ***CALCIDISCUS*** Kamptner, 1950

C. leptoporus (Murray & Blackman, 1898) Loeblich & Tappan, 1978 f. *leptoporus*
– Nishida, 1979; Knappertsbusch, 1990; Kleijne, 1993

Gattung: ***COCCOLITHUS*** Schwarz, 1894

C. pelagicus (Wallich, 1877) Schiller, 1930 f. *pelagicus*
– McIntyre and Bé, 1967; Nishida, 1979; Samtleben & Schröder, 1992

Gattung: ***CYCLOLITHUS*** Kamptner, 1948, ex Deflandre, in Grassé, 1952

C. anulus Lecal, 1967
– Kleijne, 1993

Gattung: ***HAYASTER*** Bukry, 1973

H. perplexus (Bramlette & Riedel, 1954) Bukry, 1973
– Nishida, 1979; Reid, 1980

Gattung: ***NEOSPHAERA*** Lecal-Schlauder, 1950

N. coccolithomorpha Lecal-Schlauder, 1950
– Nishida, 1985; Kleijne, 1993

Gattung: ***OOLITHOTUS*** Reinhardt, in Cohen & Reinhardt, 1968

O. fragilis (Lohmann, 1912) Martini & Müller, 1972 var. *fragilis*
– Baumann, 1990; Kleijne, 1993

Gattung: ***UMBILICOSPHAERA*** Lohmann, 1902

U. hulburtiana Gaarder, 1970
– Gaarder, 1970; Knappertsbusch, 1990
U. sibogae var. *foliosa* (Kamptner, 1963) Okada & McIntyre, 1977
– Okada & McIntyre, 1977; Inouye & Pienaar, 1984
U. sibogae (Weber-van Bosse, 1901) Gaarder, 1970 var. *sibogae*
– Okada & McIntyre, 1977; Winter & Siesser, 1994

Familie: **HELICOSPAERACEAE** Black, 1971, emend. Jafar & Martini, 1975

Gattung: ***HELICOSPAERA*** Kamptner, 1954

H. carteri (Wallich, 1877) Kamptner, 1954 var. *carteri*
– Borsetti & Cati, 1972;
H. carteri var. *hyalina* (Gaarder, 1970) Jordan & Young, 1990
– Gaarder, 1970; Borsetti & Cati, 1972; Jordan & Young, 1990
H. carteri var. *wallichii* (Lohmann, 1902) Theodoridis, 1984
– Okada & McIntyre, 1977; Nishida, 1979
H. pavimentum Okada & McIntyre, 1977
– Okada & McIntyre, 1977; Borsetti & Cati, 1979

Familie: **NOELAERHABDACEAE** Jerkovic, 1970

Gattung: ***EMILIANIA*** Hay & Mohler, in Hay *et al.*, 1967

E. huxleyi (Lohmann, 1902) Hay & Mohler, in Hay *et al.*, 1967 var. *huxleyi*
– Okada & McIntyre, 1977; Samtleben & Bickert, 1990; Kleijne, 1993

Gattung: ***GEPHYROCAPSA*** Kamptner, 1943

G. ericsonii McIntyre & Bé, 1967
– Nishida, 1979; Samtleben, 1980
G. muellerae Bréhéret, 1978
– Samtleben, 1980; Kleijne, 1993
G. oceanica Kamptner, 1943
– Okada & McIntyre, 1977; Nishida, 1979
G. ornata Heimdal, 1973
– Samtleben, 1980; Kleijne, 1993; Winter & Siesser, 1994

Gattung: ***RETICULOFENESTRA*** Hay, Mohler & Wade, 1966

R. parvula (Okada & McIntyre, 1977) Bierkart, 1989 var. *parvula*
– Okada & McIntyre, 1977
R. sessilis (Lohmann, 1912) Jordan & Young, 1990
– Reid, 1980; Hallegraeff, 1984

Familie: **PAPPOSPHAERACEAE** Jordan & Young, 1990

Gattung: ***PAPPOSPHAERA*** Tangen, 1972

P. lepida Tangen, 1972
– Tangen, 1972

Familie: **PONTOSPHAERACEAE** Lemmermann, 1908

Gattung: ***PONTOSPHAERA*** Lohmann, 1902

P. discopora Schiller, 1925
– Borsetti & Cati, 1979; Nishida, 1979
P. syracusana Lohmann, 1902
– Borsetti & Cati, 1976; Nishida, 1979

Gattung: ***SCYPHOSPHAERA*** Lohmann, 1902

S. apsteinii Lohmann, 1902 f. *apsteinii*
– Winter & Siesser, 1994

Familie: **RHABDOSPHAERACEAE** Ostenfeld, 1899

Gattung: ***ACANTHOICA*** Lohmann, 1903, emend. Schiller, 1913 and Kleijne, 1992

A. quattrospina Lohmann, 1903
– Kleijne, 1992; Winter & Siesser, 1994

Gattung: ***ALGIROSPHAERA*** Schlauder, 1945, emend. Norris, 1984

A. oryza Schlauder, 1945
– Reid, 1980
A. robusta (Lohmann, 1902) Norris, 1984
– Halldal & Markali, 1955; Norris, 1984

Gattung: ***CYRTOSPHAERA*** Kleijne, 1992

C. aculeata (Kamptner, 1941) Kleijne, 1992
– Kleijne, 1992

Gattung: ***DISCOSPHAERA*** Haeckel, 1894

D tubifera (Murray & Blackman, 1898) Ostenfeld, 1900
– Borsetti & Cati, 1972; Knappertsbusch, 1990

Gattung: ***RHABDOSPHAERA*** Haeckel, 1894

R. clavigera Murray & Blackman, 1898 var. *clavigera*
R. clavigera var. *stylifera* (Lohmann, 1902) Kleijne & Jordan, 1990
– Borsetti & Cati, 1972
R. xiphos (Deflandre & Fert, 1954) Norris, 1984
– Kleijne, 1992

Familie: **SYRACOSHAERACEAE** Lemmermann, 1908

Gattung: ***ALISPHAERA*** Heimdal, 1973

A. unicornis Okada & McIntyre, 1977
– Okada & MacIntyre, 1977; Samtleben & Schröder, 1992; Kleijne, 1993

Gattung: ***CALCIOPAPPUS*** Gaarder & Ramsfjell, 1954, emend. Manton & Oates, 1983

C. caudatus Gaarder & Ramsfjell, 1954
– Manton & Oates, 1983; Samtleben & Schröder, 1992

Gattung: ***CORONOSPHAERA*** Gaarder, in Gaarder & Heimdal, 1977

C. binodata (Kamptner, 1927) Gaarder, in Gaarder & Heimdal, 1977
C. mediterranea (Lohmann, 1902) Gaarder, in Gaarder & Heimdal, 1977
– Gaarder & Heimdal, 1977; Kleijne, 1993

Gattung: ***MICHAELSARSIA*** Gran, 1912, emend. Manton *et al.*, 1984

M. elegans Gran, 1912, emend. Manton *et al.*, 1984
– Manton *et al.*, 1984

Gattung: ***OPHIASTER*** Gran, 1912, emend. Manton & Oates, 1983

O. hydroideus (Lohmann, 1903) Lohmann, 1913, emend. Manton & Oates, 1983
– Manton & Oates, 1983; Kleijne, 1993

Gattung: ***SYRACOSPHAERA*** Lohmann, 1902

S. anthos (Lohmann, 1912) Jordan & Young, 1990
– Heimdal & Gaarder, 1981; Jordan & Young, 1990
S. borealis Okada & McIntyre, 1977
– Okada & McIntyre, 1977; Kleijne, 1993
S. corolla Lecal, 1966
– Okada & McIntyre, 1977; Borsetti & Cati, 1979
S. corrugis Okada & McIntyre, 1977
– Okada & McIntyre, 1977; Winter *et al.*, 1979
S. epigrosa Okada & McIntyre, 1977
– Okada & McIntyre, 1977; Heimdal & Gaarder, 1981
S. halldalii Gaarder, in Gaarder & Hasle, 1971 f. *halldalii*
– Gaarder & Heimdal, 1977
S. histrica Kamptner, 1941
– Gaarder & Heimdal, 1977; Okada & McIntyre, 1977
S. lamina Lecal-Schlauder, 1951
– Borsetti & Cati, 1976; Okada & McIntyre, 1977
S. molischii Schiller, 1925
– Gaarder & Heimdal, 1977; Okada & McIntyre, 1977
S. nodosa Kamptner, 1941
S. ossa (Lecal, 1966) Loeblich & Tappan, 1968
– Okada & McIntyre, 1977
S. pirus Halldal & Markali, 1955
– Gaarder & Heimdal, 1977
S. prolongata Gran, 1912, ex Lohmann
S. pulchra Lohmann, 1902
S. rotula Okada & McIntyre, 1977
– Okada & McIntyre, 1977

Gattung: ***TETRALITHOIDES*** Theodoridis emend. Jordan *et al.*, 1993

T. quadrilaminata (Okada & McIntyre, 1977) Jordan *et al.*, 1993
– Okada & McIntyre, 1977; Winter & Siesser, 1994

Gattung: ***UMBELLOSPHAERA*** Paasche, in Markali & Paasche, 1955

U. irregularis Paasche, in Markali & Paasche, 1955
– Nishida, 1979; Reid, 1980
U. tenuis (Kamptner, 1937) Paasche, in Markali & Paasche, 1955
– Borsetti & Cati, 1972; Nishida, 1979

GENERA INCERTAE SEDIS

Gattung: ***FLORISPHAERA*** Okada & Honjo, 1973

F. profunda var. *elongata* (Okada & Honjo, 1973) Okada & McIntyre, 1980
– Okada & Honjo, 1973

Gattung: ***GLADIOLITHUS*** Jordan & Chamberlain, 1993

G. flabellatus (Halldal & Markali, 1955) Jordan & Chamberlain, 1993
– Reid, 1980

(B) Holococcolithophoriden

Familie: **CALYPTROSPHAERACEAE** Boudreaux & Hay, 1969

Gattung: ***CALYPTROLITHINA*** Heimdal, 1982

C. divergens (Halldal & Markali, 1955) Heimdal, 1982 var. *divergens*
– Winter *et al.*, 1979; Kleijne, 1991

Gattung: ***CALYPTROSPHAERA*** Lohmann, 1902

C. oblonga Lohmann, 1902
– Kleijne, 1991

Gattung: ***CORISPHAERA*** Lohmann, 1902

Corisphaera gracilis Kamptner, 1937
– Kleijne, 1991

Gattung: ***HOMOZYGOSPHAERA*** Deflandre, 1952

H. arethusae (Kamptner, 1941) Kleijne, 1991
– Borsetti & Cati, 1972; Kleijne, 1991

Gattung: ***PERIPHYLLOPHORA*** Lohmann, 1902

P. mirabilis (Schiller, 1925) Kamptner, 1937
– Borsetti & Cati, 1972; Kleijne, 1991

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3. Fototafeln

Tafel I

1. *Emiliania huxleyi*, Coccosphäre Typ A (EBC2-1, 700 m)

2. *Emiliania huxleyi*, mehrlagige Coccosphäre Typ C (EBC2-1, 700 m)

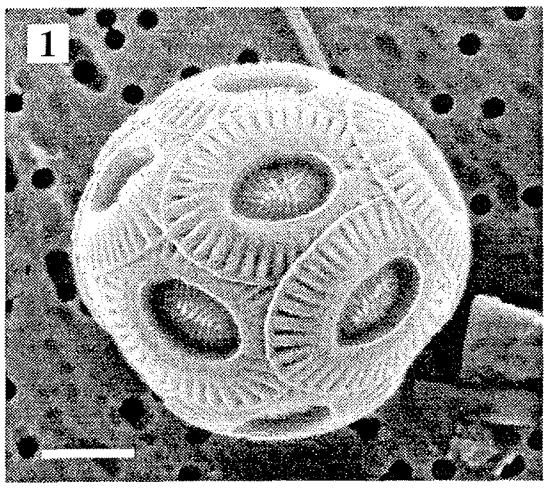
3. *Emiliania huxleyi*, Coccolith Typ B, distal (ESTOC - CI6u, 3000 m)

4. *Gephyrocapsa ericsonii*, Coccosphäre (ESTOC - CI5m, 1000 m)

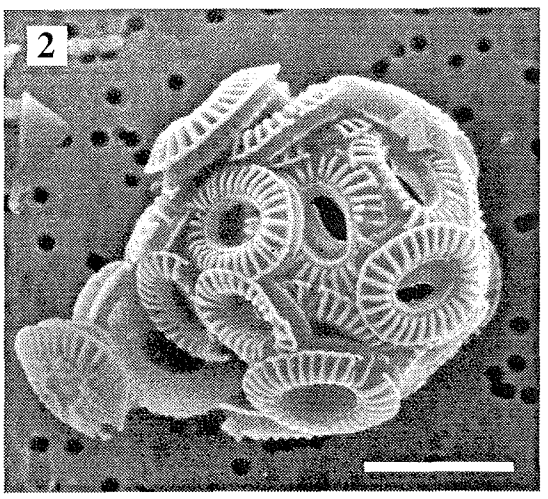
5. *Gephyrocapsa ornata*, Coccosphäre (LP1u, 3700 m)

6. Aggregat (EBC2-1, 700 m)

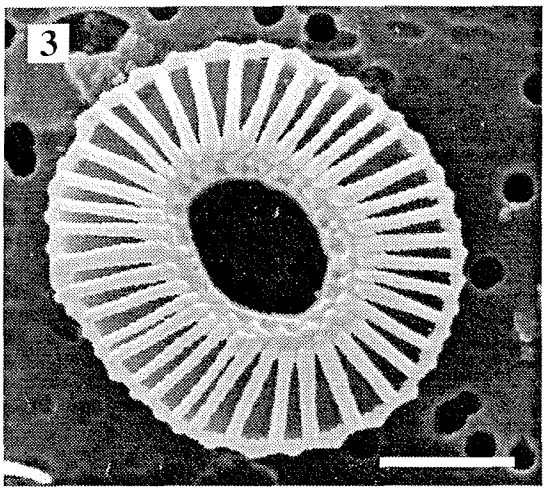
Tafel I



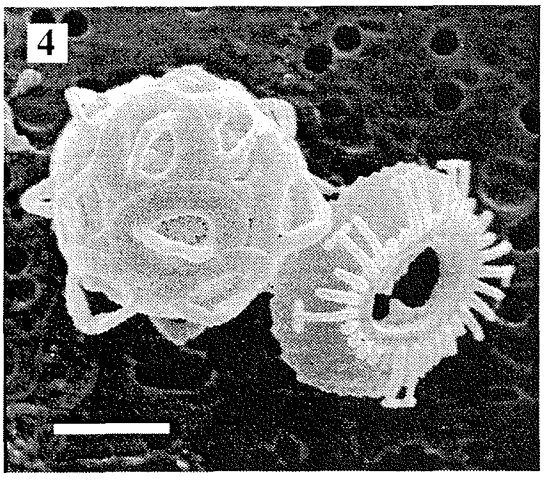
Emiliania huxleyi – Typ A Balken = 1 µm



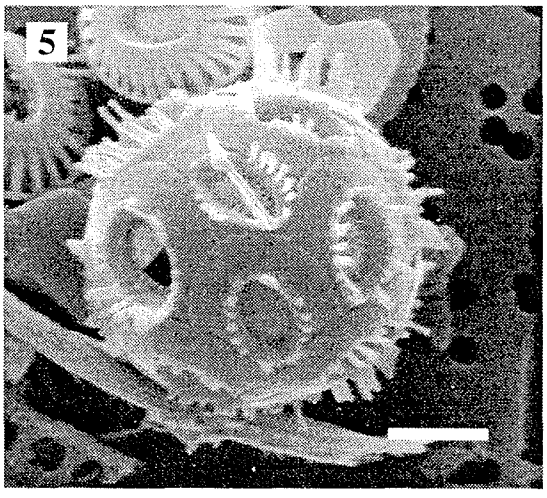
Emiliania huxleyi – Typ C Balken = 2 µm



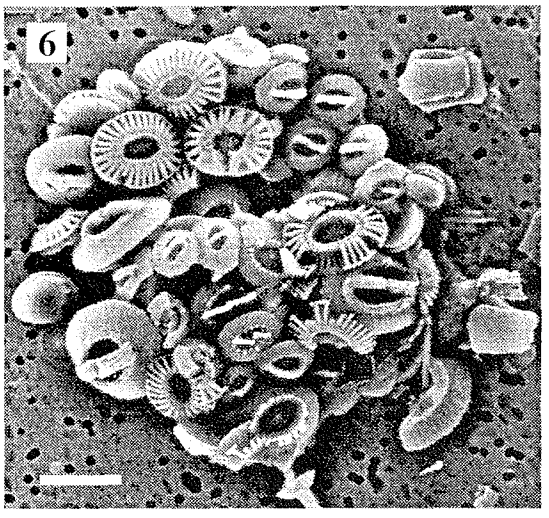
Emiliania huxleyi – Typ B Balken = 1 µm



Gephyrocapsa ericsonii (links) Balken = 1 µm



Gephyrocapsa ornata Balken = 1 µm



Aggregat Balken = 2 µm

Tafel II

1. *Gephyrocapsa oceanica*, Coccolith, distal (ESTOC - CI4u, 3000 m)

2. *Gephyrocapsa oceanica*, Coccosphäre (ESTOC - CI6m, 1000 m)

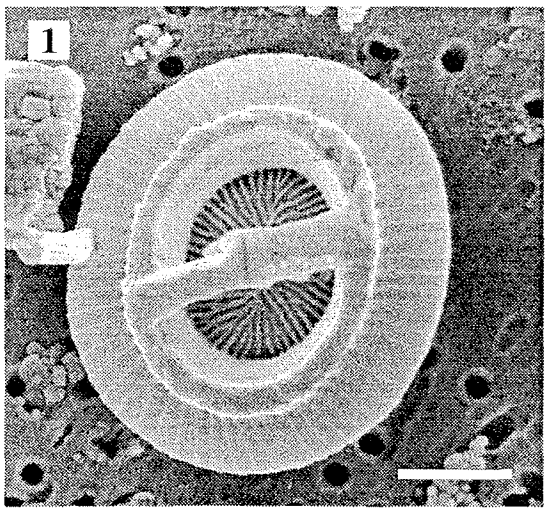
3. *Calcidiscus leptoporus*, Coccosphäre (CI6m, 1000 m)

4. *Umbilicosphaera sibogae* var. *foliosa*, Coccosphäre (EBC2-1, 7000 m)

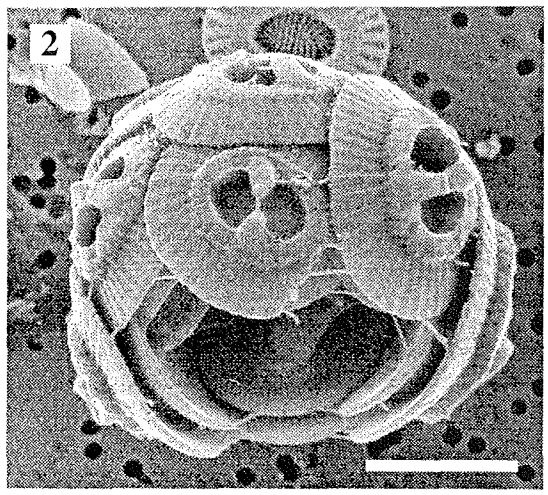
5. *Florisphaera profunda*, Coccosphäre (EBC2-1, 700 m)

6. *Algirosphaera* sp., Coccosphäre (ESTOC - CI7m, 750 m)

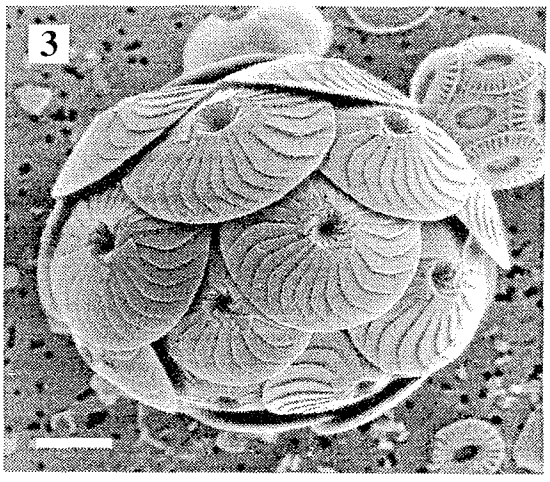
Tafel II



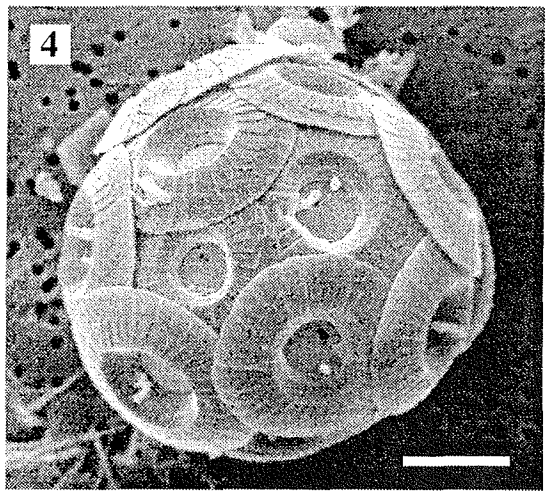
Gephyrocapsa oceanica Balken = 1 µm



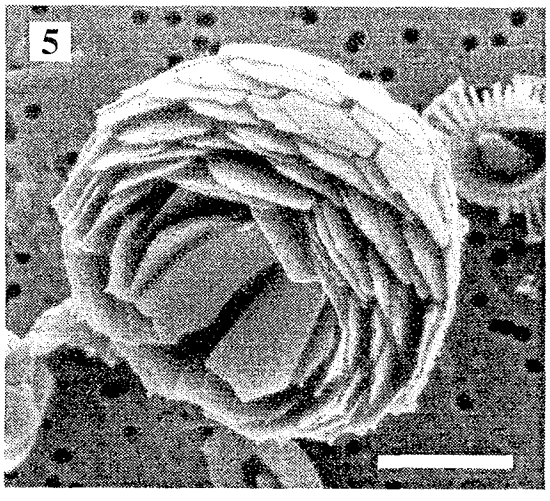
Gephyrocapsa oceanica Balken = 2 µm



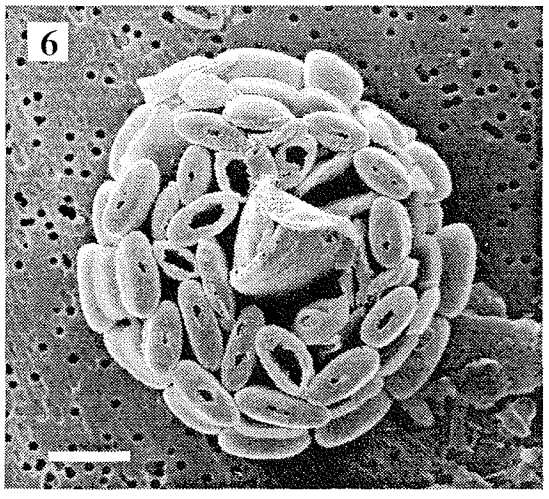
Calcidiscus leptoporus Balken = 2 µm



Umbillicosphaera sibogae var. *foliosa* Balken = 2 µm



Florisphaera profunda Balken = 2 µm



Algirospaera sp. Balken = 2 µm

Tafel III

1. *Syracosphaera* sp., zerfallene Coccosphäre (ESTOC - CI6m, 1000 m)

2. *Syracosphaera epigrosa*, zerfallene Coccosphäre (ESTOC - CI7m, 750 m)

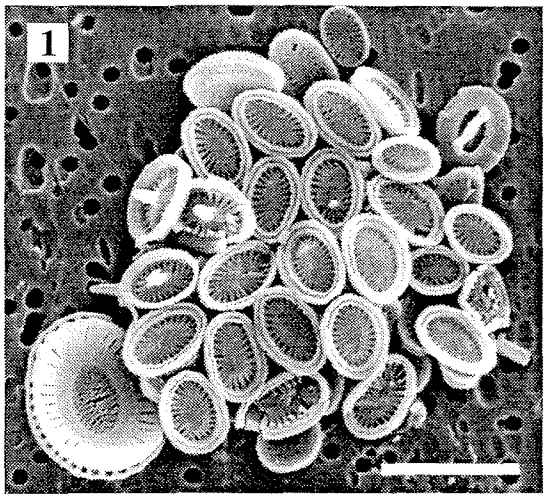
3. *Syracosphaera molischii*, Coccolith, distal (ESTOC - CI7m, 750 m)

4. *Syracosphaera rotula*, Coccolith (Cyrtolith), distal (LP1u, 3700 m)

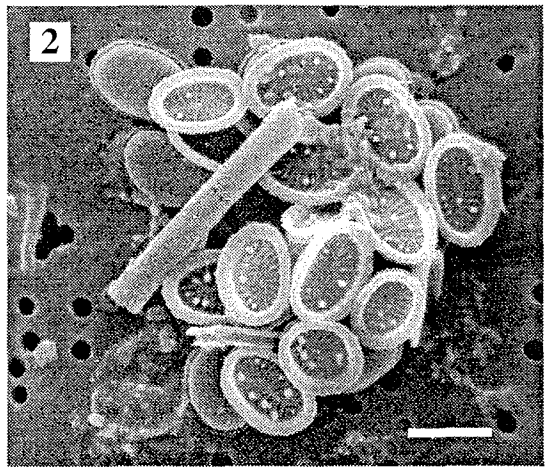
5. *Scyphosphaera apsteinii*, Coccolith (LP1o, 900 m)

6. *Hayaster perplexus*, Coccolith, proximal (LP1u, 3700 m)

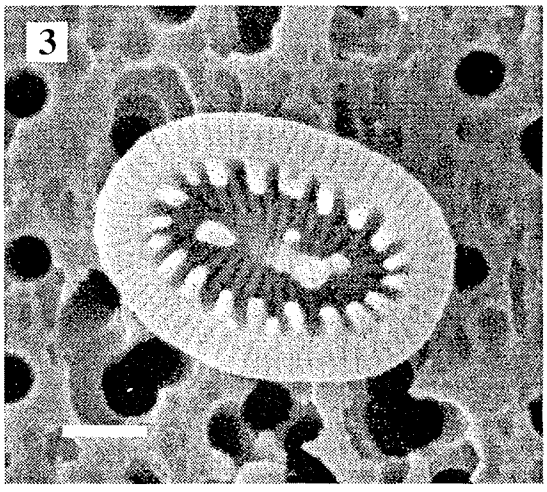
Tafel III



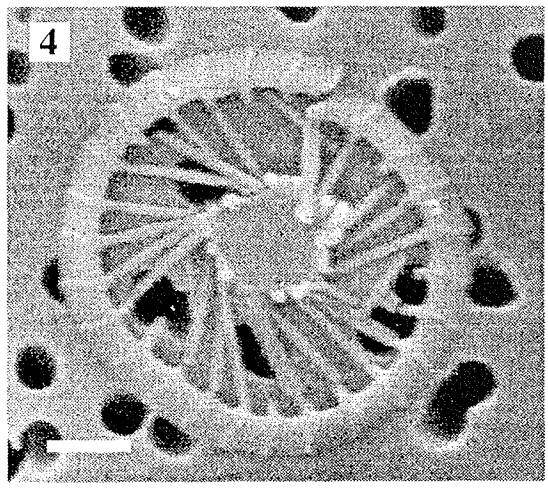
Syracosphaera sp. Balken = 2 µm



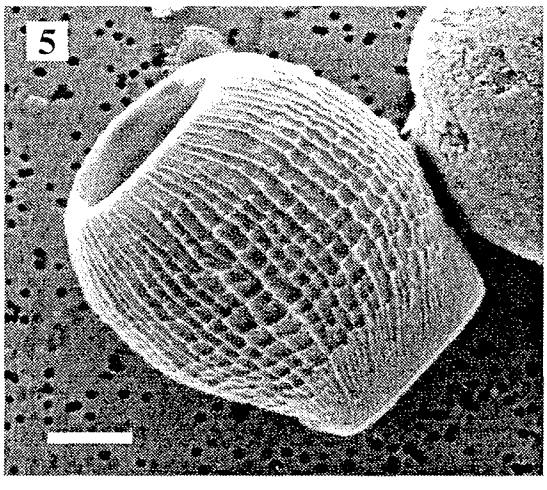
Syracosphaera epigrosa Balken = 1 µm



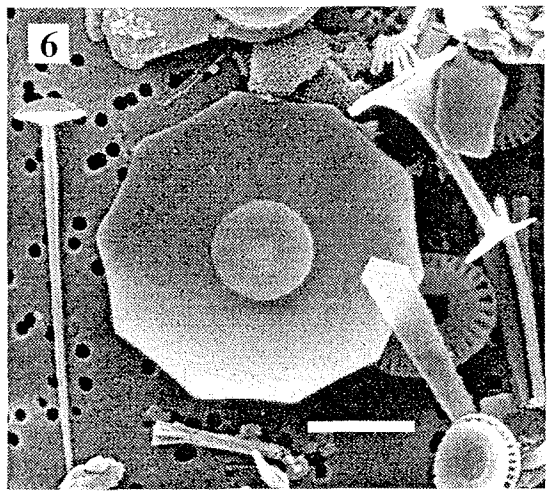
Syracosphaera molischii Balken = 0,5 µm



Syracosphaera rotula Balken = 0,5 µm



Scyphosphaera apsteinii Balken = 2 µm



Hayaster perplexus Balken = 2 µm

ESTOC - CI3u (3086 m): Coccolithenfluss (Mio Coccolithen m^{-2} d^{-1})

Probe	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Verschlusszeit	23.04.93	14.05.93	04.06.93	25.06.93	16.07.93	06.08.93	27.08.93	17.09.93	08.10.93	29.10.93	19.11.93	10.12.93	31.12.93	21.01.94	11.02.94	04.03.94	25.03.94	15.04.94	07.06.94
Sammelintervall (d)	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	52
Gesamtfluss	676.29	2216.68	1664.23	1874.60	1133.64	1432.83	1126.63	991.06	1189.74	1111.80	544.15	563.05	699.27	2136.39	5533.05	8199.96	2811.81	1601.90	833.19
Acanthoica spp.	0.00	10.39	25.71	14.02	16.36	16.36	14.02	7.48	11.69	10.39	6.54	4.16	1.95	23.37	101.31	110.81	20.78	9.35	23.91
Algirosphaera spp.	21.82	72.73	84.15	102.85	49.09	67.78	72.46	56.10	53.76	44.16	29.92	31.17	47.72	84.15	374.07	498.65	173.14	77.91	42.79
A. unicornis	0.00	0.00	4.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
A. brasiliensis	0.00	0.00	11.69	0.00	4.67	0.00	2.34	7.48	9.35	7.79	2.80	2.08	0.00	0.00	15.59	41.55	0.00	0.00	0.00
C. leptoporus	12.47	24.24	23.37	23.37	4.67	21.04	25.71	18.70	14.02	15.59	5.61	12.47	8.77	32.72	70.14	138.51	41.55	15.58	11.33
C. murrayi	7.79	0.00	0.00	23.37	7.01	4.67	14.02	18.70	21.04	7.79	1.87	3.12	8.77	28.05	62.34	166.22	41.55	6.23	5.03
C. pelagicus	0.00	0.00	0.00	4.67	0.00	0.00	0.00	1.87	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. mediterranea	0.00	3.46	7.01	0.00	4.67	4.67	0.00	5.61	2.34	0.00	0.00	1.04	0.97	4.67	0.00	27.70	0.00	6.23	3.78
D. tubifera	0.00	27.71	9.35	0.00	11.69	16.36	16.36	3.74	23.37	15.59	7.48	8.31	7.79	42.07	31.17	41.55	27.70	3.12	6.29
E. huxleyi	283.60	900.53	621.75	808.74	444.11	549.29	458.13	366.50	446.44	363.67	169.23	173.49	269.78	799.39	2221.01	3975.32	1322.80	825.88	431.70
F. profunda	93.50	384.46	243.09	247.76	191.67	217.38	156.61	172.03	261.79	226.00	113.13	127.78	97.39	406.71	865.03	803.37	297.80	193.23	66.71
G. ericsonii	56.10	96.98	130.89	172.97	65.45	88.82	74.80	61.71	70.12	93.52	42.07	43.63	79.86	285.16	568.89	997.29	332.43	158.94	51.60
G. muellerae	9.35	34.64	11.69	37.40	23.37	16.36	11.69	9.35	14.02	10.39	2.80	3.12	7.79	14.02	15.59	27.70	6.93	12.47	15.10
G. oceanica	35.84	65.81	58.44	88.82	53.76	23.37	30.39	28.05	16.36	28.57	16.83	11.43	29.22	32.72	116.90	83.11	83.11	56.10	37.76
G. omata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.04	0.00	0.00	23.38	0.00	0.00	0.00	0.00
G. flabellatus	4.67	55.42	42.07	4.67	30.39	39.74	30.39	26.18	25.71	20.78	12.15	12.47	8.77	37.40	124.69	83.11	34.63	31.17	10.07
H. carteri	3.12	6.93	9.35	9.35	2.34	2.34	4.67	1.87	0.00	0.00	0.93	3.12	0.97	0.00	7.79	0.00	0.00	9.35	3.78
N. coccolithom.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
O. fragilis	9.35	13.85	4.67	4.67	4.67	23.37	2.34	5.61	4.67	2.60	2.80	2.08	1.95	0.00	23.38	27.70	0.00	3.12	2.52
O. hydroideus	6.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.95	4.67	31.17	0.00	0.00	0.00	0.00
P. lepida	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.26
Pontosphaera spp.	0.00	0.00	0.00	0.00	0.00	2.34	0.00	1.87	0.00	0.00	0.93	1.04	0.00	0.00	15.59	0.00	0.00	0.00	1.26
R. sessilis	1.56	6.93	9.35	0.00	0.00	0.00	2.34	3.74	0.00	2.60	3.74	2.08	1.95	0.00	15.59	0.00	0.00	9.35	2.52
R. clavigera	9.35	10.39	11.69	42.07	4.67	21.04	23.37	9.35	14.02	5.20	10.28	12.47	6.82	18.70	77.93	55.41	34.63	3.12	3.78
R. xiphos	7.79	41.56	32.72	32.72	7.01	42.07	25.71	20.57	16.36	33.77	8.41	8.31	12.66	32.72	54.55	55.41	6.93	15.58	12.59
S. apsteinii	0.00	3.46	0.00	0.00	0.00	0.00	0.00	0.00	2.34	0.00	0.93	0.00	0.00	0.00	7.79	0.00	0.00	0.00	0.00
S. anthos	7.79	6.93	11.69	14.02	0.00	16.36	0.00	0.00	2.34	2.60	6.54	5.19	1.95	42.07	62.34	27.70	0.00	0.00	5.03
S. epigrosa	0.00	6.93	2.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S. halldalii	7.79	0.00	7.01	14.02	0.00	11.69	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.52
S. histrica	4.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S. lamina	0.00	13.85	14.02	0.00	2.34	0.00	2.34	5.61	2.34	5.20	2.80	4.16	0.00	9.35	15.59	41.55	20.78	0.00	2.52
S. molischii	3.12	0.00	2.34	9.35	0.00	2.34	4.67	5.61	4.67	0.00	2.80	2.08	1.95	32.72	46.76	207.77	27.70	24.93	7.55
S. nodosa	0.00	17.32	4.67	0.00	0.00	0.00	0.00	0.00	4.67	2.60	0.00	0.00	1.95	0.00	15.59	0.00	20.78	12.47	0.00
S. ossa	0.00	0.00	0.00	0.00	0.00	4.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S. pulchra	12.47	34.64	39.74	37.40	18.70	9.35	18.70	9.35	16.36	25.98	11.22	9.35	5.84	18.70	46.76	69.26	6.93	18.70	8.81
S. rotula	0.00	0.00	7.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Syracosphaera spp.	7.79	38.10	16.36	9.35	14.02	0.00	7.01	13.09	14.02	12.99	8.41	8.31	10.71	37.40	93.52	263.17	96.96	15.58	6.29
T. quadrilaminata	9.35	41.56	16.36	23.37	25.71	23.37	14.02	16.83	16.36	33.77	16.83	9.35	14.61	14.02	93.52	138.51	41.55	18.70	11.33
U. irregularis	21.82	41.56	39.74	37.40	23.37	46.75	21.04	13.09	21.04	12.99	7.48	5.19	9.74	23.37	38.97	83.11	13.85	9.35	8.81
U. tenuis	3.12	65.81	58.44	37.40	35.06	51.42	28.05	39.27	32.72	36.37	14.02	18.70	24.35	84.15	85.72	69.26	41.55	18.70	7.55
U. hulburtiana	0.00	6.93	2.34	0.00	7.01	0.00	2.34	1.87	2.34	10.39	1.87	0.00	0.97	0.00	46.76	0.00	6.93	3.12	6.29
U. sibogae	31.17	110.83	60.77	60.77	67.78	81.81	53.76	56.10	53.76	51.95	24.31	29.09	32.14	28.05	140.27	138.51	103.88	28.05	23.91
Holococcolithen	4.67	51.95	35.06	4.67	14.02	23.37	9.35	3.74	7.01	28.57	9.35	6.23	0.00	0.00	23.38	27.70	6.93	9.35	8.81

ESTOC - CI3u (3086 m): relative Artenanteile (%)

Probe	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Verschlusszeit	23.04.93	14.05.93	04.06.93	25.06.93	16.07.93	06.08.93	27.08.93	17.09.93	08.10.93	29.10.93	19.11.93	10.12.93	31.12.93	21.01.94	11.02.94	04.03.94	25.03.94	15.04.94	07.06.94
Sammelintervall (d)	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	52
Gesamtfluss	676.29	2216.68	1664.23	1874.60	1133.64	1432.83	1126.63	991.06	1189.74	1111.80	544.15	563.05	699.27	2136.39	5533.05	8199.96	2811.81	1601.90	833.19
Acanthoica spp.	0.00	0.47	1.54	0.75	1.44	1.14	1.24	0.75	0.98	0.93	1.20	0.74	0.28	1.09	1.83	1.35	0.74	0.58	2.87
Algirosphaera spp.	3.23	3.28	5.06	5.49	4.33	4.73	6.43	5.66	4.52	3.97	5.50	5.54	6.82	3.94	6.76	6.08	6.16	4.86	5.14
A. unicornis	0.00	0.00	0.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
A. brasiliensis	0.00	0.00	0.70	0.00	0.41	0.00	0.21	0.75	0.79	0.70	0.52	0.37	0.00	0.00	0.28	0.51	0.00	0.00	0.00
C. leptoporus	1.84	1.09	1.40	1.25	0.41	1.47	2.28	1.89	1.18	1.40	1.03	2.21	1.25	1.53	1.27	1.69	1.48	0.97	1.36
C. murrayi	1.15	0.00	0.00	1.25	0.62	0.33	1.24	1.89	1.77	0.70	0.34	0.55	1.25	1.31	1.13	2.03	1.48	0.39	0.60
C. pelagicus	0.00	0.00	0.00	0.25	0.00	0.00	0.00	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. mediterranea	0.00	0.16	0.42	0.00	0.41	0.33	0.00	0.57	0.20	0.00	0.00	0.18	0.14	0.22	0.00	0.34	0.00	0.39	0.45
D. tubifera	0.00	1.25	0.56	0.00	1.03	1.14	1.45	0.38	1.96	1.40	1.37	1.48	1.11	1.97	0.56	0.51	0.99	0.19	0.76
E. huxleyi	41.94	40.63	37.36	43.14	39.18	38.34	40.66	36.98	37.52	32.71	31.10	30.81	38.58	37.42	40.14	48.48	47.04	51.56	51.81
F. profunda	13.82	17.34	14.61	13.22	16.91	15.17	13.90	17.36	22.00	20.33	20.79	22.69	13.93	19.04	15.63	9.80	10.59	12.06	8.01
G. ericsonii	8.29	4.38	7.87	9.23	5.77	6.20	6.64	6.23	5.89	8.41	7.73	7.75	11.42	13.35	10.28	12.16	11.82	9.92	6.19
G. muellerae	1.38	1.56	0.70	2.00	2.06	1.14	1.04	0.94	1.18	0.93	0.52	0.55	1.11	0.66	0.28	0.34	0.25	0.78	1.81
G. oceanica	5.30	2.97	3.51	4.74	4.74	1.63	2.70	2.83	1.38	2.57	3.09	2.03	4.18	1.53	2.11	1.01	2.96	3.50	4.53
G. ornata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.18	0.00	0.00	0.42	0.00	0.00	0.00	0.00
G. flabellatus	0.69	2.50	2.53	0.25	2.68	2.77	2.70	2.64	2.16	1.87	2.23	2.21	1.25	1.75	2.25	1.01	1.23	1.95	1.21
H. carteri	0.46	0.31	0.56	0.50	0.21	0.16	0.41	0.19	0.00	0.00	0.17	0.55	0.14	0.00	0.14	0.00	0.00	0.58	0.45
N. coccolithom.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
O. fragilis	1.38	0.63	0.28	0.25	0.41	1.63	0.21	0.57	0.39	0.23	0.52	0.37	0.28	0.00	0.42	0.34	0.00	0.19	0.30
O. hydroideus	0.92	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.28	0.22	0.56	0.00	0.00	0.00	0.00
P. lepida	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15
Pontosphaera spp.	0.00	0.00	0.00	0.00	0.00	0.16	0.00	0.19	0.00	0.00	0.17	0.18	0.00	0.00	0.28	0.00	0.00	0.00	0.15
R. sessilis	0.23	0.31	0.56	0.00	0.00	0.00	0.21	0.38	0.00	0.23	0.69	0.37	0.28	0.00	0.28	0.00	0.00	0.58	0.30
R. clavigera	1.38	0.47	0.70	2.24	0.41	1.47	2.07	0.94	1.18	0.47	1.89	2.21	0.97	0.88	1.41	0.68	1.23	0.19	0.45
R. xiphos	1.15	1.88	1.97	1.75	0.62	2.94	2.28	2.08	1.38	3.04	1.55	1.48	1.81	1.53	0.99	0.68	0.25	0.97	1.51
S. apsteinii	0.00	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.00	0.17	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.00
S. anthos	1.15	0.31	0.70	0.75	0.00	1.14	0.00	0.00	0.20	0.23	1.20	0.92	0.28	1.97	1.13	0.34	0.00	0.00	0.60
S. epigrosa	0.00	0.31	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S. halldalii	1.15	0.00	0.42	0.75	0.00	0.82	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30
S. histrica	0.69	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S. lamina	0.00	0.63	0.84	0.00	0.21	0.00	0.21	0.57	0.20	0.47	0.52	0.74	0.00	0.44	0.28	0.51	0.74	0.00	0.30
S. molischii	0.46	0.00	0.14	0.50	0.00	0.16	0.41	0.57	0.39	0.00	0.52	0.37	0.28	1.53	0.85	2.53	0.99	1.56	0.91
S. nodosa	0.00	0.78	0.28	0.00	0.00	0.00	0.00	0.00	0.39	0.23	0.00	0.00	0.28	0.00	0.28	0.00	0.74	0.78	0.00
S. ossa	0.00	0.00	0.00	0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S. pulchra	1.84	1.56	2.39	2.00	1.65	0.65	1.66	0.94	1.38	2.34	2.06	1.66	0.84	0.88	0.85	0.84	0.25	1.17	1.06
S. rotula	0.00	0.00	0.42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Syracosphaera spp.	1.15	1.72	0.98	0.50	1.24	0.00	0.62	1.32	1.18	1.17	1.55	1.48	1.53	1.75	1.69	3.21	3.45	0.97	0.76
T. quadrilaminata	1.38	1.88	0.98	1.25	2.27	1.63	1.24	1.70	1.38	3.04	3.09	1.66	2.09	0.66	1.69	1.69	1.48	1.17	1.36
U. irregularis	3.23	1.88	2.39	2.00	2.06	3.26	1.87	1.32	1.77	1.17	1.37	0.92	1.39	1.09	0.70	1.01	0.49	0.58	1.06
U. tenuis	0.46	2.97	3.51	2.00	3.09	3.59	2.49	3.96	2.75	3.27	2.58	3.32	3.48	3.94	1.55	0.84	1.48	1.17	0.91
U. hulburtiana	0.00	0.31	0.14	0.00	0.62	0.00	0.21	0.19	0.20	0.93	0.34	0.00	0.14	0.00	0.85	0.00	0.25	0.19	0.76
U. sibogae	4.61	5.00	3.65	3.24	5.98	5.71	4.77	5.66	4.52	4.67	4.47	5.17	4.60	1.31	2.54	1.69	3.69	1.75	2.87
Holococcolithen	0.69	2.34	2.11	0.25	1.24	1.63	0.83	0.38	0.59	2.57	1.72	1.11	0.00	0.00	0.42	0.34	0.25	0.58	1.06

ESTOC - CI3u (3086 m): Coccolithenkarbonatfluss (mg m^{-2} d^{-1})

Probe	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Verschlusszeit	23.04.93	14.05.93	04.06.93	25.06.93	16.07.93	06.08.93	27.08.93	17.09.93	08.10.93	29.10.93	19.11.93	10.12.93	31.12.93	21.01.94	11.02.94	04.03.94	25.03.94	15.04.94	07.06.94
Sammelintervall (d)	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	52
Gesamtfluss	6.001	14.795	12.118	15.059	6.899	11.964	9.607	7.895	7.432	7.134	4.187	4.995	4.817	11.871	38.003	48.696	17.240	9.379	6.231
C. leptoporus	1.136	2.209	2.129	2.129	0.426	1.916	2.342	1.703	1.278	1.420	0.511	1.136	0.799	2.981	6.390	12.619	3.786	1.420	1.032
C. pelagicus	0.000	0.000	0.000	0.465	0.000	0.000	0.000	0.186	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
D. tubifera	0.000	0.042	0.014	0.000	0.018	0.025	0.025	0.006	0.035	0.023	0.011	0.012	0.012	0.063	0.047	0.062	0.042	0.005	0.009
E. huxleyi	0.596	1.891	1.306	1.698	0.933	1.154	0.962	0.770	0.938	0.764	0.355	0.364	0.591	1.679	5.122	8.348	2.981	1.898	0.907
F. profunda	0.150	0.615	0.389	0.396	0.307	0.348	0.251	0.275	0.419	0.362	0.181	0.204	0.274	0.651	1.384	1.285	0.476	0.309	0.107
G. ericsonii	0.050	0.087	0.118	0.156	0.059	0.080	0.067	0.056	0.063	0.084	0.038	0.039	0.096	0.433	0.512	1.047	0.299	0.222	0.065
G. muellerae	0.059	0.218	0.074	0.236	0.147	0.103	0.074	0.059	0.088	0.065	0.018	0.020	0.049	0.088	0.098	0.175	0.044	0.079	0.095
G. oceanica	0.570	1.046	0.929	1.412	0.855	0.372	0.483	0.446	0.260	0.454	0.268	0.182	0.465	0.520	1.859	1.321	1.321	0.892	0.800
H. carteri	0.445	0.989	1.335	1.335	0.334	0.334	0.668	0.267	0.000	0.000	0.134	0.445	0.139	0.000	1.113	0.000	0.000	1.335	0.539
O. fragilis	0.905	1.341	0.453	0.453	0.453	2.263	0.226	0.543	0.453	0.251	0.272	0.201	0.189	0.000	2.263	2.682	0.000	0.302	0.244
Pontosphaera spp.	0.000	0.000	0.000	0.000	0.000	0.159	0.000	0.127	0.000	0.000	0.064	0.071	0.000	0.000	1.060	0.000	0.000	0.000	0.086
R. clavigera	0.631	0.701	0.789	2.840	0.316	1.420	1.578	0.631	0.947	0.351	0.694	0.841	0.460	1.262	5.260	3.740	2.337	0.210	0.255
S. pulchra	0.199	0.554	0.636	0.598	0.299	0.150	0.299	0.150	0.262	0.416	0.180	0.150	0.093	0.299	0.748	1.108	0.111	0.299	0.141
Syracosphaera spp.	0.094	0.461	0.198	0.113	0.170	0.000	0.085	0.158	0.170	0.157	0.102	0.101	0.130	0.453	1.132	3.184	1.173	0.189	0.076
Syracosphaera spp. (small)	0.093	0.180	0.196	0.150	0.009	0.140	0.028	0.045	0.056	0.312	0.049	0.046	0.023	0.337	0.561	1.108	0.277	0.150	0.070
U. tenuis	0.027	0.573	0.508	0.325	0.305	0.447	0.244	0.342	0.285	0.316	0.122	0.163	0.212	0.732	0.746	0.603	0.362	0.163	0.066
U. sibogae	0.393	1.397	0.766	0.766	0.854	1.031	0.677	0.707	0.677	0.655	0.306	0.367	0.405	0.353	1.767	1.745	1.309	0.353	0.301
Holococcolithen	0.005	0.052	0.035	0.005	0.014	0.023	0.009	0.004	0.007	0.029	0.009	0.006	0.000	0.000	0.023	0.028	0.007	0.009	0.009
Resti. Arten	0.648	2.438	2.244	1.982	1.402	2.001	1.589	1.421	1.496	1.475	0.875	0.648	0.880	2.020	7.918	9.640	2.715	1.546	1.430

ESTOC - CI3u (3086 m): Rel. Anteil am Coccolithenkarbonatfluss (%)

Probe	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Verschlusszeit	23.04.93	14.05.93	04.06.93	25.06.93	16.07.93	06.08.93	27.08.93	17.09.93	08.10.93	29.10.93	19.11.93	10.12.93	31.12.93	21.01.94	11.02.94	04.03.94	25.03.94	15.04.94	07.06.94
Sammelintervall (d)	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	52
Gesamtfluss	6.001	14.795	12.118	15.059	6.899	11.964	9.607	7.895	7.432	7.134	4.187	4.995	4.817	11.871	38.003	48.696	17.240	9.379	6.231
C. leptoporus	18.92	14.93	17.57	14.14	6.17	16.02	24.38	21.58	17.19	19.90	12.20	22.73	16.58	25.11	16.81	25.91	21.96	15.13	16.56
C. pelagicus	0.00	0.00	0.00	3.09	0.00	0.00	0.00	2.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. tubifera	0.00	0.28	0.12	0.00	0.25	0.21	0.26	0.07	0.47	0.33	0.27	0.25	0.24	0.53	0.12	0.13	0.24	0.05	0.15
E. huxleyi	9.92	12.78	10.77	11.28	13.52	9.64	10.01	9.75	12.61	10.70	8.49	7.29	12.27	14.14	13.48	17.14	17.29	20.23	14.55
F. profunda	2.49	4.16	3.21	2.63	4.44	2.91	2.61	3.49	5.64	5.07	4.32	4.09	5.69	5.48	3.64	2.64	2.76	3.30	1.71
G. ericsonii	0.84	0.59	0.97	1.03	0.85	0.67	0.70	0.70	0.85	1.18	0.90	0.79	2.00	3.65	1.35	2.15	1.74	2.36	1.04
G. muellerae	0.98	1.47	0.61	1.56	2.13	0.86	0.77	0.75	1.19	0.92	0.42	0.39	1.02	0.74	0.26	0.36	0.25	0.84	1.53
G. oceanica	9.50	7.07	7.67	9.38	12.39	3.11	5.03	5.65	3.50	6.37	6.39	3.64	9.64	4.38	4.89	2.71	7.66	9.51	12.85
H. carteri	7.42	6.69	11.02	8.87	4.84	2.79	6.95	3.38	0.00	0.00	3.19	8.91	2.89	0.00	2.93	0.00	0.00	14.24	8.66
O. fragilis	15.08	9.06	3.73	3.00	6.56	18.91	2.35	6.88	6.09	3.52	6.48	4.03	3.91	0.00	5.95	5.51	0.00	3.22	3.91
Pontosphaera spp.	0.00	0.00	0.00	0.00	0.00	1.33	0.00	1.61	0.00	0.00	1.52	1.41	0.00	0.00	2.79	0.00	0.00	0.00	1.37
R. clavigera	10.52	4.74	6.51	18.86	4.57	11.87	16.42	7.99	12.74	4.92	16.58	16.84	9.55	10.63	13.84	7.68	13.56	2.24	4.09
S. pulchra	3.32	3.75	5.25	3.97	4.34	1.25	3.11	1.89	3.52	5.83	4.29	2.99	1.94	2.52	1.97	2.28	0.64	3.19	2.26
Syracosphaera spp.	1.57	3.12	1.63	0.75	2.46	0.00	0.88	2.01	2.28	2.20	2.43	2.01	2.69	3.81	2.98	6.54	6.81	2.01	1.22
Syracosphaera spp. (small)	1.56	1.22	1.62	0.99	0.14	1.17	0.29	0.57	0.75	4.37	1.16	0.91	0.49	2.84	1.48	2.28	1.61	1.59	1.13
U. tenuis	0.45	3.87	4.19	2.16	4.42	3.74	2.54	4.33	3.83	4.43	2.91	3.26	4.40	6.17	1.96	1.24	2.10	1.73	1.05
U. sibogae	6.54	9.44	6.32	5.08	12.38	8.62	7.05	8.95	9.11	9.18	7.31	7.34	8.41	2.98	4.65	3.58	7.59	3.77	4.84
Holococcolithen	0.08	0.35	0.29	0.03	0.20	0.20	0.10	0.05	0.09	0.40	0.22	0.12	0.00	0.00	0.06	0.06	0.04	0.10	0.14
Restl. Arten	10.80	16.48	18.52	13.16	20.33	16.72	16.54	18.00	20.13	20.68	20.90	12.98	18.28	17.01	20.83	19.80	15.75	16.48	22.94

ESTOC - CI4o (923 m): Coccolithenfluss (Mio Coccolithen m^{-2} d^{-1})											**ESTOC - CI4u (3070 m): Coccolithenfluss** (Mio Coccolithen m^{-2} d^{-1})									
Probe	1+2	3+4	5+6	7+8	9+10	11+12	13+14	15+16	17+18	19+20	1+2	3+4	5+6	7+8	9+10	11+12	13+14	15+16	17+18	19+20
Verschlusszeit	17.06.94	26.06.94	04.07.94	13.07.94	21.07.94	30.07.94	07.08.94	16.08.94	24.08.94	02.09.94	17.06.94	26.06.94	04.07.94	13.07.94	21.07.94	30.07.94	07.08.94	16.08.94	24.08.94	02.09.94
Sammelintervall (d)	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6
Gesamtfluss	19.84	104.72	313.92	188.18	99.37	103.50	129.72	236.55	47.43	84.24	457.75	427.95	372.98	796.19	944.99	663.92	1247.60	1058.20	792.04	464.32
Acanthoica spp.	0.00	0.00	0.00	2.96	0.43	0.00	1.59	2.34	0.39	1.01	2.28	4.23	0.00	7.61	9.02	2.82	5.62	2.13	1.76	3.26
Algirosphaera spp.	1.42	4.26	25.11	17.76	6.52	5.48	15.86	12.30	3.71	5.84	41.09	33.83	20.30	33.49	51.87	43.70	92.73	83.04	36.88	28.27
A. brasiliensis	0.00	0.00	0.00	0.00	0.00	0.00	0.63	0.00	0.29	0.00	3.42	0.00	0.00	0.00	2.26	1.41	0.00	2.13	3.51	0.00
C. leptoporus	2.18	4.26	11.42	6.77	4.13	6.70	4.12	7.03	1.17	2.28	11.42	8.46	9.30	12.18	22.55	9.87	33.72	19.16	21.07	6.52
C. caudatus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.13	0.00	4.35
C. murrayi	0.00	0.61	3.42	2.11	0.43	0.61	0.63	2.34	0.39	1.01	3.42	5.07	0.85	7.61	0.00	1.41	2.81	6.39	3.51	2.17
C. pelagicus	0.05	0.00	0.00	0.00	0.22	0.00	0.00	1.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.41	0.00	0.00	0.00	0.00
C. mediterranea	0.10	0.00	2.28	0.42	0.00	0.30	0.32	0.00	0.10	0.00	1.14	1.69	0.00	3.04	0.00	0.00	0.00	4.26	1.76	2.17
C. aculeata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.25	1.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. tubifera	0.20	1.52	5.71	0.85	1.74	0.91	2.85	4.10	0.49	1.52	6.85	5.92	8.46	13.70	15.79	9.87	22.48	14.90	14.05	5.44
E. huxleyi	8.62	56.01	144.97	60.89	37.40	44.75	43.77	76.12	12.30	28.42	186.07	159.85	156.46	321.22	354.09	341.12	539.50	442.87	331.92	165.28
F. profunda	0.10	0.61	10.27	9.73	5.00	1.83	11.42	16.39	3.81	6.98	31.96	42.29	20.30	86.77	74.43	45.11	89.92	95.81	72.00	34.80
G. corolla	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.52	0.00	1.41	0.00	0.00	0.00	0.00
G. ericsonii	0.76	3.65	18.26	13.53	7.39	5.48	6.34	21.66	3.42	6.47	29.68	36.37	24.53	73.07	85.70	36.65	123.64	95.81	68.49	31.53
G. muellerae	0.76	3.04	5.71	10.57	4.35	1.83	6.03	13.47	2.63	4.57	33.10	19.45	26.22	35.01	36.09	22.55	44.96	46.84	38.64	40.23
G. oceanica	1.47	2.74	14.84	13.95	4.35	4.26	8.56	14.05	2.54	4.44	22.83	15.22	25.37	39.58	47.36	28.19	64.63	34.07	38.64	18.49
G. ornata	0.00	0.00	0.00	0.42	0.00	0.00	0.00	2.34	0.29	0.13	0.00	0.00	0.85	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G. flabellatus	0.00	0.00	0.00	1.27	0.00	0.00	0.00	2.34	0.20	0.25	3.42	10.15	10.15	18.27	13.53	16.92	14.05	38.33	8.78	28.27
H. perplexus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.81	0.00	0.00	0.00
H. carteri	0.15	0.30	2.28	0.42	0.00	0.00	0.00	0.59	0.10	0.13	1.14	0.00	0.85	3.04	2.26	1.41	5.62	2.13	3.51	1.09
H. pavimentum	0.00	0.00	0.00	0.42	0.00	0.30	0.00	0.00	0.00	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.51	0.00
M. elegans	0.00	0.00	0.00	0.00	0.00	0.00	0.63	0.00	0.00	0.00	4.57	0.00	0.00	0.00	0.00	0.00	0.00	2.13	0.00	2.17
O. fragilis	0.05	0.00	1.14	0.00	0.65	0.30	0.95	1.76	0.00	0.00	0.00	4.23	5.07	7.61	0.00	1.41	2.81	0.00	1.76	2.17
P. lepida	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.14	0.85	0.00	1.52	2.26	0.00	0.00	0.00	0.00	1.09
Pontosphaera spp.	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.59	0.00	0.13	1.14	0.00	0.00	0.00	0.00	0.00	2.81	0.00	0.00	0.00
R. parvula	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.23	0.00	0.00	0.00	0.00
R. sessilis	0.00	0.00	0.00	0.42	0.22	0.30	0.00	1.17	0.00	0.25	2.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
R. clavigera	0.00	0.00	0.00	1.69	0.00	0.91	0.95	3.51	0.39	1.14	4.57	4.23	2.54	9.13	4.51	9.87	11.24	14.90	8.78	5.44
R. xiphos	0.76	5.48	9.13	5.07	4.78	3.96	4.12	4.68	1.66	2.16	3.42	17.76	10.15	19.79	81.19	8.46	16.86	17.03	19.32	8.70
S. anthos	0.00	0.30	0.00	0.00	0.00	0.00	0.32	0.00	0.00	0.00	1.14	0.00	0.00	0.00	2.26	2.82	2.81	0.00	0.00	0.00
S. borealis	0.00	0.00	0.00	0.00	0.00	0.30	0.00	0.00	0.00	0.13	0.00	0.85	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S. epigrosa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.76	0.00
S. halldalii	0.00	0.00	0.00	0.00	0.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S. histrica	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.27	0.00
S. lamina	0.05	0.00	0.00	1.27	0.22	0.91	0.00	2.34	0.00	0.13	2.28	2.54	2.54	4.57	0.00	0.00	2.81	0.00	0.00	0.00
S. molischii	0.10	0.00	0.00	0.00	0.43	0.00	0.00	0.00	0.20	0.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.51	3.26
S. nodosa	0.05	0.30	2.28	0.00	0.00	0.00	0.00	0.59	0.29	0.38	0.00	0.85	0.85	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S. pulchra	0.25	3.96	7.99	4.23	3.04	3.04	1.27	2.93	1.17	1.65	4.57	4.23	6.77	9.13	20.30	8.46	28.10	8.52	8.78	5.44
S. rotula	0.00	0.00	0.00	0.42	0.00	0.00	0.00	0.59	0.00	0.00	1.14	0.00	0.00	1.52	2.26	2.82	2.81	0.00	1.76	1.09
Syracosphaera spp.	0.20	0.91	0.00	1.69	3.04	1.22	2.22	4.10	0.49	1.27	0.00	6.77	3.38	6.09	11.28	0.00	2.81	6.39	1.76	2.17
U. irregularis	0.10	1.22	1.14	2.11	0.22	1.83	1.27	1.76	0.20	1.01	0.00	1.69	0.85	3.04	0.00	0.00	5.62	0.00	0.00	1.09
U. tenuis	0.25	0.61	0.00	4.23	1.30	1.83	3.17	8.20	4.10	3.30	13.70	9.30	9.30	13.70	24.81	22.55	28.10	40.45	33.37	13.05
U. sibogae	1.42	7.91	25.11	12.69	10.65	11.57	8.56	19.91	3.32	5.84	29.68	21.14	19.45	42.63	47.36	26.78	75.87	61.75	38.64	33.71
Holococcolithen	0.36	4.57	17.12	10.99	1.52	3.35	2.54	7.03	3.42	2.54	6.85	7.61	7.61	18.27	33.83	8.46	16.86	12.78	14.05	9.79

ESTOC - CI4o (923 m): relative Artenanteile (%)											ESTOC - CI4u (3070 m): relative Artenanteile (%)									
Probe	1+2	3+4	5+6	7+8	9+10	11+12	13+14	15+16	17+18	19+20	1+2	3+4	5+6	7+8	9+10	11+12	13+14	15+16	17+18	19+20
Verschlusszeit	17.06.94	26.06.94	04.07.94	13.07.94	21.07.94	30.07.94	07.08.94	16.08.94	24.08.94	02.09.94	17.06.94	26.06.94	04.07.94	13.07.94	21.07.94	30.07.94	07.08.94	16.08.94	24.08.94	02.09.94
Sammelintervall (d)	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6
Gesamtfluss	19.84	104.72	313.92	188.18	99.37	103.50	129.72	236.55	47.43	84.24	457.75	427.95	372.98	796.19	944.99	663.92	1247.60	1058.20	792.04	464.32
Acanthoica spp.	0.00	0.00	0.00	1.57	0.44	0.00	1.22	0.99	0.82	1.20	0.50	0.99	0.00	0.96	0.95	0.42	0.45	0.20	0.22	0.70
Algirosphaera spp.	7.16	4.07	8.00	9.44	6.56	5.29	12.22	5.20	7.82	6.93	8.98	7.91	5.44	4.21	5.49	6.58	7.43	7.85	4.66	6.09
A. brasiliensis	0.00	0.00	0.00	0.00	0.00	0.00	0.49	0.00	0.62	0.00	0.75	0.00	0.00	0.00	0.24	0.21	0.00	0.20	0.44	0.00
C. leptoporus	11.00	4.07	3.64	3.60	4.16	6.47	3.18	2.97	2.47	2.71	2.49	1.98	2.49	1.53	2.39	1.49	2.70	1.81	2.66	1.41
C. caudatus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.00	0.94
C. murrayi	0.00	0.58	1.09	1.12	0.44	0.59	0.49	0.99	0.82	1.20	0.75	1.19	0.23	0.96	0.00	0.21	0.23	0.60	0.44	0.47
C. pelagicus	0.26	0.00	0.00	0.00	0.22	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.21	0.00	0.00	0.00	0.00
C. mediterranea	0.51	0.00	0.73	0.22	0.00	0.29	0.24	0.00	0.21	0.00	0.25	0.40	0.00	0.38	0.00	0.00	0.00	0.40	0.22	0.47
C. aculeata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.21	0.30	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. tubifera	1.02	1.45	1.82	0.45	1.75	0.88	2.20	1.73	1.03	1.81	1.50	1.38	2.27	1.72	1.67	1.49	1.80	1.41	1.77	1.17
E. huxleyi	43.48	53.49	46.18	32.36	37.64	43.24	33.74	32.18	25.93	33.73	40.65	37.35	41.95	40.34	37.47	51.38	43.24	41.85	41.91	35.60
F. profunda	0.51	0.58	3.27	5.17	5.03	1.76	8.80	6.93	8.02	8.28	6.98	9.88	5.44	10.90	7.88	6.79	7.21	9.05	9.09	7.49
G. ericsonii	3.84	3.49	5.82	7.19	7.44	5.29	4.89	9.16	7.20	7.68	6.48	8.50	6.58	9.18	9.07	5.52	9.91	9.05	8.65	6.79
G. muellerae	3.84	2.91	1.82	5.62	4.38	1.76	4.65	5.69	5.56	5.42	7.23	4.55	7.03	4.40	3.82	3.40	3.60	4.43	4.88	8.67
G. oceanica	7.42	2.62	4.73	7.42	4.38	4.12	6.60	5.94	5.35	5.27	4.99	3.56	6.80	4.97	5.01	4.25	5.18	3.22	4.88	3.98
G. ornata	0.00	0.00	0.00	0.22	0.00	0.00	0.00	0.99	0.62	0.15	0.00	0.00	0.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G. flabellatus	0.00	0.00	0.00	0.67	0.00	0.00	0.00	0.99	0.41	0.30	0.75	2.37	2.72	2.29	1.43	2.55	1.13	3.62	1.11	6.09
H. perplexus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.23	0.00	0.00	0.00
H. carteri	0.77	0.29	0.73	0.22	0.00	0.00	0.00	0.25	0.21	0.15	0.25	0.00	0.23	0.38	0.24	0.21	0.45	0.20	0.44	0.23
H. pavimentum	0.00	0.00	0.00	0.22	0.00	0.29	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.44	0.00
M. elegans	0.00	0.00	0.00	0.00	0.00	0.00	0.49	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.00	0.47
O. fragilis	0.26	0.00	0.36	0.00	0.66	0.29	0.73	0.74	0.00	0.00	0.00	0.99	1.36	0.96	0.00	0.21	0.23	0.00	0.22	0.47
P. lepida	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.20	0.00	0.19	0.24	0.00	0.00	0.00	0.00	0.23
Pontosphaera spp.	0.51	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.00	0.15	0.25	0.00	0.00	0.00	0.00	0.00	0.23	0.00	0.00	0.00
R. parvula	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.64	0.00	0.00	0.00	0.00
R. sessilis	0.00	0.00	0.00	0.22	0.22	0.29	0.00	0.50	0.00	0.30	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
R. clavigera	0.00	0.00	0.00	0.90	0.00	0.88	0.73	1.49	0.82	1.36	1.00	0.99	0.68	1.15	0.48	1.49	0.90	1.41	1.11	1.17
R. xiphos	3.84	5.23	2.91	2.70	4.81	3.82	3.18	1.98	3.50	2.56	0.75	4.15	2.72	2.49	8.59	1.27	1.35	1.61	2.44	1.87
S. anthos	0.00	0.29	0.00	0.00	0.00	0.00	0.24	0.00	0.00	0.00	0.25	0.00	0.00	0.00	0.24	0.42	0.23	0.00	0.00	0.00
S. borealis	0.00	0.00	0.00	0.00	0.00	0.29	0.00	0.00	0.00	0.15	0.00	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S. corolla	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.19	0.00	0.21	0.00	0.00	0.00	0.00
S. epigrosa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.22	0.00
S. halldalii	0.00	0.00	0.00	0.00	0.44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S. histrica	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.67	0.00
S. lamina	0.26	0.00	0.00	0.67	0.22	0.88	0.00	0.99	0.00	0.15	0.50	0.59	0.68	0.57	0.00	0.00	0.23	0.00	0.00	0.00
S. molischii	0.51	0.00	0.00	0.00	0.44	0.00	0.00	0.00	0.41	0.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.44	0.70
S. nodosa	0.26	0.29	0.73	0.00	0.00	0.00	0.00	0.25	0.62	0.45	0.00	0.20	0.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S. pulchra	1.28	3.78	2.55	2.25	3.06	2.94	0.98	1.24	2.47	1.96	1.00	0.99	1.81	1.15	2.15	1.27	2.25	0.80	1.11	1.17
S. rotula	0.00	0.00	0.00	0.22	0.00	0.00	0.00	0.25	0.00	0.00	0.25	0.00	0.00	0.19	0.24	0.42	0.23	0.00	0.22	0.23
Syracosphaera spp.	1.02	0.87	0.00	0.90	3.06	1.18	1.71	1.73	1.03	1.51	0.00	1.58	0.91	0.76	1.19	0.00	0.23	0.60	0.22	0.47
U. irregularis	0.51	1.16	0.36	1.12	0.22	1.76	0.98	0.74	0.41	1.20	0.00	0.40	0.23	0.38	0.00	0.00	0.45	0.00	0.00	0.23
U. tenuis	1.28	0.58	0.00	2.25	1.31	1.76	2.44	3.47	8.64	3.92	2.99	2.17	2.49	1.72	2.63	3.40	2.25	3.82	4.21	2.81
U. sibogae	7.16	7.56	8.00	6.74	10.72	11.18	6.60	8.42	7.00	6.93	6.48	4.94	5.22	5.35	5.01	4.03	6.08	5.84	4.88	7.26
Holococcolithen	1.79	4.36	5.45	5.84	1.53	3.24	1.96	2.97	7.20	3.01	1.50	1.78	2.04	2.29	3.58	1.27	1.35	1.21	1.77	2.11

ESTOC - CI4o (923 m): Coccolithenkarbonatfluss (mg m^{-2} d^{-1})

Probe	1+2	3+4	5+6	7+8	9+10	11+12	13+14	15+16	17+18	19+20
Verschlußzeit	17.06.94	26.06.94	04.07.94	13.07.94	21.07.94	30.07.94	07.08.94	16.08.94	24.08.94	02.09.94
Sammelintervall (d)	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6
Gesamtfluß	0.358	1.297	2.939	1.827	1.011	1.239	1.234	2.625	0.408	0.741
C. leptoporus	0.199	0.388	1.040	0.616	0.376	0.610	0.376	0.640	0.107	0.208
C. pelagicus	0.005	0.000	0.000	0.000	0.022	0.000	0.000	0.117	0.000	0.000
D. tubifera	0.000	0.002	0.009	0.001	0.003	0.001	0.004	0.006	0.001	0.002
E. huxleyi	0.018	0.133	0.304	0.142	0.091	0.102	0.097	0.202	0.026	0.060
F. profunda	0.000	0.001	0.016	0.016	0.008	0.003	0.018	0.026	0.006	0.011
G. ericsonii	0.001	0.003	0.016	0.012	0.007	0.005	0.009	0.019	0.003	0.006
G. muellerae	0.005	0.019	0.036	0.067	0.027	0.012	0.038	0.085	0.017	0.029
G. oceanica	0.048	0.189	0.236	0.222	0.069	0.068	0.136	0.317	0.040	0.071
H. carteri	0.022	0.043	0.326	0.060	0.000	0.000	0.000	0.084	0.014	0.018
O. fragilis	0.005	0.000	0.110	0.000	0.063	0.029	0.092	0.170	0.000	0.000
Pontosphaera spp.	0.007	0.000	0.000	0.000	0.000	0.000	0.000	0.040	0.000	0.009
R. clavigera	0.000	0.000	0.000	0.114	0.000	0.062	0.064	0.237	0.026	0.077
S. pulchra	0.004	0.063	0.128	0.068	0.049	0.049	0.020	0.047	0.019	0.026
Syracosphaera spp.	0.002	0.011	0.000	0.020	0.037	0.015	0.027	0.050	0.006	0.015
Syracosphaera spp. (small)	0.001	0.002	0.009	0.007	0.004	0.005	0.001	0.014	0.002	0.004
U. tenuis	0.002	0.005	0.000	0.037	0.011	0.016	0.028	0.071	0.036	0.029
U. sibogae	0.018	0.100	0.316	0.160	0.134	0.146	0.108	0.251	0.042	0.074
Holococcolithen	0.000	0.005	0.017	0.011	0.002	0.003	0.003	0.007	0.003	0.003
Restl. Arten	0.022	0.331	0.374	0.274	0.108	0.114	0.213	0.244	0.061	0.100

CI4u (3070 m): Coccolithenkarbonatfluss (mg m^{-2} d^{-1})

Probe	1+2	3+4	5+6	7+8	9+10	11+12	13+14	15+16	17+18	19+20
Verschlußzeit	17.06.94	26.06.94	04.07.94	13.07.94	21.07.94	30.07.94	07.08.94	16.08.94	24.08.94	02.09.94
Sammelintervall (d)	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6
Gesamtfluß	3.806	3.457	3.620	6.664	7.232	5.671	10.732	7.735	6.642	3.913
C. leptoporus	1.040	0.770	0.848	1.109	2.055	0.899	3.072	1.746	1.920	0.594
C. pelagicus	0.000	0.000	0.000	0.000	0.000	0.140	0.000	0.000	0.000	0.000
D. tubifera	0.010	0.009	0.013	0.021	0.024	0.015	0.034	0.022	0.021	0.008
E. huxleyi	0.391	0.368	0.329	0.675	0.744	0.716	1.133	0.930	0.697	0.347
F. profunda	0.051	0.068	0.032	0.139	0.119	0.072	0.144	0.153	0.115	0.056
G. ericsonii	0.045	0.033	0.037	0.088	0.077	0.056	0.111	0.086	0.090	0.028
G. muellerae	0.209	0.123	0.165	0.221	0.227	0.142	0.283	0.295	0.243	0.253
G. oceanica	0.363	0.242	0.565	0.920	0.753	1.076	1.028	0.542	0.614	0.536
H. carteri	0.163	0.000	0.121	0.435	0.322	0.201	0.803	0.304	0.502	0.155
O. fragilis	0.000	0.409	0.491	0.737	0.000	0.136	0.272	0.000	0.170	0.211
Pontosphaera spp.	0.078	0.000	0.000	0.000	0.000	0.000	0.191	0.000	0.000	0.000
R. clavigera	0.308	0.285	0.171	0.617	0.304	0.666	0.759	1.006	0.593	0.367
S. pulchra	0.073	0.068	0.108	0.146	0.325	0.135	0.450	0.136	0.140	0.087
Syracosphaera spp.	0.000	0.082	0.041	0.074	0.136	0.000	0.034	0.077	0.021	0.026
Syracosphaera spp. (small)	0.018	0.017	0.014	0.030	0.018	0.028	0.034	0.000	0.049	0.017
U. tenuis	0.119	0.081	0.081	0.119	0.216	0.196	0.244	0.352	0.290	0.114
U. sibogae	0.374	0.266	0.245	0.537	0.597	0.337	0.956	0.778	0.487	0.425
Holococcolithen	0.007	0.008	0.008	0.018	0.034	0.008	0.017	0.013	0.014	0.010
Restl. Arten	0.557	0.629	0.352	0.779	1.281	0.846	1.169	1.295	0.674	0.679

ESTOC - CI4o (923 m): Rel. Anteil am Coccolithenkarbonatfluss (%)

Probe	1+2	3+4	5+6	7+8	9+10	11+12	13+14	15+16	17+18	19+20
Verschlußzeit	17.06.94	26.06.94	04.07.94	13.07.94	21.07.94	30.07.94	07.08.94	16.08.94	24.08.94	02.09.94
Sammelintervall (d)	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6
Gesamtfluß	0.358	1.297	2.939	1.827	1.011	1.239	1.234	2.625	0.408	0.741
C. leptoporus	55.47	29.94	35.38	33.74	37.22	49.24	30.44	24.38	26.15	28.07
C. pelagicus	1.41	0.00	0.00	0.00	2.14	0.00	0.00	4.44	0.00	0.00
D. tubifera	0.08	0.18	0.29	0.07	0.26	0.11	0.35	0.23	0.18	0.31
E. huxleyi	5.06	10.25	10.36	7.78	9.03	8.20	7.88	7.68	6.33	8.05
F. profunda	0.05	0.08	0.56	0.85	0.79	0.24	1.48	1.00	1.49	1.51
G. ericsonii	0.19	0.25	0.56	0.67	0.66	0.40	0.69	0.74	0.75	0.79
G. muellerae	1.34	1.48	1.22	3.65	2.71	0.93	3.08	3.23	4.07	3.88
G. oceanica	13.28	14.56	8.03	12.14	6.84	5.47	11.03	12.06	9.89	9.52
H. carteri	6.07	3.35	11.10	3.31	0.00	0.00	0.00	3.19	3.42	2.45
O. fragilis	1.37	0.00	3.76	0.00	6.24	2.38	7.46	6.48	0.00	0.00
Pontosphaera spp.	1.93	0.00	0.00	0.00	0.00	0.00	0.00	1.52	0.00	1.16
R. clavigera	0.00	0.00	0.00	6.25	0.00	4.97	5.20	9.03	6.46	10.40
S. pulchra	1.13	4.88	4.35	3.70	4.82	3.93	1.64	1.78	4.59	3.56
Syracosphaera spp.	0.69	0.85	0.00	1.12	3.64	1.19	2.18	1.89	1.45	2.07
Syracosphaera spp. (small)	0.23	0.19	0.31	0.37	0.43	0.39	0.10	0.54	0.48	0.55
U. tenuis	0.62	0.41	0.00	2.01	1.12	1.28	2.24	2.72	8.74	3.87
U. sibogae	5.00	7.69	10.77	8.75	13.28	11.76	8.74	9.55	10.25	9.92
Holococcolithen	0.10	0.35	0.58	0.60	0.15	0.27	0.21	0.27	0.84	0.34
Restl. Arten	6.00	25.54	12.74	15.00	10.67	9.24	17.27	9.28	14.93	13.56

CI4u (3070 m): Rel. Anteil am Coccolithenkarbonatfluss (%)

Probe	1+2	3+4	5+6	7+8	9+10	11+12	13+14	15+16	17+18	19+20
Verschlußzeit	17.06.94	26.06.94	04.07.94	13.07.94	21.07.94	30.07.94	07.08.94	16.08.94	24.08.94	02.09.94
Sammelintervall (d)	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6
Gesamtfluß	3.806	3.457	3.620	6.664	7.232	5.671	10.732	7.735	6.642	3.913
C. leptoporus	27.32	22.28	23.41	16.65	28.41	15.85	28.62	22.57	28.90	15.19
C. pelagicus	0.00	0.00	0.00	0.00	0.00	2.47	0.00	0.00	0.00	0.00
D. tubifera	0.27	0.26	0.35	0.31	0.33	0.26	0.31	0.29	0.32	0.21
E. huxleyi	10.27	10.63	9.08	10.12	10.28	12.63	10.56	12.02	10.49	8.87
F. profunda	1.34	1.96	0.90	2.08	1.65	1.27	1.34	1.98	1.73	1.42
G. ericsonii	1.19	0.95	1.03	1.32	1.07	0.98	1.04	1.11	1.36	0.73
G. muellerae	5.48	3.54	4.56	3.31	3.14	2.51	2.64	3.81	3.66	6.48
G. oceanica	9.54	7.00	15.60	13.80	10.41	18.97	9.57	7.00	9.25	13.70
H. carteri	4.29	0.00	3.34	6.53	4.46	3.55	7.48	3.93	7.56	3.97
O. fragilis	0.00	11.84	13.57	11.06	0.00	2.41	2.53	0.00	2.56	5.38
Pontosphaera spp.	2.04	0.00	0.00	0.00	0.00	0.00	1.78	0.00	0.00	0.00
R. clavigera	8.10	8.26	4.73	9.25	4.21	11.74	7.07	13.01	8.92	9.38
S. pulchra	1.92	1.96	2.99	2.19	4.49	2.39	4.19	1.76	2.12	2.22
Syracosphaera spp.	0.00	2.37	1.13	1.11	1.89	0.00	0.32	1.00	0.32	0.67
Syracosphaera spp. (small)	0.48	0.49	0.37	0.46	0.25	0.50	0.31	0.00	0.74	0.44
U. tenuis	3.13	2.34	2.24	1.79	2.98	3.46	2.28	4.55	4.37	2.90
U. sibogae	9.83	7.71	6.77	8.06	8.25	5.95	8.91	10.06	7.33	10.85
Holococcolithen	0.18	0.22	0.21	0.27	0.47	0.15	0.16	0.17	0.21	0.25
Restl. Arten	14.64	18.20	9.72	11.70	17.71	14.91	10.89	16.74	10.15	17.34

ESTOC - Cl5m (976 m): Coccolithenfluss (Mio Coccolithen m^{-2} d^{-1})

Probe	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Verschlusszeit	24.09.94	16.10.94	07.11.94	29.11.94	21.12.94	12.01.95	03.02.95	25.02.95	19.03.95	10.04.95	02.05.95	24.05.95	15.06.95	07.07.95	29.07.95	20.08.95	11.09.95	03.10.95	25.10.95	12.11.95
Sammelintervall (d)	19	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	18
Gesamtfluss	179.12	222.25	205.50	371.76	261.62	454.04	755.04	1020.97	1182.77	1758.53	737.68	102.63	184.51	338.17	266.69	432.88	440.82	194.40	207.41	193.92
Acanthoica spp.	0.00	1.47	0.76	2.94	1.12	4.41	4.96	11.16	12.40	14.88	3.72	0.67	1.89	1.89	5.51	3.53	4.41	0.99	0.00	0.00
Algirosphaera spp.	20.28	20.20	23.04	30.86	2.81	29.09	55.79	59.51	52.07	89.27	28.52	9.43	9.45	22.04	15.98	26.45	28.21	6.45	8.83	13.39
A. unicornis	0.00	0.37	0.38	0.00	0.00	0.88	0.00	0.00	0.00	0.00	1.24	0.22	0.31	0.00	0.00	0.00	1.76	0.00	0.00	0.00
A. brasiliensis	0.00	0.37	0.76	0.00	1.12	0.00	0.00	0.00	0.00	5.95	1.24	1.12	0.94	1.26	4.41	0.00	0.88	0.00	1.47	0.46
C. leptoporus	2.30	4.04	1.89	2.94	10.11	12.34	3.72	20.46	19.84	17.85	7.44	1.35	3.46	5.67	1.65	1.76	3.53	5.46	9.32	2.77
C. murrayi	3.06	3.31	2.27	6.61	0.56	8.82	11.16	16.74	12.40	29.76	8.68	2.25	2.83	1.89	3.31	3.53	3.53	1.98	0.49	0.46
C. pelagicus	0.00	0.37	0.00	0.73	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. mediterranea	0.00	0.00	0.00	0.73	1.12	0.00	0.00	0.00	0.00	11.90	0.00	0.67	0.63	0.63	0.00	0.00	1.76	0.00	0.00	0.92
D. tubifera	2.68	1.47	1.89	4.41	1.68	0.88	3.72	11.16	12.40	8.93	4.96	1.35	1.57	7.56	5.51	4.41	5.29	1.98	3.92	3.69
E. huxleyi	61.24	77.88	72.53	127.84	26.39	94.33	254.16	444.47	498.40	845.05	303.75	37.73	70.53	98.87	81.55	161.34	152.52	42.15	52.46	69.26
F. profunda	10.72	22.41	31.35	51.43	52.77	108.44	95.46	148.78	119.02	181.51	75.63	7.19	25.19	49.12	62.82	82.87	73.18	47.61	43.64	31.40
G. corolla	0.00	0.00	0.00	0.00	0.00	0.00	1.24	0.00	0.00	0.00	1.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G. ericsonii	19.52	22.41	15.11	24.24	74.67	48.49	117.78	132.04	213.25	258.87	96.70	8.31	15.43	49.12	17.08	35.27	52.90	42.65	29.42	16.16
G. muellerae	9.19	9.92	5.67	15.43	34.25	15.87	9.92	14.88	34.71	23.80	11.16	1.57	2.83	9.45	4.41	5.29	7.93	7.93	8.34	3.23
G. oceanica	7.27	8.82	9.44	17.63	20.21	17.63	27.28	33.47	32.23	26.78	13.64	3.14	4.72	16.37	7.71	6.17	15.87	7.44	7.85	11.54
G. ornata	0.00	0.00	0.76	1.47	1.12	0.00	3.72	0.00	2.48	11.90	0.00	0.00	0.31	0.00	1.10	0.88	1.76	0.00	0.00	0.46
G. flabellatus	1.91	1.84	0.76	5.14	1.68	1.76	4.96	7.44	7.44	11.90	7.44	1.35	1.26	3.78	6.61	7.05	9.70	2.48	2.45	3.23
H. perplexus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.31	0.00	0.55	0.00	0.00	0.00	0.00	0.00
H. carteri	0.00	0.37	1.13	0.00	0.00	0.88	0.00	0.00	0.00	0.00	0.00	0.00	0.31	1.26	0.55	0.00	0.00	0.50	1.47	1.85
M. elegans	1.15	0.00	0.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.63	0.00	1.76	0.00	0.00	0.00	0.00
N. coccolithom.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.46
O. fragilis	1.91	1.10	1.51	1.47	1.68	0.88	1.24	7.44	4.96	2.98	0.00	0.67	0.31	5.04	0.00	3.53	3.53	0.00	0.49	0.92
O. hydroideus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.46
P. lepida	0.38	1.10	0.38	0.73	0.00	0.88	0.00	0.00	4.96	0.00	2.48	0.22	0.00	0.00	1.10	1.76	0.88	0.00	0.00	0.00
Pontosphaera spp.	0.77	0.37	0.00	0.73	0.00	0.00	0.00	1.86	2.48	0.00	1.24	0.22	0.31	0.00	0.55	0.88	0.00	0.50	0.00	0.46
R. parvula	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.24	0.00	0.00	0.00	2.20	0.00	0.00	0.00	0.00	0.00
R. sessilis	0.00	0.73	0.76	0.00	1.12	0.88	3.72	0.00	0.00	0.00	0.00	0.00	0.63	0.00	0.55	0.00	0.88	0.00	0.00	0.46
R. clavigera	5.74	1.84	3.02	5.14	1.12	8.82	13.64	7.44	12.40	17.85	13.64	1.57	6.93	6.93	4.96	7.93	7.05	2.98	2.94	2.31
R. xiphos	2.68	5.51	4.16	15.43	1.68	13.22	17.36	22.32	34.71	20.83	38.43	3.37	3.15	3.78	4.41	13.22	10.58	0.99	2.94	1.85
S. anthos	0.77	4.04	1.13	0.00	1.12	3.53	4.96	3.72	17.36	2.98	3.72	0.67	0.63	1.89	1.10	2.64	0.88	0.99	0.49	0.92
S. halldalii	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.90	0.00	1.26	0.00	0.00	0.88	0.00	0.00	0.00
S. histrica	0.00	0.00	0.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S. lamina	0.77	0.73	0.76	0.73	0.00	1.76	6.20	0.00	2.48	11.90	0.00	0.00	0.63	0.00	0.00	1.76	0.00	0.00	0.98	0.00
S. molischii	0.77	0.73	0.00	0.00	0.00	1.76	7.44	0.00	7.44	11.90	1.24	0.45	0.94	0.63	0.00	2.64	0.88	1.49	0.00	0.92
S. nodosa	0.38	0.37	0.00	2.20	0.56	3.53	7.44	3.72	2.48	0.00	0.00	0.45	0.00	1.26	0.55	0.88	0.88	0.00	0.00	0.00
S. pulchra	1.53	2.94	1.13	4.41	1.12	9.70	11.16	3.72	12.40	14.88	7.44	1.12	2.52	3.78	2.20	5.29	7.93	0.00	2.45	3.69
S. rotula	0.00	1.10	0.76	0.73	0.00	24.69	2.48	0.00	2.48	0.00	7.44	0.90	0.94	0.63	0.00	2.64	0.00	0.00	0.49	0.00
Syracosphaera spp.	1.53	2.94	0.76	5.88	5.05	4.41	14.88	7.44	12.40	14.88	8.68	2.25	1.57	1.89	2.76	2.64	3.53	0.50	0.98	3.23
T. quadrilaminata	0.00	0.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.22	0.00	0.00	0.00	1.76	0.00	0.00	0.49	0.46
U. irregularis	2.68	2.57	1.13	5.14	2.25	2.64	4.96	0.00	0.00	5.95	3.72	0.67	0.63	1.89	2.20	2.64	2.64	4.46	3.43	3.23
U. tenuis	4.98	6.24	9.44	8.82	4.49	19.40	17.36	14.88	9.92	14.88	9.92	3.14	6.61	7.56	6.06	10.58	6.17	2.98	5.88	7.39
U. hulburtiana	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.49	0.00
U. sibogae	9.19	7.71	8.69	15.43	9.54	6.17	21.08	39.05	37.19	65.46	57.03	6.96	11.97	20.15	10.47	18.51	22.04	10.41	12.75	7.39
Holococcolithen	4.59	4.78	0.76	5.88	0.00	2.64	9.92	3.72	2.48	29.76	16.12	1.35	2.52	8.82	6.61	5.29	3.53	1.49	2.94	0.46

ESTOC - CI5m (976 m): relative Artenanteile (%)

Probe	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Verschlusszeit	24.09.94	16.10.94	07.11.94	29.11.94	21.12.94	12.01.95	03.02.95	25.02.95	19.03.95	10.04.95	02.05.95	24.05.95	15.06.95	07.07.95	29.07.95	20.08.95	11.09.95	03.10.95	25.10.95	12.11.95
Sammelintervall (d)	19	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	18
Gesamtfluss	179.12	222.25	205.50	371.76	261.62	454.04	755.04	1020.97	1182.77	1758.53	737.68	102.63	184.51	338.17	266.69	432.88	440.82	194.40	207.41	193.92
Acanthoica spp.	0.00	0.66	0.37	0.79	0.43	0.97	0.66	1.09	1.05	0.85	0.50	0.66	1.02	0.56	2.07	0.81	1.00	0.51	0.00	0.00
Algirosphaera spp.	11.32	9.09	11.21	8.30	1.07	6.41	7.39	5.83	4.40	5.08	3.87	9.19	5.12	6.52	5.99	6.11	6.40	3.32	4.26	6.90
A. unicornis	0.00	0.17	0.18	0.00	0.00	0.19	0.00	0.00	0.00	0.00	0.17	0.22	0.17	0.00	0.00	0.00	0.40	0.00	0.00	0.00
A. brasiliensis	0.00	0.17	0.37	0.00	0.43	0.00	0.00	0.00	0.00	0.34	0.17	1.09	0.51	0.37	1.65	0.00	0.20	0.00	0.71	0.24
C. leptoporus	1.28	1.82	0.92	0.79	3.86	2.72	0.49	2.00	1.68	1.02	1.01	1.31	1.88	1.68	0.62	0.41	0.80	2.81	4.49	1.43
C. murrayi	1.71	1.49	1.10	1.78	0.21	1.94	1.48	1.64	1.05	1.69	1.18	2.19	1.54	0.56	1.24	0.81	0.80	1.02	0.24	0.24
C. pelagicus	0.00	0.17	0.00	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. mediterranea	0.00	0.00	0.00	0.20	0.43	0.00	0.00	0.00	0.00	0.68	0.00	0.66	0.34	0.19	0.00	0.00	0.40	0.00	0.00	0.48
D. tubifera	1.50	0.66	0.92	1.19	0.64	0.19	0.49	1.09	1.05	0.51	0.67	1.31	0.85	2.23	2.07	1.02	1.20	1.02	1.89	1.90
E. huxleyi	34.19	35.04	35.29	34.39	10.09	20.78	33.66	43.53	42.14	48.05	41.18	36.76	38.23	29.24	30.58	37.27	34.60	21.68	25.30	35.71
F. profunda	5.98	10.08	15.26	13.83	20.17	23.88	12.64	14.57	10.06	10.32	10.25	7.00	13.65	14.53	23.55	19.14	16.60	24.49	21.04	16.19
G. ericsonii	10.90	10.08	7.35	6.52	28.54	10.68	15.60	12.93	18.03	14.72	13.11	8.10	8.36	14.53	6.40	8.15	12.00	21.94	14.18	8.33
G. muellerae	5.13	4.46	2.76	4.15	13.09	3.50	1.31	1.46	2.94	1.35	1.51	1.53	1.54	2.79	1.65	1.22	1.80	4.08	4.02	1.67
G. oceanica	4.06	3.97	4.60	4.74	7.73	3.88	3.61	3.28	2.73	1.52	1.85	3.06	2.56	4.84	2.89	1.43	3.60	3.83	3.78	5.95
G. ornata	0.00	0.00	0.37	0.40	0.43	0.00	0.49	0.00	0.21	0.68	0.00	0.00	0.17	0.00	0.41	0.20	0.40	0.00	0.00	0.24
G. flabellatus	1.07	0.83	0.37	1.38	0.64	0.39	0.66	0.73	0.63	0.68	1.01	1.31	0.68	1.12	2.48	1.63	2.20	1.28	1.18	1.67
H. perplexus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.00	0.21	0.00	0.00	0.00	0.00	0.00
H. carteri	0.00	0.17	0.55	0.00	0.00	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.37	0.21	0.00	0.00	0.26	0.71	0.95
M. elegans	0.64	0.00	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.19	0.00	0.41	0.00	0.00	0.00	0.00
N. coccolithom.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.24
O. fragilis	1.07	0.50	0.74	0.40	0.64	0.19	0.16	0.73	0.42	0.17	0.00	0.66	0.17	1.49	0.00	0.81	0.80	0.00	0.24	0.48
O. hydroideus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.24
P. lepida	0.21	0.50	0.18	0.20	0.00	0.19	0.00	0.00	0.42	0.00	0.34	0.22	0.00	0.00	0.41	0.41	0.20	0.00	0.00	0.00
Pontosphaera spp.	0.43	0.17	0.00	0.20	0.00	0.00	0.00	0.18	0.21	0.00	0.17	0.22	0.17	0.00	0.21	0.20	0.00	0.26	0.00	0.24
R. parvula	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.00	0.00	0.00	0.83	0.00	0.00	0.00	0.00	0.00
R. sessilis	0.00	0.33	0.37	0.00	0.43	0.19	0.49	0.00	0.00	0.00	0.00	0.00	0.34	0.00	0.21	0.00	0.20	0.00	0.00	0.24
R. clavigera	3.21	0.83	1.47	1.38	0.43	1.94	1.81	0.73	1.05	1.02	1.85	1.53	3.75	2.05	1.86	1.83	1.60	1.53	1.42	1.19
R. xiphos	1.50	2.48	2.02	4.15	0.64	2.91	2.30	2.19	2.94	1.18	5.21	3.28	1.71	1.12	1.65	3.05	2.40	0.51	1.42	0.95
S. anthos	0.43	1.82	0.55	0.00	0.43	0.78	0.66	0.36	1.47	0.17	0.50	0.66	0.34	0.56	0.41	0.61	0.20	0.51	0.24	0.48
S. corolla	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.00	0.00	0.00	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S. halldalii	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.88	0.00	0.37	0.00	0.00	0.20	0.00	0.00	0.00
S. histrica	0.00	0.00	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S. lamina	0.43	0.33	0.37	0.20	0.00	0.39	0.82	0.00	0.21	0.68	0.00	0.00	0.34	0.00	0.00	0.41	0.00	0.00	0.47	0.00
S. molischii	0.43	0.33	0.00	0.00	0.00	0.39	0.99	0.00	0.63	0.68	0.17	0.44	0.51	0.19	0.00	0.61	0.20	0.77	0.00	0.48
S. nodosa	0.21	0.17	0.00	0.59	0.21	0.78	0.99	0.36	0.21	0.00	0.00	0.44	0.00	0.37	0.21	0.20	0.20	0.00	0.00	0.00
S. pulchra	0.85	1.32	0.55	1.19	0.43	2.14	1.48	0.36	1.05	0.85	1.01	1.09	1.37	1.12	0.83	1.22	1.80	0.00	1.18	1.90
S. rotula	0.00	0.50	0.37	0.20	0.00	5.44	0.33	0.00	0.21	0.00	1.01	0.88	0.51	0.19	0.00	0.61	0.00	0.00	0.24	0.00
Syracosphaera spp.	0.85	1.32	0.37	1.58	1.93	0.97	1.97	0.73	1.05	0.85	1.18	2.19	0.85	0.56	1.03	0.61	0.80	0.26	0.47	1.67
T. quadrilaminata	0.00	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.22	0.00	0.00	0.00	0.41	0.00	0.00	0.24	0.24
U. irregularis	1.50	1.16	0.55	1.38	0.86	0.58	0.66	0.00	0.00	0.34	0.50	0.66	0.34	0.56	0.83	0.61	0.60	2.30	1.65	1.67
U. tenuis	2.78	2.81	4.60	2.37	1.72	4.27	2.30	1.46	0.84	0.85	1.34	3.06	3.58	2.23	2.27	2.44	1.40	1.53	2.84	3.81
U. hulburtiana	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.24	0.00
U. sibogae	5.13	3.47	4.23	4.15	3.65	1.36	2.79	3.83	3.14	3.72	7.73	6.78	6.48	5.96	3.93	4.28	5.00	5.36	6.15	3.81
Holococcolithen	2.56	2.15	0.37	1.58	0.00	0.58	1.31	0.36	0.21	1.69	2.18	1.31	1.37	2.61	2.48	1.22	0.80	0.77	1.42	0.24

ESTOC - Cl5m (976 m): Coccolithenkarbonatfluss (mg m^{-2} d^{-1})

Probe	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Verschlusszeit	24.09.94	16.10.94	07.11.94	29.11.94	21.12.94	12.01.95	03.02.95	25.02.95	19.03.95	10.04.95	02.05.95	24.05.95	15.06.95	07.07.95	29.07.95	20.08.95	11.09.95	03.10.95	25.10.95	12.11.95
Sammelintervall (d)	19	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	18
Gesamtfluss	1.659	1.728	1.753	2.996	2.286	3.892	4.787	7.029	7.576	9.284	4.696	0.818	1.657	3.075	1.855	2.793	3.031	1.540	2.133	1.693
C. leptoporus	0.209	0.368	0.172	0.268	0.921	1.124	0.339	1.864	1.807	1.626	0.678	0.123	0.316	0.516	0.151	0.161	0.321	0.497	0.849	0.252
C. pelagicus	0.000	0.037	0.000	0.073	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
D. tubifera	0.004	0.002	0.003	0.007	0.003	0.001	0.006	0.017	0.019	0.013	0.007	0.002	0.002	0.011	0.008	0.007	0.008	0.003	0.006	0.006
E. huxleyi	0.129	0.164	0.152	0.268	0.055	0.220	0.534	1.004	1.047	1.775	0.638	0.079	0.148	0.208	0.171	0.339	0.320	0.089	0.110	0.145
F. profunda	0.017	0.036	0.050	0.082	0.084	0.174	0.304	0.238	0.190	0.290	0.121	0.011	0.040	0.079	0.101	0.133	0.117	0.076	0.070	0.050
G. ericsonii	0.018	0.027	0.020	0.048	0.067	0.044	0.173	0.146	0.250	0.335	0.087	0.011	0.014	0.044	0.015	0.032	0.048	0.038	0.026	0.021
G. muellerae	0.058	0.062	0.036	0.097	0.216	0.100	0.062	0.094	0.219	0.150	0.070	0.010	0.018	0.060	0.028	0.033	0.050	0.100	0.053	0.020
G. oceanica	0.116	0.140	0.150	0.280	0.321	0.280	0.434	0.532	0.513	0.426	0.217	0.050	0.075	0.260	0.263	0.098	0.252	0.118	0.125	0.184
H. carteri	0.000	0.052	0.162	0.000	0.000	0.126	0.000	0.000	0.000	0.000	0.000	0.000	0.045	0.180	0.079	0.000	0.000	0.071	0.210	0.264
O. fragilis	0.185	0.107	0.146	0.142	0.163	0.085	0.120	0.720	0.480	0.288	0.000	0.065	0.030	0.488	0.000	0.341	0.341	0.000	0.047	0.089
Pontosphaera spp.	0.052	0.025	0.000	0.050	0.000	0.000	0.000	0.126	0.169	0.000	0.084	0.015	0.021	0.000	0.037	0.060	0.000	0.034	0.000	0.031
R. clavigera	0.388	0.124	0.204	0.347	0.076	0.595	0.921	0.502	0.837	1.205	0.921	0.106	0.468	0.468	0.335	0.536	0.476	0.201	0.199	0.156
S. pulchra	0.024	0.047	0.018	0.071	0.018	0.155	0.179	0.060	0.198	0.238	0.119	0.018	0.040	0.060	0.035	0.085	0.127	0.000	0.039	0.059
Syracosphaera spp.	0.019	0.036	0.009	0.071	0.061	0.053	0.180	0.090	0.150	0.180	0.105	0.027	0.019	0.023	0.033	0.032	0.043	0.006	0.012	0.039
Syracosphaera (small)	0.011	0.028	0.012	0.015	0.007	0.141	0.119	0.030	0.129	0.107	0.055	0.013	0.013	0.023	0.007	0.042	0.014	0.010	0.008	0.007
U. tenuis	0.043	0.054	0.082	0.077	0.039	0.169	0.151	0.129	0.086	0.129	0.086	0.027	0.058	0.066	0.053	0.092	0.054	0.026	0.051	0.064
U. sibogae	0.116	0.097	0.109	0.194	0.120	0.078	0.266	0.492	0.469	0.825	0.719	0.088	0.151	0.254	0.132	0.233	0.278	0.131	0.161	0.093
Holococcolithen	0.005	0.005	0.001	0.006	0.000	0.003	0.010	0.004	0.002	0.030	0.016	0.001	0.003	0.009	0.007	0.005	0.004	0.001	0.003	0.000
Restl. Arten	0.266	0.317	0.426	0.899	0.135	0.543	0.992	0.982	1.012	1.666	0.774	0.171	0.196	0.327	0.401	0.564	0.578	0.139	0.165	0.211

ESTOC - Cl5m (976 m): Rel. Anteil am Coccolithenkarbonatfluss (%)

Probe	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Verschlusszeit	24.09.94	16.10.94	07.11.94	29.11.94	21.12.94	12.01.95	03.02.95	25.02.95	19.03.95	10.04.95	02.05.95	24.05.95	15.06.95	07.07.95	29.07.95	20.08.95	11.09.95	03.10.95	25.10.95	12.11.95
Sammelintervall (d)	19	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	18
Gesamtfluss	1.659	1.728	1.753	2.996	2.286	3.892	4.787	7.029	7.576	9.284	4.696	0.818	1.657	3.075	1.855	2.793	3.031	1.540	2.133	1.693
C. leptoporus	12.61	21.30	9.82	8.94	40.27	28.89	7.08	26.51	23.85	17.52	14.43	15.00	19.04	16.79	8.12	5.75	10.60	32.27	39.79	14.91
C. pelagicus	0.00	2.12	0.00	2.44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. tubifera	0.24	0.13	0.16	0.22	0.11	0.03	0.12	0.24	0.25	0.14	0.16	0.25	0.14	0.37	0.45	0.24	0.26	0.19	0.28	0.33
E. huxleyi	7.75	9.46	8.69	8.96	2.42	5.66	11.15	14.28	13.82	19.11	13.58	9.68	8.94	6.75	9.23	12.13	10.57	5.75	5.17	8.59
F. profunda	1.03	2.07	2.86	2.75	3.69	4.46	6.34	3.39	2.51	3.13	2.58	1.40	2.43	2.56	5.42	4.75	3.86	4.95	3.27	2.97
G. ericsonii	1.06	1.55	1.12	1.61	2.94	1.12	3.61	2.07	3.30	3.61	1.85	1.31	0.84	1.44	0.83	1.14	1.57	2.49	1.24	1.25
G. muellerae	3.49	3.62	2.04	3.24	9.44	2.57	1.31	1.33	2.89	1.62	1.50	1.21	1.08	1.94	1.50	1.19	1.65	6.49	2.46	1.20
G. oceanica	6.97	8.11	8.57	9.36	14.06	7.20	9.06	7.57	6.77	4.59	4.62	6.11	4.53	8.47	14.17	3.51	8.32	7.68	5.85	10.84
H. carteri	0.00	3.04	9.24	0.00	0.00	3.24	0.00	0.00	0.00	0.00	0.00	0.00	2.72	5.85	4.24	0.00	0.00	4.60	9.85	15.59
O. fragilis	11.17	6.17	8.34	4.75	7.13	2.19	2.51	10.24	6.34	3.10	0.00	7.97	1.84	15.86	0.00	12.22	11.26	0.00	2.23	5.28
Pontosphaera spp.	3.14	1.45	0.00	1.67	0.00	0.00	0.00	1.80	2.23	0.00	1.80	1.87	1.29	0.00	2.02	2.15	0.00	2.19	0.00	1.85
R. clavigera	23.36	7.17	11.64	11.59	3.32	15.29	19.23	7.14	11.05	12.98	19.60	12.97	28.22	15.21	18.04	19.18	15.71	13.04	9.31	9.20
S. pulchra	1.48	2.72	1.03	2.35	0.79	3.99	3.73	0.85	2.62	2.56	2.53	2.20	2.43	1.97	1.90	3.03	4.19	0.00	1.84	3.49
Syracosphaera spp.	1.12	2.06	0.52	2.37	2.67	1.37	3.76	1.28	1.98	1.94	2.24	3.32	1.15	0.74	1.80	1.15	1.41	0.39	0.56	2.31
Syracosphaera (small)	0.65	1.62	0.69	0.49	0.29	3.62	2.49	0.42	1.70	1.15	1.16	1.65	0.76	0.74	0.36	1.52	0.47	0.64	0.37	0.44
U. tenuis	2.61	3.14	4.69	2.56	1.71	4.34	3.15	1.84	1.14	1.39	1.84	3.34	3.47	2.14	2.84	3.30	1.77	1.68	2.40	3.80
U. sibogae	6.98	5.62	6.24	6.49	5.26	2.00	5.55	7.00	6.19	8.88	15.30	10.72	9.10	8.26	7.11	8.35	9.16	8.52	7.53	5.50
Holococcolithen	0.28	0.28	0.04	0.20	0.00	0.07	0.21	0.05	0.03	0.32	0.34	0.16	0.15	0.29	0.36	0.19	0.12	0.10	0.14	0.03
Restl. Arten	16.06	18.37	24.31	30.02	5.89	13.95	20.72	13.97	13.35	17.95	16.47	20.85	11.86	10.65	21.62	20.21	19.08	9.02	7.72	12.43

ESTOC - CI6m (976 m): Coccolithenfluss (Mio Coccolithen m^{-2} d^{-1})

Probe	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Verschlusszeit	07.12.95	27.12.95	16.01.96	05.02.96	25.02.96	16.03.96	05.04.96	25.04.96	15.05.96	04.06.96	24.06.96	14.07.96	03.08.96	23.08.96	12.09.96	02.10.96	22.10.96	11.11.96	01.12.96	21.12.96
Sammelintervall (d)	26	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Gesamtfluss	496.52	318.73	133.00	845.91	2891.21	4537.68	1724.54	841.18	644.25	362.01	189.47	49.88	83.77	75.71	123.26	88.11	50.76	43.71	89.44	206.98
Acanthoica spp.	0.94	1.96	3.27	4.91	27.28	87.26	26.18	9.82	4.91	2.45	0.98	0.30	0.82	0.00	0.91	0.97	0.67	0.47	0.55	2.86
Algirosphaera spp.	32.09	24.22	9.58	40.90	76.37	167.25	117.81	49.10	44.18	27.61	11.78	3.37	2.13	2.68	12.00	9.94	4.01	4.13	6.41	14.32
A. unicornis	0.94	0.00	0.00	0.00	0.00	14.54	6.54	1.64	0.00	0.00	0.65	0.10	0.00	0.74	0.00	0.00	0.00	0.00	0.14	0.00
A. brasiliensis	0.00	1.31	0.23	8.18	32.73	87.26	16.36	8.18	2.45	3.07	0.65	0.00	0.00	0.30	0.55	0.12	0.00	0.16	0.14	1.23
C. leptoporus	2.83	2.62	0.47	1.64	16.37	65.45	22.91	11.46	4.91	1.23	1.64	1.78	0.65	1.64	2.00	0.61	0.50	0.78	1.09	3.68
C. murrayi	6.61	0.65	0.47	19.63	87.28	276.33	29.45	16.37	9.82	9.20	1.96	0.20	0.98	0.15	0.36	0.97	0.67	0.00	0.55	3.27
C. pelagicus	0.94	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. binodata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.00
C. mediterranea	1.89	0.65	0.00	3.27	5.46	0.00	0.00	0.00	1.23	0.61	0.98	0.00	0.00	0.45	0.36	0.12	0.00	0.08	0.27	0.00
D. tubifera	7.55	7.20	2.34	19.63	70.92	87.26	16.36	8.18	9.82	6.14	1.96	0.30	1.80	1.93	2.55	1.58	0.92	0.93	1.91	2.45
E. huxleyi	90.62	67.41	35.06	343.60	1331.05	1854.34	723.19	340.40	273.65	129.46	70.03	18.15	38.12	27.22	38.00	21.82	14.53	14.02	23.04	68.31
F. profunda	195.40	100.13	36.70	117.81	349.13	501.76	242.15	117.83	77.31	59.52	32.40	10.31	11.45	12.49	21.82	22.18	11.19	6.93	17.18	42.54
G. corolla	0.00	2.62	0.93	4.91	10.91	7.27	0.00	0.00	4.91	0.61	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.14	0.41
G. ericsonii	26.43	17.02	11.22	91.63	338.22	494.49	215.98	80.19	73.63	33.75	17.02	3.57	5.73	5.50	8.18	5.45	2.42	1.71	6.27	15.54
G. muellerae	10.38	2.62	0.47	1.64	0.00	14.54	16.36	3.27	2.45	1.23	1.31	1.09	0.82	0.74	1.09	0.36	0.50	0.55	0.82	2.45
G. oceanica	7.55	8.51	3.51	1.64	27.28	21.82	52.36	29.46	11.04	5.52	3.60	2.18	3.60	2.53	4.54	2.79	0.83	1.17	1.50	4.09
G. ornata	0.00	0.00	0.00	0.00	10.91	0.00	0.00	4.91	0.00	1.23	0.65	0.00	0.00	0.00	0.00	0.24	0.00	0.23	0.00	0.00
G. flabellatus	9.44	11.13	2.80	11.45	49.10	94.53	9.82	1.64	4.91	0.61	1.31	0.40	0.33	0.15	2.36	1.33	1.17	0.47	1.23	2.45
H. perplexus	0.00	0.00	0.00	0.00	5.46	0.00	0.00	0.00	0.00	0.61	0.00	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
H. carteri	0.94	1.96	0.47	1.64	5.46	7.27	3.27	1.64	1.23	1.23	0.33	0.50	0.98	0.45	0.18	0.73	0.25	0.31	0.41	0.00
H. pavimentum	0.00	0.65	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.20	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.00
M. elegans	0.00	0.00	0.23	6.54	27.28	65.45	9.82	4.91	0.00	0.61	0.00	0.00	0.16	0.00	0.18	0.00	0.08	0.00	0.68	0.00
N. coccolithom.	0.94	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.18	0.00	0.00	0.00	0.00	0.00
O. fragilis	1.89	1.31	0.00	0.00	5.46	0.00	0.00	0.00	0.00	0.61	0.33	0.10	0.65	0.15	0.18	0.24	0.17	0.00	0.41	0.00
O. hydroideus	4.72	3.27	0.23	24.54	32.73	116.35	29.45	26.18	9.82	3.07	0.65	0.40	0.49	0.00	0.73	1.70	0.50	0.16	0.55	2.05
P. lepida	0.00	1.31	0.47	1.64	0.00	7.27	0.00	0.00	1.23	1.23	0.00	0.10	0.00	0.00	0.18	0.24	0.00	0.08	0.00	0.00
Pontosphaera spp.	0.00	0.65	0.00	0.00	0.00	0.00	0.00	0.00	1.23	0.00	0.00	0.10	0.16	0.00	0.18	0.12	0.08	0.00	0.00	0.00
R. sessilis	0.00	1.31	0.00	1.64	0.00	14.54	0.00	0.00	0.00	0.61	0.65	0.10	0.33	0.15	0.00	0.00	0.33	0.16	0.14	1.23
R. clavigera	12.27	7.20	3.74	16.36	43.64	7.27	26.18	13.09	8.59	6.75	2.62	0.40	1.47	1.93	2.36	1.70	1.17	1.32	2.18	4.50
R. xiphos	16.05	7.20	5.38	37.63	76.37	79.99	26.18	8.18	25.77	9.82	2.62	0.40	1.31	0.59	2.18	2.67	1.50	1.79	4.50	4.09
S. apsteinii	0.00	0.00	0.00	1.64	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S. anthos	1.89	0.00	0.47	0.00	10.91	7.27	3.27	1.64	0.00	1.84	0.33	0.20	0.16	0.15	0.18	0.24	0.00	0.39	0.68	1.23
S. borealis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.12	0.00	0.00	0.00	0.00
S. epigrosa	0.94	0.00	0.00	3.27	54.55	0.00	0.00	1.64	0.00	0.00	0.00	0.00	0.16	0.00	0.00	0.00	0.08	0.00	0.00	0.00
S. histrica	0.00	0.00	0.23	0.00	0.00	7.27	3.27	1.64	0.00	3.68	1.64	0.10	0.00	0.15	0.00	0.00	0.08	0.00	0.14	1.23
S. lamina	0.00	1.31	0.23	3.27	0.00	14.54	3.27	3.27	0.00	1.23	0.33	0.10	0.00	0.15	0.18	0.12	0.08	0.00	0.00	0.82
S. molischii	0.94	1.31	0.00	0.00	10.91	7.27	0.00	4.91	6.14	3.68	0.33	0.20	0.33	0.45	0.36	0.12	0.17	0.08	0.14	0.41
S. nodosa	12.27	1.96	1.17	8.18	5.46	43.63	0.00	1.64	8.59	2.45	0.98	0.00	0.00	0.89	0.73	0.24	0.50	0.47	2.32	0.82
S. pirus	0.00	1.31	0.00	0.00	0.00	0.00	3.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S. prolongata	0.00	0.00	0.00	6.54	5.46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S. pulchra	1.89	3.93	1.40	1.64	27.28	29.09	6.54	6.55	6.14	4.91	1.96	0.50	1.15	2.53	1.27	1.21	0.67	1.64	1.09	3.27
S. rotula	0.94	1.31	0.47	1.64	16.37	7.27	0.00	1.64	0.00	1.23	0.65	0.00	0.16	0.15	0.36	0.12	0.00	0.08	0.55	0.00
Syracosphaera spp.	0.94	3.27	2.10	13.09	27.28	79.99	16.36	16.37	7.36	7.36	2.95	0.40	1.47	0.74	2.73	1.21	1.09	0.78	2.45	2.05
T. quadrilaminata	4.72	5.24	1.40	9.82	16.37	29.09	13.09	6.55	2.45	3.68	3.93	0.40	0.82	1.34	2.18	2.06	2.00	1.09	1.77	4.91
U. irregularis	3.78	1.96	0.70	6.54	0.00	14.54	3.27	0.00	1.23	1.84	1.31	0.20	1.15	0.45	1.27	0.00	0.33	0.08	0.14	1.23
U. tenuis	7.55	7.85	4.21	6.54	38.19	36.36	19.63	14.73	8.59	7.98	8.18	0.89	2.13	3.12	3.45	2.06	1.34	1.56	2.86	5.32
U. sibogae	16.99	10.47	1.40	11.45	16.37	72.72	55.63	31.09	15.95	9.82	5.56	1.19	3.93	2.97	3.64	2.18	1.25	1.01	2.45	6.54
Holococcolithen	11.33	3.93	1.40	3.27	5.46	79.99	0.00	6.55	13.50	4.29	4.91	1.39	0.16	2.83	5.64	2.18	1.34	0.86	4.36	2.45

ESTOC - Cl6u (3062 m): Coccolithenfluss (Mio Coccolithen m^{-2} d^{-1})

Probe	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Verschlusszeit	07.12.95	27.12.95	16.01.96	05.02.96	25.02.96	16.03.96	05.04.96	25.04.96	15.05.96	04.06.96	24.06.96	14.07.96	03.08.96	23.08.96	12.09.96	02.10.96	22.10.96	11.11.96	01.12.96
Sammelintervall (d)	26	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Gesamtfluss	446.20	663.64	631.24	1940.51	3562.19	8113.98	1711.45	2152.04	1259.04	1182.40	703.71	778.72	904.19	1069.20	981.92	524.23	534.05	339.65	544.85
Acanthoica spp.	2.80	2.95	0.98	6.54	0.00	161.63	32.72	8.18	12.27	24.55	13.64	8.18	10.23	13.64	2.05	0.00	2.95	2.92	1.96
Algirosphaera spp.	27.97	53.99	37.30	124.35	130.92	436.41	62.17	139.11	76.08	71.60	65.46	45.00	57.28	70.92	69.55	48.10	49.09	28.49	26.51
A. unicornis	0.70	0.00	0.98	0.00	5.46	16.16	13.09	0.00	0.00	4.09	0.00	0.00	0.00	0.00	0.00	0.98	0.00	0.00	1.96
A. brasiliensis	2.10	2.95	3.93	0.00	98.19	113.14	13.09	12.27	0.00	16.37	1.36	6.82	6.14	0.00	32.73	0.00	3.93	0.00	1.96
C. leptoporus	6.99	8.84	4.91	19.63	49.10	32.33	29.45	36.82	14.73	14.32	4.09	8.18	2.05	10.91	10.23	5.89	3.93	2.92	4.91
C. murrayi	6.29	3.93	5.89	16.36	27.28	274.78	39.27	49.10	19.63	10.23	2.73	10.91	8.18	8.18	2.05	4.91	2.95	0.73	3.93
C. binodata	0.00	0.00	1.96	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. mediterranea	1.40	0.98	0.98	13.09	5.46	0.00	6.54	12.27	2.45	2.05	6.82	0.00	4.09	5.46	4.09	0.98	2.95	0.00	0.98
D. tubifera	13.29	18.65	12.76	16.36	125.47	145.47	32.72	12.27	27.00	16.37	9.55	6.82	6.14	19.09	8.18	7.85	4.91	8.03	4.91
E. huxleyi	115.40	221.87	184.56	674.11	1352.87	2941.72	520.31	756.90	434.41	396.86	222.30	267.30	343.67	340.94	349.81	175.73	182.60	119.06	203.21
F. profunda	100.01	140.38	160.02	428.68	616.43	1276.90	320.69	454.14	213.52	265.94	155.47	147.29	104.33	204.57	192.29	110.93	97.19	70.85	125.66
G. corolla	0.00	0.00	1.96	0.00	0.00	0.00	0.00	0.00	2.45	0.00	0.00	0.00	0.00	0.00	2.05	0.00	0.00	0.00	0.00
G. ericsonii	26.58	39.27	42.21	186.52	321.85	872.82	199.61	220.93	137.44	100.24	66.83	81.83	108.42	95.46	75.69	29.45	42.21	21.18	25.52
G. muellerae	6.99	10.80	6.87	13.09	60.01	32.33	26.18	28.64	2.45	16.37	15.00	8.18	6.14	13.64	12.27	3.93	6.87	4.38	8.84
G. oceanica	21.68	17.67	12.76	36.00	43.64	48.49	49.09	36.82	34.36	45.00	12.27	39.55	34.78	38.19	32.73	19.63	20.62	8.77	22.58
G. ornata	0.00	0.98	0.00	0.00	0.00	32.33	0.00	8.18	2.45	0.00	0.00	0.00	0.00	0.00	2.05	2.95	0.98	0.00	0.98
G. flabellatus	10.49	18.65	19.63	26.18	141.83	226.29	49.09	61.37	31.91	18.41	6.82	10.91	8.18	8.18	18.41	9.82	5.89	6.57	6.87
H. perplexus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.36	0.00	0.00	0.00	0.00	0.98	0.00	0.00
H. carteri	2.10	3.93	1.96	6.54	5.46	0.00	6.54	4.09	7.36	2.05	1.36	5.46	8.18	2.73	4.09	0.00	0.00	0.00	1.96
H. pavimentum	0.00	0.00	0.00	3.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.46	0.00	0.00	0.00	0.00	0.00
M. elegans	0.70	0.00	2.95	0.00	5.46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.73	0.00
N. coccolithom.	0.70	0.00	0.00	9.82	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.96
O. fragilis	0.70	0.00	0.98	6.54	0.00	16.16	3.27	4.09	2.45	0.00	4.09	1.36	2.05	2.73	0.00	1.96	1.96	0.73	0.98
O. hydroideus	0.70	1.96	0.00	29.45	0.00	177.80	26.18	4.09	2.45	0.00	0.00	1.36	4.09	8.18	6.14	1.96	3.93	0.00	0.00
P. lepida	0.00	0.00	0.00	6.54	5.46	0.00	3.27	4.09	0.00	0.00	0.00	0.00	2.05	0.00	4.09	0.00	0.00	0.00	0.00
Pontosphaera spp.	0.00	1.96	0.00	0.00	0.00	0.00	0.00	4.09	0.00	0.00	0.00	1.36	0.00	0.00	2.05	0.00	0.00	0.00	0.00
R. sessilis	4.20	0.00	0.00	6.54	5.46	0.00	3.27	4.09	4.91	0.00	0.00	0.00	2.05	0.00	0.00	0.00	3.93	0.73	1.96
R. clavigera	6.29	11.78	16.69	39.27	76.37	80.82	26.18	20.46	14.73	10.23	6.82	25.91	14.32	30.00	8.18	13.74	6.87	9.50	10.80
R. xiphos	15.39	6.87	19.63	62.17	81.83	290.94	62.17	40.91	66.27	24.55	19.09	16.37	32.73	46.37	28.64	13.74	13.74	8.03	14.73
S. apsteinii	0.00	0.98	0.98	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S. anthos	0.00	0.00	2.95	13.09	0.00	32.33	3.27	4.09	9.82	6.14	6.82	1.36	0.00	0.00	0.00	0.98	0.98	0.73	0.98
S. borealis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.05	0.00	1.36	0.00	2.73	0.00	0.00	0.00	0.00	0.00
S. epigrosa	0.00	0.00	0.00	0.00	5.46	0.00	0.00	0.00	4.91	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S. halldalii	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.73	0.00	0.00	0.00	0.00	0.00
S. histrica	0.00	0.00	0.00	6.54	5.46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.05	0.00	0.00	0.00	0.98	0.00	0.00
S. lamina	0.00	0.98	0.98	6.54	5.46	48.49	19.63	8.18	2.45	0.00	1.36	5.46	8.18	2.73	2.05	0.00	0.98	0.00	0.00
S. molischii	0.00	1.96	1.96	3.27	10.91	16.16	0.00	0.00	0.00	4.09	0.00	1.36	4.09	2.73	0.00	0.00	0.00	0.73	0.00
S. nodosa	2.10	0.00	1.96	0.00	54.55	48.49	3.27	4.09	2.45	8.18	6.82	0.00	8.18	5.46	2.05	2.95	3.93	0.73	2.95
S. ossa	0.00	1.96	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S. pirus	0.00	0.98	5.89	0.00	0.00	0.00	9.82	0.00	0.00	2.05	4.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S. prolongata	0.00	0.00	0.98	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.73	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S. pulchra	8.39	10.80	11.78	16.36	16.37	48.49	6.54	24.55	12.27	16.37	4.09	8.18	18.41	13.64	2.05	9.82	4.91	3.65	10.80
S. rotula	0.00	0.00	0.00	0.00	5.46	0.00	3.27	4.09	0.00	6.14	0.00	0.00	4.09	5.46	2.05	1.96	0.00	0.00	0.00
Syracosphaera spp.	4.90	5.89	7.85	16.36	32.73	161.63	22.91	40.91	29.45	20.46	9.55	10.91	10.23	16.37	20.46	6.87	15.71	2.92	4.91
T. quadrilaminata	3.50	6.87	4.91	6.54	0.00	0.00	0.00	0.00	0.00	2.05	0.00	0.00	0.00	2.73	2.05	1.96	3.93	4.38	5.89
U. irregularis	6.29	6.87	3.93	16.36	32.73	64.65	22.91	16.37	4.91	14.32	6.82	4.09	16.37	8.18	10.23	4.91	2.95	5.84	4.91
U. tenuis	12.59	17.67	7.85	32.72	60.01	113.14	19.63	36.82	19.63	26.59	13.64	21.82	16.37	32.73	20.46	8.84	10.80	5.11	10.80
U. hulburtiana	0.00	0.00	0.00	3.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
U. sibogae	23.08	29.45	27.49	49.09	92.74	242.45	55.63	61.37	34.36	14.32	21.82	9.55	36.82	24.55	30.69	25.52	14.73	15.34	21.60
Holococcolithen	9.09	10.80	11.78	29.45	76.37	96.98	19.63	20.46	22.09	20.46	6.82	17.73	14.32	16.37	12.27	5.89	6.87	4.38	5.89

ESTOC - CI6m (976 m): relative Artenanteile (%)

Probe	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Verschlusszeit	07.12.95	27.12.95	16.01.96	05.02.96	25.02.96	16.03.96	05.04.96	25.04.96	15.05.96	04.06.96	24.06.96	14.07.96	03.08.96	23.08.96	12.09.96	02.10.96	22.10.96	11.11.96	01.12.96	21.12.96
Sammelinterval	26	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Gesamtfluss	496.52	318.73	133.00	845.91	2891.21	4537.68	1724.54	841.18	644.25	362.01	189.47	49.88	83.77	75.71	123.26	88.11	50.76	43.71	89.44	206.98
Acanthoica spp.	0.19	0.62	2.46	0.58	0.94	1.92	1.52	1.17	0.76	0.68	0.52	0.60	0.98	0.00	0.74	1.10	1.32	1.07	0.61	1.38
Algirosphaera spp.	6.46	7.60	7.21	4.84	2.64	3.69	6.83	5.84	6.86	7.63	6.22	6.76	2.54	3.54	9.73	11.28	7.89	9.45	7.16	6.92
A. unicornis	0.19	0.00	0.00	0.00	0.00	0.32	0.38	0.19	0.00	0.00	0.35	0.20	0.00	0.98	0.00	0.00	0.00	0.00	0.15	0.00
A. brasiliensis	0.00	0.41	0.18	0.97	1.13	1.92	0.95	0.97	0.38	0.85	0.35	0.00	0.00	0.39	0.44	0.14	0.00	0.36	0.15	0.59
C. leptoporus	0.57	0.82	0.35	0.19	0.57	1.44	1.33	1.36	0.76	0.34	0.86	3.58	0.78	2.16	1.62	0.69	0.99	1.78	1.22	1.78
C. murrayi	1.33	0.21	0.35	2.32	3.02	6.09	1.71	1.95	1.52	2.54	1.04	0.40	1.17	0.20	0.29	1.10	1.32	0.00	0.61	1.58
C. pelagicus	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. binodata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.18	0.00	0.00
C. mediterranea	0.38	0.21	0.00	0.39	0.19	0.00	0.00	0.00	0.19	0.17	0.52	0.00	0.00	0.59	0.29	0.14	0.00	0.18	0.30	0.00
D. tubifera	1.52	2.26	1.76	2.32	2.45	1.92	0.95	0.97	1.52	1.69	1.04	0.60	2.15	2.55	2.06	1.79	1.81	2.14	2.13	1.19
E. huxleyi	18.25	21.15	26.36	40.62	46.04	40.87	41.94	40.47	42.48	35.76	36.96	36.38	45.51	35.95	30.83	24.76	28.62	32.09	25.76	33.00
F. profunda	39.35	31.42	27.59	13.93	12.08	11.06	14.04	14.01	12.00	16.44	17.10	20.68	13.67	16.50	17.70	25.17	22.04	15.86	19.21	20.55
G. ericsonii	5.32	5.34	8.44	10.83	11.70	10.90	12.52	9.53	11.43	9.32	8.98	7.16	6.84	7.27	6.64	6.19	4.77	3.92	7.01	7.51
G. muellerae	2.09	0.82	0.35	0.19	0.00	0.32	0.95	0.39	0.38	0.34	0.69	2.19	0.98	0.98	0.88	0.41	0.99	1.25	0.91	1.19
G. oceanica	1.52	2.67	2.64	0.19	0.94	0.48	3.04	3.50	1.71	1.53	1.90	4.37	4.30	3.34	3.69	3.16	1.64	2.67	1.68	1.98
G. ornata	0.00	0.00	0.00	0.00	0.38	0.00	0.00	0.58	0.00	0.34	0.35	0.00	0.00	0.00	0.00	0.28	0.00	0.53	0.00	0.00
G. flabellatus	1.90	3.49	2.11	1.35	1.70	2.08	0.57	0.19	0.76	0.17	0.69	0.80	0.39	0.20	1.92	1.51	2.30	1.07	1.37	1.19
H. perplexus	0.00	0.00	0.00	0.00	0.19	0.00	0.00	0.00	0.00	0.17	0.00	0.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
H. carteri	0.19	0.62	0.35	0.19	0.19	0.16	0.19	0.19	0.19	0.34	0.17	0.99	1.17	0.59	0.15	0.83	0.49	0.71	0.46	0.00
H. pavimentum	0.00	0.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.40	0.00	0.00	0.00	0.00	0.00	0.18	0.00	0.00
M. elegans	0.00	0.00	0.18	0.77	0.94	1.44	0.57	0.58	0.00	0.17	0.00	0.00	0.20	0.00	0.15	0.00	0.16	0.00	0.76	0.00
N. coccolithom.	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00
O. fragilis	0.38	0.41	0.00	0.00	0.19	0.00	0.00	0.00	0.00	0.17	0.17	0.20	0.78	0.20	0.15	0.28	0.33	0.00	0.46	0.00
O. hydroideus	0.95	1.03	0.18	2.90	1.13	2.56	1.71	3.11	1.52	0.85	0.35	0.80	0.59	0.00	0.59	1.93	0.99	0.36	0.61	0.99
P. lepida	0.00	0.41	0.35	0.19	0.00	0.16	0.00	0.00	0.19	0.34	0.00	0.20	0.00	0.00	0.15	0.28	0.00	0.18	0.00	0.00
Pontosphaera spp.	0.00	0.21	0.00	0.00	0.00	0.00	0.00	0.00	0.19	0.00	0.00	0.20	0.20	0.00	0.15	0.14	0.16	0.00	0.00	0.00
R. sessilis	0.00	0.41	0.00	0.19	0.00	0.32	0.00	0.00	0.00	0.17	0.35	0.20	0.39	0.20	0.00	0.00	0.66	0.36	0.15	0.59
R. clavigera	2.47	2.26	2.81	1.93	1.51	0.16	1.52	1.56	1.33	1.86	1.38	0.80	1.76	2.55	1.92	1.93	2.30	3.03	2.44	2.17
R. xiphos	3.23	2.26	4.04	4.45	2.64	1.76	1.52	0.97	4.00	2.71	1.38	0.80	1.56	0.79	1.77	3.03	2.96	4.10	5.03	1.98
S. apsteinii	0.00	0.00	0.00	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S. anthos	0.38	0.00	0.35	0.00	0.38	0.16	0.19	0.19	0.00	0.51	0.17	0.40	0.20	0.20	0.15	0.28	0.00	0.89	0.76	0.59
S. borealis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.00	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.00
S. corolla	0.00	0.82	0.70	0.58	0.38	0.16	0.00	0.00	0.76	0.17	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.18	0.15	0.20
S. epigrosa	0.19	0.00	0.00	0.39	1.89	0.00	0.00	0.19	0.00	0.00	0.00	0.00	0.20	0.00	0.00	0.00	0.16	0.00	0.00	0.00
S. histrica	0.00	0.00	0.18	0.00	0.00	0.16	0.19	0.19	0.00	1.02	0.86	0.20	0.00	0.20	0.00	0.00	0.16	0.00	0.15	0.59
S. lamina	0.00	0.41	0.18	0.39	0.00	0.32	0.19	0.39	0.00	0.34	0.17	0.20	0.00	0.20	0.15	0.14	0.16	0.00	0.00	0.40
S. molischii	0.19	0.41	0.00	0.00	0.38	0.16	0.00	0.58	0.95	1.02	0.17	0.40	0.39	0.59	0.29	0.14	0.33	0.18	0.15	0.20
S. nodosa	2.47	0.62	0.88	0.97	0.19	0.96	0.00	0.19	1.33	0.68	0.52	0.00	0.00	1.18	0.59	0.28	0.99	1.07	2.59	0.40
S. pirus	0.00	0.41	0.00	0.00	0.00	0.00	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S. prolongata	0.00	0.00	0.00	0.77	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S. pulchra	0.38	1.23	1.05	0.19	0.94	0.64	0.38	0.78	0.95	1.36	1.04	0.99	1.37	3.34	1.03	1.38	1.32	3.74	1.22	1.58
S. rotula	0.19	0.41	0.35	0.19	0.57	0.16	0.00	0.19	0.00	0.34	0.35	0.00	0.20	0.20	0.29	0.14	0.00	0.18	0.61	0.00
Syracosphaera spp.	0.19	1.03	1.58	1.55	0.94	1.76	0.95	1.95	1.14	2.03	1.55	0.80	1.76	0.98	2.21	1.38	2.14	1.78	2.74	0.99
T. quadrilaminata	0.95	1.64	1.05	1.16	0.57	0.64	0.76	0.78	0.38	1.02	2.07	0.80	0.98	1.77	1.77	2.34	3.95	2.50	1.98	2.37
U. irregularis	0.76	0.62	0.53	0.77	0.00	0.32	0.19	0.00	0.19	0.51	0.69	0.40	1.37	0.59	1.03	0.00	0.66	0.18	0.15	0.59
U. tenuis	1.52	2.46	3.16	0.77	1.32	0.80	1.14	1.75	1.33	2.20	4.32	1.79	2.54	4.13	2.80	2.34	2.63	3.57	3.20	2.57
U. sibogae	3.42	3.29	1.05	1.35	0.57	1.60	3.23	3.70	2.48	2.71	2.94	2.39	4.69	3.93	2.95	2.48	2.47	2.32	2.74	3.16
Holococcolithen	2.28	1.23	1.05	0.39	0.19	1.76	0.00	0.78	2.10	1.19	2.59	2.78	0.20	3.73	4.57	2.48	2.63	1.96	4.88	1.19

ESTOC - CI6u (3062 m): relative Artenanteile (%)

Probe	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Verschlusszeit	07.12.95	27.12.95	16.01.96	05.02.96	25.02.96	16.03.96	05.04.96	25.04.96	15.05.96	04.06.96	24.06.96	14.07.96	03.08.96	23.08.96	12.09.96	02.10.96	22.10.96	11.11.96	01.12.96
Sammelintervall (d)	26	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Gesamtfluss	446.20	663.64	631.24	1940.51	3562.19	8113.98	1711.45	2152.04	1259.04	1182.40	703.71	778.72	904.19	1069.20	981.92	524.23	534.05	339.65	544.85
Acanthoica spp.	0.63	0.44	0.16	0.34	0.00	1.99	1.91	0.38	0.97	2.08	1.94	1.05	1.13	1.28	0.21	0.00	0.55	0.86	0.36
Algirosphaera spp.	6.27	8.14	5.91	6.41	3.68	5.38	3.63	6.46	6.04	6.06	9.30	5.78	6.33	6.63	7.08	9.18	9.19	8.39	4.86
A. unicornis	0.16	0.00	0.16	0.00	0.15	0.20	0.76	0.00	0.00	0.35	0.00	0.00	0.00	0.00	0.00	0.19	0.00	0.00	0.36
A. brasiliensis	0.47	0.44	0.62	0.00	2.76	1.39	0.76	0.57	0.00	1.38	0.19	0.88	0.68	0.00	3.33	0.00	0.74	0.00	0.36
C. leptoporus	1.57	1.33	0.78	1.01	1.38	0.40	1.72	1.71	1.17	1.21	0.58	1.05	0.23	1.02	1.04	1.12	0.74	0.86	0.90
C. murrayi	1.41	0.59	0.93	0.84	0.77	3.39	2.29	2.28	1.56	0.87	0.39	1.40	0.90	0.77	0.21	0.94	0.55	0.22	0.72
C. binodata	0.00	0.00	0.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. mediterranea	0.31	0.15	0.16	0.67	0.15	0.00	0.38	0.57	0.19	0.17	0.97	0.00	0.45	0.51	0.42	0.19	0.55	0.00	0.18
D. tubifera	2.98	2.81	2.02	0.84	3.52	1.79	1.91	0.57	2.14	1.38	1.36	0.88	0.68	1.79	0.83	1.50	0.92	2.37	0.90
E. huxleyi	25.86	33.43	29.24	34.74	37.98	36.25	30.40	35.17	34.50	33.56	31.59	34.33	38.01	31.89	35.63	33.52	34.19	35.05	37.30
F. profunda	22.41	21.15	25.35	22.09	17.30	15.74	18.74	21.10	16.96	22.49	22.09	18.91	11.54	19.13	19.58	21.16	18.20	20.86	23.06
G. ericsonii	5.96	5.92	6.69	9.61	9.04	10.76	11.66	10.27	10.92	8.48	9.50	10.51	11.99	8.93	7.71	5.62	7.90	6.24	4.68
G. muellerae	1.57	1.63	1.09	0.67	1.68	0.40	1.53	1.33	0.19	1.38	2.13	1.05	0.68	1.28	1.25	0.75	1.29	1.29	1.62
G. oceanica	4.86	2.66	2.02	1.85	1.23	0.60	2.87	1.71	2.73	3.81	1.74	5.08	3.85	3.57	3.33	3.75	3.86	2.58	4.14
G. ornata	0.00	0.15	0.00	0.00	0.00	0.40	0.00	0.38	0.19	0.00	0.00	0.00	0.00	0.00	0.21	0.56	0.18	0.00	0.18
G. flabellatus	2.35	2.81	3.11	1.35	3.98	2.79	2.87	2.85	2.53	1.56	0.97	1.40	0.90	0.77	1.88	1.87	1.10	1.94	1.26
H. perplexus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.18	0.00	0.00	0.00	0.00	0.18	0.00	0.00
H. carteri	0.47	0.59	0.31	0.34	0.15	0.00	0.38	0.19	0.58	0.17	0.19	0.70	0.90	0.26	0.42	0.00	0.00	0.00	0.36
H. pavimentum	0.00	0.00	0.00	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.51	0.00	0.00	0.00	0.00	0.00
M. elegans	0.16	0.00	0.47	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.22	0.00
N. coccolithom.	0.16	0.00	0.00	0.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.36
O. fragilis	0.16	0.00	0.16	0.34	0.00	0.20	0.19	0.19	0.19	0.00	0.58	0.18	0.23	0.26	0.00	0.37	0.37	0.22	0.18
O. hydroideus	0.16	0.30	0.00	1.52	0.00	2.19	1.53	0.19	0.19	0.00	0.00	0.18	0.45	0.77	0.63	0.37	0.74	0.00	0.00
P. lepida	0.00	0.00	0.00	0.34	0.15	0.00	0.19	0.19	0.00	0.00	0.00	0.00	0.23	0.00	0.42	0.00	0.00	0.00	0.00
Pontosphaera spp.	0.00	0.30	0.00	0.00	0.00	0.00	0.00	0.19	0.00	0.00	0.00	0.18	0.00	0.00	0.21	0.00	0.00	0.00	0.00
R. sessilis	0.94	0.00	0.00	0.34	0.15	0.00	0.19	0.19	0.39	0.00	0.00	0.00	0.23	0.00	0.00	0.00	0.74	0.22	0.36
R. clavigera	1.41	1.78	2.64	2.02	2.14	1.00	1.53	0.95	1.17	0.87	0.97	3.33	1.58	2.81	0.83	2.62	1.29	2.80	1.98
R. xiphos	3.45	1.04	3.11	3.20	2.30	3.59	3.63	1.90	5.26	2.08	2.71	2.10	3.62	4.34	2.92	2.62	2.57	2.37	2.70
S. apsteinii	0.00	0.15	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S. anthos	0.00	0.00	0.47	0.67	0.00	0.40	0.19	0.19	0.78	0.52	0.97	0.18	0.00	0.00	0.00	0.19	0.18	0.22	0.18
S. borealis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.00	0.18	0.00	0.26	0.00	0.00	0.00	0.00	0.00
S. corolla	0.00	0.00	0.31	0.00	0.00	0.00	0.00	0.00	0.19	0.00	0.00	0.00	0.00	0.00	0.21	0.00	0.00	0.00	0.00
S. epigrosa	0.00	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S. halldalii	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.26	0.00	0.00	0.00	0.00	0.00
S. histrica	0.00	0.00	0.00	0.34	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.23	0.00	0.00	0.00	0.18	0.00	0.00
S. lamina	0.00	0.15	0.16	0.34	0.15	0.60	1.15	0.38	0.19	0.00	0.19	0.70	0.90	0.26	0.21	0.00	0.18	0.00	0.00
S. molischii	0.00	0.30	0.31	0.17	0.31	0.20	0.00	0.00	0.00	0.35	0.00	0.18	0.45	0.26	0.00	0.00	0.00	0.22	0.00
S. nodosa	0.47	0.00	0.31	0.00	1.53	0.60	0.19	0.19	0.19	0.69	0.97	0.00	0.90	0.51	0.21	0.56	0.74	0.22	0.54
S. ossa	0.00	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S. pirus	0.00	0.15	0.93	0.00	0.00	0.00	0.57	0.00	0.00	0.17	0.58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S. prolongata	0.00	0.00	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S. pulchra	1.88	1.63	1.87	0.84	0.46	0.60	0.38	1.14	0.97	1.38	0.58	1.05	2.04	1.28	0.21	1.87	0.92	1.08	1.98
S. rotula	0.00	0.00	0.00	0.00	0.15	0.00	0.19	0.19	0.00	0.52	0.00	0.00	0.45	0.51	0.21	0.37	0.00	0.00	0.00
Syracosphaera spp.	1.10	0.89	1.24	0.84	0.92	1.99	1.34	1.90	2.34	1.73	1.36	1.40	1.13	1.53	2.08	1.31	2.94	0.86	0.90
T. quadrilaminata	0.78	1.04	0.78	0.34	0.00	0.00	0.00	0.00	0.00	0.17	0.00	0.00	0.00	0.26	0.21	0.37	0.74	1.29	1.08
U. irregularis	1.41	1.04	0.62	0.84	0.92	0.80	1.34	0.76	0.39	1.21	0.97	0.53	1.81	0.77	1.04	0.94	0.55	1.72	0.90
U. tenuis	2.82	2.66	1.24	1.69	1.68	1.39	1.15	1.71	1.56	2.25	1.94	2.80	1.81	3.06	2.08	1.69	2.02	1.51	1.98
U. hulburtiana	0.00	0.00	0.00	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
U. sibogae	5.17	4.44	4.35	2.53	2.60	2.99	3.25	2.85	2.73	1.21	3.10	1.23	4.07	2.30	3.13	4.87	2.76	4.52	3.96
Holococcolithen	2.04	1.63	1.87	1.52	2.14	1.20	1.15	0.95	1.75	1.73	0.97	2.28	1.58	1.53	1.25	1.12	1.29	1.29	1.08

ESTOC - CI6m (976 m): Coccolithenkarbonatfluss (mg m^{-2} d^{-1})

Probe	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Verschlusszeit	07.12.95	27.12.95	16.01.96	05.02.96	25.02.96	16.03.96	05.04.96	25.04.96	15.05.96	04.06.96	24.06.96	14.07.96	03.08.96	23.08.96	12.09.96	02.10.96	22.10.96	11.11.96	01.12.96	21.12.96
Sammelintervall (d)	26	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Gesamtfluss	3.294	2.504	0.913	4.708	16.008	29.395	10.965	5.685	3.685	2.295	1.158	0.472	0.719	0.680	0.934	0.701	0.462	0.414	0.721	1.509
C. leptoporus	0.258	0.238	0.043	0.149	1.491	5.962	2.087	1.044	0.447	0.112	0.149	0.163	0.060	0.149	0.182	0.055	0.046	0.071	0.099	0.335
C. pelagicus	0.094	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
D. tubifera	0.011	0.011	0.004	0.029	0.106	0.131	0.025	0.012	0.015	0.009	0.003	0.000	0.003	0.003	0.004	0.002	0.001	0.001	0.003	0.004
E. huxleyi	0.190	0.142	0.074	0.722	3.208	4.230	1.519	0.715	0.575	0.290	0.147	0.038	0.080	0.057	0.080	0.046	0.031	0.029	0.048	0.154
F. profunda	0.313	0.160	0.087	0.188	0.559	0.803	0.387	0.189	0.124	0.095	0.052	0.017	0.018	0.020	0.035	0.035	0.018	0.011	0.027	0.068
G. ericsonii	0.024	0.015	0.010	0.082	0.393	0.550	0.194	0.072	0.066	0.039	0.015	0.003	0.005	0.005	0.007	0.005	0.002	0.002	0.006	0.014
G. muellerae	0.065	0.016	0.003	0.010	0.000	0.092	0.103	0.021	0.015	0.008	0.008	0.007	0.005	0.005	0.007	0.002	0.003	0.003	0.005	0.015
G. oceanica	0.120	0.135	0.056	0.026	0.434	0.347	0.832	0.468	0.176	0.088	0.057	0.035	0.057	0.040	0.072	0.044	0.013	0.019	0.024	0.065
H. carteri	0.135	0.280	0.067	0.234	0.779	1.038	0.467	0.234	0.175	0.175	0.047	0.071	0.140	0.064	0.026	0.104	0.036	0.045	0.058	0.000
O. fragilis	0.183	0.127	0.000	0.000	0.528	0.000	0.000	0.000	0.000	0.059	0.032	0.010	0.063	0.014	0.018	0.023	0.016	0.000	0.040	0.000
Pontosphaera spp.	0.000	0.045	0.000	0.000	0.000	0.000	0.000	0.000	0.083	0.000	0.000	0.007	0.011	0.000	0.012	0.008	0.006	0.000	0.000	0.000
R. clavigera	0.828	0.486	0.252	1.104	2.946	0.491	1.767	0.884	0.580	0.456	0.177	0.027	0.099	0.131	0.160	0.115	0.079	0.089	0.147	0.304
S. pulchra	0.030	0.063	0.022	0.026	0.436	0.465	0.105	0.105	0.098	0.079	0.031	0.008	0.018	0.040	0.020	0.019	0.011	0.026	0.017	0.052
Syracosphaera spp.	0.011	0.040	0.025	0.158	0.330	0.968	0.198	0.198	0.089	0.089	0.036	0.005	0.018	0.009	0.033	0.015	0.013	0.009	0.030	0.025
Syracosphaera (small)	0.068	0.039	0.014	0.281	0.458	1.891	0.052	0.065	0.079	0.059	0.020	0.002	0.003	0.008	0.007	0.004	0.004	0.004	0.016	0.020
U. tenuis	0.066	0.068	0.037	0.057	0.332	0.316	0.171	0.128	0.075	0.069	0.071	0.008	0.019	0.027	0.030	0.018	0.012	0.014	0.025	0.046
U. sibogae	0.214	0.132	0.018	0.144	0.206	3.304	0.701	0.392	0.201	0.124	0.070	0.020	0.049	0.049	0.046	0.037	0.016	0.017	0.031	0.093
Holococcolithen	0.011	0.004	0.001	0.003	0.005	0.080	0.000	0.007	0.013	0.004	0.005	0.001	0.000	0.003	0.006	0.002	0.001	0.001	0.004	0.002
Restl. Arten	0.672	0.503	0.200	1.492	3.797	8.726	2.356	1.152	0.874	0.540	0.238	0.052	0.069	0.056	0.189	0.166	0.156	0.072	0.140	0.311

ESTOC - CI6m (976 m): Rel. Anteil am Coccolithenkarbonatfluss (%)

Probe	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Verschlusszeit	07.12.95	27.12.95	16.01.96	05.02.96	25.02.96	16.03.96	05.04.96	25.04.96	15.05.96	04.06.96	24.06.96	14.07.96	03.08.96	23.08.96	12.09.96	02.10.96	22.10.96	11.11.96	01.12.96	21.12.96
Sammelintervall (d)	26	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Gesamtfluss	3.294	2.504	0.913	4.708	16.008	29.395	10.965	5.685	3.685	2.295	1.158	0.472	0.719	0.680	0.934	0.701	0.462	0.414	0.721	1.509
C. leptoporus	7.83	9.52	4.67	3.17	9.31	20.28	19.03	18.36	12.13	4.87	12.87	34.42	8.29	21.92	19.51	7.87	9.87	17.15	13.79	22.23
C. pelagicus	2.85	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. tubifera	0.34	0.43	0.38	0.63	0.66	0.45	0.22	0.22	0.40	0.40	0.25	0.09	0.38	0.43	0.41	0.34	0.30	0.34	0.40	0.24
E. huxleyi	5.78	5.65	8.07	15.33	20.04	14.39	13.85	12.57	15.59	12.63	12.70	8.07	11.13	8.41	8.54	6.53	6.60	7.12	6.71	10.19
F. profunda	9.49	6.40	9.55	4.00	3.49	2.73	3.53	3.32	3.36	4.15	4.48	3.49	2.55	2.94	3.74	5.06	3.87	2.68	3.81	4.51
G. ericsonii	0.72	0.61	1.11	1.75	2.45	1.87	1.77	1.27	1.80	1.71	1.32	0.68	0.72	0.73	0.79	0.70	0.47	0.37	0.78	0.93
G. muellerae	1.99	0.66	0.32	0.22	0.00	0.31	0.94	0.36	0.42	0.34	0.71	1.45	0.72	0.69	0.74	0.33	0.68	0.83	0.71	1.02
G. oceanica	3.64	5.40	6.11	0.55	2.71	1.18	7.59	8.24	4.77	3.83	4.94	7.34	7.96	5.91	7.74	6.32	2.87	4.49	3.31	4.31
H. carteri	4.09	11.20	7.32	4.97	4.87	3.54	4.26	4.11	4.76	7.64	4.04	15.00	19.50	9.38	2.78	14.82	7.74	10.76	8.11	0.00
O. fragilis	5.55	5.06	0.00	0.00	3.30	0.00	0.00	0.00	0.00	2.59	2.74	2.03	8.81	2.12	1.88	3.35	3.50	0.00	5.49	0.00
Pontosphaera spp.	0.00	1.78	0.00	0.00	0.00	0.00	0.00	0.00	2.26	0.00	0.00	1.43	1.55	0.00	1.32	1.18	1.23	0.00	0.00	0.00
R clavigera	25.14	19.40	27.66	23.46	18.40	1.67	16.12	15.55	15.73	19.85	15.26	5.67	13.82	19.20	17.08	16.33	17.06	21.60	20.43	20.13
S. pulchra	0.92	2.51	2.46	0.56	2.73	1.58	0.95	1.84	2.66	3.42	2.71	1.68	2.55	5.95	2.18	2.77	2.31	6.32	2.42	3.47
Syracosphaera spp.	0.35	1.58	2.79	3.36	2.06	3.29	1.81	3.48	2.42	3.88	3.08	1.02	2.48	1.32	3.53	2.09	2.84	2.28	4.12	1.64
Syracosphaera (small)	2.06	1.57	1.54	5.98	2.86	6.43	0.48	1.15	2.13	2.57	1.70	0.50	0.45	1.14	0.78	0.55	0.79	1.05	2.19	1.30
U. tenuis	1.99	2.73	4.01	1.21	2.08	1.08	1.56	2.25	2.03	3.02	6.15	1.64	2.57	4.00	3.22	2.56	2.51	3.28	3.46	3.07
U. sibogae	6.50	5.27	1.94	3.07	1.29	11.24	6.39	6.89	5.45	5.39	6.05	4.27	6.88	7.22	4.91	5.27	3.41	4.06	4.29	6.17
Holococcolithen	0.34	0.16	0.15	0.07	0.03	0.27	0.00	0.12	0.37	0.19	0.42	0.29	0.02	0.42	0.60	0.31	0.29	0.21	0.61	0.16
Restl. Arten	20.40	20.07	21.93	31.69	23.72	29.69	21.49	20.27	23.71	23.53	20.57	10.92	9.64	8.23	20.25	23.64	33.65	17.47	19.37	20.61

ESTOC - CI6u (3062 m): Coccolithenkarbonatfluss (mg m^{-2} d^{-1})

Probe	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Verschlusszeit	07.12.95	27.12.95	16.01.96	05.02.96	25.02.96	16.03.96	05.04.96	25.04.96	15.05.96	04.06.96	24.06.96	14.07.96	03.08.96	23.08.96	12.09.96	02.10.96	22.10.96	11.11.96	01.12.96
Sammelintervall (d)	26	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Gesamtfluss	3.564	5.056	4.505	13.189	23.287	43.066	12.582	14.632	8.717	7.041	4.209	6.800	6.463	8.121	6.356	3.983	3.406	2.369	3.879
C. leptoporus	0.637	0.805	0.447	1.789	4.473	2.945	2.683	3.354	1.342	1.305	0.373	0.745	0.186	0.994	0.932	0.537	0.358	0.266	0.447
C. pelagicus	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
D. tubifera	0.020	0.028	0.019	0.025	0.188	0.218	0.049	0.018	0.040	0.025	0.014	0.010	0.009	0.029	0.012	0.012	0.007	0.012	0.007
E. huxleyi	0.242	0.466	0.388	1.416	3.127	6.585	1.093	1.589	0.912	0.833	0.467	0.561	0.722	0.716	0.735	0.369	0.383	0.250	0.427
F. profunda	0.160	0.225	0.256	0.686	0.986	2.043	0.513	0.727	0.342	0.425	0.249	0.236	0.167	0.327	0.308	0.177	0.156	0.113	0.201
G. ericsonii	0.024	0.035	0.038	0.168	0.368	0.960	0.180	0.199	0.124	0.090	0.060	0.074	0.098	0.086	0.068	0.027	0.038	0.019	0.037
G. muellerae	0.044	0.068	0.043	0.082	0.378	0.204	0.165	0.490	0.015	0.103	0.095	0.052	0.039	0.086	0.077	0.025	0.043	0.028	0.056
G. oceanica	0.345	0.281	0.203	0.572	0.694	0.771	0.780	0.585	0.546	0.716	0.195	0.889	0.553	0.607	0.520	0.312	0.328	0.139	0.359
H. carteri	0.300	0.561	0.280	0.935	0.779	0.000	0.935	0.584	1.051	0.292	0.195	0.779	1.168	0.389	0.584	0.000	0.000	0.000	0.280
O. fragilis	0.068	0.000	0.095	0.634	0.000	1.565	0.317	0.396	0.238	0.000	0.396	0.132	0.198	0.264	0.000	0.190	0.190	0.071	0.095
Pontosphaera spp.	0.000	0.134	0.000	0.000	0.000	0.000	0.000	0.278	0.000	0.000	0.000	0.093	0.000	0.000	0.139	0.000	0.000	0.000	0.000
R. clavigera	0.425	0.795	1.127	2.651	5.155	5.455	1.767	1.381	0.994	0.690	0.460	1.749	0.967	2.025	0.552	0.928	0.464	0.641	0.729
S. pulchra	0.134	0.173	0.188	0.262	0.262	0.776	0.105	0.393	0.196	0.262	0.065	0.131	0.295	0.218	0.033	0.157	0.079	0.058	0.173
Syracosphaera spp.	0.059	0.071	0.095	0.198	0.396	1.956	0.277	0.495	0.356	0.248	0.116	0.132	0.124	0.198	0.248	0.083	0.190	0.035	0.059
Syracosphaera (small)	0.008	0.016	0.067	0.118	0.349	0.582	0.157	0.082	0.088	0.115	0.076	0.049	0.106	0.087	0.033	0.024	0.027	0.009	0.016
U. tenuis	0.110	0.154	0.068	0.285	0.522	0.984	0.171	0.320	0.171	0.231	0.119	0.190	0.142	0.285	0.178	0.077	0.094	0.044	0.094
U. sibogae	0.291	0.371	0.346	0.618	1.168	3.055	0.701	0.773	0.433	0.180	0.275	0.120	0.464	0.309	0.387	0.322	0.186	0.193	0.272
Holococcolithen	0.009	0.011	0.012	0.029	0.076	0.097	0.020	0.020	0.022	0.020	0.007	0.018	0.014	0.016	0.012	0.006	0.007	0.004	0.006
Restl. Arten	0.688	0.864	0.832	2.723	4.364	14.870	2.670	2.946	1.846	1.506	1.047	0.840	1.211	1.484	1.538	0.738	0.856	0.485	0.620

ESTOC - CI6u (3062 m): Rel. Anteil am Coccolithenkarbonatfluss (%)

Probe	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Verschlusszeit	07.12.95	27.12.95	16.01.96	05.02.96	25.02.96	16.03.96	05.04.96	25.04.96	15.05.96	04.06.96	24.06.96	14.07.96	03.08.96	23.08.96	12.09.96	02.10.96	22.10.96	11.11.96	01.12.96
Sammelintervall (d)	26	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Gesamtfluss	3.564	5.056	4.505	13.189	23.287	43.066	12.582	14.632	8.717	7.041	4.209	6.800	6.463	8.121	6.356	3.983	3.406	2.369	3.879
C. leptoporus	17.88	15.92	9.93	13.56	19.21	6.84	21.32	22.93	15.39	18.53	8.86	10.96	2.88	12.24	14.66	13.47	10.50	11.24	11.53
C. pelagicus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. tubifera	0.56	0.55	0.42	0.19	0.81	0.51	0.39	0.13	0.46	0.35	0.34	0.15	0.14	0.35	0.19	0.30	0.22	0.51	0.19
E. huxleyi	6.80	9.21	8.60	10.73	13.43	15.29	8.68	10.86	10.46	11.84	11.09	8.25	11.17	8.82	11.56	9.27	11.26	10.55	11.00
F. profunda	4.49	4.44	5.68	5.20	4.24	4.74	4.08	4.97	3.92	6.04	5.91	3.47	2.58	4.03	4.84	4.46	4.57	4.79	5.18
G. ericsonii	0.67	0.70	0.84	1.27	1.58	2.23	1.43	1.36	1.42	1.28	1.43	1.08	1.51	1.06	1.07	0.67	1.12	0.80	0.96
G. muellerae	1.24	1.35	0.96	0.63	1.62	0.47	1.31	3.35	0.18	1.46	2.25	0.76	0.60	1.06	1.22	0.62	1.27	1.17	1.44
G. oceanica	9.67	5.56	4.50	4.34	2.98	1.79	6.20	4.00	6.27	10.16	4.64	13.07	8.55	7.48	8.19	7.84	9.63	5.88	9.26
H. carteri	8.41	11.10	6.23	7.09	3.35	0.00	7.43	4.00	12.07	4.15	4.63	11.46	18.09	4.80	9.20	0.00	0.00	0.00	7.23
O. fragilis	1.90	0.00	2.11	4.80	0.00	3.63	2.52	2.71	2.73	0.00	9.41	1.94	3.06	3.25	0.00	4.77	5.58	2.98	2.45
Pontosphaera spp.	0.00	2.64	0.00	0.00	0.00	0.00	0.00	1.90	0.00	0.00	0.00	1.36	0.00	0.00	2.19	0.00	0.00	0.00	0.00
R. clavigera	11.92	15.72	25.00	20.10	22.14	12.67	14.04	9.44	11.40	9.81	10.94	25.72	14.95	24.94	8.69	23.29	13.62	27.06	18.79
S. pulchra	3.77	3.42	4.18	1.98	1.12	1.80	0.83	2.68	2.25	3.72	1.56	1.93	4.56	2.69	0.51	3.94	2.31	2.47	4.45
Syracosphaera spp.	1.66	1.41	2.11	1.50	1.70	4.54	2.20	3.38	4.09	3.52	2.74	1.94	1.91	2.44	3.89	2.09	5.58	1.49	1.53
Syracosphaera (small)	0.24	0.31	1.48	0.89	1.50	1.35	1.25	0.56	1.01	1 63	1.81	0.72	1.65	1.07	0.51	0.59	0.81	0.37	0.40
U. tenuis	3.07	3.04	1.52	2.16	2.24	2.29	1.36	2.19	1.96	3.29	2.82	2.79	2.20	3.51	2.80	1.93	2.76	1.88	2.42
U. sibogae	8.16	7.34	7.69	4.69	5.02	7.09	5.57	5.28	4.97	2.56	6.53	1.77	7.18	3.81	6.08	8.08	5.45	8.16	7.02
Holococcolithen	0.26	0.21	0.26	0.22	0.33	0.23	0.16	0.14	0.25	0.29	0.16	0.26	0.22	0.20	0.19	0.15	0.20	0.18	0.15
Restl. Arten	19.31	17.08	18.48	20.64	18.74	34.53	21.22	20.13	21.17	21.38	24.89	12.35	18.74	18.27	24.20	18.54	25.14	20.47	16.00

ESTOC - CI7m (750 m): Coccolithenfluss (Mio Coccolithen m^{-2} d^{-1})

Probe	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Verschlusszeit	06.01.97	20.01.97	03.02.97	17.02.97	03.03.97	17.03.97	31.03.97	14.04.97	28.04.97	12.05.97	26.05.97	09.06.97	23.06.97	07.07.97	21.07.97	04.08.97	18.08.97	01.09.97	15.09.97
Sammelintervall (d)	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14
Gesamtfluss	604.92	974.13	942.47	4691.56	528.37	846.03	245.64	156.48	247.42	338.82	128.89	84.85	159.61	44.68	192.13	63.01	67.10	26.78	12.76
Acanthoica spp.	3.74	3.12	17.53	75.57	10.91	19.00	1.70	0.74	1.52	0.00	1.34	0.50	0.33	0.20	0.00	0.30	0.11	0.07	0.06
Algirosphaera spp.	40.20	28.05	64.29	377.84	26.50	30.69	14.02	9.10	17.10	1.86	18.37	7.82	19.70	3.31	18.23	5.61	7.88	4.41	1.09
A. unicornis	0.00	0.00	1.46	94.46	0.00	1.46	0.00	0.00	0.00	0.00	0.33	0.00	0.00	0.10	0.00	0.10	0.00	0.00	0.00
A. brasiliensis	1.87	0.00	0.00	18.89	0.78	0.00	0.00	0.25	0.38	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.22	0.00	0.06
C. leptoporus	5.61	10.91	7.31	25.19	7.79	8.77	5.52	5.66	3.80	10.55	3.01	1.16	3.34	1.00	0.93	0.90	0.54	0.20	0.26
C. murrayi	5.61	10.91	7.31	88.16	9.35	16.07	2.55	1.23	4.18	0.62	0.33	0.83	0.67	0.10	0.00	0.30	0.43	0.13	0.03
C. pelagicus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. binodata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. mediterranea	0.00	0.00	4.38	6.30	1.56	0.00	0.00	0.25	0.76	0.62	0.00	0.00	0.67	0.10	2.34	0.00	0.22	0.00	0.00
C. aculeata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. tubifera	7.48	21.82	16.07	50.38	4.68	4.38	3.40	2.21	2.66	0.00	1.00	1.50	1.34	0.90	3.74	2.80	0.65	0.47	0.12
E. huxleyi	147.72	280.55	265.94	2141.11	198.72	279.09	97.75	61.02	81.33	146.45	28.05	22.13	40.74	10.52	43.94	13.02	13.81	4.74	2.91
F. profunda	198.21	299.25	303.93	516.39	115.34	143.20	46.75	26.33	53.59	124.73	38.07	26.95	54.43	17.33	71.52	17.73	27.40	8.88	5.53
G. ericsonii	33.66	87.28	45.30	623.44	74.81	141.74	19.97	15.75	26.22	21.72	7.68	5.66	12.69	1.90	14.96	2.70	3.56	1.54	0.56
G. muellerae	2.80	3.12	1.46	6.30	3.12	2.92	2.55	1.48	3.04	1.24	0.67	0.50	1.00	0.40	1.87	0.10	0.22	0.13	0.09
G. oceanica	10.28	15.59	16.07	81.87	6.23	20.46	2.55	5.41	7.22	6.21	4.34	2.33	3.67	0.90	4.67	0.90	0.86	0.53	0.18
G. ornata	0.00	3.12	0.00	6.30	0.78	1.46	0.42	0.25	0.00	0.62	0.00	0.17	0.00	0.00	0.00	0.20	0.00	0.07	0.00
G. flabellatus	10.28	10.91	14.61	18.89	3.90	5.84	2.55	0.25	2.66	0.62	1.34	0.67	2.00	0.60	3.27	1.10	1.29	0.67	0.18
H. carteri	3.74	0.00	4.38	6.30	1.56	2.92	0.00	0.25	1.90	0.00	1.34	0.33	0.00	0.50	0.00	0.10	0.22	0.07	0.00
H. pavimentum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.38	0.62	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.07	0.00
M. elegans	1.87	1.56	0.00	6.30	2.34	7.31	0.00	0.25	0.00	0.00	0.00	0.17	0.00	0.00	0.47	0.00	0.00	0.00	0.00
N. coccolithom.	0.00	0.00	0.00	0.00	0.00	0.00	0.42	0.00	0.38	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.65	0.07	0.03
O. fragilis	2.80	1.56	1.46	0.00	0.78	1.46	1.27	0.49	0.38	0.62	0.00	0.17	0.33	0.50	0.47	0.40	0.11	0.27	0.09
O. hydroideus	7.48	9.35	5.84	69.27	12.47	36.53	3.82	3.94	1.52	0.00	2.00	1.16	2.00	0.60	1.87	0.60	1.08	0.33	0.03
P. lepida	0.93	1.56	2.92	0.00	0.78	0.00	0.42	0.74	0.38	0.00	0.33	0.00	0.00	0.00	0.00	0.30	1.08	0.13	0.09
Pontosphaera spp.	0.93	0.00	0.00	0.00	0.00	1.46	0.00	0.00	0.00	0.00	0.00	0.17	0.00	0.00	0.00	0.00	0.22	0.00	0.00
R. sessilis	0.00	0.00	4.38	0.00	1.56	1.46	0.42	0.00	0.76	0.62	0.00	0.00	0.33	0.10	0.00	0.20	0.00	0.07	0.00
R. clavigera	21.50	32.73	19.00	44.08	7.01	14.61	4.67	3.20	6.84	3.10	3.34	3.33	1.67	0.90	2.34	1.50	0.86	0.33	0.18
R. xiphos	14.96	28.05	19.00	81.87	7.79	21.92	2.55	2.71	5.32	0.00	0.67	1.50	3.34	0.70	4.21	2.20	0.32	0.53	0.03
S. apsteinii	0.00	0.00	0.00	0.00	0.00	0.00	0.42	0.00	0.00	0.00	0.00	0.17	0.33	0.00	0.00	0.00	0.11	0.00	0.00
S. anthos	0.93	0.00	2.92	0.00	1.56	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.03
S. corolla	0.93	0.00	0.00	0.00	0.00	0.00	0.42	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.00	0.00	0.00
S. epigrosa	0.00	0.00	2.92	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S. halldalii	2.80	1.56	0.00	31.49	2.34	2.92	0.42	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.47	0.10	0.00	0.07	0.00
S. histrica	6.54	0.00	0.00	12.59	0.00	2.92	0.85	0.25	0.38	0.00	0.00	0.17	0.00	0.00	0.00	0.30	0.00	0.00	0.06
S. lamina	0.00	1.56	4.38	12.59	0.78	2.92	0.42	0.25	1.52	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.00	0.07	0.00
S. molischii	0.00	3.12	1.46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.00	0.67	0.10	0.00	3.01	0.00	0.07	0.06
S. nodosa	4.67	1.56	5.84	0.00	0.78	1.46	0.42	0.25	0.00	0.00	0.67	0.00	0.67	0.00	0.00	0.00	0.00	0.00	0.03
S. pirus	0.00	0.00	1.46	6.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.22	0.00	0.03
S. prolongata	0.00	0.00	0.00	25.19	1.56	0.00	0.00	0.25	0.38	0.00	0.00	0.17	0.33	0.20	0.47	0.00	0.00	0.00	0.00
S. pulchra	6.54	18.70	7.31	50.38	2.34	2.92	5.10	0.98	2.28	1.24	1.67	0.17	1.00	0.50	2.34	0.70	0.22	0.07	0.26
S. rotula	0.00	1.56	1.46	0.00	0.78	4.38	0.00	0.49	0.38	0.00	0.00	0.17	0.00	0.00	0.00	0.30	0.11	0.00	0.00
Syracosphaera spp.	5.61	15.59	19.00	81.87	1.56	20.46	2.12	1.72	2.66	0.62	2.34	0.67	2.00	0.30	0.47	0.40	0.32	0.20	0.03
T. quadrilaminata	27.11	6.23	10.23	50.38	3.90	11.69	3.82	2.46	5.32	2.48	2.67	2.00	2.67	0.60	3.27	0.90	1.19	0.53	0.15
U. irregularis	0.93	7.79	2.92	0.00	0.00	1.46	0.42	0.98	1.14	2.48	1.00	0.00	0.00	0.20	0.00	0.10	0.00	0.07	0.00
U. tenuis	14.96	28.05	24.84	37.78	3.12	20.46	5.95	2.71	6.08	6.21	3.01	2.16	2.34	0.50	3.27	3.91	0.76	0.87	0.18
U. hulburtiana	0.00	1.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.24	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.07	0.00
U. sibogae	4.67	14.03	8.77	31.49	6.23	1.46	7.65	1.72	3.04	2.48	1.00	1.33	0.33	0.70	2.80	0.70	0.86	0.20	0.03
Holococcolithen	2.80	18.70	17.53	12.59	3.90	4.38	2.97	1.97	1.90	0.00	1.00	0.50	0.67	0.60	3.27	0.80	1.40	0.80	0.32

ESTOC - CI7u (3000 m): Coccolithenfluss (Mio Coccolithen m^{-2} d^{-1})

Probe	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Verschlusszeit	06.01.97	20.01.97	03.02.97	17.02.97	03.03.97	17.03.97	31.03.97	14.04.97	28.04.97	12.05.97	26.05.97	09.06.97	23.06.97	07.07.97	21.07.97	04.08.97	18.08.97	01.09.97	15.09.97
Sammelinterval (d)	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14
Gesamtfluss	1103.92	1171.04	576.56	1563.72	1942.38	3015.90	893.08	955.42	950.75	584.48	386.67	853.93	961.66	1116.35	730.32	614.67	900.87	521.35	268.86
Acanthoica spp.	12.02	7.01	0.78	4.67	49.09	23.38	3.12	15.59	10.91	6.68	1.34	7.79	4.68	27.28	7.79	10.72	3.12	0.78	2.34
Algirosphaera spp.	66.12	77.13	29.61	98.17	80.64	112.22	48.32	79.49	51.43	38.97	14.69	45.19	70.14	87.67	44.53	37.99	31.17	31.95	20.11
A. unicornis	0.00	0.00	0.00	0.00	3.51	4.68	3.12	0.00	0.00	0.00	0.00	1.56	1.56	0.00	1.11	0.00	0.00	0.00	0.47
A. brasiliensis	0.00	5.26	3.12	4.67	0.00	0.00	0.00	0.00	3.12	1.11	2.67	3.12	0.00	3.90	0.00	0.97	1.56	0.78	0.47
C. leptoporus	16.03	15.78	5.45	16.36	14.02	14.03	17.14	26.50	6.23	11.13	4.01	9.35	14.03	13.64	12.25	6.82	6.23	7.79	2.34
C. murrayi	16.03	21.04	0.78	7.01	24.54	46.76	15.59	17.14	6.23	11.13	3.34	6.23	10.91	5.84	4.45	9.74	4.68	6.23	2.34
C. pelagicus	0.00	1.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. binodata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.56	0.00	0.00	0.00	0.00	0.00	0.00
C. mediterranea	4.01	0.00	1.56	2.34	7.01	4.68	3.12	1.56	1.56	0.00	0.00	1.56	1.56	0.00	1.11	1.95	1.56	0.00	0.47
D. tubifera	6.01	17.53	7.79	7.01	24.54	28.05	15.59	21.82	12.47	3.34	3.34	7.79	14.03	11.69	5.57	11.69	15.59	6.23	4.68
E. huxleyi	308.54	312.04	198.68	656.81	680.18	888.40	282.11	303.93	283.67	201.51	145.59	282.05	297.69	327.31	207.07	151.96	303.93	157.42	63.12
F. profunda	324.57	331.33	137.13	266.46	417.23	523.69	227.56	191.71	250.94	139.16	82.81	216.60	257.17	235.74	220.43	154.89	271.20	150.41	86.97
G. ericsonii	104.18	94.66	45.97	250.10	210.37	350.69	63.90	84.16	71.70	44.53	28.72	52.98	57.67	79.88	37.85	45.78	52.99	34.29	20.11
G. muellerae	22.04	14.02	4.67	9.35	21.04	18.70	4.68	6.23	6.23	5.57	6.01	7.79	7.79	9.74	4.45	3.90	4.68	1.56	3.74
G. oceanica	36.06	33.31	19.48	32.72	38.57	93.52	29.61	26.50	35.85	11.13	8.68	34.28	20.26	25.33	20.04	12.66	28.05	14.03	6.55
G. ornata	0.00	0.00	0.00	2.34	3.51	4.68	1.56	0.00	0.00	1.11	0.00	3.12	1.56	0.00	0.00	1.95	0.00	0.00	0.00
G. flabellatus	18.03	19.28	7.79	7.01	17.53	32.73	9.35	12.47	12.47	8.91	6.68	12.47	15.59	23.38	21.15	9.74	12.47	9.35	5.61
H. perplexus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
H. carteri	4.01	3.51	3.12	2.34	7.01	9.35	1.56	1.56	4.68	1.11	1.34	4.67	0.00	1.95	4.45	1.95	3.12	1.56	0.94
H. pavimentum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00
M. elegans	2.00	0.00	0.00	0.00	7.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.95	1.11	0.00	0.00	0.00	0.47
N. coccolithom.	0.00	0.00	0.00	0.00	0.00	4.68	3.12	0.00	3.12	0.00	0.00	0.00	3.12	1.95	1.11	0.97	1.56	0.00	0.00
O. fragilis	0.00	1.75	3.12	0.00	10.52	9.35	6.23	1.56	1.56	0.00	2.00	3.12	4.68	5.84	3.34	1.95	3.12	2.34	1.40
O. hydroideus	10.02	12.27	4.67	14.02	35.06	42.08	10.91	7.79	12.47	2.23	14.69	9.35	23.38	25.33	10.02	9.74	12.47	8.57	1.87
P. lepida	2.00	0.00	0.78	4.67	0.00	9.35	0.00	0.00	3.12	1.11	1.34	1.56	0.00	1.95	0.00	0.00	0.00	0.00	0.00
Pontosphaera spp.	0.00	0.00	0.00	0.00	3.51	0.00	0.00	0.00	0.00	0.00	0.00	1.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00
R. parvula	0.00	0.00	0.00	0.00	0.00	0.00	1.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
R. sessilis	14.02	3.51	0.78	2.34	3.51	430.18	4.68	3.12	0.00	0.00	4.01	4.67	1.56	5.84	4.45	2.92	3.12	3.90	6.55
R. clavigera	18.03	24.54	7.79	21.04	45.58	56.11	15.59	20.26	9.35	13.36	6.68	26.49	17.14	31.17	16.70	4.87	12.47	16.37	5.61
R. xiphos	6.01	29.80	10.91	28.05	28.05	46.76	20.26	12.47	10.91	8.91	5.34	12.47	18.70	21.43	8.91	33.12	21.82	7.01	2.81
S. apsteinii	0.00	0.00	0.00	2.34	0.00	0.00	0.00	0.00	0.00	1.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S. anthos	0.00	0.00	0.78	11.69	21.04	4.68	4.68	0.00	3.12	4.45	2.00	0.00	1.56	3.90	2.23	2.92	0.00	1.56	0.94
S. borealis	0.00	0.00	0.00	0.00	3.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S. corolla	4.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.56	0.00	0.00	0.00	0.00	0.00	0.78	0.00
S. halldalii	2.00	5.26	0.78	4.67	7.01	0.00	1.56	1.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.97	6.23	3.12	0.47
S. histrica	16.03	5.26	2.34	7.01	0.00	9.35	3.12	3.12	10.91	3.34	0.67	4.67	6.23	7.79	3.34	1.95	0.00	1.56	0.47
S. lamina	0.00	1.75	0.78	2.34	0.00	4.68	0.00	1.56	0.00	0.00	0.00	0.00	1.56	5.84	2.23	0.97	1.56	2.34	0.00
S. molischii	0.00	0.00	0.00	7.01	3.51	9.35	0.00	0.00	1.56	0.00	0.67	0.00	1.56	0.00	0.00	0.97	3.12	1.56	0.00
S. nodosa	2.00	1.75	0.00	2.34	0.00	0.00	3.12	6.23	0.00	0.00	0.00	1.56	3.12	7.79	0.00	9.74	4.68	1.56	1.40
S. ossa	0.00	0.00	0.00	0.00	0.00	9.35	0.00	0.00	6.23	0.00	0.00	0.00	0.00	1.95	0.00	0.00	0.00	0.78	0.47
S. pirus	0.00	1.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.56	0.00	0.00
S. prolongata	0.00	0.00	0.00	0.00	0.00	0.00	1.56	0.00	0.00	0.00	0.00	1.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S. pulchra	6.01	15.78	17.14	16.36	24.54	23.38	15.59	12.47	15.59	2.23	8.68	9.35	6.23	17.53	8.91	5.84	4.68	4.68	2.34
S. rotula	0.00	0.00	0.00	0.00	3.51	0.00	0.00	0.00	1.56	0.00	0.00	0.00	0.00	0.00	1.11	1.95	0.00	0.78	0.00
Syracosphaera spp.	8.01	8.77	4.67	14.02	21.04	14.03	6.23	6.23	14.03	8.91	2.00	4.67	4.68	15.59	3.34	4.87	9.35	9.35	0.94
T. quadrilaminata	30.05	33.31	17.14	18.70	31.55	65.46	23.38	32.73	21.82	11.13	6.68	20.26	17.14	44.81	17.81	9.74	20.26	8.57	5.61
U. irregularis	2.00	1.75	0.78	0.00	7.01	0.00	1.56	1.56	1.56	1.11	0.67	1.56	4.68	5.84	1.11	1.95	4.68	2.34	0.94
U. tenuis	20.03	36.81	20.26	23.37	38.57	42.08	15.59	14.03	29.61	17.81	7.35	18.70	35.85	17.53	20.04	19.48	18.70	11.69	5.14
U. hulburtiana	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.47
U. sibogae	16.03	31.55	15.58	14.02	35.06	46.76	15.59	21.82	29.61	16.70	11.35	23.37	21.82	27.28	23.38	4.87	17.14	7.79	7.01
Holococcolithen	8.01	1.75	2.34	2.34	14.02	32.73	12.47	20.26	15.59	6.68	2.67	9.35	12.47	11.69	7.79	32.15	14.03	2.34	3.74

ESTOC - Cl7m (750 m): relative Artenanteile (%)

Probe	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Verschlusszeit	06.01.97	20.01.97	03.02.97	17.02.97	03.03.97	17.03.97	31.03.97	14.04.97	28.04.97	12.05.97	26.05.97	09.06.97	23.06.97	07.07.97	21.07.97	04.08.97	18.08.97	01.09.97	15.09.97
Sammelintervall (d)	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14
Gesamtfluss	604.92	974.13	942.47	4691.56	528.37	846.03	245.64	156.48	247.42	338.82	128.89	84.85	159.61	44.68	192.13	63.01	67.10	26.78	12.76
Acanthoica spp.	0.62	0.32	1.86	1.61	2.06	2.25	0.69	0.47	0.61	0.00	1.04	0.59	0.21	0.45	0.00	0.48	0.16	0.25	0.46
Algirosphaera spp.	6.34	2.40	8.68	9.66	6.19	5.87	6.40	5.97	6.61	0.55	14.51	8.24	11.72	7.62	9.00	9.38	11.90	16.46	8.53
A. unicornis	0.00	0.00	0.16	2.01	0.00	0.17	0.00	0.00	0.00	0.00	0.26	0.00	0.00	0.22	0.00	0.16	0.00	0.00	0.00
A. brasiliensis	0.31	0.00	0.00	0.40	0.15	0.00	0.00	0.16	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.32	0.00	0.46
C. leptoporus	0.93	1.12	0.78	0.54	1.47	1.04	2.25	3.62	1.54	3.11	2.33	1.37	2.09	2.24	0.49	1.43	0.80	0.75	2.07
C. murrayi	0.93	1.12	0.78	1.88	1.77	1.90	1.04	0.79	1.69	0.18	0.26	0.98	0.42	0.22	0.00	0.48	0.64	0.50	0.23
C. pelagicus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. binodata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. mediterranea	0.00	0.00	0.47	0.13	0.29	0.00	0.00	0.16	0.31	0.18	0.00	0.00	0.42	0.22	1.22	0.00	0.32	0.00	0.00
C. aculeata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. tubifera	1.24	2.24	1.71	1.07	0.88	0.52	1.38	1.42	1.08	0.00	0.78	1.76	0.84	2.02	1.95	4.45	0.96	1.75	0.92
E. huxleyi	24.42	28.80	28.22	45.64	37.61	32.99	39.79	38.99	32.87	43.22	21.76	26.08	25.52	23.54	22.87	20.67	20.58	17.71	22.81
F. profunda	32.77	30.72	32.25	11.01	21.83	16.93	19.03	16.82	21.66	36.81	29.53	31.76	34.10	38.79	37.23	28.14	40.84	33.17	43.32
G. ericsonii	5.56	8.96	4.81	13.29	14.16	16.75	8.13	10.06	10.60	6.41	5.96	6.67	7.95	4.26	7.79	4.29	5.31	5.74	4.38
G. muellerae	0.46	0.32	0.16	0.13	0.59	0.35	1.04	0.94	1.23	0.37	0.52	0.59	0.63	0.90	0.97	0.16	0.32	0.50	0.69
G. oceanica	1.70	1.60	1.71	1.74	1.18	2.42	1.04	3.46	2.92	1.83	3.37	2.75	2.30	2.02	2.43	1.43	1.29	2.00	1.38
G. ornata	0.00	0.32	0.00	0.13	0.15	0.17	0.17	0.16	0.00	0.18	0.00	0.20	0.00	0.00	0.00	0.32	0.00	0.25	0.00
G. flabellatus	1.70	1.12	1.55	0.40	0.74	0.69	1.04	0.16	1.08	0.18	1.04	0.78	1.26	1.35	1.70	1.75	1.93	2.49	1.38
H. carteri	0.62	0.00	0.47	0.13	0.29	0.35	0.00	0.16	0.77	0.00	1.04	0.39	0.00	1.12	0.00	0.16	0.32	0.25	0.00
H. pavimentum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.25	0.00
M. elegans	0.31	0.16	0.00	0.13	0.44	0.86	0.00	0.16	0.00	0.00	0.00	0.20	0.00	0.00	0.24	0.00	0.00	0.00	0.00
N. coccolithom.	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.32	0.96	0.25	0.23
O. fragilis	0.46	0.16	0.16	0.00	0.15	0.17	0.52	0.31	0.15	0.18	0.00	0.20	0.21	1.12	0.24	0.64	0.16	1.00	0.69
O. hydroideus	1.24	0.96	0.62	1.48	2.36	4.32	1.56	2.52	0.61	0.00	1.55	1.37	1.26	1.35	0.97	0.95	1.61	1.25	0.23
P. lepida	0.15	0.16	0.31	0.00	0.15	0.00	0.17	0.47	0.15	0.00	0.26	0.00	0.00	0.00	0.00	0.48	1.61	0.50	0.69
Pontosphaera spp.	0.15	0.00	0.00	0.00	0.00	0.17	0.00	0.00	0.00	0.00	0.00	0.20	0.00	0.00	0.00	0.00	0.32	0.00	0.00
R. sessilis	0.00	0.00	0.47	0.00	0.29	0.17	0.17	0.00	0.31	0.18	0.00	0.00	0.21	0.22	0.00	0.32	0.00	0.25	0.00
R. clavigera	3.55	3.36	2.02	0.94	1.33	1.73	1.90	2.04	2.76	0.92	2.59	3.92	1.05	2.02	1.22	2.38	1.29	1.25	1.38
R. xiphos	2.47	2.88	2.02	1.74	1.47	2.59	1.04	1.73	2.15	0.00	0.52	1.76	2.09	1.57	2.19	3.50	0.48	2.00	0.23
S. apsteinii	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.00	0.00	0.00	0.00	0.20	0.21	0.00	0.00	0.00	0.16	0.00	0.00
S. anthos	0.15	0.00	0.31	0.00	0.29	0.00	0.00	0.00	0.00	0.00	1.55	0.00	0.00	0.22	0.00	0.00	0.00	0.00	0.23
S. corolla	0.15	0.00	0.00	0.00	0.00	0.00	0.17	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.00	0.00	0.00
S. epigrosa	0.00	0.00	0.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S. halldalii	0.46	0.16	0.00	0.67	0.44	0.35	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.22	0.24	0.16	0.00	0.25	0.00
S. histrica	1.08	0.00	0.00	0.27	0.00	0.35	0.35	0.16	0.15	0.00	0.00	0.20	0.00	0.00	0.00	0.48	0.00	0.00	0.46
S. lamina	0.00	0.16	0.47	0.27	0.15	0.35	0.17	0.16	0.61	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.00	0.25	0.00
S. molischii	0.00	0.32	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.26	0.00	0.42	0.22	0.00	4.77	0.00	0.25	0.46
S. nodosa	0.77	0.16	0.62	0.00	0.15	0.17	0.17	0.16	0.00	0.00	0.52	0.00	0.42	0.00	0.00	0.00	0.00	0.00	0.23
S. pirus	0.00	0.00	0.16	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.32	0.00	0.23
S. prolongata	0.00	0.00	0.00	0.54	0.29	0.00	0.00	0.16	0.15	0.00	0.00	0.20	0.21	0.45	0.24	0.00	0.00	0.00	0.00
S. pulchra	1.08	1.92	0.78	1.07	0.44	0.35	2.08	0.63	0.92	0.37	1.30	0.20	0.63	1.12	1.22	1.11	0.32	0.25	2.07
S. rotula	0.00	0.16	0.16	0.00	0.15	0.52	0.00	0.31	0.15	0.00	0.00	0.20	0.00	0.00	0.00	0.48	0.16	0.00	0.00
Syracosphaera spp.	0.93	1.60	2.02	1.74	0.29	2.42	0.87	1.10	1.08	0.18	1.81	0.78	1.26	0.67	0.24	0.64	0.48	0.75	0.23
T. quadrilaminata	4.48	0.64	1.09	1.07	0.74	1.38	1.56	1.57	2.15	0.73	2.07	2.35	1.67	1.35	1.70	1.43	1.77	2.00	1.15
U. irregularis	0.15	0.80	0.31	0.00	0.00	0.17	0.17	0.63	0.46	0.73	0.78	0.00	0.00	0.45	0.00	0.16	0.00	0.25	0.00
U. tenuis	2.47	2.88	2.64	0.81	0.59	2.42	2.42	1.73	2.46	1.83	2.33	2.55	1.46	1.12	1.70	6.20	1.13	3.24	1.38
U. hulburtiana	0.00	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.37	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.25	0.00
U. sibogae	0.77	1.44	0.93	0.67	1.18	0.17	3.11	1.10	1.23	0.73	0.78	1.57	0.21	1.57	1.46	1.11	1.29	0.75	0.23
Holococcolithen	0.46	1.92	1.86	0.27	0.74	0.52	1.21	1.26	0.77	0.00	0.78	0.59	0.42	1.35	1.70	1.27	2.09	2.99	2.53

ESTOC - CI7u (3000 m): relative Artenanteile (%)

Probe	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Verschlusszeit	06.01.97	20.01.97	03.02.97	17.02.97	03.03.97	17.03.97	31.03.97	14.04.97	28.04.97	12.05.97	26.05.97	09.06.97	23.06.97	07.07.97	21.07.97	04.08.97	18.08.97	01.09.97	15.09.97
Sammelintervall	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14
Gesamtfluss	1103.92	1171.04	576.56	1563.72	1942.38	3015.90	893.08	955.42	950.75	584.48	386.67	853.93	961.66	1116.35	730.32	614.67	900.87	521.35	268.86
Acanthoica spp.	1.09	0.60	0.14	0.30	2.53	0.78	0.35	1.63	1.15	1.14	0.35	0.91	0.49	2.44	1.07	1.74	0.35	0.15	0.87
Algirosphaera spp.	6.53	6.74	5.14	6.28	6.50	4.34	4.71	9.30	6.56	6.67	3.97	5.84	7.62	9.42	7.01	7.61	3.81	6.28	8.35
A. unicornis	0.00	0.00	0.00	0.00	0.18	0.16	0.35	0.00	0.00	0.00	0.00	0.18	0.16	0.00	0.15	0.00	0.00	0.00	0.17
A. brasiliensis	0.00	0.45	0.54	0.30	0.00	0.00	0.00	0.00	0.33	0.19	0.69	0.36	0.00	0.35	0.00	0.16	0.17	0.15	0.17
C. leptoporus	1.45	1.35	0.95	1.05	0.72	0.47	1.92	2.77	0.66	1.90	1.04	1.09	1.46	1.22	1.68	1.11	0.69	1.49	0.87
C. murrayi	1.45	1.80	0.14	0.45	1.26	1.55	1.75	1.79	0.66	1.90	0.86	0.73	1.13	0.52	0.61	1.58	0.52	1.20	0.87
C. pelagicus	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. binodata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.00	0.00	0.00	0.00	0.00	0.00
C. mediterranea	0.36	0.00	0.27	0.15	0.36	0.16	0.35	0.16	0.16	0.00	0.00	0.18	0.16	0.00	0.15	0.32	0.17	0.00	0.17
D. tubifera	0.54	1.50	1.35	0.45	1.26	0.93	1.75	2.28	1.31	0.57	0.86	0.91	1.46	1.05	0.76	1.90	1.73	1.20	1.74
E. huxleyi	27.95	26.65	34.46	42.00	35.02	29.46	31.59	31.81	29.84	34.48	37.65	33.03	30.96	29.32	28.35	24.72	33.74	30.19	23.48
F. profunda	29.40	28.29	23.78	17.04	21.48	17.36	25.48	20.07	26.39	23.81	21.42	25.36	26.74	21.12	30.18	25.20	30.10	28.85	32.35
G. ericsonii	9.44	8.08	7.97	15.99	10.83	11.63	7.16	8.81	7.54	7.62	7.43	6.20	6.00	7.16	5.18	7.45	5.88	6.58	7.48
G. muellerae	2.00	1.20	0.81	0.60	1.08	0.62	0.52	0.65	0.66	0.95	1.55	0.91	0.81	0.87	0.61	0.63	0.52	0.30	1.39
G. oceanica	3.27	2.84	3.38	2.09	1.99	3.10	3.32	2.77	3.77	1.90	2.25	4.01	2.11	2.27	2.74	2.06	3.11	2.69	2.43
G. ornata	0.00	0.00	0.00	0.15	0.18	0.16	0.17	0.00	0.00	0.19	0.00	0.36	0.16	0.00	0.00	0.32	0.00	0.00	0.00
G. flabellatus	1.63	1.65	1.35	0.45	0.90	1.09	1.05	1.31	1.31	1.52	1.73	1.46	1.62	2.09	2.90	1.58	1.38	1.79	2.09
H. perplexus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
H. carteri	0.36	0.30	0.54	0.15	0.36	0.31	0.17	0.16	0.49	0.19	0.35	0.55	0.00	0.17	0.61	0.32	0.35	0.30	0.35
H. pavimentum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00
M. elegans	0.18	0.00	0.00	0.00	0.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.15	0.00	0.00	0.00	0.17
N. coccolithom.	0.00	0.00	0.00	0.00	0.00	0.16	0.35	0.00	0.33	0.00	0.00	0.00	0.32	0.17	0.15	0.16	0.17	0.00	0.00
O. fragilis	0.00	0.15	0.54	0.00	0.54	0.31	0.70	0.16	0.16	0.00	0.52	0.36	0.49	0.52	0.46	0.32	0.35	0.45	0.52
O. hydroideus	0.91	1.05	0.81	0.90	1.81	1.40	1.22	0.82	1.31	0.38	3.80	1.09	2.43	2.27	1.37	1.58	1.38	1.64	0.70
P. lepida	0.18	0.00	0.14	0.30	0.00	0.31	0.00	0.00	0.33	0.19	0.35	0.18	0.00	0.17	0.00	0.00	0.00	0.00	0.00
Pontosphaera spp.	0.00	0.00	0.00	0.00	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00
R. parvula	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
R. sessilis	1.27	0.30	0.14	0.15	0.18	14.26	0.52	0.33	0.00	0.00	1.04	0.55	0.16	0.52	0.61	0.48	0.35	0.75	2.43
R. clavigera	1.63	2.10	1.35	1.35	2.35	1.86	1.75	2.12	0.98	2.29	1.73	3.10	1.78	2.79	2.29	0.79	1.38	3.14	2.09
R. xiphos	0.54	2.54	1.89	1.79	1.44	1.55	2.27	1.31	1.15	1.52	1.38	1.46	1.94	1.92	1.22	5.39	2.42	1.35	1.04
S. apsteinii	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S. anthos	0.00	0.00	0.14	0.75	1.08	0.16	0.52	0.00	0.33	0.76	0.52	0.00	0.16	0.35	0.30	0.48	0.00	0.30	0.35
S. borealis	0.00	0.00	0.00	0.00	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S. corolla	0.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.18	0.00	0.00	0.00	0.00	0.00	0.15	0.00
S. halldalii	0.18	0.45	0.14	0.30	0.36	0.00	0.17	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.69	0.60	0.17
S. histrica	1.45	0.45	0.41	0.45	0.00	0.31	0.35	0.33	1.15	0.57	0.17	0.55	0.65	0.70	0.46	0.32	0.00	0.30	0.17
S. lamina	0.00	0.15	0.14	0.15	0.00	0.16	0.00	0.16	0.00	0.00	0.00	0.00	0.16	0.52	0.30	0.16	0.17	0.45	0.00
S. molischii	0.00	0.00	0.00	0.45	0.18	0.31	0.00	0.00	0.16	0.00	0.17	0.00	0.16	0.00	0.00	0.16	0.35	0.30	0.00
S. nodosa	0.18	0.15	0.00	0.15	0.00	0.00	0.35	0.65	0.00	0.00	0.00	0.18	0.32	0.70	0.00	1.58	0.52	0.30	0.52
S. ossa	0.00	0.00	0.00	0.00	0.00	0.31	0.00	0.00	0.66	0.00	0.00	0.00	0.00	0.17	0.00	0.00	0.00	0.15	0.17
S. pirus	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.00	0.00
S. prolongata	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.00	0.00	0.00	0.00	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S. pulchra	0.54	1.35	2.97	1.05	1.26	0.78	1.75	1.31	1.64	0.38	2.25	1.09	0.65	1.57	1.22	0.95	0.52	0.90	0.87
S. rotula	0.00	0.00	0.00	0.00	0.18	0.00	0.00	0.00	0.16	0.00	0.00	0.00	0.00	0.00	0.15	0.32	0.00	0.15	0.00
Syracosphaera spp.	0.73	0.75	0.81	0.90	1.08	0.47	0.70	0.65	1.48	1.52	0.52	0.55	0.49	1.40	0.46	0.79	1.04	1.79	0.35
T. quadrilaminata	2.72	2.84	2.97	1.20	1.62	2.17	2.62	3.43	2.30	1.90	1.73	2.37	1.78	4.01	2.44	1.58	2.25	1.64	2.09
U. irregularis	0.18	0.15	0.14	0.00	0.36	0.00	0.17	0.16	0.16	0.19	0.17	0.18	0.49	0.52	0.15	0.32	0.52	0.45	0.35
U. tenuis	1.81	3.14	3.51	1.49	1.99	1.40	1.75	1.47	3.11	3.05	1.90	2.19	3.73	1.57	2.74	3.17	2.08	2.24	1.91
U. hulburtiana	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17
U. sibogae	1.45	2.69	2.70	0.90	1.81	1.55	1.75	2.28	3.11	2.86	2.94	2.74	2.27	2.44	3.20	0.79	1.90	1.49	2.61
Holococcolithen	0.73	0.15	0.41	0.15	0.72	1.09	1.40	2.12	1.64	1.14	0.69	1.09	1.30	1.05	1.07	5.23	1.56	0.45	1.39

ESTOC - CI7m (750 m): Coccolithenkarbonatfluss (mg m^{-2} d^{-1})

Probe	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Verschlusszeit	06.01.97	20.01.97	03.02.97	17.02.97	03.03.97	17.03.97	31.03.97	14.04.97	28.04.97	12.05.97	26.05.97	09.06.97	23.06.97	07.07.97	21.07.97	04.08.97	18.08.97	01.09.97	15.09.97
Sammelintervall (d)	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14
Gesamtfluss	6.012	6.732	6.551	23.789	3.788	5.557	1.880	1.744	2.047	2.153	1.239	0.717	1.033	0.500	0.995	0.528	0.401	0.185	0.087
C. leptoporus	0.511	0.994	0.666	2.295	0.710	0.799	0.503	0.516	0.346	0.961	0.274	0.106	0.304	0.091	0.085	0.082	0.049	0.018	0.024
C. pelagicus	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.062	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
D. tubifera	0.011	0.033	0.024	0.076	0.007	0.007	0.005	0.003	0.004	0.000	0.002	0.002	0.002	0.001	0.006	0.004	0.001	0.001	0.000
E. huxleyi	0.334	0.648	0.558	4.496	0.458	0.586	0.205	0.128	0.171	0.308	0.059	0.051	0.086	0.022	0.092	0.033	0.029	0.010	0.006
F. profunda	0.317	0.479	0.486	0.826	0.185	0.229	0.075	0.042	0.086	0.200	0.061	0.043	0.087	0.028	0.114	0.028	0.044	0.014	0.009
G. ericsonii	0.030	0.101	0.083	0.788	0.067	0.156	0.023	0.017	0.029	0.020	0.007	0.005	0.016	0.003	0.013	0.002	0.003	0.001	0.001
G. muellerae	0.018	0.020	0.009	0.040	0.020	0.018	0.016	0.009	0.019	0.008	0.004	0.003	0.006	0.003	0.012	0.001	0.001	0.001	0.001
G. oceanica	0.164	0.248	0.581	1.302	0.099	0.325	0.041	0.086	0.115	0.099	0.069	0.037	0.058	0.014	0.074	0.014	0.014	0.008	0.003
H. carteri	0.534	0.000	0.626	0.899	0.223	0.417	0.000	0.035	0.271	0.000	0.191	0.048	0.000	0.072	0.000	0.014	0.031	0.010	0.000
O. fragilis	0.272	0.151	0.141	0.000	0.075	0.141	0.123	0.048	0.037	0.060	0.000	0.016	0.032	0.048	0.045	0.039	0.010	0.026	0.009
Pontosphaera spp.	0.064	0.000	0.000	0.000	0.000	0.099	0.000	0.000	0.000	0.000	0.000	0.011	0.000	0.000	0.000	0.000	0.015	0.000	0.000
R. clavigera	1.452	2.209	1.282	2.976	0.473	0.986	0.316	0.216	0.462	0.209	0.225	0.225	0.113	0.061	0.158	0.101	0.058	0.023	0.012
S. pulchra	0.105	0.299	0.117	0.806	0.037	0.047	0.082	0.016	0.036	0.020	0.027	0.003	0.016	0.008	0.037	0.011	0.003	0.001	0.004
Syracosphaera spp.	0.192	0.113	0.248	1.067	0.094	0.177	0.031	0.021	0.032	0.000	0.036	0.006	0.020	0.006	0.011	0.047	0.004	0.002	0.002
Syracosphaera spp. (small)	0.172	0.062	0.076	0.327	0.006	0.082	0.008	0.007	0.011	0.002	0.009	0.003	0.008	0.001	0.002	0.002	0.001	0.001	0.000
U. tenuis	0.130	0.244	0.216	0.329	0.027	0.178	0.052	0.024	0.053	0.054	0.026	0.019	0.020	0.004	0.028	0.034	0.007	0.008	0.002
U. sibogae	0.059	0.177	0.110	0.397	0.099	0.018	0.118	0.022	0.038	0.047	0.013	0.017	0.004	0.009	0.035	0.014	0.011	0.003	0.000
Holococcolithen	0.003	0.019	0.018	0.013	0.004	0.004	0.003	0.002	0.002	0.000	0.001	0.000	0.001	0.001	0.003	0.001	0.001	0.001	0.000
Restl. Arten	1.646	0.935	1.309	7.154	1.203	1.286	0.279	0.553	0.334	0.104	0.235	0.122	0.259	0.127	0.277	0.099	0.118	0.058	0.015

ESTOC - CI7m (750 m): Rel. Anteil am Coccolithkarbonatenfluss (%)

Probe	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Verschlusszeit	06.01.97	20.01.97	03.02.97	17.02.97	03.03.97	17.03.97	31.03.97	14.04.97	28.04.97	12.05.97	26.05.97	09.06.97	23.06.97	07.07.97	21.07.97	04.08.97	18.08.97	01.09.97	15.09.97
Sammelintervall (d)	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14
Gesamtfluss	6.012	6.732	6.551	23.789	3.788	5.557	1.880	1.744	2.047	2.153	1.239	0.717	1.033	0.500	0.995	0.528	0.401	0.185	0.087
C. leptoporus	8.50	14.76	10.16	9.65	18.74	14.37	26.77	29.56	16.92	44.63	22.10	14.80	29.44	18.27	8.56	15.55	12.25	9.86	27.64
C. pelagicus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.87	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. tubifera	0.19	0.49	0.37	0.32	0.19	0.12	0.27	0.19	0.19	0.00	0.12	0.31	0.19	0.27	0.56	0.80	0.24	0.38	0.20
E. huxleyi	5.55	9.63	8.53	18.90	12.10	10.55	10.92	7.35	8.35	14.28	4.76	7.07	8.28	4.42	9.28	6.29	7.23	5.38	7.01
F. profunda	5.28	7.11	7.42	3.47	4.87	4.12	3.98	2.42	4.19	9.27	4.92	6.02	8.43	5.55	11.51	5.37	10.93	7.67	10.14
G. ericsonii	0.50	1.50	1.26	3.31	1.78	2.82	1.24	0.97	1.42	0.91	0.56	0.71	1.57	0.60	1.35	0.46	0.80	0.75	0.58
G. muellerae	0.29	0.29	0.14	0.17	0.52	0.33	0.85	0.53	0.94	0.36	0.34	0.44	0.61	0.51	1.18	0.12	0.34	0.45	0.64
G. oceanica	2.72	3.68	8.87	5.47	2.62	5.85	2.16	4.94	5.61	4.58	5.57	5.17	5.65	2.87	7.47	2.71	3.42	4.59	3.22
H. carteri	8.88	0.00	9.56	3.78	5.88	7.51	0.00	2.01	13.26	0.00	15.40	6.63	0.00	14.32	0.00	2.71	7.68	5.15	0.00
O. fragilis	4.52	2.24	2.16	0.00	1.99	2.55	6.56	2.73	1.80	2.79	0.00	2.25	3.13	9.70	4.55	7.34	2.60	13.96	9.79
Pontosphaera spp.	1.06	0.00	0.00	0.00	0.00	1.79	0.00	0.00	0.00	0.00	0.00	1.58	0.00	0.00	0.00	0.00	3.66	0.00	0.00
R. clavigera	24.14	32.82	19.57	12.51	12.50	17.75	16.78	12.38	22.56	9.73	18.20	31.33	10.91	12.18	15.86	19.20	14.52	12.17	13.66
S. pulchra	1.74	4.45	1.78	3.39	0.99	0.84	4.34	0.90	1.78	0.92	2.16	0.37	1.55	1.60	3.76	2.12	0.86	0.58	4.86
Syracosphaera spp.	3.20	1.68	3.78	4.48	2.49	3.18	1.64	1.20	1.57	0.00	2.94	0.84	1.95	1.21	1.14	8.95	0.98	1.31	2.86
Syracosphaera spp. (small)	2.86	0.93	1.16	1.38	0.16	1.47	0.45	0.40	0.52	0.12	0.75	0.37	0.78	0.24	0.19	0.30	0.32	0.43	0.13
U. tenuis	2.16	3.63	3.30	1.38	0.72	3.20	2.75	1.35	2.58	2.51	2.11	2.62	1.97	0.87	2.86	6.44	1.64	4.08	1.76
U. sibogae	0.98	2.63	1.69	1.67	2.61	0.33	6.30	1.24	1.87	2.20	1.02	2.34	0.41	1.77	3.55	2.66	2.71	1.36	0.42
Holococcolithen	0.05	0.28	0.27	0.05	0.10	0.08	0.16	0.11	0.09	0.00	0.08	0.07	0.06	0.12	0.33	0.15	0.35	0.43	0.37
Restl. Arten	27.37	13.89	19.99	30.07	31.76	23.14	14.83	31.72	16.34	4.84	18.98	17.08	25.08	25.50	27.83	18.81	29.47	31.45	16.72

ESTOC - CI7u (3000 m): Coccolithenkarbonatfluss (mg m^{-2} d^{-1})

Probe	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Verschlusszeit	06.01.97	20.01.97	03.02.97	17.02.97	03.03.97	17.03.97	31.03.97	14.04.97	28.04.97	12.05.97	26.05.97	09.06.97	23.06.97	07.07.97	21.07.97	04.08.97	18.08.97	01.09.97	15.09.97
Sammelinterval (d)	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14
Gesamtfluss	7.494	8.780	4.272	8.712	13.934	20.464	6.986	8.223	6.162	4.336	2.791	7.156	6.746	9.075	6.945	4.263	5.516	4.251	1.925
C. leptoporus	1.460	1.437	0.497	1.491	1.278	1.278	1.562	2.414	0.568	1.014	0.365	0.852	1.278	1.242	1.116	0.621	0.568	0.710	0.213
C. pelagicus	0.000	0.174	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
D. tubifera	0.009	0.026	0.012	0.011	0.037	0.042	0.023	0.033	0.019	0.005	0.005	0.012	0.021	0.018	0.008	0.018	0.023	0.009	0.007
E. huxleyi	0.648	0.655	0.417	1.497	1.428	1.866	0.592	0.638	0.596	0.423	0.306	0.592	0.625	0.687	0.435	0.344	0.638	0.353	0.133
F. profunda	0.519	0.530	0.219	0.426	0.668	0.838	0.364	0.496	0.401	0.223	0.132	0.347	0.411	0.377	0.353	0.248	0.434	0.241	0.139
G. ericsonii	0.094	0.085	0.041	0.259	0.234	0.316	0.080	0.095	0.081	0.054	0.026	0.048	0.052	0.100	0.034	0.041	0.048	0.031	0.018
G. muellerae	0.139	0.088	0.029	0.059	0.133	0.118	0.029	0.039	0.039	0.035	0.038	0.049	0.049	0.061	0.028	0.025	0.029	0.010	0.024
G. oceanica	0.573	0.530	0.310	0.520	0.613	1.487	0.471	0.421	0.570	0.177	0.138	0.545	0.322	0.403	0.319	0.201	0.446	0.223	0.104
H. carteri	0.572	0.501	0.445	0.334	1.001	1.335	0.223	0.223	0.668	0.159	0.191	0.668	0.000	0.278	0.636	0.278	0.445	0.223	0.134
O. fragilis	0.000	0.170	0.302	0.000	1.018	0.905	0.603	0.151	0.151	0.000	0.194	0.302	0.453	0.566	0.323	0.189	0.302	0.226	0.136
Pontosphaera spp.	0.000	0.000	0.000	0.000	0.238	0.000	0.000	0.000	0.000	0.000	0.000	0.106	0.000	0.000	0.000	0.000	0.000	0.000	0.000
R. clavigera	1.217	1.657	0.526	1.420	3.077	3.787	1.052	1.368	0.631	0.902	0.451	1.788	1.157	2.104	1.127	0.329	0.842	1.105	0.379
S. pulchra	0.096	0.252	0.274	0.262	0.393	0.374	0.249	0.200	0.249	0.036	0.139	0.150	0.100	0.281	0.143	0.094	0.075	0.075	0.037
Syracosphaera spp.	0.291	0.191	0.057	0.424	0.467	0.453	0.170	0.151	0.283	0.094	0.040	0.113	0.170	0.330	0.108	0.542	0.207	0.170	0.045
Syracosphaera spp. (small)	0.032	0.035	0.019	0.056	0.084	0.056	0.025	0.025	0.056	0.036	0.008	0.019	0.019	0.062	0.013	0.019	0.037	0.037	0.004
U. tenuis	0.174	0.320	0.176	0.203	0.336	0.366	0.136	0.122	0.258	0.155	0.064	0.163	0.312	0.153	0.174	0.169	0.163	0.102	0.045
U. sibogae	0.202	0.443	0.217	0.177	0.533	0.589	0.196	0.356	0.454	0.268	0.195	0.335	0.356	0.344	0.295	0.061	0.297	0.098	0.101
Holococcolithen	0.008	0.002	0.002	0.002	0.014	0.033	0.012	0.020	0.016	0.007	0.003	0.009	0.012	0.012	0.008	0.032	0.014	0.002	0.004
Restl. Arten	1.459	1.683	0.729	1.571	2.384	6.621	1.197	1.471	1.122	0.748	0.497	1.060	1.409	2.057	1.826	1.052	0.948	0.636	0.404

ESTOC - CI7u (3000 m): Rel. Anteil am Coccolithenkarbonatfluss (%)

Probe	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Verschlusszeit	06.01.97	20.01.97	03.02.97	17.02.97	03.03.97	17.03.97	31.03.97	14.04.97	28.04.97	12.05.97	26.05.97	09.06.97	23.06.97	07.07.97	21.07.97	04.08.97	18.08.97	01.09.97	15.09.97
Sammelinterval (d)	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14
Gesamtfluss	7.494	8.780	4.272	8.712	13.934	20.464	6.986	8.223	6.162	4.336	2.791	7.156	6.746	9.075	6.945	4.263	5.516	4.251	1.925
C. leptoporus	19.49	16.37	11.63	17.11	9.17	6.24	22.36	29.35	9.22	23.39	13.08	11.90	18.94	13.69	16.06	14.57	10.30	16.70	11.06
C. pelagicus	0.00	1.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. tubifera	0.12	0.30	0.27	0.12	0.26	0.21	0.33	0.40	0.30	0.12	0.18	0.16	0.31	0.19	0.12	0.41	0.42	0.22	0.36
E. huxleyi	8.65	7.46	9.77	17.19	10.25	9.12	8.48	7.76	9.67	9.76	10.95	8.28	9.27	7.57	6.26	8.06	11.57	8.32	6.89
F. profunda	6.93	6.04	5.14	4.89	4.79	4.09	5.21	6.03	6.52	5.14	4.75	4.84	6.10	4.16	5.08	5.81	7.87	5.66	7.23
G. ericsonii	1.25	0.97	0.97	2.97	1.68	1.54	1.14	1.16	1.32	1.25	0.93	0.67	0.77	1.10	0.49	0.97	0.86	0.73	0.94
G. muellerae	1.85	1.01	0.69	0.68	0.95	0.58	0.42	0.48	0.64	0.81	1.36	0.69	0.73	0.68	0.40	0.58	0.53	0.23	1.22
G. oceanica	7.65	6.03	7.25	5.97	4.40	7.27	6.74	5.12	9.25	4.08	4.95	7.62	4.78	4.44	4.59	4.72	8.09	5.25	5.41
H. carteri	7.64	5.70	10.42	3.83	7.19	6.53	3.19	2.71	10.84	3.67	6.83	9.33	0.00	3.07	9.16	6.53	8.07	5.24	6.94
O. fragilis	0.00	1.93	7.06	0.00	7.31	4.42	8.64	1.83	2.45	0.00	6.95	4.22	6.71	6.23	4.66	4.42	5.47	5.32	7.05
Pontosphaera spp.	0.00	0.00	0.00	0.00	1.71	0.00	0.00	0.00	0.00	0.00	0.00	1.48	0.00	0.00	0.00	0.00	0.00	0.00	0.00
R. clavigera	16.24	18.87	12.31	16.30	22.08	18.51	15.06	16.63	10.24	20.80	16.15	24.99	17.15	23.19	16.23	7.71	15.26	25.99	19.68
S. pulchra	1.28	2.88	6.42	3.01	2.82	1.83	3.57	2.43	4.05	0.82	4.98	2.09	1.48	3.09	2.05	2.19	1.36	1.76	1.94
Syracosphaera spp.	3.88	2.17	1.32	4.87	3.35	2.21	2.43	1.83	4.59	2.17	1.45	1.58	2.52	3.64	1.55	12.72	3.76	3.99	2.35
Syracosphaera spp. (small)	0.43	0.40	0.44	0.64	0.60	0.27	0.36	0.30	0.91	0.82	0.29	0.26	0.28	0.69	0.19	0.46	0.68	0.88	0.19
U. tenuis	2.33	3.65	4.13	2.33	2.41	1.79	1.94	1.48	4.18	3.57	2.29	2.27	4.62	1.68	2.51	3.98	2.95	2.39	2.32
U. sibogae	2.69	5.05	5.07	2.03	3.82	2.88	2.81	4.33	7.37	6.19	6.99	4.68	5.28	3.79	4.24	1.44	5.39	2.31	5.22
Holococcolithen	0.11	0.02	0.05	0.03	0.10	0.16	0.18	0.25	0.25	0.15	0.10	0.13	0.18	0.13	0.11	0.75	0.25	0.05	0.19
Restl. Arten	19.46	19.17	17.07	18.03	17.11	32.35	17.14	17.89	18.21	17.26	17.80	14.81	20.89	22.67	26.29	24.68	17.18	14.96	20.99

LP1o (900 m): Coccolithenfluss (Mio Coccolithen m^{-2} d^{-1})

Probe	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Verschlusszeit	20.01.97	03.02.97	17.02.97	03.03.97	17.03.97	31.03.97	14.04.97	28.04.97	12.05.97	26.05.97	09.06.97	23.06.97	07.07.97	21.07.97	04.08.97	18.08.97
Sammelintervall (d)	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14
Gesamtfluss	273.01	228.68	4106.90	2657.63	1860.33	106.85	135.34	13.63	346.87	48.90	56.10	165.83	101.23	107.95	40.69	5.00
Acanthoica spp.	2.80	3.90	55.41	38.57	38.36	0.83	1.17	0.05	0.93	0.09	0.16	3.44	0.18	0.00	0.11	0.00
Algirosphaera spp.	3.27	1.56	55.41	21.04	25.57	5.01	2.57	0.74	27.11	0.63	2.47	12.06	8.81	0.64	3.72	0.07
A. unicornis	0.00	0.00	6.93	3.51	0.00	0.17	0.23	0.00	0.00	0.00	0.08	0.25	0.00	0.00	0.00	0.00
A. brasiliensis	1.87	0.39	13.85	7.01	6.39	0.33	0.70	0.00	0.93	0.00	0.00	0.25	0.00	0.00	0.42	0.02
C. leptoporus	1.87	1.17	62.33	14.02	22.38	2.00	2.10	0.69	5.61	1.79	2.39	3.69	3.24	5.10	1.17	0.07
C. murrayi	0.47	4.29	90.03	52.59	63.93	2.00	3.27	0.00	4.67	0.09	0.49	3.69	0.90	0.21	0.42	0.02
C. pelagicus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.00	0.00	0.00	0.00
C. binodata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.21	0.00
C. mediterranea	0.47	3.12	13.85	3.51	6.39	0.33	0.70	0.00	0.47	0.00	0.00	0.49	0.36	0.00	0.11	0.00
C. aculeata	0.00	0.39	0.00	0.00	3.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. tubifera	3.27	3.51	76.18	24.54	19.18	1.00	2.10	0.00	6.08	0.18	0.91	2.46	0.90	0.00	0.42	0.00
E. huxleyi	77.13	98.17	2278.54	1493.60	741.58	42.41	53.29	5.54	136.04	21.67	16.99	54.13	35.06	53.76	15.19	1.31
F. profunda	109.86	62.33	380.91	375.15	329.23	26.88	38.80	3.88	65.91	16.39	18.23	41.83	24.63	35.27	9.24	2.80
G. ericsonii	10.75	15.97	512.50	361.13	290.88	9.85	8.65	0.92	31.79	2.24	3.13	7.14	3.96	2.97	2.02	0.24
G. muellerae	1.40	0.00	0.00	0.00	3.20	0.33	0.23	0.14	0.47	0.72	0.16	0.49	0.90	0.42	0.00	0.02
G. oceanica	4.21	1.95	55.41	21.04	38.36	1.84	2.10	0.46	5.61	1.07	1.07	3.94	2.34	2.97	0.64	0.04
G. ornata	0.00	0.00	6.93	3.51	3.20	0.00	0.47	0.00	0.47	0.00	0.00	0.49	0.18	0.00	0.00	0.00
G. flabellatus	2.34	3.90	41.55	10.52	6.39	1.50	2.10	0.00	2.34	0.00	0.16	4.18	0.72	0.21	0.11	0.04
H. perplexus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
H. carteri	0.93	0.00	0.00	3.51	0.00	0.67	0.70	0.23	0.93	0.18	0.33	0.49	0.18	0.00	0.21	0.00
H. pavimentum	0.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.00
M. elegans	0.00	0.78	13.85	10.52	12.79	0.67	0.00	0.00	1.40	0.00	0.00	0.25	0.00	0.00	0.11	0.00
N. coccolithom.	0.00	0.39	6.93	0.00	0.00	0.17	0.00	0.05	0.00	0.18	0.00	0.00	0.36	0.00	0.11	0.00
O. fragilis	1.87	0.39	6.93	0.00	3.20	0.00	0.23	0.00	0.47	0.00	0.00	0.25	0.18	0.00	0.21	0.00
O. hydroideus	3.74	1.17	0.00	38.57	38.36	2.00	1.64	0.00	5.61	0.09	0.16	1.97	0.90	0.21	0.21	0.00
P. lepida	0.00	0.00	0.00	0.00	0.00	0.00	0.23	0.00	0.00	0.09	0.00	0.74	0.00	0.00	0.00	0.00
Pontosphaera spp.	0.00	0.00	6.93	0.00	6.39	0.17	0.23	0.00	0.47	0.00	0.08	0.00	0.18	0.00	0.00	0.00
R. parvula	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
R. sessilis	0.47	1.17	0.00	3.51	0.00	0.17	0.70	0.00	0.47	0.09	0.16	0.25	1.08	0.21	0.11	0.02
R. clavigera	12.62	5.06	76.18	10.52	6.39	1.00	2.57	0.09	5.14	0.27	2.23	2.95	2.52	0.00	0.53	0.02
R. xiphos	1.87	1.56	76.18	31.55	15.98	1.84	0.00	0.09	7.01	0.00	0.16	2.46	1.08	0.00	1.06	0.00
S. apsteinii	0.00	0.39	0.00	0.00	0.00	0.17	0.23	0.00	0.00	0.00	0.00	0.00	0.00	0.21	0.00	0.00
S. anthos	0.00	0.00	13.85	10.52	3.20	0.00	0.00	0.00	0.93	0.00	0.08	0.25	0.00	0.00	0.00	0.02
S. borealis	0.00	0.00	0.00	17.53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S. corolla	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.93	0.00	0.16	0.00	0.18	0.00	0.00	0.00
S. epigrosa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S. halldalii	0.00	0.39	13.85	21.04	9.59	0.33	0.47	0.00	0.00	0.00	0.08	1.72	0.00	0.00	0.00	0.00
S. histrica	2.34	4.67	41.55	10.52	12.79	0.17	0.00	0.05	1.87	0.00	0.08	0.00	0.18	0.00	0.32	0.00
S. lamina	1.40	0.00	13.85	3.51	3.20	0.00	0.23	0.00	0.47	0.00	0.00	0.00	0.18	0.00	0.00	0.00
S. marginaporata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.93	0.00	0.08	0.00	0.00	0.00	0.00	0.00
S. molischii	0.00	0.39	13.85	7.01	6.39	0.17	0.23	0.05	0.47	0.00	0.00	0.00	0.36	0.00	0.11	0.02
S. nodosa	1.87	0.00	6.93	7.01	3.20	0.17	0.23	0.05	0.47	0.09	0.00	0.49	0.00	0.00	0.11	0.00
S. ossa	0.00	0.00	20.78	0.00	0.00	0.17	0.00	0.00	0.00	0.00	0.00	0.49	0.00	0.00	0.00	0.00
S. pirus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S. prolongata	0.47	0.00	6.93	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.36	0.00	0.00	0.00
S. pulchra	2.34	2.73	27.70	10.52	15.98	0.17	1.17	0.09	1.87	0.63	1.24	0.74	1.08	0.64	0.32	0.07
S. rotula	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.18	0.00	0.00	0.02
Syracosphaera spp.	0.47	0.00	48.48	10.52	28.77	0.33	1.87	0.05	5.14	0.00	0.16	2.95	0.72	0.00	0.21	0.02
T. quadrilaminata	7.01	1.95	27.70	14.02	25.57	1.00	0.70	0.00	3.74	0.27	0.41	2.71	2.16	0.21	0.85	0.02
U. irregularis	1.87	0.78	6.93	0.00	6.39	0.50	0.23	0.00	0.00	0.45	0.16	0.98	0.18	0.42	0.11	0.00
U. tenuis	11.22	2.73	6.93	0.00	12.79	0.83	1.64	0.00	10.28	0.54	3.30	2.46	1.44	2.76	0.96	0.09
U. hulburtiana	0.00	0.39	0.00	0.00	3.20	0.00	0.00	0.00	0.00	0.00	0.00	0.49	0.00	0.00	0.00	0.00
U. sibogae	1.40	1.95	0.00	7.01	35.16	1.50	1.87	0.37	4.67	1.07	0.41	2.71	2.88	1.27	0.85	0.00
Holococcolithen	0.47	0.00	6.93	7.01	9.59	0.17	0.00	0.00	3.74	0.09	0.16	1.48	2.34	0.00	0.42	0.04

LP1u (3700 m): Coccolithenfluss (Mio Coccolithen m^{-2} d^{-1})

Probe	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Verschlusszeit	20.01.97	03.02.97	17.02.97	03.03.97	17.03.97	31.03.97	14.04.97	28.04.97	12.05.97	26.05.97	09.06.97	23.06.97	07.07.97	21.07.97	04.08.97	18.08.97	01.09.97	15.09.97
Sammelintervall (d)	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14
Gesamtfluss	1383.26	1594.97	3923.87	2371.31	6353.17	2207.65	1613.16	2033.98	1646.93	1498.86	1348.19	1050.11	897.50	975.43	1069.20	755.92	801.38	1167.40
Acanthoica spp.	7.79	10.39	23.75	16.70	49.48	13.36	12.99	10.39	15.59	7.79	7.79	3.90	6.49	7.79	4.68	5.20	2.60	9.35
Algirosphaera spp.	68.19	80.53	184.02	80.16	356.25	76.82	80.53	106.50	96.11	88.32	113.00	89.62	50.65	75.33	107.54	42.86	51.95	85.72
A. unicornis	0.00	0.00	11.87	6.68	0.00	0.00	0.00	0.00	0.00	2.60	0.00	1.95	1.30	1.30	0.00	0.00	1.30	3.12
A. brasiliensis	3.90	0.00	5.94	0.00	19.79	6.68	0.00	10.39	0.00	2.60	1.95	0.00	3.90	0.00	1.56	1.30	0.00	3.12
C. leptoporus	23.38	15.59	59.36	46.76	39.58	6.68	33.77	15.59	31.17	18.18	27.28	17.53	22.08	16.88	34.29	10.39	10.39	14.03
C. murrayi	3.90	10.39	59.36	40.08	98.96	23.38	20.78	31.17	7.79	5.20	9.74	3.90	11.69	7.79	4.68	5.20	5.20	4.68
C. pelagicus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.56	0.00	0.00	0.00
C. binodata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. mediterranea	1.95	5.20	0.00	10.02	0.00	3.34	2.60	0.00	0.00	0.00	0.00	0.00	1.30	2.60	0.00	1.30	1.30	1.56
C. aculeata	0.00	0.00	0.00	3.34	19.79	0.00	0.00	0.00	2.60	0.00	0.00	0.00	0.00	0.00	0.00	1.30	0.00	0.00
D. tubifera	29.22	25.98	77.17	50.10	108.85	50.10	23.38	33.77	23.38	20.78	19.48	15.59	27.28	12.99	23.38	9.09	6.49	9.35
E. huxleyi	387.70	475.37	1763.07	1005.30	2681.79	771.51	503.95	571.49	615.65	483.17	434.46	436.41	309.12	315.62	310.16	237.69	249.38	347.57
F. profunda	436.41	524.73	682.67	511.00	1088.55	577.80	483.17	675.40	402.64	423.42	294.19	202.62	223.40	237.69	263.40	220.80	261.07	353.80
G. ericsonii	46.76	44.16	284.94	153.63	761.98	160.31	90.92	114.30	83.13	67.54	79.88	60.40	42.86	72.73	56.11	36.37	36.37	31.17
G. muellerae	21.43	12.99	5.94	6.68	39.58	26.72	2.60	10.39	15.59	10.39	9.74	1.95	7.79	10.39	6.23	2.60	5.20	14.03
G. oceanica	27.28	20.78	29.68	36.74	69.27	26.72	15.59	28.57	38.97	25.98	44.81	35.07	16.88	24.68	26.50	16.88	10.39	26.50
G. ornata	0.00	5.20	0.00	3.34	0.00	0.00	0.00	0.00	2.60	0.00	1.95	1.95	0.00	2.60	0.00	5.20	0.00	1.56
G. flabellatus	27.28	51.95	59.36	40.08	108.85	50.10	49.36	59.75	36.37	15.59	13.64	19.48	10.39	7.79	10.91	7.79	11.69	20.26
H. perplexus	0.00	5.20	0.00	0.00	0.00	0.00	0.00	2.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
H. carteri	5.84	7.79	23.75	13.36	19.79	3.34	5.20	5.20	2.60	7.79	5.84	1.95	6.49	3.90	3.12	5.20	6.49	3.12
H. pavimentum	3.90	2.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.30	0.00	0.00	0.00	0.00	0.00
M. elegans	0.00	0.00	11.87	0.00	0.00	3.34	7.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.12	0.00	0.00	0.00
N. coccolithom.	1.95	5.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
O. fragilis	1.95	5.20	5.94	3.34	9.90	6.68	2.60	2.60	5.20	7.79	7.79	0.00	1.30	2.60	4.68	6.49	5.20	4.68
O. hydroideus	3.90	15.59	53.43	56.78	148.44	36.74	7.79	18.18	10.39	15.59	23.38	11.69	14.29	10.39	14.03	11.69	15.59	26.50
P. lepida	1.95	0.00	0.00	0.00	0.00	0.00	5.20	0.00	0.00	0.00	0.00	0.00	2.60	0.00	0.00	0.00	0.00	1.56
Pontosphaera spp.	0.00	0.00	0.00	0.00	0.00	0.00	2.60	0.00	2.60	0.00	0.00	0.00	0.00	1.30	1.56	0.00	0.00	0.00
R. parvula	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
R. sessilis	3.90	12.99	5.94	0.00	19.79	0.00	5.20	12.99	5.20	5.20	7.79	1.95	5.20	3.90	3.12	2.60	1.30	3.12
R. clavigera	25.33	51.95	94.98	36.74	29.69	60.12	25.98	59.75	38.97	59.75	40.91	15.59	15.59	29.87	29.61	16.88	16.88	29.61
R. xiphos	37.02	28.57	94.98	36.74	138.54	63.46	25.98	38.97	46.76	31.17	33.12	9.74	10.39	18.18	14.03	19.48	14.29	28.05
S. apsteinii	0.00	0.00	0.00	0.00	9.90	0.00	0.00	0.00	0.00	0.00	0.00	1.95	0.00	0.00	3.12	0.00	1.30	1.56
S. anthos	0.00	5.20	59.36	3.34	29.69	13.36	0.00	10.39	5.20	12.99	9.74	3.90	3.90	1.30	0.00	2.60	2.60	4.68
S. borealis	0.00	0.00	5.94	0.00	0.00	0.00	0.00	5.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S. corolla	0.00	0.00	0.00	0.00	0.00	3.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S. epigrosa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S. halldalii	5.84	5.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.60	0.00	0.00	0.00	1.30	1.56
S. histrica	5.84	2.60	35.62	10.02	19.79	13.36	0.00	10.39	7.79	10.39	7.79	1.95	2.60	6.49	1.56	0.00	1.30	4.68
S. lamina	1.95	0.00	0.00	0.00	9.90	0.00	0.00	0.00	0.00	0.00	3.90	0.00	1.30	1.30	0.00	2.60	0.00	0.00
S. marginaporata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S. molischii	5.84	2.60	0.00	3.34	9.90	6.68	2.60	0.00	0.00	0.00	3.90	0.00	1.30	0.00	0.00	1.30	0.00	0.00
S. nodosa	3.90	0.00	17.81	6.68	9.90	6.68	5.20	2.60	0.00	7.79	0.00	1.95	1.30	2.60	0.00	0.00	2.60	3.12
S. ossa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S. pirus	0.00	0.00	0.00	3.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S. prolongata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.30	0.00	0.00	0.00	0.00
S. pulchra	21.43	18.18	23.75	16.70	69.27	23.38	38.97	18.18	15.59	12.99	23.38	17.53	11.69	10.39	15.59	11.69	15.59	15.59
S. rotula	0.00	0.00	5.94	3.34	0.00	3.34	2.60	0.00	0.00	0.00	0.00	0.00	0.00	1.30	1.56	0.00	1.30	0.00
Syracosphaera spp.	9.74	12.99	23.75	20.04	9.90	20.04	18.18	18.18	7.79	0.00	11.69	7.79	11.69	3.90	6.23	7.79	3.90	12.47
T. quadrilaminata	42.86	41.56	71.24	56.78	118.75	56.78	38.97	62.34	36.37	36.37	29.22	23.38	28.57	28.57	32.73	27.28	15.59	34.29
U. irregularis	7.79	0.00	0.00	6.68	0.00	3.34	7.79	5.20	0.00	5.20	1.95	0.00	1.30	3.90	4.68	2.60	2.60	1.56
U. tenuis	35.07	36.37	35.62	36.74	79.17	26.72	25.98	44.16	46.76	49.36	33.12	21.43	14.29	18.18	31.17	15.59	11.69	26.50
U. hulburtiana	0.00	2.60	11.87	0.00	0.00	3.34	0.00	0.00	0.00	0.00	0.00	1.95	1.30	0.00	0.00	0.00	1.30	0.00
U. sibogae	46.76	28.57	47.49	36.74	138.54	53.44	44.16	46.76	44.16	51.95	37.02	35.07	14.29	25.98	26.50	12.99	22.08	29.61
Holococcolithen	25.33	20.78	47.49	10.02	39.58	6.68	20.78	2.60	0.00	10.39	5.84	1.95	9.09	3.90	21.82	5.20	5.20	9.35

LP1o (900 m): relative Artenanteile (%)

Probe	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Verschlusszeit	20.01.97	03.02.97	17.02.97	03.03.97	17.03.97	31.03.97	14.04.97	28.04.97	12.05.97	26.05.97	09.06.97	23.06.97	07.07.97	21.07.97	04.08 97	18.08.97
Sammelintervall (d)	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14
Gesamtfluss	273.01	228.68	4106.90	2657.63	1860.33	106.85	135.34	13.63	346.87	48.90	56.10	165.83	101.23	107.95	40.69	5.00
Acanthoica spp.	1.03	1.70	1.35	1.45	2.06	0.78	0.86	0.34	0.27	0.18	0.29	2.08	0.18	0.00	0.26	0.00
Algirosphaera spp.	2.23	2.39	2.70	1.98	3.44	5.47	2.59	5.76	8.09	1.47	4.56	9.05	8.35	0.59	8.88	1.32
A. unicornis	0.00	0.00	0.17	0.13	0.00	0.16	0.17	0.00	0.00	0.00	0.15	0.15	0.00	0.00	0.00	0.00
A. brasiliensis	0.68	0.17	0.34	0.26	0.34	0.31	0.52	0.00	0.27	0.00	0.00	0.15	0.00	0.00	1.04	0.44
C. leptoporus	0.68	0.51	1.52	0.53	1.20	1.88	1.55	5.08	1.62	3.66	4.26	2.23	3.20	4.72	2.87	1.32
C. murrayi	0.17	1.87	2.19	1.98	3.44	1.88	2.42	0.00	1.35	0.18	0.88	2.23	0.89	0.20	1.04	0.44
C. pelagicus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.00
C. binodata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.52	0.00
C. mediterranea	0.17	1.36	0.34	0.13	0.34	0.31	0.52	0.00	0.13	0.00	0.00	0.30	0.36	0.00	0.26	0.00
C. aculeata	0.00	0.17	0.00	0.00	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. tubifera	1.20	1.53	1.85	0.92	1.03	0.94	1.55	0.00	1.75	0.37	1.62	1.48	0.89	0.00	1.04	0.00
E. huxleyi	28.25	42.93	55.48	56.20	39.86	39.69	39.38	40.68	39.22	44.32	30.29	32.64	34.64	49.80	37.34	26.32
F. profunda	40.24	27.26	9.27	14.12	17.70	25.16	28.67	28.47	19.00	33.52	32.50	25.22	24.33	32.68	22.72	56.14
G. ericsonii	3.94	6.98	12.48	13.59	15.64	9.22	6.39	6.78	9.16	4.58	5.59	4.30	3.91	2.76	4.96	4.82
G. muellerae	0.51	0.00	0.00	0.00	0.17	0.31	0.17	1.02	0.13	1.47	0.29	0.30	0.89	0.39	0.00	0.44
G. oceanica	1.54	0.85	1.35	0.79	2.06	1.72	1.55	3.39	1.62	2.20	1.91	2.37	2.31	2.76	1.57	0.88
G. ornata	0.00	0.00	0.17	0.13	0.17	0.00	0.35	0.00	0.13	0.00	0.00	0.30	0.18	0.00	0.00	0.00
G. flabellatus	0.86	1.70	1.01	0.40	0.34	1.41	1.55	0.00	0.67	0.00	0.29	2.52	0.71	0.20	0.26	0.88
H. perplexus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
H. carteri	0.34	0.00	0.00	0.13	0.00	0.63	0.52	1.69	0.27	0.37	0.59	0.30	0.18	0.00	0.52	0.00
H. pavimentum	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00
M. elegans	0.00	0.34	0.34	0.40	0.69	0.63	0.00	0.00	0.40	0.00	0.00	0.15	0.00	0.00	0.26	0.00
N. coccolithom.	0.00	0.17	0.17	0.00	0.00	0.16	0.00	0.34	0.00	0.37	0.00	0.00	0.36	0.00	0.26	0.00
O. fragilis	0.68	0.17	0.17	0.00	0.17	0.00	0.17	0.00	0.13	0.00	0.00	0.15	0.18	0.00	0.52	0.00
O. hydroideus	1.37	0.51	0.00	1.45	2.06	1.88	1.21	0.00	1.62	0.18	0.29	1.19	0.89	0.20	0.52	0.00
P. lepida	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.00	0.00	0.18	0.00	0.45	0.00	0.00	0.00	0.00
Pontosphaera spp.	0.00	0.00	0.17	0.00	0.34	0.16	0.17	0.00	0.13	0.00	0.15	0.00	0.18	0.00	0.00	0.00
R. parvula	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
R. sessilis	0.17	0.51	0.00	0.13	0.00	0.16	0.52	0.00	0.13	0.18	0.29	0.15	1.07	0.20	0.26	0.44
R. clavigera	4.62	2.21	1.85	0.40	0.34	0.94	1.90	0.68	1.48	0.55	3.97	1.78	2.49	0.00	1.31	0.44
R. xiphos	0.68	0.68	1.85	1.19	0.86	1.72	0.00	0.68	2.02	0.00	0.29	1.48	1.07	0.00	2.61	0.00
S. apsteinii	0.00	0.17	0.00	0.00	0.00	0.16	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.00	0.00
S. anthos	0.00	0.00	0.34	0.40	0.17	0.00	0.00	0.00	0.27	0.00	0.15	0.15	0.00	0.00	0.00	0.44
S. borealis	0.00	0.00	0.00	0.66	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S. corolla	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.27	0.00	0.29	0.00	0.18	0.00	0.00	0.00
S. epigrosa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S. halldalii	0.00	0.17	0.34	0.79	0.52	0.31	0.35	0.00	0.00	0.00	0.15	1.04	0.00	0.00	0.00	0.00
S. histrica	0.86	2.04	1.01	0.40	0.69	0.16	0.00	0.34	0.54	0.00	0.15	0.00	0.18	0.00	0.78	0.00
S. lamina	0.51	0.00	0.34	0.13	0.17	0.00	0.17	0.00	0.13	0.00	0.00	0.00	0.18	0.00	0.00	0.00
S. marginaporata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.27	0.00	0.15	0.00	0.00	0.00	0.00	0.00
S. molischii	0.00	0.17	0.34	0.26	0.34	0.16	0.17	0.34	0.13	0.00	0.00	0.00	0.36	0.00	0.26	0.44
S. nodosa	0.68	0.00	0.17	0.26	0.17	0.16	0.17	0.34	0.13	0.18	0.00	0.30	0.00	0.00	0.26	0.00
S. ossa	0.00	0.00	0.51	0.00	0.00	0.16	0.00	0.00	0.00	0.00	0.00	0.30	0.00	0.00	0.00	0.00
S. pirus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S. prolongata	0.17	0.00	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.00	0.36	0.00	0.00	0.00
S. pulchra	0.86	1.19	0.67	0.40	0.86	0.16	0.86	0.68	0.54	1.28	2.21	0.45	1.07	0.59	0.78	1.32
S. rotula	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.18	0.00	0.00	0.44
Syracosphaera spp.	0.17	0.00	1.18	0.40	1.55	0.31	1.38	0.34	1.48	0.00	0.29	1.78	0.71	0.00	0.52	0.44
T. quadrilaminata	2.57	0.85	0.67	0.53	1.37	0.94	0.52	0.00	1.08	0.55	0.74	1.63	2.13	0.20	2.09	0.44
U. irregularis	0.68	0.34	0.17	0.00	0.34	0.47	0.17	0.00	0.00	0.92	0.29	0.59	0.18	0.39	0.26	0.00
U. tenuis	4.11	1.19	0.17	0.00	0.69	0.78	1.21	0.00	2.96	1.10	5.88	1.48	1.42	2.56	2.35	1.75
U. hulburtiana	0.00	0.17	0.00	0.00	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.00	0.00	0.00	0.00
U. sibogae	0.51	0.85	0.00	0.26	1.89	1.41	1.38	2.71	1.35	2.20	0.74	1.63	2.84	1.18	2.09	0.00
Holococcolithen	0.17	0.00	0.17	0.26	0.52	0.16	0.00	0.00	1.08	0.18	0.29	0.89	2.31	0.00	1.04	0.88

LP1u (3700 m): relative Artenanteile (%)

Probe	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Verschlusszeit	20.01.97	03.02.97	17.02.97	03.03.97	17.03.97	31.03.97	14.04.97	28.04.97	12.05.97	26.05.97	09.06.97	23.06.97	07.07.97	21.07.97	04.08.97	18.08.97	01.09.97	15.09.97
Sammelintervall (d)	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14
Gesamtfluss	1383.26	1594.97	3923.87	2371.31	6353.17	2207.65	1613.16	2033.98	1646.93	1498.86	1348.19	1050.11	897.50	975.43	1069.20	755.92	801.38	1167.40
Acanthoica spp.	0.56	0.65	0.61	0.70	0.78	0.61	0.81	0.51	0.95	0.52	0.58	0.37	0.72	0.80	0.44	0.69	0.32	0.80
Algirosphaera spp.	5.21	5.70	5.30	4.08	6.39	4.08	5.80	5.75	6.78	6.41	8.96	8.91	6.37	8.52	10.50	6.36	6.81	8.14
A. unicornis	0.00	0.00	0.30	0.28	0.00	0.00	0.00	0.00	0.00	0.17	0.00	0.19	0.14	0.13	0.00	0.00	0.16	0.27
A. brasiliensis	0.28	0.00	0.15	0.00	0.31	0.30	0.00	0.51	0.00	0.17	0.14	0.00	0.43	0.00	0.15	0.17	0.00	0.27
C. leptoporus	1.69	0.98	1.51	1.97	0.62	0.30	2.09	0.77	1.89	1.21	2.02	1.67	2.46	1.73	3.21	1.37	1.30	1.20
C. murrayi	0.28	0.65	1.51	1.69	1.56	1.06	1.29	1.53	0.47	0.35	0.72	0.37	1.30	0.80	0.44	0.69	0.65	0.40
C. pelagicus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.00	0.00	0.00
C. binodata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. mediterranea	0.14	0.33	0.00	0.42	0.00	0.15	0.16	0.00	0.00	0.00	0.00	0.00	0.14	0.27	0.00	0.17	0.16	0.13
C. aculeata	0.00	0.00	0.00	0.14	0.31	0.00	0.00	0.00	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.00	0.00
D. tubifera	2.11	1.63	1.97	2.11	1.71	2.27	1.45	1.66	1.42	1.39	1.45	1.48	3.04	1.33	2.19	1.20	0.81	0.80
E. huxleyi	28.03	29.80	44.93	42.39	42.21	34.95	31.24	28.10	37.38	32.24	32.23	41.56	34.44	32.36	29.01	31.44	31.12	29.77
F. profunda	31.55	32.90	17.40	21.55	17.13	26.17	29.95	33.21	24.45	28.25	21.82	19.29	24.89	24.37	24.64	29.21	32.58	30.31
G. ericsonii	3.38	2.77	7.26	6.48	11.99	7.26	5.64	5.62	5.05	4.51	5.92	5.75	4.78	7.46	5.25	4.81	4.54	2.67
G. muellerae	1.55	0.81	0.15	0.28	0.62	1.21	0.16	0.51	0.95	0.69	0.72	0.19	0.87	1.07	0.58	0.34	0.65	1.20
G. oceanica	1.97	1.30	0.76	1.55	1.09	1.21	0.97	1.40	2.37	1.73	3.32	3.34	1.88	2.53	2.48	2.23	1.30	2.27
G. ornata	0.00	0.33	0.00	0.14	0.00	0.00	0.00	0.00	0.16	0.00	0.14	0.19	0.00	0.27	0.00	0.69	0.00	0.13
G. flabellatus	1.97	3.26	1.51	1.69	1.71	2.27	3.06	2.94	2.21	1.04	1.01	1.86	1.16	0.80	1.02	1.03	1.46	1.74
H. perplexus	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
H. carteri	0.42	0.49	0.61	0.56	0.31	0.15	0.32	0.26	0.16	0.52	0.43	0.19	0.72	0.40	0.29	0.69	0.81	0.27
H. pavimentum	0.28	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.00	0.00
M. elegans	0.00	0.00	0.30	0.00	0.00	0.15	0.48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.29	0.00	0.00	0.00
N. coccolithom.	0.14	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
O. fragilis	0.14	0.33	0.15	0.14	0.16	0.30	0.16	0.13	0.32	0.52	0.58	0.00	0.14	0.27	0.44	0.86	0.65	0.40
O. hydroideus	0.28	0.98	1.36	2.39	2.34	1.66	0.48	0.89	0.63	1.04	1.73	1.11	1.59	1.07	1.31	1.55	1.94	2.27
P. lepida	0.14	0.00	0.00	0.00	0.00	0.00	0.32	0.00	0.00	0.00	0.00	0.00	0.29	0.00	0.00	0.00	0.00	0.13
Pontosphaera spp.	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.00	0.16	0.00	0.00	0.00	0.00	0.13	0.15	0.00	0.00	0.00
R. parvula	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
R. sessilis	0.28	0.81	0.15	0.00	0.31	0.00	0.32	0.64	0.32	0.35	0.58	0.19	0.58	0.40	0.29	0.34	0.16	0.27
R. clavigera	1.83	3.26	2.42	1.55	0.47	2.72	1.61	2.94	2.37	3.99	3.03	1.48	1.74	3.06	2.77	2.23	2.11	2.54
R. xiphos	2.68	1.79	2.42	1.55	2.18	2.87	1.61	1.92	2.84	2.08	2.46	0.93	1.16	1.86	1.31	2.58	1.78	2.40
S. apsteinii	0.00	0.00	0.00	0.00	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.19	0.00	0.00	0.29	0.00	0.16	0.13
S. anthos	0.00	0.33	1.51	0.14	0.47	0.61	0.00	0.51	0.32	0.87	0.72	0.37	0.43	0.13	0.00	0.34	0.32	0.40
S. borealis	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S. corolla	0.00	0.00	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S. epigrosa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S. halldalii	0.42	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.29	0.00	0.00	0.00	0.16	0.13
S. histrica	0.42	0.16	0.91	0.42	0.31	0.61	0.00	0.51	0.47	0.69	0.58	0.19	0.29	0.67	0.15	0.00	0.16	0.40
S. lamina	0.14	0.00	0.00	0.00	0.16	0.00	0.00	0.00	0.00	0.00	0.29	0.00	0.14	0.13	0.00	0.34	0.00	0.00
S. marginaporata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S. molischii	0.42	0.16	0.00	0.14	0.16	0.30	0.16	0.00	0.00	0.00	0.29	0.00	0.14	0.00	0.00	0.17	0.00	0.00
S. nodosa	0.28	0.00	0.45	0.28	0.16	0.30	0.32	0.13	0.00	0.52	0.00	0.19	0.14	0.27	0.00	0.00	0.32	0.27
S. ossa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S. pirus	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S. prolongata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.00	0.00	0.00	0.00
S. pulchra	1.55	1.14	0.61	0.70	1.09	1.06	2.42	0.89	0.95	0.87	1.73	1.67	1.30	1.07	1.46	1.55	1.94	1.34
S. rotula	0.00	0.00	0.15	0.14	0.00	0.15	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.15	0.00	0.16	0.00
Syracosphaera spp.	0.70	0.81	0.61	0.85	0.16	0.91	1.13	0.89	0.47	0.00	0.87	0.74	1.30	0.40	0.58	1.03	0.49	1.07
T. quadrilaminata	3.10	2.61	1.82	2.39	1.87	2.57	2.42	3.07	2.21	2.43	2.17	2.23	3.18	2.93	3.06	3.61	1.94	2.94
U. irregularis	0.56	0.00	0.00	0.28	0.00	0.15	0.48	0.26	0.00	0.35	0.14	0.00	0.14	0.40	0.44	0.34	0.32	0.13
U. tenuis	2.54	2.28	0.91	1.55	1.25	1.21	1.61	2.17	2.84	3.29	2.46	2.04	1.59	1.86	2.92	2.06	1.46	2.27
U. hulburtiana	0.00	0.16	0.30	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.19	0.14	0.00	0.00	0.00	0.16	0.00
U. sibogae	3.38	1.79	1.21	1.55	2.18	2.42	2.74	2.30	2.68	3.47	2.75	3.34	1.59	2.66	2.48	1.72	2.76	2.54
Holococcolithen	1.83	1.30	1.21	0.42	0.62	0.30	1.29	0.13	0.00	0.69	0.43	0.19	1.01	0.40	2.04	0.69	0.65	0.80

LP1o (900 m): Coccolithenkarbonatfluss (mg m^{-2} d^{-1})

Probe	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Verschlusszeit	20.01.97	03.02.97	17.02.97	03.03.97	17.03.97	31.03.97	14.04.97	28.04.97	12.05.97	26.05.97	09.06.97	23.06.97	07.07.97	21.07.97	04.08.97	18.08.97
Sammelintervall (d)	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14
Gesamtfluss	2.222	1.428	24.935	10.330	9.783	0.712	0.953	0.147	2.320	0.349	0.607	1.306	0.912	0.776	0.349	0.020
C. leptoporus	0.170	0.106	5.678	1.278	2.038	0.183	0.192	0.063	0.511	0.163	0.218	0.336	0.295	0.465	0.106	0.006
C. pelagicus	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.024	0.000	0.000	0.000	0.000
D. tubifera	0.005	0.005	0.114	0.037	0.029	0.002	0.003	0.000	0.009	0.000	0.001	0.004	0.001	0.000	0.001	0.000
E. huxleyi	0.174	0.216	4.989	3.321	1.651	0.095	0.124	0.012	0.286	0.046	0.036	0.114	0.078	0.113	0.032	0.003
F. profunda	0.176	0.100	0.609	0.600	0.527	0.043	0.062	0.006	0.105	0.026	0.029	0.067	0.039	0.056	0.015	0.004
G. ericsonii	0.010	0.021	0.648	0.376	0.262	0.009	0.008	0.001	0.029	0.003	0.003	0.006	0.004	0.003	0.002	0.000
G. muellerae	0.009	0.000	0.000	0.000	0.020	0.002	0.001	0.001	0.003	0.005	0.001	0.003	0.006	0.003	0.000	0.000
G. oceanica	0.067	0.031	0.881	0.334	0.610	0.029	0.033	0.007	0.089	0.017	0.017	0.063	0.037	0.047	0.010	0.001
H. carteri	0.134	0.000	0.000	0.501	0.000	0.095	0.100	0.033	0.134	0.026	0.047	0.070	0.026	0.000	0.030	0.000
O. fragilis	0.181	0.038	0.670	0.000	0.309	0.000	0.023	0.000	0.045	0.000	0.000	0.024	0.017	0.000	0.021	0.000
Pontosphaera spp.	0.000	0.000	0.471	0.000	0.435	0.011	0.016	0.000	0.032	0.000	0.006	0.000	0.012	0.000	0.000	0.000
R. clavigera	0.852	0.342	5.142	0.710	0.432	0.068	0.174	0.006	0.347	0.018	0.150	0.199	0.170	0.000	0.036	0.001
S. pulchra	0.037	0.044	0.443	0.168	0.256	0.003	0.019	0.001	0.030	0.010	0.020	0.012	0.017	0.010	0.005	0.001
Syracosphaera spp.	0.074	0.259	1.592	0.933	0.464	0.012	0.014	0.002	0.079	0.001	0.007	0.036	0.017	0.000	0.006	0.001
Syracosphaera spp. (small)	0.002	0.000	0.194	0.042	0.115	0.001	0.007	0.000	0.021	0.000	0.001	0.012	0.003	0.000	0.001	0.000
U. tenuis	0.098	0.024	0.060	0.000	0.111	0.007	0.014	0.000	0.089	0.005	0.029	0.021	0.013	0.024	0.008	0.001
U. sibogae	0.018	0.025	0.000	0.088	0.443	0.019	0.030	0.006	0.059	0.014	0.005	0.034	0.036	0.033	0.013	0.000
Holococcolithen	0.000	0.000	0.007	0.007	0.010	0.000	0.000	0.000	0.004	0.000	0.000	0.001	0.002	0.000	0.000	0.000
Restl. Arten	0.217	0.218	3.435	1.935	2.071	0.134	0.133	0.008	0.449	0.016	0.038	0.280	0.138	0.022	0.062	0.002

LP1o (900 m): Rel. Anteil am Coccolithenkarbonatfluss (%)

Probe	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Verschlusszeit	20.01.97	03.02.97	17.02.97	03.03.97	17.03.97	31.03.97	14.04.97	28.04.97	12.05.97	26.05.97	09.06.97	23.06.97	07.07.97	21.07.97	04.08.97	18.08.97
Sammelintervall (d)	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14
Gesamtfluss	2.222	1.428	24.935	10.330	9.783	0.712	0.953	0.147	2.320	0.349	0.607	1.306	0.912	0.776	0.349	0.020
C. leptoporus	7.67	7.46	22.77	12.37	20.84	25.63	20.11	43.07	22.03	46.78	35.89	25.74	32.33	59.90	30.49	29.81
C. pelagicus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.87	0.00	0.00	0.00	0.00
D. tubifera	0.22	0.37	0.46	0.36	0.29	0.21	0.33	0.00	0.39	0.08	0.22	0.28	0.15	0.00	0.18	0.00
E. huxleyi	7.82	15.12	20.01	32.14	16.88	13.29	13.03	7.94	12.31	13.05	5.88	8.70	8.57	14.56	9.14	13.74
F. profunda	7.91	6.98	2.44	5.81	5.38	6.04	6.51	4.24	4.55	7.52	4.80	5.12	4.32	7.28	4.24	22.34
G. ericsonii	0.44	1.45	2.60	3.63	2.68	1.24	0.82	0.57	1.23	0.90	0.46	0.49	0.39	0.35	0.52	1.08
G. muellerae	0.40	0.00	0.00	0.00	0.21	0.30	0.15	0.60	0.13	1.29	0.17	0.24	0.62	0.35	0.00	0.69
G. oceanica	3.01	2.17	3.53	3.24	6.23	4.10	3.51	5.01	3.84	4.90	2.81	4.79	4.07	6.10	2.90	3.47
H. carteri	6.01	0.00	0.00	4.85	0.00	13.39	10.51	22.50	5.75	7.33	7.76	5.38	2.82	0.00	8.69	0.00
O. fragilis	8.15	2.64	2.69	0.00	3.16	0.00	2.37	0.00	1.95	0.00	0.00	1.82	1.91	0.00	5.89	0.00
Pontosphaera spp.	0.00	0.00	1.89	0.00	4.44	1.59	1.67	0.00	1.37	0.00	0.92	0.00	1.34	0.00	0.00	0.00
R. clavigera	38.34	23.94	20.62	6.87	4.41	9.49	18.21	4.25	14.96	5.20	24.76	15.26	18.63	0.00	10.27	7.36
S. pulchra	1.68	3.06	1.78	1.63	2.61	0.38	1.96	1.01	1.29	2.88	3.26	0.90	1.89	1.32	1.46	5.24
Syracosphaera spp.	3.31	18.16	6.39	9.03	4.74	1.70	1.48	1.14	3.41	0.31	1.15	2.73	1.91	0.00	1.84	3.96
Syracosphaera spp. (small)	0.08	0.00	0.78	0.41	1.18	0.19	0.78	0.13	0.89	0.00	0.11	0.90	0.32	0.00	0.24	0.44
U. tenuis	4.39	1.66	0.24	0.00	1.14	1.02	1.49	0.00	3.86	1.34	4.73	1.64	1.37	3.10	2.38	3.80
U. sibogae	0.80	1.72	0.00	0.86	4.53	2.66	3.11	4.00	2.54	3.88	0.86	2.61	3.97	4.21	3.86	0.00
Holococcolithen	0.02	0.00	0.03	0.07	0.10	0.02	0.00	0.00	0.16	0.03	0.03	0.11	0.26	0.00	0.12	0.22
Restl. Arten	9.76	15.28	13.78	18.73	21.17	18.75	13.93	5.55	19.34	4.52	6.19	21.40	15.14	2.85	17.77	7.85

LP1u (3700 m): Coccolithenkarbonatfluss (mg m^{-2} d^{-1})

Probe	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Verschlusszeit	20.01.97	03.02.97	17.02.97	03.03.97	17.03.97	31.03.97	14.04.97	28.04.97	12.05.97	26.05.97	09.06.97	23.06.97	07.07.97	21.07.97	04.08.97	18.08.97	01.09.97	15.09.97
Sammelintervall (d)	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14
Gesamtfluss	10.395	12.859	29.323	17.186	32.929	13.979	12.092	13.953	12.764	15.291	12.801	7.325	7.464	8.445	10.513	6.668	6.500	9.074
C. leptoporus	2.130	1.420	5.408	4.260	3.606	0.609	3.076	1.420	2.840	1.657	2.485	1.597	2.012	1.538	3.124	0.947	0.947	1.278
C. pelagicus	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.155	0.000	0.000	0.000
D. tubifera	0.044	0.039	0.116	0.075	0.163	0.075	0.035	0.051	0.035	0.031	0.029	0.023	0.041	0.019	0.035	0.014	0.010	0.014
E. huxleyi	0.814	0.998	3.877	2.195	5.923	1.620	1.058	1.200	1.293	1.015	0.970	0.916	0.649	0.663	0.651	0.499	0.524	0.730
F. profunda	0.698	0.840	1.092	0.818	1.742	0.924	0.773	1.081	0.644	0.677	0.471	0.324	0.357	0.380	0.421	0.387	0.418	0.566
G. ericsonii	0.042	0.040	0.256	0.138	0.810	0.144	0.082	0.103	0.075	0.061	0.103	0.054	0.039	0.065	0.050	0.033	0.033	0.028
G. muellerae	0.135	0.082	0.037	0.042	0.249	0.168	0.016	0.065	0.098	0.065	0.061	0.012	0.049	0.065	0.039	0.016	0.033	0.088
G. oceanica	0.434	0.330	0.472	0.584	1.101	0.425	0.248	0.454	0.620	0.413	0.712	0.558	0.268	0.392	0.421	0.558	0.165	0.421
H. carteri	0.835	1.113	3.391	1.908	2.826	0.477	0.742	0.742	0.371	1.113	0.835	0.278	0.927	0.556	0.445	0.742	0.927	0.445
O. fragilis	0.189	0.503	0.575	0.323	0.958	0.647	0.251	0.251	0.503	0.754	0.754	0.000	0.126	0.251	0.453	0.629	0.503	0.453
Pontosphaera spp.	0.000	0.000	0.000	0.000	0.000	0.000	0.177	0.000	0.177	0.000	0.000	0.000	0.000	0.088	0.106	0.000	0.000	0.000
R. clavigera	1.710	3.507	6.411	2.480	2.004	4.058	1.753	4.033	2.630	4.033	2.762	1.052	1.052	2.016	1.999	1.140	1.140	1.999
S. pulchra	0.343	0.291	0.380	0.267	1.108	0.374	0.623	0.291	0.249	0.208	0.374	0.281	0.187	0.166	0.249	0.187	0.249	0.249
Syracosphaera spp.	0.283	0.189	1.508	0.364	0.958	0.566	0.126	0.346	0.157	0.377	0.306	0.094	0.157	0.173	0.038	0.079	0.110	0.170
Syracosphaera spp. (small)	0.039	0.052	0.095	0.080	0.040	0.080	0.073	0.073	0.031	0.000	0.047	0.031	0.047	0.016	0.025	0.031	0.016	0.050
U. tenuis	0.305	0.316	0.310	0.320	0.689	0.232	0.226	0.384	0.407	0.429	0.288	0.186	0.124	0.158	0.271	0.136	0.102	0.231
U. sibogae	0.640	0.563	0.598	0.463	2.003	0.847	0.692	0.589	0.556	0.790	0.618	0.543	0.214	0.530	0.374	0.197	0.312	0.535
Holococcolithen	0.025	0.021	0.047	0.010	0.040	0.007	0.021	0.003	0.000	0.010	0.006	0.002	0.009	0.004	0.022	0.005	0.005	0.009
Restl. Arten	1.730	2.556	4.749	2.859	8.708	2.725	2.120	2.868	2.078	3.658	1.979	1.372	1.205	1.361	1.633	1.070	1.008	1.808

LP1u (3700 m): Rel. Anteil am Coccolithenkarbonatfluss (%)

Probe	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Verschlusszeit	20.01.97	03.02.97	17.02.97	03.03.97	17.03.97	31.03.97	14.04.97	28.04.97	12.05.97	26.05.97	09.06.97	23.06.97	07.07.97	21.07.97	04.08.97	18.08.97	01.09.97	15.09.97
Sammelintervall (d)	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14
Gesamtfluss	10.395	12.859	29.323	17.186	32.929	13.979	12.092	13.953	12.764	15.291	12.801	7.325	7.464	8.445	10.513	6.668	6.500	9.074
C. leptoporus	20.49	11.04	18.44	24.79	10.95	4.35	25.44	10.18	22.25	10.83	19.41	21.81	26.95	18.22	29.71	14.20	14.56	14.08
C. pelagicus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.48	0.00	0.00	0.00
D. tubifera	0.42	0.30	0.39	0.44	0.50	0.54	0.29	0.36	0.27	0.20	0.23	0.32	0.55	0.23	0.33	0.20	0.15	0.15
E. huxleyi	7.83	7.76	13.22	12.77	17.99	11.59	8.75	8.60	10.13	6.64	7.57	12.51	8.70	7.85	6.20	7.49	8.06	8.04
F. profunda	6.72	6.53	3.72	4.76	5.29	6.61	6.39	7.74	5.05	4.43	3.68	4.43	4.79	4.50	4.01	5.80	6.43	6.24
G. ericsonii	0.40	0.31	0.87	0.80	2.46	1.03	0.68	0.74	0.59	0.40	0.81	0.74	0.52	0.78	0.48	0.49	0.50	0.31
G. muellerae	1.30	0.64	0.13	0.24	0.76	1.20	0.14	0.47	0.77	0.43	0.48	0.17	0.66	0.78	0.37	0.25	0.50	0.97
G. oceanica	4.17	2.57	1.61	3.40	3.34	3.04	2.05	3.26	4.85	2.70	5.57	7.61	3.60	4.65	4.01	8.36	2.54	4.64
H. carteri	8.03	8.65	11.56	11.10	8.58	3.41	6.14	5.32	2.91	7.28	6.52	3.80	12.42	6.59	4.23	11.13	14.27	4.91
O. fragilis	1.81	3.91	1.96	1.88	2.91	4.63	2.08	1.80	3.94	4.93	5.89	0.00	1.68	2.98	4.31	9.43	7.74	4.99
Pontosphaera spp.	0.00	0.00	0.00	0.00	0.00	0.00	1.46	0.00	1.38	0.00	0.00	0.00	0.00	1.05	1.01	0.00	0.00	0.00
R. clavigera	16.45	27.27	21.86	14.43	6.09	29.03	14.50	28.90	20.61	26.37	21.57	14.36	14.10	23.88	19.01	17.09	17.53	22.03
S. pulchra	3.30	2.26	1.30	1.55	3.37	2.68	5.16	2.09	1.95	1.36	2.92	3.83	2.51	1.97	2.37	2.80	3.84	2.75
Syracosphaera spp.	2.72	1.47	5.14	2.12	2.91	4.05	1.04	2.48	1.23	2.47	2.39	1.29	2.11	2.05	0.36	1.18	1.69	1.87
Syracosphaera spp. (small)	0.37	0.40	0.32	0.47	0.12	0.57	0.60	0.52	0.24	0.00	0.37	0.43	0.63	0.18	0.24	0.47	0.24	0.55
U. tenuis	2.94	2.46	1.06	1.86	2.09	1.66	1.87	2.75	3.19	2.81	2.25	2.55	1.67	1.87	2.58	2.03	1.56	2.54
U. sibogae	6.16	4.38	2.04	2.69	6.08	6.06	5.72	4.22	4.36	5.16	4.83	7.42	2.86	6.28	3.56	2.96	4.80	5.90
Holococcolithen	0.24	0.16	0.16	0.06	0.12	0.05	0.17	0.02	0.00	0.07	0.05	0.03	0.12	0.05	0.21	0.08	0.08	0.10
Restl. Arten	16.64	19.88	16.20	16.64	26.45	19.50	17.53	20.55	16.28	23.92	15.46	18.72	16.15	16.12	15.54	16.05	15.51	19.92

EBC2-1 (700 m): Coccolithenfluss (Mio Coccolithen m^{-2} d^{-1})

Probe	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Verschlusszeit	06.01.97	20.01.97	03.02.97	17.02.97	03.03.97	17.03.97	31.03.97	14.04.97	28.04.97	12.05.97	26.05.97	09.06.97	23.06.97	07.07.97	21.07.97	04.08.97	18.08.97	01.09.97	15.09.97	29.09.97
Sammelintervall (d)	4	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14
Gesamtfluss	1276.11	1931.70	1884.88	7273.49	2152.75	1953.82	924.25	403.11	298.15	760.44	1791.42	432.85	1184.28	1256.19	589.03	779.76	477.97	261.50	275.81	149.04
Acanthoica spp.	0.00	5.84	5.61	318.65	35.06	3.34	9.35	4.25	2.08	6.23	20.46	0.72	3.78	4.01	0.00	1.40	4.33	0.87	0.52	1.92
Algirosphaera spp.	9.74	55.53	98.17	235.52	45.58	26.72	26.50	24.09	2.60	18.70	96.44	4.33	20.78	26.05	3.24	8.41	13.85	11.26	2.60	10.72
A. unicornis	0.00	0.00	2.80	13.85	0.00	0.00	0.00	0.00	2.08	0.00	2.92	0.00	1.89	4.01	0.00	1.40	0.00	0.43	0.00	0.00
A. brasiliensis	0.00	0.00	0.00	13.85	0.00	3.34	0.00	3.54	0.00	0.00	11.69	0.00	0.00	0.00	0.00	0.00	3.46	1.30	0.52	0.00
C. leptoporus	7.79	14.61	11.22	41.56	3.51	23.38	9.35	4.25	3.64	7.79	17.53	2.89	13.22	12.02	6.47	9.82	8.66	3.46	0.52	0.00
C. murrayi	13.64	29.22	22.44	207.81	35.06	23.38	14.03	4.96	1.56	7.79	20.46	3.61	15.11	4.01	6.47	11.22	8.66	1.73	0.52	4.40
C. pelagicus	0.00	5.84	0.00	0.00	0.00	0.00	0.00	0.00	0.52	0.00	0.00	0.00	0.00	0.00	0.00	1.40	0.87	0.00	0.00	0.00
C. binodata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00
C. mediterranea	0.00	2.92	2.80	13.85	3.51	0.00	0.00	1.42	0.52	3.12	0.00	0.00	1.89	6.01	0.00	1.40	0.00	0.43	0.52	0.00
D. tubifera	0.00	17.53	19.63	13.85	14.02	13.36	14.03	2.83	4.67	12.47	14.61	2.16	5.67	6.01	6.47	2.80	2.60	2.16	0.52	0.00
E. huxleyi	360.43	736.44	695.61	3214.19	1034.30	988.60	358.48	153.03	128.30	285.16	517.26	147.17	400.43	486.85	271.86	265.06	177.51	87.89	114.27	61.60
F. profunda	629.29	432.51	420.73	858.96	262.96	270.53	126.25	75.80	62.33	157.39	569.86	144.28	385.32	312.54	111.12	239.82	122.09	74.90	46.23	23.65
G. ericsonii	66.24	192.88	244.02	1205.32	410.21	253.83	116.90	47.47	35.84	87.26	175.34	44.01	120.88	142.25	81.99	115.00	44.16	21.65	85.70	24.75
G. muellerae	23.38	46.76	42.07	55.42	49.09	20.04	7.79	2.13	5.19	15.58	14.61	12.26	24.55	36.06	18.34	12.62	9.52	3.46	3.64	3.02
G. oceanica	48.71	81.83	72.93	193.96	66.62	63.46	34.29	17.71	6.23	31.17	40.91	24.53	47.22	44.08	12.95	26.65	19.92	11.69	4.67	6.32
G. ornata	0.00	0.00	2.80	0.00	3.51	0.00	0.00	0.71	1.56	3.12	2.92	1.44	5.67	2.00	4.32	5.61	0.00	0.00	0.00	0.00
G. flabellatus	0.00	23.38	5.61	13.85	10.52	0.00	6.23	2.13	1.04	3.12	2.92	5.77	5.67	10.02	3.24	2.80	6.06	1.73	0.00	0.27
H. carteri	0.00	8.77	2.80	27.71	3.51	6.68	1.56	1.42	1.04	0.00	2.92	2.89	11.33	2.00	0.00	0.00	2.60	0.87	0.52	0.27
H. pavimentum	0.00	2.92	0.00	13.85	0.00	0.00	0.00	0.00	0.52	0.00	0.00	0.00	1.89	0.00	0.00	0.00	0.00	0.00	0.00	0.00
M. elegans	0.00	2.92	5.61	27.71	3.51	3.34	1.56	0.71	0.00	0.00	5.84	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.52	0.00
N. coccolithom.	0.00	0.00	2.80	0.00	0.00	0.00	1.56	0.71	0.52	0.00	0.00	1.44	0.00	0.00	0.00	0.00	0.87	0.00	0.00	0.00
O. fragilis	1.95	2.92	5.61	27.71	14.02	6.68	4.68	0.71	0.52	1.56	20.46	0.72	3.78	6.01	0.00	1.40	1.73	0.43	0.52	0.00
O. hydroideus	0.00	8.77	25.24	96.98	14.02	26.72	6.23	0.71	1.56	6.23	43.84	2.16	3.78	4.01	3.24	9.82	3.46	3.03	1.04	1.92
P. lepida	1.95	0.00	0.00	0.00	0.00	0.00	1.56	0.00	0.00	0.00	2.92	0.00	1.89	2.00	0.00	0.00	0.87	0.00	0.00	0.00
Pontosphaera spp.	0.00	0.00	2.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.43	0.00	0.00
R. sessilis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.42	0.00	0.00	2.92	0.00	1.89	2.00	0.00	2.80	0.87	0.43	0.00	0.00
R. clavigera	9.74	35.07	16.83	41.56	21.04	23.38	21.82	7.08	2.60	14.02	14.61	2.89	5.67	22.04	3.24	4.21	2.60	2.16	2.08	1.37
R. xiphos	0.00	5.84	14.02	0.00	0.00	13.36	74.81	2.13	1.56	4.67	37.99	1.44	0.00	14.02	1.08	5.61	1.73	5.20	0.00	1.65
S. anthos	0.00	0.00	2.80	0.00	7.01	0.00	3.12	0.71	0.52	0.00	0.00	0.00	1.89	2.00	0.00	0.00	1.73	0.43	0.00	1.10
S. borealis	0.00	0.00	0.00	0.00	0.00	0.00	1.56	0.00	0.00	1.56	2.92	0.72	0.00	0.00	0.00	0.00	0.87	0.00	0.00	0.00
S. corolla	0.00	0.00	0.00	13.85	0.00	0.00	1.56	0.00	0.52	0.00	0.00	0.00	1.89	0.00	0.00	0.00	0.00	0.43	0.00	0.00
S. halldalii	1.95	11.69	0.00	27.71	0.00	6.68	0.00	1.42	0.00	0.00	2.92	0.72	0.00	0.00	3.24	0.00	0.00	0.00	0.00	0.00
S. histrica	7.79	14.61	11.22	27.71	7.01	20.04	1.56	0.00	1.04	6.23	0.00	2.16	1.89	2.00	2.16	0.00	0.87	0.87	0.00	0.00
S. lamina	0.00	0.00	0.00	13.85	0.00	13.36	6.23	0.00	8.31	1.56	0.00	0.72	0.00	4.01	1.08	0.00	0.87	0.00	0.00	0.00
S. molischii	1.95	2.92	5.61	27.71	3.51	3.34	3.12	3.54	0.52	0.00	0.00	0.00	0.00	0.00	2.16	2.80	0.00	0.87	0.52	0.00
S. nodosa	0.00	2.92	0.00	0.00	3.51	0.00	0.00	0.00	0.00	4.67	2.92	0.00	1.89	0.00	0.00	0.00	0.00	0.87	0.00	0.00
S. ossa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.56	0.00	2.92	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S. pirus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.87	0.00	0.00	0.00
S. prolongata	0.00	0.00	0.00	0.00	0.00	0.00	1.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.55
S. pulchra	37.02	26.30	22.44	83.13	10.52	20.04	4.68	7.08	3.64	12.47	35.07	5.05	13.22	14.02	3.24	4.21	3.46	2.60	0.52	0.82
S. rotula	0.00	2.92	0.00	0.00	0.00	0.00	3.12	0.00	1.04	0.00	5.84	0.00	1.89	0.00	0.00	0.00	0.87	0.00	0.00	0.00
Syracosphaera spp.	7.79	20.46	25.24	152.40	24.54	26.72	18.70	4.25	1.56	14.02	11.69	2.16	13.22	12.02	5.39	5.61	2.60	4.76	3.12	0.55
T. quadrilaminata	13.64	49.68	39.27	110.83	21.04	16.70	7.79	6.38	3.12	7.79	20.46	1.44	18.89	26.05	16.18	2.80	5.20	3.46	1.56	0.82
U. irregularis	1.95	2.92	5.61	0.00	7.01	0.00	3.12	1.42	0.52	6.23	5.84	0.72	0.00	2.00	0.00	2.80	0.00	0.43	0.00	0.27
U. tenuis	19.48	32.15	19.63	96.98	14.02	43.42	12.47	10.63	5.71	34.28	37.99	7.94	18.89	24.04	19.42	18.23	9.52	4.33	3.12	2.47
U. hulburtiana	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.87	0.87	0.52	0.00
U. sibogae	9.74	37.99	16.83	69.27	24.54	20.04	6.23	5.67	3.12	4.67	8.77	5.05	20.78	20.03	1.08	9.82	9.52	4.76	0.52	0.27
Holococcolithen	1.95	11.69	11.22	13.85	0.00	0.00	7.79	1.42	0.00	1.56	11.69	0.00	3.78	0.00	0.00	2.80	2.60	0.43	1.04	0.27

EBC2-1 (700 m): relative Artenanteile (%)

Probe	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Verschlusszeit	06.01.97	20.01.97	03.02.97	17.02.97	03.03.97	17.03.97	31.03.97	14.04.97	28.04.97	12.05.97	26.05.97	09.06.97	23.06.97	07.07.97	21.07.97	04.08.97	18.08.97	01.09.97	15.09.97	29.09.97
Sammelintervall (d)	4	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14
Gesamtfluss	1276.11	1931.70	1884.88	7273.49	2152.75	1953.82	924.25	403.11	298.15	760.44	1791.42	432.85	1184.28	1256.19	589.03	779.76	477.97	261.50	275.81	149.04
Acanthoica spp.	0.00	0.30	0.30	4.38	1.63	0.17	1.01	1.05	0.70	0.82	1.14	0.17	0.32	0.32	0.00	0.18	0.91	0.33	0.19	1.29
Algirosphaera spp.	0.76	3.03	5.51	7.62	3.75	1.54	3.88	7.03	1.57	3.07	6.36	1.17	1.91	2.23	0.37	1.26	3.62	4.64	1.13	8.12
A. unicornis	0.00	0.00	0.15	0.19	0.00	0.00	0.00	0.00	0.70	0.00	0.16	0.00	0.16	0.32	0.00	0.18	0.00	0.17	0.00	0.00
A. brasiliensis	0.00	0.00	0.00	0.19	0.00	0.17	0.00	0.88	0.00	0.00	0.65	0.00	0.00	0.00	0.00	0.00	0.72	0.50	0.19	0.00
C. leptoporus	0.61	0.76	0.60	0.57	0.16	1.20	1.01	1.05	1.22	1.02	0.98	0.67	1.12	0.96	1.10	1.26	1.81	1.32	0.19	0.00
C. murrayi	1.07	1.51	1.19	2.86	1.63	1.20	1.52	1.23	0.52	1.02	1.14	0.83	1.28	0.32	1.10	1.44	1.81	0.66	0.19	2.95
C. pelagicus	0.00	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.18	0.18	0.00	0.00	0.00
C. binodata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.00	0.00	0.00	0.00	0.00	0.00
C. mediterranea	0.00	0.15	0.15	0.19	0.16	0.00	0.00	0.35	0.17	0.41	0.00	0.00	0.16	0.48	0.00	0.18	0.00	0.17	0.19	0.00
D. tubifera	0.00	0.91	1.04	0.19	0.65	0.68	1.52	0.70	1.57	1.64	0.82	0.50	0.48	0.48	1.10	0.36	0.54	0.83	0.19	0.00
E. huxleyi	28.24	38.12	36.90	44.19	48.05	50.60	38.79	37.96	43.03	37.50	28.87	34.00	33.81	38.76	46.15	33.99	37.14	33.61	41.43	41.33
F. profunda	49.31	22.39	22.32	11.81	12.21	13.85	13.66	18.80	20.91	20.70	31.81	33.33	32.54	24.88	18.86	30.76	25.54	28.64	16.76	15.87
G. ericsonii	5.19	9.98	12.95	16.57	19.06	12.99	12.65	11.78	12.02	11.48	9.79	10.17	10.21	11.32	13.92	14.75	9.24	8.28	31.07	16.61
G. muellerae	1.83	2.42	2.23	0.76	2.28	1.03	0.84	0.53	1.74	2.05	0.82	2.83	2.07	2.87	3.11	1.62	1.99	1.32	1.32	2.03
G. oceanica	3.82	4.24	3.87	2.67	3.09	3.25	3.71	4.39	2.09	4.10	2.28	5.67	3.99	3.51	2.20	3.42	4.17	4.47	1.69	4.24
G. ornata	0.00	0.00	0.15	0.00	0.16	0.00	0.00	0.18	0.52	0.41	0.16	0.33	0.48	0.16	0.73	0.72	0.00	0.00	0.00	0.00
G. flabellatus	0.00	1.21	0.30	0.19	0.49	0.00	0.67	0.53	0.35	0.41	0.16	1.33	0.48	0.80	0.55	0.36	1.27	0.66	0.00	0.18
H. carteri	0.00	0.45	0.15	0.38	0.16	0.34	0.17	0.35	0.35	0.00	0.16	0.67	0.96	0.16	0.00	0.00	0.54	0.33	0.19	0.18
H. pavimentum	0.00	0.15	0.00	0.19	0.00	0.00	0.00	0.00	0.17	0.00	0.00	0.00	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00
M. elegans	0.00	0.15	0.30	0.38	0.16	0.17	0.17	0.18	0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.19	0.00
N. coccolithom.	0.00	0.00	0.15	0.00	0.00	0.00	0.17	0.18	0.17	0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.18	0.00	0.00	0.00
O. fragilis	0.15	0.15	0.30	0.38	0.65	0.34	0.51	0.18	0.17	0.20	1.14	0.17	0.32	0.48	0.00	0.18	0.36	0.17	0.19	0.00
O. hydroideus	0.00	0.45	1.34	1.33	0.65	1.37	0.67	0.18	0.52	0.82	2.45	0.50	0.32	0.32	0.55	1.26	0.72	1.16	0.38	1.29
P. lepida	0.15	0.00	0.00	0.00	0.00	0.00	0.17	0.00	0.00	0.00	0.16	0.00	0.16	0.16	0.00	0.00	0.18	0.00	0.00	0.00
Pontosphaera spp.	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.00	0.00
R. sessilis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.35	0.00	0.00	0.16	0.00	0.16	0.16	0.00	0.36	0.18	0.17	0.00	0.00
R. clavigera	0.76	1.82	0.89	0.57	0.98	1.20	2.36	1.76	0.87	1.84	0.82	0.67	0.48	1.75	0.55	0.54	0.54	0.83	0.75	0.92
R. xiphos	0.00	0.30	0.74	0.00	0.00	0.68	8.09	0.53	0.52	0.61	2.12	0.33	0.00	1.12	0.18	0.72	0.36	1.99	0.00	1.11
S. anthos	0.00	0.00	0.15	0.00	0.33	0.00	0.34	0.18	0.17	0.00	0.00	0.00	0.16	0.16	0.00	0.00	0.36	0.17	0.00	0.74
S. borealis	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.00	0.00	0.20	0.16	0.17	0.00	0.00	0.00	0.00	0.18	0.00	0.00	0.00
S. corolla	0.00	0.00	0.00	0.19	0.00	0.00	0.17	0.00	0.17	0.00	0.00	0.00	0.16	0.00	0.00	0.00	0.00	0.17	0.00	0.00
S. halldalii	0.15	0.61	0.00	0.38	0.00	0.34	0.00	0.35	0.00	0.00	0.16	0.17	0.00	0.00	0.55	0.00	0.00	0.00	0.00	0.00
S. histrica	0.61	0.76	0.60	0.38	0.33	1.03	0.17	0.00	0.35	0.82	0.00	0.50	0.16	0.16	0.37	0.00	0.18	0.33	0.00	0.00
S. lamina	0.00	0.00	0.00	0.19	0.00	0.68	0.67	0.00	2.79	0.20	0.00	0.17	0.00	0.32	0.18	0.00	0.18	0.00	0.00	0.00
S. molischii	0.15	0.15	0.30	0.38	0.16	0.17	0.34	0.88	0.17	0.00	0.00	0.00	0.00	0.00	0.37	0.36	0.00	0.33	0.19	0.00
S. nodosa	0.00	0.15	0.00	0.00	0.16	0.00	0.00	0.00	0.00	0.61	0.16	0.00	0.16	0.00	0.00	0.00	0.00	0.33	0.00	0.00
S. ossa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.52	0.00	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S. pirus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.18	0.00	0.00	0.00
S. prolongata	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.37
S. pulchra	2.90	1.36	1.19	1.14	0.49	1.03	0.51	1.76	1.22	1.64	1.96	1.17	1.12	1.12	0.55	0.54	0.72	0.99	0.19	0.55
S. rotula	0.00	0.15	0.00	0.00	0.00	0.00	0.34	0.00	0.35	0.00	0.33	0.00	0.16	0.00	0.00	0.00	0.18	0.00	0.00	0.00
Syracosphaera spp.	0.61	1.06	1.34	2.10	1.14	1.37	2.02	1.05	0.52	1.84	0.65	0.50	1.12	0.96	0.92	0.72	0.54	1.82	1.13	0.37
T. quadrilaminata	1.07	2.57	2.08	1.52	0.98	0.85	0.84	1.58	1.05	1.02	1.14	0.33	1.59	2.07	2.75	0.36	1.09	1.32	0.56	0.55
U. irregularis	0.15	0.15	0.30	0.00	0.33	0.00	0.34	0.35	0.17	0.82	0.33	0.17	0.00	0.16	0.00	0.36	0.00	0.17	0.00	0.18
U. tenuis	1.53	1.66	1.04	1.33	0.65	2.22	1.35	2.64	1.92	4.51	2.12	1.83	1.59	1.91	3.30	2.34	1.99	1.66	1.13	1.66
U. hulburtiana	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.18	0.33	0.19	0.00
U. sibogae	0.76	1.97	0.89	0.95	1.14	1.03	0.67	1.41	1.05	0.61	0.49	1.17	1.75	1.59	0.18	1.26	1.99	1.82	0.19	0.18
Holococcolithen	0.15	0.61	0.60	0.19	0.00	0.00	0.84	0.35	0.00	0.20	0.65	0.00	0.32	0.00	0.00	0.36	0.54	0.17	0.38	0.18

EBC2-1 (700 m): Coccolithenkarbonatfluss (mg m^{-2} d^{-1})

Probe	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Verschlusszeit	06.01.97	20.01.97	03.02.97	17.02.97	03.03.97	17.03.97	31.03.97	14.04.97	28.04.97	12.05.97	26.05.97	09.06.97	23.06.97	07.07.97	21.07.97	04.08.97	18.08.97	01.09.97	15.09.97	29.09.97
Sammelintervall (d)	4	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14
Gesamtfluss	11.328	13.241	10.077	39.439	10.332	12.000	6.543	2.751	1.785	4.669	11.471	2.510	7.555	7.787	2.664	3.947	3.360	1.653	0.970	0.733
C. leptoporus	0.710	1.331	1.022	3.786	0.319	2.130	0.852	0.387	0.331	0.710	1.597	0.263	1.204	1.095	0.590	0.894	0.789	0.316	0.047	0.000
C. pelagicus	0.000	0.582	0.000	0.000	0.000	0.000	0.000	0.000	0.052	0.000	0.000	0.000	0.000	0.000	0.000	0.140	0.086	0.000	0.000	0.000
D. tubifera	0.000	0.026	0.029	0.021	0.021	0.020	0.021	0.004	0.007	0.019	0.022	0.003	0.008	0.009	0.010	0.004	0.004	0.003	0.001	0.000
E. huxleyi	0.757	1.547	1.461	6.750	2.172	2.076	0.753	0.321	0.269	0.599	1.086	0.309	0.841	1.022	0.603	0.557	0.373	0.185	0.267	0.171
F. profunda	1.007	0.692	0.673	1.374	0.421	0.433	0.202	0.121	0.100	0.252	0.912	0.231	0.617	0.500	0.178	0.384	0.195	0.120	0.074	0.038
G. ericsonii	0.060	0.174	0.220	1.085	0.369	0.228	0.105	0.043	0.032	0.079	0.210	0.071	0.109	0.128	0.074	0.104	0.040	0.024	0.090	0.036
G. muellerae	0.147	0.295	0.265	0.349	0.309	0.126	0.049	0.013	0.033	0.098	0.092	0.077	0.155	0.227	0.116	0.080	0.060	0.022	0.023	0.019
G. oceanica	0.774	1.301	1.160	3.084	1.059	1.009	0.545	0.282	0.099	0.496	0.651	0.390	0.751	0.701	0.206	0.424	0.317	0.186	0.074	0.101
H. carteri	0.000	1.252	0.401	3.957	0.501	0.954	0.223	0.202	0.148	0.000	0.417	0.412	1.618	0.286	0.000	0.000	0.371	0.124	0.074	0.039
O. fragilis	0.189	0.283	0.543	2.682	1.358	0.647	0.453	0.069	0.050	0.151	1.980	0.070	0.366	0.582	0.000	0.136	0.168	0.042	0.050	0.000
Pontosphaera spp.	0.000	0.000	0.191	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.029	0.000	0.000
R. clavigera	0.658	2.367	1.136	2.805	1.420	1.578	1.473	0.478	0.175	0.947	0.986	0.195	0.382	1.488	0.218	0.284	0.175	0.146	0.140	0.093
S. pulchra	0.592	0.421	0.359	1.330	0.168	0.321	0.075	0.113	0.058	0.199	0.561	0.081	0.212	0.224	0.052	0.067	0.055	0.042	0.008	0.013
Syracosphaera spp.	0.141	0.424	0.238	1.341	0.255	0.525	0.264	0.069	0.163	0.170	0.212	0.052	0.114	0.097	0.104	0.034	0.073	0.042	0.006	0.020
Syracosphaera (small)	0.031	0.082	0.101	0.610	0.098	0.107	0.075	0.017	0.006	0.056	0.047	0.009	0.053	0.048	0.022	0.022	0.010	0.019	0.012	0.002
U. tenuis	0.169	0.280	0.171	0.844	0.122	0.378	0.108	0.092	0.050	0.298	0.331	0.069	0.164	0.209	0.169	0.159	0.083	0.038	0.027	0.022
U. sibogae	5.763	0.631	0.212	0.873	0.309	0.426	0.079	0.090	0.053	0.059	0.110	0.082	0.262	0.305	0.014	0.197	0.143	0.060	0.007	0.003
Holococcolithen	0.002	0.012	0.011	0.014	0.000	0.000	0.008	0.001	0.000	0.002	0.012	0.000	0.004	0.000	0.000	0.003	0.003	0.000	0.001	0.000
Restl. Arten	0.327	1.543	1.885	8.534	1.430	1.042	1.259	0.448	0.158	0.536	2.244	0.196	0.695	0.866	0.311	0.460	0.416	0.256	0.066	0.176

EBC2-1 (700 m): Rel. Anteil am Coccolithenkarbonatfluss (%)

Probe	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Verschlusszeit	06.01.97	20.01.97	03.02.97	17.02.97	03.03.97	17.03.97	31.03.97	14.04.97	28.04.97	12.05.97	26.05.97	09.06.97	23.06.97	07.07.97	21.07.97	04.08.97	18.08.97	01.09.97	15.09.97	29.09.97
Sammelintervall (d)	4	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14
Gesamtfluss	11.328	13.241	10.077	39.439	10.332	12.000	6.543	2.751	1.785	4.669	11.471	2.510	7.555	7.787	2.664	3.947	3.360	1.653	0.970	0.733
C. leptoporus	6.27	10.05	10.14	9.60	3.09	17.75	13.02	14.07	18.55	15.20	13.93	10.47	15.94	14.06	22.13	22.66	23.48	19.09	4.88	0.00
C. pelagicus	0.00	4.39	0.00	0.00	0.00	0.00	0.00	0.00	2.89	0.00	0.00	0.00	0.00	0.00	0.00	3.54	2.56	0.00	0.00	0.00
D. tubifera	0.00	0.20	0.29	0.05	0.20	0.17	0.32	0.15	0.39	0.40	0.19	0.13	0.11	0.12	0.36	0.11	0.12	0.20	0.08	0.00
E. huxleyi	6.68	11.68	14.50	17.11	21.02	17.30	11.51	11.68	15.09	12.83	9.47	12.31	11.13	13.13	22.62	14.10	11.09	11.16	27.56	23.33
F. profunda	8.89	5.23	6.68	3.48	4.07	3.61	3.09	4.41	5.59	5.39	7.95	9.20	8.16	6.42	6.67	9.72	5.81	7.25	7.63	5.16
G. ericsonii	0.53	1.31	2.18	2.75	3.57	1.90	1.61	1.55	1.81	1.68	1.83	2.82	1.44	1.64	2.77	2.62	1.18	1.46	9.30	4.86
G. muellerae	1.30	2.22	2.63	0.89	2.99	1.05	0.75	0.49	1.83	2.10	0.80	3.08	2.05	2.92	4.34	2.01	1.79	1.32	2.36	2.60
G. oceanica	6.84	9.83	11.51	7.82	10.25	8.41	8.33	10.24	5.55	10.61	5.67	15.54	9.94	9.00	7.73	10.74	9.42	11.24	7.67	13.72
H. carteri	0.00	9.46	3.97	10.03	4.85	7.95	3.40	7.35	8.31	0.00	3.64	16.42	21.42	3.67	0.00	0.00	11.04	7.48	7.65	5.36
O. fragilis	1.66	2.14	5.39	6.80	13.14	5.39	6.92	2.49	2.82	3.23	17.26	2.78	4.84	7.47	0.00	3.44	4.99	2.54	5.19	0.00
Pontosphaera spp.	0.00	0.00	1.89	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.78	0.00	0.00
R. clavigera	5.80	17.88	11.27	7.11	13.74	13.15	22.51	17.38	9.82	20.28	8.60	7.76	5.06	19.10	8.20	7.20	5.22	8.84	14.46	12.67
S. pulchra	5.23	3.18	3.56	3.37	1.63	2.67	1.14	4.12	3.26	4.27	4.89	3.22	2.80	2.88	1.94	1.71	1.65	2.51	0.86	1.80
Syracosphaera spp.	1.25	3.20	2.36	3.40	2.46	4.38	4.04	2.49	9.15	3.63	1.85	2.09	1.51	1.25	3.92	0.86	2.18	2.54	0.65	2.72
Syracosphaera (small)	0.28	0.62	1.00	1.55	0.95	0.89	1.14	0.62	0.35	1.20	0.41	0.34	0.70	0.62	0.81	0.57	0.31	1.15	1.29	0.30
U. tenuis	1.50	2.11	1.70	2.14	1.18	3.15	1.66	3.36	2.78	6.39	2.88	2.75	2.18	2.69	6.34	4.02	2.47	2.28	2.80	2.94
U. sibogae	50.87	4.76	2.10	2.21	2.99	3.55	1.20	3.27	2.96	1.26	0.96	3.28	3.47	3.91	0.51	4.98	4.24	3.63	0.67	0.47
Holococcolithen	0.02	0.09	0.11	0.04	0.00	0.00	0.12	0.05	0.00	0.03	0.10	0.00	0.05	0.00	0.00	0.07	0.08	0.03	0.11	0.04
Restl. Arten	2.89	11.65	18.71	21.64	13.85	8.68	19.25	16.27	8.84	11.48	19.57	7.82	9.20	11.12	11.66	11.66	12.37	15.50	6.86	24.02