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SHORT NOTE

ANNUAL CHANGES IN SPECIES COMPOSITION AND ABUNDANCE OF MYCTOPHID FISH IN THE NORTH OF SOUTH GEORGIA (SUBAREA 48.3), ANTARCTICA, DURING AUSTRAL WINTERS FROM 2002 TO 2008

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Abstract

Species composition and abundance of myctophid fish were analysed using the fish by-catch samples collected by scientific observers on board Japanese commercial krill fishing vessels in the area north and northwest of South Georgia, Antarctica, during austral winters from 2002 to 2008. A total of 10 myctophid species were identified in the by-catch samples, among which *Krefftichthys anderssoni*, *Gymnoscopelus nicholsi* and *Protomyctophum choriodon* were abundant. Different life stages of *K. anderssoni* and *G. nicholsi* from larvae to adults were found, suggesting that these species may have their nursery ground around South Georgia. *Electrona antarctica* was not a major component of the recent mesopelagic ichthyofauna in this area, although this species used to be dominant in the Antarctic coastal waters. In contrast, *P. choriodon*, which is known as a south temperate species, became dominant in recent samples. Additionally, the size distribution of *P. choriodon* was unimodal, indicating that individuals in the samples belonged to the same size group and probably migrated from the population in warmer northern areas.

Key words: Antarctic krill, by-catch, Myctophidae, Scotia Sea, species composition, annual change, CCAMLR

Introduction

CCAMLR has expressed concerns about the impact of incidental catch in the krill fishery on some fish stocks, and recommended that those countries participating in the krill trawl fishery collect scientific data on fish by-catch. Japan initiated on-board scientific observer activities in the 1989/90 fishing season to collect information on the incidental catch of juvenile fish (Kiyota and Iida, 2009). Through scientific observations and sampling on Japanese commercial fishing vessels, it became apparent that myctophid fish constituted an important part of small fish species caught incidentally in the krill trawl fishery.

As pointed out by Collins et al. (2008), the ecological role of myctophid fish is very important

in the Southern Ocean. Especially their potential role as a krill-alternative pathway in the Antarctic marine food web is attracting a great deal of attention (Murphy et al., 2007). Although information on the fine-scale distribution of myctophid fish in some areas of the Southern Ocean has been accumulated, data on interannual variation in their abundance and geographical range are scarce. Since myctophids are a good indicator of water mass, temporal changes in species composition of myctophids may reflect the oceanographic and climatic changes in the Antarctic Ocean. This paper reports the interannual variability of species composition and abundance of myctophid fish and length-frequency distribution for the dominant species in the area north of South Georgia (Subarea 48.3), Antarctica, based on the fish by-catch samples collected by the Japanese scientific observers on board commercial krill trawl vessels.

Material and methods

The by-catch of fish in krill catches was collected by scientific observers on board Japanese commercial krill fishing vessels. A total of 1 173 net hauls of a midwater trawl, carried out during the austral winter months from 2002 to 2008 in the north and northwest of South Georgia, were surveyed (Figure 1). Only the 2003 survey was performed by the FV *Chiyo Maru No. 5*; the others were undertaken by the FV *Niitaka Maru*. An Otter midwater trawl of ca. 100 m long with a horizontal opening of ca. 20 m and a vertical opening of ca. 30 m was used throughout the survey. Inner meshes of the net were ca. 15 mm at the codend. Sampling data of hauls containing by-catch of myctophid fish are given in Appendix 1. The by-catch of fish was sorted from a random sub-sample of ca. 50 kg (33.6–75.5 kg) of krill in each haul. Fish samples were stored frozen or fixed in 10% seawater formalin and brought back to Japan. All the myctophid fish were identified and counted later in the laboratory, because species identification of myctophids is too difficult for on-board scientific observers.

Results and discussion

A total of 1 203 specimens of Myctophidae belonging to 10 species (i. e. *Electrona antarctica*, *E. carlsbergi*, *Gymnoscopelus braueri*, *G. nicholsi*, *Krefftichthys anderssoni*, *Protomyctophum andriashevi*, *P. bolini*, *P. choriodon*, *P. gemmatum* and *P. tenisoni*, were obtained as by-catch of fish from 2002 to 2008 (Table 1). The total catch of myctophid fish in 2004 was relatively higher than in other years. This is because of the sampling locations of the 2004 survey which were mostly situated in offshore areas over 500 m depth (Figure 1). Among the by-catch of myctophids as a whole, the most common species in number were *K. anderssoni*, *G. nicholsi* and *P. choriodon*. The former two species are known to occur throughout the Southern Ocean from the Antarctic divergence to the Polar Front and further north to ca. 35°S (Hulley, 1981, 1990; McGinnis, 1982). Collins et al. (2008) recorded 15 myctophid species from the northwest of South Georgia during austral autumn, with the abovementioned three species being abundant along with another five species, *E. carlsbergi*, *E. antarctica*, *P. bolini*, *G. braueri* and *G. fraseri*.

Electrona antarctica was considered to be one of the most abundant mesopelagic fish in the Antarctic coastal waters in the Southern Ocean (Hulley, 1981, 1990; Iwami and Kubodera, 1990; Duhamel, 1998; Pusch et al., 2004). However, *E. antarctica* has not been found in Japanese by-catch samples since 2005 and may not be a major component of mesopelagic ichthyofauna in South Georgia in winter. None of the factors influencing the change of distribution and biomass of *E. antarctica* is properly understood as yet, but it is likely that the environmental changes are reflected in the mesopelagic ichthyofauna.

In contrast, the current biomass of *P. choriodon* could be higher than that in 2002 or earlier when Hulley (1990) described only a few records from the Southern Ocean. Reid et al. (2006) reported the occurrence of *P. choriodon* from the diet of Antarctic fur seals at South Georgia in austral autumn, and the occurrence suggested seasonal migration of this species associated with warmer surface waters (Collins et al., 2008). Olsson and North (1997) pointed out that *P. choriodon* was rare or absent in early summer but more important later and the dominant prey for king penguins at South Georgia. The observation results also suggested seasonal migration of *P. choriodon*. The size distribution of *P. choriodon* was mostly unimodal with no significant differences among years (Figure 2a). The size composition suggests that this species may migrate south from the mother population located to the north of the Antarctic Polar Front. In contrast, the size compositions of *K. anderssoni* (Figure 2b)

Table 1: Occurrence of myctophid species in by-catch. Rate of occurrence is shown as percentage of the number of hauls containing each species (taxa) to the total number of hauls containing fish by-catch.

Date:	2002	2003	2004	2005	2006	2007	2008
	13 Jul–18 Aug	8 Aug–16 Sep	6 Aug–9 Sep	8 Jul–13 Aug	17 Jul–25 Aug	6 Aug–30 Aug	13 May–9 Aug
No. hauls examined:	101	279	100	227	183	87	196
No. hauls with fish by-catch:	44	34	76	132	66	26	102
Myctophidae	38.6	32.4	67.8	34.1	9.1	69.2	52.0
E. antarctica	0.0	5.9	17.8	0.0	0.0	0.0	0.0
E. carlsbergi	0.0	0.0	0.0	0.0	0.0	0.0	1.0
K. anderssoni	11.4	23.5	25.6	25.0	7.6	38.5	11.8
G. braueri	2.3	2.9	2.2	0.0	0.0	0.0	0.0
G. nicholsi	11.4	0.0	38.9	4.5	1.5	0.0	6.9
P. andriashevi	0.0	0.0	0.0	3.8	0.0	0.0	0.0
P. bolini	0.0	2.9	4.4	3.8	0.0	0.0	0.0
P. choriodon	15.9	0.0	15.6	2.3	0.0	15.4	38.2
P. gemmatum	0.0	0.0	0.0	0.0	0.0	0.0	2.0
P. tenisoni	6.8	0.0	14.4	0.8	0.0	15.4	3.9

and *G. nicholsi* (Figure 2c) were slightly broader and multi-modal, indicating that these species may have their nursery grounds in the seas surrounding South Georgia.

Results of this study demonstrated possible changes in the distribution pattern and abundance of myctophid fish in South Georgia. Since the distribution patterns of myctophid fish are related to the oceanographic structure of water masses, the shifts in species composition may demonstrate oceanographic and climatic changes in the Antarctic Ocean. Long-term monitoring of ichthyofauna through the scientific observer program and close examination of the biological samples would provide important information on life-history traits of fish and environmental fluctuations in the Southern Ocean.

Conclusions

(i) *Electronoa antarctica* was considered to be one of the most abundant mesopelagic fish in Antarctic coastal waters. However, this species has not been found in Japanese trawl by-catch samples since 2005 and may not be a major component of mesopelagic ichthyofauna in South Georgia in winter.

(ii) The current biomass of *P. choriodon* could be higher than that in 2002 or earlier in the area north of South Georgia. Its unimodal size distribution suggests that this species may migrate south from the mother population located to the north of the Antarctic Polar Front.

(iii) Annual changes and shifts in myctophid species composition may demonstrate oceanographic and climatic changes in the Southern Ocean. Long-term monitoring of ichthyofauna through the scientific observer program and close examination of the biological samples, therefore, would provide important information on environmental fluctuations in the Southern Ocean.

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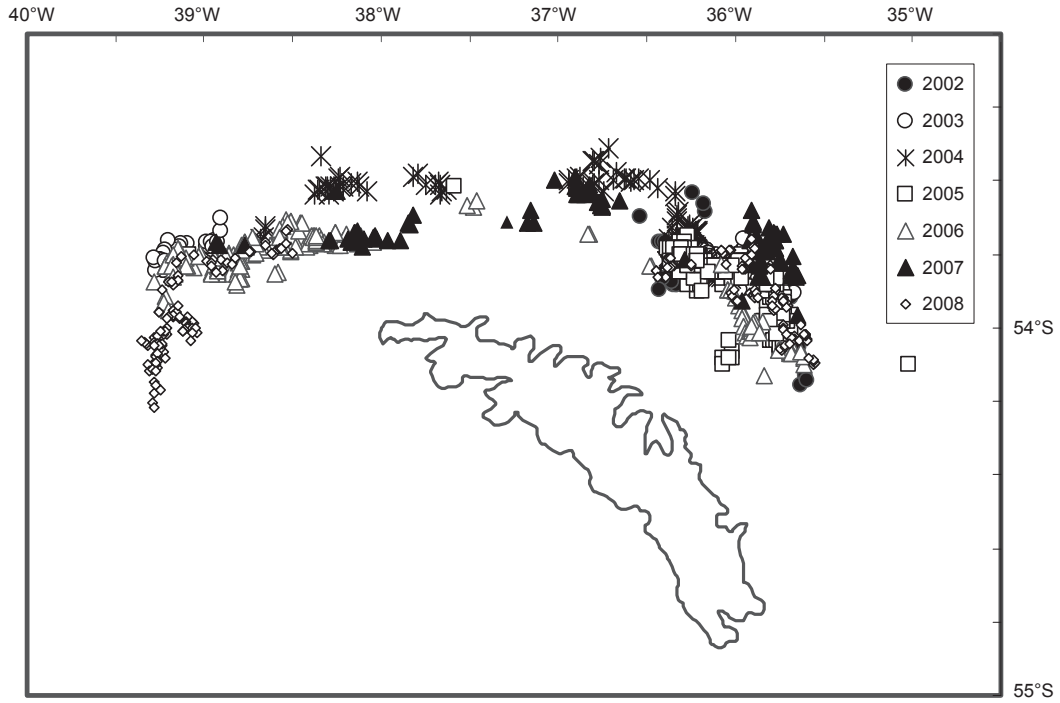

Figure 1: Sampling locations of by-catch of fish collected by scientific observers on Japanese krill fishing vessels during austral winters from 2002 to 2008.

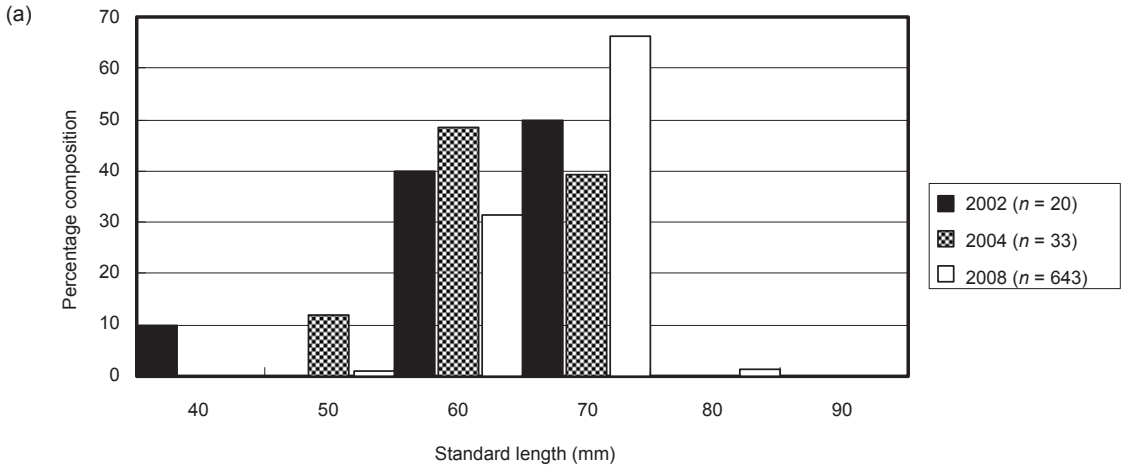

Figure 2: Length-frequency distributions of three abundant species of myctophid fish: (a) *Protomyctophum choriodon*.

(continued)

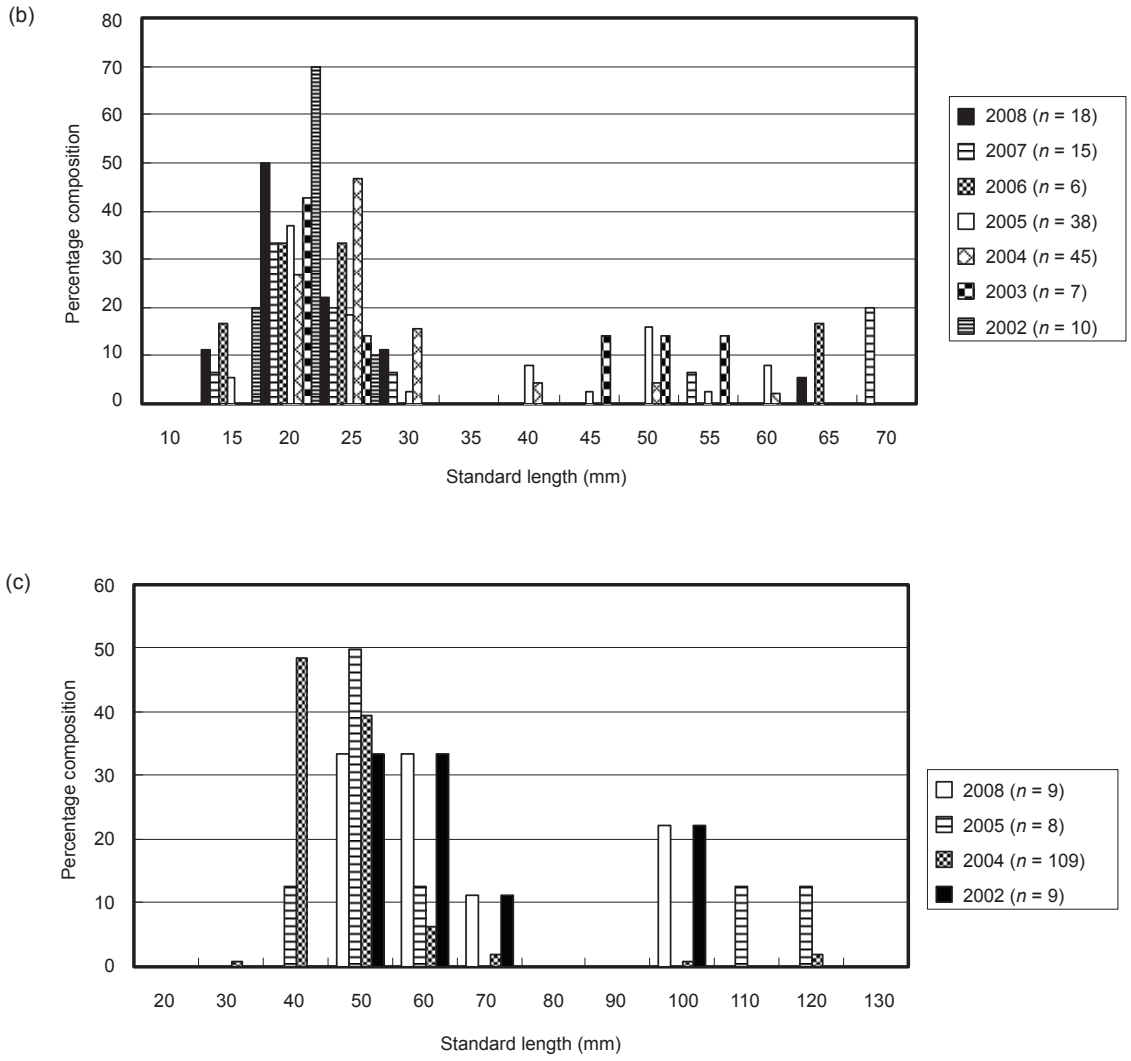

Figure 2 (continued): Length-frequency distributions of three abundant species of myctophid fish: (b) *Krefftichthys anderssoni*, (c) *Gymnoscopelus nicholsi*.

Appendix

Details of net hauls for analysing the by-catch of myctophid fish carried out by Japanese commercial krill fishing vessels during the austral winter from 2002 to 2008 in the north and northwest of South Georgia. Haul positions are recorded for the starting point of each haul. The number of individuals of myctophids sorted out from random sub-samples is shown in the parentheses. Abbreviations of taxa: Ea – *Electrona antarctica*; Ec – *Electrona carlsbergi*; Gb – *Gymnoscopelus braueri*; Gn – *Gymnoscopelus nicholsi*; Ka – *Krefftichthys anderssoni*; Pa – *Protomyctophum andriashevi*; Pb – *Protomyctophum bolini*; Pc – *Protomyctophum choriodon*; Pg – *Protomyctophum gemmatum*; Pt – *Protomyctophum tenisoni*.

Date (YYMMDD)	Haul No.	Start time	Duration (min)	Latitude (S)	Longitude (W)	Trawl depth (m)	Water depth (m)	By-catch of myctophids
020714	003	7:55	65	53.888	35.822	160	200	Ka(3)/Pc(3)
020714	011	22:40	65	53.917	35.688	180	600	Pc(1)
020715	015	6:45	55	53.873	35.783	160	500	Pc(9)/Pt(1)
020715	020	16:30	10	53.887	35.757	150	1000	Pc(1)
020716	029	18:00	35	53.948	35.737	145	248	Ka(1)
020717	033	0:55	50	53.952	35.755	230	229	Pc(1)
020717	034	3:00	35	53.942	35.765	180	268	Pc(2)
020725	119	3:10	45	53.830	35.905	150	-	Gn(3)
020727	157	19:40	55	53.843	35.885	160	-	Gn(1)
020727	159	23:20	35	53.820	35.838	120	-	Pc(1)
020728	161	3:15	50	53.832	35.825	90	-	Pt(1)
020803	219	3:00	30	53.823	35.927	160	-	Gn(1)/Ka(1)
020808	297	22:55	65	53.827	36.022	110	340	Ka(1)
020809	302	8:40	25	53.852	36.365	110	229	Ka(1)
020813	354	23:25	35	53.827	36.163	160	-	Gn(1)
020814	368	20:10	75	53.835	36.222	100	162	Gn(1)
020817	391	21:20	55	53.683	36.170	120	-	Gb(1)/Pt(4)
030809	1592	17:50	45	53.787	38.953	200	350	Ka(2)
030810	1598	13:00	30	53.845	36.092	180	570	Ka(1)
030814	1647	4:40	50	53.815	36.043	200	724	Gb(1)/Ka(1)
030815	1669	19:55	30	53.832	35.838	200	576	Pb(1)
030826	1800	19:35	25	53.813	36.145	140	1028	Ea(1)
030828	1802	23:00	30	53.807	36.142	140	1117	Ka(1)
030830	1831	10:55	10	53.897	35.960	80	205	Ka(1)
030830	1832	12:35	15	53.890	35.915	90	220	Ka(1)
030901	1852	5:35	40	53.850	35.960	150	255	Ka(1)
030905	1904	12:15	40	53.905	35.668	70	1045	Ka(1)
030905	1909	23:25	55	53.763	35.938	90	897	Ea(1)
040806	291	17:45	55	53.830	36.368	160	231	Ka(2)
040807	297	05:00	50	53.817	36.375	170	226	Ka(1)
040807	304	18:20	55	53.822	36.303	160	227	Ka(1)
040808	315	22:55	50	53.800	36.343	160	231	Gn(2)
040809	316	00:55	45	53.767	36.350	160	290	Gn(6)
040809	317	02:40	50	53.777	36.347	170	306	Gn(2)/Pc(2)
040809	325	18:10	75	53.782	36.353	140	305	Ea(1)/Gn(1)
040809	326	20:20	45	53.772	36.255	115	-	Ea(1)/Gn(2)
040810	330	03:05	65	53.782	36.220	120	-	Gn(1)/Pc(2)
040810	337	16:00	55	53.760	36.257	165	788	Pc(1)
040810	340	21:55	65	53.760	36.268	80	931	Gn(3)
040811	344	06:05	55	53.782	36.262	90	601	Pt(5)
040811	345	08:00	65	53.783	36.258	140	850	Ka(1)
040811	350	17:35	45	53.815	36.157	140	996	Ea(1)/Pt(7)

Date (YYMMDD)	Haul No.	Start time	Duration (min)	Latitude (S)	Longitude (W)	Trawl depth (m)	Water depth (m)	By-catch of myctophids
040811	351	19:20	55	53.840	36.137	180	315	Ka(1)/Pt(1)
040811	352	21:35	65	53.838	36.137	220	525	Gn(1)/Ka(1)/Pb(1) /Pc(1)
040812	356	05:45	60	53.852	36.103	250	431	Gn(3)/Pc(3)/Pt(1)
040812	362	17:20	55	53.867	36.025	240	416	Ea(1)/Pc(1)
040813	365	23:55	55	53.860	36.078	210	389	Ka(3)
040813	366	02:00	55	53.853	36.075	200	475	Gn(3)/Ka(1)/Pc(1)
040813	373	18:30	60	53.863	36.112	135	185	Pt(1)
040814	378	04:50	55	53.835	36.155	220	329	Gn(2)/Pb(1)/Pc(2)
040814	386	20:20	60	53.827	36.198	195	330	Gn(3)/Ka(4)
040815	391	07:40	55	53.817	36.232	210	365	Ka(1)/Pb(3)
040815	396	16:45	60	53.822	36.197	220	500	Ka(1)
040815	398	20:40	50	53.837	36.128	205	482	Gn(1)/Ka(5)
040816	400	01:00	40	53.825	36.187	200	412	Gn(1)/Ka(5)/Pc(2)
040816	401	02:55	45	53.813	36.215	220	705	Gb(1)/Gn(13)/ Ka(5)/Pc(7)/Pt(1)
040816	410	20:20	60	53.803	36.293	200	225	Ka(3)
040816	411	22:40	60	53.807	36.322	195	218	Ka(2)/Pt(1)
040819	416	23:55	60	53.812	36.223	180	610	Gn(1)
040819	427	21:50	60	53.802	36.270	155	580	Ka(2)
040821	442	04:30	60	53.813	36.198	150	865	Gn(2)
040822	455	18:50	60	53.780	36.308	130	391	Ea(1)
040824	474	06:30	60	53.725	36.268	145	794	Pc(4)
040824	481	19:10	60	53.728	36.243	110	842	Ea(2)/Gb(1)
040825	485	03:10	55	53.737	36.213	110	1086	Ea(4)/Pc(2)/Pt(1)
040825	486	05:00	60	53.742	36.225	120	1046	Pc(2)/Pt(1)
040825	493	17:45	60	53.787	36.222	160	1205	Ea(1)/Gn(2)/Pt(2)
040827	504	00:50	60	53.840	36.080	110	682	Gn(2)
040827	505	02:40	50	53.810	36.137	150	1082	Gn(6)
040827	506	04:10	65	53.838	36.110	120	655	Ea(1)/Gn(9)
040827	516	22:20	60	53.828	36.207	180	285	Gn(2)
040828	518	02:00	60	53.785	36.278	160	876	Gn(3)/Pb(1)
040828	519	03:40	60	53.818	36.250	160	281	Gn(9)
040828	527	18:20	65	53.763	36.307	130	508	Gn(2)/Ka(1)
040829	530	00:30	60	53.702	36.327	120	624	Gn(3)
040829	539	17:40	65	53.640	36.337	160	626	Gn(1)/Pc(2)/Pt(2)
040829	540	20:00	60	53.627	36.335	110	859	Ea(4)/Pt(2)
040830	552	19:05	60	53.593	36.620	100	845	Ea(6)/Gn(1)
040830	553	21:15	55	53.592	36.627	120	851	Gn(3)
040830	554	23:00	35	53.600	36.573	130	738	Gn(1)
040831	563	19:15	55	53.600	36.770	110	872	Ea(1)
040831	564	21:20	60	53.608	36.795	125	872	Gn(9)
040901	565	23:30	45	53.610	36.807	150	481	Ea(1)/Gn(6)/Ka(1)
040901	576	19:00	45	53.598	36.942	140	321	Ea(1)/Gn(1)/Ka(1)
040903	580	18:00	75	53.512	36.713	120	802	Pt(11)
040903	582	22:45	50	53.537	36.758	115	832	Ea(2)/Gn(1)
040905	594	00:35	60	53.602	37.678	80	853	Ea(1)/Gn(1)
040906	610	15:50	40	53.758	38.685	100	266	Ka(1)
050708	468	21:55	55	54.000	35.683	170	206	Ka(1)
050709	472	5:45	40	53.933	35.817	170	262	Ka(2)
050710	483	7:50	55	53.883	36.267	130	234	Ka(1)
050711	495	4:45	55	54.017	35.767	150	230	Ka(2)
050711	496	6:50	35	53.967	35.750	150	248	Ka(1)
050711	497	8:25	30	53.950	35.767	180	259	Ka(1)
050712	508	3:55	50	53.917	35.800	200	283	Ka(1)

Date (YYMMDD)	Haul No.	Start time	Duration (min)	Latitude (S)	Longitude (W)	Trawl depth (m)	Water depth (m)	By-catch of myctophids
050712	509	5:40	40	53.883	35.833	220	314	Ka(1)/Pc(2)
050712	516	19:45	90	53.983	35.833	150	256	Ka(1)
050712	517	22:05	80	54.033	35.800	100	222	Ka(2)/PA(1)
050713	519	2:30	65	53.983	35.833	180	257	Ka(1)
050713	529	21:15	70	54.017	35.767	110	228	Ka(2)
050714	535	11:50	30	54.003	35.767	180	229	Ka(1)
050714	540	21:35	55	54.050	35.750	140	197	Ka(2)
050714	541	23:15	45	54.033	35.767	130	229	Ka(1)
050715	549	15:45	15	54.033	35.717	140	206	Ka(1)
050715	550	18:20	65	54.050	35.717	130	200	Pt(1)
050718	566	0:30	40	53.783	36.300	110	412	Ka(1)
050718	570	8:05	30	53.783	36.300	190	317	Pb(3)
050718	577	22:45	70	53.917	35.783	240	277	Ka(1)
050719	579	2:50	65	53.900	35.817	200	286	Ka(1)
050719	586	17:15	55	53.883	35.817	260	526	Gn(1)/Ka(1)
050719	588	21:20	70	53.900	35.767	90	405	Ka(1)/Pb(1)
050721	603	3:10	60	53.783	35.883	140	750	Gn(2)
050721	613	21:50	120	53.867	35.700	140	1037	Pc(1)
050723	618	12:40	75	53.817	35.950	300	415	Pb(3)
050723	621	20:00	50	53.833	35.983	140	385	Gn(1)
050724	627	9:00	70	53.850	36.067	210	367	Pb(5)
050728	663	4:50	90	53.817	35.983	180	383	Ka(1)
050728	665	10:05	55	53.850	36.050	320	637	Pb(4)
050729	675	4:30	65	53.817	36.250	150	203	Ka(1)
050730	688	3:15	50	53.817	36.283	130	225	Ka(1)
050731	711	22:30	75	53.767	36.267	100	928	Ka(1)
050801	715	6:25	115	53.767	36.283	130	835	Gn(1)
050801	719	18:00	70	53.783	36.367	190	286	Ka(1)
050803	727	11:05	25	53.617	37.583	150	313	Ka(1)
050804	743	22:40	80	53.783	36.283	150	616	Gn(1)
050805	747	7:00	85	53.783	36.300	110	356	PA(1)/Pc(1)
050808	780	2:20	80	53.800	36.317	160	227	Gn(2)
050809	794	4:00	45	53.783	36.300	150	290	Ka(1)
050810	806	0:20	55	53.817	36.267	120	204	Ka(1)
050810	807	2:50	50	53.800	36.317	150	223	Ka(1)
050810	816	23:00	60	53.800	36.283	100	262	Ka(1)
050811	817	1:25	65	53.833	36.217	130	167	Ka(1)
050813	845	23:35	70	53.800	36.217	190	677	Ka(1)
060717	239	18:15	40	53.676	37.478	100	331	Ka(1)
060718	241	0:35	40	53.748	38.120	200	317	Ka(1)
060727	365	0:30	10	53.750	38.372	100	218	Ka(1)
060728	387	10:00	30	53.737	38.573	210	290	Ka(1)
060808	517	16:05	35	53.800	38.722	60	255	Ka(1)
060822	673	0:50	35	53.830	39.217	100	342	Gn(1)
070809	441	7:00	30	53.862	35.658	100	1142	Pt(1)
070809	443	10:00	20	53.858	35.652	140	1198	Ka(3)
070809	448	17:25	20	53.845	35.683	130	871	Pt(38)
070810	456	9:10	15	53.845	35.670	120	916	Ka(1)
070810	458	12:20	60	53.825	35.738	150	812	Ka(1)
070810	461	17:40	45	53.820	35.760	130	815	Pc(1)
070810	462	19:10	70	53.825	35.760	80	808	Pt(1)
070811	469	7:20	50	53.783	35.778	120	842	Pc(1)
070811	475	18:25	50	53.783	35.828	70	821	Pt(1)
070814	506	14:25	50	53.717	35.898	120	973	Ka(1)

Date (YYMMDD)	Haul No.	Start time	Duration (min)	Latitude (S)	Longitude (W)	Trawl depth (m)	Water depth (m)	By-catch of myctophids
070815	512	6:30	55	53.682	35.907	80	815	Pc(1)
070815	515	11:40	70	53.747	35.733	110	897	Ka(1)
070817	546	14:45	40	53.657	36.782	80	187	Ka(1)
070818	560	15:10	35	53.628	36.828	100	228	Ka(1)
070819	572	11:15	50	53.613	36.903	160	267	Ka(1)
070819	573	13:10	35	53.618	36.898	110	211	Ka(1)
070819	574	14:45	45	53.618	36.897	80	204	Ka(1)
070823	601	7:35	75	53.763	37.967	90	241	Pc(2)
080531	018	8:05	35	53.732	38.532	110	313	Pc(1)
080601	031	5:40	40	53.772	38.542	130	225	Pc(1)
080604	080	6:40	30	53.792	38.745	150	274	Pc(1)
080606	114	14:05	25	53.822	38.842	220	230	Pc(19)
080606	115	15:30	15	53.810	38.825	220	235	Pc(22)
080607	124	6:25	55	53.845	38.900	160	218	Pc(41)
080607	125	8:05	45	53.813	38.905	130	247	Gn(1)/Pc(147)
080611	155	14:35	45	53.953	39.172	240	254	Pc(7)
080611	157	17:55	35	53.967	39.155	150	252	Pc(7)
080612	172	17:50	35	53.967	39.172	150	251	Pc(7)
080612	173	19:30	45	53.958	39.160	195	256	Pc(2)
080612	174	21:25	25	53.940	39.147	190	242	Pc(1)
080612	175	23:00	30	53.950	39.950	190	256	Pc(4)
080613	176	0:30	35	53.967	39.175	190	264	Pc(4)
080614	194	7:20	35	53.987	39.062	140	230	Pc(1)
080614	202	19:30	45	53.977	39.142	150	249	Pc(1)
080614	203	21:20	35	53.968	39.140	160	248	Pc(2)
080616	228	13:15	20	53.985	39.098	210	234	Pc(1)
080616	231	17:25	55	53.998	39.097	150	221	Pc(1)
080618	251	1:00	55	54.008	39.125	160	225	Ka(2)
080623	302	20:05	60	54.073	39.277	150	266	Ka(1)
080625	326	13:10	45	54.017	39.232	230	278	Pc(2)
080625	327	14:50	50	54.020	39.263	250	282	Pc(4)
080625	328	16:30	55	54.002	39.207	230	249	Pc(1)
080626	344	17:50	40	54.008	39.227	165	257	Ka(1)
080626	345	19:30	40	54.010	39.215	160	259	Ka(1)/Pc(1)
080626	346	21:10	60	54.010	39.248	180	313	Gn(1)/Ka(1)
080627	355	12:55	40	54.042	39.265	260	293	Pc(2)
080627	356	14:45	40	54.047	39.268	260	307	Pc(2)
080628	371	18:30	30	54.048	39.322	170	359	Pc(1)
080629	375	1:00	50	54.037	39.350	160	399	Ka(1)
080630	396	13:15	35	54.045	39.243	210	283	Pc(2)
080630	397	14:50	25	54.048	39.237	260	270	Pc(2)
080630	398	16:20	30	54.065	39.232	250	254	Pc(337)
080704	416	18:10	20	54.045	39.263	135	295	Ka(1)
080704	417	19:35	45	54.047	39.255	135	291	Ka(2)/Pc(1)
080705	423	5:25	55	54.050	39.282	160	317	Ec(1)/Ka(1)/Pc(1)
080705	426	10:00	50	54.108	39.267	180	248	Pt(1)
080706	440	9:50	15	54.072	39.267	235	268	Pc(2)/Pg(1)
080706	441	11:20	45	54.102	39.288	240	268	Pg(1)
080707	457	13:10	30	54.113	39.295	200	277	Pt(1)
080707	458	14:40	25	54.118	39.277	230	248	Ka(2)/Gn(2)
080709	483	7:15	60	54.170	39.248	160	222	Ka(4)/Pc(2)
080709	487	15:00	30	54.203	39.290	260	271	Pc(1)
080711	507	7:15	35	53.998	35.732	180	210	Pc(1)
080711	508	8:50	30	54.003	35.730	200	220	Pc(1)
080715	553	19:40	45	54.082	35.582	140	156	Ka(1)

Date (YYMMDD)	Haul No.	Start time	Duration (min)	Latitude (S)	Longitude (W)	Trawl depth (m)	Water depth (m)	By-catch of myctophids
080718	587	18:05	25	53.917	35.727	70	787	Pc(1)/Pt(2)
080721	634	20:00	40	53.783	35.890	150	677	Gn(1)
080721	635	21:40	30	53.783	35.907	160	735	Gn(1)
080721	636	23:05	25	53.782	35.898	140	751	Gn(2)/Pc(9)/Pt(3)
080722	637	3:00	15	53.785	35.888	200	634	Pc(1)
080723	652	1:30	50	53.832	35.965	200	361	Gn(1)