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## A revised checklist of planktonic diatoms and dinoflagellates from Helgoland (North Sea, German Bight)

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**Abstract** A checklist based on net samples taken twice weekly from 2001 until May 2003 is presented. Identification is based on observations under direct light microscopy and after taking some organisms in culture. The checklist includes 227 taxa observed at the Helgoland Reede sampling station. One hundred and thirty-two species of diatoms from 53 genera and 95 species of dinoflagellates from 35 genera have been recorded from net samples and cultures. Thirty-five diatom and 28 dinoflagellate taxa were documented in the Helgoland phytoplankton for the first time. The list does not claim to be complete, but provides an updated list of the taxa found at Helgoland and, for convenience, also includes data published for different adjacent areas.

**Keywords** Diatoms · Dinoflagellates · Species list · Helgoland Reede

### Introduction

Phytoplankton species composition and physico-chemical parameters have been recorded in the framework of a time series at Helgoland since 1962 (Hagmeier et al. 2004; Van Beusekom et al. 2004; Wiltshire and Dürselen 2004; Wiltshire et al. 2004). The Helgoland Reede station is sampled daily on weekdays. Water-bottle samples were fixed and phytoplankton taxa counted mainly for the estimation of the carbon content (quantification for the determination of biomass).

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Since the species survey by Drebes from 1966 to 1971 (Drebes 1974), there has been no continuous species composition record from net samples. For that reason there was no actual data set covering microphytoplankton species diversity. This knowledge is not only important for getting an idea about the percentage of species diversity coverage that is recorded in the Helgoland timeseries, but also because there are continuous species composition records for the Wadden Sea phytoplankton at Sylt, Germany. The data presented here are the first results of an intensive taxonomic phytoplankton reinvestigation. They could be used as a basis for phytoplankton count quality control and for the start of a continuous detailed species recording in the framework of the Helgoland time series. Since the publication of the 1976 list (Drebes and Elbrächter 1976), nomenclatural changes have been sufficiently numerous to warrant the present list, incorporating additions, synonyms and corrections. Only those species that have been personally observed by the author and/or by Drebes (Drebes 1974; Drebes and Elbrächter 1976) are listed. It is an addition to the checklist of benthic species found in the vicinity of the island of Helgoland (Harms 1993).

### Methods

Net samples from the surface water of the Helgoland Reede station (54°11.30'N 7°54.00'E) were collected twice a week from 2001 until May 2003 for qualitative species identification (in addition to the routine water-bottle samples for biomass determination). Nets of different mesh size, 20 µm and 80 µm, were used. The samples were brought to the laboratory and living organisms in small Petri dishes were identified using an inverted light microscope equipped with seawater-immersion objectives for about half a day. All species observed and identified were listed. Additionally, diatom cells were isolated and cultured and some samples were fixed with Lugol's solution, for further investigations

**Table 1** Checklist of marine phytoplankton, diatoms and dinoflagellates from Helgoland and other North Sea areas. 1 Hoppenrath, present study; 2 Drebes (1974); 3 Drebes and Elbrächter (1976); 4 Parke and Dixon (1976; coasts of Britain and Ireland and adjacent waters); 5 Hendey (1974; British marine diatoms); 6 Hartley (1986; marine diatoms of the British Isles and adjoining coastal waters);

7 Heimdal et al. (1973; Oslofjord, Norway); 8 Kuylenstierna and Karlson (2000; Skagerrak and Kattegat, Sweden); 9 Hansen and Larsen (1992; Kattegat, Denmark); 10 Leewis (1985; Dutch coast); 11 Pankow (1990; Baltic Sea); 12 Hällfors (Baltic Sea); *t* potentially toxic species

Species	Listed in:											
	1	2	3	4	5	6	7	8	9	10	11	12
<b>Bacillariophyceae</b>												
<i>Achnanthes longipes</i> Agardh	+		+		+	+	+				+	+
<i>Actinocyclus curvatulus</i> Janisch (syn. <i>Coscinodiscus curvatulus</i> )	+				?			+				
<i>Actinocyclus octonarius</i> Ehrenberg (syn. <i>Actinocyclus ehrenbergii</i> )	+	+	+		+	+		+			+	+
<i>Actinoptychus senarius</i> (Ehrenberg) Ehrenberg (syn. <i>Actinoptychus undulatus</i> )	+	+	+		+	+		+		+	+	+
<i>Actinoptychus splendens</i> (Shadbbolt) Ralfs	+	+	+		+	+				+		+
<i>Asterionellopsis glacialis</i> (Castracane) Round (syn. <i>Asterionella glacialis</i> , <i>Asterionella japonica</i> )	+	+	+		+	+	+	+		+	+	+
<i>Asteroplanus karianus</i> (Grunow) Crawford (syn. <i>Asterionella karianus</i> )	+	+	+		+	+		+		+		+
<i>Aulacodiscus argus</i> (Ehrenberg) Schmidt	+	+	+		+	+				+		+
<i>Bacillaria paxillifer</i> (O.F. Müller) Hendey (syn. <i>Bacillaria paradoxa</i> )	+	+			+	+	+			+	+	+
<i>Bacteriastrium hyalinum</i> Lauder	+	+	+		+	+		+		+		+
<i>Bellerochea malleus</i> (Brightwell) van Heurck (syn. <i>Triceratium malleus</i> )	+	+	+		+	+				+		+
<i>Biddulphia alternans</i> (Bailey) van Heurck (syn. <i>Triceratium alternans</i> )	+	+	+		+	+				+		+
<i>Brockmanniella brockmannii</i> (Hustedt) Hasle et al. (syn. <i>Plagiogramma brockmannii</i> )	+	+	+		+	+				+		+
<i>Campylosira cymbelliformis</i> Van Heurck			+			+						
<i>Calyptrella robusta</i> (Norman) Hernández-Becerril et Meave (syn. <i>Rhizosolenia robusta</i> )	+	+	+		+	+				+		+
<i>Catenula adhaerens</i> (Mereschkowsky) Mereschkowsky	+				+	+					+	+
<i>Cerataulina pelagica</i> (Cleve) Hendey (syn. <i>Cerataulina bergonii</i> )	+	+	+		+	+	+	+		+	+	+
<i>Cerataulus radiatus</i> (Roper) Ross (syn. <i>Cerataulus smithii</i> )	+	+	+		+	+				+		+
<i>Chaetoceros affinis</i> Lauder	+	+	+			+	+	+			+	+
<i>Chaetoceros borealis</i> Bailey	+	+	+		+	+	+	+		+	+	+
<i>Chaetoceros compressus</i> Lauder <sup>a</sup>	cf+	+	+		+	+	+	+		+	+	+
<i>Chaetoceros convolutus</i> Castracane			+		+	+	+	+				+
<i>Chaetoceros coronatus</i> Gran			+		+	+		+			+	+
<i>Chaetoceros costatus</i> Gran	+	+	+		+	+		+				+
<i>Chaetoceros crinitus</i> Schütt	cf+	+	+		+	+					+	+
<i>Chaetoceros curvisetus</i> Cleve	+	+	+		+		+	+		+	+	+
<i>Chaetoceros danicus</i> Cleve	+	+	+		+	+	+	+		+	+	+
<i>Chaetoceros debilis</i> Cleve	+	+	+		+	+	+	+		+	+	+
<i>Chaetoceros decipiens</i> Cleve	+	+	+		+	+	+	+		+	+	+
<i>Chaetoceros densus</i> (Cleve) Cleve	+	+	+		+	+	+	+		+	+	+
<i>Chaetoceros diadema</i> (Ehrenberg) Gran (syn. <i>Chaetoceros subsecundus</i> )	+	+	+		+	+		+			+	+
<i>Chaetoceros didymus</i> Ehrenberg	+	+	+		+	+	+	+		+	+	+
<i>Chaetoceros eibenii</i> Grunow	+	+	+		+	+		+		+	+	+
<i>Chaetoceros externus</i> Gran			+		+	+						+
<i>Chaetoceros lauderi</i> Ralfs	+	+	+		+	+	+	+			+	+
<i>Chaetoceros protuberans</i> Lauder	+	+	+									+
<i>Chaetoceros radicans</i> Schütt	+	+	+			+	+	+				+
<i>Chaetoceros similis</i> Cleve	+				+	+	+	+			+	+
<i>Chaetoceros simplex</i> Ostenfeld	+				+	+	+	+		+	+	+
<i>Chaetoceros socialis</i> Lauder	+	+	+		+	+	+	+		+	+	+
<i>Chaetoceros subtilis</i> Cleve	+				+	+	+	+		+	+	+
<i>Chaetoceros teres</i> Cleve	+	+	+		+	+	+	+		+	+	+
<i>Chaetoceros tortissimus</i> Gran	+	+	+		+	+		+		+		+
<i>Chaetoceros willei</i> Gran <sup>b</sup>		+	+		+	+						+
<i>Corethron hystrix</i> Hensen	+				+	+	+	cf+		+		

Table 1 (Contd.)

Species	Listed in:											
	1	2	3	4	5	6	7	8	9	10	11	12
<i>Coscinodiscus commutatus</i> Grunow (today: <i>Coscinodiscus centralis</i> Ehrenberg?) <sup>c</sup>	+	+	+			?	?	?		?	+	+
<i>Coscinodiscus concinnus</i> Smith	+	+	+		+	+	+	+		+	+	+
<i>Coscinodiscus granii</i> Gough	+	+	+		+	+	+	+			+	+
<i>Coscinodiscus pavillardii</i> Forti <sup>d</sup>	cf +	+	+			?						
<i>Coscinodiscus radiatus</i> Ehrenberg	+	+	+		+	+	+	+		+	+	+
<i>Coscinodiscus stellaris</i> Roper		+	+		+	+						+
<i>Coscinodiscus wailiesii</i> Gran et Angst <sup>e</sup>	+					+		+				+
<i>Cylindrotheca closterium</i> (Ehrenberg) Reimann et Lewin (syn. <i>Nitzschia closterium</i> )	+				+	+		+		?	+	+
<i>Delphineis surirella</i> (Ehrenberg) Andrews (syn. <i>Rhaphoneis surirella</i> )	+	+	+		+	+				+	+	
<i>Detonula confervacea</i> (Cleve) Gran	+	+	+		+	+	+	+		+	+	+
<i>Detonula pumila</i> (Castracane) Schütt (syn. <i>Schroederella pumila</i> , <i>Schroederella schroederi</i> )	+	+	+		?		+	+		+		+
<i>Ditylum brightwellii</i> (West) Grunow	+	+	+		+	+	+	+		+	+	+
<i>Eucampia zodiacus</i> Ehrenberg	+	+	+		+	+	+	+		+	+	+
<i>Eunotogramma dubium</i> Hustedt	+											
<i>Fragilaria islandica</i> Grunow		+	?+		+	+					+	
<i>Fragilaria oblonga</i> Drebes et Schulz	+											
<i>Grammatophora marina</i> (Lyngbye) Kützing	cf +				+	+					+	+
<i>Guinardia delicatula</i> (Cleve) Hasle (syn. <i>Rhizosolenia delicatula</i> )	+	+	+		+	+	+	+		+	+	+
<i>Guinardia flaccida</i> (Castracane) Peragallo	+	+	+		+	+	+	+		+	+	+
<i>Guinardia striata</i> (Stolterfoth) Hasle (syn. <i>Rhizosolenia stolterfothii</i> )	+	+	+		+	+	+	+		+	+	+
<i>Helicothe catamesis</i> (Shrubsole) Ricard (syn. <i>Streptothoe catamesis</i> )	+	+	+		+	+		+		+		+
<i>Lauderia annulata</i> Cleve (syn. <i>Lauderia borealis</i> )	+	+	+		+	+		+		+	+	+
<i>Leptocylindrus danicus</i> Cleve	+	+	+		+	+	+			+	+	+
<i>Leptocylindrus minimus</i> Gran	+	+	+		+	+		+		+	+	+
<i>Lithodesmium undulatum</i> Ehrenberg	+	+	+		+	+		+		+	+	+
<i>Melosira moniliformis</i> (O.F. Müller) Agardh (syn. <i>Melosira borneri</i> )	+	+	+		+	+	+			+	+	+
<i>Melosira nummuloides</i> (Dillwyn) Agardh	+	+	+		+	+	+			+	+	+
<i>Minidiscus trioculatus</i> (Taylor) Hasle (syn. <i>Coscinodiscus trioculatus</i> )	cf +					+		+				
<i>Nitzschia longissima</i> (Kützing) Grunow		+	+		+	+	+	+			+	+
<i>Odontella aurita</i> (Lyngbye) Agardh (syn. <i>Biddulphia aurita</i> )	+	+	+		+	+	+	+		+	+	+
<i>Odontella aurita</i> var. <i>minima</i> (Grunow) Drebes	+									+		
<i>Odontella granulata</i> (Roper) Ross (syn. <i>Biddulphia granulata</i> )	+	+	+		+	+						+
<i>Odontella mobiliensis</i> (Bailey) Grunow (syn. <i>Biddulphia mobiliensis</i> )	+	+	+		+	+		+		+	+	+
<i>Odontella obtusa</i> Kützing	cf +	+			+	+						?
<i>Odontella regia</i> (Schultze) Simonsen (syn. <i>Biddulphia regia</i> )	+	+	+		+	+		+		+		
<i>Odontella rhombus</i> (Ehrenberg) Kützing (syn. <i>Biddulphia rhombus</i> )	+	+	+		+	+				+		+
<i>Odontella rhombus</i> f. <i>trigona</i> (van Heurck) Ross	+	+			+	+						+
<i>Odontella sinensis</i> (Greville) Grunow (syn. <i>Biddulphia sinensis</i> ) <sup>f</sup>	+	+	+		+	+	+	+		+	+	+
<i>Paralia marina</i> (Smith) Heiberg (syn. <i>Paralia sulcata</i> )	+	+	+		+	+		+			+	+
<i>Plagiogrammopsis vanheurckii</i> (Grunow) Hasle et al. (syn. <i>Plagiogramma vanheurckii</i> )	+				+	+		+		+		
<i>Podosira stelliger</i> (Bailey) Mann (syn. <i>Hyalodiscus stelliger</i> )	+	+	+		+	+	+			+	+	+
<i>Porosira glacialis</i> (Grunow) Jörgensen (syn. <i>Lauderia glacialis</i> )	+	+	+		+	+	+	+		+		+
<i>Proboscia alata</i> (Brightwell) Sundström (syn. <i>Rhizosolenia alata</i> )	+	+	+		+	+	+	+			+	+
<i>Proboscia indica</i> (Peragallo) Drebes (syn. <i>Rhizosolenia indica</i> ) <sup>g</sup>	+	+	+			?						

Table 1 (Contd.)

Species	Listed in:											
	1	2	3	4	5	6	7	8	9	10	11	12
<i>Pseudo-nitzschia delicatissima</i> (Cleve) Heiden (syn. <i>Nitzschia delicatissima</i> ) t	cf+	+	+		+			+		+	+	+
<i>Pseudo-nitzschia fraudulentata</i> Cleve t	+							+				+
<i>Pseudo-nitzschia pungens</i> Grunow [= <i>Nitzschia "seriata"</i> in Drebes (1974)] t	+	+	+		+	+	?	+			+	+
<i>Pseudopodosira westii</i> (Smith) Sheshukova-Poretzkaya (syn. <i>Melosira westii</i> )	+				+	+				+		
<i>Rhaphoneis amphiceros</i> (Ehrenberg) Ehrenberg	+	+	+		+	+				+		
<i>Rhizosolenia hebetata</i> f. <i>semispina</i> (Hensen) Gran		+	+		+	+		+		+	+	+
<i>Rhizosolenia imbricata</i> Brightwell (syn. <i>Rhizosolenia shrubsolei</i> )	+	+	+		+	+	+	+		+		+
<i>Rhizosolenia pungens</i> Cleve-Euler	+	+	+					+		+		+
<i>Rhizosolenia setigera</i> Brightwell	+	+	+		+	+	+	+		+	+	+
<i>Rhizosolenia cf. similoides</i> Cleve-Euler	+											
<i>Rhizosolenia styliformis</i> Brightwell	+	+	+		+	+	+	+		+	+	+
<i>Roperiastes selata</i> (Roper) Grunow	+	+	+		+	+		+		+		+
<i>Skeletonema costatum</i> (Greville) Cleve	+	+	+		+	+	+	+		+	+	+
<i>Stauroneis membranacea</i> (Cleve) Meunier (syn. <i>Stauroneis membranacea</i> )	+	+	+		+	+				+		
<i>Stephanopyxis turris</i> (Greville et Arnott) Ralfs	+	+	+		+	+		+		+	+	+
<i>Subsilicea fragilarioides</i> Stosch et Reimann	+											
<i>Thalassionema frauenfeldii</i> (Grunow) Hallegraeff (syn. <i>Thalassiothrix frauenfeldii</i> )	+				+	+		+		+		+
<i>Thalassionema nitzschioides</i> (Grunow) Hustedt	+	+	+		+	+	+	+		+	+	+
<i>Thalassiosira aestivalis</i> Gran et Angst	+											
<i>Thalassiosira cf. allenii</i> Takano	+											
<i>Thalassiosira angulata</i> (Gregory) Hasle	+					+		+				+
<i>Thalassiosira anguste-lineata</i> (Schmidt) Fryxell et Hasle (syn. <i>Coscinodiscus anguste-lineata</i> , <i>Thalassiosira polychorda</i> )	+	+	+		+	+	+	+			+	+
<i>Thalassiosira concavuscula</i> Makarova	+											
<i>Thalassiosira curviseriata</i> Takano <sup>h</sup>	cf+							+				
<i>Thalassiosira decipiens</i> (Grunow) Jörgensen	+	+	+		+	+	+	+		+	+	+
<i>Thalassiosira delicatula</i> Ostenfeld	+							+				
<i>Thalassiosira diporocyclus</i> Hasle	+				+	+	+	+			+	
<i>Thalassiosira eccentrica</i> (Ehrenberg) Cleve (syn. <i>Coscinodiscus eccentricus</i> )	+	+	+									+
<i>Thalassiosira hendeyi</i> Hasle et Fryxell	+											
<i>Thalassiosira cf. kuschirensis</i> Takano	+											
<i>Thalassiosira lundiana</i> Fryxell	+											
<i>Thalassiosira mala</i> Takano	+							+				
<i>Thalassiosira minima</i> Gaarder	+	?				+		+		cf+		
<i>Thalassiosira monoprocyclus</i> Hasle	+											
<i>Thalassiosira nordenskioeldii</i> Cleve	+	+	+		+	+	+	+		+	+	+
<i>Thalassiosira oceanica</i> Hasle	+							+			+	
<i>Thalassiosira proshkinae</i> Makarova	+							+				+
<i>Thalassiosira punctigera</i> (Castracane) Hasle (syn. <i>Thalassiosira angustii</i> , <i>Thalassiosira japonica</i> ) <sup>i</sup>	+					+		+				
<i>Thalassiosira rotula</i> Meunier	+	+	+		+	+	+	+		+	+	+
<i>Thalassiosira subtilis</i> (Ostenfeld) Gran		+	+		+	+		+		+		
<i>Thalassiosira tealata</i> Takano <sup>j</sup>	+											
<i>Thalassiosira tenera</i> Proshkina-Lavrenko	+					+		+				
<i>Triceratium favus</i> Ehrenberg	+	+	+		+	+				+		+
<b>Dinophyceae</b>												
<i>Actiniscus pentasterias</i> (Ehrenberg) Ehrenberg (syn. <i>Gymnaster pentasterias</i> )	+			+				+	+	+		+
<i>Akashiwo sanguinea</i> (Hirasaki) Hansen et Moestrup (syn. <i>Gymnodinium sanguineum</i> , <i>Gymnodinium splendens</i> )	+	+	+	+				+	+	+	+	+
<i>Amoebophrya ceratii</i> (Koeppen) Cachon		+	+	+					+			
<i>Amylax triacantha</i> (Jörgensen) Sournia (syn. <i>Gonyaulax triacantha</i> )	+	+	+	+				+	+	+	+	+
<i>Ceratium arietinum</i> Cleve (= <i>Ceratium bucephalum</i> ) <sup>k</sup>	+			+				?	+		+	+
<i>Ceratium furca</i> (Ehrenberg) Claparède et Lachmann	+	+	+	+				+	+	+	+	+

Table 1 (Contd.)

Species	Listed in:											
	1	2	3	4	5	6	7	8	9	10	11	12
<i>Ceratium fusus</i> (Ehrenberg) Dujardin	+	+	+	+			+	+	+	+	+	+
<i>Ceratium horridum</i> (Cleve) Gran (syn. <i>Ceratium intermedium</i> )	+	+	+	+			+	+	+	+	+	+
<i>Ceratium lineatum</i> (Ehrenberg) Cleve	+	+	+	+			+	+	+	+	+	+
<i>Ceratium longipes</i> (Bailey) Gran	+	+	+	+			+	+	+	+	+	+
<i>Ceratium macroceros</i> (Ehrenberg) Vanhöffen	+	+	+	+			+	+		+	+	+
<i>Ceratium tripos</i> (Müller) Nitzsch	+	+	+	+			+	+	+	+	+	+
<i>Dinophysis acuminata</i> Claparède et Lachmann <b>t</b>	+	+	+	+				+	+	+	+	+
<i>Dinophysis acuta</i> Ehrenberg <b>t</b>	+	+	+	+			+	+	+	+	+	+
<i>Dinophysis dens</i> Pavillard	cf+			+				+	+	+		+
<i>Dinophysis norvegica</i> Claparède et Lachmann <b>t</b>	+	+	+	+			+	+	+		+	+
<i>Dinophysis rotundata</i> Claparède et Lachmann (syn. <i>Phalacrocoma rotundatum</i> )	+	+	+	+			+	+	+	+	+	+
<i>Diplopelta bomba</i> Stein ex Jörgensen (syn. <i>Dissodinium asymmetricum</i> , <i>Diplopsalis</i> <i>symmetrica</i> ) <sup>1</sup>	+	+	+	+				+	+	+		+
<i>Diplopsalis lenticula</i> Bergh	+			+			+	+	+	+	+	+
<i>Dissodinium pseudocalani</i> (Gönnert) Drebes ex Elbrächter et Drebes	+	+	+	+								
<i>Dissodinium pseudolumula</i> Swift ex Elbrächter et Drebes	+	+	+	+				+		+	+	+
“ <i>Exuviaella marina</i> ” Cienkowski	+									+		
<i>Fragilidium subglobosum</i> (v. Stosch) Balech (syn. <i>Helgolandinium subgobosum</i> )	+	+	+	+				+	+			+
<i>Gonyaulax diegensis</i> Kofoid	+			+								
<i>Gonyaulax digitale</i> (Pouchet) Kofoid	+	+	+	+			+	+	+	+	+	+
<i>Gonyaulax spinifera</i> (Claparède et Lachmann) Diesing	+	+	+	+			+	+	+	+	+	+
<i>Gonyaulax verior</i> Sournia	+			+				+	+		+	+
<i>Gymnodinium chlorophorum</i> Elbrächter et Schnepf (syn. <i>Lepidodinium viride</i> ) <sup>m</sup>	+											+
<i>Gymnodinium</i> cf. <i>endofasciculum</i> Campell	+							+				+
<i>Gymnodinium gracile</i> Bergh (syn. <i>Gymnodinium</i> <i>abbreviatum</i> , <i>Gymnodinium lohmannii</i> )	cf+	+	+	+				+	+		+	+
<i>Gymnodinium lebourae</i> Pavillard	+			+				+	+	+		+
<i>Gymnodinium striatissimum</i> Hulburt (syn. <i>Gymnodinium heterostriatum</i> *)	+	+	+	+				+	+	+		+
<i>Gyrodinium britannicum</i> Kofoid et Swezy	+	+	+	+				+		+		
<i>Gyrodinium calyptoglyphe</i> Lebour (syn. <i>Sclerodinium calyptoglyphe</i> )	+	+	+	+					+	+		+
<i>Gyrodinium lacryma</i> (Meunier) Kofoid et Swezy <sup>n</sup>	?+	?+		+				+		cf+		
<i>Gyrodinium prunus</i> (Wulff) Lebour <sup>o</sup>	?+	+	+	+					+			
<i>Gyrodinium spirale</i> (Bergh) Kofoid et Swezy	+	+	+	+				+	+	+	+	+
<i>Gyrodinium undulans</i> Hulburt	+			+			+	+	+	+		+
<i>Heterocapsa minima</i> Pomroy	cf+							cf+	+			+
<i>Heterocapsa niei</i> (Loeblich) Morill et Loeblich (syn. <i>Cachonina niei</i> )	+	+	+	+								+
<i>Heterocapsa rotundata</i> (Lohmann) Hansen (syn. <i>Katodinium rotundatum</i> , <i>Amphidinium</i> <i>rotundatum</i> )	+			+			+	+	+	+	+	+
<i>Heterocapsa triquetra</i> (Ehrenberg) Stein (syn. <i>Peridinium triquetrum</i> )	+	+	+	+			+	+	+	+	+	+
<i>Karenia mikimotoi</i> (Miyake et Kominami ex Oda) Hansen et Moestrup (syn. <i>Gymnodinium</i> <i>mikimotoi</i> , <i>Gyrodinium aureolum</i> *) <sup>p t</sup>	?	+	+	+			+	+	+	+	+	+
<i>Katodinium glaucum</i> (Lebour) Loeblich (syn. <i>Massartia glauca</i> )	+	+	+	+				+	+	+		+
<i>Mesoporus perforatus</i> (Gran) Lillick	+	+	+	+			+	+	+	+		+
<i>Nematodinium armatum</i> (Dogiel) Kofoid et Swezy	+	+	+	+				+				+
<i>Noctiluca scintillans</i> (Macartney) Kofoid (syn. <i>Noctiluca miliaris</i> )	+	+	+	+			+		+	+	+	+
<i>Oblea rotunda</i> (Lebour) Balech ex Sournia (syn. <i>Peridiniopsis rotunda</i> , <i>Glenodinium rotundum</i> )	+			+				+	+	+	+	+
<i>Oodinium pouchetii</i> (Lemmermann) Chatton		+	+	+						+		

Table 1 (Contd.)

Species	Listed in:											
	1	2	3	4	5	6	7	8	9	10	11	12
<i>Oxyrrhis marina</i> Dujardin <sup>a</sup>	+			+			+	+		+	+	+
<i>Paulsenella chaetoceratis</i> (Paulsen) Chatton		+	+	+								
<i>Polykrikos kofoidii</i> Chatton (syn. <i>Polykrikos schwartzii</i> *) <sup>r</sup>	+	+	+	+				+				
<i>Polykrikos schwartzii</i> Bütschli	+	+		+			+	+	+	+	+	+
<i>Preperidinium meunierii</i> (Pavillard) Elbrächter (syn. <i>Diplopeltopsis minor</i> , <i>Zygabikodinium lenticulatum</i> )	+	+	+	+				+	+		+	+
<i>Prorocentrum balticum</i> (Lohmann) Loeblich (syn. <i>Exuviaella baltica</i> )		+	+	+			+	+	+	+	+	+
<i>Prorocentrum micans</i> Ehrenberg	+	+	+	+			+	+	+	+	+	+
<i>Prorocentrum minimum</i> (Pavillard) Schiller (syn. <i>Exuviaella mariae-lebouriae</i> , <i>Exuviaella apora</i> *) <sup>t</sup>	+			+				+	+		+	+
<i>Prorocentrum redfieldii</i> Bursa (syn. <i>Prorocentrum triestinum</i> *) <sup>t</sup>	+			+				+		+		
<i>Proterothropsis vigilans</i> Marshall (syn. <i>Nematopsides vigilans</i> )	+	+	+	+				+	+			+
<i>Protoceratium reticulatum</i> (Claparède et Lachmann) Bütschli (syn. <i>Gonyaulax grindleyi</i> ) <sup>t</sup>	+	+	+	+			+	+	+	+	+	+
<i>Protoperidinium achromaticum</i> (Levander) Balech (syn. <i>Peridinium achromaticum</i> )	cf +			+						+	+	+
<i>Protoperidinium bipes</i> (Paulsen) Balech (syn. <i>Minuscula bipes</i> , <i>Peridinium minusculum</i> )	+	+	+	+			+	+	+	+	+	+
<i>Protoperidinium brevipes</i> (Paulsen) Balech (syn. <i>Peridinium brevipes</i> )	+	+	+	+			+	+	+	+	+	+
<i>Protoperidinium cerasus</i> (Paulsen) Balech (syn. <i>Peridinium cerasus</i> ) <sup>s</sup>	+	?+		+				+		+		+
<i>Protoperidinium claudicans</i> (Paulsen) Balech (syn. <i>Peridinium claudicans</i> )	+	+	+	+				+		+	+	+
<i>Protoperidinium conicum</i> (Gran) Balech (syn. <i>Peridinium conicum</i> )	+	+	+	+			+	+	+	+	+	+
<i>Protoperidinium curtipes</i> (Jørgensen) Balech (syn. <i>Peridinium curtipes</i> )	+	+	+	+				+	+			+
<i>Protoperidinium curvipes</i> (Ostenfeld) Balech (syn. <i>Peridinium curvipes</i> )	+	+	+	+				+			+	+
<i>Protoperidinium denticulatum</i> (Gran et Braarud) Balech (syn. <i>Peridinium denticulatum</i> )	+	+	+	+				+	+			+
<i>Protoperidinium depressum</i> (Bailey) Balech (syn. <i>Peridinium depressum</i> )	+	+	+	+			+	+	+	+	+	+
<i>Protoperidinium divergens</i> (Ehrenberg) Balech (syn. <i>Peridinium divergens</i> ) <sup>t</sup>	cf +	?+		+			+	+	+	+	+	+
<i>Protoperidinium excentricum</i> (Paulsen) Balech (syn. <i>Peridinium excentricum</i> )	+	+	+	+				+	+	+	+	+
<i>Protoperidinium granii</i> (Ostenfeld) Balech	+			+			+	+	+	+	+	+
<i>Protoperidinium leonis</i> (Pavillard) Balech (syn. <i>Peridinium leonis</i> )	+			+				+	+	+	+	+
<i>Protoperidinium mariae-lebouriae</i> (Paulsen) Balech (syn. <i>Peridinium mariae-lebouriae</i> )	+		+	+			+	+				
<i>Protoperidinium minutum</i> (Kofoid) Loeblich (syn. <i>Peridinium minutum</i> )	+	+	+	+				+		+		+
<i>Protoperidinium monospinum</i> (Paulsen) Zonnefeld et Dale	+			?								
<i>Protoperidinium oblongum</i> (Aurivillius) Parke et Dodge (syn. <i>Peridinium oblongum</i> )	+			+				+	+	+	+	+
<i>Protoperidinium obtusum</i> (Karsten) Parke et Dodge (syn. <i>Peridinium obtusum</i> )	+			+							+	
<i>Protoperidinium ovatum</i> Pouchet (syn. <i>Peridinium ovatum</i> )	+	+	+	+			+	cf +	+	+	+	+
<i>Protoperidinium pallidum</i> (Ostenfeld) Balech (syn. <i>Peridinium pallidum</i> )	+	+	+	+			+	+	+	+	+	+
<i>Protoperidinium pellucidum</i> Bergh (syn. <i>Peridinium pellucidum</i> )	+	+	+	+			+	+	+	+	+	+
<i>Protoperidinium pentagonum</i> (Gran) Balech (syn. <i>Peridinium pentagonum</i> )	+	+	+	+				+	+	+	+	+

Table 1 (Contd.)

Species	Listed in:											
	1	2	3	4	5	6	7	8	9	10	11	12
<i>Protoperidinium punctulatum</i> (Paulsen) Balech (syn. <i>Peridinium punctulatum</i> )	cf +			+				+	+	+	+	+
<i>Protoperidinium pyriforme</i> (Paulsen) Balech (syn. <i>Peridinium pyriforme</i> )	+	+	+	+			+	+		+	+	+
<i>Protoperidinium steinii</i> (Jørgensen) Balech (syn. <i>Peridinium steinii</i> )	cf +	+	+	+			+	+	+	+	+	+
<i>Protoperidinium subinerme</i> (Paulsen) Loeblich (syn. <i>Peridinium subinerme</i> ) <sup>u</sup>	+	+	+	+			+	+	+	+		+
<i>Protoperidinium thorianum</i> (Paulsen) Balech (syn. <i>Peridinium thorianum</i> )	+	+	+	+			+	+	+	+		+
<i>Protoperidinium thulesense</i> (Balech) Balech	cf +			+								
<i>Pyrophacus horologium</i> Stein	+	+	+	+			+	+	+		+	+
<i>Scrippsiella lachrymosa</i> Lewis	cf +							+				
<i>Scrippsiella trochoidea</i> (Stein) Loeblich (syn. <i>Peridinium trochoideum</i> , <i>Scrippsiella faeroense</i> )	+	+	+	+				+	+	+	+	+
<i>Spatulodinium pseudonoctiluca</i> (Pouchet) Cachon et Cachon ex Loeblich et Loeblich	+			+				+	+			+
<i>Torodinium robustum</i> Kofoid et Swezy	+	+	+	+				+	+	+		+
<i>Warnowia rosea</i> (Pouchet) Kofoid et Swezy	cf +			+				+	+			+

\*Misidentification, not taxonomic synonymy

<sup>a</sup>According to Jensen and Moestrup (1998), *Chaetoceros compressus* is probably mistaken for *Chaetoceros contortus*

<sup>b</sup>According to Jensen and Moestrup (1998), *Chaetoceros williei* is a synonym of *Chaetoceros affinis*

<sup>c</sup>*Coscinodiscus centralis* Ehrenberg in Hartley (1986)

<sup>d</sup>*Coscinodiscus perforatus* var. *pavillardii* in Hartley (1986)

<sup>e</sup>Species introduced in 1977, *Coscinodiscus nobilis* in Robinson et al. (1980)

<sup>f</sup>Species introduced in 1903, *Odontella* (as *Biddulphia*) *sinensis* in Ostenfeld (1908)

<sup>g</sup>*Rhizosolenia alata* f. *indica* in Hartley (1986)

<sup>h</sup>Possibly identical to *Thalassiosira iratealata* Takano

<sup>i</sup>Species introduced in 1978 (see Nehring 1998; Reise et al. 1999)

<sup>j</sup>Species possibly introduced in 1950 (see Nehring 1998; Reise et al. 1999)

<sup>k</sup>*Ceratium bucephalum* in Heimdal et al. (1973)

<sup>l</sup>*Diplopsalopsis bomba* in Kuylenstierna and Karlson (2000)

<sup>m</sup>See Elbrächter and Schnepf (1996), Sournia et al. (1992); *L. viride* is a misidentification in some cases and not a real synonym

<sup>n</sup>Requires re-investigation, see comments in Drebes and Elbrächter (1976, p. 81)

<sup>o</sup>Requires re-investigation

<sup>p</sup>Possibly an introduced species (see Braarud and Heimdal 1970; Hickel et al. 1971; Elbrächter 1999; Reise et al. 1999)

<sup>q</sup>Recorded in a tidal pool (sample from Dr S. Kühn), not at the Helgoland Reede station

<sup>r</sup>In Drebes (1974) as *Polykrikos schwartzii* (p. 125, Figs. 106a, b)

<sup>s</sup>May be in Drebes (1974) as *Peridinium* sp. (p. 134, Fig. 117c)

<sup>t</sup>Requires re-investigation

<sup>u</sup>In Drebes (1974) as *Peridinium punctulatum* (p. 140, Figs. 122a, b)

with a scanning electron microscope. For frustule preparation, diatom cultures were boiled in nitric acid and washed 10 times with distilled water.

The species are listed alphabetically within each class. Some synonyms, previously in common use, are given behind the species names for an easier comparison between the findings presented here and older publications and the cited lists.

## Results

Table 1 gives a list of the marine phytoplankton diatoms and dinoflagellates found in Helgoland and other North Sea areas

The following changes should also be noted: the genus *Neocalyptrella* Hernández-Becerril et Meave has replaced *Calyptrella* (Hernández-Becerril and Meave del Castillo 1997); and *Stauropsis membranacea* is a synonym of *Meuniera membranacea* (Cleve) P.C. Silva (Hasle and Syvertsen 1997).

During the year of revision (May 2003 to April 2004), some additional species were recorded at the Helgoland

Reede station: *Chaetoceros rostratus* Lauder; *Dactyliosolen fragilissimus* (Bergon) Hasle; *Fragilaria islandica* Grunow sensu Drebes (1974); *Stephanopyxis* cf. *palmeriana* (Greville) Grunow; and *Amphidinium crassum* Lohmann.

## Discussion

One hundred and thirty-two species of diatoms from 53 genera and 95 species of dinoflagellates from 35 genera were recorded from net samples and cultures. From these 227 taxa, 35 diatoms and 28 dinoflagellate taxa were documented in the Helgoland phytoplankton for the first time. Eleven diatom and four dinoflagellate species could not be found again. Since the publication of the 1976 list (Drebes and Elbrächter 1976), numerous nomenclatural changes have occurred. This list does not claim to be complete, but provides an updated listing. Further continuous observations will be necessary to complete the species list.

Some taxa have been observed but not yet identified to species level, e.g. *Thalassiosira* spp, *Chaetoceros* spp,

*Cyclotella* sp, *Licmophora* spp, *Navicula* spp, *Nitzschia* sp, *Pleurosigma* spp, some benthic diatoms, dinoflagellate species of the *Diplopsalis* group, *Gymnodinium* spp, *Gyrodinium* spp, and *Protoperidinium* spp. In addition, *Pseudo-nitzschia multiseriata* (Hasle) Hasle was identified in earlier Helgoland samples (Hasle 1995; Hasle et al. 1996) and should be mentioned here because it is toxic.

There have been some single records of benthic, sand-dwelling dinoflagellates: *Adenoides eludens* (Herdman) Balech, 1956; *Amphidinium bipes* Herdman, 1924; *Amphidinium glabrum* Hoppenrath & Okolodkov, 2000; *Amphidiniopsis galericulata* Hoppenrath, 2000; *Prorocentrum clipeus* Hoppenrath, 2000; and *Thecadinium ornatum* Hoppenrath, 2000. In my opinion, these tychoplanktonic species occurred only "by accident" in the plankton and therefore they were not included in the present checklist. Other regularly observed plankton species from other groups include: *Phaeocystis globosa* Scherffel; *Dictyocha speculum* Ehrenberg; and *Ebria tripartita* (Schumann) Lemmermann (see also Drebes 1974).

Detection of long-term trends in the species composition needs more detailed investigations. The high number of "first" records (63) should not be interpreted as a real change in species composition but as a result of more detailed species knowledge. Drebes and Elbrächter have experienced the same results at the Sylt station, Wadden Sea since 1976. Additionally, there have been some newly described species since the 1970s. Some small *Thalassiosira* species could only be identified using scanning electron microscopy. Since Drebes and Elbrächter's (1976) checklist, only *Coscinodiscus walesii* (Boalch and Harbour 1977; Robinson et al. 1980) and *Thalassiosira punctigera* (Nehring 1998) have been documented as introduced species. The present list may include some native species which were only discovered recently but may have been around long before without being noticed, because our attention and taxonomic expertise generally decrease with decreasing size of the organisms. Therefore, there is a great need for intensive phytoplankton species documentation as a baseline for a less ambiguous recognition of changes in the species composition with respect to toxic species occurrence and global change aspects. A continuous routine net phytoplankton species monitoring, in combination with the regular determination of the species abundance, is essential.

The comparison of checklists is problematic because of the subjective taxon recognition by the authors and the lack of illustrations of the observed specimens. But it may be useful (e.g. for biogeographic comparisons) to compare this species list with data from other areas, and for convenience records have been added to Table 1 (columns labelled 4–12; Grøntved 1952; Braarud et al. 1953).

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