

Country: Atlantis Bank, Sapmer Bank, Middle of What Seamount, Coral Seamount and Melville Bank, on the South West Indian Ocean Ridge, and an un-named seamount to the north of Walter's Shoal on the Madagascar Ridge.

Research vessel: R/V DR. FRIDTJOF NANSEN

Survey number: 2009

Number of days:

General objectives:

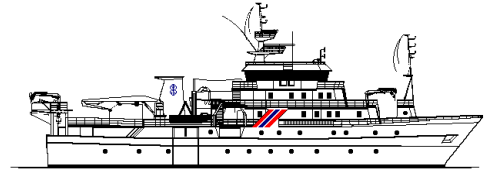
	Port	Date	Coverage	Specific objectives
Departure				<p>The cruise was aimed at</p> <ul style="list-style-type: none"> • Collect physical and biological observations and samples along the South West Indian Ocean Ridge, targeting five seamounts, two of which were SIODFA voluntary benthic protected areas, the others of which had been previously targeted by fishing. • Analyse the physical structure and changes in phytoplankton communities • Analyse the structure of the water column • Observe the influence of tides on the water masses immediately around each seamount • Analyse the relative biomass and movements of the deep-scattering layers and fish shoals on and off seamounts • Analyse samples of chlorophyll, phytoplankton and micro- and mesozooplankton taken with phytoplankton, bongo and multinetts • Establish the boundaries of the Agulhas-Somali Current Large Marine Ecosystem (ASCLME) • Ascertain the influence of seamounts on the pelagic ecosystem and to investigate the interaction between seamounts and the water column in terms of physical oceanography.
Arrival				

Cruise leader:





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Participants:

Summary of the results:

The Southern Indian Ocean seamounts expedition achieved many of its sampling objectives. The data gathered are likely to form a significant contribution to knowledge in the following areas:

- Hydrographic structure of the Sub-Tropical Convergence zone
- Patterns of chlorophyll concentration, nutrient chemistry and phytoplankton diversity from the oligotrophic Sub-Tropical Anticyclonic Gyre system through the Sub-Tropical Front to Sub-Antarctic waters
- Small scale current topography interactions around seamounts with differing summit heights, including evidence of tidally driven concentration and / or mixing of water and phytoplankton and influence on the distribution of zooplankton
- Trapping of multiple deep-scattering layers of zooplankton and predation by resident seamount predators
- Evidence supporting proposed biogeographic zones within the southern Indian Ocean
- Evidence of the significance of both water masses and the presence of elevated topography on seabird distributions
- Connectivity of populations of pelagic organisms across the South West Indian Ocean Ridge

The extremely large number of specimens gathered during this expedition (see Chapters 6,7) means that a large post-cruise effort will be required in order to extract the maximum information from the cruise. These data will be most significant when combined across the disciplines of oceanography, biogeochemistry, botany and zoology represented on the cruise by the scientists. Additional benefits of the cruise included:

- Training of regional scientists
- Training of international Ph.D. students
- Public awareness and education
- Increased networking of regional scientists with the international research community

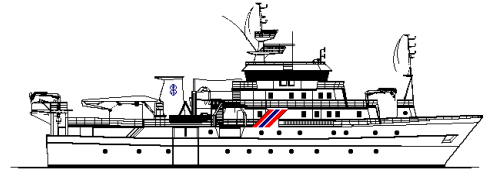
Physical Oceanography

Plots of parameters measured underway by the meteorological and thermosalinograph instruments showed the extent of the gale force winds and bad weather experienced during the cruise. Air bubbles in the thermosalinograph caused noise in the salinity data and the instrument had to be turned off during particularly bad weather. **Sapmer Bank**. The seamount trends roughly northeast to southwest and, like Atlantis Bank, lies on the edge of a fracture zone. It has a highly irregular shape and very rough topography that seems to be associated with significant mass-wasting in the





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form of obvious slide features, particularly along the southern face of the seamount, but also along the north. The seamount summit lies at a shallowest depth of approximately 300m, and the entire feature is > 12km in length across its longest axis. There are no available data on the geology of Sapmer Bank.

Although **Atlantis** reached about 70 m below the sea surface at its highest point most of the plateau was about 750 m deep. The yoyo was worked near the centre of the plateau and showed evidence of tidal periodicity in the bottom 350 m of the water column.

Middle of What was one of the deeper features examined, at its highest elevation reaching no closer than 1000 m to the sea surface. The CTD yoyo was worked close to the summit on the northern edge of the plateau, at the northern drop off into the central rift valley. Surface currents showed weak eastwards flow of about 25 cm/s. The only evidence of tidal signals was a small temperature difference at the seabed in the bottom 100 m of the yoyo.

Coral was the only seamount of the survey that was south of the STC and therefore sited in different water masses, providing a colder and fresher environment than the other seamounts studied. It was a shallow seamount, at its highest point reaching about 100 m below the sea surface. The CTD yoyo was worked on the western side, on the edge of the summit plateau, in about 400 m of water above the drop off into the fracture zone. The seamount survey took place at almost full moon, spring tides. The first cast worked in 954m of water, but the topography was too steep to judge safely the CTD depth relative to the bottom, so the vessel was repositioned at end of first cast to a small flattened area in about 425 m depth of water. Tidal effects were visible throughout the water column over the 24 hour period of the yoyo. Water column ADCP measurements suggested bottom intensification and rapid changes in strength and direction of the currents. Surface currents showed a variable easterly flow. The effects of the tide were strongest at the sea bed, but extended upwards to the sea surface, including affecting the phytoplankton layer. The base of the fluorescence maximum was elevated over columns of cold water, rising from about 100 m to less than 40 m depth. This appeared to be associated with changes in the concentration of fluorescence from >1 $\mu\text{g/l}$ (uncalibrated) as the isolines rose to <0.5 $\mu\text{g/l}$ as the isolines relaxed downwards.

Melville Bank. Melville Bank lies just to the north of the sub-tropical convergence and is influenced by meanders and eddies associated with the front. It possibly corresponds to seamount 102 fished by Soviet fleets (Romanov, 2003) and is the shallowest seamount on the South West Indian Ocean Ridge with a summit depth of about 90m (Gershanovich & Dubinets, 1991). Melville Bank has been fished by the Soviet fleet and has been heavily fished between the depths of 750 – 1000m and as deep as 1500m depth (Shotton, 2006). Melville Bank trends roughly east to west with two distinct peaks, summit depths ~90m and ~550m. The seamount is about 12km along its longest axis.

Unnamed Seamount, Madagascar Ridge. This seamount was predicted to have a summit depth of approximately 700m from Gebco. Instead a sub-conical seamount was located with a summit depth of approximately 1300m. The seamount showed a much more regular outline in shape than those located on the South West Indian Ocean Ridge and is circular and approximately dome-shaped in profile. It is a large feature of more than 16km in diameter.

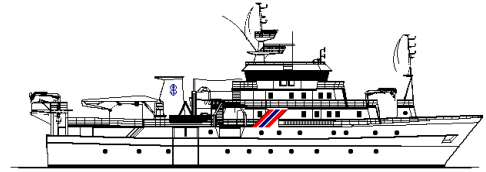
Phytoplankton

Diatoms formed the dominant phytoplankton group south of 36°S. The stations north of Sapmer Seamount (including Atlantis Seamount) was characterized by low fluorescence and a relatively deep (80 – 100 m) Deep Chlorophyll Maximum (DCM) typical of oligotrophic tropical and subtropical water. The dominant diatoms included the chain forming species belonging to the





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genus *Pseudonitzschia*, *Chaetocerus*, *Fragilariopsis*, *Melosira* and *Thalassiosira*; large centrals, such as *Planktoniella* and *Coscinodiscus*; and others, including the large *Rhizosolenia* spp. and several dinoflagellate species belonging to genus *Ceratium*. The highest fluorescence was measured in the surface waters between the Subtropical Front and the Subantarctic Front around 40°S. In the Subantarctic water the important high latitude flagellate, *Phaeocystis* sp. (probably *P. antarctica*), made its appearance in large numbers, although diatoms remained the dominant group.

Mesozooplankton

The catches showed high temporal, spatial and temporal variability in quantity and taxon presence. The 500 µm net yielded consistently greater catches than the 375 µm net. The Bongo net generally caught animals of a greater size range than the multinet. A complete picture of the biogeography will emerge following more thorough post-cruise analysis. The highest catch of mesozooplankton was caught in the depth range scoping the highest fluorescence reading (f-max, see section 5). Information on the presence and absence of main zooplankton identified are shown in Table 1, from which it can be seen that most stations were dominated by copepods, euphausiids, chaetognaths and amphipods. Typically oceanic taxa (pteropods, thaliaceans) were present at the far south and Subtropical front stations. Settled volumes for zooplankton were fairly similar across the sampled stations but lowest at the off seamount station (Station 2) and Atlantis bank (Station 4). The greatest number of euphausiids was caught during the net deployments at night. A large collection of Salps and deeper-living crustaceans were caught off Walter's Shoal (e.g. *Systellaspis debillis*).

Aakra trawl Crustaceans

Crustaceans from the Aakra trawl were removed from the samples and identified to the nearest taxa. We identified 16 species of decapods, 22 species of amphipods, 18 species of euphausiids, 1 species of Ostracoda and 3 species of lophogastridea (Table 3). Due to the semi-quantitative nature of the sampling the numerical abundance of each species caught in each trawl is omitted from this report but can be found in Appendix A. The crustacean diversity was highest in the deep trawls. Lowest diversity and abundance of crustaceans was caught at station 2. Amphipod diversity was highest over seamounts. Euphausiid diversity was highest in the vicinity and south of the subtropical front.

Fish identifications

In total, 60 fish identifications were made to species level, representing 41 families.

Two other fish categories are listed in the database: "unidentified" and "Telescope eye fish". A large portion of the fish categorised as "unidentified" were from the first 3 trawls when the catch was sorted and stored before we were able to identify individual samples. These will be identified at a later date and are likely to include many of the species also identified from later trawls. A small number of fish in each remaining trawl could not be immediately identified and were categorised as "unidentified". Identification of these will also be attempted at a later date and will undoubtedly add to the total species list outlined in Table 2. The category "Telescope eye fish" was used to distinguish a specific fish which appeared in several catches but which could not be satisfactorily identified. This species will be carefully examined at a later date.

Species presence-absence

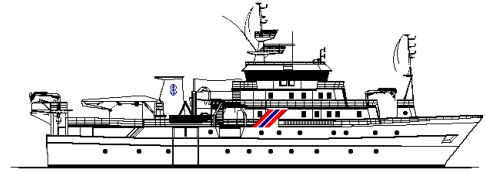
The representation of each fish family in the 40 trawls undertaken is outlined in Table 7.4. There was a particularly diverse catch at Walter's Shoal probably reflecting the proximity of the large area of shallow water in this region associated with Walter's Shoals Seamount itself.

Though larval fish are not included in Table 7.4, it is worth noting that a large number of juvenile scabbardfish (*Trichuiridae*) were caught at the off-ridge site just after the vessel entered colder





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waters (Station 7). The cardinal fishes (*Rossenblattia robusta*) were also only found at this site. Larval fish were fixed in ethanol and formalin for later examination and it is not possible to quantify them at this stage.

Invertebrates

The Akra-trawl sampled a broad spectrum of invertebrate, spanning a size range from makrozooplankton to metre-long cephalopods. Results for crustaceans are discussed in detail in chapter 6. For lack of specialist taxonomic knowledge and time constraints all other invertebrate taxa remain to be identified during post-cruise analysis. Apart from Crustaceans, cephalopods and gelata were the most abundant groups (Figure 2).

Cephalopod diversity appeared very high north of the subtropical front, including several species from the Sepiida, Chranchiidae, Enoploteuthidae, Histioteuthidae and Ctenopterygidae. South of the front diversity appeared to be lower. Octopodids were rare, at present we are only aware of two specimens (#5353 and #5722).

The vast majority of gelatinous specimens were severely damaged by the net, hindering identification of most specimens. Hydromedusae and Siphonophores usually made up a significant proportion of the gelatinous fraction. Among scyphozoans *Atolla* sp. and *Peryphylla* sp. were common. Salps were very abundant south of the front and at Walters Shoal. At least four species of pyrosomes were collected.

Chaetognaths were abundant on most stations. Heteropods and Pteropods were taken in small numbers on most stations.

Figure 7.2 log-transformed invertebrate biomass for all trawls. The “rest” category includes the remaining invertebrates as well as the “rest of catch” lots which usually contained a number of small fishes. The category gelata includes coelenterates and pelagic tunicates.

Acoustic Sampling of Zooplankton, Micronekton and Fish

Visual inspection of echograms showed distinct differences in scattering features between acoustic-frequencies and between sites. While the off-ridge control sites showed a stable layer structure, the scattering layers (SL) around and over seamount summits were often perturbed. An overview of interactions between the topography, seamount associated aggregations and the scattering layers is presented in Table 8.6.

Perturbations were apparently caused by both biological (i.e. feeding aggregations of fish and other scatterers, see Figure 8.1) and physical processes (Figure 8.2). Observations of the diel vertical migration were made during steaming and other sampling activities. Visual inspection of echograms showed distinct differences in scattering features between acoustic-frequencies and between sites. While the off-ridge control sites showed a stable layer structure, the scattering layers (SL) around and over seamount summits were often perturbed. An overview of interactions between the topography, seamount associated aggregations and the scattering layers is presented in Table 8.6.

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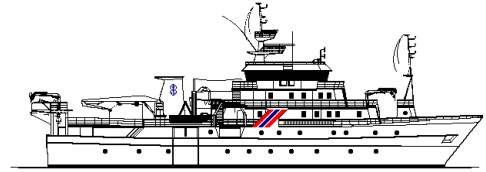
Seabird and cetacean observations

Seabirds: We surveyed 2630 km (1640km²) of around 6000 km cruise track over 150 hours, sighted a high number of seabirds (we have not the exact number yet) belonging to 36 taxa (Table 2). For this report, we will just present few qualitative results (presence/absence) of seabird's assemblage along seamounts. Higher species richness (18-20) occurred in cool (SST<10°C) sub-Antarctic waters, and intermediate (10-13) in Subtropical Convergence (13°C >SST <17°C). Seabird's diversity declined north of the northern Subtropical Convergence and tropical stations





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(>17°C) supported lower species number (2-10) (Fig. 9.2). We documented the highest species richness (20) close to the sub-Antarctic front on the Coral seamount (41.39°S, 42.88°E). Seabird assemblage varied also substantially across the study area (Fig. 9.3). The species assemblages in sub-Antarctic, subtropical and tropical waters seem distinct. These preliminary results suggest that the avifauna of the southern Indian Ocean is structured by large-scale gradients in physical and biological properties. Cooler sub-Antarctic waters of higher ocean productivity and phytoplankton standing stocks supported an order of magnitude higher seabird diversity, than lower productivity subtropical waters. This result is consistent with past at-sea surveys, which have documented higher bird densities in sub-Antarctic waters than in less productive subtropical and tropical regions (Griffiths et al., 1982; Stahl et al., 1985; Hyrenbach et al., 2007).

Mammals: Each mammal observed during the survey was recorded. However, marine mammals are very difficult to identify and we were not specialists. Photos were taken and were sent to specialists for identification. During this mission, we recorded 25 mammals that we classified in 5 sighting-categories (Table 9.3). We recorded nine whales in subtropical convergence (STC, Table 3) and 15 in Tropical waters.

Indian Ocean Whalebone Moorings:

Report: status: final References:

A.D. Rogers, O. Alvheim, E. Bemanaja, D. Benivary, P.H. Boersch-Supan, T. Bornman, R. Cedras, N. Du Plessis, S. Gotheil, A. Hoines, K. Kemp, J. Kristiansen, T. Letessier, V. Mangar, N. Mazungula, T. Mørk, P. Pinet, J. Read, T. Sonnekus. **PRELIMINARY** - Cruise Report "Dr. Fritjof Nansen", Southern Indian Ocean Seamounts, (IUCN/ UNDP/ ASCLME/ NERC /EAF Nansen Project 2009 Cruise 410), 12th November – 19th December, 2009.

Constraints/Comments:

Just preliminary report available.

