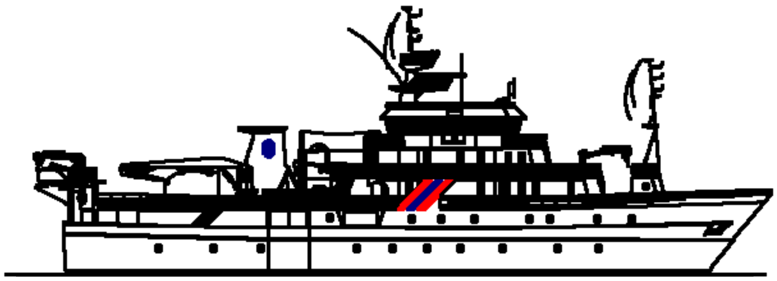
NORAD - FAO PROJECT GCP/INT/003/NOR

CRUISE REPORTS "DR. FRIDTJOF NANSEN"
EAF - N2009/9



2009 Survey of the Comores Gyre (ASCLME & SWIOFP)

Cruise report No 9/2009

5 October – 3 November 2009

University of Cape Town
South Africa

Institute of Marine Research – IMR
Norway

Rhodes University
South Africa

Megaptera
France

Bergen June 2010

THE EAF-NANSEN PROJECT

FAO started the implementation of the project “Strengthening the Knowledge Base for and Implementing an Ecosystem Approach to Marine Fisheries in Developing Countries (EAF-Nansen GCP/INT/003/NOR)” in December 2006 with funding from the Norwegian Agency for Development Cooperation (Norad). The EAF-Nansen project is a follow-up to earlier projects/programmes in a partnership involving FAO, Norad and the Institute of Marine Research (IMR), Bergen, Norway on assessment and management of marine fishery resources in developing countries. The project works in partnership with governments and also GEF-supported Large Marine Ecosystem (LME) projects and other projects that have the potential to contribute to some components of the EAF-Nansen project.

The EAF-Nansen project offers an opportunity to coastal countries in sub-Saharan Africa, working in partnership with the project, to receive technical support from FAO for the development of national and regional frameworks for the implementation of Ecosystem Approach to Fisheries management and to acquire additional knowledge on their marine ecosystems for their use in planning and monitoring. The project contributes to building the capacity of national fisheries management administrations in ecological risk assessment methods to identify critical management issues and in the preparation, operationalization and tracking the progress of implementation of fisheries management plans consistent with the ecosystem approach to fisheries.

LE PROJET EAF-NANSEN

La FAO a initié la mise en oeuvre du projet "Renforcement de la base des connaissances pour mettre en œuvre une approche écosystémique des pêcheries marines dans les pays en développement (EAF-Nansen GCP/INT/003/NOR)" en décembre 2006. Le projet est financé par de l'Agence norvégienne de coopération pour le développement (Norad). Le projet EAF-Nansen fait suite aux précédents projets/ programmes dans le cadre du partenariat entre la FAO, Norad et l'Institut de recherche marine (IMR) de Bergen en Norvège, sur l'évaluation et l’aménagement des ressources halieutiques dans les pays en développement. Le projet est mis en oeuvre en partenariat avec les gouvernements et en collaboration avec les projets grands écosystèmes marins (GEM) soutenus par le Fonds pour l’Environnement Mondial (FEM) et d'autres projets régionaux qui ont le potentiel de contribuer à certains éléments du projet EAF-Nansen.

Le projet EAF-Nansen offre l’opportunité aux pays côtiers de l'Afrique subsaharienne partenaires de recevoir un appui technique de la FAO pour le développement de cadres nationaux et régionaux visant une approche écosystémique de l’aménagement des pêches et la possibilité d'acquérir des connaissances complémentaires sur leurs écosystèmes marins. Ces éléments seront utilisés pour la planification et le suivi des pêcheries et de leurs écosystèmes. Le projet contribue à renforcer les capacités des administrations nationales responsables de l’aménagement des pêches en introduisant des méthodes d'évaluation des risques écologiques pour identifier les questions d’aménagement d’importance majeure ainsi que la préparation, la mise en œuvre et le suivi des progrès de la mise en œuvre de plans d’aménagement des ressources marines conformes à l'approche écosystémique des pêches.

Cruise Report ”Dr. Fridtjof Nansen”

Survey of the Comores Gyre

(ASCLME & SWIOFP)

5 October – 3 November 2009

By

R. Roman[1], S. Kaehler[2], K. Michalsen[3], M. Olsen[3] and Morgane Perri[4]

[1]University of Cape Town
Private Bag X3
Rondebosch 7701, South Africa

2)Rhodes University
PO Box 94
Grahamstown
6940

[3]Institute of Marine Research
P.O.Box 1870 Nordnes
N-5817 Bergen, Norway

[4] Megaptera, France

Table of Contents

1 Introduction

This is a ***preliminary*** cruise report made at the end of the 2009 FAO/ASCLME /SWIOFP survey of the Comoroes Gyre. Not all results (eg. Zooplankton data) are ready at the time of writing and the analyses presented are *initial* and conclusions may therefore change as the data is analyzed more thoroughly.

To fully understand the processes in Comoros Gyre the design of the 2009 survey encompassed the Comoros Gyre and its three inflow regimes; the East Madagascar Current, along the African coast sub-surface of the East African Coastal Current and the southern Mozambique Channel. Although the Comoros Gyre shows no distinct flow pattern intermediate depth floats do however indicate the overall flow in the basin to be to the south (Di Marco et. al., 2002). The northern branch of the East Madagascar Current is formed between 18-20°S where the South Equatorial Current hits the coast of Madagascar. The current flows around the northern tip of Madagascar towards the east African coast from where the water flows south into the Comoros Basin and northwards as part of the East African Coastal Current. At intermediate level it appears that most of the flow is towards the Comoros Basin along the African shelf break. The East African Coastal Current is a shallow current that flows between 11 and 3°S where after it becomes the eastward flowing Equatorial Counter Current. Sub-surface of the current to flow is overall to the south, towards the Comoros Gyre. Flow in the southern Mozambique Channel is also overall to the south but it has been shown that at deeper levels there is some flow into the Comoros Basin. Eddies across the narrows of the Mozambique Channel further enhances the interaction allowing for surface level transport between the southern part of the channel and the Comoros Basin.

1.1 Aims & Objectives

To establish for the very first time the physical, chemical and biological characteristics of the Comoros Gyre. The Gyre is an anti-cyclonic eddy that is generally located from 10°S to 15°S and between the north-east coast of Mozambique and the north-west coast of Madagascar (Figure 1.1.1). The location of the Gyre is not constant, necessitating the long transects depicted in Figure 1.4.1. A number of recent exploratory cruises, satellite tracking and remote sensing studies have shown that the northern Mozambique Channel to be a generally oligotrophic environment that nonetheless supports a large number of fisheries, a high biodiversity and high densities of ecologically important top predators. To date, the processes that sustain the biomass and diversity of this ecosystem are not well understood. It has been acknowledged, however, that the region at a global scale, is physically unusually dynamic and it has been suggested that the observed spatial and temporal variability of the physical environment may well play an important role in enhancing both pelagic and coastal production and the distribution of fish, zoo & phytoplankton and coral larvae.

SWIOFP has identified small pelagic fishes (scads, mackerels, herrings and sardines) as a potential future resource in the Comoros islands. The R/V *Dr Fridtjof Nansen* survey around the islands will undertake acoustics transects to determine the distribution and abundance of small pelagic fish shoals. Mid-water trawls will be undertaken on fish aggregations to determine species and size composition. Biological sampling to determine the length, weight, sex, and reproductive condition of random samples of selected species will be undertaken. Otoliths for age/growth determination and genetic samples for population genetic studies will be collected from selected species.

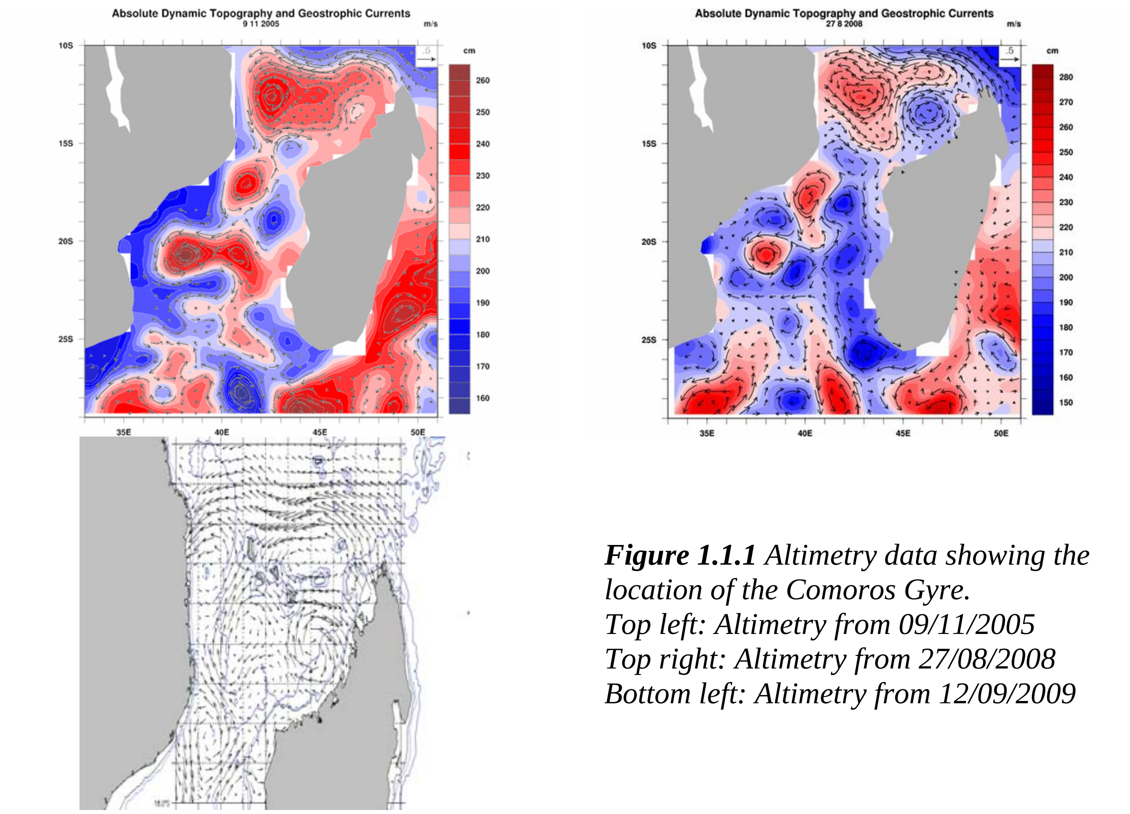


Figure 1.1.1 *Altimetry data showing the location of the Comoros Gyre.*
Top left: Altimetry from 09/11/2005
Top right: Altimetry from 27/08/2008
Bottom left: Altimetry from 12/09/2009

1.1 Objectives are:

- To carry out a multi-disciplinary cruise that investigates the physico-chemical processes and fisheries potential of small pelagic fishes in the Comoros Basin.
- To establish the distribution, abundance and composition of organisms at a number of trophic levels in the Comoros Basin.
- To establish, as far as possible, the productivity, diversity and biomass of the pelagic ecosystem.
- To establish the role of the island shelf region and terrestrial input in linking coastal and pelagic biomes (coupling).
- To investigate the role of the Comoros Gyre as a dispersal agent.
- To investigate mesopelagic and, if trawlable conditions exist, demersal fish species diversity and abundance.
- To determine the distribution and abundance of small pelagic fish shoals around the islands of the Union of Comoros and Mayotte using acoustics methods and a systematic grid survey strategy.
- To use regular surface and midwater trawls on target fish aggregations for species composition, biological information and genetic material of selected small pelagic fishes for fisheries resource assessment purposes.
- To link various sources of energy and nutrition to different food-web

compartments.

- Capacity building of ASCLME and SWIOFP trainees & young scientists.
- To fulfil the data management agreement contained in Appendix A.

1.2 Key Questions & deliverables

- What are the processes that drive production in the region?
- What is the phytoplankton, zooplankton, ichthyoplankton diversity of the pelagic ecosystem and the main mesopelagic fish fauna?
- What is the distribution and abundance of the marine flora and fauna including the avifauna, marine turtles and mammals in the Comoros Basin?
- What determine the relative abundance and assemblage composition of larvae/juveniles in relation to hydrographic features?
- What are the main energy and nutrient sources that subsidise the pelagic food-web?
- What are the cross-basin characteristics of the current and its biota?
- How important is coastal-pelagic coupling in supporting fish biomass?
- What is the relative importance of the Comoros Gyre in producing and/or relocating biomass?
- What are the species composition, abundance and distribution of small pelagic fishes of potential importance to fisheries?
- What are the biological characteristics (size composition; length-weight; age-length; size at maturity) of selected small pelagic fish species captured during the survey?

Deliverables will be:

- Cruise reports
- Data reports
- Genetic samples and otoliths
- Electronic inventories
- Scientific publications in peer reviewed international journals
- Training and capacity building

1.3 Participation

Field	Names	Affiliation & nationality	Gender
Cruise Leader	Kathrine Michalsen	IMR, Norwegian	Female
Cruise Leader (Local)	Raymond Roman	UCT, South African	Male
Physical Oceanography	Nicolas Rascle	UCT, South African	Male
Oceanography	Charine Collins	UCT, South African	Female
Oceanography	Kate Munnik	UCT, South African	Female
Oceanographic	Caren George	SAEON, South	Female
Biological	Sven Kaehler	RU, German	Male
Zooplankton	Ali Binty Soafia	IHSM, Malagasy	Female
Fisheries biology	Abdallah Youssouf Ben	Comores	Male
Fisheries biology	Jaffar Mohidone*	Comores	Male
Fisheries biology	Ahmed Soifa	Comores	Male

Fisheries biology	Jessica Escobar*	ORI, South African	Female
Marine mammals	Morgane Perri*	Megaptera, France	Female
Technician	Magne Olsen	IMR, Norwegian	Male
Instrument Chief	Terje Hovland	IMR, Norwegian	Male
Instrument Operator	Ole Sverre Fossheim	IMR, Norwegian	Male

* SWIOFP Scientists

List of abbreviations

ASCLME: Agulhas Somali Current Large Marine Ecosystem
RU: Rhodes University
UCT: University of Cape Town
IMR: Institute of Marine Research, Norway
SAEON: South African Earth Observation Network
IHSM: Institut Halieutique et des Sciences Marines

Land based personnel:

ASCLME scientific advisor: J. R. E. Lutjeharms
Nansen-EAF Project Research Coordinator: Dr Tore Strømme (Tore.Stromme@fao.org)
ASCLME Coordinator: Tommy Bornman (t.bornman@ru.ac.za)

1.4 Overview of the cruise and study area

Logistics

R/V *Dr Fridtjof Nansen* docked in Moroni, Comoros, on 5 October 2009. The ship remained in port for two days to take on the scientific crew. The ship departed on the afternoon of 6 October, but due to problems with licences to enter the 6 EEZ's that were involved, the order of the transects had to be changed (Figure 1.4.1). First all the stations around the Comoros Island were completed after which transect 10 was sampled. The vessel then sailed south east along transect 3 to the coast of Madagascar, followed by Transect 2 due north from the northern tip of Madagascar. After section 2, sections 4, 5, 6, 8 and 9 followed. The Comoros Gyre cruise in total encompassed a period of 27 days of environmental stations, acoustic surveys, trawling and steaming. The cruise ended in Anjouan, Comoros, on 3 November 2009.

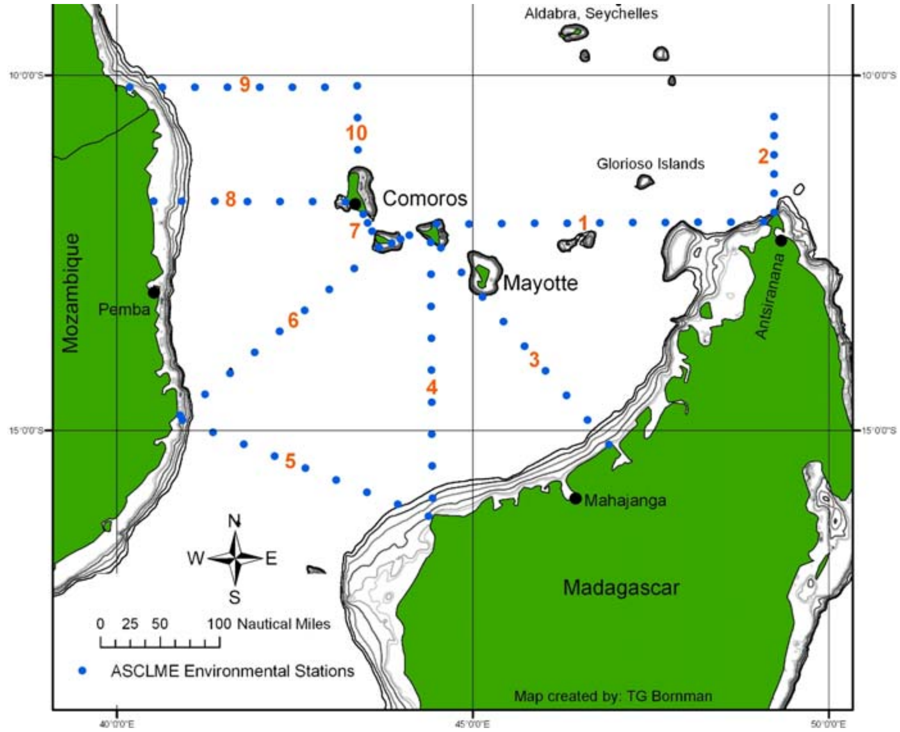


Figure 1.4.1 Survey design of The Comoros Gyre cruise. The different transect are indicated by numbers in red.

Scientific work

The principal tasks was carried out using the station grid shown in Figure 1.4.2 & 1.4.3 as closely as possible, but being guided at all times by the time available, by new satellite information and suggestions relayed by the shore-based teams. At each environmental station *CTD profiles* and Niskin bottle *water sample collection* was carried out to near the bottom or as deep as the CTD cable can go (3000 m). In addition to CTD casts, multi-nets and, if necessary, oblique bongo nets (200 micron mesh) was be deployed. Underway, hydro-acoustics was used to locate midwater trawl stations, which would be independent of the above full environmental stations. An overview of the acoustic coverage is shown in Figure 2.4.3 below. Acoustic coverage of the southern reefs was carried out during Transect 1 and the northern reef after completion of Transect 2. Demersal/bottom trawling took place where the seafloor was suitable for trawling. Approximately two surface trawls per transect were conducted (Figure 1.4.3).

In each of the transects, a number of physical or full environmental stations were completed (Table. 1.3.1). These varied in composition depending on requirements of the survey. Full environmental stations typically included CTD, multinet, bongo, as well as water samples for size-fractionated chlorophyll, phyto-pigments, particulate organic matter (POM), primary production, nutrients and nitrate isotope analysis. A detailed summary of samples taken at each station are provided in Table 1.3.1. Additionally, surface and meso-pelagic trawls were conducted in areas of interest, hydro-accoustics were used to identify areas of high zooplankton and fish biomass and bird and marine mammal observations were carried out during daylight hours.

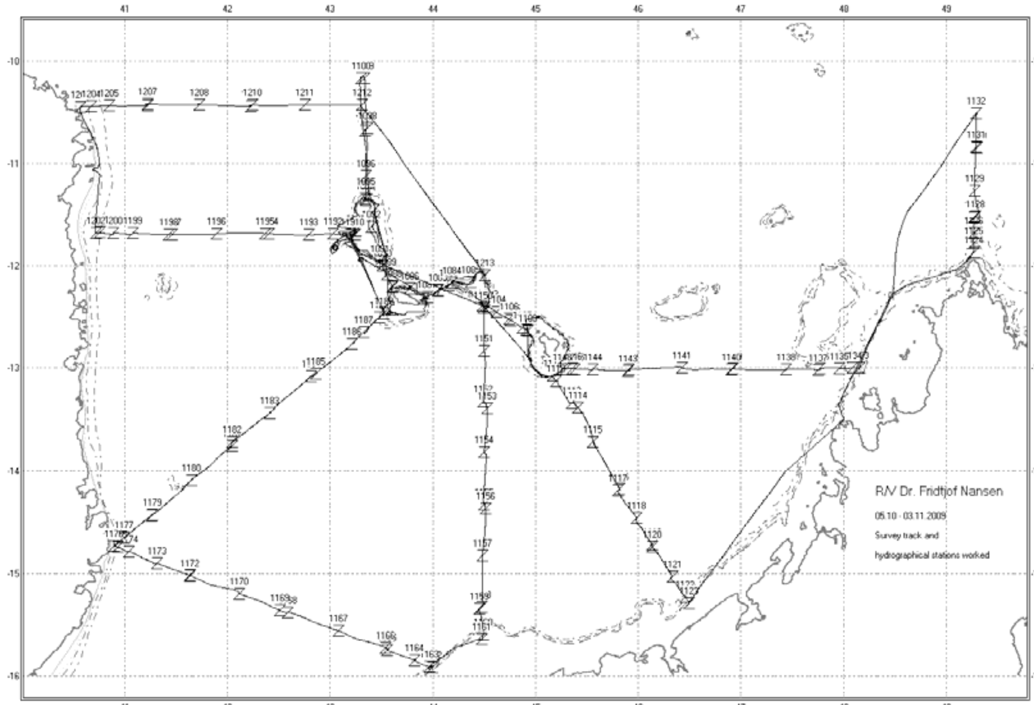


Figure 1.4.2 *Map of the hydrographical stations (CTD) taken during the cruise. The symbol "Z" marks the position of the stations taken.*

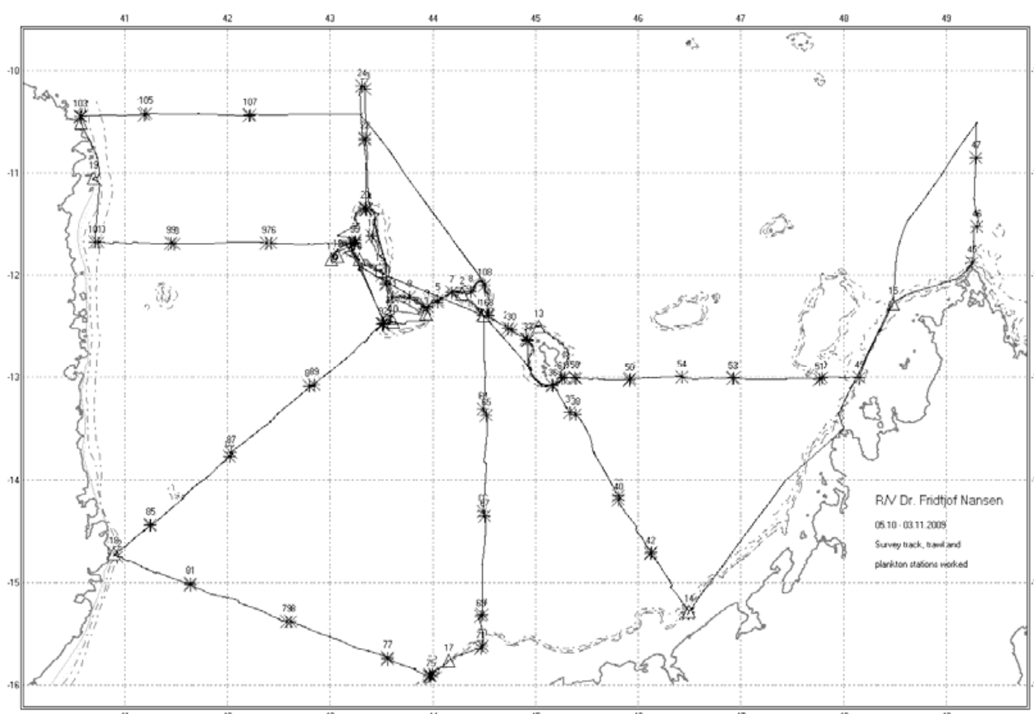


Figure 1.4.3 *Map of the biological stations taken during the cruise. The triangle marks the position of the surface trawl stations, while the star marks the position of the multinet and Bongo sampling.*

Summary of Survey effort

For the purpose of establishing the physical, chemical and biological characteristics of the Comoros Gyre the sampling was conducted along 10 straight transects. Figures 1.1-1.3 show the cruise tracks with bottom trawls, pelagic trawls, hydrographical stations and plankton stations. Table 1.1 summarises the survey effort in each transect, while Table 1.2 gives an overview of the position of the hydrographical stations (CTD) taken during the cruise. In Annex I an overview of the juvenile fish species caught in the surface trawl is shown, while in Annex II detailed information about the trawl stations are given.

Table 1.1 Number of hydrographic (CTD), plankton (PL), pelagic trawl (PT), bottom trawl (BT) and surface trawl (ST) stations, by transects.

Region	CTD	PL	PT	BT	ST	NM
Line 1	9	9	0	0	1	170
Line 2	8	8	0	0	1	82
Line 3	12	12	0	0	2	150
Line 4	12	12	0	0	1	202
Line 5	13	13	0	0	2	211
Line 6	13	13	0	0	1	214
Line 7	5	5	0	1	1	25
Line 8	14	14	0	0	2	150
Line 9	10	10	0	0	1	163
Line 10	8	8	0	0	1	74
Total						1437

Table 1.2: Overview of the position of the 133 hydrographical stations (CTD) taken during the cruise.

Station	Latitude	Longitude	Station	Latitude	Longitude	Station	Latitude	Longitude
1080	-12.318	43.913	1129	-11.27	49.275	1178	-14.439	41.257
1081	-12.303	43.945	1130	-10.846	49.294	1179	-14.429	41.271
1082	-12.245	44.047	1131	-10.841	49.292	1180	-14.095	41.646
1083	-12.188	44.157	1132	-10.514	49.291	1181	-13.759	42.043
1084	-12.168	44.187	1133	-12.999	48.157	1182	-13.723	42.047
1085	-12.16	44.371	1134	-12.999	48.083	1183	-13.439	42.414
1086	-12.216	43.778	1135	-13.001	47.957	1184	-13.081	42.816
1087	-12.207	43.607	1136	-13.007	47.771	1185	-13.055	42.862
1088	-12.195	43.604	1137	-13.019	47.749	1186	-12.759	43.212
1089	-12.082	43.549	1138	-13.015	47.442	1187	-12.648	43.327
1090	-12.001	43.507	1139	-13.002	46.919	1188	-12.502	43.478
1091	-11.954	43.482	1140	-13.012	46.908	1189	-12.465	43.522
1092	-11.617	43.404	1141	-12.999	46.425	1190	-11.693	43.242
1093	-11.355	43.347	1142	-13.012	45.911	1191	-11.692	43.194
1094	-11.342	43.347	1143	-13.029	45.899	1192	-11.688	43.031
1095	-11.299	43.347	1144	-13.01	45.556	1193	-11.696	42.788
1096	-11.119	43.346	1145	-13.009	45.385	1194	-11.687	42.399
1097	-10.678	43.342	1146	-13.007	45.358	1195	-11.683	42.361
1098	-10.657	43.359	1147	-13.008	45.284	1196	-11.688	41.886
1099	-10.169	43.332	1148	-13.009	45.262	1197	-11.69	41.459
1100	-10.168	43.301	1149	-12.387	44.48	1198	-11.695	41.428
1101	-11.653	43.251	1150	-12.412	44.489	1199	-11.682	41.074
1102	-12.391	44.532	1151	-12.832	44.496	1200	-11.679	40.887
1103	-12.398	44.545	1152	-13.324	44.494	1201	-11.674	40.756
1104	-12.447	44.617	1153	-13.394	44.527	1202	-11.676	40.715
1105	-12.529	44.757	1154	-13.824	44.498	1203	-10.452	40.567
1106	-12.521	44.407	1155	-14.329	44.499	1204	-10.445	40.672
1107	-12.604	44.875	1156	-14.367	44.511	1205	-10.438	40.852
1108	-12.624	44.908	1157	-14.825	44.48	1206	-10.439	41.224
1109	-12.628	44.924	1158	-15.328	44.478	1207	-10.424	41.225
1110	-13.072	45.166	1159	-15.348	44.45	1208	-10.432	41.722
1111	-13.077	45.167	1160	-15.599	44.492	1209	-10.444	42.225
1112	-13.128	45.199	1161	-15.639	44.476	1210	-10.432	42.239
1113	-13.338	45.355	1162	-15.914	43.992	1211	-10.429	42.754
1114	-13.388	45.413	1163	-15.905	43.966	1212	-10.428	43.311
1115	-13.722	45.559	1164	-15.848	43.82	1213	-12.094	44.506
1116	-14.18	45.819	1165	-15.745	43.553			
1117	-14.193	45.798	1166	-15.724	43.537			
1118	-14.461	45.987	1167	-15.559	43.079			
1119	-14.721	46.135	1168	-15.378	42.588			
1120	-14.743	46.136	1169	-15.361	42.507			
1121	-15.031	46.333	1170	-15.194	42.111			
1122	-15.229	46.459	1171	-15.012	41.635			
1123	-15.292	46.493	1172	-15.026	41.636			

1124	-11.867	49.267	1173	-14.9	41.309
1125	-11.773	49.266	1174	-14.787	41.039
1126	-11.679	49.268	1175	-14.745	40.935
1127	-11.526	49.269	1176	-14.729	40.897
1128	-11.522	49.286	1177	-14.65	40.997

2 Methods, Instruments, Calibrations:

2.1 Conductivity, Temperature and Depth Instrument (CTD):

A Seabird 911 plus CTD was used to obtain vertical profiles of temperature, salinity, pressure and oxygen. Real time plotting and logging was carried out using the Seabird Seasave software installed on a PC.

2.1.1 CTD sensor calibrations:

Three calibrations were completed for this survey:

a) Dissolved Oxygen:

The dissolved oxygen calibration shows a very stable sensor with considerable correction needed to the raw data (Fig. 2.1.1). Calibrations were done using the Winkler Titration on a manual 725 Dosimat system.

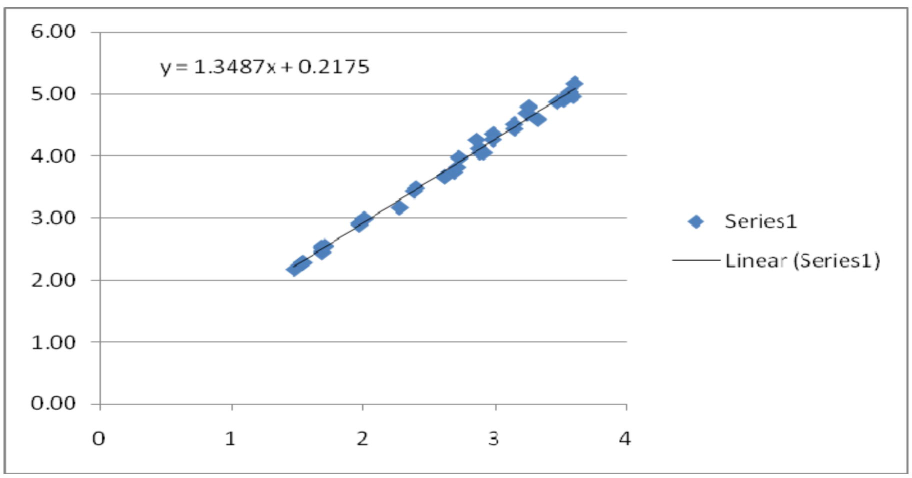


***Figure 2.1.1**: Dissolved oxygen linear regression plot – CTD bottle oxygen vs. Winkler Titrations.*

2.2. Methods for water samples:

2.2.1 Dissolved Oxygen

Dissolved oxygen samples were taken at selected full hydrographic stations along each line, from all twelve Niskin bottles. Seawater was tapped from the Niskin bottle using a PVC pipe that fits over the tap. Water was allowed to flow for 20 seconds before the pipe was removed, without entrapping any bubbles within the glass container. Two reagents were then added to the bottle, Manganous chloride and Potassium Iodide with Sodium Hydroxide (1 ml each). The lid was replaced onto the bottle and shaken to capture all the dissolved oxygen out of the seawater. This precipitate was titrated against Sodium thiosulphate, after mixing in 2 ml of concentrated hydrochloric acid. The titrated volume was then used to calculate dissolved oxygen.

2.2.2 Salinity

Salinity samples were taken at most of the full stations along the last two transects for calibration purposes. The reason for this was the lack of standard sea water to calibrate the Portosal. Sample bottles were washed out three times with seawater from the Niskin bottle, before being filled to the bottle neck. These samples were stored alongside the Portasal and analyzed once they reached room temperature.

2.2.3 Total Chlorophyll

At each full environmental station, five samples were taken for total chlorophyll *a*. One sample was taken at the fluorescence maximum (Fmax), one below Fmax, one at the surface and two samples in between the surface and Fmax, in order to get a description of the fluorometric profile. At physical stations additional filtrations were taken at any bottles that were within the photic zone (usually three). 250 ml of seawater was filtered for each depth, onto 25 mm glass fibre GF/F filters. These filters were frozen , labelled and await analysis in Cape Town.

2.2.4 Phytoplankton samples

1000ml phytoplankton samples were collected at the surface and Fmax at all environmental stations and at physical stations, where possible. Storage was in plastic bottles and fixation occurred with Lugols solution. Samples were then stored in the dark.

2.2.5 Nutrients

Samples were collected at all water depths where Niskin bottles were triggered. The test tubes were rinsed three times and filled to ¾ volume to allow space for freezing. Test tubes were marked with a pencil (station # and depth), and trays of samples were stored in plastic bags in the freezer once the samples had frozen properly.

2.2.6 Size fractionated POM

Water samples for particulate organic matter were collected at the surface (20 l) and from Fmax (20 l) at all full environmental stations. For the determination of the smaller POM size fraction (pico and nano), 10 l from each depth was pre-screened through a 20µm mesh and the resulting water filtered onto precombusted GFF filters. For the determination of total POM (pico, nano and micro), 10 l of water from each depth was prescreened through 64µm mesh (to remove zooplankton but maintain the micro POM size-fraction) and the resulting water filtered onto precombusted GFF filters. Attempts were also made to isolate the micro size fraction of the POM, but concentrations were too low for this to work.
The GFF filters were then labelled, packed, dried at 50^oC for 24 hrs and stored for analysis in South Africa.

2.3 Underway Acoustic Doppler Current Profiler

The vessel-mounted Acoustic Doppler Current Profiler (VMADCP) from RD Instruments was run continuously during the survey in broadband mode shallower than about 400 m and in narrow band mode in deeper waters. The frequency of the VMADCP is 150 kHz, and data was stored in 3 m or 4 m vertical bins for post survey processing.

2.4 Biological sampling methods

2.4.1 Multinet sampling

Oblique multi-nets (190µm mesh size) were deployed at all full environmental stations; with the exception of transect 2. During the latter transect windy conditions and high swell did not allow for multi-net deployments. At each station, the multi-net was lowered while steaming at 0.3-0.5 $m.s^{-1}$ to 200 m depth. The five nets were then opened sequentially at 200-120m, 120-80m, 80-50m, 50-25m, 25m to surface. Between 50-60 m^3 of water were filtered per stratum.
After deployment, the nets were rinsed into 250 ml jars and fixed in 8% formalin. Jars were labelled on the inside and outside and stored for analysis in South Africa.

2.4.2 Bongo sampling

Oblique bongos were deployed at each full environmental station to a depth of 200m with 190 & 370µm nets. Flow meter readings on both nets were noted before and after each dip and allowed for the determination of water volume filtered. Between stations, the flow-meters were washed in distilled water. The bongo was lowered to 200 m while steaming at 2 to 3 knots. Thereafter it was retrieved at a rate of 10m per minute. From each Bongo, the 190µm sample was washed into 250 ml plastic jars and fixed in 8% formalin for future investigation. These samples will be used to work on fish larval abundance and zooplankton composition patterns. The 370 µm samples were size-fractionated by washing through serial 2mm, 1mm, 500 µm and 250 µm sieves. Each size fraction was touch dried on a paper towel and then weighed to the nearest 0.1 g. Subsamples for stable isotope analysis were extracted from the 250µm size fraction (copepods) and the 1 and 2 mm size fraction (euphausids). These samples were dried at 50°C for 24hrs in Eppendorf vials, before storage. The largest size fraction from the 370um net was also sorted and all fish larvae removed under a dissecting microscope. Fish larvae from each Bongo were stored in labelled Eppendorf vials, in 70% alcohol. Larvae will be described and barcoded for identification in South Africa / Canada.

2.4.3 Acoustics

Dr Fridtjof Nansen use ER-60 echo sounders (with ER-60 software) and LSSS ("Large scale survey system", also called "El-trippel-S") for scrutinizing of echoes. The acoustic transducer is attached to an adjustable keel that can be lowered in rough weather to avoid the damping effect of bubbles. Echo intensities per nautical mile are integrated continuously, and mean values per 1 nautical mile are recorded for mapping and further calculations. The echograms, with their corresponding s_A-values, are scrutinized every day. Contributions from the seabed, false echoes, and noise are deleted. Data was stored on raw data files. Acoustic recordings were carried out along all the 10 transects, as well as around the three Islands of Comoros and around Mayotte, zigzagging between bottom depths of 50 to 500 m. Four frequencies are being used (18, 38, 120 and 200 kHz). The acoustic surveys were pursued at a cruising speed of 10 knots or less.

The survey targeted firstly plankton, mesopelagic fish and pelagic fish aggregating in the upper 200 m of the water column. Secondly, an acoustic survey around the Comoros Island and Mayotte was conducted in order to determine the distribution and abundance of small pelagic fish shoals. Secondly, the dynamics of the migrating scattering layer and the pelagic layer communities was studied in more detail using fisheries acoustic and mulinet trawling. The corrected values for integrated echo intensity were allocated to species according to the trace pattern of the echograms and the composition of the trawl catches. Data from pelagic trawl hauls and bottom trawl hauls were not considered to be 100 % representative for the pelagic component of the stocks. The reason is that we did see several schools of tuna and mackerel jumping in the surface, but these were not possible to catch in the trawl, nor did they show up on the acoustical recordings. Fishing rods were tried, but these attempts did not give any successful output. The schooling fish was obviously avoiding the ship.

The echo sounders were watched continuously, and trawl hauls in addition to the predetermined hauls were carried out whenever the recordings changed their characteristics and/or the need for biological data made it necessary. Trawling was carried out both for identification purposes and to obtain biological observations, i.e., length, weight, maturity stage, stomach data, and age.

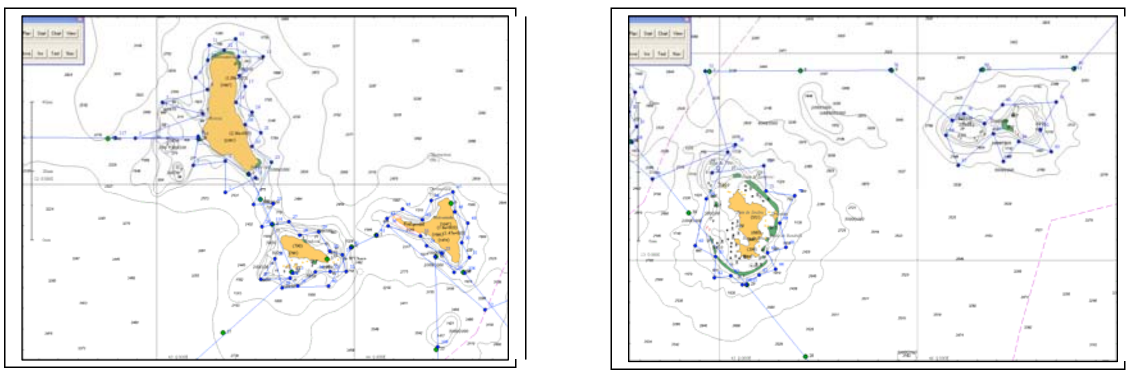


Figure 2.4.3. *An overview of the acoustic cruise track where the vessel is* zigzagging between depths of 50 to 500 m. The panel to the left shows the 3 Comoros Island while the panel to the right shows cruise track around Mayotte

2.4.4 Acoustic zooplankton calibrations

In one station several Multinets were conducted to attempt to calibrate underway acoustic data with zooplankton abundance estimates. Well defined scattering layers were specifically targeted for composition and size frequency distribution with the Multinet. The surface and deep scattering layers were targeted both before and after dark and the migrating layer investigated.

2.4.5 Surface trawls

Surface trawls were carried out at the end of each transect (on or close to the shelf) and in a few additional locations; where time permitted. Daytime surface trawls were carried out specifically for the collection of juvenile life-stages of coastal fishes. Each trawl occurred for approx 30min at a speed of ~ 3 kn. Juvenile fish and all other trawl contents were immediately sorted, counted and weighed to the nearest 0.1g. Representative photos were taken of all new juvenile fish and a juvenile larval inventory (with photos) was constructed. Representative samples were collected (3 individuals per species) and individually packed in 70% alcohol for identification using barcoding. All remaining larvae were also kept, but stored mixed in alcohol in one container for each trawl.

2.4.6 Mesopelagic trawls

Mesopelagic trawls were carried out in locations where the acoustics suggested fish aggregations. Each trawl occurred for approx 30min at a speed of ~ 3 kn. All fish and other trawl contents were immediately sorted, counted and weighed to the nearest 0.1g. For larger fish specimen, length was determined. Representative photos were taken of adult and juvenile fish. Representative samples of fish were collected (3 individuals per species per trawl) and frozen for further processing at the South African Institute for Aquatic Biodiversity (SAIAB). Fish juveniles were individually packed into vials with 70% alcohol for identification using barcoding.

2.4.7 Demersal trawls

Demersal trawls were carried out wherever the substratum allowed. Unfortunately, due to the steep slopes of the volcanic Comoros islands, only one demersal trawl was performed. Fish samples (3 individuals per species) were photographed, identified and weighed. Thereafter they were stored in large plastic bags and frozen.

3 Results

3.1 Flow and Water masses of the Comoros Basin

Section 1

At the surface the isolines indicate cyclonic circulation for most of the transect. Close to Mayotte the flow however appear to be southward. This southward flow is evident even at intermediate depth levels. The surface layer consists of Tropical Surface Water which is a low salinity water mass transported in the South Equatorial Current and eventually via the East Madagascan Current into the Comoros Basin. Below the surface waters the high salinity, low oxygen Subtropical Surface Water layer is clearly visible with the most saline found close to the Comoros. Indian Central Water with its high oxygen content can be seen below this layer. The influence of Australasian Mediterranean Water can only be determined ones we get the nutrient results. At intermediate depths the influences of high salinity low oxygen Red Sea Intermediate Water and low salinity high oxygen Antarctic Intermediate Water can be seen. The Antarctic Intermediate Water layer appears to be overlaying the more saline Red Sea Intermediate Water layer. There is probably also some influence from the high silicate Indonesian Intermediate throughflow Water but this can only be determined ones nutrient samples has been analyzed. The highest salinity values were found near the middle of the transect. T/S plots indicate the deeps waters to be Circumpolar Deep Water and North Indian Deep Water. A clear distinction will only be seen after the nutrients have been analyzed.

Section 2

Flow along this section is dominated by the northern branch of the East Madagascar Current that rounds the northern tip of Madagascar and flows towards the African coast. Away from the Madagascar shelf the flow turns weakly eastward and then westward again. Except for the extreme north much of the surface water along this transect was Tropical Surface Water that is transported in the South Equatorial Current and eventually in the East Madagascar Current westwards. Below the surface waters two different water types is evident. In the East Madagascar Current Subtropical Surface Water seem to be the dominant water mass whilst further north it changes the saline and even more oxygen depleted Arabian Sea sub-surface waters. At the thermocline depth the flow is much the same with South Indian Central Water dominating in the East Madagascar Current whilst in the extreme north of the transect it changes to North Indian Central Water. At intermediate layer Antarctic Intermediate Water with it low salinities is clearly visible in the East Madagascar Current whilst further north the influence of Red Sea Intermediate Water can clearly be observed. Distinction of the deeper waters can only be made once the nutrients have been analyzed but will most likely be a blend of Circumpolar Deep Water of southern origin and North Indian Deep of northern origin.

Section 3

From the upwelling of the isolines it is clear that this section at least partially crosses a cyclonic eddy centred near the middle of the transect. The warm saline surface core of the eddy indicates it to be of northern origin. Surrounding the core the low salinity Tropical Surface Water associated with the northern branch East Madagascar Current is clearly visible. Sub-surface water masses distributions mirror that of section 1 with the minor difference that the most saline Red Sea Intermediate Water is found along the coast of Mayotte.

Section 4

The flow and water mass distribution along this section mirrors that of section 1 with the isolines indicating cyclonic circulation centred slightly to the south. The high salinity surface core indicates Arabian Sea Surface Water that would indicate a northern origin for the eddy. Again the cyclonic circulation is only evident in the upper 450m where after it appears anti-cyclonic. Sub-surface waters are similar to that discussed above with the biggest difference again being at intermediate level depth. The Red Sea Intermediate Water core appears larger and enhanced compared to the above section. This would indicate that either variable input or additional input through the Anjouan-Mayotte channel or finally flow from the western part of the channel. The flow appears to be southward and it is therefore more plausible that it came through the Anjouan-Mayotte channel.

Section 5

The flow along this transect appear allot more complicated than along the other transects. Along the Madagascar shelf the isolines show the flow to be northward whilst in the centre of the channel the flow appears to be cyclonic. Along the Mozambique shelf the flow changes direction and is strongly southward. This flow pattern however only holds for the upper 250 m where after it changes direction along the African shelf to about the intermediate water depth. The surface waters are mainly Tropical Surface Water with some vestiges of Arabian Sea Surface Water in the middle of the channel that is associated with the cyclonic eddy. Water mass distributions below the surface water masses are similar than that of the above transects with some changes in their contributions. The Antarctic Intermediate Water core appear reduced which would indicate the low salinity cores observed in the above sections to have entered the Comoros Basin to the north via the East Madagascar Current.

Section 6

The isolines indicated anti-cyclonic circulation along most of the transect except for close to the Comoros island of Mohele where the flow was southward eastward. Much of the surface water along this section appears to be Tropical Surface Water, except for close the Comoros. Close to the island the surface waters appear to be the more saline Arabian Sea Surface Water. The sub-surface water masses mirror the above sections with a minor difference in the thermocline layer. In this layer there is a core of oxygen minimum water in the middle of the section indicating a strong influence from the northern Indian Ocean. The intermediate layer with salinities above 34.7 shows no definable Antarctic Intermediate Water core.

Section 7

The flow along much of this section is toward the southwest except for along Grand Comore where the flow was in a northeast direction. The surface water consists of Tropical Surface Water with the freshest variant found along the coast of Grand Comore. Sub-surface the layers consist of Subtropical Surface Water, South Indian Central Water and Red Sea Intermediate Water with some influence of Antarctic Intermediate Water and Indonesian Intermediate Water.

Section 8

In terms of flow patterns this section appears featureless. Much of the flow is toward the south except for close to the African slope. The surface waters appear to be a mix of Tropical Surface Water and Arabian Sea Surface Water. Sub-surface similarly there is a blend of Subtropical Surface Water and Arabian surface waters. The deeper waters are similar to that discussed above

Section 9

The surface flow along this section was mostly northwest with waters from the South Equatorial Current feeding into the East African Coastal Current. From the salinity and oxygen values it is clear the south Indian Ocean water masses have experienced considerable mixing with that in the northern Indian Ocean at al depths. The water mass layers are similar to that discussed above. The above interpretations may however change as the calibrated salinity values and nutrient data become available.

Section 10

The flow along this transect is overall westward except along the two northern most stations where the flow at intermediate and deeper levels were slightly south eastward. The south eastward flow of water masses were associated with the spreading of the saline low oxygen Red Sea

Intermediate Water and North Indian Deep Water. The surface waters appear to be mostly Tropical Surface Water with some northern Indian influence in the northern part of the section. Sub-surface water masses are similar to that discussed above. The freshest Antarctic Intermediate Water are found in the extreme northern part of the transect and most likely found its way here via the East Madagascar Current. This is the only viable explanation considering the high intermediate level salinities found in the Comoros Basin

3.2 Biology

Only partial and preliminary results will be presented here as more detailed data and laboratory analyses are required for most biological studies and additional background information needs to be acquired.

3.2.1 Nutrients and total Chlorophyll

Total chlorophyll and nutrients samples were collected at 135 stations. Both nutrient and chlorophyll analysis will be carried out upon return to South Africa and cannot be further commented on in this preliminary report.

3.2.2 Fish juveniles

Juvenile stages of fish were collected in a total of 19 trawls (surface or near surface), on or near the shelf of the Comoros, Mayotte, Magagascar and Mozambique. Some 151 taxa were distinguished, photographed and prepared for bar-coding and identification (see appendix 1). The taxa ranged from species with potential commercial importance such as scombrids (2 or 3 tuna species), anchovies and carangids (10 kingfish species) to coral reef inhabitants such as parrot fish, rock cods and surgeon fishes.

In terms of juvenile species richness, distribution and abundance the current cruise data must be interpreted with great care. The number of trawls was relatively low and no attempts have yet been made to link our sample compositions to the physical environment. In order to strengthen the data, samples from previous ASCLME cruises as well as upcoming regional cruises need to be added to the analysis. Nonetheless some patterns do seem to emerge. The number of species caught in each trawl did not vary dramatically between locations (Fig 3.2.2a). On average 21 species were distinguished per trawl. The fact that this is only a tiny fraction of the total number of species identified, suggests that we have under sampled the representative taxa and/or or that different species are to be found in different localities (apparently true in some cases). Only a more complete analysis of all data sets will allow for a less subjective interpretation.

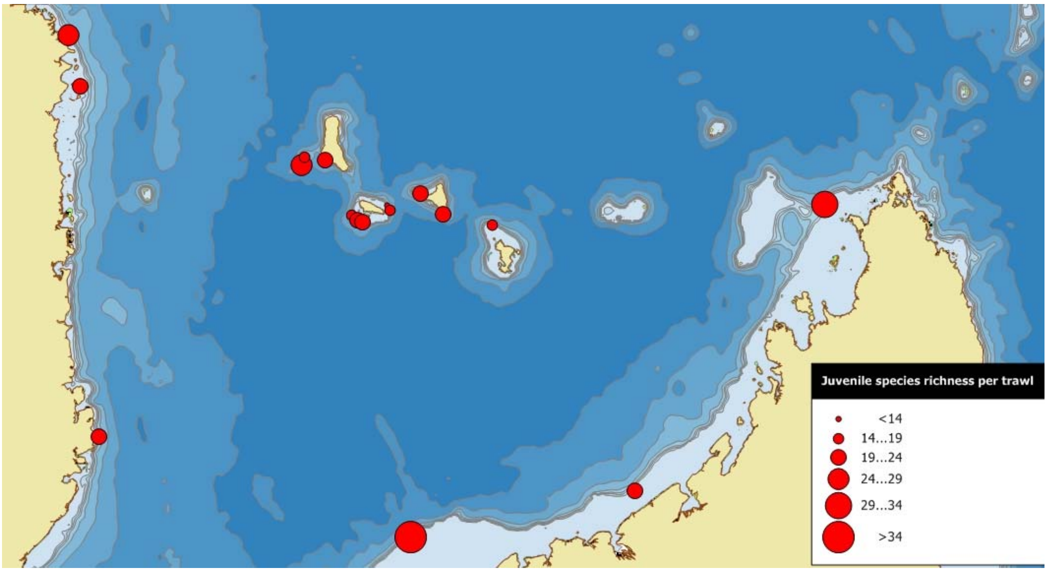


Fig. 3.2.2a: Map of juvenile species richness in the region

While the number of taxa collected show little variation between locations, the number of individuals per unit water volume vary more dramatically (Fig. 3.2.2b). The highest densities of juveniles were generally caught along the Madagasi shelf, with fewer being observed in the Comoros region and the lowest overall abundances along the Mozambique coast. Again, additional samples need to be added to this analysis to see whether this pattern stands up to scrutiny. At the time the cruise, the eastern Comoros Basin was dominated by a cyclonic eddie, while the western part was dominated by a large anti-cyclone. Both physical and nutritional aspects of these features might have affected the survival and distribution of juvenile fish stages.

The juveniles caught during this cruise will add to a regional juvenile identification guide, will allow us to better understand larval and juvenile origins and dispersal (with the help of genetics) and should eventually allow for more informed regional management strategies (pertaining to commercial fisheries as well as coastal ecosystem health).

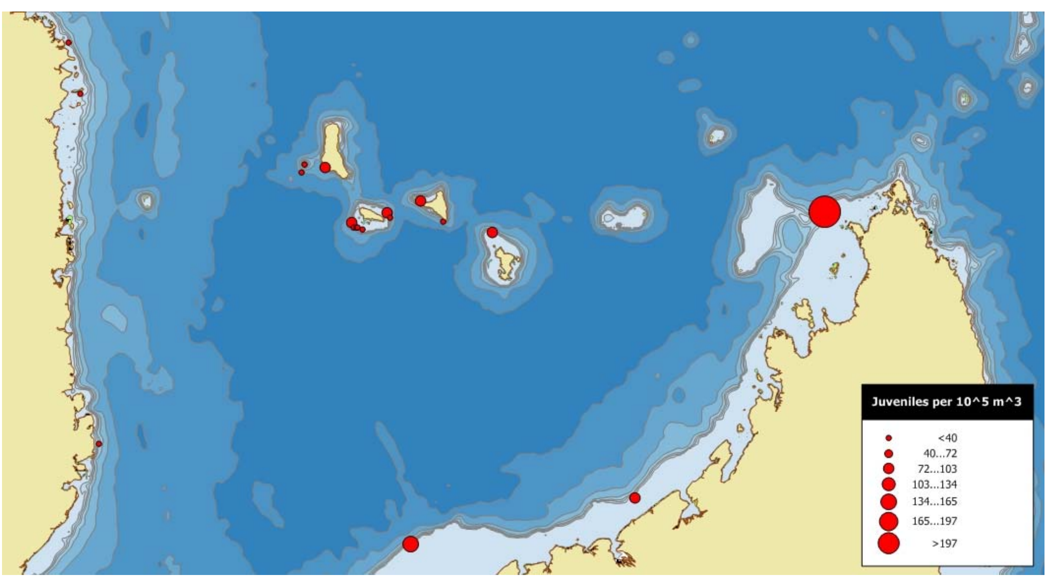


Fig. 3.2.2b: Map of juvenile species abundance (individuals per 10^5 cubic meters)

3.2.3 Zooplankton

Zooplankton results as presented here comprise data from only the 370µm net of the Bongo. The 180µm net and the Multinet samples require analysis after the cruise before they may be commented on.

a) Bongo samples

The main aims of the Bongo sampling were to:

a) provide samples for stable isotope analysis and investigation of trophic links
b) provide samples for fish-larval identification and abundance estimates
c) provide an estimate of size-fractionated biomass distribution

Of the three aims, only the biomass estimates can be discussed at this stage as the other samples require further lab-based analysis.

During the Comoros survey, at total of 47 Bongo trawls were conducted at transect-linked full biological stations (Table 3.2.3.a) as well as a further 14 around the Comoros for a comparative study (Comoros vs Madagascar) by Soafia Binty Ali.

Table 3.2.3a.: Position of oblique Bongo stations.

DATE	TIME (GMT)	LON	LAT	Bottom Depth	STA	corrCTD
07-Oct-09	12:35:30	43.9191	-12.3238	314	PL1	1080
07-Oct-09	18:52:42	44.0472	-12.263	1971	PL4	1082
08-Oct-09	01:13:14	44.1865	-12.1678	270	PL7	1084
09-Oct-09	05:22:12	43.6065	-12.2115	86	PL10	1087
09-Oct-09	09:24:00	43.5459	-12.0752	828	PL13	1089
09-Oct-09	12:14:10	43.4812	-11.9567	216	PL15	1091
10-Oct-09	11:46:51	43.3562	-11.3557	146	PL18	1093
10-Oct-09	22:32:26	43.3435	-10.6833	3329	PL21	1096
11-Oct-09	07:00:14	43.311	-10.1579	3376	PL24	1099
14-Oct-09	03:32:33	44.529	-12.3945	156	PL26	1102
14-Oct-09	09:08:15	44.7345	-12.515	3203	PL29	1105
14-Oct-09	16:31:43	44.9266	-12.6366	218	PL32	1109
15-Oct-09	09:52:26	45.1612	-13.074	264	PL35	1110
15-Oct-09	14:13:13	45.3385	-13.3394	3483	PL37	1113
16-Oct-09	03:39:56	45.8056	-14.1918	3327	PL40	1116
16-Oct-09	09:52:06	46.1275	-14.7073	2736	PL41	1119
16-Oct-09	19:54:36	46.4839	-15.3061	276	PL44	1123
18-Oct-09	23:02:44	49.2538	-11.8776	222	PL45	1124
19-Oct-09	05:53:46	49.2951	-11.5235	2114	PL46	1128
19-Oct-09	13:08:14	49.2884	-10.8545	3930	PL47	1130
20-Oct-09	13:17:25	48.1562	-13.0019	355	PL48	1133
20-Oct-09	21:07:26	47.7647	-13.0165	2400	PL51	1136
21-Oct-09	04:57:17	46.9315	-13.0072	3426	PL52	1139
21-Oct-09	19:04:37	45.9146	-13.0278	3509	PL56	1142

22-Oct-09	00:48:36	45.3963	-13.0095	2182	PL57	1145
22-Oct-09	05:04:03	45.2825	-13.0081	974	PL59	1148
22-Oct-09	15:15:56	44.4859	-12.3894	323	PL63	1149
23-Oct-09	02:13:18	44.492	-13.3102	3551	PL64	1152
23-Oct-09	16:41:07	44.5089	-14.3529	3518	PL67	1155
24-Oct-09	01:47:47	44.4837	-15.3139	3371	PL68	1158
24-Oct-09	09:20:31	44.4645	-15.6394	660	PL71	1160
24-Oct-09	19:28:44	43.9815	-15.9123	740	PL75	1162
24-Oct-09	23:59:50	43.5637	-15.751	3025	PL76	1165
25-Oct-09	13:40:52	42.5756	-15.3833	3095	PL79	1168
25-Oct-09	22:16:26	41.6443	-15.0205	2276	PL80	1171
26-Oct-09	10:42:37	40.8955	-14.72	404	PL83	1176
26-Oct-09	16:07:18	41.2469	-14.4451	2773	PL84	1178
27-Oct-09	05:33:55	42.039	-13.7343	3002	PL87	1181
27-Oct-09	13:49:54	42.8007	-13.092	3410	PL88	1184
28-Oct-09	05:47:18	43.5184	-12.4821	715	PL92	1189
28-Oct-09	13:26:30	43.2391	-11.6852	716	PL94	1191
29-Oct-09	02:46:42	42.3794	-11.6843	2897	PL97	1194
29-Oct-09	10:25:39	41.4776	-11.6946	1989	PL98	1197
29-Oct-09	21:59:58	40.7121	-11.677	384	PL101	1202
30-Oct-09	09:35:58	40.5707	-10.4507	319	PL102	1203
30-Oct-09	19:53:22	41.2097	-10.4243	2427	PL105	1206
31-Oct-09	04:41:43	42.2159	-10.4452	2672	PL106	1209

At each of the biological stations, both Copepod and Euphausid samples were collected for isotope analysis. Additionally, an estimated 300 fish larval samples were collected for barcoding.

b) Bongo composition and biomass:

Only partial and preliminary biomass estimates will be provided in this section as additional work is required to separate abundance estimates at the taxonomic group level (i.e. copepods, euphausids, decapods etc). Furthermore, any interpretation of zooplankton distributions must at this stage be tentative as mesoscale anomalies cannot yet be positioned with certainty.

Total mesozooplankton wet biomass in the top 200m of the water column (as sampled by the 370µm Bongo) ranged from 11 to 94 mg m^{-3}. The predominant taxa in the smaller size fractions from most stations were:

280µm – 500µm:	copepods (also some gastropods, ostracods and amphipods)
500µm – 1mm:	copepods (also some amphipods, ostracods and euphausiid nauplii)
1mm – 2mm:	small euphausiids and chaetognaths (also some large copepods, amphipods, decapods)

The larger size fractions were more variable in composition, with euphausids, decapods, fish larvae and gelatinous zooplankton making up the bulk of the biomass. These larger size fractions of the zooplankton tended to make up a large proportion of the total biomass only during night-time stations. Particularly obvious in their temporal variability were the larger euphausids and decapods which occurred primarily during night time stations.

Preliminary results suggest that mesozooplankton biomass was highly variable throughout the survey. Total zooplankton wetmass (mg m^{-3}) was highest south-east of the Comoros and lowest south west of the islands. Spatially this pattern coincided closely with the position of a cyclonic and anti-cyclonic eddie in the vicinity of the Comoros.
As in previous cruises in the region, horizontal (geographical) distribution of zooplankton suggests that warm-core eddies contain overall very little zooplankton when compared to cold-core eddies and frontal boundary regions. While this result needs to be reinvestigated once updated altimetry data is available, current data suggest that biomass increases drastically outside of the warm-core eddies.

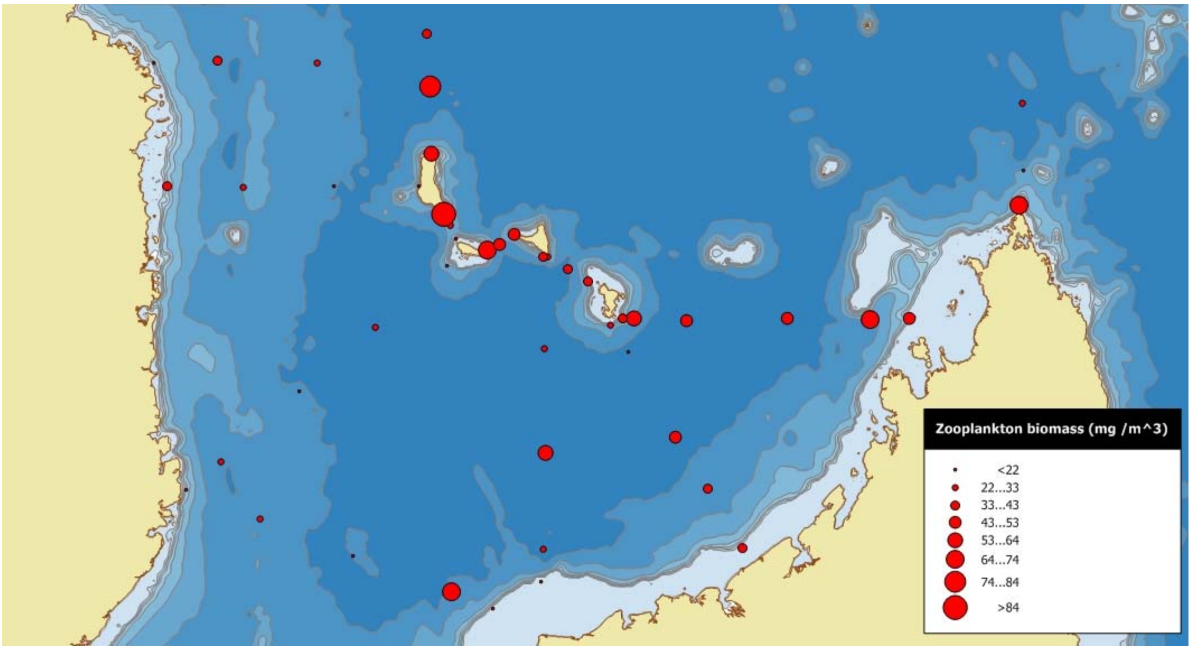


Fig. 3.2.3.: Horizontal distribution of mesozooplankton biomass

c) Multinet zooplankton

Multinets were deployed at all full biological stations with the exception of transect 10 (north of Madagascar). A total of 46 multinet stations were sampled all of which require further analysis before comments can be made.

Table 3.2.3b: Position of multinet stations

DATE	TIME (GMT)	LOG	LON	LAT	Bottom Depth	STA
07-Oct-09	15:53:44	4369.35	43.9471	-12.3145	509	PL2
07-Oct-09	21:07:42	4384.91	44.0467	-12.2399	1859	PL5
07-Oct-09	23:56:17	4397.47	44.1868	-12.169	213	PL6
09-Oct-09	05:54:54	4624.26	43.6086	-12.2125	77	PL11
09-Oct-09	07:48:06	4632.73	43.5449	-12.0867	786	PL12
09-Oct-09	12:48:20	4647.25	43.481	-11.9514	92	PL16
10-Oct-09	12:22:40	4844.71	43.3493	-11.3554	104	PL19
11-Oct-09	00:45:22	4895.33	43.338	-10.6681	3349	PL22
11-Oct-09	04:20:26	4925.01	43.3378	-10.1875	3383	PL23
14-Oct-09	04:09:31	5334.3	44.5335	-12.3902	122	PL27
14-Oct-09	11:44:47	5355.1	44.7624	-12.5306	3201	PL30

14-Oct-09	17:06:57	5372.94	44.9246	-12.6288	127	PL33
15-Oct-09	08:56:54	5520.75	45.1608	-13.0718	91	PL34
15-Oct-09	17:00:47	5548.1	45.3914	-13.3634	3508	PL38
16-Oct-09	00:48:22	5602.33	45.8058	-14.1549	3347	PL39
16-Oct-09	12:04:40	5646.69	46.1219	-14.7227	2718	PL42
16-Oct-09	19:00:13	5689.25	46.4954	-15.2909	184	PL43
20-Oct-09	14:10:08	6243.64	48.1559	-13.0015	354	PL49
20-Oct-09	18:38:06	6266.59	47.7917	-13.002	2150	PL50
21-Oct-09	07:34:13	6321.68	46.9175	-13.0117	3400	PL53
21-Oct-09	12:45:54	6351.92	46.4291	-12.9991	516	PL54
21-Oct-09	16:23:31	6381.43	45.9266	-13.0129	3511	PL55
22-Oct-09	02:35:35	6418.42	45.3798	-13.0076	2097	PL58
22-Oct-09	06:56:05	6427.63	45.2596	-13.0133	416	PL61
22-Oct-09	14:18:44	6492.53	44.4983	-12.3972	372	PL62
23-Oct-09	05:07:17	6563.42	44.5214	-13.3689	3551	PL65
23-Oct-09	13:38:53	6611.11	44.4915	-14.3047	3520	PL66
24-Oct-09	04:39:30	6677.77	44.4655	-15.3291	3326	PL69
24-Oct-09	08:06:54	6696.41	44.4853	-15.6177	924	PL70
24-Oct-09	18:34:31	6741.57	43.9754	-15.9026	1160	PL74
25-Oct-09	02:20:02	6774	43.5625	-15.7356	2959	PL77
25-Oct-09	10:56:49	6834.79	42.6134	-15.3816	2514	PL78
26-Oct-09	00:03:42	6900.05	41.6396	-15.0056	2284	PL81
26-Oct-09	09:22:04	6949.09	40.9263	-14.7465	800	PL82
26-Oct-09	18:25:04	6986.75	41.2539	-14.4379	2774	PL85
27-Oct-09	02:53:59	7047.2	42.0188	-13.7744	2916	PL86
28-Oct-09	03:51:40	7170.95	43.509	-12.4775	910	PL90
27-Oct-09	16:12:58	7113.29	42.8412	-13.0749	3422	PL89
28-Oct-09	03:51:40	7170.95	43.509	-12.4775	910	PL90
28-Oct-09	13:59:21	7233.2	43.2376	-11.6754	900	PL95
28-Oct-09	23:55:00	7284.16	42.4224	-11.6898	2938	PL96
29-Oct-09	12:12:21	7342.96	41.4536	-11.6846	2001	PL99
29-Oct-09	20:44:42	7387.64	40.7419	-11.6784	584	PL100
30-Oct-09	10:33:07	7477.41	40.5647	-10.4487	304	PL103
30-Oct-09	17:10:17	7516.43	41.1935	-10.4388	2318	PL104
31-Oct-09	06:50:35	7583.93	42.2191	-10.434	2662	PL107

3.2.4. Other Fish samples

Due to the lack of suitable ground for demersal trawls, an effort was made to obtain bottom fish by hand-line as well as from fish markets. Approx 40 individuals were caught and photos and ids can be viewed on the Comoros 2009 data CD.

3.2.5 Acoustics

The aim of the acoustic assessment was to study the spatial distribution of fish and zooplankton biomass continuously along the cruise track. Firstly, the objective was to look for the total "acoustic population", including micro organisms and fish. Secondly, an acoustic survey around the Comoros Island and Mayotte was conducted in order to determine the distribution and abundance of small pelagic fish shoals. For this purpose mid-water trawls were used on fish aggregations to determine species and size composition. However, very few pelagic shoals were recorded. Thirdly, the dynamics of the migrating scattering layer and the pelagic layer communities was studied in more detail using fisheries acoustic and Mulinet trawling.

Oceanographic measurements and trawl fishing were carried out during the day as well as at night. The cruise track was designed in order to conduct detailed description of different mesoscale features in the area. The strategy, for acoustics/fisheries, consisted of conducting trawling according to the scattering structures observed during the acoustic survey.

Schools of fish were observed in the surface a couple of times, and we have tried to catch them by rod fishing, but without success. These fish aggregations were not recorded acoustically (se section 3.7.6 visual observations). The reason for this could either be that they are too close to the surface (the ecosounder can only record fish deeper than 6 m depth, or that the fish swim so fast and avoid the research vessel. Strong scatters of mesopelagic fish were recorded, but no schools which could have any resembling to mackerel, sardines, anchovy or tuna were seen. The conclusion is that there is very little fish in this area.

Design of the acoustic survey

Most of the acoustic data were collected along straight transects designed to explore the mesoscale eddies field of the studied area. This strategy, linked to the "environmental" objectives of the cruise, differs from the classical shape of an acoustic survey (gridding coverage of the prospected area) and results in limited goals in the acoustic survey, particularly in terms of fish aggregates prospecting. However, around the island of Comoros and Mayotte, the R/V *Dr Fridtjof Nansen* were zigzagging between depth of 50 to 500 m around the islands and did undertake acoustics transects to determine the distribution and abundance of small pelagic fish shoals. Due to the large avoidance behaviour discovered, a horizontal sonar would have been a more appropriate tool to map the distribution of these fast swimming fishes.

Data processing

Acoustic data were collected with four synchronized SIMRAD split-beam ER60 echo sounders with hull-mounted transducers. The frequencies used were 18, 38 (Fig. 3.2.4 d), 120 and 200 kHz; the pulse durations were all set at 1 ms. The water column was sampled down to a depth of 500 m. A –82 dB threshold was applied on data to reject noise and non-micronekton organisms. Due to the very step and highly variable bottom depth (Figure 3.2.5a), contributions from the seabed, false echoes, and noise was large and had to be deleted manually during scrutinizing of the data.

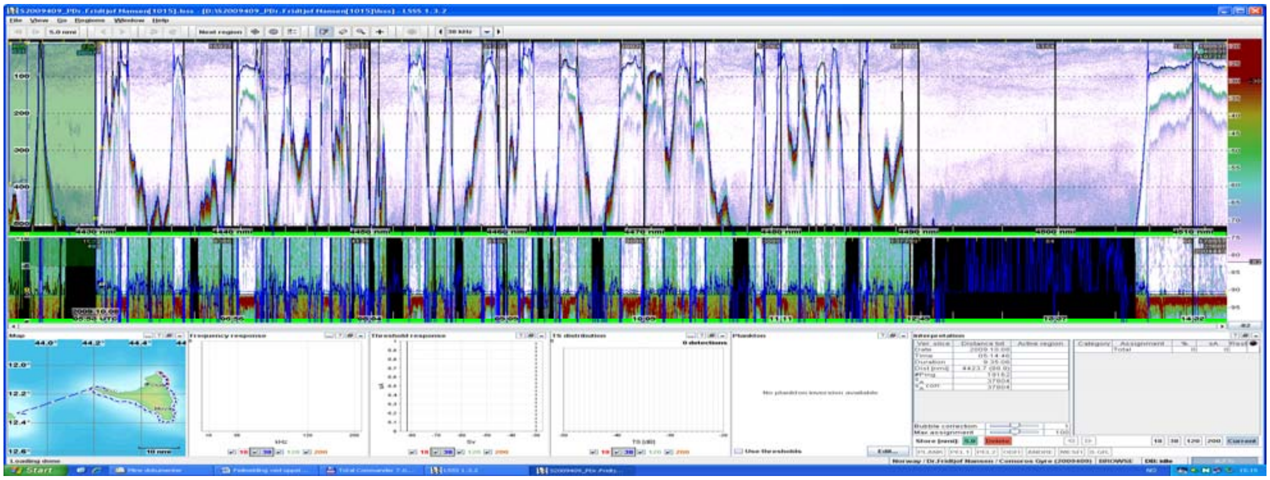


Figure 3.2.5a Example of acoustic recordings, showing the problem with highly variable and step bottom.

The total acoustic back-scattering energy per surface unit (s_A) values were calculated along the full survey track. Considering that organisms do not have the same acoustic response at different frequencies, the multi-frequency analysis, performed using frequency masks (by overlapping and comparison between these frequencies), allow us to discriminate plankton and fish. The next step of the data processing could be post processing of the three other frequencies. In Figure 3.2.5b, the acoustic abundance of mesopelagic fish around the 3 Comores Islands and Mayotte, can be seen. In general the acoustic values were low, though out the whole surveyed area. The highest acoustic densities (3001-10 000 m^2 per nm^2) were recorded in the northern and northwestern parts of the southern Island of the Comores. The bathymetry of easternmost island of the Comores was so steep that is was quite risky manoeuvre the ship so close to land and the acoustic survey could not be conducted in this area. Mayotte is surrounded by a lagoon and the acoustic recordings had to be conducted outside the lagoon.

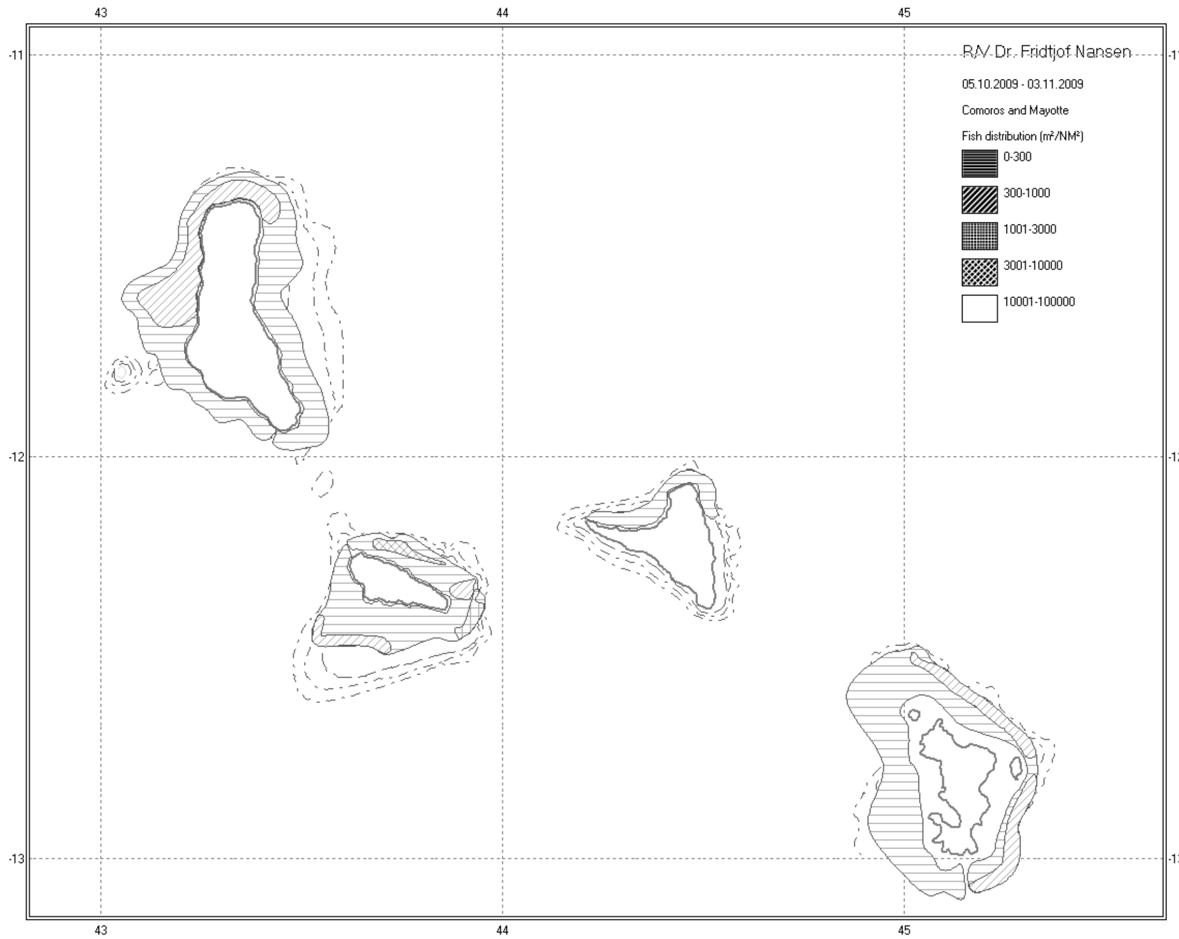


Figure 3.2.5b Acoustic recordings of mesopelagic fish around the 3 Comores Islands and Mayotte.

3.2.6 Fish trawls

Part of the cruise strategy is to assess the bottom (demersal) fauna and biodiversity of shallow shelf areas. This is typically done by demersal trawls in areas that are neither too steep and rough nor covered in vulnerable species such as corals. Around the Comoros, such habitat was only found once. The volcanic origin of the islands have resulted in very steep and uneven slopes. To visualize the extreme of the slopes, imagine the ship anchored outside the port of Moroni. While the bow (front) anchor was in 35m of water, the stern (back) of the ship was floating 300m above the bottom.

Our first demersal trawl at 90m depth therefore caused much excitement. Highlights of this trawl were the capture of what appear to be six species of Unicorn fish (*Naso* sp). While some species such as the humpback unicornfish were easy to identify, others did not agree with all characteristics as provided by species keys. Are there more species in this genus than currently accepted? Only a closer examination of the specimen back at the museum will tell! In Figure 3.2.6 some examples are shown.

Figure 3.2.6 Picture of three of the possible six different species of Unicorn fish (*Naso* sp), caught in the demersal trawl.

1 marine turtle or was seen close to the coral reef just outside Moroni. Swimming crabs were observed during the last CTD- station on line 9 close to Mozambique. Cephalops was observed several times during the survey.

3.2.7 Cetacean observations

<u>Methods :</u>
Observations have been done by a single observer (always the same) by naked eyes, binoculars have been used only to confirm a sighting and follow animals. The viewing height above sea level was approximately of 6m. Both sides were covering alternatively, the fact to have only one observer does not permit a qualitative abundance's estimation. Attention was focus on cetaceans, but birds sightings were also recording.

When it was possible (distance, weather conditions), photos of individuals have been taken to confirm or help on precise identification. A special focus has been done on humpback whales (*Megaptera novaeangliae*) to try to do some photo-identification through internal face of dorsal fin.

When cetaceans 'identification was not sure and when it was possible, the boat changed its road to go closer (i.e.: not during station). At the beginning and the end of each session, and when it seems necessary, environmental conditions were collected: GPS position, sea state (Beaufort scale), swell, wind speed (in knot) and direction, clouds cover (on 8) and an estimation of conditions of observation was done. For each sighting of cetaceans were also recorded: cue, angle and distance with the boat at the first time of detection, specie, number of animals (minimum, maximum and best estimation), presence or not of calves and immature, activity, behaviors, reaction to the boat, photos' reference and other comments.

<u>Results:</u>

Table 3.2.7 gives an overview of number of sightings of whales between days and species.

Table 3.2.7 Overview of number of sightings between days and species.

	04/10/2009	05/10/2009	06/10/2009	07/10/2009	08/10/2009	09/10/2009	10/10/2009	11/10/2009	12/10/2009	13/10/2009	14/10/2009	15/10/2009	16/10/2009	17/10/2009	18/10/2009	19/10/2009	20/10/2009
Effort ' time	4H45	1H30		4H10	6H50	5H50	6H00	6H25	2H00	6H15	5H50	4H35	6H45	3H20	3H40	0H30	5H50
Humpback whales (*Megaptera novaeangliae*)		2				9	5		1					10	4		5
Unidentified balleen whale														1			
Unid. dolphin (*Stenella* or *Delphinus*)							15O										50
Risso's dolphin (*Grampus griseus*)															90		
Spinner dolphin (*Stenella longirostris*)			4				30										
Bottlenose dolphin (*Tursiops truncatus*)																	
Sperm whale (*Physeter macrocephalus*)			5														
Unidentified dolphin			30							2			1				10
Spotted dolphins (*Stenella attenuata*)																	

Table 3.2.7 continued

	21/10/2009	22/10/2009	23/10/2009	24/10/2009	25/10/2009	26/10/2009	27/10/2009	28/10/2009	29/10/2009	30/10/2009	31/10/2009	Total
Effort ' time	**6H00**	**6H00**	**4H50**	**6H25**	**3H30**	**6H25**	**5H50**	**6H40**	**6H35**	**7H00**	**6H45**	**147H15**
Humpback whales (*Megaptera novaeangliae*)	2									10		48
Unidentified balleen whale			2	2								5
Unidentified dolphin (*Stenella* or *Delphinus*)												50
Risso's dolphin (*Grampus griseus*)												90
Spinner dolphin (*Stenella longirostris*)												34
Bottlenose dolphin (*Tursiops truncatus*)												0
Sperm whale (*Physeter macrocephalus*)												5
Unidentified dolphin				2						3		48
Spotted dolphins (*Stenella attenuata*)		15										15

Birds sightings:
_ shy or yellow nose albatross (*Diodemea cauta* or *D. chlororynchos*)
_pintado petrels (*Faption capense*)
_ skua (*Stercorarius sp.*)
_ swift terns (*Sterna bergii*)
_ sooty terns (*Sterna fusca*ta)
_ bridled terns (*Sterna anaethetus*)
_ fregatebirds (*Fregata minor* and *F.ariel*)
_ sandwich terns (*Sterna sandvicensis*)
_ 1 plover (*Charadrius sp.*)
_ boobies (*Sula dactylatra* and *S.sula*)

Terns are the most even seen species.

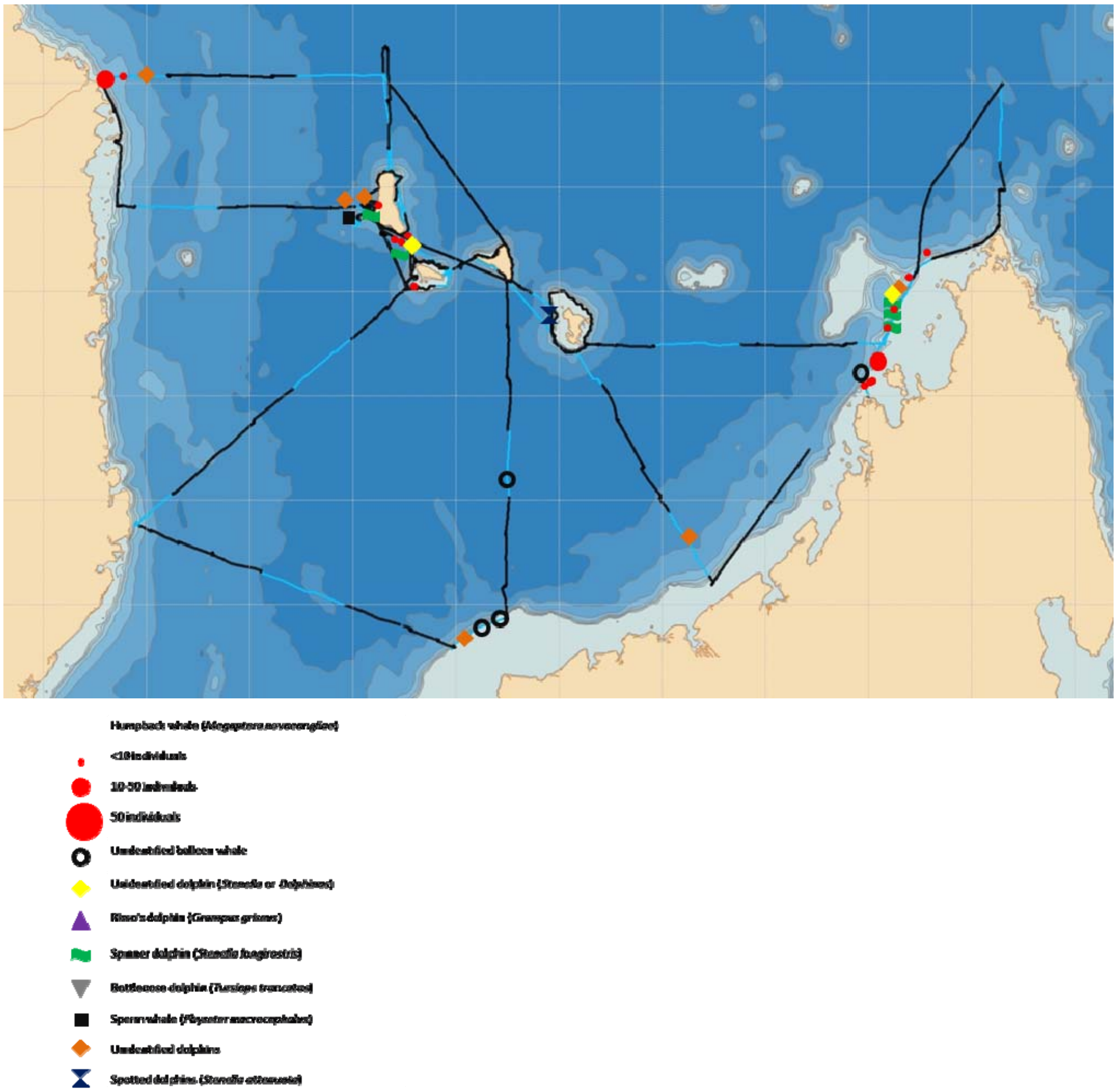


Figure 3.2.7 maps showing geographic positioning of the different sightings.

4 Summary and Conclusions

4.1 Summary of results

The aim of the cruise was to establish for the very first time the physical, chemical and biological characteristics of the Comoros Gyre

At the time the cruise, the eastern Comoros Basin was dominated by a cyclonic eddie, while the western part was dominated by a large anti-cyclone. Both physical and nutritional aspects of these features might have affected the survival and distribution of juvenile fish stages.

While much of the sample analysis remains to be done and data need to be put into context with the help of updated satellite imagery, preliminary results already suggest that the cruise as a whole was a success in terms of meeting its objectives.

The highest densities of juveniles were generally caught along the Madagasi shelf, with fewer being observed in the Comoros region and the lowest overall abundances along the Mozambique coast. Again, additional samples need to be added to this analysis to see whether this pattern stands up to scrutiny.

The juveniles caught during this cruise will add to a regional juvenile identification guide, will allow us to better understand larval and juvenile origins and dispersal (with the help of genetics) and should eventually allow for more informed regional management strategies (pertaining to commercial fisheries as well as coastal ecosystem health).

Mid-water trawls have been used on fish aggregations to determine species and size composition, however, very few pelagic shoals which could have any resembling to mackerel, sardines, anchovy or tuna have been recorded acoustically. Strong scatters of mesopelagic fish have been recorded. The conclusion is that there is very low abundance of large fish in this area, while the number of species diversity of fish larvae is high.

4.2 Logistics

Overall, the cruise was successful in achieving most of its objectives and to a large extent; this was due to the professional handling of the logistics by both the crew and the scientists. For future purposes, a number of possible improvements and ideas for future cruises should be considered. The following should be regarded as an idealised wish-list.

1) One important lesson learned from this cruise is that all **fishing licenses** must be received before the cruise starts. Only this way can the cruise be conducted in the most efficient way.
2) **Trawling and acoustics**: Trawling and acoustics were performed without any problems. However, the offshore cruise strategy of sampling along straight lines did not facilitate the ideal sampling grid as required for fisheries surveys. On future fishery surveys this could be improved upon by increasing the time available and then gridding the acoustic transects.
3) Focuses on processes/features would have increased the ecological outcome of the survey, but then more time must have been made available for staying in one to follow features. A towed undulator (or similar) could be used to reduce the number of hydrographic stations needed by such a survey and thereby free up time for a more detailed gridded sampling

strategy. Use of sonar and other types of equipment for fishing would have increased the possibility of getting more fish samples.

4) **Trainees**: The trainee's involvement in both the underway science and the analysis and interpretation of the data for this report was exemplary. Nonetheless, it was felt that in some cases our regional collaborators could have gained more from the cruise had individual projects of interest been developed and made available to them. Due to time-constraints, this was not possible during this past cruise. For future purposes, however, this possibility should be investigated in more detail. Requests from two of the trainees were also made to remain part of the science team during the upcoming analysis and write-up of the research. Additional funding might have to be sought to facilitate their continual involvement. Even though the trainees on this cruise was very dedicated it could have been advantageous to have had more scientist onboard, especially those that are supposed to work with the sampled data in the near future

4.3 Acknowledgements

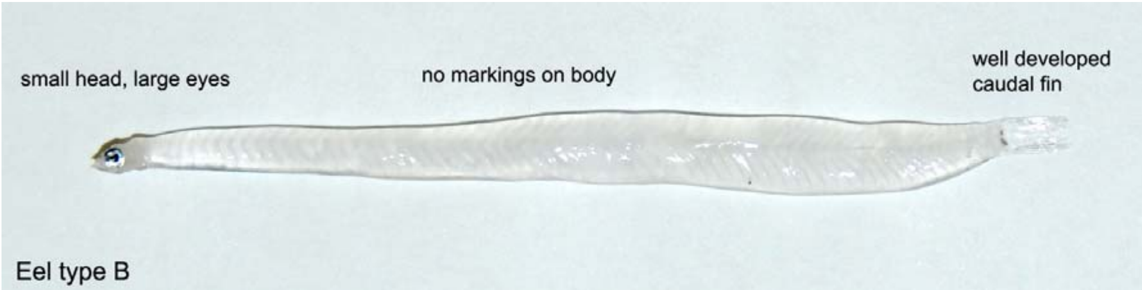
Many thanks are due to the officers, scientists and crew of the RV Dr. Fridtjof Nansen for their continuous support and for generally making this cruise a successful and enjoyable one.

Last, but certainly not least a great many thanks to all those who made this cruise possible in first place. Specific thanks must go to the GEF/UNDP funded ASCLME programme and all of its regional representatives and the EAF Nansen project. We would like to thank David Vousden (ASCLME director), Tore Strømme (EAF Nansen research coordinator) and Tommy Bornman (ASCLME cruise coordinator) for their insights, financial and management support and generally for making this cruise possible.

Annex I Pictures of juvenile stages of fish collected in surface trawls

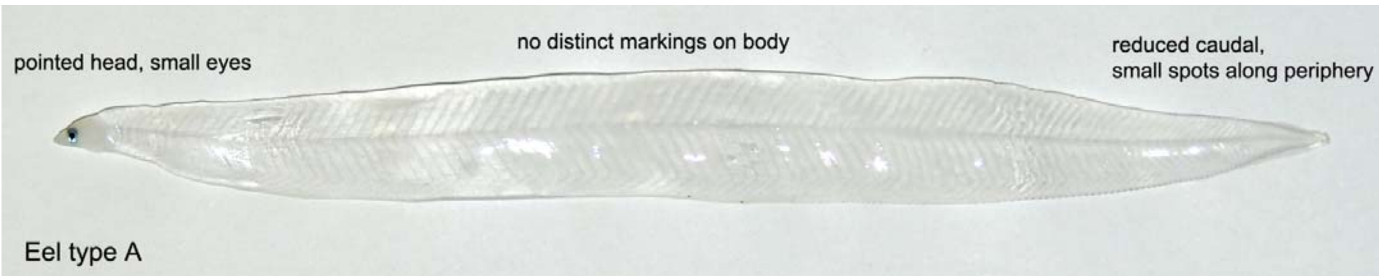
1. ELOPIFORMES

UNIDED2

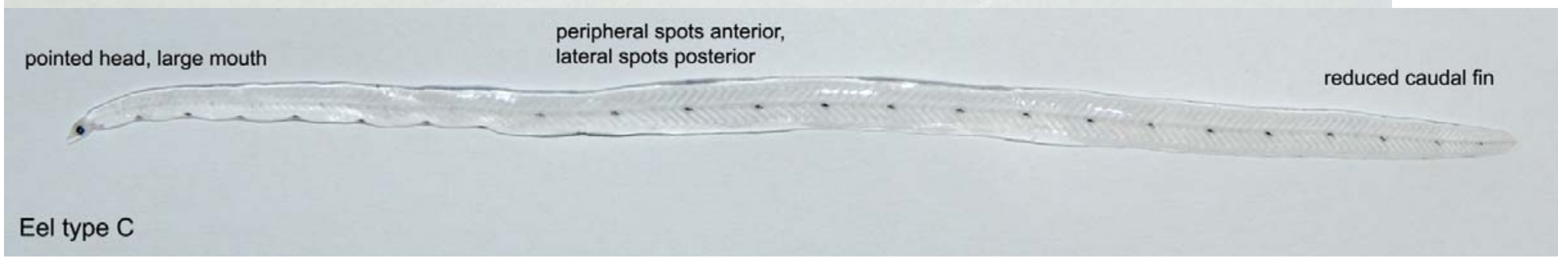


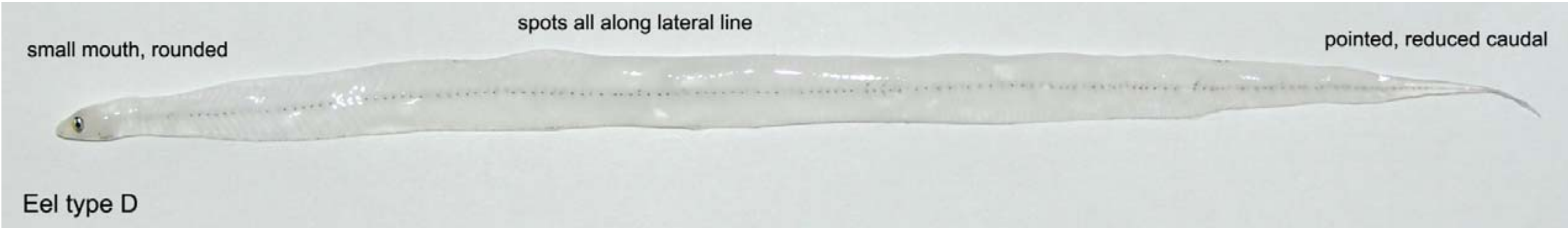
2. ANGUILLIFORMES

UNIDEQ3

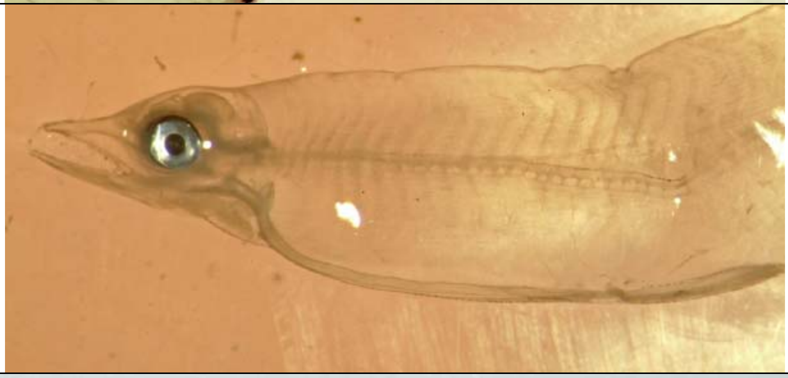


UNIDEO3 = UNIDEE9?




spots all along lateral line
small mouth, rounded
pointed, reduced caudal
Eel type D

UNIDEQ4

<table>
<tr><td></td><td>UNIDED9</td></tr>
<tr><td></td><td>UNIDEE9
=
UNIDEO3
?</td></tr>
<tr><td></td><td>UNIDEX5
(pointed head, diagonal marks along lateral line)</td></tr>
</table>

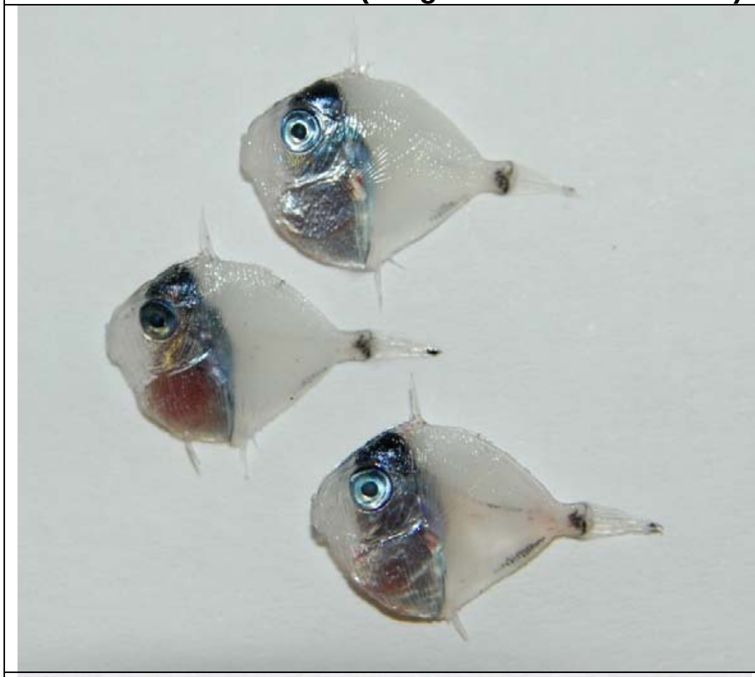
3. ANTENNARIIDAE (Anglers) ?

	**UNIDEP5**

4. HOLOCENTRIDAE (Squirrel fish)

	**UNIDEG1 = UNIDEN1 ?** (no markings, no yellow dorsal, silver to caudal fin)
	**UNIDEN1 = UNIDEG1?** (no markings, no yellow dorsal, silver to caudal fin)
	**UNIDEG2** (black bar on peduncle, tail pink)
	**UNIDEJ3** (yellow dorsal, no markings, tail pink)

	**UNIDEL7** (red bar on nose, tail pink)
	**UNIDEL8** (yellow with black bar on nose, tail pink)
	**UNIDEM2** (not yellow with black bar on nose, tail pink)

5. ACANTHURIDAE (Surgeon and unicorn fish)	
	**UNIDED3** (black peduncle, black caudal tips, blunt nose)
	**UNIDES9** (black peduncle, no black caudal tips, blunt nose)
	**UNIDES4** (black markings on peduncle and caudal fin, black markings on body, blunt nose)

	**UNIDES8** (black peduncle, no black caudal tips or body markings, pointed nose)

6. PLEURONECTIFORMES (Flatfish)	
	UNIDEA7
	UNIDEV8
	UNIDEC8
	UNIDEP3

	UNIDER4
	UNIDEF3 = UNIDEJ9 ?
	UNIDEJ9 = UNIDEF3 ?

	UNIDEJ7
	UNIDET8

7. CARANGIDAE	
	**UNIDET4**
	**UNIDEC2**
	**UNIDEC3**
	**UNIDET5**

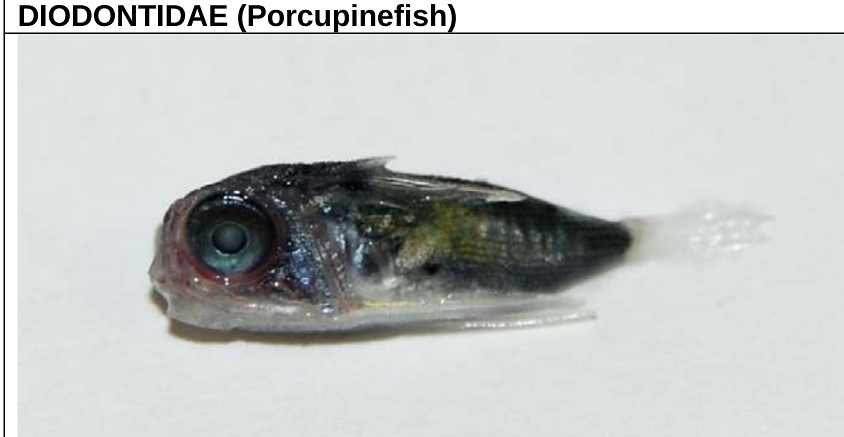
	**UNIDEW2** (*Gnathanodon speciosus*?)
	**UNIDER5**
	**UNIDET6**
	**UNIDES3** (narrow scutes)

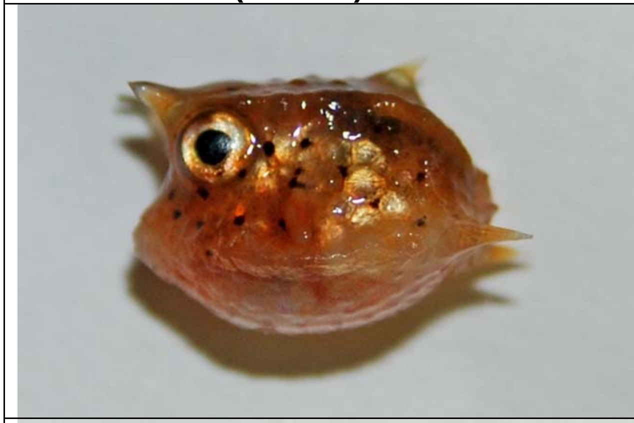
	**UNIDER6** (wide scutes)
	**UNIDEG5** (narrow scutes)

8. BALISTIDAE	
	**UNIDEA6 = UNIDEN2**
	**UNIDET3**

MONACANTHIDAE (Filefish)	
 ??	**UNIDEA5** (wrong body width)
	**UNIDET1** (*Pervagor janthinosoma*?)
	**UNIDET2** (*Paramonacanthus cingalensis*?)

	**UNIDEB5** (*Pseudalutarius nasicornis*?)
TETRAODONTIDAE (Pufferfish)	
	**UNIDEA3** (black around dorsal)
	**UNIDEC4** (blue around pectoral)
	**UNIDEN9** (spiky)

	**UNIDEN1** (warty)
	**UNIDEU3** (*Arothron stellatus*?)
DIODONTIDAE (Porcupinefish)	
	**UNIDEC5**

OSTRACIIDAE (Boxfish)	
	**UNIDEO1**
	**UNIDEO2**

SCORPINIDAE	
	**UNIDEN7**
	**UNIDEM1**
	**UNIDEB3**
	**UNIDEB4**

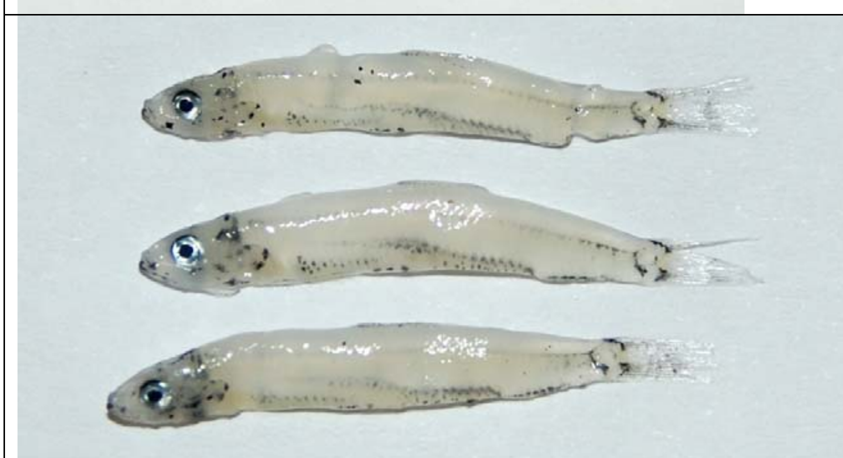
	**UNIDEE6 = UNIDES7?**
	**UNIDES7 = UNIDEE6?**
	**UNIDEU4**
	**UNIDEW8**

	**UNIDEB2** (horizontal black spots above lateral line, dark lateral line)
	**UNIDER7 = UNIDEX2** (no black spots above lateral line, dark lateral line)
	**UNIDEO5** (vertical black bars dorsally, no black lateral)

<table>
<tr><td></td><td>UNIDEG9 =
UNIDEX8
(no black dorsally or laterally)</td></tr>
<tr><td></td><td></td></tr>
</table>

SCOMBRIDAE (Tuna)	
	**UNIDET9**
	**UNIDEW9**
	**UNIDEJ1 = UNIDEX1?**
	**UNIDEX1 = UNIDEJ1?**

SPHYRAENIDAE (Barracudas)	
	**UNIDEB6**
	**UNIDED1**
	**UNIDER3**
	**UNIDEU2**

	**UNIDEA1**
	**UNIDEC1**
	**UNIDEX7**
	**UNIDEX6**

	**UNIDER2**
	**UNIDEA9**
	**UNIDEB7**
	**INIDEG7**
	**UNIDEL9**

	**UNIDEQ1**
	**UNIDEQ2**
	**UNIDEN3**
	**UNIDEP4**

	**UNIDEA4 = UNIDED6**
	**UNIDEM5**
	**UNIDEO4**

	**UNIDEB1 = UNIDEX9** (orange marks, red dorsal and pectorals)
	**UNIDEF8 = juv UNIDEB1?**
	**UNIDEE8**
	**UNIDEU8**

	**UNIDER8**
	**UNIDES1**
	**UNIDER9**
	**UNIDEN6** **= juv. UNIDER9?**

	**UNIDEU7**
	**UNIDEV2**

	**UNIDEA2**
	**UNIDEO8**
	**UNIDEY1**

	**UNIDED4**
	**UNIDEE7** (orange, black caudal tips)
	**UNIDEF9** (orange hind body)
	**UNIDEU9** (orange peduncle, yellow face)

	**UNIDEV1** (black peduncle)
	**UNIDEC9** (lateral line pigments below skin)
	**UNIDEG6** (lateral line pigments on skin, black tip caudal)
	**UNIDEW7**

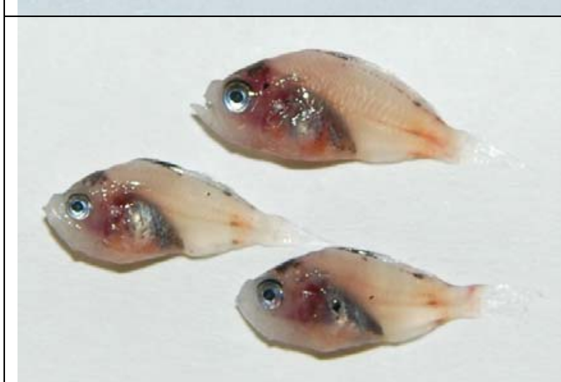
	**UNIDEV6**
	**UNIDER1**

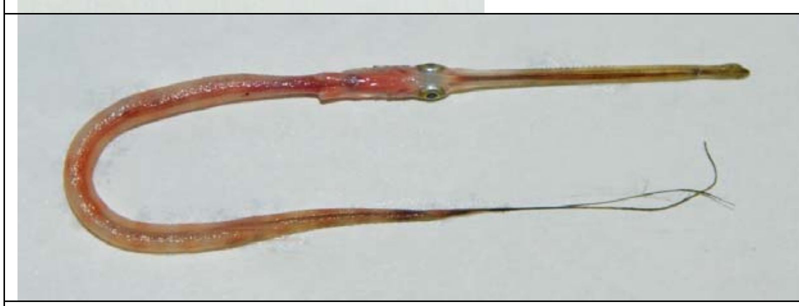
	**UNIDEM4**
	**UNIDEP6**
	**UNIDEG8** **= juv. UNIDEP6?**
	**UNIDES6**

		**UNIDEE5**
		**UNIDED7**
		**UNIDEU5**

	**UNIDEW5**
	**UNIDEC7**
	**UNIDEP1**
	**UNIDEP2**

	**UNIDEF7**
	**UNIDEO7**
	**UNIDEN4**

	**UNIDEV5**
	**UNIDEA8**
	**UNIDES2** **= INDEV3?**
	**UNIDEV3** **= UNIDES2?**

	**UNIDEW4**
	**UNIDEX3**
	**UNIDEC6**

	**UNIDEL1**
	**UNIDEL2**
	**UNIDEU6**
	**UNIDEL3**

	**UNIDEW1**
	**UNIDEV7**
	**UNIDEF4**
	**UNIDEF5**

	**UNIDET7**
	**UNIDEU1**
	**UNIDEV4**
	**UNIDEB8**

	**UNIDEN5**
	**UNIDEN8**
	**UNIDEO6**
	**UNIDEO9**

	**UNIDEJ5**
	**UNIDEW3**
	**UNIDEX4**

Annex II Records of fishing stations

```
R/V Dr. Fridtjof Nansen       SURVEY:2009409        STATION:    1
DATE  :07.10.2009          GEAR TYPE: PT NO:  4  POSITION:Lat   S 12°19.54
        start    stop    duration                         Lon   E 43°55.00
TIME  :14:34:27 15:04:12  29.8 (min)          Purpose   : 1
LOG   : 4364.23  4365.97   1.7                Region    : 7700
FDEPTH:      10       10                      Gear cond.: 0
BDEPTH:     275       78                      Validity  : 0
Towing dir:   0°     Wire out   : 100  m      Speed     : 3.5 kn
Sorted    :   0      Total catch: 0.13        Catch/hour: 0.25
```

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Not found	0.05	67	0.00	
UNIDEA2	0.06	186	0.00	
Not found	0.08	46	0.00	
Not found	0.06	18	0.00	
Not found	0.00	4	0.00	
Not found	0.00	2	0.00	
Not found	0.00	2	0.00	
Not found	0.00	2	0.00	
Not found	0.00	2	0.00	
Not found	0.00	4	0.00	
Not found	0.00	2	0.00	
Not found	0.00	2	0.00	
Not found	0.00	2	0.00	

```
R/V Dr. Fridtjof Nansen       SURVEY:2009409        STATION:    2
DATE  :08.10.2009          GEAR TYPE: PT NO:  4  POSITION:Lat   S 12°10.70
        start    stop    duration                         Lon   E 44°17.27
TIME  :11:39:16 12:08:12  28.9 (min)          Purpose   : 1
LOG   : 4482.70  4484.62   1.9                Region    : 7700
FDEPTH:      10        0                      Gear cond.: 0
BDEPTH:      78      476                      Validity  : 0
Towing dir:   0°     Wire out   : 90   m      Speed     : 4.0 kn
Sorted    :   0      Total catch: 0.13        Catch/hour: 0.28
```

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Symplectoteuthys oualaniensis	0.04	23	0.00	
Sepia sp.	0.01	4	0.00	
Not found	0.14	228	0.00	
UNIDEA2	0.02	66	0.00	
Not found	0.01	21	0.00	
Not found	0.00	2	0.00	
Not found	0.00	4	0.00	
Not found	0.00	6	0.00	
Not found	0.00	6	0.00	
Not found	0.00	4	0.00	
Not found	0.00	2	0.00	
Not found	0.00	2	0.00	
Not found	0.04	35	0.00	
Not found	0.00	2	0.00	
Not found	0.00	2	0.00	
Not found	0.01	6	0.00	
Not found	0.00	2	0.00	
Not found	0.00	2	0.00	
Not found	0.00	2	0.00	
Not found	0.00	2	0.00	
Not found	0.00	10	0.00	
Not found	0.00	4	0.00	
Not found	0.00	4	0.00	

```
R/V Dr. Fridtjof Nansen       SURVEY:2009409        STATION:    3
DATE  :08.10.2009          GEAR TYPE: PT NO:  4  POSITION:Lat   S 12°22.60
        start    stop    duration                         Lon   E 43°56.01
TIME  :15:28:52 15:58:23  29.5 (min)          Purpose   : 1
LOG   : 4517.56  4519.38   1.8                Region    : 7700
FDEPTH:      20       20                      Gear cond.: 0
BDEPTH:      79      458                      Validity  : 0
Towing dir:   0°     Wire out   : 80   m      Speed     : 3.7 kn
Sorted    :   0      Total catch: 1.43        Catch/hour: 2.90
```

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Not found	1.65	752	56.84	
Not found	0.63	144	21.75	
Loligo sp.	0.32	47	11.12	
C R U S T A C E A N S, juvenile	0.12	646	4.02	
J E L L Y F I S H	0.04	16	1.55	
Lestidiops sp.	0.04	4	1.31	
Not found	0.04	14	1.27	
Not found	0.02	2	0.67	
Sepia sp.	0.02	2	0.58	
Not found	0.01	4	0.36	
Not found	0.01	4	0.18	
Not found	0.00	6	0.17	
Not found	0.00	2	0.04	
Not found	0.00	4	0.04	
UNIDEA2	0.00	4	0.02	
Not found	0.00	2	0.02	
Not found	0.00	2	0.01	
Not found	0.00	2	0.01	
Not found	0.00	2	0.01	
Not found	0.00	2	0.01	
Total	2.90		100.00	

```
R/V Dr. Fridtjof Nansen       SURVEY:2009409        STATION:    4
DATE  :08.10.2009          GEAR TYPE: PT NO:  1  POSITION:Lat   S 12°22.80
        start    stop    duration                         Lon   E 43°33.56
TIME  :21:17:39 21:47:42  30.1 (min)          Purpose   : 1
LOG   : 4559.71  4561.34   1.6                Region    : 7700
FDEPTH:      40       50                      Gear cond.: 0
BDEPTH:     338      353                      Validity  : 0
Towing dir:   0°     Wire out   : 170  m      Speed     : 3.3 kn
Sorted    :   0      Total catch: 1.16        Catch/hour: 2.32
```

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Not found	0.66	423	28.35	
C R U S T A C E A N S	0.48	0	20.62	
Symplectoteuthis sp.	0.39	0	16.70	
Not found	0.33	110	14.28	
SALPS	0.19	0	8.08	
J E L L Y F I S H	0.13	0	5.48	
Invertebrate	0.04	12	1.89	
Not found	0.03	66	1.29	
Diaphus effulgens	0.02	18	0.79	
Not found	0.01	12	0.45	
Not found	0.01	6	0.42	
Not found	0.01	6	0.36	
UNIDEA2	0.01	14	0.27	
Not found	0.01	16	0.27	
Not found	0.00	4	0.20	
Not found	0.00	4	0.20	
Not found	0.00	4	0.14	
Not found	0.00	4	0.12	
Not found	0.00	8	0.10	
Not found	0.00	4	0.02	
Not found	0.00	6	0.01	
Total	2.32		100.03	

```
R/V Dr. Fridtjof Nansen       SURVEY:2009409        STATION:    5
DATE  :09.10.2009          GEAR TYPE: BT NO: 21  POSITION:Lat   S 11°57.76
        start    stop    duration                         Lon   E 43°30.49
TIME  :14:09:59 14:25:00  15.0 (min)          Purpose   : 1
LOG   : 4654.97  4655.73   0.8                Region    : 7700
FDEPTH:      90       94                      Gear cond.: 0
BDEPTH:      90       94                      Validity  : 0
Towing dir:   0°     Wire out   : 220  m      Speed     : 3.0 kn
Sorted    :  44      Total catch: 43.61       Catch/hour: 174.32
```

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Naso sp.	95.74	40	54.92	
Starfish (pentagon)	16.99	12	9.75	
Naso brachycentron	12.99	8	7.45	
Aprion virescens	12.19	4	6.99	
Naso cf. tuberosus	9.79	4	5.62	
Holothuria sp.	5.04	72	2.89	
Lethrinus rubrioperculatus	4.60	40	2.64	
Ostracion cubicus	4.20	4	2.41	
Pseudobalistes fuscus	3.60	4	2.06	
Starfish red	3.20	4	1.83	
Lactoria sp.	1.40	4	0.80	
Fistularia commersonii	1.00	8	0.57	
Nudibranchs	0.92	4	0.53	
Anthias cooperi	0.80	967	0.46	
Apolemichthys trimaculatus	0.80	4	0.46	
Starfish small	0.52	4	0.30	
Acanthistius sp	0.20	176	0.11	
Parupeneus macronemus	0.11	4	0.06	
LABRIDAE	0.09	4	0.05	
ACANTHURIDAE	0.04	4	0.02	
Anthiinae	0.03	32	0.02	
Starfish, mixed	0.02	4	0.01	
SERRANIDAE	0.02	4	0.01	
Anthias sp.	0.01	16	0.01	
Nudibranch sp	0.01	4	0.01	
SCORPAENIDAE	0.01	4	0.01	
Hippocampus sp.	0.00	4	0.00	
Total	174.30		99.99	

R/V Dr. Fridtjof Nansen SURVEY:2009409 STATION: 6
DATE :10.10.2009 GEAR TYPE: PT NO: 4 POSITION:Lat S 11°50.83
start stop duration Lon E 43°17.01
TIME :05:08:03 05:38:19 30.3 (min) Purpose : 1
LOG : 4781.98 4784.10 2.1 Region : 7700
FDEPTH: 0 10 Gear cond.: 0
BDEPTH: 199 234 Validity : 0
Towing dir: 0° Wire out : 90 m Speed : 4.2 kn
Sorted : 0 Total catch: 0.10 Catch/hour: 0.19

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
C R U S T A C E A N S	0.02	157	0.00	
J E L L Y F I S H	0.09	85	0.00	
Lolliguncula sp.	0.00	2	0.00	
OMMASTREPHIDAE	0.00	2	0.00	
Not found	0.05	216	0.00	
UNIDEA2	0.00	24	0.00	
UNIDEA2	0.00	4	0.00	0
Not found	0.01	28	0.00	
Not found	0.00	2	0.00	
Not found	0.00	2	0.00	
Not found	0.00	4	0.00	
Not found	0.00	2	0.00	
Not found	0.00	26	0.00	
Not found	0.00	6	0.00	
Not found	0.00	4	0.00	
Not found	0.00	4	0.00	
Not found	0.00	4	0.00	
Not found	0.00	24	0.00	
Not found	0.00	2	0.00	
Not found	0.00	2	0.00	
Not found	0.00	2	0.00	
Not found	0.00	4	0.00	
Not found	0.00	4	0.00	
Not found	0.00	4	0.00	
Not found	0.00	2	0.00	
UNIDEN1	0.00	4	0.00	

R/V Dr. Fridtjof Nansen SURVEY:2009409 STATION: 7
DATE :12.10.2009 GEAR TYPE: PT NO: 4 POSITION:Lat S 12°27.02
start stop duration Lon E 43°34.95
TIME :13:35:08 14:04:37 29.5 (min) Purpose : 1
LOG : 5079.81 5081.60 1.8 Region : 7700
FDEPTH: 0 10 Gear cond.: 0
BDEPTH: 917 741 Validity : 0
Towing dir: 0° Wire out : 90 m Speed : 3.7 kn
Sorted : 0 Total catch: 0.10 Catch/hour: 0.20

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
C R U S T A C E A N S	0.02	0	0.00	
Not found	0.02	26	0.00	
UNIDEA2	0.03	77	0.00	
Not found	0.02	6	0.00	
Not found	0.02	6	0.00	
Not found	0.00	2	0.00	
Not found	0.03	18	0.00	0
Not found	0.04	10	0.00	
Not found	0.00	2	0.00	
Not found	0.02	6	0.00	

R/V Dr. Fridtjof Nansen SURVEY:2009409 STATION: 8
DATE :12.10.2009 GEAR TYPE: PT NO: 4 POSITION:Lat S 12°26.94
start stop duration Lon E 43°33.95
TIME :14:31:15 15:00:45 29.5 (min) Purpose : 1
LOG : 5082.85 5085.06 2.2 Region : 7700
FDEPTH: 10 10 Gear cond.: 0
BDEPTH: 892 726 Validity : 0
Towing dir: 0° Wire out : 90 m Speed : 4.5 kn
Sorted : 0 Total catch: 0.03 Catch/hour: 0.05

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
C R U S T A C E A N S	0.00	45	0.00	
SALPS	0.02	2	0.00	
Symplectoteuthys oualaniensis	0.00	2	0.00	
Small squids	0.00	2	0.00	
Not found	0.00	28	0.00	
UNIDEA2	0.01	45	0.00	
Not found	0.00	2	0.00	
Not found	0.00	2	0.00	
Not found	0.00	10	0.00	
Not found	0.00	2	0.00	
Not found	0.00	4	0.00	
Not found	0.01	6	0.00	
Not found	0.00	2	0.00	

R/V Dr. Fridtjof Nansen SURVEY:2009409 STATION: 9
DATE :12.10.2009 GEAR TYPE: PT NO: 4 POSITION:Lat S 12°27.06
start stop duration Lon E 43°33.94
TIME :16:08:44 16:38:42 30.0 (min) Purpose : 1
LOG : 5089.78 5091.68 1.9 Region : 7700
FDEPTH: 10 10 Gear cond.: 0
BDEPTH: 972 504 Validity : 0
Towing dir: 0° Wire out : 80 m Speed : 3.8 kn
Sorted : 0 Total catch: 0.32 Catch/hour: 0.64

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
C R U S T A C E A N S	0.02	104	0.00	
JELLYFISH	0.09	8	0.00	
MYCTOPHIDAE	0.17	26	0.00	
ALPHEIDAE	0.00	2	0.00	
S H R I M P S	0.01	16	0.00	
Loligo sp.	0.17	10	0.00	
Small squids	0.06	10	0.00	
Not found	0.00	6	0.00	
UNIDEA2	0.02	18	0.00	
Not found	0.02	10	0.00	
Not found	0.00	8	0.00	
Not found	0.00	8	0.00	
Not found	0.00	4	0.00	
Not found	0.00	2	0.00	
Not found	0.04	26	0.00	
Not found	0.00	2	0.00	
Not found	0.00	2	0.00	
Not found	0.03	12	0.00	
Not found	0.00	8	0.00	
Not found	0.00	4	0.00	
Not found	0.00	4	0.00	
Not found	0.01	6	0.00	
Not found	0.00	8	0.00	
Not found	0.00	2	0.00	
Not found	0.00	2	0.00	
Not found	0.00	2	0.00	
UNIDEN1	0.00	2	0.00	

R/V Dr. Fridtjof Nansen SURVEY:2009409 STATION: 10
DATE :12.10.2009 GEAR TYPE: PT NO: 4 POSITION:Lat S 12°27.37
start stop duration Lon E 43°37.00
TIME :17:01:03 17:31:01 30.0 (min) Purpose : 1
LOG : 5093.04 5095.24 2.2 Region : 7700
FDEPTH: 10 10 Gear cond.: 0
BDEPTH: 614 423 Validity : 0
Towing dir: 0° Wire out : 80 m Speed : 4.4 kn
Sorted : 0 Total catch: 0.32 Catch/hour: 0.63

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Astronesthes sp.	0.00	4	0.00	
C R U S T A C E A N S	0.01	64	0.00	
J E L L Y F I S H	0.01	2	0.00	
MYCTOPHIDAE	0.01	6	0.00	
Myctophid sp. A	0.04	22	0.00	
Myctophid sp. B	0.07	36	0.00	
S H R I M P S	0.01	22	0.00	
Loligo sp.	0.36	22	0.00	
Not found	0.00	6	0.00	
UNIDEA2	0.00	6	0.00	
Not found	0.01	2	0.00	
Not found	0.00	2	0.00	
Not found	0.00	8	0.00	
Not found	0.00	2	0.00	
Not found	0.00	4	0.00	
Not found	0.01	16	0.00	
Not found	0.00	2	0.00	
Not found	0.01	6	0.00	
Not found	0.02	20	0.00	
Not found	0.03	30	0.00	
Not found	0.02	12	0.00	
Not found	0.00	4	0.00	
Not found	0.03	8	0.00	
Not found	0.00	6	0.00	
Not found	0.00	2	0.00	
Not found	0.00	16	0.00	
Not found	0.00	2	0.00	

```
R/V Dr. Fridtjof Nansen       SURVEY:2009409        STATION:   11
DATE  :13.10.2009          GEAR TYPE: PT NO:  4  POSITION:Lat   S 11°50.77
         start    stop   duration                        Lon   E 43°0.56
TIME  :13:12:33 13:42:38  30.1 (min)          Purpose   : 1
LOG   : 5211.36  5213.19   1.8                Region    : 7700
FDEPTH:       0       0                       Gear cond.: 0
BDEPTH:    1473    2070                       Validity  : 0
Towing dir:   0°     Wire out   : 80   m      Speed     : 3.7 kn
Sorted    :   0      Total catch: 0.35        Catch/hour: 0.70
```

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
C R U S T A C E A N S	0.04	138	0.00	
J E L L Y F I S H	0.13	34	0.00	
Loligo sp.	0.05	26	0.00	
SEPIIDAE	0.06	4	0.00	
TRACHIPTERIDAE	0.00	8	0.00	
Not found	0.03	72	0.00	
Not found	0.00	2	0.00	
Not found	0.09	20	0.00	
Not found	0.00	10	0.00	
Not found	0.00	2	0.00	
Not found	0.00	14	0.00	
Not found	0.00	4	0.00	
Not found	0.00	2	0.00	
Not found	0.01	56	0.00	
Not found	0.00	2	0.00	
Not found	0.01	26	0.00	
Not found	0.20	110	0.00	
Not found	0.04	112	0.00	
Not found	0.00	2	0.00	
Not found	0.00	4	0.00	
Not found	0.00	2	0.00	
Not found	0.00	2	0.00	
Not found	0.01	2	0.00	
Not found	0.00	2	0.00	
Not found	0.00	2	0.00	
Not found	0.00	10	0.00	
Not found	0.00	2	0.00	
Not found	0.00	2	0.00	
Not found	0.00	4	0.00	
Not found	0.00	4	0.00	
Not found	0.01	8	0.00	

```
R/V Dr. Fridtjof Nansen       SURVEY:2009409        STATION:   12
DATE  :13.10.2009          GEAR TYPE: PT NO:  4  POSITION:Lat   S 11°48.80
         start    stop   duration                        Lon   E 43°4.41
TIME  :14:31:02 15:01:44  30.7 (min)          Purpose   : 1
LOG   : 5219.39  5221.29   1.9                Region    : 7700
FDEPTH:       0      10                       Gear cond.: 0
BDEPTH:     402     509                       Validity  : 0
Towing dir:   0°     Wire out   : 90   m      Speed     : 3.7 kn
Sorted    :   0      Total catch: 0.02        Catch/hour: 0.04
```

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
C R U S T A C E A N S	0.00	21	0.00	
J E L L Y F I S H	0.00	2	0.00	
Loligo sp.	0.00	2	0.00	
Not found	0.00	31	0.00	
UNIDEA2	0.01	27	0.00	
Not found	0.00	2	0.00	
Not found	0.00	4	0.00	
Not found	0.00	2	0.00	
Not found	0.00	8	0.00	
Not found	0.00	6	0.00	
Not found	0.00	8	0.00	
Not found	0.00	2	0.00	
Not found	0.01	4	0.00	
Not found	0.00	21	0.00	
Not found	0.00	6	0.00	
Not found	0.00	2	0.00	
Not found	0.00	2	0.00	
Not found	0.00	2	0.00	

```
R/V Dr. Fridtjof Nansen       SURVEY:2009409        STATION:   13
DATE  :14.10.2009          GEAR TYPE: PT NO:  4  POSITION:Lat   S 12°29.99
         start    stop   duration                        Lon   E 45°2.00
TIME  :19:45:04 20:15:37  30.6 (min)          Purpose   : 1
LOG   : 5391.35  5393.09   1.7                Region    : 7700
FDEPTH:       0      10                       Gear cond.: 0
BDEPTH:     459     443                       Validity  : 0
Towing dir:   0°     Wire out   : 90   m      Speed     : 3.4 kn
Sorted    :   0      Total catch: 0.37        Catch/hour: 0.72
```

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
C R U S T A C E A N S	0.05	281	0.00	
J E L L Y F I S H	0.27	55	0.00	
MYCTOPHIDAE	0.11	31	0.00	
Loligo sp.	0.02	2	0.00	
UNIDEA2	0.00	2	0.00	
Not found	0.00	2	0.00	
Not found	0.19	82	0.00	
Not found	0.00	22	0.00	
Not found	0.00	2	0.00	
Not found	0.00	2	0.00	
Not found	0.05	35	0.00	
Not found	0.00	2	0.00	
Not found	0.00	2	0.00	
Not found	0.00	2	0.00	
Not found	0.00	2	0.00	
Not found	0.01	16	0.00	
Not found	0.00	16	0.00	
Not found	0.01	10	0.00	
Not found	0.00	2	0.00	
Not found	0.00	4	0.00	
Not found	0.00	2	0.00	
Not found	0.00	2	0.00	

```
R/V Dr. Fridtjof Nansen       SURVEY:2009409        STATION:   14
DATE  :16.10.2009          GEAR TYPE: PT NO:  4  POSITION:Lat   S 15°16.91
         start    stop   duration                        Lon   E 46°29.74
TIME  :20:48:00 21:18:20  30.3 (min)          Purpose   : 1
LOG   : 5693.39  5695.22   1.8                Region    : 7510
FDEPTH:       0       0                       Gear cond.: 0
BDEPTH:     273     648                       Validity  : 0
Towing dir:   0°     Wire out   : 87   m      Speed     : 3.6 kn
Sorted    :   0      Total catch: 22.68       Catch/hour: 44.84
```

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Stolephorus indicus	26.80	1374	59.75	
J E L L Y F I S H	8.84	0	19.71	
MYCTOPHIDAE	4.05	4548	9.04	
Selar crumenophthalmus	1.25	10	2.78	
Pterocaesio sp.	1.23	77	2.73	
Lestrolepis intermedia	0.85	194	1.90	
Parapriacanthus ransonneti	0.36	67	0.79	
OMMASTREPHIDAE	0.30	20	0.66	
Dipterygonotus balteatus	0.20	36	0.44	
Symplectoteuthys oualaniensis	0.18	28	0.40	
Loligo sp.	0.14	10	0.31	
Myctophid sp. A	0.10	26	0.22	
Myctophid sp. B	0.10	36	0.22	
UNIDEQ3	0.05	34	0.11	
Not found	0.04	105	0.10	
C R U S T A C E A N S	0.04	89	0.09	
Not found	0.03	38	0.06	
Rexea sp.	0.02	2	0.04	
Not found	0.02	65	0.04	
Not found	0.01	10	0.03	
Not found	0.01	16	0.02	
Not found	0.01	22	0.02	
Not found	0.01	6	0.01	
Apogon sp. 'spot'	0.01	2	0.01	
UNIDEA2	0.01	26	0.01	
Not found	0.00	8	0.01	
Not found	0.00	8	0.01	
Not found	0.00	6	0.01	
Not found	0.00	4	0.01	
Not found	0.00	2	0.00	
Not found	0.00	2	0.00	
Not found	0.00	8	0.00	
Not found	0.00	4	0.00	
Not found	0.00	2	0.00	
Not found	0.00	2	0.00	
Not found	0.00	2	0.00	
Not found	0.00	2	0.00	
Total	44.65		99.56	

```
R/V Dr. Fridtjof Nansen       SURVEY:2009409        STATION:   15
DATE  :20.10.2009          GEAR TYPE: PT NO:  4  POSITION:Lat   S 12°16.82
         start    stop   duration                        Lon   E 48°28.91
TIME  :07:50:09 08:20:23  30.2 (min)          Purpose   : 1
LOG   : 6193.75  6195.97   2.2                Region    : 7510
FDEPTH:       0      10                       Gear cond.: 0
BDEPTH:      67     339                       Validity  : 0
Towing dir:   0°     Wire out   : 100  m      Speed     : 4.4 kn
Sorted    :   0      Total catch: 0.21        Catch/hour: 0.42
```

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
C R U S T A C E A N S	0.05	175	0.00	
J E L L Y F I S H	0.10	18	0.00	
Loligo sp.	0.00	8	0.00	
Not found	0.00	2	0.00	
Not found	0.05	167	0.00	
UNIDEA2	0.02	115	0.00	
Not found	0.00	2	0.00	
Not found	0.00	4	0.00	
Not found	0.00	20	0.00	
Not found	0.00	12	0.00	
Not found	0.00	6	0.00	
Not found	0.00	22	0.00	
Not found	0.00	6	0.00	
Not found	0.00	2	0.00	
Not found	0.00	14	0.00	
Not found	0.00	14	0.00	
Not found	0.00	2	0.00	
Not found	0.00	18	0.00	
Not found	0.00	2	0.00	
UNIDEN1	0.00	2	0.00	
Not found	0.00	2	0.00	
Not found	0.15	1002	0.00	
Not found	0.00	22	0.00	
Not found	0.00	2	0.00	
Not found	0.00	6	0.00	
Not found	0.00	2	0.00	
Not found	0.00	6	0.00	
Not found	0.02	175	0.00	
Not found	0.00	12	0.00	
Not found	0.00	4	0.00	
Not found	0.00	2	0.00	
Not found	0.00	2	0.00	
Not found	0.00	4	0.00	

R/V Dr. Fridtjof Nansen SURVEY:2009409 STATION: 16
DATE :22.10.2009 GEAR TYPE: PT NO: 4 POSITION:Lat S 12°23.53
start stop duration Lon E 44°29.82
TIME :15:53:54 16:31:54 38.0 (min) Purpose : 1
LOG : 6496.11 6498.78 2.7 Region : 7700
FDEPTH: 0 10 Gear cond.: 0
BDEPTH: 110 268 Validity : 0
Towing dir: 0° Wire out : 100 m Speed : 4.2 kn
Sorted : 0 Total catch: 3.65 Catch/hour: 5.76

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
JELLYFISH	3.17	55	55.14	
Myctophid sp. A	0.92	346	15.91	
Sphyraena acutipinnis	0.74	2	12.89	
Herklotsichthys quadrimaculat.	0.28	2	4.94	
Myctiphid 'fully scaled'	0.14	90	2.42	
Parapriacanthus ransonneti	0.11	25	1.96	
Dosidicus sp.	0.07	2	1.18	
C R U S T A C E A N S	0.06	182	1.00	
Lestrolepis intermedia	0.06	9	0.98	
Loligo sp.	0.04	19	0.67	
C E P H A L O P O D A	0.03	5	0.55	
Not found	0.03	19	0.48	
UNIDEQ3	0.02	2	0.36	
JELLYFISH	0.02	5	0.27	
Not found	0.01	6	0.21	
Metapenaeus sp.	0.01	2	0.18	
Astronesthes sp.	0.01	17	0.14	
Not found	0.01	5	0.14	
Not found	0.01	5	0.13	
Not found	0.01	2	0.11	
Not found	0.01	6	0.11	
Not found	0.00	5	0.08	
Not found	0.00	2	0.04	
Not found	0.00	9	0.04	
Not found	0.00	2	0.03	
Not found	0.00	2	0.02	
Not found	0.00	6	0.01	
Not found	0.00	5	0.01	
Not found	0.00	2	0.01	
Not found	0.00	2	0.01	
Not found	0.00	2	0.01	
Not found	0.00	2	0.01	
Not found	0.00	2	0.01	
Not found	0.00	3	0.01	
Not found	0.00	2	0.00	
Not found	0.00	2	0.00	
Unidentified fish	0.00	2	0.00	
Total	5.76		100.05	

R/V Dr. Fridtjof Nansen SURVEY:2009409 STATION: 17
DATE :24.10.2009 GEAR TYPE: PT NO: 4 POSITION:Lat S 15°45.64
start stop duration Lon E 44°9.41
TIME :11:40:43 12:10:44 30.0 (min) Purpose : 1
LOG : 6718.17 6719.95 1.8 Region : 7510
FDEPTH: 0 0 Gear cond.: 0
BDEPTH: 957 909 Validity : 0
Towing dir: 0° Wire out : 80 m Speed : 3.6 kn
Sorted : 0 Total catch: 0.55 Catch/hour: 1.10

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Not found	0.54	284	48.88	
Not found	0.20	190	17.92	
J E L L Y F I S H	0.19	0	16.85	
Not found	0.05	16	4.24	
C R U S T A C E A N S	0.02	152	1.72	
C E P H A L O P O D A	0.01	12	1.09	
Not found	0.01	16	0.76	
UNIDEA2	0.01	20	0.72	
Xiphasia setifer	0.01	4	0.62	
Not found	0.01	2	0.56	
Not found	0.01	18	0.54	
Parapriacanthus ransonneti	0.01	2	0.54	
Not found	0.01	2	0.51	
Not found	0.00	14	0.43	
Not found	0.00	8	0.42	
Not found	0.00	6	0.36	
Not found	0.00	2	0.33	
Not found	0.00	2	0.31	
Not found	0.00	6	0.31	
Symplectoteuthys oualaniensis	0.00	2	0.27	
Not found	0.00	12	0.25	
Not found	0.00	14	0.25	
Not found	0.00	6	0.24	
Not found	0.00	2	0.18	
Not found	0.00	6	0.13	
Not found	0.00	6	0.13	
Not found	0.00	2	0.13	
Not found	0.00	2	0.13	
Not found	0.00	2	0.11	
Not found	0.00	2	0.11	
Not found	0.00	2	0.09	
Not found	0.00	2	0.09	
Not found	0.00	4	0.09	
Not found	0.00	2	0.09	
Not found	0.00	2	0.07	
Not found	0.00	2	0.07	0
Not found	0.00	2	0.07	
Not found	0.00	2	0.07	
C R A B S	0.00	4	0.07	
Not found	0.00	4	0.05	
Not found	0.00	2	0.05	
Not found	0.00	2	0.04	
Not found	0.00	2	0.04	
Not found	0.00	2	0.04	
Not found	0.00	2	0.04	
Not found	0.00	2	0.02	
Not found	0.00	2	0.02	
Total	1.10		100.04	

R/V Dr. Fridtjof Nansen SURVEY:2009409 STATION: 18
DATE :26.10.2009 GEAR TYPE: PT NO: 4 POSITION:Lat S 14°43.07
start stop duration Lon E 40°53.75
TIME :11:18:01 11:48:10 30.2 (min) Purpose : 1
LOG : 6953.60 6955.19 1.6 Region : 7410
FDEPTH: 0 0 Gear cond.: 0
BDEPTH: 422 468 Validity : 0
Towing dir: 0° Wire out : 80 m Speed : 3.2 kn
Sorted : 0 Total catch: 0.12 Catch/hour: 0.25

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
C R U S T A C E A N S	0.01	97	0.00	
JELLYFISH	0.04	0	0.00	
Symplectoteuthys oualaniensis	0.03	36	0.00	
Small squids	0.09	78	0.00	
Not found	0.03	50	0.00	
UNIDEA2	0.00	4	0.00	
Not found	0.00	2	0.00	
Not found	0.00	2	0.00	
Not found	0.00	2	0.00	
Not found	0.03	14	0.00	
Not found	0.00	4	0.00	
Not found	0.00	2	0.00	
Not found	0.00	6	0.00	
Not found	0.00	2	0.00	
Not found	0.00	4	0.00	
Not found	0.01	16	0.00	
Not found	0.00	2	0.00	
Not found	0.00	2	0.00	
Not found	0.01	10	0.00	
Not found	0.00	14	0.00	
Not found	0.00	2	0.00	
Not found	0.00	6	0.00	
Not found	0.00	2	0.00	
Not found	0.00	2	0.00	
Not found	0.00	2	0.00	

R/V Dr. Fridtjof Nansen SURVEY:2009409 STATION: 19
DATE :30.10.2009 GEAR TYPE: PT NO: 4 POSITION:Lat S 11°3.31
start stop duration Lon E 40°41.65
TIME :03:22:57 03:53:07 30.2 (min) Purpose : 1
LOG : 7429.08 7431.07 2.0 Region : 7410
FDEPTH: 0 10 Gear cond.: 0
BDEPTH: 406 42 Validity : 0
Towing dir: 0° Wire out : 100 m Speed : 3.9 kn
Sorted : 0 Total catch: 0.15 Catch/hour: 0.30

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Unident. crustacean rems	0.00	14	0.00	
C R U S T A C E A N S	0.01	84	0.00	
JELLYFISH	0.08	54	0.00	
Symplectoteuthys oualaniensis	0.00	6	0.00	
SEPIIDAE	0.01	2	0.00	
Small squids	0.00	6	0.00	
Not found	0.04	72	0.00	
UNIDEA2	0.00	8	0.00	
UNIDEA2	0.00	2	0.00	0
Not found	0.01	14	0.00	
Not found	0.00	16	0.00	
Not found	0.02	16	0.00	
Not found	0.00	4	0.00	
Not found	0.00	2	0.00	
Not found	0.00	2	0.00	
Not found	0.01	40	0.00	
Not found	0.00	6	0.00	
UNIDEN1	0.00	2	0.00	
Not found	0.00	2	0.00	
UNIDEQ3	0.09	34	0.00	
Not found	0.00	2	0.00	
Not found	0.00	2	0.00	
Not found	0.00	2	0.00	
Not found	0.00	6	0.00	
Not found	0.00	6	0.00	
Not found	0.00	6	0.00	
Not found	0.00	2	0.00	
Not found	0.00	2	0.00	

```
R/V Dr. Fridtjof Nansen       SURVEY:2009409        STATION:   20
DATE  :30.10.2009          GEAR TYPE: PT NO:  4  POSITION:Lat   S 10°30.94
         start    stop    duration                        Lon   E 40°34.48
TIME  :08:30:46 09:01:16  30.5 (min)          Purpose   : 1
LOG   : 7471.09  7473.65   2.6                Region    : 7410
FDEPTH:       0        0                      Gear cond.: 0
BDEPTH:     109      183                      Validity  : 0
Towing dir:   0°     Wire out   : 90   m      Speed     : 5.0 kn
Sorted    :   0      Total catch: 0.33        Catch/hour: 0.64
```

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
C R U S T A C E A N S	0.07	238	0.00	
Symplectoteuthys oualaniensis	0.33	108	0.00	
Not found	0.12	35	0.00	
UNIDEA2	0.00	6	0.00	
Not found	0.01	12	0.00	
Not found	0.00	2	0.00	
Not found	0.00	2	0.00	
Not found	0.00	2	0.00	
Not found	0.04	65	0.00	
Not found	0.00	4	0.00	
Not found	0.00	4	0.00	
Not found	0.00	2	0.00	0
Not found	0.00	2	0.00	
Not found	0.00	12	0.00	
Not found	0.00	2	0.00	
UNIDEN1	0.00	2	0.00	
UNIDEQ3	0.01	8	0.00	
Not found	0.00	2	0.00	
Not found	0.00	2	0.00	
Not found	0.00	6	0.00	
Not found	0.00	8	0.00	
Not found	0.01	45	0.00	
Not found	0.00	2	0.00	
Not found	0.00	2	0.00	
Not found	0.01	6	0.00	
Not found	0.00	18	0.00	
Not found	0.02	47	0.00	
Not found	0.00	4	0.00	
Not found	0.00	4	0.00	
Not found	0.00	6	0.00	