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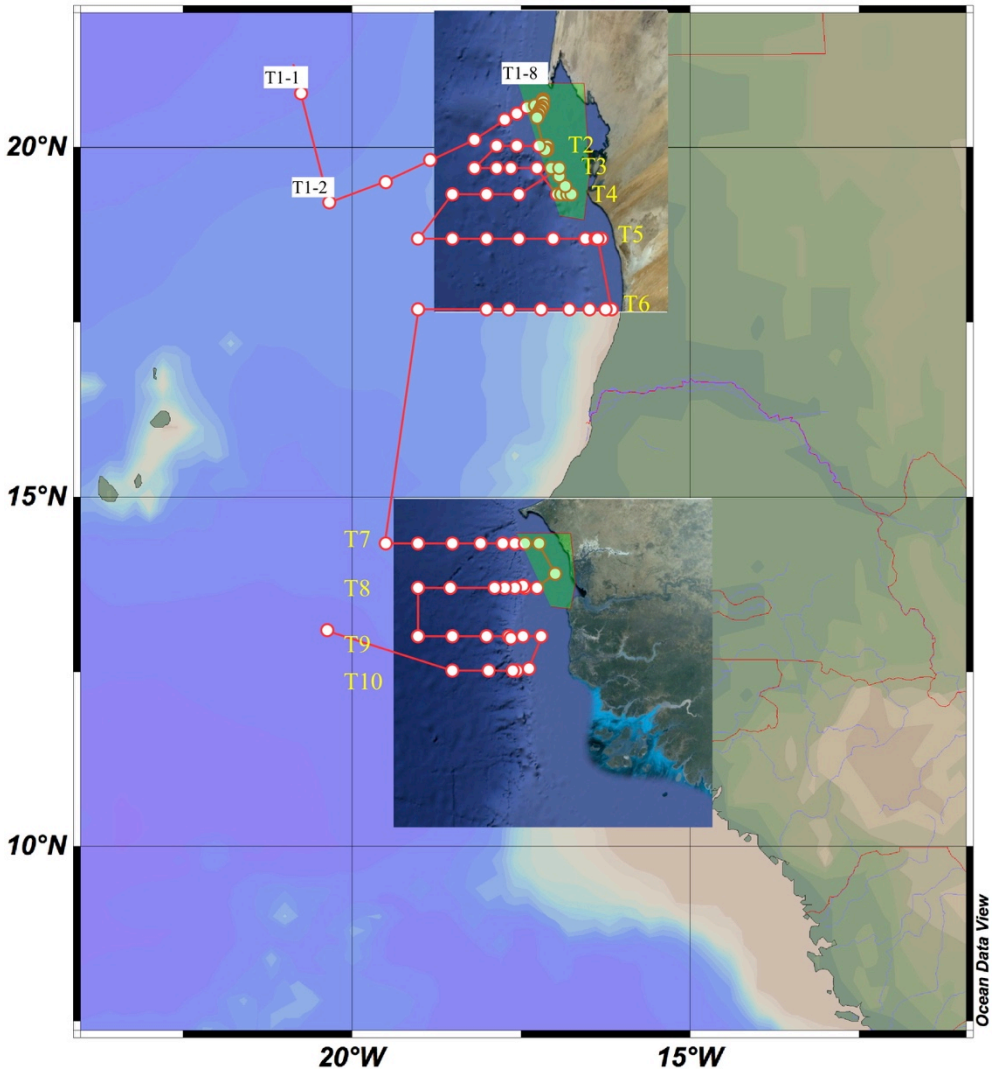
Short Cruise Report
FS Meteor M129

Ponta Delgada - Mindelo
30 July – 25 August 2016
Chief Scientist: Werner Ekau
Captain: Jan Schubert



Objectives

The upwelling-influenced shelf off NW-Africa is the most nutrified regional tropical marine ecosystem in the present-day oceans. This eutrophication is the combined effect of the NW African upwelling and the input of eolian dust from the Sahara. Mauritanian waters are among the most productive fishery areas in the world, and the wide shallow-water shelf off Northern Mauritania is a textbook example of a eutrophic warm-water ecosystem (Michel et al., 2011). The uniqueness of the shallow-water ecosystem off Mauritania has been previously recognized, and its oceanographic and biogeochemical context as well as its record on a larger and more offshore scale has been studied intensively and in detail (among many others: Flögel et al. 2014, Plewa et al., 2012, Schafstall et al., 2010, Stramma et al., 2005).

Ship-based expeditions in the 1970s (e.g. Einsele et al. 1974; Koopmann et al., 1979) have provided a sedimentological reference for the depositional system off Northern Mauritania. Various biological groups of the shallowest parts of the shelf have been studied including studies on eolian input concentrated on the continental slope. Beyound these studies biological and ecological research of this shallow-water ecosystem and the shallow water-open ocean coupling has remained largely descriptive. The exact mechanisms of the trophic network from the nutrient input via microbes and plankton to larger benthic and nektonic organisms at enhanced CO_2 concentrations is largely unknown.

These topics, however, are of high **societal relevance**:

- The nutrified and CO_2-enriched system may serve as model for **eutrophication** and **acidification** predicted in global change scenarios. It is an analogon for predictions of future developments of large areas of the tropical seas;
- The study area is a highly productive fisheries area (shelf and open waters) that is intensively exploited; a better understanding of matter and energy flows will support management efforts.

The expedition concentrated on the energy and matter fluxes through the ecosystem, availability of nutrients, the role of microbes and plankton in making nutrients availabile to higher organisms, food-webs, and the record of those in the sediment in order to gain a systemic understanding of the properties of this eutrophic and CO_2-rich ecosystem and its resilience to overexploitation of the biological resources. The investigations will complement in an ideal way the ongoing investigations of SFB 754 (e.g. Meteor cruise 107), SOPRAN, and AWA (see international collaborations).

Four major topics of research were covered during the cruise:

A. The eutrophic, low-pH ecosystem offshore Mauritania to Senegal

The sea off Mauritania and Senegal represents a transition zone between the relatively cool water masses of the Canary Current upwelling system coming from the North and the outreaches of the warm tropical waters of the Guinea Current from the South. The boundary between these water masses varies seasonally between the Cap Blanc (northern edge of Banc d'Arguin) and the region Cap Vert to Cabo Roxo.

B. Trophic networks in the upwelling ecosystem

Traditionally, the main autotrophs, including large unicellular algae (diatoms, dinoflagellates and cocccolithophores) have been thought to be mainly grazed by copepods, which are themselves grazed by planktivorous fish. However, ciliates and heterotrophic dinoflagellates often have a larger grazing impact on autotrophs than do copepods. Understanding the mechansims underlying the carbon flux of the Mauritanian continental shelf requires better knowledge of the phytoplankton-protist and copepod-protist links.

C. Fisheries biology

The upwelling area of the Canary Current off Northwest Africa is the second most productive upwelling system of the world ocean (2 Mill. mt). Catches are dominated by pelagic species such as sardine (Sardina pilchardus), several sardinellas (Sardinella spp.), anchovy (Engraulis encrasicolus), and in addition, the bonga shad (Ethmalosa fimbriata). It is unclear what is the role of the Banc D'Arguin for the recruitment of commercially interesting species and the outreach of systems like this or the Sine Saloum estuary to adjacent waters.

D. The shallow-water "bioreactor"

The heterotrophic-dominated benthos on the Banc d'Arguin is a typical tropical shallow-water systes and is explained by the extremely low transparency of the eutrophic waters that are loaded by eolian dust and high concentrations of as yet unstudied microbes and plankton.

Narrative

Scientific participants boarded the RV METEOR in the morning of 29 July 2016 and immediately started to prepare the laboratories using the calm conditions in the port. After leaving the port on 30 July, the ship deployed an ARGO float as soon as it left the Azorean EEZ, and reached the first station (T1-1) on 3 August. Here regular station work started with CTD cast and various plankton nets: Vertical Multi-net – midi, towed Multi-net maxi, RMT, catamaran with Neuston net and GULF plankton sampler.

A total of 62 stations could be worked up in the Mauretanian waters reaching from about 20°W to the coast and from 17°40' to 21°N (Fig. 2). The area covered by the station net included to large extent oceanic area but also reached until very shallow waters near the coast of ~15m water depth. A total of 31 stations were sampled in Senegalese waters distributed along four transects perpendicular to the coast between 12°30' and 14°20'N.

Hydrographical investigations were conducted to describe the distribution of water masses in the area and their influence on the shelf and the shallow coastal waters. The oceanic area was obviously dominated by southerly tropical water masses with counter flow of Canary Current waters at the outer reach of the northern station grit. There could also be observed some small intrusions of colder water on the Banc d'Arguin. The southern station grit in Senegalese waters was completely governed by hot tropical water masses.

Underway measurements were conducted to measure currents (ADCP), nutrients (Ferrybox) and carbon (various instruments). Dust samples were regularly collected to be analysed after the cruise in the lab of TROPOS (Leibniz Institut für Troposphärenforschung, Leipzig).

To gain a better understanding of the outreach of the Banc d'Arguin on the shelf, six coast-perpendicular transects were worked up in the Mauritanian study area. The first transect with a length of approximately 190 nm was laid parallel to the EEZ border of Mauretania into 25m deep coastal waters. The shallow station was used as a first starting point for the sampling of neuston and sediment on the Banc d'Arguin. The ship then moved southward following the 30m depth line and carried out another two trips with the rubber boat and catamaran to collect neuston and sediment in shallower areas.

The neuston and ring trawl hauls aimed to describe the potential link between the ichthyoplankton on the bank and in the estuary and at the shelf. The samples were checked for fish larvae immediately after the haul. Abundant species were deep frozen for later analysis in the home lab. Bulk catches were preserved in alcohol for taxonomic identification and DNA analysis.

A towed multiple opening/closing net (Multinet maxi, Hydrobios) was routinely used to estimate the horizontal and vertical distribution of the ichthyoplankton. Another multiple opening/closing net (Multinet midi, Hydrobios) was deployed vertically to assess the zooplankton biomass. In addition, a Rectangular Midwater Trawl (RMT) and a GULF plankton sampler were used applying intergrated hauls between 500 - 0 and 200 - 0 m, respectively. These integrating hauls will allow large scale overviews on the species communities of epipelagic and mesopelagic fishes.

The sediment samples were predominantly taken on the shelf and in the shallow waters off the Banc d'Arguin. 22 grab samples were collected plus 4 box corer samples. In Senegalese waters a total of 14 grab stations could be worked up plus 2 box corer casts.

The vessel finished the first part of the cruise including 6 transects in Mauritanian waters on the 15th of August and sailed south to the Senegalese investigation area south of Dakar including four transects. Last research station was done on 22nd of August, and the 2nd ARGO buoy was deployed after leaving the Senegalese EEZ and before entering into the Cape Verdean EEZ.

RV Meteor called in the port of Mindelo on the 25th of August. The ship sailed more than ~3300 nm and spent ~255 hours at stations.

Acknowledgements

Our gratitude goes to captain Jan Schubert and his crew for their excellent support during the cruise. The ship time of RV Meteor was provided by the German Science Foundation (DFG) within the core program METEOR/MERIAN. The cruise was financially supported by the AWA program of the BMBF.

Teilnehmerliste

Name	Discipline	Institution
Ekau, Werner	Chief scientist	ZMT
Reymond, Claire	Carbonate sediment.	ZMT
Müller, Peter	Carbonate sediment.	ZMT
Hornidge, Anna-Katharina	Carbonate sediment.	ZMT
Flotow, Sebastian	Carbonate sediment.	ZMT
Taviani, Marco	Carbonate sediment.	UdGM
Klenz, Thilo	Physical Oceanography	GEOMAR
Martens, Wiebke	Physical Oceanography	GEOMAR
Wischnewski, Fanny	Physical Oceanography	ZMT
Mawick, Jule	Ichthyoplankton	ZMT
Rixen, Tim	Biogeochemistry	ZMT
Bahlmann, Enno	Biogeochemistry	ZMT
Bachmann, Jennifer	Microbiology	ZMT
Heimbach, Tabea	Microbiology	ZMT
Wickham, Stephen	Plankton	USBG
Wenta, Philipp	Plankton	USBG
Sinner, Anita	Plankton	USBG
Tiedemann, Maik	Ichthyoplankton	TI
Sloterdijk, Hans	Ichthyoplankton	ZMT
Bröhl, Stefanie	Ichthyoplankton	ZMT
Müller, Carolin	Ichthyoplankton	ZMT
Otto, Kateryna	Biogeochemistry	ZMT
Börner, Gregor	Ichthyoplankton	TI
Balde, Bocar	Ichthyoplankton	CRODT/AWA
Howes, Caroline	Macrofauna	Birdlife
Sleymane, Abdel Karimy	Observer	IMROP/Mauretania
Ndiaye, Meissa	Observer	Senegal
Rohleder, Christian	Meteorology	DWD

ZMT	Leibniz-Zentrum für Marine Tropenökologie, Bremen
GEOMAR	Helmholtz-Zentrum für Ozeanforschung Kiel
IdGM	Instituto di Geologia Marina, Bologna
USBG	Universität Salzburg
TI	Thünen Institut für Seefischerei, Hamburg
CRODT	Centre de Recherche Oceanographique Dakar-Thiaroye, Dakar, Senegal
IMROP	Institut Mauritanien de Recherches Océanographiques et des Pêches, Nouadhibou, Mauretania
DWD	Deutscher Wetterdienst, Hamburg

Station list

Station	Ship	Start of sta-	Lat (N)	Long (	Water	Argo float	CTD	MNv-200	MNo	RMT	Neuston	GULF	GS	GKG	Zodiac
P. Delgada		30.07.2016 9:00:00	37°44'	25°40'											
Argo 1	836	31.07.2016 11:07:57	33°37'	24°09'	3000	x	x								
T-1-1	837	03.08.2016 10:27:51	20°45'	20°45'	3000		x	x	x	x	x	x			
T-1-2	838	04.08.2016 4:36:21	19°11'	20°20'	3000		x		x			x			
T-1-3	839	04.08.2016 12:42:47	19°29'	19°30'	3000		x	x	x	x	x	x			
T-1-4	840	04.08.2016 22:15:32	19°47'	18°50'	2500		x		x			x			
T-1-5	841	05.08.2016 4:53:56	20°05'	18°10'	2000		x	x	x	x	x	x			
T-1-6	842	05.08.2016 12:36:11	20°22'	17°43'	300		x		x			x	x	x	
T-1-6a	843	05.08.2016 17:02:32	20°27'	17°32'	190								x		
T-1-7	844	05.08.2016 19:13:40	20°32'	17°24'	50		x	x	x			x	x		
T-1-7a	845	05.08.2016 22:17:41	20°35'	17°16'	30								x		
B. d'Arguin	846	06.08.2016 8:05:00	20°39,6'	17°08'	10										x
T-1-8	847	06.08.2016 8:05:00	20°39,6'	17°08'	10		x						x		
B. d'Arguin	848	06.08.2016 10:15:00	20°39,6'	17°08'	10										x
GS-1	849	06.08.2016 10:27:00	20°39,6'	17°08'	10								x		
GS-2	850	06.08.2016 12:50:00	20°37,6'	17°08'	10								x		
B. d'Arguin	851	06.08.2016 13:15:00	20°37,6'	17°08'	10										x
GS-3	852	06.08.2016 14:11:00	20°35,4'	17°09'	10								x	x	
GS-4	853	06.08.2016 16:15:00	20°33,2'	17°10'	10								x		
GS-5	854	06.08.2016 16:55:00	20°31,4'	17°10'	10								x		
GS-6	855	06.08.2016 17:21:00	20°29,8'	17°12'	10								x		
GS-7	856	06.08.2016 17:53:00	20°27,9'	17°13'	10								x		
GS-8	857	06.08.2016 18:21:00	20°26'	17°14'	10								x		
GS-9	858	06.08.2016 18:46:00	20°24'	17°15'	10								x		
B. d'Arguin	859	07.08.2016 8:00:00	20°00'	17°08'	10										x
T-2-7	859	07.08.2016 8:15:37	20°00'	17°08'	10		x						x		
GS-10	860	07.08.2016 9:44:37	19°59'	17°06'	10								x		
GS-11	861	07.08.2016 10:29:37	19°57'	17°05'	10								x		
GS-12	862	07.08.2016 11:14:37	19°57'	17°05'	10								x		
GS-13	863	07.08.2016 13:38:37	19°57'	17°07'	20							x	x		
T2-7a	864	07.08.2016 16:15:55	20°00'	17°13'	50								x	x	
T-2-6	865	07.08.2016 18:03:26	20°00'	17°33'	150		x	x	x			x	x		
T-2-5	866	07.08.2016 21:53:17	20°00'	17°50'	1500		x	x	x			x			
T-3-3	867	08.08.2016 3:55:00	19°40'	18°10'	2500		x	x	x	x	x	x			
T-3-4	868	08.08.2016 12:14:04	19°40'	17°50'	1900		x		x			x			
T-3-5	869	08.08.2016 17:00:24	19°40'	17°38'	1200		x	x	x	x		x			
T-3-6	870	08.08.2016 23:58:01	19°40'	17°15'	750		x	x				x			
T-4-5	871	09.08.2016 5:20:21	19°19'	16°57'	600		x	x	x			x			
GS-14	872	09.08.2016 10:06:00	19°19'	16°53'	200								x		
T-4-6	873	09.08.2016 11:06:19	19°19'	16°48'	50		x		x			x	x		
T-4-7	874	09.08.2016 14:02:18	19°19'	16°43'	15		x	x			x	x	x		
GS-15	875	09.08.2016 18:33:49	19°26'	16°49'	50								x		
GS-16	876	09.08.2016 20:16:49	19°33'	16°55'	100								x		
T-3-7	877	10.08.2016 5:36:25	19°40'	17°02'	150		x	x	x		x	x	x	x	
T-3-8	878	10.08.2016 10:38:37	19°40'	16°54'	15		x	x	x		x	x	x		
T-4-4	879	10.08.2016 16:45:34	19°19'	17°30'	1800		x		x			x			
T-4-3	880	10.08.2016 22:26:46	19°19'	18°00'	2500		x	x	x			x			
T-4-2	881	11.08.2016 3:37:18	19°19'	18°30'	2500		x	x	x	x	x	x			
T-5-1	882	11.08.2016 13:43:59	18°40'	19°00'	3000		x		x			x			
T-5-2	883	11.08.2016 21:33:51	18°40'	18°30'	2500		x		x			x			
T-5-3	884	12.08.2016 2:35:00	18°40'	18°00'	2500		x	x	x	x	x				
T-5-4	885	12.08.2016 11:24:35	18°40'	17°30'	2200		x		x			x			
T-5-5	886	12.08.2016 16:51:27	18°40'	17°00'	1500		x	x	x	x	x	x			

Station	Ship	Start of sta-	Lat (N)	Long (	Water	Argo float	CTD	MNv-200	MNo	RMT	Neuston	GULF	GS	GKG	Zodiac	
T-5-6	887	13.08.2016 0:40:17	18°40'	16°32'	150		x		x			x	x			
T-5-7	888	13.08.2016 3:59:26	18°40'	16°23'	50		x	x	x			x	x	x		
T-5-8	889	13.08.2016 8:02:12	18°40'	16°17'	20										x	
GS-17	890	13.08.2016 12:08:35	18°40'	16°20'	150								x	x		
T-6-8	891	13.08.2016 18:03:10	17°40'	16°08'	30		x		x			x	x			
T-6-7	892	13.08.2016 19:58:45	17°40'	16°13'	60		x		x			x	x			
T-6-6	893	13.08.2016 22:36:30	17°40'	16°28'	150		x	x	x			x				
T-6-5	894	14.08.2016 1:35:41	17°40'	16°45'	600		x		x			x				
T-6-4	895	14.08.2016 6:06:37	17°40'	17°10'	2000		x	x	x	x	x	x				
T-6-3	896	14.08.2016 13:35:28	17°40'	17°40'	2500		x	x	x	x	x	x				
T-6-2	897	14.08.2016 20:16:08	17°40'	18°00'	2800		x		x			x				
T-6-1	898	15.08.2016 4:44:09	17°40'	19°00'	3000		x	x	x	x	x	x				
T-7-1	899	16.08.2016 10:20:50	14°19'	19°30'	3500		x	x	x	x	x	x				
T-7-2	900	16.08.2016 18:34:35	14°19'	19°00'	3500		x		x			x				
T-7-3	901	17.08.2016 0:18:20	14°19'	18°30'	2900		x	x	x			x				
T-7-4	902	17.08.2016 6:24:49	14°19'	18°04'	2000		x		x	x	x	x				
T-7-5	903	17.08.2016 13:28:17	14°19'	17°45'	1100		x	x	x		x	x				
T-7-6	904	17.08.2016 17:43:14	14°19'	17°34'	200		x	x	x			x	x	x		
T-7-7	905	17.08.2016 21:46:33	14°19'	17°25'	100		x	x	x			x	x			
T-7-8	906	18.08.2016 1:20:19	14°19'	17°13'	50		x	x	x			x	x			
Sine Saloum	907	18.08.2016 9:36:04	13°53'	16°58'	20										x	
T-8-8	908	18.08.2016 16:46:02	13°40'	17°15'	50		x	x	x			x	x	x	x	
T-8-7	909	18.08.2016 20:11:20	13°40'	17°25'	100		x	x	x			x	x			
GS-18	910	18.08.2016 22:28:00	13°43'	17°26'	142								x			
GS-19	911	18.08.2016 23:00:29	13°43'	17°27'	220								x			
GS-20	912	18.08.2016 23:34:29	13°43'	17°27'	300								x			
T-8-6	913	19.08.2016 0:49:48	13°40'	17°34'	400		x	x	x			x				
T-8-5	914	19.08.2016 4:31:16	13°40'	17°43'	1500		x		x	x	x	x				
T-8-4	915	19.08.2016 9:45:44	13°40'	17°52'	2000		x	x	x	x	x	x				
T-8-3	916	19.08.2016 18:14:00	13°40'	18°31'	3000		x		x			x				
T-8-2	917	19.08.2016 23:28:54	13°40'	19°00'	3500		x	x	x			x				
T-9-2	918	20.08.2016 6:53:54	13°00'	19°00'	4200		x	x	x	x	x	x				
T-9-3	919	20.08.2016 14:54:37	13°00'	18°30'	3700		x	x	x	x		x				
T-9-4	920	21.08.2016 0:18:00	13°00'	18°00'	3000		x	x	x			x				
T-9-5	921	21.08.2016 6:13:02	13°00'	17°39'	200		x		x			x	x			
T-9-6	922	21.08.2016 8:30:05	12°58'	17°37'	100		x	x			x	x	x			
T-9-7	923	21.08.2016 11:09:30	13°00'	17°27'	50		x		x		x	x	x			
T-9-8	924	21.08.2016 14:39:15	13°00'	17°10'	25		x	x	x		x	x	x			
T-10-7	925	21.08.2016 20:03:23	12°31'	17°22'	30		x	x	x			x	x			
T-10-6	926	21.08.2016 22:59:33	12°30'	17°33'	100		x	x	x			x	x			
T-10-5	927	22.08.2016 0:54:07	12°30'	17°36'	1200		x	x	x			x				
T-10-4	928	22.08.2016 7:13:26	12°30'	17°58'	2500		x		x	x	x	x				
T-10-3	929	22.08.2016 15:11:53	12°30'	18°30'	4000		x	x	x	x	x	x				
Argo 2	930	23.08.2016 8:56:15	13°04'	20°22'	4000	x	x									
Mindelo		25.08.2016 8:00:00	16°53'	24°59'												