

Cruise report, RV “G.O. Sars”

Cruise no. 2021105

Mesopelagic biomass estimation and ecosystem studies, 1-30 June 2021

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1. Introduction

The cruise with R/V «G.O. Sars» started 1 June in Bergen, Norway, and ended there, 30 June. The scientific crew counted 12 scientists and 2 technical engineers (see Table 1). The cruise leader was Webjørn Melle, IMR.

The mesopelagic ecosystem is contained within the water depths between 200 and 1000 m. Mesopelagic fish resources have been assessed at 1 billion tonnes (Gjøsæter and Kawaguchi 1980) and more recently at 2-50 billion tonnes (Irigoien et al. 2014). The recent upgrade of potential biomass in the mesopelagic ecosystem has provoked interest from scientist as well as fishing companies and marine fish feed producers. The present cruise was conducted in the Iceland Basin and the Norwegian Sea from 1-30 June, starting and ending in Bergen, Norway. The main objectives were related to the mesopelagic ecosystem, but also the epipelagic ecosystem was observed to assess potential drivers of the mesopelagic biomass. Primary productivity and transport of energy to mesopelagic depths are hypothesized to be main drivers for the mesopelagic biomass, its biodiversity and vertical structure. This cruise was part of the MEESO field campaign.

During the cruise we used submersible broadband acoustics and optical sensors on the towed platform, MESSOR, to quantify abundance and biomass of mesopelagic organisms down to 1000 m. In combination with non-graded trawls with Deep Vision (cod-end camera system) and new developments in the use of acoustic models, we will improve our knowledge of mesopelagic stock's biomass and their ecological role.

The University of Bergen (Cristian Tiedemann) was responsible for the underwater light characterization. This characterization was based on *in situ* measurements of the epipelagic and a proxy method similar to that used in Aksnes et al. (2017) for the mesopelagic.

The University of Bergen, PI: Tatiana Tsagaraki, also contributed with measurements of particulate nutrients and their distribution between depths and productivity gradients. Their focus were on nutrients within the lower trophic food web, that are utilised by both autotrophic and heterotrophic plankton. This information is important both for estimating energy transfer to higher trophic levels and as a proxy of export potential. Specifically, they measured the concentration and ratios of particulate Carbon, Nitrogen, Phosphorus, Iron, Calcium, Silicon, Sulphur, Magnesium, Zinc and Manganese. Calcium and Silicon can additionally be used as proxies for calcifying (e.g. coccolithophores) and silicifying organisms (e.g. diatoms). For many of these nutrients, very little is known about their concentration in different areas and water masses.

UoB in cooperation with IMR explored the vertical carbon transport. From the surface mixed layer sinking particles are impacted by physical and biological factors, leading to fractionation, aggregation and recycling (amongst other processes) and thus modulating carbon export to the deep ocean. If diel vertically migrating fishes and zooplankton eat more of their food in the epipelagic than in the mesopelagic, they will likely contribute, via active carbon flux, to increased vertical carbon flux and sequestration. This is because the carbon ingested as food in the epipelagic is rapidly transported by swimming to mesopelagic depths.

Here, parts of this carbon are respired as CO₂, excreted as DOC, defecated as POC, and consumed by stationary mesopelagic piscivores. To investigate this potentially important link to carbon sequestration, and thus climate change, we collect water samples above and below the deep scattering layers with large (100 L) Niskin bottles, called Marine Snow Catchers (MSC). The MSC, in combination with Flowcams, allows us to estimate sinking velocity and size distribution of organic particles, including marine snow and faecal pellets. We analyse these particles for their carbon content, other major elements, as well as bacterial abundances and diversity. This will allow us to get a better understanding of remineralisation rates. From vertical profiles, 0-1000 m, with Video Plankton Recorder (VPR) on MESSOR, images of marine snow were extracted and quantified and measured. In combination with sinking speeds measured with the MSCs, the total particle sinking rates were estimated.

During the cruise we collect mesopelagic species to investigate the levels of contaminants including heavy metals and persistent organic contaminants as well as nutrients such as fatty acid and amino acid profile, vitamins and minerals and bulk nutrients. Using existing regulations and recommendations, the safety of different mesopelagic species will be evaluated as food or feed and how they can contribute into nutrition security.

We also study the transfer and magnification of the measured nutrients and contaminants in the mesopelagic food webs of the North Atlantic.

The scientific personnel attending the cruise is listed in Tab. 1.

The cruise track with position of sampling stations are shown in Fig.1 and sampling stations and gears are listed in Tab. 2.

The main scientific objectives of the cruise were:

To measure abundance, biomass and diversity of the ecosystems and how it vary among ocean regions. Identify drivers of biomass.

Assess microbial loop functionality and nutrient cycling within the different water masses and depth layers

Established particulate macro and micro nutrient concentrations

Describe vertical distribution, DVM and the main drivers

Study the main flow of energy in the system (diet)

Measure active and passive carbon flux, the role of mesopelagics in active flux.

Map the hydrography, PP (chlorophyll), nutrients and oxygen distributions of the ocean

Table 1. Scientific personnel.

Name	Affiliation
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Atabak Azad	Institute of Marine Research
Mette Agersted	Institute of Marine Research
Babak Khodabandeloo	Institute of Marine Research
Thor Klevjer	Institute of Marine Research
Chris Lindemann	University of Bergen
Monica Martinussen	Institute of Marine Research
Webjørn Melle (cruise leader)	Institute of Marine Research
Jon Rønning	Institute of Marine Research
Espen Strand	Institute of Marine Research
Tatiana Tsagaraki	University of Bergen
Mel Underwood	Institute of Marine Research
Rupert Wienerroither	Institute of Marine Research

2. Sampling and cruise track

A total of 67 trawl stations, 18 MESSOR tows, 14 Multinet Mammoth and 18 CTD stations were conducted. In addition we measured light (multi-spectral) and did a vertical algae net haul from 30 m to the surface at all CTD stations. At CTD stations we also collected water with Snow Catchers from several depths.

Table 2. Overview of sampling program. Details are in IMR database structures.

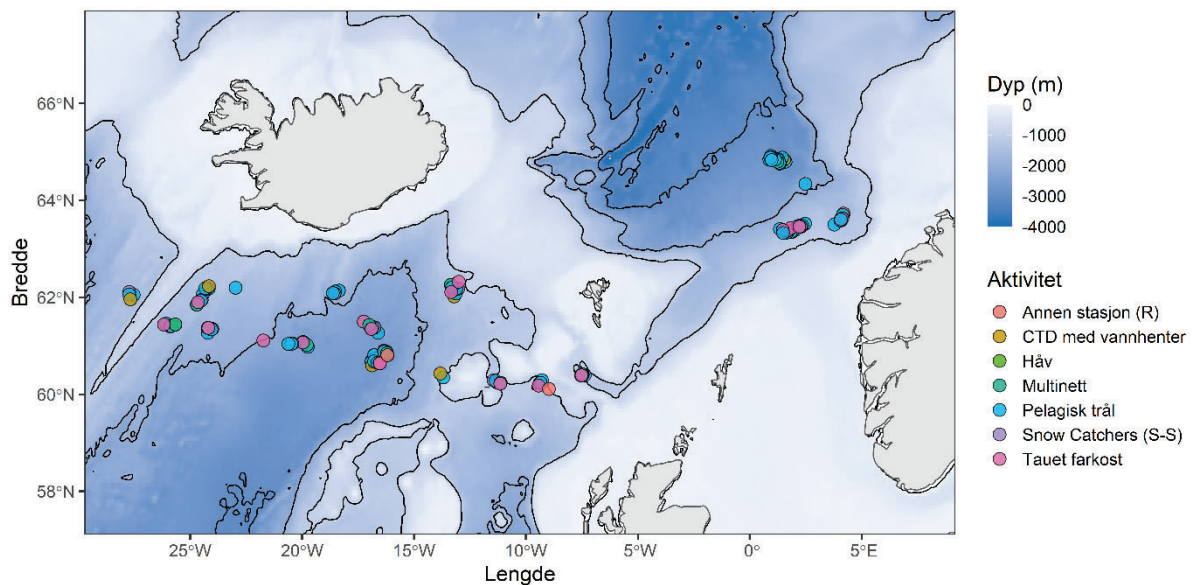
Gear	Station	Time	Latitude	Longitude
Pelagisk trål	53	03.06.2021 09:41	60.40	-7.38
Pelagisk trål	54	03.06.2021 13:36	60.39	-7.54
Annen stasjon (S-S)	163	03.06.2021 16:42	60.41	-7.46
CTD med vannhenter	163	03.06.2021 17:03	60.41	-7.47
Håv	163	03.06.2021 17:47	60.41	-7.49
Multinett	163	03.06.2021 18:21	60.42	-7.51
Tauet farkost	163	03.06.2021 20:33	60.39	-7.52
Pelagisk trål	55	04.06.2021 06:22	60.29	-9.29
Multinett	164	04.06.2021 09:59	60.23	-9.39
CTD med vannhenter	164	04.06.2021 11:17	60.23	-9.34
Annen stasjon (S-S)	164	04.06.2021 12:27	60.23	-9.34
Pelagisk trål	56	04.06.2021 13:37	60.24	-9.35
Tauet farkost	164	04.06.2021 16:16	60.18	-9.43
Annen stasjon (R)	164	04.06.2021 21:11	60.11	-8.98
Pelagisk trål	57	05.06.2021 05:48	60.24	-11.27

Annen stasjon (S-S)	165	05.06.2021 08:46	60.29	-11.45
Pelagisk trål	58	05.06.2021 11:40	60.28	-11.36
Annen stasjon (S-S)	165	05.06.2021 14:59	60.24	-11.14
CTD med vannhenter	165	05.06.2021 15:04	60.24	-11.14
Håv	165	05.06.2021 15:57	60.24	-11.14
Multinett	165	05.06.2021 16:22	60.24	-11.14
Tauet farkost	165	05.06.2021 18:14	60.22	-11.15
Pelagisk trål	59	06.06.2021 05:37	60.35	-13.70
CTD med vannhenter	166	06.06.2021 09:05	60.43	-13.83
Pelagisk trål	60	07.06.2021 05:39	60.98	-19.75
Annen stasjon (S-S)	167	07.06.2021 09:11	61.08	-19.96
CTD med vannhenter	167	07.06.2021 12:05	61.08	-19.96
Håv	166	07.06.2021 13:00	61.08	-19.96
Annen stasjon (S-S)	167	07.06.2021 13:12	61.08	-19.96
Pelagisk trål	61	07.06.2021 13:52	61.07	-19.94
Multinett	167	07.06.2021 16:43	61.02	-19.79
Tauet farkost	167	07.06.2021 19:43	61.07	-19.97
Pelagisk trål	62	08.06.2021 01:16	61.05	-20.44
Pelagisk trål	63	08.06.2021 02:39	61.04	-20.48
Pelagisk trål	64	08.06.2021 05:08	61.04	-20.62
Tauet farkost	168	08.06.2021 14:47	61.11	-21.74
Pelagisk trål	65	09.06.2021 05:19	61.27	-24.22
CTD med vannhenter	168	09.06.2021 09:11	61.35	-24.02
Annen stasjon (S-S)	168	09.06.2021 10:26	61.35	-24.02
Pelagisk trål	66	09.06.2021 12:50	61.34	-24.06
Annen stasjon (S-S)	168	09.06.2021 15:45	61.37	-24.22
Håv	168	09.06.2021 15:49	61.37	-24.22
Multinett	168	09.06.2021 16:09	61.37	-24.21
Tauet farkost	169	09.06.2021 18:08	61.37	-24.19
Pelagisk trål	67	10.06.2021 06:32	61.46	-26.08
Annen stasjon (R)	169	10.06.2021 09:42	61.40	-25.90
Pelagisk trål	68	10.06.2021 12:27	61.41	-25.86
CTD med vannhenter	169	10.06.2021 14:58	61.44	-25.67
Annen stasjon (S-S)	169	10.06.2021 16:01	61.44	-25.67
Håv	169	10.06.2021 16:13	61.44	-25.67
Multinett	169	10.06.2021 16:32	61.44	-25.67
Tauet farkost	170	10.06.2021 20:21	61.44	-26.18
Pelagisk trål	69	11.06.2021 06:32	62.05	-27.53
Annen stasjon (S-S)	170	11.06.2021 09:50	62.11	-27.73
Pelagisk trål	70	11.06.2021 12:35	62.06	-27.73
CTD med vannhenter	170	11.06.2021 16:47	61.96	-27.68
Pelagisk trål	71	12.06.2021 07:23	62.07	-24.44
Annen stasjon (S-S)	171	12.06.2021 11:24	61.95	-24.49
Pelagisk trål	72	12.06.2021 14:22	61.93	-24.53
CTD med vannhenter	171	12.06.2021 17:14	61.85	-24.71
Håv	171	12.06.2021 18:14	61.85	-24.71

Annen stasjon (S-S)	171	12.06.2021 18:28	61.85	-24.71
Multinett	171	12.06.2021 18:54	61.85	-24.70
Tauet farkost	171	12.06.2021 20:41	61.90	-24.66
Pelagisk trål	73	13.06.2021 02:45	62.18	-24.18
Pelagisk trål	74	13.06.2021 03:38	62.18	-24.27
Pelagisk trål	75	13.06.2021 07:01	62.19	-24.33
CTD med vannhenter	172	13.06.2021 09:30	62.23	-24.17
Pelagisk trål	76	13.06.2021 14:21	62.20	-22.98
Pelagisk trål	77	14.06.2021 07:33	62.14	-18.36
Pelagisk trål	78	14.06.2021 10:15	62.14	-18.36
Pelagisk trål	79	14.06.2021 12:32	62.12	-18.53
CTD med vannhenter	173	14.06.2021 14:18	62.08	-18.56
Håv	172	14.06.2021 15:14	62.08	-18.56
Annen stasjon (S-S)	173	14.06.2021 15:31	62.08	-18.56
Pelagisk trål	80	14.06.2021 16:34	62.09	-18.63
Tauet farkost	172	14.06.2021 23:25	61.50	-17.25
Pelagisk trål	81	15.06.2021 06:44	61.27	-16.61
Annen stasjon (S-S)	174	15.06.2021 10:08	61.38	-16.77
CTD med vannhenter	174	15.06.2021 12:37	61.38	-16.77
Annen stasjon (S-S)	174	15.06.2021 13:46	61.38	-16.77
Pelagisk trål	82	15.06.2021 14:45	61.38	-16.86
Multinett	174	15.06.2021 17:46	61.43	-17.01
Tauet farkost	174	15.06.2021 20:34	61.35	-16.91
Pelagisk trål	83	16.06.2021 08:35	60.75	-16.65
Pelagisk trål	84	16.06.2021 10:13	60.73	-16.78
Annen stasjon (S-S)	175	16.06.2021 12:11	60.69	-16.90
Pelagisk trål	85	16.06.2021 14:53	60.67	-16.91
CTD med vannhenter	175	16.06.2021 17:25	60.60	-16.88
Pelagisk trål	86	17.06.2021 08:39	60.81	-16.79
Pelagisk trål	87	17.06.2021 13:30	60.68	-16.79
Pelagisk trål	88	17.06.2021 16:08	60.65	-16.64
Annen stasjon (R)	175	17.06.2021 18:06	60.64	-16.54
Tauet farkost	175	17.06.2021 20:41	60.64	-16.53
Pelagisk trål	89	18.06.2021 01:48	60.88	-16.24
Pelagisk trål	90	18.06.2021 08:25	60.81	-16.19
Annen stasjon (R)	176	18.06.2021 11:32	60.90	-16.35
Pelagisk trål	91	18.06.2021 13:09	60.88	-16.34
Multinett	175	18.06.2021 16:19	60.85	-16.21
Annen stasjon (R)	176	18.06.2021 18:24	60.81	-16.19
CTD med vannhenter	176	19.06.2021 05:04	62.02	-13.21
Pelagisk trål	92	19.06.2021 07:05	62.08	-13.14
Annen stasjon (S-S)	176	19.06.2021 10:17	62.18	-13.03
Pelagisk trål	93	19.06.2021 13:40	62.18	-13.11
Pelagisk trål	94	19.06.2021 16:12	62.23	-13.28
Annen stasjon (R)	176	19.06.2021 18:02	62.26	-13.36
Håv	176	19.06.2021 18:13	62.26	-13.36

Multinett	176	19.06.2021 18:29	62.26	-13.36
Pelagisk trål	95	19.06.2021 20:21	62.20	-13.32
Tauet farkost	176	19.06.2021 23:26	62.11	-13.34
Tauet farkost	177	20.06.2021 03:53	62.32	-13.01
CTD med vannhenter	177	23.06.2021 04:38	63.59	4.04
Pelagisk trål	96	23.06.2021 06:24	63.63	4.09
Annen stasjon (R)	177	23.06.2021 09:17	63.73	4.19
Pelagisk trål	97	23.06.2021 11:32	63.70	4.15
Håv	177	23.06.2021 15:04	63.61	4.09
Annen stasjon (S-S)	177	23.06.2021 15:30	63.61	4.09
Multinett	177	23.06.2021 15:52	63.61	4.09
Pelagisk trål	98	23.06.2021 17:42	63.59	4.08
Tauet farkost	178	23.06.2021 20:40	63.63	4.13
Pelagisk trål	99	24.06.2021 01:13	63.50	3.78
Annen stasjon (S-S)	178	24.06.2021 05:54	63.59	4.04
Pelagisk trål	100	24.06.2021 09:21	63.61	4.07
Pelagisk trål	101	24.06.2021 17:32	64.34	2.48
Pelagisk trål	102	25.06.2021 00:40	64.80	1.59
CTD med vannhenter	178	25.06.2021 04:32	64.84	1.53
Pelagisk trål	103	25.06.2021 06:24	64.88	1.44
Annen stasjon (S-S)	178	25.06.2021 09:54	64.85	1.26
Pelagisk trål	104	25.06.2021 11:36	64.83	1.28
Håv	178	25.06.2021 14:05	64.76	1.34
Annen stasjon (S-S)	178	25.06.2021 14:18	64.76	1.34
Pelagisk trål	105	25.06.2021 15:07	64.78	1.32
Multinett	178	25.06.2021 16:35	64.80	1.23
Pelagisk trål	106	25.06.2021 18:44	64.84	1.13
Pelagisk trål	107	26.06.2021 01:00	64.92	0.95
Pelagisk trål	108	26.06.2021 04:56	64.84	0.87
Annen stasjon (S-S)	178	26.06.2021 06:32	64.89	0.94
Pelagisk trål	109	26.06.2021 09:11	64.88	0.92
Pelagisk trål	110	26.06.2021 11:13	64.83	0.97
Pelagisk trål	111	26.06.2021 22:29	63.38	1.93
Pelagisk trål	112	27.06.2021 01:00	63.40	2.05
CTD med vannhenter	179	27.06.2021 03:49	63.35	1.88
Pelagisk trål	113	27.06.2021 05:01	63.35	1.83
Annen stasjon (S-S)	179	27.06.2021 08:01	63.34	1.64
Pelagisk trål	114	27.06.2021 09:36	63.34	1.68
Pelagisk trål	115	27.06.2021 11:41	63.34	1.67
Håv	179	27.06.2021 13:07	63.37	1.60
Annen stasjon (S-S)	179	27.06.2021 13:21	63.37	1.60
Tauet farkost	179	27.06.2021 14:10	63.37	1.66
Annen stasjon (S-S)	179	27.06.2021 18:13	63.48	2.20
Pelagisk trål	116	27.06.2021 19:19	63.47	2.14
Tauet farkost	179	27.06.2021 23:00	63.43	1.83
Pelagisk trål	117	28.06.2021 04:52	63.52	2.47

Multinett	179	28.06.2021 06:58	63.48	2.34
Annen stasjon (S-S)	180	28.06.2021 08:42	63.46	2.27
CTD med vannhenter	180	28.06.2021 10:12	63.46	2.27
Annen stasjon (S-S)	180	28.06.2021 11:00	63.46	2.27
Annen stasjon (S-S)	180	28.06.2021 11:33	63.46	2.27
Tauet farkost	180	28.06.2021 12:46	63.46	2.21
Pelagisk trål	118	28.06.2021 19:15	63.41	1.34
Multinett	180	28.06.2021 20:59	63.39	1.47
Tauet farkost	180	28.06.2021 23:24	63.39	1.47
Pelagisk trål	119	29.06.2021 01:06	63.33	1.49



Cruise map.

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