

Acquired phototrophy in aquatic protists

Diane K. Stoecker^{1,*}, Matthew D. Johnson², Colomban de Vargas³, Fabrice Not³

¹University of Maryland Center for Environmental Science, Horn Point Laboratory, PO Box 775,
2020 Horns Point Rd, Cambridge, Maryland 21613, USA

²Woods Hole Oceanographic Institution, Watson Building 109, MS#52, Woods Hole, Massachusetts 02643, USA

³Evolution du Plancton et PaleOceans (EPPO) Lab., UMR 7144 - CNRS & Univ. Paris VI,
Station Biologique de Roscoff - SBR, Place George Teissier, BP 74 29682 Roscoff, Cedex, France

*Email: stoecker@hpl.umces.edu

Aquatic Microbial Ecology 57:279–310 (2009)

Table S1. Radiolaria and foraminifera that host intact photosynthetic endosymbionts (E), possess a permanent and reduced eukaryotic algal 'endosymbiont', or retain only the chloroplasts from algal prey (O*)

Taxon ^a	Known endosymbionts or sources of plastids	Known distribution	Source
Acantharea			
<i>Diploconus fascies</i>	E Prymnesiophyceae	Pelagic, Gulf of Aqaba, cosmopolitan	Kimor et al. 1992
<i>Acanthmetra pellucida</i>	E Prymnesiophyceae	Pelagic, Gulf of Aqaba, cosmopolitan	Febvre & Febvre-Chevalier 1979, Kimor et al. 1992
<i>Amphilonche elongata</i>	E Prymnesiophyceae	Pelagic, Gulf of Aqaba, cosmopolitan	Kimor et al. 1992, Febvre & Febvre-Chevalier 1979
<i>Lithoptera mulleri</i>	E Prymnesiophyceae	Eastern Mediterranean Sea	Febvre & Febvre-Chevalier 1979, Taylor 1990
Polycystinea			
Spumellarida			
<i>Didymocytis tetrathalamus</i>	E Dinoflagellates	Pelagic, Barbados	Sugiyama & Anderson 1998
<i>Spongaster tetras tetras</i>	E Dinoflagellates	Pelagic	Anderson et al. 1989
<i>Spongodymus</i> sp.	E Dinoflagellates	Pelagic	Gast & Caron 2001
<i>Tetrapetalon elegans</i>	E Dinoflagellates	Pelagic	Anderson et al. 1998a
<i>Spongostaurus</i> spp.	E Dinoflagellates, <i>Scrippsiella</i> sp.	Pelagic, Sargasso Sea, cosmopolitan	Gast & Caron 2001
<i>Dictyocoryne truncatum</i>	E Prymnesiophyceae	Pelagic	Anderson & Matsuoka 1992
<i>Spongodymus</i> sp.	E Prymnesiophyceae	Pelagic, Barbados	Anderson et al. 1983b
<i>Spongodymus</i> sp.	E Prasinophyceae, <i>Tetraselmis</i>	Pelagic, Sargasso Sea	Gast et al. 2000
<i>Thalassolampe margarodes</i>	E Prasinophyceae, <i>Pedinomonas symbiotica</i>	Pelagic	Cachon & Caram 1979
<i>Euchitonina elegans</i>	E Undetermined	Pelagic, Japan	Takahashi et al. 2003
<i>Spongodiscus biconcavus</i>	E Undetermined	Pelagic, Japan	Takahashi et al. 2003
<i>Acanthosphaera</i> sp.	E Undetermined	Pelagic, Sargasso Sea	Rivkin & Lessard 1986
<i>Actinomma</i> sp.	E Undetermined	Pelagic, Sargasso Sea	Rivkin & Lessard 1986
<i>Plegmosphaera</i> sp.	E Undetermined	Pelagic, Sargasso Sea	Rivkin & Lessard 1986
<i>Haxacantium</i> sp.	E Undetermined	Pelagic, Sargasso Sea	Rivkin & Lessard 1986
<i>Spongotrochus</i> sp.	E Undetermined	Pelagic, Sargasso Sea	Rivkin & Lessard 1986
Collodaria			
<i>Collozoum</i> spp.	E Dinoflagellates, <i>Scrippsiella</i> sp.	Pelagic, Cosmopolitan	Anderson et al. 1998b, Swanberg & Anderson 1981, Swanberg 1983, Gast & Caron 2001
<i>Collosphaera</i> sp.	E Dinoflagellates	Pelagic	Anderson et al. 1985
<i>Sphaerozoum</i> spp.	E Dinoflagellates	Pelagic, Eastern Mediterranean Sea, Japan	Anderson 1976, Kimor et al. 1992, Takahashi et al. 2003
<i>Acrosphaera spinosa</i>	E Dinoflagellates		Swanberg 1983
<i>Thalassicolla</i> spp.	E Dinoflagellates, <i>Scrippsiella</i> sp.	Pelagic, Sargasso Sea, cosmopolitan	Gast & Caron 2001, Zettler et al. 1998

Table S1 (continued)

Taxon ^a		Known endosymbionts or sources of plastids	Known distribution	Source
Nassellarida				
<i>Pterocorys zancleus</i>	E	Dinoflagellates	Pelagic	Anderson 1983, Sugiyama & Anderson 1997
<i>Pterocanium praetextum</i>	E	Undetermined	Pelagic, Japan	Takahashi et al. 2003
<i>Physematium muelleri</i>	E	Chrysophycophytes	Pelagic	Anderson et al. 1986
<i>Heliodiscus</i> sp.	E	Undetermined	Pelagic, Japan	Takahashi et al. 2003
<i>Phorticium pylonium</i>	E	Dinoflagellates	Neretic, Norwegian fjord	Dolven et al. 2007
<i>Ceratospyrus hyperborea</i>	E	Dinoflagellates	Neretic, Norwegian fjord	Dolven et al. 2007
<i>Androcyclas gamphonyca</i>	E	Dinoflagellates	Neretic, Norwegian fjord	Dolven et al. 2007
Astrosphaeridae		Prasinophyceae	Pelagic, Bermuda	Anderson 1976
Foraminifera				
<i>Globigerinoides</i> spp.	E	<i>Gymnodinium beii</i>	Pelagic	Shaked & de Vargas 2006, Taylor 1982
<i>Orbulina</i> spp.	E	<i>Gymnodinium beii</i>	Pelagic	Shaked & de Vargas 2006
<i>Globigerina</i> spp.	E	Dinoflagellates	Pelagic	Faber et al. 1988, Bé et al. 1977, Taylor 1982
<i>Globigerinella siphonifera</i>	E	Prymnesiophyceae	Pelagic, Sargasso Sea, cosmopolitan	Gast et al. 2000, Gast & Caron 2001, Faber et al. 1988
<i>Globorotalia menardii</i>	E	Prymnesiophyceae	Pelagic	Taylor 1982
<i>Pulleniatina obliqueloculata</i>	E	Prymnesiophyceae	Pelagic	Bé et al. 1977, Taylor 1982
<i>Amphisorus hemprichii</i>	E	Dinoflagellates, <i>Symbiodinium complex</i>	Benthic, Indian Ocean, Red Sea	Pawlowski et al. 2001b
<i>Sorites</i> sp.	E	Dinoflagellates, <i>Symbiodinium complex</i>	Benthic, Cosmopolitan	Pawlowski et al. 2001b
<i>Peneroplis</i> spp.	E	Rhodophytes, <i>Porphyridium</i>	Benthic, Red Sea	Lee 1990
<i>Amphistegina gibbosa</i>	E	Diatoms <i>Nitzschia</i> spp.	Benthic, Florida Keys, Worldwide	Pawlowski et al. 2001a, Tagle et al. 1997
<i>Heterosigma depressa</i>	E	Diatoms <i>Nitzschia</i> sp.	Benthic, Gulf of Eilat	Lee et al. 1982
<i>Archaias</i> spp.	E	Green, <i>Chlamydomonas</i> spp.	Benthic, Caribbean, Indo-pacific	Cotter & Hallock 1988
<i>Marginopora vertebralis</i>	E	Prymnesiophyceae, <i>Pleurochrysis scherffellii</i>	Benthic, off Lizard Island	Lee et al. 1997
<i>Elphidium</i> spp.	O*	Diatoms <i>Nitzschia</i> spp.	Benthic	Correia & Lee 2002
<i>Bulimina elegantissima</i>	O*	Diatoms	Benthic, cold seeps, brackish water	Bernhard et al. 2001
<i>Nonionella stella</i>	O*	Diatoms	Benthic, Santa Barbara basin	Bernhard 2003
<i>Virgulina fragilis</i>	O*	Diatoms	Benthic, Cariaco basin	Bernhard 2003
^a Higher level classification according to Adl et al. 2005				

Table S2. Marine (Ma), estuarine (Es) and freshwater (Fr) ciliates that host intact photosynthetic endosymbionts (E), possess a permanent and reduced eukaryotic algal 'endosymbiont' (E*), retain multiple organelles from algal prey (O), or retain only the chloroplasts from algal prey (O*). '±' indicates that algal endosymbionts or plastids are sometimes present and sometimes absent in a species. '?' indicates uncertainty in identification of endosymbiont or plastid

Taxon ^a		Known endosymbionts or sources of plastids	Known distribution	Source
Heterotrichea				
<i>Climacostomum virens</i>	E	Chlorophyte- <i>Chlorella</i>	Fr-temperate	Reisser & Kurmeier 1984
<i>Maristentor dinoferus</i>	E	Dinoflagellate <i>Symbiodinium</i>	Ma-coral reefs	Lobban et al. 2002
<i>Stentor</i> sp.			Fr-subtropical, tropical	Laybourn-Parry et al. 1997
<i>Stentor amethystinus</i>	E	Cyanobacteria? <i>Chlorella</i> ?	Fr-temperate	Macek et al. 2001, Woelfl & Geller 2002
<i>Stentor araucanus</i>	E	Chlorophyte-cf. <i>Chlorella</i>	Fr-temperate	Modenutti et al. 2002, 2005, Queimalinos et al. 1999, Woelfl & Geller 2002
<i>Stentor niger</i>	E	Chlorophyte- <i>Chlorella</i>	Fr-subtropical, acidic lakes	Beaver & Crisman 1989; Bienert et al. 1991
<i>Stentor polymorphus</i>	E	Chlorophyte- <i>Chlorella</i>	Fr	Reisser 1986
Hypotrichia				
<i>Euplotes daidaleos</i>	E	Chlorophyte- <i>Chlorella</i>	Fr-temperate-tropical, oxic-anoxic boundary	Finlay et al. 1987, Berninger et al. 1986, Beaver & Crisman 1989, Peřtová et al. 2008
<i>Euplotes uncinatus</i>	E	Dinoflagellate- <i>Symbiodinium</i> .	Ma-coral reefs	Lobban et al. 2005
Oligotrichida				
<i>Cyrtostrombidium</i> sp.	O*?	No data	Ma-subtropical, coastal	Modigh 2001
<i>Laboea cf. pulchra</i>	O*?		Ma-Es?	Sime-Ngando et al. 1992
<i>Laboea strobilia</i>	O*	Cryptophytes, Haptophytes, other chromophytes?	Ma, Es-polar, temperate, subtropical	Blackbourn et al. 1973, McManus & Fuhrman 1986, Dale 1987, Stoecker et al. 1987, Jonsson 1987, Laval- Peuto & Rassoulzadegan 1988, Stoecker et al. 1988, Bernard & Rassoulzadegan 1994, Stoecker et al. 1995, Levinsen & Nielsen 2002, Ota & Taniguchi 2003
<i>Limnostrombidium viride</i> = <i>Strombidium viride</i>	O*	Chlorophyceae, likely <i>Kirchneriella</i>	Fr- all lake types, world-wide, surface layer, stable stratification	Rogerson et al. 1989, Beaver & Crisman 1989, Hecky & Kling 1981, Laybourn-Parry & Marchant 1992, Perriss et al. 1994, Holen 2000, Foissner et al. 1999
<i>Pelagostrombidium</i>	O*?		Fr-temperate oligotrophic bog lakes	Macek et al. 2001, 2006
<i>Pelagostrombidium fallax</i>	O*	Greenish plastids	Fr	Sonntag et al. 2006, Macek et al. 2001, Müller et al. 1991, Foissner et al. 1999
<i>Pelagostrombidium mirabile</i> = <i>Strombidium mirabile</i>	O*	Yellow and green plastids	Fr-eutrophic lakes	Foissner et al. 1999
<i>Pelagostrombidium viridis</i>	O*?		Fr	Sonntag et al. 2006
<i>Rimostrombidium velox</i>	E	Green alga	Fr-temperate, bog lake	Macek et al. 2001, Foissner et al. 1999
<i>Strombidium acutum</i>	O*	Prasinophytes	Ma, Es-temperate, subtropical	Stoecker et al. 1988/89, Laval-Peuto & Rassoulzadegan 1988, Montagnes et al. 1988
<i>S. captiatum</i>	O*	Cryptophytes, haptophytes, prasinophytes	Ma, Es-temperate, subtropical	Laval-Peuto & Rassoulzadegan Stoecker et al. 1988/89, Montagnes et al. 1988, Stoecker & Silver 1990
<i>S. chlorophilum</i>	O* E?	Prasinophytes, cryptophytes	Es-temperate	Stoecker et al. 1988/89, Montagnes et al. 1988
<i>S. conicum</i>	O*	Prasinophytes	Ma, Es-temperate	Jonsson 1987, Stoecker et al. 1988/89, Montagnes et al. 1988
<i>S. crassulum</i>	O*? E?	No data	Ma-temperate, subtropical	Reid 1987, Laval-Peuto & Rassoulzadegan 1988
<i>S. delicatissimum</i>	O*	No data	Ma-temperate, subtropical	Laval-Peuto & Rassoulzadegan 1988

Table S2 (continued)

Taxon ^a		Known endosymbionts or sources of plastids	Known distribution	Source
<i>S. elegans</i>	O*	No data	Ma-temperate, subtropical	Laval-Peuto & Rassoulzadegan 1988
<i>S. kryalis</i>	O*	Cryptophyte & other algae	Ma-polar, sea ice	Petz et al. 1994
<i>S. oculatum</i>	O	Chlorophyte	Ma, Es-temperate tidepools	Faure-Fremiet 1948, McManus et al. 2004, Jonsson 1994
<i>S. cf. oculatum</i>	O?E?	No data	Fr- humid subtropical lake, stratification	Beaver & Crisman 1989, Beaver et al. 1988
<i>S. purpureum</i>	E	Purple non-sulfur bacteria	Es-temperate, anerobic microbial mat	Fenchel & Bernard 1993, Bernard & Fenchel 1994
<i>S. reticulatum</i>	E, O?	Prasinophytes	Ma-temperate, subtropical	Dale & Dahl 1987, Jonsson 1987, Laval-Peuto & Rassoulzadegan 1988
<i>S. styliifer</i>	O?	Chlorophyte	Ma-temperate, tidepool	McManus et al. 2004
<i>S. typicum</i>	O*	No data	Ma-temperate, subtropical	Laval-Peuto & Rassoulzadegan 1988
<i>S. vestitum</i>	O*? E?	No data	Ma-temperate, subtropical	Jonsson 1987, Laval-Peuto & Rassoulzadegan 1988
<i>S. viride</i> -see <i>Limnostrombidium viride</i>				
<i>Pseudotontonia cornuta</i>	O*	No data	Ma-temperate	Skovgaard & Legrand 2005
<i>Tontonia appendiculariformis</i>	O*	Mixture of Chromophytes	Ma-temperate, subtropical	Laval-Peuto & Febvre 1986, Laval-Peuto et al. 1986, Bernard & Rassoulzadegan 1994, Ota & Taniguchi 2003
<i>T. gracillima</i>	O*	No data	Ma-temperate, subtropical	Laval-Peuto & Rassoulzadegan 1988, Bernard and Rassoulzadegan 1994
<i>T. ovalis</i>	O*	No data	Ma-temperate, subtropical	Laval-Peuto & Rassoulzadegan 1988, Bernard and Rassoulzadegan 1994
<i>T. cf. poopsia</i>	O*	No data	Ma-subtropical	Ota & Tanguchi 2003
<i>T. cf. simplicidens</i>	O*	No data	Ma-subtropical	Ota & Tangiguchi 2003
Choreotrichia				
<i>Lohmaniella</i> sp. ?	O*? E?	No data	Ma-temperate, subtropical	Blackbourn et al. 1973, Bernard & Rassoulzadegan 1994
<i>Strobilidium gyrans</i>	E?		Fr-Canadian Lake	Amblard et al. 1993
Stichotrichia				
<i>Halteria bifurcata</i>	E?	<i>Chlorella</i>	Fr	Reisser 1986, Foissner et al. 1999
<i>Halteria grandinella</i>	E?		Fr	Finlay et al. 1988 cited in Dolan 1992
<i>Pelagohalteria viridis</i> (= <i>Halteria viridis</i>)	E	Algae, but not <i>Chlorella</i>	Fr-temperate and alpine lakes	Muller et al. 1991, Macek et al. 1996, Simek et al. 1996, Foissner et al. 1999, Sonntag et al. 2006
<i>Stichotricha secunda</i>	E	Chlorophyte	Fr	Macek et al. 2001
Litostomatea				
<i>Acaryophyra</i> sp.	E	Chlorophyte- <i>Chlorella</i>	Fr-temperate, oxic-anoxic boundary	Berninger et al. 1986, Beaver & Crisman 1989
<i>Actinobolina smalli</i>	E	Green algae	Fr- temperate, bottom layer	Foissner et al. 1999
<i>Actinobolina wenrichii</i>	E	Zoochlorellae	Fr-temperate	Foissner et al. 1999
<i>Askensia chlorelligera</i>	E	Green algae	Fr-temperate, oligotrophic to eutrophic	Sonntag et al. 2006, Krainer & Foissner 1990, Foissner et al. 1999, Macek et al. 1996
<i>Cyclotrichium viride</i>	E	± zoochlorellae	Fr-sometimes blooms	Foissner et al. 1999
<i>Didinium chlorelligerum</i>	E	Green algae	Fr-temperate ponds	Foissner et al. 1999
<i>Dileptus monilatus</i>	E	Chlorophyte- <i>Chlorella</i>	Fr	Karpov et al. 1991
<i>Homalozoon vermiculare</i>	E	Chlorophyte- <i>Chlorella</i>	Fr	Karpov et al. 1991
<i>Lacrymaria olor</i>	E	Chlorophyte- <i>Chlorella</i>	Fr	Karpov et al. 1991
<i>Liliomorpha viridis</i>	E	Green algae	Fr	Foissner et al. 1999
<i>Monodinium chlorelligerum</i>	E	Green algae	Fr	Foissner et al. 1999, Sonntag et al. 2006
<i>Myrionecta rubra</i> (= <i>Mesodinium rubrum</i>)	O, E*	Cryptophytes	Ma, Es and saline lakes-polar, temperate, subtropical, tropical	Taylor et al. 1971, Hibberd 1977, Oakley & Taylor 1978, Lindholm 1985, Crawford 1989, Stoecker et al. 1995, Gustafson et al. 2000, Levinsen & Nielsen 2002, Yih et al. 2004, Hansen & Fenchel 2006, Johnson et al. 2006, 2007, Park et al. 2007, Montagnes et al. 2008, Smith & Hansen 2007

Table S2 (continued)

Taxon ^a		Known endosymbionts or sources of plastids	Known distribution	Source
<i>Pelagodileptus trachelioides</i> = <i>Paradileptus caducus</i>	E	± zoochlorellae	Fr, temperate, stratification	Foissner et al. 1999, Pace 1982
<i>Perispira ovum</i>	O	Euglenophyta- <i>Euglena proxima</i>	Es, Fr-temperate, oxic– anoxic interface	Johnson et al. 1995
<i>Teuthophrys trisulca trisulca</i>	E	± green algae	Fr	Foissner et al. 1999
Prostomatea				
<i>Bursellopsis spumosa</i>	E	Green algae	Fr-temperate	Foissner et al. 1999
<i>Pelagothrix</i> sp.	E?	No data	Fr-tropical	Peřtová et al. 2008, Macek et al. 2008
<i>Pelagothrix chlorelligera</i>	E	Algae	Fr-temperate, eutrophic	Foissner et al. 1999
<i>Pelagothrix plancticola</i>	E	Green algae	Fr-temperate, eutrophic	Foissner et al. 1999
<i>Coleps</i> sp.	E	Chlorophyte- <i>Chlorella vulgaris</i>	Fr-temperate	Esteve et al. 1988, Stabell et al. 2002
<i>Coleps hirtus viridis</i>	E	Chlorophyte- <i>Chlorella vulgaris</i>	Fr-temperate, micro-oxic	Auer et al. 2004, Reisser 1986, Zingel & Ott 2000
<i>Coleps spetai</i>	E	Chlorophyte- <i>Chlorella</i>	Fr-temperate, micro-oxic	Reisser 1986; Sonntag et al. 2006
<i>Holophyra</i> sp.	E	Chlorophyte- <i>Chlorella</i>	Fr	Karpov et al. 1991
<i>Malacophrys sphagni</i>	E	Chlorophyte- <i>Chlorella</i>	Fr	Karpov et al. 1991, Reisser 1986
<i>Prorodon</i> sp.	?	No data	Ma-temperate	Blackbourn et al. 1973
Peniculia				
<i>Disematostoma butschlii</i>	E	± Chlorophyte- <i>Chlorella</i>	Fr-temperate, micro-oxic, can lose symbionts during winter mixis	Berninger et al. 1986, Beaver & Crisman 1989
<i>Disematostoma tetraedricum</i>	E	Green algae	Fr	Foissner et al. 1999
<i>Frontonia leucas</i>	E	Chlorophyte- <i>Chlorella</i>	Fr-benthic	Reisser 1986
<i>Frontonia vernalis</i>	E	Chlorophyte- <i>Chlorella</i>	Fr-temperate eutrophic ponds, micro-oxic	Finlay et al. 1987, Berninger et al. 1986
<i>Paramecium bursaria</i>	E	Chlorophyte- <i>Chlorella</i>	Fr	Reisser 1986
<i>Stokesia vernalis</i>	E	± Chlorophyte- <i>Chlorella</i>	Fr-temperate, eutrophic	Berninger et al. 1986, Amblard et al. 1993, Foissner et al. 1999
Peritrichia				
<i>Colthurnia oblonga</i>	E?		Fr-epiphytic	Macek et al. 1994
<i>Ophrydium eutrophicum</i>	E	Green algae	Fr-eutrophic	Foissner et al. 1999
<i>Ophrydium naumanni</i>	E	Chlorophyte- <i>Chlorella</i>	Fr-oligotrophic, metalimnion	Queimalinos et al. 1999, Modenutti & Balseiro 2002, Modenutti et al. 2005, Woelfl & Geller 2002
<i>Ophrydium versatile</i>	E	Chlorophyte- <i>Chlorella</i>	Fr	Reisser 1986
<i>Vorticella</i> sp.	E	Chlorophyte- <i>Chlorella</i>	Fr- epiphytic	Karpov et al. 1991, Reisser 1986
<i>Vorticella chlorellata</i>	E	Green algae	Fr- epiphytic	Sonntag et al. 2006, Foissner et al. 1999
^a Higher level classification according to Adl et al. 2005				

Table S3. Marine, estuarine, and freshwater dinoflagellates that host intact photosynthetic eukaryotic endosymbionts (E), possess a permanent and reduced eukaryotic algal 'endosymbiont' (E*), retain multiple organelles from algal prey (O), or retain only the chloroplasts from algal prey (O*)

Taxon ^a	Known endosymbionts or sources of plastids	Known distribution	Source
Dinophyceae			
<i>Amphidinium latum</i>	O Cryptophytes		Horiguchi & Pienaar 1992
<i>Amphidinium poecilochroum</i>	O Cryptophytes	Temperate oceans	Larsen 1988; Jakobsen et al. 2000
<i>Amphidinium wigrense</i>	O Phycocyanin Cryptophytes	Temperate lakes	Wilcox & Wedemeyer 1985
<i>Amylax triacantha</i>	O <i>Teleaulax amphioxeia</i>	Temperate oceans	Koike and Takishita 2008
<i>Cryptoperidiniopsis</i> sp.	O* Cryptophytes	Estuarine and coastal marine habitats	Eriksen et al. 2002
<i>Dinophysis acuminata</i>	O* <i>Myrionecta rubra</i> ; <i>Teleaulax</i> spp.	Temperate oceans	Park et al. 2006
<i>Dinophysis caudata</i>	O* <i>Myrionecta rubra</i>	Temperate oceans	Park et al. 2008
<i>Dinophysis fortii</i>	O* <i>Myrionecta rubra</i> ; <i>Teleaulax amphioxeia</i>	Temperate oceans	Nagai et al. 2008
<i>Dinophysis infundibulus</i>	O* <i>Myrionecta rubra</i> ; <i>Teleaulax amphioxeia</i>	Temperate oceans?	Nishitani et al. 2008
<i>Dinophysis mitra</i>	O* Haptophyte algae	Temperate oceans	Koike et al. 2005
<i>Dinophysis norvegica?</i>	O* <i>Teleaulax amphioxeia?</i>	Temperate and sub-polar oceans	Carvalho et al. 2008
<i>Dinotrithix paradoxa</i>	E* Diatom	Estuarine and coastal marine habitats	Horiguchi & Chihara 1993
<i>Durinskia baltica</i>	E* Diatom	Estuarine and coastal marine habitats	Tomas & Cox 1973
<i>Durinskia capensis</i>	E* Diatom	Estuarine and coastal marine habitats	Pienaar et al. 2007
<i>Galeidinium rugatum</i>	E* Diatom	Estuarine and coastal marine habitats	Tamura et al. 2005
<i>Gymnodinium acidotum</i> (= <i>G. aeruginosum</i>)	O <i>Chroomonas</i> spp.	Temperate fresh water acidic lakes	Fields and Rhodes 1991
<i>Gymnodinium gracilentum</i>	O*? Cryptophytes	Estuarine and coastal marine habitats	Skovgaard 1998; Jakobsen et al. 2000
' <i>Kleptodinium</i> '	O <i>Phaeocystis antarctica</i>	Southern Ocean	Gast et al. 2007
<i>Kryptoperidinium foliaceum</i>	E* Diatom	Estuarine and coastal marine habitats	Jeffrey & Vesik 1976
<i>Noctiluca miliaris</i> (= <i>N. scintillans</i>)	E <i>Pedinomonas noctilucae</i>	Tropical Indian and Pacific Ocean	Sweeney 1978
<i>Peridinium quinquecorne</i>	E* Diatom	Estuarine and coastal marine habitats	Horiguchi & Pienaar 1991
<i>Pfiesteria piscicida</i>	O* Cryptophytes	Estuarine and coastal marine habitats	Lewitus et al. 1999
<i>Podolampas bipes</i>	E* Dictyophyte	Temperate, sub-tropical oceans	Schweiker and Elbräcter 2004

^aHigher level classification according to Adl. et al. 2007

LITERATURE CITED

- Adl SM, Leander BS, Simpson AGB, Archibald JM, Anderson OR, Bass D, Bowser SS, Brugerolle G, Farmer MA, Karpov S, Kolisko M, Lane CE, Lodge DJ, Mann DG, Meisterfeld R, Mendoza L, Moestrup O, Mozley-Standridge SE, Smirnov AV, Spiegel F (2007) Diversity, nomenclature, and taxonomy of protists. *Syst Biol* 56:684–689
- Amblard C, Simengando T, Rachiq S, Bourdier G (1993) Importance of ciliated protozoa in relation to the bacterial and phytoplanktonic biomass in an oligo-mesotrophic lake, during the spring diatom bloom. *Aquat Sci* 55:1–9
- Anderson OR (1976) Fine structure of a Collodarian Radiolarian (*Sphaerozoum punctatum*, Müller 1958) and cytoplasmic changes during reproduction. *Mar Micropaleontol* 1:287–297
- Anderson OR (1983) The radiolarian symbiosis. In: Goff L (ed) *Algal symbiosis: a continuum of interaction strategies*. Cambridge University Press, Cambridge, p 69–89
- Anderson OR, Bennett P, Angel D, Bryan M (1989) Experimental and observational studies of radiolarian physiological ecology: 2. Trophic activity and symbiont primary productivity of *Spongaster tetras tetras* with comparative data on predatory activity of some *Nassellarida*. *Mar Micropaleontol* 14:267–273
- Anderson OR, Langdon C, Danelian T (1998) Fine structure of a large dinoflagellate symbiont associated with a colonial radiolarian (*Collozoum* sp.) in the Banda Sea. *Symbiosis* 24:259–269
- Anderson OR, Matsuoka A (1992) Endocyttoplasmic microalgae and bacteroids within the central capsule of the radiolarian *Dictyocoryne truncatum*. *Symbiosis* 12:237–247
- Anderson OR, Swanberg NR, Bennett P (1985) Laboratory studies of the ecological significance of host-algal nutritional associations in solitary and colonial Radiolaria. *J Mar Biol Assoc UK* 65:263–272
- Anderson OR, Swanberg NR, Lindsey JL, Bennett P (1986) Functional morphology and species characteristics of a

- large, solitary radiolarian *Physematium muelleri*. Biol Bull 171:175–187
- Auer B, Czioska E, Arndt H (2004) The pelagic community of a gravel pit lake: Significance of *Coleps hirtus viridis* (Prostomatida) and its role as a scavenger. Limnologica 34:187–198
- Bé AWH, Hemleben C, Anderson OR, Spindler M, Hacunda J, Tuntivate-Choy S (1977) Laboratory and field observations of living planktonic foraminifera. Micropaleontology 23:155–179
- Beaver JR, Crisman TL (1989a) Analysis of the community structure of planktonic ciliated protozoa relative to trophic state in Florida Lakes. Hydrobiologia 174:177–184
- Beaver JR, Crisman TL (1989b) The role of ciliated Protozoa in pelagic fresh-water ecosystems. Microb Ecol 17: 111–136
- Beaver JR, Crisman TL, Bienert RW (1988) Distribution of planktonic ciliates in highly colored sub-tropical lakes—comparison with clearwater ciliate communities and the contribution of mixotrophic taxa to total autotrophic biomass. Freshwat Biol 20:51–60
- Bernard C, Fenchel T (1994) Chemosensory behavior of *Strombidium purpureum*, an anaerobic oligotrich with endosymbiotic purple nonsulfur bacteria. J Eukaryot Microbiol 41:391–396
- Bernard C, Rassoulzadegan F (1994) Seasonal-variations of mixotrophic ciliates in the Northwest Mediterranean Sea. Mar Ecol Prog Ser 108:295–301
- Bernhard JM (2003) Potential symbionts in bathyal foraminifera. Science 299:861
- Bernhard JM, Buck KR, Barry JP (2001) Monterey Bay cold-seep biota: assemblages, abundance, and ultrastructure of living foraminifera. Deep-Sea Res PT 1 48:2233–2249
- Berninger UG, Finlay BJ, Canter HM (1986) The spatial-distribution and ecology of zoochlorellae-bearing ciliates in a productive pond. J Protozool 33:557–563
- Bienert RW, Beaver JR, Crisman TL (1991) The contribution of ciliated protozoa to zooplankton biomass in an acidic, Subtropical Lake. J Protozool 38:352–354
- Blackbourn DJ, Taylor F, Blackburn J (1973) Foreign organelle retention by ciliates. J Protozool, 20: 286–288
- Cachon M, Caram B (1979) Symbiotic green-alga, *Pedinomonas symbiotica* sp-nov (Prasinophyceae), in the radiolarian *Thalassolampe margarodes*. Phycologia 18: 177–184
- Carvalho WF, Minnhagen S, Graneli E (2008) *Dinophysis norvegica* (Dinophyceae), more a predator than a producer? Harmful Algae 7:174–183
- Correia MJ, Lee JJ (2002) Fine structure of the plastids retained by the foraminifer *Elphidium excavatum* (Terquem). Symbiosis 32:27–38
- Cotter TL, Hallock P (1988) Test surface degradation in *Archaias Angulatus*. J Foraminifer Res 18:187–202
- Crawford DW (1989) *Mesodinium rubrum*: the phytoplankton that wasn't. Mar Ecol Prog Ser 58:161–174
- Dale T, Dahl E (1987a) Mass occurrence of planktonic oligotrichous ciliates in a bay in southern Norway. J Plankton Res 9:871–879
- Dolan JR (1992) trophic in ciliates: a review of *Chlorella* symbiosis and chloroplast retention. Mar Microb Food Webs 6:115–132
- Dolven JK, Lindqvist C, Albert VA, Bjorklund KR, Yuasa T, Takahashi O, Mayama S (2007) Molecular diversity of alveolates associated with neritic north Atlantic Radiolarians. Protist 158:65–76
- Eriksen NT, Hayes KC, Lewitus AJ (2002) Growth responses of the mixotrophic dinoflagellates, *Cryptoperidiniopsis* sp. and *Pfiesteria piscicida*, to light under prey-saturated conditions. Harmful Algae 1:191–203
- Esteve I, Mir J, Gaju N, Mckhann HI, Margulis L (1988) Green endosymbiont of *Coleps* from Lake Ciso identified as *Chlorella vulgaris*. Symbiosis 6:197–210
- Faber WW, Anderson OR, Lindsey JL, Caron DA (1988) Algal-foraminiferal symbiosis in the planktonic foraminifer *Globigerinella aequilateralis*. 1. Occurrence and stability of 2 mutually exclusive chrysophyte endosymbionts and their ultrastructure. J Foraminifer Res 18:334–343
- Faure-Fremiet E (1948) Le rythme de marée du *Strombidium oculatum* Gruber. Bull Biol France-Belgique 82:3–23
- Febvre J, Febvre-Chevalier C (1979) Ultrastructural study of zooxanthellae of three species of *Acantharia* (Protozoa: Actinopoda), with details of their taxonomic position in the Prymnesiales (Prymnesiophyceae Hibberd, 1976). J Mar Biol Assoc UK 59:215–226
- Fenchel T, Bernard C (1993) Endosymbiotic purple nonsulfur bacteria in an anaerobic ciliated protozoan. FEMS Microbiol Lett 110:21–25
- Fields SD, Rhodes RG (1991) Ingestion and retention of *Chroomonas* spp. (Cryptophyceae) by *Gymnodinium acidotum* (Dinophyceae). J Phycol 27:525–529
- Finlay BJ, Berninger UG, Stewart LJ, Hindle RM, Davison W (1987) Some factors controlling the distribution of 2 pond-dwelling ciliates with algal symbionts (*Frontonia vernalis* and *Euplotes daidaleos*). J Protozool 34:349–356
- Finlay BJ, Clarke KJ, Cowling AJ, Hindle RM, Rogerson A, Berninger UG (1988) On the abundance and distribution of protozoa and their food in a productive fresh water pond. Eur J Protistol 23:205–217
- Foissner W, Berger H, Schaumburg J (1999) Identification and ecology of limnetic plankton ciliates. Bavarian State Office for Water Management, Munich
- Gast RJ, Caron DA (2001) Photosymbiotic associations in planktonic foraminifera and radiolaria. Hydrobiologia 461:1–7
- Gast RJ, McDonnell TA, Caron DA (2000) srDNA-based taxonomic affinities of algal symbionts from a planktonic foraminifer and a solitary radiolarian. J Phycol 36:172–177
- Gast RJ, Moran DM, Dennett MR, Caron DA (2007) Kleptoplasty in an Antarctic dinoflagellate: caught in evolutionary transition? Environ Microbiol 9:39–45
- Gustafson DE, Stoecker DK, Johnson MD, Van Heukelem WF, Sneider K (2000) Cryptophyte algae are robbed of their organelles by the marine ciliate *Mesodinium rubrum*. Nature 405:1049–1052
- Hansen PJ, Fenchel T (2006) The bloom-forming ciliate *Mesodinium rubrum* harbours a single permanent endosymbiont. Mar Biol Res 2:169–177
- Hecky RE, Kling HJ (1981) The phytoplankton and proto-zooplankton of the euphotic zone of Lake Tanganyika — species composition, biomass, chlorophyll content, and spatio-temporal distribution. Limnol Oceanogr 26:548–564
- Hibberd DJ (1977) Ultrastructure of the cryptomonad endosymbiont of the red-water ciliate *Mesodinium rubrum*. J Mar Biol Assoc UK 57:45–61
- Holen DA (2000) The relative abundance of mixotrophic and heterotrophic ciliates in an oligotrophic lake. Archiv Hydrobiologie 150:1–15
- Horiguchi T, Chihara M (1993) Life cycle and ultrastructure of *Dinotrix paradoxa* (Dinophyceae) The 15th International Botanical Congress, Yokohama, p 216
- Horiguchi T, Pienaar RN (1991) Ultrastructure of a marine dinoflagellate, *Peridinium quinquecorne* Abe (Peridinales) from South Africa with particular reference to Its Chrysophyte endosymbiont. Bot Mar 34:123–131

- Horiguchi T, Pienaar RN (1992) *Amphidinium latum* Lebour (Dinophyceae), a sand-dwelling dinoflagellate feeding on cryptomonads. JPN J Phycol 40:353–363
- Jakobsen HH, Hansen PJ, Larsen J (2000) Growth and grazing responses of two chloroplast-retaining dinoflagellates: effect of irradiance and prey species. Mar Ecol Prog Ser 201:121–128
- Johnson MD, Oldach D, Delwiche CF, Stoecker DK (2007) Retention of transcriptionally active cryptophyte nuclei by the ciliate *Myrionecta rubra*. Nature 445:426–428
- Johnson MD, Stoecker DK (2005) Role of feeding in growth and photophysiology of *Myrionecta rubra*. Aquat Microb Ecol 39:303–312
- Johnson MD, Tengs T, Oldach D, Stoecker DK (2006) Sequestration, performance, and functional control of cryptophyte plastids in the ciliate *Myrionecta rubra* (Ciliophora). J Phycol 42:1235–1246
- Johnson PW, Donaghy PL, Small EB, Sieburth JM (1995) Ultrastructure and ecology of *Perispira ovum* (Ciliophora, Litostomatea)—an aerobic, planktonic ciliate that sequesters the chloroplasts, mitochondria, and paramylon of *Euglena proxima* in a micro-oxic habitat. J Eukaryot Microbiol 42:323–335
- Jonsson PR (1987) Photosynthetic assimilation of inorganic carbon in marine oligotrich ciliates (Ciliophora, Oligotrichina). Mar Microb Food Webs, 2:55–68
- Jonsson PR (1994) Tidal rhythm of cyst formation in the rock pool ciliate *Strombidium oculatum* Gruber (Ciliophora, Oligotrichida)—a description of the functional biology and an analysis of the tidal dynchronization of encystment. J Exp Mar Biol Ecol 175:77–103
- Karpov AS, Goodkov AV, Marinich MA (1991) The variety of algae-bearing invertebrates from inner lakes of the Valamo Island. Zoologicheskyy Zhurnal 70:5–11
- Kimor B, Gordon N, Neori A (1992) Symbiotic associations among the microplankton in oligotrophic marine environments, with special reference to the Gulf of Aqaba, Red-Sea. J Plankton Res 14:1217–1231
- Koike K, Sekiguchi H, Kobiyama A, Takishita K, Kawachi M, Ogata T (2005) A novel type of kleptoplastidy in Dinophysis (Dinophyceae): presence of haptophyte-type plastid in *Dinophysys mitra*. Protist 156:225–237
- Koike K, Takishita K (2008) Anucleated cryptophyte vestiges in the gonyaulacalean dinoflagellates *Amylax buxus* and *Amylax triacantha* (Dinophyceae). Phycol Res 56:301–311
- Krainer KH, Foissner W (1990) Revision of the genus *Askenasia* Blochmann, 1895, with proposal of two new species, and description of *Rhabdoaskenasia minima* n.g., n.sp. (Ciliophora, Cyclotrichida). J Protozool, vol 37:414–427
- Larsen J (1988) An ultrastructural-study of *Amphidinium poecilochroum* (Dinophyceae), a phagotrophic dinoflagellate feeding on small species of Cryptophytes. Phycologia 27:366–377
- Laval-Peuto M, Febvre MM (1986) On plastid symbiosis in *Tontonia appendiculariformis*. BioSyst 19:137–157
- Laval-Peuto M, Rassoulzadegan F (1988) Autofluorescence of marine planktonic oligotrichina and other ciliates. Hydrobiologia 159:99–110
- Laval-Peuto M, Salvano P, Gayol P, Greuet C (1986) Mixotrophy in marine planktonic ciliates: ultrastructural study of *Tontonia appendiculariformis* (Ciliophora, Oligotrichina). Mar Microb Food Webs, vol 1:81–104
- Laybourn-Parry J, Marchant HJ (1992) The microbial plankton of fresh-water lakes in the Vestfold Hills, Antarctica. Polar Biol 12:405–410
- Laybourn-Parry J, Perriss SJ, Seaton GGR, Rohozinski J (1997) A mixotrophic ciliate as a major contributor to plankton photosynthesis in Australian lakes. Limnol Oceanogr 42:1463–1467
- Lee JJ (1990) Fine structure of the rhodophycean of *porphyridium purpureum* in situ in *Peneropolis pertusus* (Forsk.) and *P. acicularis* (Batsch) and in axenic culture. J Foraminifer Res 20:162–169
- Lee JJ, Morales J, Bacus S, Diamont A, Hallock P, Pawlowski J, Thorpe J (1997) Progress in characterizing the endosymbiotic dinoflagellates of soritid foraminifera and related studies on some stages of the life cycle of *Marginopora vertebralis*. J Foraminifer Res 27:254–263
- Lee MJ, Ellis R, Lee JJ (1982) A comparative study of photoadaptation in four diatoms isolated as endosymbionts from larger foraminifera. Mar Biol 68:193–197
- Levinsen H, Nielsen TG (2002) The trophic role of marine pelagic ciliates and heterotrophic dinoflagellates in arctic and temperate coastal ecosystems: a cross-latitude comparison. Limnol Oceanogr 47:427–439
- Lewitus AJ, Glasgow HB, Burkholder JM (1999) Kleptoplastidy in the toxic dinoflagellate *Pfiesteria piscicida* (Dinophyceae). J Phycol 35:303–312
- Lin SJ, Mulholland MR, Zhang H, Feinstein TN, Jochem FJ, Carpenter EJ (2004) Intense grazing and prey-dependent growth of *Pfiesteria piscicida* (Dinophyceae). J Phycol 40:1062–1073
- Lindholm T (1985) *Mesodinium rubrum*- a unique photosynthetic ciliate. Adv Aquat Microb 3:1–48
- Lobban CS, Modeo L, Verni F, Rosati G (2005) *Euplotes uncinatus* (Ciliophora, Hypotrichia), a new species with zooxanthellae. Mar Biol 147:1055–1061
- Lobban CS, Scheffer M, Simpson AGB, Pochon X, Pawlowski J, Foissner W (2002) *Maristentor dinoferus* n. gen., n. sp., a giant heterotrich ciliate (Spirotrichea: Heterotrichida) with zooxanthellae, from coral reefs on Guam, Mariana Islands (vol 140, pg 411, 2002). Mar Biol 141:207–208
- Macek M, Callieri C, Simek K, Vazquez AL (2006) Seasonal dynamics, composition and feeding patterns of ciliate assemblages in oligotrophic lakes covering a wide pH range. Archiv Fur Hydrobiologie 166:261–287
- Macek M, Pestova D, Perez MEM (2008) Seasonal and spatial dynamics of a ciliate assemblage in a warm-monomictic Lake Alchichica (Puebla, Mexico). Hidrobiologica 18: 25–35
- Macek M, Simek K, Bittl T (2001) Conspicuous peak of oligotrichous ciliates following winter stratification in a bog lake. J Plankton Res 23:353–363
- Macek M, Simek K, Pernthaler J, Vyhnaek V, Psenner R (1996) Growth rates of dominant planktonic ciliates in two freshwater bodies of different trophic degree. J Plankton Res 18:463–481
- Macek M, Vilaclara G, Lugo A (1994) Changes in protozoan assemblage structure and activity in a stratified tropical lake. Marine Microbial Food Webs 8:235–249
- McManus GB, Fuhrman JA (1986) Photosynthetic pigments in the ciliate *Laboea strobila* from Long Island Sound, USA. J Plankton Res 8:317–327
- McManus GB, Zhang H, Lin SJ (2004) Marine planktonic ciliates that prey on macroalgae and enslave their chloroplasts. Limnol Oceanogr 49:308–313
- Modenutti BE, Balseiro EG (2002) Mixotrophic ciliates in an Andean lake: dependence on light and prey of an *Ophrydium naumanni* population. Freshwat Biol 47:121–128
- Modenutti BE, Balseiro EG, Callieri C, Bertoni R, Queimalinos CP (2005) Effect of UV-B and different PAR intensities on the primary production of the mixotrophic planktonic ciliate *Stentor araucanus*. Limnol Oceanogr 50: 864–871

- Modigh M (2001) Seasonal variations of photosynthetic ciliates at a Mediterranean coastal site. *Aquat Microb Ecol* 23:163–175
- Montagnes DJS, Allen J, Brown L, Bulit C, Davidson R, Diaz-Avalos C, Fielding S, Heath M, Holliday NP, Rasmussen J, Sanders R, Waniek JJ, Wilson D (2008) factors controlling the abundance and Size distribution of the phototrophic ciliate *Myrionecta rubra* in open waters of the North Atlantic. *J Eukaryot Microbiol* 55:457–465
- Montagnes DJS, Lynn DH, Roff JC, Taylor WD (1988) The annual cycle of heterotrophic planktonic ciliates in the waters surrounding the Isles of Shoals, Gulf of Maine: an assessment of their trophic role. *Marine biology Berlin, Heidelberg* 99, no. 1:21–30
- Müller H, Schone A, Pintocoelho RM, Schweizer A, Weisse T (1991) Seasonal succession of ciliates in Lake Constance. *Microb Ecol* 21:119–138
- Nagai S, Nitshitani G, Tomaru Y, Sakiyama S, Kamiyama T (2008) Predation by the toxic dinoflagellate *Dinophysis fortii* on the ciliate *Myrionecta rubra* and observation of sequestration of ciliate chloroplasts. *J Phycol* 44:909–922
- Nishitani G, Nagai S, Takano Y, Sakiyama S, Baba K, Kamiyama T (2008) Growth characteristics and phylogenetic analysis of the marine dinoflagellate *Dinophysis infundibulus* (Dinophyceae). *Aquat Microb Ecol* 52: 209–221
- Oakley BR, Taylor FJR (1978) Evidence for a new type of endosymbiotic organization in a population of the ciliate *Mesodinium rubrum* from British Columbia. *BioSyst* 10:361–369
- Ota T, Taniguchi A (2003) Standing crop of planktonic ciliates in the East China Sea and their potential grazing impact and contribution to nutrient regeneration. *Deep-Sea Res Part 2* 50:423–442
- Pace ML (1982) Planktonic ciliates — their distribution, abundance, and relationship to microbial resources in a monomictic lake. *Can J Fish Aquat Sci* 39:1106–1116
- Park JS, Myung G, Kim HS, Cho BC, Yih W (2007) Growth responses of the marine photosynthetic ciliate *Myrionecta rubra* to different cryptomonad strains. *Aquat Microb Ecol* 48:83–90
- Park MG, Kim S, Kim HS, Myung G, Kang YG, Yih W (2006) First successful culture of the marine dinoflagellate *Dinophysis acuminata*. *Aquat Microb Ecol* 45:101–106
- Park MG, Park JS, Kim M, Yih W (2008) Plastid dynamics during survival of *Dinophysis caudata* without its ciliate prey. *J Phycol* 44:1154–1163
- Pawlowski J, Holzmann M, Fahrni JF, Hallock P (2001a) Molecular identification of algal endosymbionts in large miliolid foraminifera: 1. Chlorophytes. *J Eukaryot Microbiol* 48:362–367
- Pawlowski J, Holzmann M, Fahrni JF, Pochon X, Lee JJ (2001b) Molecular identification of algal endosymbionts in large miliolid foraminifera: 2. Dinoflagellates. *J Eukaryot Microbiol* 48:368–373
- Perriss SJ, Laybournparry J, Jones RI (1994) Chlorophyll contents and photosynthetic rates of the fresh-water mixotrophic ciliate *Strombidium viride* (Ciliophora, Oligotrichida). *Archiv Fur Hydrobiologie* 130:473–483
- Peštová D, Macek M, Perez MEM (2008) Ciliates and their picophytoplankton-feeding activity in a high-altitude warm-monomictic saline lake. *Eur J Protistol* 44:13–25
- Petz W (1994) Morphology and morphogenesis of *Strombidium kryalis* nov spec (Ciliophora, Strombidiida) from Antarctic Sea-Ice. *Archiv Fur Protistenkunde* 144:185–195
- Pienaar RN, Sakai H, Horiguchi T (2007) Description of a new dinoflagellate with a diatom endosymbiont, *Durinskia capensis* sp. nov (Peridinales, Dinophyceae) from South Africa. *J Plant Res* 120:247–258
- Queimalinos CP, Modenutti BE, Balseiro EG (1999) Symbiotic association of the ciliate *Ophrydium naumanni* with *Chlorella* causing a deep chlorophyll a maximum in an oligotrophic South Andes lake. *J Plankton Res* 21:167–178
- Reid PC (1987) Mass encystment of a planktonic oligotrich ciliate. *Mar Biol* 95:221–230
- Reisser W (1986) Endosymbiotic associations of freshwater protozoa and algae. *Prog Protist* 1:195–214
- Reisser W, Kurmeier B (1984) The endosymbiotic unit of *Climacostomum virens* and *Chlorella* sp. symbiotic features of the association and host-symbiont regulatory mechanisms. *Protistologica* 20:265–270
- Rivkin RB, Lessard EJ (1986) Photoadaptation of photosynthetic carbon uptake by solitary Radiolaria: comparisons with free-living phytoplankton. *Deep-Sea Research* 33:1025–1038
- Rogerson A, Finlay BJ, Berninger UG (1989) Sequestered chloroplasts in the fresh-water ciliate *Strombidium viride* (Ciliophora, Oligotrichida). *T Am Microsc Soc* 108: 117–126
- Schweiker M, Elbrächter M (2004) First ultrastructural investigations of the consortium between a phototrophic eukaryotic endocytobiont and *Podolampas bipes* (Dinophyceae). *Phycologia* 43:614–623
- Shaked Y, de Vargas C (2006) Pelagic photosynthesis: rDNA assessment of diversity and evolution of dinoflagellates symbionts and planktonic foraminiferal hosts. *Mar Ecol Prog Ser* 325:59–71
- Sime-Ngando T, Juniper K, Vezina A (1992) Ciliated protozoan communities over Cobb Seamount — increase in biomass and spatial patchiness. *Mar Ecol Prog Ser* 89:37–51
- Simek K, Macek M, Perntaler J, Straskrabova V, Psenner R (1996) Can freshwater planktonic ciliates survive on a diet of picoplankton? *J Plankton Res* 18:597–613
- Skovgaard A (1998) Role of chloroplast retention in a marine dinoflagellate. *Aquat Microb Ecol* 15:293–301
- Skovgaard A, Legerand C (2005) Observation of live specimens of *Pseudotontonia cornuta* (Ciliophora: Oligotrichida) reveals new distinctive characters. *J Mar Biol Assoc UK* 85:783–786
- Smith M, Hansen PJ (2007) Interaction between *Mesodinium rubrum* and its prey: importance of prey concentration, irradiance and pH. *Mar Ecol Prog Ser* 338:61–70
- Sonntag B, Posch T, Klammer S, Teubner K, Psenner R (2006) Phagotrophic ciliates and flagellates in an oligotrophic, deep, alpine lake: contrasting variability with seasons and depths. *Aquat Microb Ecol* 43:193–207
- Stabell T, Andersen T, Klaveness D (2002) Ecological significance of endosymbionts in a mixotrophic ciliate — an experimental test of a simple model of growth coordination between host and symbiont. *J Plankton Res* 24: 889–899
- Stoecker DK, Michaels AE, Davis LH (1987) Large proportion of marine planktonic ciliates found to contain functional chloroplasts. *Nature* 326:790–792
- Stoecker DK, Putt M, Davis LH, Michaels AE (1991) Photosynthesis in *Mesodinium rubrum*: species-specific measurements and comparison to community rates. *Mar Ecol Prog Ser* 73:245–252
- Stoecker DK, Putt M, Moisan T (1995) Nanoplankton and microplankton dynamics during the spring *Phaeocystis* sp. bloom in Mcmurdo Sound, Antarctica. *J Mar Biol Assoc UK* 75:815–832
- Stoecker DK, Silver MW (1990) Replacement and aging of chloroplasts in *Strombidium capitatum* (Ciliophora, Oligotrichida). *Mar Biol* 107:491–502

- Stoecker DK, Silver MW, Michaels AE, Davis LH (1988) Obligate mixotrophy in *Laboea strobila*, a ciliate which retains chloroplasts. *Mar Biol* 99:415–423
- Stoecker DK, Silver MW, Michaels AE, Davis LH (1988-1989) Enslavement of algal chloroplasts by four *Strombidium* spp. (Ciliophora, Oligotrichida). *Mar Microb Food Webs* 3: 79–100
- Sugiyama K, Anderson OR (1997) Experimental and observational studies of radiolarian physiological ecology, 6. Effects of silicate-supplemented seawater on the longevity and weight gain of spongioid radiolarians *Spongaster tetras* and *Dictyocoryne truncatum*. *Mar Micropaleontol* 29:159–172
- Sugiyama K, Anderson OR (1998) Cytoplasmic organization and symbiotic associations of *Didymocystis tetrathalamus* (Haeckel) (Spumellaria, Radiolaria). *Micropaleontology* 44:277–289
- Swanberg NR (1983) The trophic role of colonial radiolaria in oligotrophic oceanic environments. *Limnol Oceanogr* 28: 655–666
- Swanberg NR, Anderson OR (1981) *Collozoum caudatum* sp. nov.: a giant colonial radiolarian from equatorial and Gulf Stream waters. *Deep-Sea Research* 28A:1033–1047
- Sweeney BM (1978) Ultrastructure of *Noctiluca millaris* (Pyrrophyta) with green flagellate symbionts. *J Phycol* 14:116–120
- Tagle HK, Williams DE, Hallock P, Harney JN (1997) Symbiont loss in reef foraminifera: consequences for affected populations. In: Lessios HA, Macintyre IG (eds) Proceedings 8th International Coral Reef Symposium, Panama, p 589–594
- Takahashi O, Mayama S, Matsuoka A (2003) Host-symbiont associations of polycystine Radiolaria: epifluorescence microscopic observation of living Radiolaria. *Mar Micropaleontol* 49:187–194
- Tamura M, Shimada S, Horiguchi T (2005) *Galeidinium rugatum* gen. et sp. nov. (Dinophyceae), a new coccoid dinoflagellate with a diatom endosymbiont. *J Phycol* 41: 658–671
- Taylor FJR (1982) Symbioses in marine microplankton. *Annales De l'Institut Oceanographique* 58:61–90
- Taylor FJR (1990) Symbiosis in marine Protozoa. In: Capriulo GM (ed) The ecology of marine protozoa. Oxford University Press, New York, p 323–340
- Taylor FJR, Blackboun DJ, Blackboun J (1971) Red-water ciliate *Mesodinium rubrum* and its incomplete-symbionts review including new ultrastructural observations. *J Fish Res Board of Can* 28:391–407
- Tomas RN, Cox ER (1973) Observations on the symbiosis of *Peridinium balticum* and its intracellular algae. I. Ultrastructure. *J Phycol* 9:304–323
- Wilcox LW, Wedemayer GJ (1985) Dinoflagellate with blue-green chloroplasts derived from an endosymbiotic eukaryote. *Science* 227:192–194
- Woelfl S, Geller W (2002) Chlorella-bearing ciliates dominate in an oligotrophic North Patagonian lake (Lake Pirehuelico, Chile): abundance, biomass and symbiotic photosynthesis. *Freshwat Biol* 47:231–242
- Yih W, Kim HS, Jeong HA, Myung G, Kim YG (2004) Ingestion of cryptophyte cells by the marine photosynthetic ciliate *Mesodinium rubrum*. *Aquat Microb Ecol* 36: 165–170
- Zettler LA, Anderson OR, Caron DA (1998) Insights on the diversity within a 'species' of *Thalassicolla* (Spumellarida) based on 16S-like ribosomal RNA gene sequencing. *J Eukaryot Microbiol* 45:488–496
- Zingel P, Ott I (2000) Vertical distribution of planktonic ciliates in strongly stratified temperate lakes. *Hydrobiologia* 435:19–26