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現世放散虫に関する生態情報リスト

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Compiled ecological data on living Polycystine radiolarians

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Abstract

This paper summarized ecological data of Polycystine radiolarians in wide ranges of ocean from previously published references. This compiled table could provide for advanced paleoceanographic study using polycystine radiolarian assemblages, although users should check the original sources.

はじめに

過去の堆積物に含まれる放散虫化石を用いて当時の海洋環境を復元するためには，現在の海洋に生息する放散虫（種）がどのような環境因子（水温・塩分・栄養塩など）に対応した棲み分けを行っているのかを把握することが必要不可欠である．特に，放散虫は海洋表層から水深 2000m 以深に至るまで幅広く生存が確認されており，その生息深度分布を明らかにすることは極めて重要である．1970 年代以降，様々な海域においてプランクトンネットやセディメントトラップを用いた放散虫の生態に関する研究が行われ，北太平洋・赤道太平洋・南極海周辺などでは現在までに比較的多くの情報が得られてきた．一方，北大西洋や南太平洋などでは表層堆積物を用いた研究も含めて放散虫の生息分布はほとんど明らかになっておらず，このような海域の放散虫化石群集を扱う場合には他の海域で得られたできる限り多くのデータをもとに種の生態情報を推測する必要がある．

本論では筆者が北大西洋の放散虫群集を用いた古海洋学的研究を始めるにあたり，これまで（2005 年まで）行われてきた現世放散虫の地理分布・生態情報に関する研究成果をコンパイルしたものを紹介する．

結果

以下の表は，主にプランクトンネットおよびセディメントトラップを用いて得られたデータをもとに，合計 98 タクサについて産出した海域，生息深度，産出パターンの季節変動，環境パラメーターなどとの対応関係をまとめたものである．

利用上の注意点

ここで紹介したデータは，引用した論文中で特に重要と思われる部分を抽出したものであり各種の生態情報についてより理解を深めるためには元となる文献の内容全体を把握することが好ましい．放散虫化石を用いた古海洋環境解析を始められる方々に，まずは得られた種の大まかな生息深度・生態について理解し，群集と海洋環境との関係をイメージするのに役立ててもらうことができればと考えている．

終わりにあたって

今後はさらに現世放散虫の生態に関するデータが蓄積され，これまで情報量の少なかった海域や深度（中層−深層）の放散虫についても生態的特徴や海洋環境との対応関係が明らかになっていくことを期待したい．

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表1．1

Taxon name	Area	Method	Occurrence	Seasonal flux	Comments	References
Acrobotrys cribrosa	Southern California	Plankton	50-125m	summer peak	stratified Equatorial water incursion in summer	Casey et al (1979)
	Central Pacific (25N-25S)	Plankton	0-75m		(*B.dictyocephalus* in the original paper)	Renz (1976)
Acrosphaera spinosa	Eastern Equatorial Atlantic	Plankton	0-50-(100m)		warm oligotrophic condition	Boltovskoy et al. (1996)
	Eastern Equatorial Atlantic	Plankton	0-50m			Dworetzky and Morley (1987)
	Equatorial North Atlantic	Sediment trap	upper 389m			Takahashi and Honjo (1981); Takahashi (1991)
Acrosphaera murrayana	Southern California	Plankton	0-25m	summer peak	stratified Equatorial water incursion in summer	Casey et al (1979)
	Eastern Equatorial Atlantic	Plankton	0-50m		peak below chlorophyll α maxima	Dworetzky and Morley (1987)
	Caribbean Sea	Plankton	0-50m		warm saline surface water	McMillen and Casey (1978)
Actinomma antarcticum	Southern Ocean (Atlantic sector)	Plankton	0-300-(400)m		Antarctic Cold Water factor: temperature<1.5℃, high contents of dissolved silica (H_4SiO_4), south of 50S	Abelmann and Gowing (1997)
Actinomma arcadophorum	Central Pacific (25N-25S)	Plankton	25-125m		abundance increase between 10N and 10S	Renz (1976)
	Equatorial North Atlantic	Sediment trap	upper 389m			Takahashi and Honjo (1981); Takahashi (1991)
Actinomma boreale	Okhotsk Sea	Piston core	*not available*		high relative abundance in MIS 2-3 (glacial condition)	Okazaki et al. (2003)
	Japan Sea	Plankton	1000-2000m		related to cold and highly oxygenated deep water	Itaki (2003)
	fjords of western Norway	Plankton	100-200, 400-500m			Bjørklund (1974)
	Equatorial North Atlantic	Sediment trap	389-988m		(*Cromyechinus* aff. *borealis* in the original paper) rare	Takahashi and Honjo (1981); Takahashi (1991)
	Southern Ocean (Atlantic sector)	Plankton	300-1000m		(*C. antarctica* in the original paper) Circumpolar Deep Water factor: temperature<2.5℃, salinity>34.5‰	Abelmann and Gowing (1997)
	western Arctic Ocean	Plankton	50-150-500m		shallow (50-150m peak) in one site and no pronounce peak in another	Itaki et al. (2003)
Actinomma boreale/leptodermum	Norwegian and Greenland Sea	Sediment trap	upper 500m			Samtleben et al. (1995)
Actinomma leptodermum	Okhotsk Sea	Piston core	not available		high relative abundance in MIS 2-3 (glacial condition)	Okazaki et al. (2003)
	western Arctic Ocean	Plankton	50-150-500m		shallow (50-150m peak) in one site and no pronounce peak in another	Itaki et al. (2003)
	Southern Ocean (Atlantic sector)	Plankton	400-1000m		Northern AAIW factor	Abelmann and Gowing (1997)
	Greenland Iceland Norwegian sea	Surface sediment	*not available*		abundant in central Norwegian basin and ice edge of Greenland	Bjørklund et al. (1998)
	Greenland Sea (ice edge)	Plankton	0-400m (one tow)		no relation to nutrient and chlorophyll α, abundant in eastern advanced blooming are (low nutrient)	Swanberg and Eide (1992)
	Okhotsk and Oyashio region	Plankton	200-1000m 0-100-(500m)		intermediate in the Okhotsk Sea, while surface water in the Oyashio Water associated with unfavorable surface condition in the Okhotsk	Okazaki et al. (2004)
Actinomma medianum	Southern California Current	Plankton	0-50m		(*Actinomma antarcticum* in the original paper)	Kling and Boltovskoy (1995)
Amphimelissa setosa	western Arctic Ocean	Plankton	25-150m		maximum abundance correlated with Cold halocline (-1.9℃, high silica low oxygen). Near the summer ice edge	Itaki et al. (2003)
	Norwegian fjords	Plankton	25-100m	summer>winter		Swanberg and Bjørklund (1986)
	Greenland Iceland Norwegian sea	Surface sediment	*not available*		more than 60 % in Iceland Plateau associated with SST lower than 10℃	Bjørklund et al. (1998)
	Greenland Sea (ice edge)	Plankton	0-400m (one tow)		correlated to nutrient and chlorophyll α, dominant in ice edge (early phytoplankton bloom)=rich nutrient, low chlorophyll α	Swanberg and Eide (1992)
	Norwegian and Greenland Sea	Sediment trap	upper 500m			Samtleben et al. (1995)
Amphirhopalum ypsilon	Gulf of Mexico	Plankton	85-172m		Subtropical Underwater	Casey et al (1979)
Anomalacantha dentata	Gulf of California	Plankton	200-400m		Gulf of California Water, subsurface water caused by subduction	Molina-Cruz et al. (1999)
Antarctissa denticulata	Weddell Sea (Antarctic)	Plankton	0-100m		(higher abundance in Ice age)	Morley and Stepien (1985)
	Southern Ocean (Atlantic sector)	Surface sediment	*not available*		temperature -1 to 2℃ (surface sediments distribution)	Abelmann et al. (1999)
Antarctissa strelkovi	Weddell Sea (Antarctic)	Plankton	0-100m		(higher abundance in Ice age)	Morley and Stepien (1985)
	Southern Ocean (Atlantic sector)	Plankton	0-200m		Antarctic Cold Water factor: temperature<1.5℃, high contents of dissolved silica (H_4SiO_4), south of 50S	Abelmann and Gowing (1997)
	Southern Ocean (Atlantic sector)	Surface sediment	*not available*		temperature 0 to 5℃ (surface sediments distribution)	Abelmann et al. (1999)
Antarctissa (?) sp.1 Popofsky	Okhotsk Sea	Plankton	50-130m		may be an indicator of dichothermal in Okhotsk	Nimmergut and Abelmann (2002)
	Okhotsk Sea	Plankton	50-150m	summer peak	highest standing stock in the western Sea of Okhotsk	Abelmann and Nimmergut (2005)
Anthocyrtidium ophirense	Central North Pacific	Plankton	50-200m		coincide with salinity minimum, oxygen (chlorophyll α) maxima	Kling (1979)
	Eastern Equatorial Atlantic	Plankton	100-200m (only)		(*Anthocyrtidium* spp. in the original paper)	Dworetzky and Morley (1987)
	Southern California	Plankton	50-200m	summer peak	stratified Equatorial water incursion in summer	Casey et al (1979)
	Central Pacific (25N-25S)	Plankton	50m-200m (only)		common except for 0 and 10S	Renz (1976)
	Caribbean Sea Windward Passage (Atlantic)	Plankton	49-100m		(*A. cineraria* in the original paper) Surface to Subtropical Underwater	McMillen and Casey (1978)
Anthocyrtidium zanguebaricum	Central Pacific (25N-25S)	Plankton	50-200m		present at 0N and 15S	Renz (1976)

表1．2

Taxon name	Area	Method	Occurrence	Seasonal flux	Comments	References
Artobotrys borealis	Greenland Iceland Norwegian sea	Surface sediment	*not available*		northern and central Norwegian basin mixing of cold and warm water geographic distribution confined to high northern latitude	Bjørklund et al. (1998)
	Hawaii	Sediment trap	upper 389m		rare	Takahashi (1991)
	Panama basin		upper 667m		abundant	
Artostrobus annulatus	Norwegian and Greenland Sea	Sediment trap	below 500m			Samtleben et al. (1995)
	Eastern Equatorial Atlantic	Sediment trap	upper 853m		generally cold water species (from sediment data), possibly living below 300-400m in the tropics and subtropics	Boltovskoy et al. (1993)
	Southern California Current	Plankton	below 300m		rare and difficult to define reliable vertical trend	Kling and Boltovskoy (1995)
Botryocampe inflata	Okhotsk Sea	Sediment trap	258-1061m	autumn peak		Hays and Morley (2003)
Botryocyrtis scutum	Gulf of California	Plankton	0-100(200m)		Subtropical surface water	Molina-Cruz et al. (1999)
	Southern California	Plankton	0-200m		Equatorial Central Shallow Water	Casey et al (1979)
	Windward Passage	Plankton	0-200m		Surface to Subtropical Underwater	McMillen and Casey (1978)
	Equatorial North Atlantic	Sediment trap	upper 389m			Takahashi and Honjo (1981); Takahashi (1991)
Botryostrobus aquilonaris	Central North Pacific	Plankton	1000-2000m			Kling (1979)
	Southern California	Plankton	20-500m		Transition Central Water	Casey et al (1979)
	Southern California Current	Plankton	below 300m		rare and difficult to define reliable vertical trend	Kling and Boltovskoy (1995)
	Okhotsk and Oyashio region	Plankton	300-1000m		associate with stable hydrographic condition throughout the year in the intermediate water; more abundant in off Hokkaido	Okazaki et al. (2004)
Botryostrobus auritus/australis	Southern California current	Plankton	0-100m		much more abundant than the warm, oligotrophic Central North Pacific	Kling and Boltovskoy (1995)
	Southern California	Plankton	0-200m		Equatorial Central Shallow Water	Casey et al (1979)
	Central Pacific (25N-25S)	Plankton	0-200m(max)			Renz (1976)
	Norwegian and Greenland Sea	Sediment trap	below 500m		(*Lithostrobus botryocyrtis* in the original paper)	Samtleben et al. (1995)
Carpocanistrum sp.	Southern California	Plankton	0-200m		Equatorial Central Shallow Water	Casey et al (1979)
	Central Pacific (25N-25S)	Plankton	0-75m			Renz (1976)
	Equatorial North Atlantic	Sediment trap	upper 389m			Takahashi and Honjo (1981); Takahashi (1991)
Carpocanarium papillosum	Equatorial North Atlantic	Sediment trap	389-988m			Takahashi and Honjo (1981); Takahashi (1991)
Ceratocyrtis historicosus	western Arctic Ocean	Plankton	(200)300-500m		correspond to upper Arctic Intermediate Water (warmer:0.5-1 ℃)	Itaki et al. (2003)
	Japan Sea	Plankton	40-300 (500)m		temperature ranges from 0.5 to 4℃ (most abundant at 2℃)	Itaki (2003)
	Equatorial North Atlantic	Sediment trap	upper 389m			Takahashi and Honjo (1981); Takahashi (1991)
	Greenland Sea (ice edge)	Plankton	0-400m (one tow)		rare	Swanberg and Eide (1992)
Ceratospyris borealis	Okhotsk Sea	Plankton	(100)200-500m	summer>spring	most abundant where an increased productivity food supply from stable stratified euphotic zone to intermediate depth (heterotrophic organisms increase by consuming organic material produced in spring blooming and transport to deep, but it requires specific physico-chemical condition because they are not in food production area)	Nimmergut and Abelmann (2002)
	Okhotsk Sea	Plankton	50-500m		highest standing stock during late summer close to Sakhalin	Abelmann and Nimmergut (2005)
	Okhotsk Sea	Sediment trap	upper 258m	autumn peak		Hays and Morley (2003)
	Okhotsk Sea	Sediment trap	upper 300m	summer-autumn peak	flux peak synchronous with phytoplankton and bacterioplankton bloom in eastern Sakhalin; paleoproductivity indicator for fossil record	Okazaki et al. (2003)
		Piston core	not available			
	Eastern subarctic Pacific	Sediment trap	*not available*	spring and autumn peak	flux pattern synchronous with *N.seminae* (diatom) = productivity indicator	Takahashi (1997)
Clathrocorys murrayi	Cathalina basin, southern California	Plankton	50-200m	summer peak	stratified Equatorial water incursion in summer	Casey et al (1979)
Collosphaera tuberosa	Central Equatorial Pacific	Plankton	0-120m		associated with oligotrophic environments=indicator for the WPWP	Yamashita et al. (2002)
	Southern Ocean (Atlantic sector)	Plankton	0-100m		in Namibia upwelling regime	Abelmann and Gowing (1997)
	Eastern Tropical Atlantic	Plankton	0-50m		peak above chlorophyll α maxima	Dworetzky and Morley (1987)
	Equatorial North Atlantic	Sediment trap	upper 389m			Takahashi and Honjo (1981); Takahashi (1991)
Collosphaeridae	Central Equatorial Pacific	Plankton	*not available*		symbiont-bearing and abundant in the anti-cyclonic gyres = associate with a stable water column and oligotrophic conditions	Welling et al. (1996)
Cornutella profunda	Central North Pacific	Plankton	1000-2000m			Kling (1979)
	western Arctic Ocean	Surface sediment	bellow 1700m			Itaki et al. (2003)
	Equatorial North Atlantic	Sediment trap	upper 389m		more abundant in deeper trap	Takahashi and Honjo (1981); Takahashi (1991)
	Gulf of Mexico	Plankton	(354)-1942m		Antarctic Intermediate Water and/or North Atlantic Deep Water	Casey et al (1979)
	South California		500-1000m		Subarctic Intermediate water	
	Central Pacific (25N-25S)	Plankton	below 125m		present in 25N-10N and 0	Renz (1976)
	North Pacific	Plankton	200-550-(2000m)			Gowing (1993)

表1．3

Taxon name	Area	Method	Occurrence	Seasonal flux	Comments	References
Corocalyptra craspedota/cervus	Eastern Equatorial Atlantic	Plankton	50-200m (max)		(*Theopilium tricostatum* in the original paper)	Dworetzky and Morley (1987)
	Equatorial North Atlantic	Sediment trap	upper 389m		(*Eucecryphalus tricostatus* in the original paper)	Takahashi and Honjo (1981); Takahashi (1991)
	Central North Pacific	Plankton	50-200m		coincide with salinity minimum, oxygen (chlorophyll α) maxima	Kling (1979)
	Central Equatorial Pacific	Plankton	200-500m			Yamashita et al. (2002)
	Caribbean Sea Gulf of Mexico Windward Passage (Atlantic)	Plankton	(0)-50-200m		Surface to Underwater	McMillen and Casey (1978)
	Southern Ocean (Atlantic sector)	Plankton	100-400m		living in relatively colder and deeper waters (broader depth habitat) factor extends into SACW and Antarctic Intermediate Water	Abelmann and Gowing (1997)
	Central Pacific (25N-25S)	Plankton	0-200m (only)			Renz (1976)
Cycladophora bicornis	Southern Ocean (Atlantic sector)	Plankton	100-300m		Southern AAIW factor	Abelmann and Gowing (1997)
	Southern California current	Plankton	below 300m		abundance peak at around 500m	Kling and Boltovskoy (1995)
	Central North Pacific	Plankton	100-300m-(750m)		lower subsurface: salinity maximum between shallow and deep minima	Kling (1979)
	Caribbean Sea Gulf of Mexico Windward Passage (Atlantic)	Plankton	200-below 400m		intermediate depth (rare)	McMillen and Casey (1978)
	Gulf of Mexico	Plankton	354-834m		Antarctic Intermediate Water	Casey et al (1979)
	Equatorial North Atlantic	Sediment trap	upper 389m			Takahashi and Honjo (1981); Takahashi (1991)
Cycladophora cornutoides	Southern California current	Plankton	below 200m		coherent deep vertical pattern throughout the area: peak at 200m	Kling and Boltovskoy (1995)
	Equatorial North Atlantic	Sediment trap	upper 389m			Takahashi and Honjo (1981); Takahashi (1991)
Cycladophora davisiana	Okhotsk Sea	Plankton	200-500m	summer>spring	food supply from stable stratified euphotic zone to intermediate depth (heterotrophic organisms increase by consuming organic material produced in spring blooming and transport to deep, but it requires specific physico-chemical condition because they are not in food production area)	Nimmergut and Abelmann (2002)
	Okhotsk Sea	Plankton	200-500m		upper Sea of Okhotsk Intermediate Water (cold and well oxygenized) high abundance of *C. davisiana* is associated with inflow of cold deep/ intermediate waters, high export of organic matter to mesopelagic depth: an indicator for a mesopelagic productivity regime mainly linked to enhanced phytoplankton production in surface layer)	Abelmann and Nimmergut (2004)
	Okhotsk Sea	Sediment trap	(0-300m)-1500m		much abundant in deeper trap (1500m); flux pattern associated with terrigenous organic material from continental shelf	Okazaki et al. (2003)
		Piston core	*not available*		low RAR in MIS 2 and 4 caused by a longer sea-ice coverage during the glacial period	
	Okhotsk Sea	Sediment trap	258-1061m	autumn peak		Hays and Morley (2003)
	Okhotsk and Oyashio region	Plankton	(100)500-1000m		abundant in the Okhotsk Sea than in the Oyashioa Water: caused by a reflection of bacterial biomass	Okazaki et al. (2004)
	Japan Sea	Plankton	1000-2000m		related to cold and highly oxygenated deep water	Itaki (2003)
	Northwest Pacific	Deep-sea core	*not available*		evolved from *C. sakaii* ; Evolutionary transition coincides with global cooling event (development of Northern Hemisphere ice (3.3-2.4Ma))	Motoyama (1997)
	Southern California Current	Plankton	100-200m		very rare	Kling and Boltovskoy (1995)
	Southern Ocean (Atlantic sector)	Plankton	400-1000m		deep water of Antarctic Polar Front	Abelmann and Gowing (1997)
	western Arctic Ocean	Surface sediment	(230)below 500m		lower AIW or CBDW	Itaki et al. (2003)
	Norwegian and Greenland Sea	Sediment trap	below 500m			Samtleben et al. (1995)
	Greenland-Spitsbergen	Cleve collection	below 500m			Bjørklund and Ciesielski (1994)
Dictyocoryne profunda	Eastern Tropical Atlantic	Plankton	0-50m		warm oligotrophic condition	Boltovskoy et al. (1996)
	Eastern Tropical Atlantic	Plankton	0-50m		peak above chlorophyll α maxima	Dworetzky and Morley (1987)
	Equatorial North Atlantic	Sediment trap	upper 389m			Takahashi and Honjo (1981); Takahashi (1991)
	Central Equatorial Pacific	Plankton	0-120m		distributed in the warm mixed layer above the thermocline	Yamashita et al. (2002)
	Central North Pacific	Plankton	100-300m		lower subsurface: salinity maximum between shallow and deep minima	Kling (1979)
	Central Pacific (25N-25S)	Plankton	0-75m		abundance maximum between 5N and 5S	Renz (1976)
Dictyocoryne profunda/truncatum	Gulf of Mexico	Plankton	0-50m		warm saline surface water	Casey et al (1979)
			0-200m		Equatorial Central Shallow water	
Dictyocoryne truncatum	Eastern Equatorial Atlantic	Plankton	0-50m		peak above chlorophyll α maxima	Dworetzky and Morley (1987)
	Caribbean Sea Gulf of Mexico	Plankton	0-100m		Surface to Subtropical Underwater	McMillen and Casey (1978)
	west of Barbados	Culture	surface		have narrow growth temperature optimum around 28℃ wide tolerance to salinity (at least 27 to 30‰) bear algal symbionts	Matsuoka and Anderson (1992)

表1．4

Taxon name	Area	Method	Occurrence	Seasonal flux	Comments	References
Dictyophimus hirundo/crisiae	Okhotsk Sea	Plankton	500-1000m			Nimmergut and Abelmann (2002)
	Okhotsk Sea	Plankton	500-1000m		related to an environment characterized by mixing processes that transport oxygen to the deep ocean and enhanced nutrient supply via export of organic matter released from highly productive surface water to the deep ocean	Abelmann and Nimmergut (2004)
	Okhotsk Sea	Sediment trap	258-1061m	autumn peak		Hays and Morley (2003)
	Okhotsk and Oyashio region	Plankton	300-1000m		associate with stable hydrographic condition throughout the year in the intermediate water (showing wide geographic distribution)	Okazaki et al. (2004)
	Southern California current	Plankton	100-300m			Kling and Boltovskoy (1995)
	Southern California	Plankton	25-100m	winter peak	associated with cold eutrophic water in winter	Casey et al (1979)
	Equatorial North Atlantic	Sediment trap	389-988			Takahashi and Honjo (1981); Takahashi (1991)
	Caribbean Sea Gulf of Mexico Windward Passage (Atlantic)	Plankton	200-1000m		intermediate depth (rare)	McMillen and Casey (1978)
Didymocyrtis tetrathalamus	Central North Pacific	Plankton	surface water		SST dependent (warm water)	Kling (1979)
	Central Equatorial Pacific	Plankton	0-120m		distributed in the warm mixed layer above the thermocline	Yamashita et al. (2002)
	Central Equatorial Pacific	Plankton	surface water	increase in El Nino	confined in surface water above thermocline which is advected from Western Pacific. (North Equatorial Countercurrent)	Welling et al. (1996)
	Southern California Current	Plankton	0-50m		more abundant in the warm Central Water imprinting at St. F and A	Kling and Boltovskoy (1995)
	Eastern Equatorial Atlantic	Plankton	0-50m		warm oligotrophic condition	Boltovskoy et al. (1996)
	Gulf of Mexico	Plankton	0-50m		warm saline surface water	Casey et al (1979)
	west of Barbados	Culture	0-200m		highest longevity occurred at temperature 21-27℃, but can survive at around 10℃. Light is required for growth High abundance occurred in spring 1989 with temperature (26.5-27.5 ℃) relatively cooler than normal (27.7-28.2℃) when mixing of surface and nutrient-rich deep waters	Anderson et al. (1990)
	Central Pacific (25N-25S)	Plankton	0-75m		abundant in all latitude (especially 10S)	Renz (1976)
	Eastern Equatorial Atlantic	Plankton	0-50m		abundant at or near chlorophyll α maxima	Dworetzky and Morley (1987)
	Equatorial North Atlantic	Sediment trap	upper 389m			Takahashi and Honjo (1981); Takahashi (1991)
	Caribbean Sea Gulf of Mexico Windward Passage (Atlantic)	Plankton	0-100m		warm saline surface water	McMillen and Casey (1978)
Druppatractus variabilis	Gulf of California	Plankton	400-700m			Molina-Cruz et al. (1999)
Euchitonia elegans/furcata	Central Equatorial Pacific	Plankton	surface water	increase in El Nino	confined in surface water above thermocline which is advected from Western Pacific (North Equatorial Countercurrent)	Welling et al. (1996)
	Central Equatorial Pacific	Plankton	0-120m		distributed in the warm mixed layer above the thermocline	Yamashita et al. (2002)
	Equatorial North Atlantic	Sediment trap	upper 389m			Takahashi and Honjo (1981); Takahashi (1991)
	Eastern Tropical Atlantic	Plankton	0-50m		warm oligotrophic condition	Boltovskoy et al. (1996)
	Gulf of Mexico	Plankton	0-50m		warm saline surface water	Casey et al (1979)
	South California		0-200m	autumn peak	North Central Shallow Water (short lived in autumn)	
	Eastern Equatorial Atlantic	Plankton	0-50m		abundant at or near chlorophyll α maxima	Dworetzky and Morley (1987)
	Caribbean Sea Gulf of Mexico Windward Passage (Atlantic)	Plankton	0-100m		Surface to Subtropical Underwater	McMillen and Casey (1978)
Eucyrtidium acuminatum	Southern California current	Plankton	0-50m		more abundant in the warm Central Water imprinting at St. F and A	Kling and Boltovskoy (1995)
Eucyrtidium calvertense	Gulf of Mexico	Plankton	354-838m		AAIW or NADW (very rare); absent in the other two station	McMillen and Casey (1978)
	Gulf of Mexico	Plankton	(354)-1942m		AAIW and/or NADW	Casey et al (1979)
Eucyrtidium hexagonatum	Southern California	Plankton	0-200m		Equatorial Central Shallow Water	Casey et al (1979)
	Central Pacific (25N-25S)	Plankton	0-75m		abundant in 10N-10S (especially in 5S)-Chlorophyll?	Renz (1976)
	Windward Passage (Atlantic)	Plankton	0-50m		Surface to Subtropical Underwater (absent in Caribbean Sea and Gulf of Mexico	McMillen and Casey (1978)
Eucyrtidium hexastichum	Southern Ocean (Atlantic sector)	Plankton	0-100m		extend into Subtropical area (shallow warm water indicator) (40-45 S)	Abelmann and Gowing (1997)
	Central Pacific (25N-25S)	Plankton	50-200m (only)			Renz (1976)
Heliodiscus asteriscus/echiniscus	Central North Pacific	Plankton	surface water		Rare; SST dependent (warm water)	Kling (1979)
	Gulf of Mexico	Plankton	85-172m		Subtropical Underwater indicator	Casey et al (1979)
	Central Pacific (25N-25S)	Plankton	25-125m		abundant within 5N-5S, shallow warm water	Renz (1976)
	Equatorial North Atlantic	Sediment trap	upper 389m			Takahashi and Honjo (1981); Takahashi (1991)

表1．5

Taxon name	Area	Method	Occurrence	Seasonal flux	Comments	References
Lamprocyclas maritalis	Central North Pacific	Plankton	100-300m		lower subsurface: salinity maximum between shallow and deep minima	Kling (1979)
	Eastern Equatorial Atlantic	Plankton	below 150m			Boltovskoy et al. (1996)
	Southern Ocean (Atlantic sector)	Plankton	300-1000m		AAIW factor	Abelmann and Gowing (1997)
	Gulf of Mexico Windward Passage (Atlantic)	Plankton	85-838m		(*L. nupitalis* in the original paper) Subtropical Underwater to Antarctic Intermediate Water	McMillen and Casey (1978)
Lamprocyrtis hannai	Central North Pacific	Plankton	below 750m			Kling (1979)
Lamprocyrtis nigrinae	Central North Pacific	Plankton	below 750m			Kling (1979)
Larcopyle buetschlii	Japan Sea	Plankton	200-300m			Itaki (2003)
	Okhotsk and Oyashio region	Plankton	50-200m(500m)			Okazaki et al. (2004)
	Southern California Current	Plankton	below 200m		coherent deep vertical pattern throughout the area: peak at 200m	Kling and Boltovskoy (1995)
	Eastern Tropical Atlantic	Plankton	below 150m			Boltovskoy et al. (1996)
Larcospira minor	Southern Ocean (Atlantic sector)	Plankton	400-1000m		Northern AAIW factor: Subtropical to Subantarctic region (not in the cold polar region)	Abelmann and Gowing (1997)
	Weddell Sea (Antarctic)	Plankton	0-200, 1000m			Morley and Stepien (1985)
	Central Equatorial Pacific	Plankton	120-200m(500m)			Yamashita et al. (2002)
	Caribbean Sea Gulf of Mexico Windward Passage (Atlantic)	Plankton	0-100m		Surface to Underwater	McMillen and Casey (1978)
Larcospira quadrangula	Southern California	Plankton	0-200m		Equatorial Central Shallow Water	Casey et al (1979)
	Equatorial North Atlantic	Sediment trap	upper 389m		rare	Takahashi and Honjo (1981); Takahashi (1991)
	Central Pacific (25N-25S)	Plankton	25-200m		abundance maxima variable among stations	Renz (1976)
Lipmanella dictyoceras	Southern California current	Plankton	0-50m		more abundant in the warm Central Water imprinting at St. F and A	Kling and Boltovskoy (1995)
	Central North Pacific	Plankton	0-100m			Kling (1979)
	Central Pacific (25N-25S)	Plankton	50-200m		(*Lithopilium sphaerocephalum* in the original paper)	Renz (1976)
	Southern California	Plankton	25-50m	summer peak	(*L. virchowii* in the original paper) stratified Equatorial water incursion in s	Casey et al (1979)
	Southern Ocean (Atlantic sector)	Plankton	0-100m		(*L. virchowii* in the original paper) extend into Subtropical area (shallow warm	Abelmann and Gowing (1997)
Litharachnium tentorium	Central North Pacific	Plankton	50-200m		coincide with salinity minimum, oxygen (chlorophyll α) maxima	Kling (1979)
	Central Equatorial Pacific	Plankton	200-500m			Yamashita et al. (2002)
	Southern California	Plankton	0-200m		Equatorial Central Shallow Water	Casey et al (1979)
	Okhotsk and Oyashio region	Plankton	300-1000m		associate with stable hydrographic condition throughout the year in the intermediate water (showing wide geographic distribution)	Okazaki et al. (2004)
Lithomelissa setosa	Central Equatorial Pacific	Plankton	0-120m		abundant in eastern Upwelling Region of high nutrients= related to the primary production and trophic condition	Yamashita et al. (2002)
	Subarctic Pacific	Sediment trap	*not available*		sensitive to the abundance of background primary producers	Takahashi (1987)
	Greenland Iceland Norwegian sea	Surface sediment	*not available*		east of Norwegian basin: warm water affinity	Bjørklund et al. (1998)
	Greenland Sea (ice edge)	Plankton	0-400m (only)		rare	Swanberg and Eide (1992)
Lithomelissa thoracites	Southern Ocean (Atlantic sector)	Plankton	0-100m		extend into Subtropical area (shallow warm water indicator) (40-45 S)	Abelmann and Gowing (1997)
	Gulf of California	Plankton	0-400m		related to sinking of dense, high salinity surface water caused by summer evaporation and winter cooling	Molina-Cruz et al. (1999)
Lithopera bacca	Central North Pacific	Plankton	surface water		SST dependent (warm water)	Kling (1979)
	Central Pacific (25N-25S)	Plankton	0-75m		present in 10N-25N only	Renz (1976)
	North Pacific	Plankton	0-200m		contains dinoflagellate symbionts	Gowing (1993)
	Equatorial North Atlantic	Sediment trap	upper 389m			Takahashi and Honjo (1981); Takahashi (1991)
Lithostrobus cuspidatus	Gulf of Mexico South California	Plankton	354-1940m below 500m		(*Stichophormis cornutella* and *Cyrtopera languncula* in the original paper)	Casey et al (1979)
	Southern California Current	Plankton	below 300m			Kling and Boltovskoy (1995)
	Equatorial North Atlantic	Sediment trap	389-988m		(*Stichophormis cornutella* and *Cyrtopera languncula* in the original paper	Takahashi and Honjo (1981); Takahashi (1991)
Lophophaena hispida	Central Equatorial Pacific	Plankton	*not available*		equatorial species (strong latitudinal hydrodynamical gradient, and high latitudinal transport of cold, upwelling water off the equator)	Wellin et al. (1996)
	World ocean	Plankton	*no data*		circumtropical form confined to warm surface water but can tolerate considerable temperature and salinity	Petrushevskaya (1971)
Lophospyris pentagona	Equatorial North Atlantic	Sediment trap	upper 389m			Takahashi and Honjo (1981); Takahashi (1991)
Peridium longispinum	Greenland Sea (ice edge)	Plankton	0-400m (only)		no relation to nutrient and chlorophyll α, abundant in eastern advanced blooming area (low nutrient)	Swanberg and Eide (1992)

表1．6

Taxon name	Area	Method	Occurrence	Seasonal flux	Comments	References
Peridium spinipes	Gulf of Mexico	Plankton	0-50m		warm saline surface water	Casey et al (1979)
	South California	Plankton	25-200m	summer peak	stratified Equatorial water incursion in summer	
	Equatorial North Atlantic	Sediment trap	upper 389m			Takahashi and Honjo (1981); Takahashi (1991)
	Central Equatorial Pacific	Plankton	0-120m(500m)			Yamashita et al. (2002)
Peripyramis circumtexta	Central North Pacific	Plankton	1000-2000m			Kling (1979)
	Equatorial North Atlantic	Sediment trap	389-988m			Takahashi and Honjo (1981); Takahashi (1991)
	Gulf of Mexico	Plankton	(354)-1942m		Antarctic Intermediate Water and/or North Atlantic Deep Water	Casey et al (1979)
	South California		200-1000m		Transition Central to Subarctic Intermediate Water	
	Central Pacific (25N-25S)	Plankton	below 200m		(*Bathropyramis* sp. in the original paper)	Renz (1976)
Phormacantha hystrix	Greenland Sea (ice edge)	Plankton	0-400m (only)		rare	Swanberg and Eide (1992)
	Equatorial North Atlantic	Sediment trap	upper 389m			Takahashi and Honjo (1981); Takahashi (1991)
Phormospyris stabilis scaphipes	Central North Pacific	Plankton	50-200m		coincide with salinity minimum, oxygen (chlorophyll α) maxima	Kling (1979)
Phormospyris stabilis stabilis	Central North Pacific	Plankton	50-200m		coincide with salinity minimum, oxygen (chlorophyll α) maxima	Kling (1979)
Phormostichoartus corbula	Central North Pacific	Plankton	50-200m		coincide with salinity minimum, oxygen (chlorophyll α) maxima	Kling (1979)
	Central Pacific (25N-25S)	Plankton	125-200m (only)		restricted in 0N	Renz (1976)
	Equatorial North Atlantic	Sediment trap	389-988m			Takahashi and Honjo (1981); Takahashi (1991)
Phormostichoartus platycephala	Greenland Iceland Norwegian sea	Surface sediment	not available		mixing of Eastern Iceland current and warm Norwegian current ice edge of Greenland	Bjørklund et al. (1998)
Phorticium clevei	Southern Ocean (Atlantic sector)	Plankton	0-100m		Polarfrontal surface water factor: temperature 3.5-5℃, salinity 33.9-34.0‰, North and South of Polar front (45-50S)	Abelmann and Gowing (1997)
	Greenland Sea (ice edge)	Plankton	0-400m (one tow)		rare	Swanberg and Eide (1992)
Plagiacantha panarium	Gulf of California	Plankton	0-100m		coastal upwelling: only reported from Mediterranean Sea (Dumitrica, 1973) in the region of upwelling	Molina-Cruz et al. (1999)
Porodiscus sp. B Nigrini and Moore, 1979	Gulf of California	Plankton	400-700m		abundant in surface sediments of the eastern subtropical Pacific southward expansion of high latitude species due to its winter flux	Molina-Cruz et al. (1999)
Pseudocubus obeliscus	Central Equatorial Pacific	Plankton	0-120m		closely linked with the Upwelling Region of high nutrients	Yamashita et al. (2002)
	Equatorial North Atlantic	Sediment trap	upper 389m			Takahashi and Honjo (1981); Takahashi (1991)
Pseudodictyophimus gracilipes	Central North Pacific	Plankton	100-300m		lower subsurface: salinity maximum between shallow and deep minima	Kling (1979)
	Central Equatorial Pacific	Plankton	120-200m		associated with the chlorophyll-α maximum	Yamashita et al. (2002)
	Southern Ocean (Atlantic sector)	Plankton	400-1000m 100-200m		Circumpolar Deep Water (<2.5℃, 34.5‰) and AAIW factor (global distribution); 100-200m occurrence in Namibia upwelling region	Abelmann and Gowing (1997)
	Southern California Current	Plankton	100-300m			Kling and Boltovskoy (1995)
	Norwegian and Greenland Sea	Sediment trap	upper 500m			Samtleben et al. (1995)
	Equatorial North Atlantic	Sediment trap	upper 389m		more abundant in deeper trap	Takahashi and Honjo (1981); Takahashi (1991)
	Norwegian and Greenland Sea	Sediment trap	upper 500m			Samtleben et al. (1995)
	Greenland Iceland Norwegian sea	Surface sediment	not available		Western GIN sea: Atlantic water and mixing of warm and cold water ice edge of Greenland	Bjørklund et al. (1998)
	western Arctic Ocean	Plankton	0-50m		Arctic Surface Water (low temperature, low salinity) habitat	Itaki et al. (2003)
	Greenland Sea (ice edge)	Plankton	0-400m (one tow)		correlated to nutrient, dominant in ice edge (early phytoplankton bloom) =rich in nutrient, low chlorophyll α	Swanberg and Eide (1992)
	Okhotsk Sea	Sediment trap	(0-300m)-1500m		rare and few flux in upper 300m and 700m trap; abundant in 1500m trap	Okazaki et al. (2003)
		Piston core	*not available*			
	Okhotsk Sea	Sediment trap	258-1061m	autumn peak		Hays and Morley (2003)
	Okhotsk and Oyashio region	Plankton	50-300m(1000m)			Okazaki et al. (2004)
Pterocanium praetextum	Southern California current	Plankton	0-50m		more abundant in the warm Central Water imprinting at St. F and A	Kling and Boltovskoy (1995)
	Central North Pacific	Plankton	surface water		SST dependent (warm water)	Kling (1979)
	Equatorial North Atlantic	Sediment trap	upper 389m			Takahashi and Honjo (1981); Takahashi (1991)
	Gulf of Mexico	Plankton	0-50m		warm saline surface water	Casey et al (1979)
	South California	Plankton	0-200m		Equatorial Central Shallow Water	
	Central Pacific (25N-25S)	Plankton	0-75m		all latitudes (abundant in 0-10S)	Renz (1976)
	Gulf of Mexico	Plankton	0-50m		surface water group	McMillen and Casey (1978)
	Windward Passage (Atlantic)		0-100m			
Pterocanium trilobum	Southern California current	Plankton	0-50m		more abundant in the warm Central Water imprinting at St. F and A	Kling and Boltovskoy (1995)
	Southern California	Plankton	0-200m		Equatorial Central Shallow Water	Casey et al (1979)
	Central Pacific (25N-25S)	Plankton	0-200m (only)		abundance maxima variable among stations	Renz (1976)

表1．7

Taxon name	Area	Method	Occurrence	Seasonal flux	Comments	References
Pterocorys clausus/zancleus	Southern Ocean (Atlantic sector)	Plankton	0-200m (500-1000m)		Upper to lower Subantarctic water factor down to intermediate depth	Abelmann and Gowing (1997)
	Gulf of Mexico South California	Plankton	0-50m		warm saline surface water	Casey et al (1979)
			0-200m		Equatorial Central Shallow water	
	Caribbean Sea Gulf of Mexico Windward Passage (Atlantic)	Plankton	0-100m		warm saline surface water	McMillen and Casey (1978)
	Southern California Current	Plankton	0-100m		more preferable to the Central Water (St. F) much more abundant than the warm, oligotrophic Central North Pacific	Kling and Boltovskoy (1995)
	Equatorial North Atlantic	Sediment trap	upper 389m		very abundant in this site (13N, 54W)	Takahashi and Honjo (1981); Takahashi (1991)
Pterocorys hertwigii	Southern California current	Plankton	0-50m		more abundant in the warm Central Water imprinting at St. F and A	Kling and Boltovskoy (1995)
	Gulf of Mexico South California	Plankton	85-172m		Subtropical Underwater indicator	Casey et al (1979)
			0-200m	autumn peak	North Central Shallow Water (short lived in autumn)	
	Central Pacific (25N-25S)	Plankton	0-75m		abundant in 5-10N	Renz (1976)
	Caribbean Sea	Plankton	49-197m		Subtropical Underwater	McMillen and Casey (1978)
Rhizoplegma boreale	Okhotsk Sea	Plankton	50-200m		Subsurface water: near freezing temperature minimum (-1.7~1℃) more abundant in the eastern part off Kamchatka during summer	Nimmergut and Abelmann (2002)
	Okhotsk Sea	Plankton	150-200m		maximum below Sea of Okhotsk Dichothermal Line different seasonal flux maximum among each area in Okhotsk Sea, showing latitudinal migration during the year	Abelmann and Nimmergut (2004)
	Okhotsk Sea	Sediment trap	upper 300m	autumn peak	no significant seasonal flux change	Okazaki et al. (2003)
		Piston core	*not available*		abundant during MIS 1, associated with climate transition of deglaciation	
	Okhotsk Sea	Sediment trap	upper 258m	spring peak	occurs concomitantly with phytoplankton blooms	Hays and Morley (2003)
	Okhotsk and Oyashio region	Plankton	50-300m		more abundant in Okhotsk region associated with higher productivity in this area than Oyashio region	Okazaki et al. (2004)
	Bering Sea, Subarctic Pacific	Sediment trap	*not available*	autumn peak	flux much higher in Bering Sea than Subarctic Pacific	Itaki and Takahashi (1995)
	Norwegian and Greenland Sea	Sediment trap	upper 500m			Samtleben et al. (1995)
	Greenland Iceland Norwegian sea	Surface sediment	*not available*		abundance maximum (3.5 %) in mixing of nutrient rich water masses and a high primary production transition zone between cold- and warm-water	Dolven and Bjørklund (2001) Bjørklund et al. (1998)
Saturnalis circularis	Central Pacific (25N-25S)	Plankton	below 200m			Renz (1976)
Sethoconus cf. *dogieli*	Southern California Current	Plankton	below 300m		rare and difficult to define reliable vertical trend	Kling and Boltovskoy (1995)
Siphocampe arachnea	Southern California Current	Plankton	below 300m		rare and difficult to define reliable vertical trend	Kling and Boltovskoy (1995)
Siphocampe lineata	Greenland Iceland Norwegian sea	Surface sediment	*not available*		northern and central Norwegian basin mixing of cold and warm water geographic distribution confined to high northern latitude	Bjørklund et al. (1998)
	Hawaii Panama basin	Sediment trap	below 600m			Takahashi (1991)
	Eastern Equatorial Atlantic	Sediment trap	upper 853m		generally cold water species (from sediment data), possibly living below 300-400m in the tropics and subtropics	Boltovskoy et al. (1993)
	Hawaii Panama basin	Sediment trap	389-988m			Takahashi (1991)
			upper 667m		abundant	
Siphocampe nodosaria	Equatorial North Atlantic	Sediment trap	389-988m		morphologically resembles to *S. lineata* and *S. arachnea*	Takahashi and Honjo (1981); Takahashi (1991)
Siphonosphaera polysiphinia	Eastern Equatorial Atlantic	Plankton	0-50-(100m)		warm oligotrophic condition	Boltovskoy et al. (1996)
	Eastern Equatorial Atlantic	Plankton	0-50m			Dworetzky and Morley (1987)
	Equatorial North Atlantic	Sediment trap	upper 389m			Takahashi and Honjo (1981); Takahashi (1991)
	Central North Pacific	Plankton	0-100m			Kling (1979)
	Southern Ocean (Atlantic sector)	Plankton	0-100m		Namibia upwelling regime	Abelmann and Gowing (1997)
Spongaster t. tetras/irregularis	Central North Pacific	Plankton	surface water		SST dependent (warm water)	Kling (1979)
	Central Pacific (25N-25S)	Plankton	0-75m			Renz (1976)
	Eastern Equatorial Atlantic	Plankton	0-50m		warm oligotrophic condition	Boltovskoy et al. (1996)
	Eastern Equatorial Atlantic	Plankton	0-50m		peak above chlorophyll α maxima	Dworetzky and Morley (1987)
	Equatorial North Atlantic	Sediment trap	upper 389m			Takahashi and Honjo (1981); Takahashi (1991)
	Gulf of Mexico South California	Plankton	0-50m		warm saline surface water	Casey et al (1979)
			0-200m		Equatorial Central Shallow Water	
	west of Barbados	Culture	surface water	early summer peak	chlorophyll α related to the size of the organism, but has no relation to its abundance, and low salinity may be harmful	Anderson et al. (1989a)

表1．8

Taxon name	Area	Method	Occurrence	Seasonal flux	Comments	References
Spongaster t. tetras/irregularis (continued)	west of Barbados	Culture	surface water		maximum growth and longevity are achieved at warm temperature (27.5℃), high salinity (40‰). above 31℃ suppressed grows	Anderson et al. (1989b)
	west of Barbados	Culture	surface		sometimes bear algal symbionts	Sugiyama and Anderson (1997)
	Eastern Equatorial Atlantic	Plankton	0-100m		abundant at or near chlorophyll α maxima	Dworetzky and Morley (1987)
	Gulf of Mexico Caribbean Sea	Plankton	0-50m		warm saline surface water	McMillan and Casey (1978)
Spongocore puella	Central North Pacific	Plankton	100-300m-(1000m)		lower subsurface: salinity maximum between shallow and deep minima	Kling (1979)
	Central Equatorial Pacific	Plankton	120-200m(500m)		(*S. cylindricus* in the original paper) not synchronous with temperature and nutrients = contribution of depth and other physical parameter	Yamashita et al. (2002)
	Eastern Tropical Atlantic	Plankton	below 150m			Boltovskoy et al. (1996)
	Equatorial North Atlantic	Sediment trap	upper 389m		(*Spongurus cylindrica* in the original paper)	Takahashi and Honjo (1981); Takahashi (1991)
	Southern California	Plankton	0-200m		Equatorial Central Shallow Water	Casey et al (1979)
	Southern California Current	Plankton	100m		much more abundant than the warm, oligotrophic Central North Pacific	Kling and Boltovskoy (1995)
	Eastern Equatorial Atlantic	Plankton	100-200m (max)			Dworetzky and Morley (1987)
Spongodiscus resurgens	Central North Pacific	Plankton	50-200m		coincide with salinity minimum, oxygen (chlorophyll α) maxima	Kling (1979)
	Eastern Tropical Atlantic	Plankton	50-150m			Boltovskoy et al. (1996)
	Eastern Equatorial Atlantic	Plankton	0-50m		peak above chlorophyll α maxima	Dworetzky and Morley (1987)
	Equatorial North Atlantic	Sediment trap	upper 389m		(*Spongodiscus* spp. B group in the original paper)	Takahashi and Honjo (1981); Takahashi (1991)
	Central Pacific (25N-25S)	Plankton	0-50m			Renz (1976)
Spongopyle osculosa	Southern Ocean (Atlantic sector)	Plankton	300-1000m 0-200m		living in relatively colder and deeper waters (broader depth habitat) factor extends into SACW and Antarctic Intermediate Water (global distribution); 0-200m occurrence in Namibia upwelling regime	Abelmann and Gowing (1997)
	Weddell Sea (Antarctic)	Plankton	below 200m			Morley and Stepien (1985)
	Gulf of California	Plankton	200-400m		Gulf of California Water, subsurface water caused by subduction	Molina-Cruz et al. (1999)
	Southern California Current	Plankton	300-1000m			Kling and Boltovskoy (1995)
	Eastern Tropical Atlantic	Plankton	below 150m			Boltovskoy et al. (1996)
	Gulf of Mexico South California Sargasso Sea	Plankton	(354)-1942m 200-500m 200-1000m		Antarctic Intermediate Water and/or North Atlantic Deep Water Transition Central Water intermediate water group	Casey et al (1979)
	Gulf of Mexico Windward Passage (Atlantic)	Plankton	848-1492m 198-689m		Deep Water indicator (AAIW or NADW mixed with MOW)	McMillen and Casey (1978)
	Okhotsk and Oyashio region	Plankton	200-1000m 0-100-(500m)		intermediate in the Okhotsk Sea, while surface water in the Oyashio Water associated with unfavorable surface condition in the Okhotsk	Okazaki et al. (2004)
Spongotrochus glacialis	Okhotsk Sea	Plankton	0-50m		only juvenile form abundant (high adaptation capability to low temperature and low salinity)	Nimmergut and Abelmann (2002)
	Okhotsk Sea	Plankton	0-50m(150-200m)		sea-ice coverage in winter and warming of surface up to 14℃ in summer occurs in the upper 50m during summer, whereas it goes down to 150-200m in spring when sea-surface stratification is not yet developed	Abelmann and Nimmergut (2004)
	Okhotsk and Oyashio region	Plankton	50-200m(500m)		associated with phytoplankton production	Okazaki et al. (2004)
	Weddell Sea (Antarctic)	Plankton	0-200m		most abundant in Weddell Sea	Morley and Stepien (1985)
	Southern Ocean (Atlantic sector)	Surface sediment	surface water		-1 to 11℃	Abelmann et al. (1999)
	Southern Ocean (Atlantic sector)	Plankton	upper 100m		Polar frontal surface water factor: temperature 3.5-5 ℃, salinity 33.9-34.0‰, North of Polar front (45-50S)	Abelmann and Gowing (1997)
	Eastern Tropical Atlantic	Plankton	50-150m			Boltovskoy et al. (1996)
	western Arctic Ocean	Plankton	25-300 (500)m		Arctic Surface Water habitat	Itaki et al. (2003)
	Gulf of Mexico South California Sargasso Sea	Plankton Plankton Plankton	848-1942m 0-200m 200-1000m		Deep water Equatorial Central Shallow Water (east boundary upwelling) standing crop four times greater than in the Gulf of Mexico	Casey et al (1979)
	Central Pacific (25N-25S)	Plankton	0-75m		(*S. multispinus* in the original paper) abundant only in 10N	Renz (1976)
	Eastern Equatorial Atlantic	Plankton	0-200m		abundant at or near chlorophyll α maxima	Dworetzky and Morley (1987)
low latitude site (shaded)	Caribbean Sea Gulf of Mexico Windward Passage (Atlantic)	Plankton	50-100-(700m) 100-400m 198-686m		abundant especially in neritic environment (0-100m in the Texas shelf)	McMillen and Casey (1978)
	Greenland Sea (ice edge)	Plankton	0-400m (one tow)		rare	Swanberg and Eide (1992)
Spongurus (?) sp.	Southern Ocean (Atlantic sector)	Plankton	400-1000m		Circumpolar Deep Water factor: temperature<2.5℃, salinity>34.5‰	Abelmann and Gowing (1997)
	Southern California Current	Plankton	below 300m		abundance peak at around 500m	Kling and Boltovskoy (1995)

表1．9

Taxon name	Area	Method	Occurrence	Seasonal flux	Comments	References
Stylochlamydium asteriscus	Central Equatorial Pacific	Plankton	surface water	increase in El Nino	confined in surface water above thermocline which is advected from the Western Pacific (North Equatorial Countercurrent)	Welling et al. (1996)
	Eastern Tropical Atlantic	Plankton	below 150m			Boltovskoy et al. (1996)
	Equatorial North Atlantic	Sediment trap	upper 389m			Takahashi and Honjo (1981); Takahashi (1991)
	Central Gulf of Mexico Windward Passage (Atlantic)	Plankton	200-300-800m		Subtropical Underwater to Antarctic Intermediate Water	McMillen and Casey (1978)
Stylochlamydium venustum	Okhotsk Sea	Plankton	0-50m		only juvenile form abundant (high adaptation capability to low temperature and low salinity)	Nimmergut and Abelmann (2002)
	Okhotsk Sea	Plankton	0-50m(150-200m)		sea-ice coverage in winter and warming of surface up to 14℃ in summer occurs in the upper 50m during summer, whereas it goes down to 150-200m in spring when sea-surface stratification is not yet developed.	Abelmann and Nimmergut (2004)
	Okhotsk Sea	Sediment trap	shallow water	spring peak	spring maxima of *S. venustum* synchronous to the diatom production peak, showing direct relation to the phytoplankton production (Abelmann and Nimmergut, 2005)	Hays and Morley (2003)
	Okhotsk and Oyashio region	Plankton	50-200m(500m)		associated with phytoplankton production	Okazaki et al. (2004)
	Southern Ocean (Atlantic sector)	Plankton	upper 100m		Polar frontal surface water factor: temperature 3.5-5 ℃, salinity 33.9-34.0‰, North of Polar front (45-50S)	Abelmann and Gowing (1997)
Stylodictya validispina	Central Equatorial Pacific	Plankton	0-120m		(including *S. multispina* in the original paper) closely linked with the Upwelling	Yamashita et al. (2002)
	Central Pacific (25N-25S)	Plankton	0-200m (only)		(*S.multispina* in the original paper) no pronounce peak	Renz (1976)
	Eastern Tropical Atlantic	Plankton	50-150m		(*S.multispina* in the original paper)	Boltovskoy et al. (1996)
	Central Pacific (25N-25S)	Plankton	0-75m		abundant in 0-10N	Renz (1976)
	Caribbean Sea Windward Passage (Atlantic)	Plankton	0-197m		(*S. multispina*) Surface to Underwater	McMillen and Casey (1978)
	Okhotsk and Oyashio region	Plankton	200-1000m 0-100-(500m)		intermediate in the Okhotsk Sea, while surface water in the Oyashio Water associated with unfavorable surface condition in the Okhotsk	Okazaki et al. (2004)
Tetrapyle octacantha	Central North Pacific	Plankton	surface water		SST dependent (warm water)	Kling (1979)
Pyloniidae	Central Equatorial Pacific	Plankton	0-120m		abundance increases eastward (possible upwelling indicator)	Yamashita et al. (2002)
	Southern Ocean (Atlantic sector)	Plankton	0-100m		in Namibia upwelling regime	Abelmann and Gowing (1997)
	Central Equatorial Pacific	Plankton	*not available*		subtropical factor overlain by contours of meridional velocity: primary found in southward-flowing waters.	Welling et al. (1996)
	Gulf of California	Plankton	0-100-(200m)		Subtropical surface water	Molina-Cruz et al. (1999)
	Southern California Current	Plankton	0-50m		more abundant in the warm Central Water imprinting at St. F and A	Kling and Boltovskoy (1995)
	Central Pacific (25N-25S)	Plankton	0-75m		abundant in 10N-15S	Renz (1976)
	Eastern Equatorial Atlantic	Plankton	0-50m		warm oligotrophic condition	Boltovskoy et al. (1996)
	Eastern Equatorial Atlantic	Plankton	0-200m		peak below chlorophyll α maxima	Dworetzky and Morley (1987)
	Equatorial North Atlantic	Sediment trap	upper 389m			Takahashi and Honjo (1981); Takahashi (1991)
	Caribbean Sea Gulf of Mexico Windward Passage (Atlantic)	Plankton	0-100m		Surface to Subtropical Underwater, especially abundant in the Windward Passage (high salinity >36.5‰)	McMillen and Casey (1978)
Theocorys veneris	Central Equatorial Pacific	Plankton	0-120m			Yamashita et al. (2002)
	Central North Pacific	Plankton	50-200m		coincide with salinity minimum, oxygen and chlorophyll α maxima	Kling (1979)
	Southern California Current	Plankton	0-100m		more preferable to the Central Water (St. F)	Kling and Boltovskoy (1995)
	Central Pacific (25N-25S)	Plankton	0-125m		abundance maxima variable among stations	Renz (1976)
	Equatorial North Atlantic	Sediment trap	upper 389m			Takahashi and Honjo (1981); Takahashi (1991)
Theocorythium trachelium	Southern Ocean (Atlantic sector)	Plankton	0-100m		extend into Subtropical area (shallow warm water indicator) (40-45 S)	Abelmann and Gowing (1997)
	Eastern Equatorial Atlantic	Plankton	50-200m (max)			Dworetzky and Morley (1987)
	Southern California current	Plankton	0-50m		warm Central Water imprinting	Kling and Boltovskoy (1995)
	Southern California	Plankton	0-200m	autumn peak	North Central Shallow Water (short lived in autumn)	Casey et al (1979)
	Central North Pacific	Plankton	0-100m			Kling (1979)
	Central Pacific (25N-25S)	Plankton	0-125m		present but rare	Renz (1976)