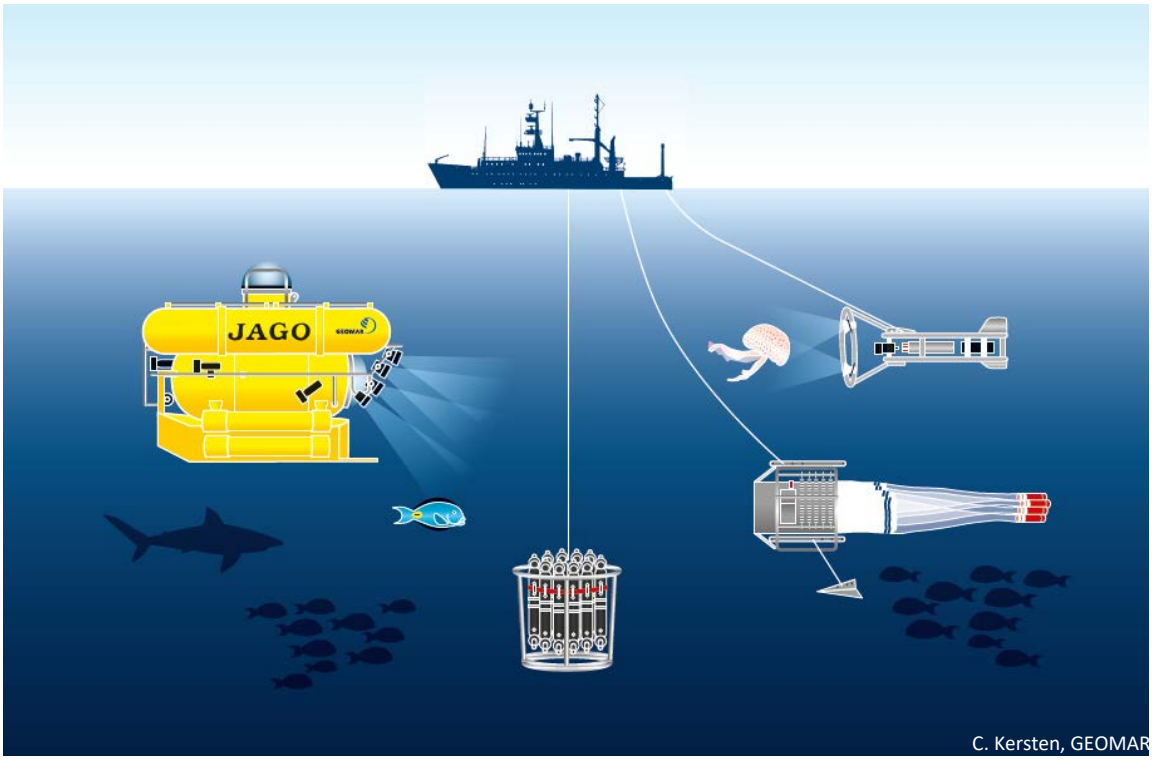
Cruise Report POS520

RV POSEIDON

Mindelo, Cape Verde (14/2/2018) –

Mindelo Cape Verde (1/3/2018)

Biological baseline studies in the pelagic deep seas of Cape Verde



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1: Cruise participants

	Name	Institute	
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3	Florian Schütte	GEOMAR	Physical Oceanography
4	Karen Hissmann	GEOMAR	JAGO
5	Jürgen Schauer	GEOMAR	JAGO
6	Peter Striewski	GEOMAR	JAGO
7	Eduard Fabrizius	GEOMAR	TLZ
8	Veronique Merten	GEOMAR	Evolutionary Ecology of Marine Fishes
9	Nuno Vieira	INDP (Cape Verde)	
10	Bruce Robison	MBARI (USA)	Midwater Ecology
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2: Narrative of the cruise

By H.J.T. Hoving

The aim of this cruise was to investigate the biodiversity, abundance and distribution of pelagic fauna, including nekton and macrozooplankton, in the deep-sea ecosystem of Cape Verde, and to combine biological observations with chemical and physical observations. During POS520 we used the manned submersible JAGO for the first time in this area. Additional in situ observations were obtained using the towed camera system PELAGIOS. To discretely sample pelagic fauna we applied two kinds of multinet (midi and maxi) and we used the CTD to collect hydrographic data and environmental DNA samples. For safe and practical operation of JAGO and other towed gears, we planned to work in the leeway of the islands Santo Antão and Fogo to perform mesopelagic stations (1000 m) and bathypelagic stations (3000 m). In addition to the biological and oceanographic work of the cruise an elaborate physical oceanographic sampling program was planned around the islands using CTD, microstructure and ADCP. Another goal was to perform a full oceanographic and biological sampling at the oceanic time series station Cape Verde Ocean Observatory, north of Sao Vicente.

On February 13th the science team embarked on POSEIDON in Mindelo, Cape Verde. The JAGO team already embarked on February 12th and had started their preparations. The plan was to leave the harbor at 9.00 on February 14th. However, a delay in the delivery of scientific equipment by airplane resulted in postponing our departure time with 24 hours. On February 15th we departured at 8.00 and steamed to the first station, located in the Bay of Tarrafal, Santo Antao (16.98°N, -25.34°W). We were all excited and surprised by the calm waters that we encountered and started the station work with a mesopelagic CTD (1000 m), followed by a JAGO test dive (J. Schauer and E. Fabrizius). All worked well and the deployment and recovery were very smooth. Then we did a test cast with the Multinet midi until 18.00. The rest of the night was used for Microstructure profiles until 3.00 am, followed by ADCP sections until 7.39 am. The biological program was continued in the morning of 16/2 at 9.10 am with a JAGO dive (J. Schauer, B. Robison) until 13.15. Then we performed horizontal video transects with the pelagic in situ observation system PELAGIOS down to 1000 m from 14.00-17.25, followed by a CTD with which we took water samples for oxygen measurements as well as to filter out environmental DNA. In the evening of 16/2 we performed a JAGO night dive (J. Schauer, H.J. Hoving) from 20.47-00.41.

In the night we continued with microstructure and ADCP transects. We started on 17/2 in the morning with a CTD (1000 m) followed by a PELAGIOS daytime transect (1000 m) and a Multinet Maxi cast (1000 m) which ended at 19.15. After another CTD (1000 m) we did a night transect with PELAGIOS (1000 m) followed by a night cast with the Multinet Maxi (1000 m) which ended at 01.04 am. The rest of the night was used for ADCP sections. In the morning of 18/2 we started with a JAGO dive (J. Schauer, Karen Osborn) followed by a Multinet Maxi cast (1000 m) until 15.20, and we did a night dive with JAGO (J. Schauer and Bruce Robison) from 20.53-00.59. The rest of the night was used to perform microstructure and ADCP transects until the morning of 08.15 on 19/2. We then did a morning JAGO dive (J. Schauer and P. Striewski),

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followed by a PELAGIOS day transect (1000 m), and the day ended with a JAGO night dive (J. Schauer and H.J. Hoving) until 00.53. We performed microstructure transects close to shore in waters between 150-650 m. We then steamed to the 3000 m site (16.86°N, -25.52°W) and started in the morning with a bathypelagic CTD (2700 m) followed by a deep PELAGIOS transect and a Multinet Maxi cast each down to 2500 m. In the evening both PELAGIOS and Multinet were again used down to 2500 m, followed by a 400 m CTD, which was on deck at 5.58 am. This ended our operations on 21/2 at the Bay of Tarrafal, a wonderful place to work.

The next station was a potential mesoscale eddy which was identified via satellite imaging to be located between Santo Antao and Fogo at 15.24°N, -25.00°W. Eddies have a distinct hydrographic signal and therefore we started with a CTD to 600 m, followed by a microstructure transect, to identify the horizontal extent of the hydrographic patterns and a PELAGIOS video transect down to 400 m which ended at 20.58. Unfortunately we did not find the low oxygen conditions as expected from some mesoscale eddies nor did we observe high abundances of pelagic fauna such as pelagic polychaete worms that are typical for mesoscale eddies (Hauss et al 2016; Christiansen et al 2018). Therefore we decided not to extend our sampling any further and to continue to our next station.

We started an ADCP transect (14.89°N, -24.54°W) before arriving at our third station off Fogo (14.78°N, -24.38°W) in the morning of 22/2. Here we started with a JAGO dive (J. Schauer and B. Robison) followed by a mesopelagic CTD and PELAGIOS (1000 m). The night JAGO dive (J. Schauer and H.J. Hoving) which lasted from 20.48-01.02 was preceded by a microstructure transect. After the dive we continued with microstructure transects from 2.34-5.58. On 23/2 we started with a CTD (1000 m) and then performed a bathypelagic program at our deep station (3000 m) (14.65°N, -24.36°W) with a Multinet Midi to 2500 m followed by a Multinet Maxi cast to 3000 m, a PELAGIOS day transect to 2500 m and a night Multinet Midi cast to 1000 m followed by a Multinet Maxi cast to 2500 m. The rest of the night we continued with microstructure and ADCP transect until 8.34 am. On 24/2 we did a morning dive with JAGO (J. Schauer and K. Osborn), followed by microstructure transects, and we ended the midwater work at with a night dive with JAGO (J. Schauer and B. Robison) which lasted until 01.08 am. During the night we continued with microstructure transects. The next day 25/2 we started with a CTD followed by a Multinet midi (1000 m), and a bathypelagic multinet Maxi cast until 15.48, and microstructure transect until 18.41. We then did a bathypelagic CTD followed by Multinet midi (1000 m) and a bathypelagic night cast with the Multinet maxi until 00.36. A microstructure section was done until 02.36. The next day 26/2 we started with a JAGO day dive (J. Schauer and N. Vereira) from 8.54-10.40 and another JAGO day dive (J. Schauer and V. Merten) from 11.08-13.05. We recovered a Slocum glider at 13.59, and performed a CTD at 14.22. The last JAGO dive of the cruise was a night dive (J. Schauer and H. Hauss) which took place from 20.49-01.05.

We then steamed for more than 21 hours to our fourth and last station, the oceanographic, biogeochemical and biological time series station Cape Verde Ocean Observatory (17.58°N, -24.28°W) where we performed a deep full CTD cast as well as a 500 m CTD cast, followed by a Multinet midi and a Multinet maxi night cast. During the day we repeated a Multinet midi and a Multinet maxi cast to have the comparison with the night casts. At 15.27 on 28/2/2018 the work

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at the time series station was done and we returned to Mindelo harbor. In the morning of 1/3/2018 we offloaded the ship, loaded the container and disembarked from R/V POSEIDON after a very successful cruise.

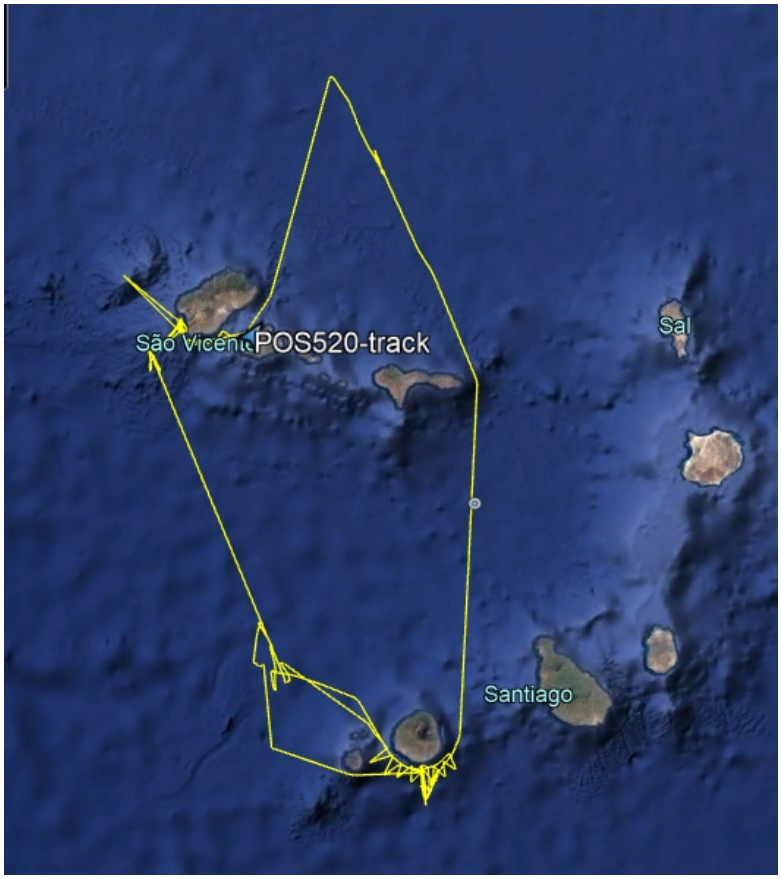

Figure 1: Cruise track of cruise POS520 around the archipelago of the Republic of Cape Verde

We collected an extensive biological and oceanographic dataset which allows a comparison between communities and productivity near two Cape Verdean islands in waters over 1000 m and 3000 m, and the open ocean time series station CVOO. Our sampling provided one of the first views and sampling efforts in the nearshore pelagic ecosystem of Cape Verde, and the biological specimens collected resulted in unique photographic and biological records. Several organisms collected were among the first records for the Atlantic Ocean. New collection tools on JAGO also allowed the collection of fauna which cannot be sampled by nets. The JAGO is an ideal instrument for mesopelagic biological work, as it can maintain neutral buoyancy in the water column allowing detailed video recordings, it can collect pelagic organisms for biological analysis and finally, and the direct observation with the scientist own eye provides an unprecedented view on the pelagic deep-sea ecosystem. The deep tows with PELAGIOS and the Multinet allowed the one of the first bathypelagic sampling in the area. The Cape Verdean islands provide ideal and reliable circumstances for efficient deep-sea biological research since work can be done close to shore, and sea conditions close to the islands are calm and independent of the weather conditions in the rest of the archipelago. Such a combination is unique and promising for the future efforts and for establishing a biological time series sites.

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3: Preliminary results

3.1 Physical Oceanography and Hydrography

by Florian Schütte, Nuno Viera, Helena Hauss, Boris Kisjeloff (not on board)

3.1.1 CTD and Niskin samples

During P520 14 profiles of pressure (p), temperature (T), conductivity (c), oxygen (O) and chlorophyll-a (Chl) were recorded. In the Cape Verdean waters, most of the CTD-O_2 profiles ranged maximal to 1000m or to the shallower bottom (only 2 CTD-O_2 profiles ranged deeper up to 4000m at the CVOO station). A Seabird Electronics (SBE) 9plus system is used, which is attached to a water sampler carousel, and the latest Seabird Seasave software. The SBE underwater unit had two sensor sets: p #89964, T1 #2920, c1 #2995, O1 #1302, T2 #2814, c2 #2537 and O2 #0631. The two sensor sets worked properly during the entire cruise. The secondary sensor set was chosen for report, for being slightly less noisy. Oxygen was calibrated using a relation linear in T and O, and quadratic in p. Winkler titration was performed on water from 100 bottle samples taken during the cruise. This led to a relation with an rms misfit for the first/second sensor of 0.735/0.906 µmol/kg for the down cast and 0.843/0.794 µmol/kg for the up cast (33% of bottle values removed). Conductivity was also calibrated using a linear relation in p, T and c. This relation will be also obtained by fitting the according CTD salinity to 22 water samples, which are taken during the cruise. But they will be analyzed later with a Guildline Autosal salinometer in Kiel. Chl probes for calibrating the fluorescence sensor (Wetlabs) are also taken during the cruise, but the calibration is not yet done (first the Chl probes need to be analyzed in Kiel). The data will be used to provide the other working groups with the hydrographic background. Of special interest are the oxygen data because of the strong impact on the marine life. In total 212 nutrient samples were taken from the CTD rosette (with triplicate sampling at CVOO and single samples at all other stations) to quantify nutrient flux into the euphotic zone in conjunction with microstructure measurements (see below). The nutrient samples were snap-frozen at -80°C and stored at -20°C until analysis at the Ocean Science Center Mindelo.

3.1.2. Shipboard microstructure measurements

A MSS90-D microstructure profiler (#028) of Sea and Sun Technology was used to infer turbulent dissipation rate and diapycnal diffusivity, aiming at calculating diapycnal fluxes of several solutes for example oxygen or nitrous oxide (N_2O). The loosely tethered profiler was equipped with 2 airfoil shear sensors (SHE1#121 and SHE2 #122) and a fast thermistor, as well as with a pressure, a conductivity, a temperature, a turbidity and a oxygen sensor. Profiler sink velocity was adjusted to 0.5 m/s. In total 65 profiles to usually 400m depth were recorded at 22 ship stations. The system worked well throughout the cruise and there were no technical issues beyond maintenance. The data will be used to get an idea about the vertical mixing/ vertical fluxes of for example nutrients near the islands and above the observed seamounts.

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3.1.3. Vessel-mounted ADCP

Underway-current measurements were performed continuously throughout the entire cruise using a vessel mounted ADCP (VMADCP): a 75kHz RDI Ocean Surveyor (OS75) placed in the moon pool. The OS75 worked well throughout the cruise. The OS75 was configured with 100 bins of 8 m, pinging 30 times per minute. To ensure precise data (goof quality range up to 600 m), it was run in the more precise but less robust broadband mode. During the entire cruise, the navigational data was delivered by fibre optic gyro. The standard derivation of the heading was 0.71°. The data will be used to provide the background water velocities.

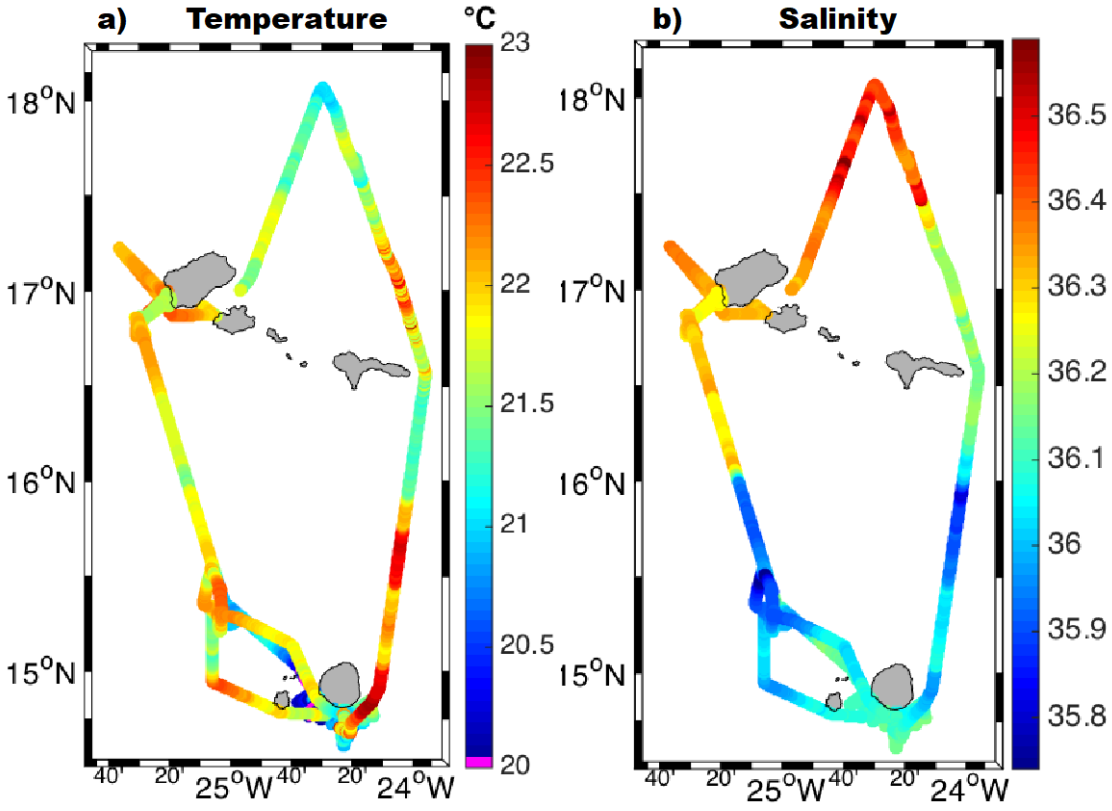

Figure 2: Measurements of the Thermosalinograph during P520 of **a)** temperature and **b)** salinity.

3.1.4. Thermosalinograph

Underway measurements of sea surface temperature (SST) and sea surface salinity (SSS) are continuously done by the ship's thermosalinograph. It is located at the bow of the ship in around 2m depth. The temperature sensor and the conductivity sensors will be calibrated against the 2dbar values from the CTD-O_2 profiles taken during the cruise. In general, the system worked well throughout the cruise (see Figure 1a and 1b).

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3.2. Environmental DNA

By Veronique Merten and Henk-Jan Hoving

During cruise POS520 around Cape Verde we were interested in sampling environmental DNA (eDNA). eDNA is defined as genetic material that is shed by organisms (mucus, skin cells etc) and that can be obtained directly from the environment (e.g. seawater, freshwater, sediment, soil) without any obvious signs of the organisms it originated from. This technique is non-invasive and allows biodiversity assessments and the detection of elusive species in a wide range of marine environments. Environmental DNA analysis has been successfully used to reconstruct horizontal and vertical distribution of various marine organisms and is an upcoming tool for assessment of aquatic biodiversity (Thomsen and Willerslev, 2015; Thomsen et al 2016). To date there are only few studies that apply eDNA analysis for deep water environments. Our goal is to reconstruct the vertical distribution of pelagic invertebrates such as cephalopods and gelatinous zooplankton in Cape Verde waters by collection and analysis of eDNA from the same depths where we perform our other sampling and observations. Since cephalopods are hard to catch and gelatinous zooplankton are fragile, net sampling is not the ideal sampling technique for these organisms and there is a need for new approaches.

Figure 3: The filter set up for eDNA sampling showing water inside the glass beakers, the manifold which holds the beakers and the pump which sucks water through the filters.

The eDNA in the water can be collected on filters and then amplified and sequenced with sensitive next-generation DNA sequencing. The barcodes obtained by sequencing give information about the biodiversity in the sampled area. We sampled four different stations at nine depths from 50 to 1000m and one station from 50 to 2500m together resulting in 134 water samples. One sample consists of 2 litres of filtered seawater (0.45 µm filter pore size) and was sampled via a CTD rosette with attached 10l Niskin bottles. Each depth was sampled in (pseudo) triplicates. Additionally, we run an eDNA degradation experiment on board to validate the impact of temperature and storage time on the quality of eDNA when it is stored for longer

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times. Therefore, we stored seawater either in the fridge or at room temperature and sampled the water every 1 to 2 hours for 24 hours. Furthermore, we have tested two different filter pore sizes (0.45 and 0.22 µm).

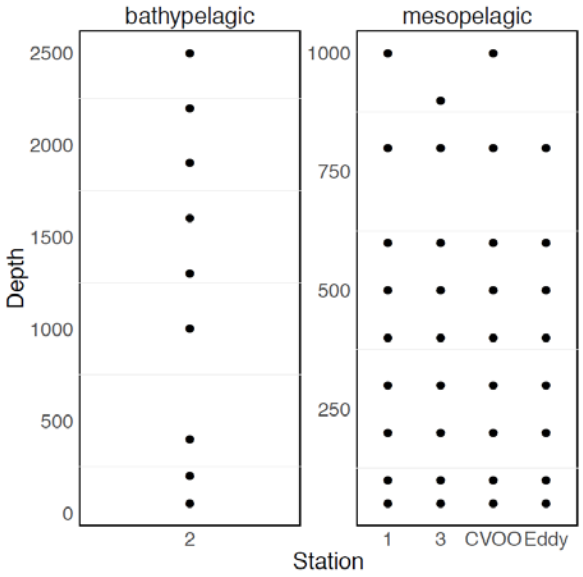

Figure 4: The sampling depths for eDNA collection showing corresponding depths with Multinet maxi casts and PELAGIOS transects

The water samples for eDNA analysis were collected at the same depths as where the pelagic video transects were performed with PELAGIOS, and where the casts with the Multinet systems were made, allowing for comparison of three methods to investigate deep pelagic biodiversity. There are no preliminary results available yet, since we are now testing different primer pairs that target a small fragment of the mitochondrial cytochrome oxidase 1 region in DNA of invertebrates, and we are improving the sequencing method and extracting the DNA from the filters. The prepared libraries will be send to the IKMB for Illumina Sequencing. The obtained sequencing data will be analysed for operational taxonomic units (OTUs) to assess the biodiversity around Cape Verde and to compare this approach with net hauls and video surveys. The obtained sequences from the water samples will be compared with existing databases such as Genbank, and we will use our existing collections from previous cruises as well as the barcodes obtained from specimens collected during POS520.

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3.3 Submersible JAGO dives during POS520

By JAGO-Team (Karen Hissmann, Jürgen Schauer, Peter Striewski) and Henk-Jan Hoving

The largest research gear used during POS520 was the GEOMAR-owned manned submersible JAGO that can take two persons – a pilot and a scientific observer – to water depths of maximum 400 m (Fig. 5). The submersible has a compact size and a low weight of 3 tons that enables shipment in a single 20' ISO container and deployment from a wide variety of support vessels that have sufficient crane capacity. JAGO is equipped with USBL navigation and positioning system for tracking the submersible under water, fluxgate compass, vertical and horizontal sonar, underwater telephone for voice communication, LED lamps, digital video (HD) and still cameras, CTD sensors and a manipulator arm for collecting and handling various sampling devices and instruments. The buoyancy of the vehicle can be adjusted by variable ballast (water) to neutral at any depth for hovering or floating in the water column without using any thruster. JAGO is therefore an ideal tool to study blue water inhabitants.

The submersible operates worldwide and is regularly used from on board the German research vessels including FS POSEIDON. The vessel is very suitable for handling JAGO since it has a low working deck of only 1.5 meters. Periods during which the submersible is lifted and transferred from deck into the water and vice versa are therefore short.

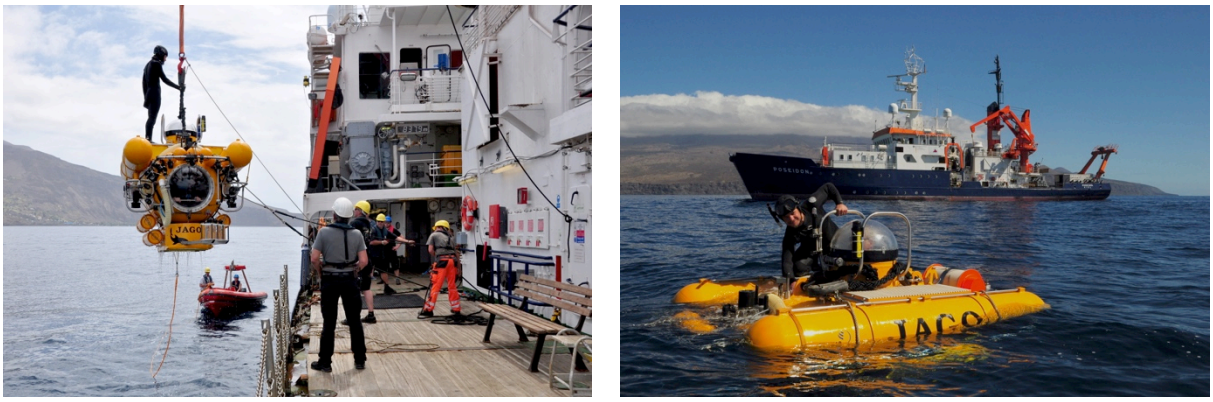

Fig. 5. Manned submersible JAGO launched from on board the RV POSEIDON off Santo Antao island and before submerging off Fogo island.

The mobilization of the submersible on board the POSEIDON in the port of Mindelo took place from 12-14th of February (installation of the USBL underwater navigation and positioning system, UT-communication, sampling devices etc). JAGO was lashed on deck amidships, and lifted and transferred into and out of the water over the ship's side by the main deck crane (SWL 5 tons). The vessel's Rigid Inflatable Boat (RIB, 5.5 m TL, 60 HP Yamaha outboard engine), steered by a crew member, was used to tow the submersible away from the ship's side after deployment and back under crane position for recovery.

While submerged, JAGO was tracked and guided by means of a USBL underwater positioning and navigation system (ORE Trackpoint 3, GEOMAR equipment). The position data were integrated into the navigation software OFOP to display and follow both JAGO and POSEIDON tracks geographically and in real time on a computer screen. Position data were logged in

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column-based ASCII files. Dive tracks can be combined for annotation with individual dive logs, visual and video observations and CTD records. Time codes were all set and synchronised to UTC. Voice communication between JAGO and POSEIDON during dives were maintained by acoustic underwater telephone (Subphone 580 by Subsea Import).

During POS520, JAGO was used for (1) visual in situ observation, (2) high-resolution video documentation and (3) highly selective non-intrusive collection of pelagic organisms in the upper 400 m of the water column, mostly above ± 1000 m bottom depth, and (4) collection of CTD data while flying through and hovering in the open water.

The water column in front of the submersible's bow window, including organisms and any type of particles, as well as all activities performed with the manipulator arm were continuously HD video-documented from inside the submersible with a CANON XA25 HD-Camcorder. The camera was mounted forward-looking in the centre of the large acrylic bow window. The 3.67-73.4mm camera lens allowed wide-angle and detailed close up footage of the pelagic fauna. After each dive, the original HD footage was copied and overlaid with UTC time stamp for geo-referencing and annotation by the science party. Video still images can be captured from the original HD footage by frame-grabbing. A dive protocol was produced by each of the dive participants to log observations and activities.

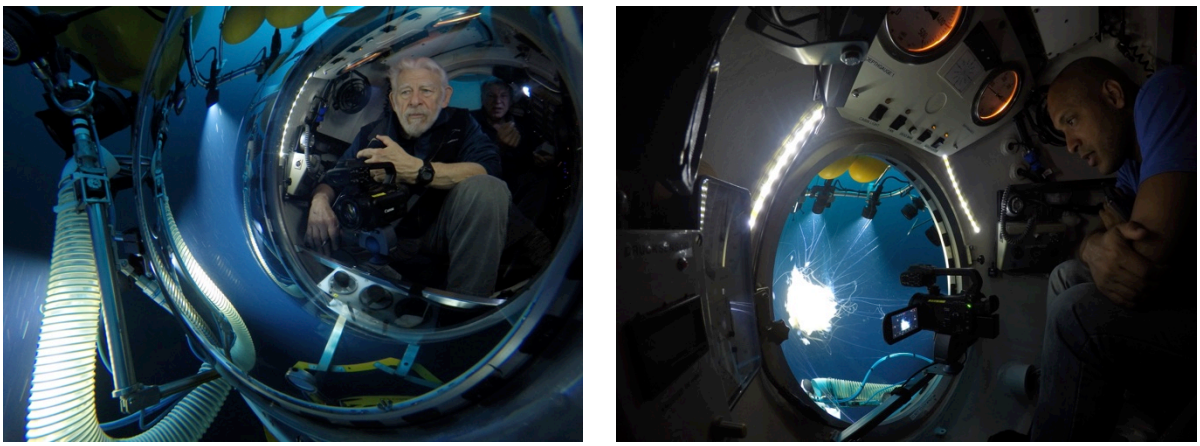

Fig. 6. Left: Front view into manned submersible JAGO while descending through the water column. Right: View inside the submersible with survey camera mounted in JAGO's front window.

Pelagic organisms were collected alive and intact with two different devices that were especially designed and manufactured for this purpose by the JAGO-Team and colleagues at the GEOMAR technology and logistics centre. One of these devices is a suction sampler with controllable inflow rate. A long flexible suction tube is brought close to the animals with the manipulator arm of the submersible. Once sucked in, the animal then lands gently in a large Plexiglas container filled with seawater (Fig. 7). The second device are acrylic collecting cylinders, so called scoop tubes, that are open on one end and closed on the other by a mesh screen. A hand knob is attached to the closed end. The tubes can be placed around an animal with the manipulator arm and then safely stored in tubulars mounted on a rack in front of the submersible until it is brought back on board the vessel (Fig. 8). Both devices worked very well for the different types and sizes of organisms. Most of the caught animals were in excellent condition when they were transferred into different containers in the lab for close up observation and photography (Fig. 7).

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Some of these collections and observations involved spectacular specimens of barely known species. We observed great numbers of pelagic amphipods *Phronima*. The females brood their eggs inside the barrels of salps. We managed to collect more than 10 individuals with their broods, and this collection now allows for paternity analyses of the offspring of each female. The delicate small siphonophore *Lilyopsis* was observed repeatedly on pelagic video transects with PELAGIOS and using JAGO we collected a living specimen and took photographs and DNA. The large lobate ctenophore *Kiyohimea usagi* is in the literature only known from the Monterey Bay in the central Pacific (Matsumoto and Robison, 1992). We observed this ctenophore during PELAGIOS transects and obtained close up observations with JAGO allowing the detailed description of the internal anatomy, and the reporting of the first documentation of this species in the Atlantic (Hoving et al submitted). The large amphipod *Cystosoma* was collected alive and photographed in detail, and will now become part of a study on eye evolution in amphipods (see section on photography and barcoding). The in situ observations with JAGO also allowed the study of behaviour and associations between pelagic animals. The egg yolk jellyfish was observed to consume pyrosomes, and fishes were hiding in between the tentacles of this large medusa. Crustaceans were observed in situ attach to pyrosomes. We also recorded unusual swimming behaviour of the siphonophore *Forskalia* and the ctenophore *Cestum*.

A CTD (SAIV A/S SD204 Norway), attached to the stern of the submersible, continuously recorded depth, temperature, salinity and density during de- and ascents and horizontal transects. All CTD data are available as ASCII files.

In total, fifteen JAGO dives were performed during POS520; seven dives took place in the first working area off the Bay of Tarrafal at Santo Antao, and eight dives in the second working area off the south coast of Fogo (Table 1). Total dive time was 43 hours and 27 minutes, during which 34 hours of HD video footage were recorded. Eight members of the scientific team participated in a dive.

Both dive sites were located in inshore waters not far from shore in the lee side of the islands. The high volcanic mountains on Santo Antao and Fogo provided sufficient shelter from the constant northeast wind. Therefore sea conditions were usually calm and in favour for a routine of up to two JAGO dives per day. Dives were performed during day- and night time hours between 08:00 am and midnight (local time) in survey water depths between 20 and 380 m. Horizontal transects at target depth ranged from relatively short distances covered (e.g. during intense sampling dives) to transects of up to 1 km total length. During all dives, the visibility was excellent. Pelagic organisms were collected during most dives, beside video images and CTD data.

The handling of the submersible from on board the POSEIDON went very safe and smooth. The teamwork between the captain and officers on the bridge, the bosun and his deck hands, the work boat team and the JAGO-Team during launch and recovery was as excellent and professional as during previous JAGO-POSEIDON cruises. Deployment and recovery of the submersible took usually only few minutes. The POSEIDON once again proved to be a very suitable support vessel for JAGO operations.

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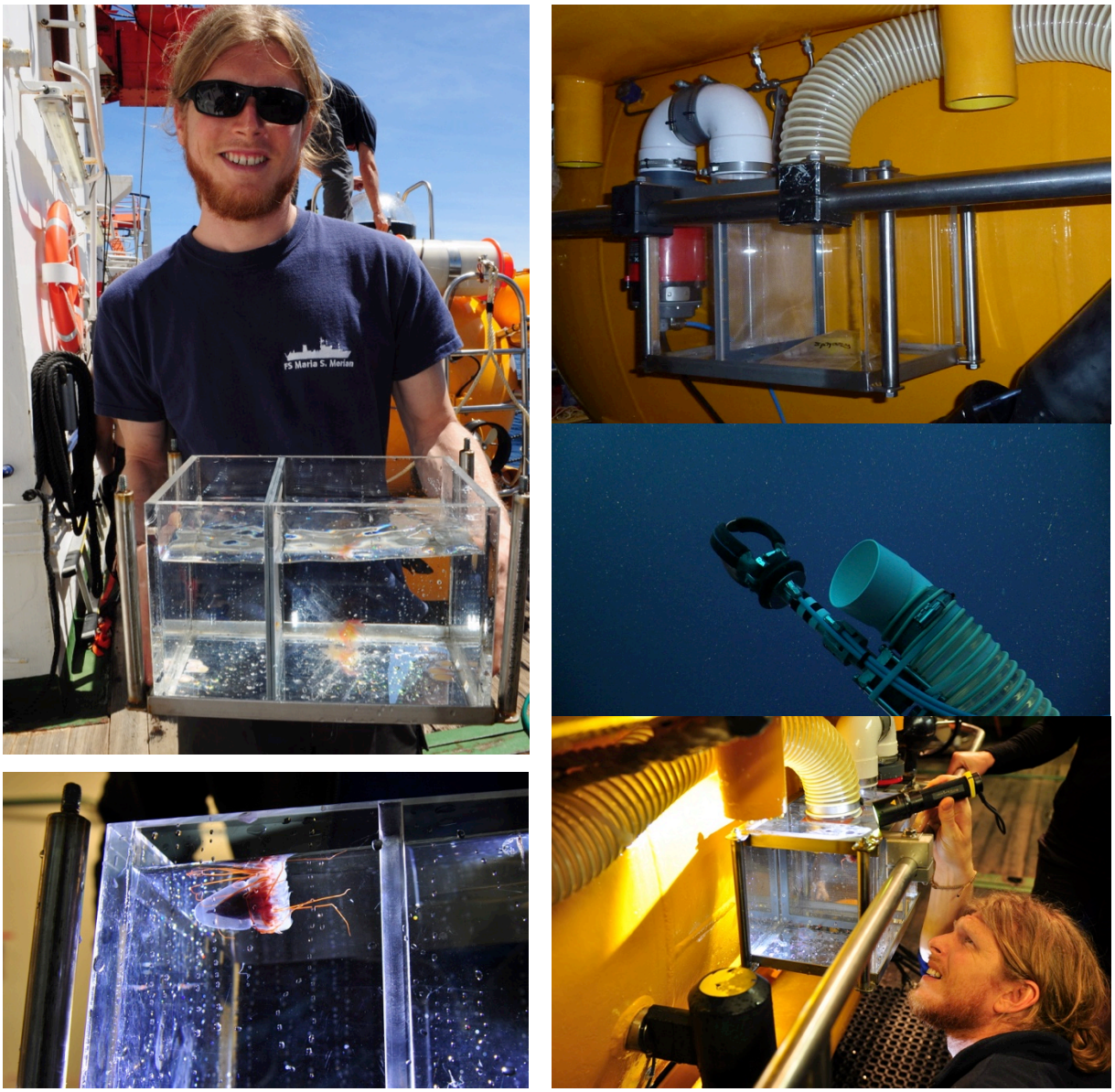

Fig. 7. Suction sampler. Top right: Collecting container at the starboard side of JAGO, divided in an inflow and an outflow chamber by an exchangeable mesh screen (mesh size 1mm), adjustable underwater suction pump (red, 130 l/min) and flexible suction tube (DN 80mm) attached to manipulator arm (middle right). Top left: detached collecting container with large pelagic siphonophore in inflow chamber. Lower left: caught *Periphylla* jellyfish in detached collecting container. Lower right: Content inspection of second collecting container on JAGO's port side after a dive.

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Fig. 8. Top left: Submersible JAGO with scoop tube rack and suction sampler during a recovery off Santo Antao. Top right: rack with three collecting cylinders (Ø 133, L 200mm), middle right: scoop tube in use during a dive. Lower right: dismounted tubular with scoop tube and caught, completely transparent animal inside

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Table 1. Metadata of submersible JAGO dives conducted during RV POSEIDON cruise POS520 (time is related to submerging and surfacing, position is related to dive start and end at seabed). Max D: maximum water depth during the survey

Dive #	Station #		Date [ddmm]	Time [UTC]	Longitude [N]	Latitude [E]	Max D [m]	Remarks
Bay of Tarrafal / Santo Antao								
1356/01	2	Start	15.02.	14:56	16°58.37'	25°20.28'	120	Test dive for sampling devices
		End	15.02.	16:17	16°57.21'	25°20.65'		
1357/02	11	Start	16.02.	09:09	16°58.54'	25°20.69'	376	Different species of ctenophores, siphono-phores, jellyfish etc
		End	16.02.	13:02	16°59.11'	25°20.48'		
1358/03	14	Start	16.02.	21:07	16°58.55'	25°20.57'	370	Collect siphonophore *Lilyopsis*, long pelagic worm, *Colobonema* jellyfish
		End	17.02.	00:20	16°59.69'	25°20.76'		
1359/04	19	Start	18.02.	09:27	16°57.95'	25°20.50'	360	Observation + sampling dive
		End	18.02.	13:02	16°57.47'	25°20.37'		
1360/05	21	Start	18.02.	21:04	16°58.14'	25°20.47'	357	Swarm of *Phronima* amphipods, adults + juveniles, females with eggs in salp barrels
		End	19.02.	00:46	16°58.71'	25°20.27'		
1361/06	24	Start	19.02.	09:16	16°57.86'	25°20.66'	373	Collect giant amphi-pod *Cystisoma* magna
		End	19.02.	12:53	16°58.52'	25°20.98'		
1362/07	26	Start	19.02.	21:14	16°57.83'	25°20.71'	371	Collect helmet jellyfish *Periphylla*, deep-sea fish
		End	20.02.	00:37	16°58.33'	25°20.87'		
Fogo south coast								
1363/08	33	Start	22.02	09:28	14°47.35'	24°23.23'	351	Dense swarm of mini jellyfish
		End	22.02.	12:49	14°47.32'	24°23.34'		
1364/09 A	37	Start	22.02.	21:04	14°47.69'	24°23.22'	36	Night dive close to surface, many larvaceans
		End	22.02.	23:03	14°47.88'	24°23.34'		
1364/09 B	37	Start	22.02.	23:52	14°47.31'	24°23.39'	27	Continue same dive in shallow water
		End	23.02.	00:48	14°47.48'	24°23.37'		
1365/10	49	Start	24.02.	09:15	14°46.58'	24°23.19'	355	Long siphonophore with luminescent polyps, *Physophora*
		End	24.02.	12:45	14°46.25'	24°23.51'		
1366/11	51	Start	24.02.	21:04	14°46.62'	24°23.08'	350	Lobate ctenophore *Kiyohimea usagi*
		End	25.02.	00:52	14°45.89'	24°23.11'		
1367/12	60	Start	26.02.	09:14	14°46.55'	24°23.06'	60	Egg-york jellyfish *Phacellophora camtschatica*
		End	26.02.	10:30	14°46.34'	24°23.78'		
1368/13	61	Start	26.02	11:39	14°46.32'	24°23.01'	150	Survey dive without sampling
		End	26.02.	12:51	14°46.36'	24°23.79'		
1369/14	64	Start	26.02.	21:01	14°41.16'	24°21.80'	350	Several metres long calycophore siphonophore
		End	27.02.	00:45	14°41.18'	24°21.47'		

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3.4 Hydrobios Multinet sampling

by Helena Hauss, Karen Osborn, Veronique Merten and Henk-Jan Hoving

For vertically stratified zooplankton sampling, two different plankton nets were used: a Hydrobios Multinet Midi (five nets, 200µm mesh size) was deployed vertically with standard depths 1000-600-300-200-100-0m at each station in a day/night pair to sample mesozooplankton standing stock and vertical migration. These samples were fixed as a whole in 4% buffered formaldehyde in seawater solution and transported to the Ocean Science Center Mindelo, where they are currently scanned using the ZooScan method (Gorsky et al. 2010). To sample larger zooplankton and micronekton, a Hydrobios Multinet Maxi was used (nine nets, 4mm mesh size). Oblique hauls were obtained with this instrument at a ship speed of around 1.5 to 2kn. In total, twelve deployments were conducted, nine in the upper 1000m, two (an D/N pair at CVOO) down to 2000m and one down to 2500m off Santo Antao. These samples were partly sorted alive on board, where specimens of target groups were photographed and fixed in ethanol for DNA barcoding. The remainder of each sample was fixed in 4% buffered formaldehyde in seawater solution and transported to GEOMAR, where they were sorted by experts to the lowest possible taxonomic level (132 taxa). The oceanographic data and vertical distribution of larger taxonomic groups at the coastal station off Santo Antao is depicted in Figure. 9.

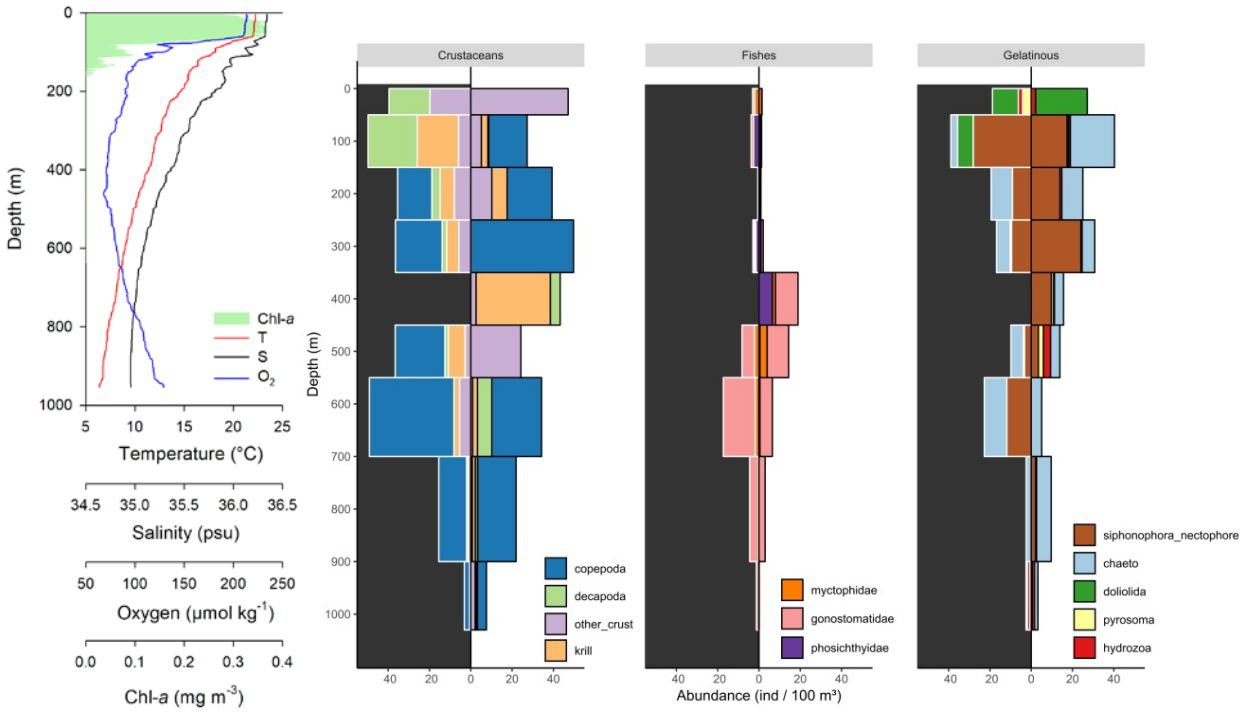

Figure 9: A) Vertical hydrographic profile of the water column off Santo Antao, data obtained by sensors of the Multinet maxi B) Vertical distribution of different faunal groups captured by Multinet Maxi off Santa Antao.

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3.5 DNA Barcoding and Photography

By Karen Osborn, Veronique Merten, Helena Hauss and Henk-Jan Hoving

We collected a wide variety of animals using multi-nets and the HOV JAGO in order to determine the diversity of midwater animals and ground truth the PELAGIOS video transects. Diversity of midwater animals is historically under estimated using traditional taxonomic methods but barcoding is helping us recognize and identify previously unrecognized diversity. Additionally, midwater animals are delicate and often do not preserve well – loosing their shape and coloration once in fixative – yet there is a lot of information in knowledge of these morphological features making photography of intact specimens highly valuable. Further, the photos are often the only voucher possible if the specimens are small, as many animals are, or the body is needed for genetic or chemical analyses. Therefore we made extensive efforts to document the collected specimens and take tissue samples for further genetic analysis.

Nearly 3000 photographs were taken at sea and have all been prepared for cataloguing and public release and will be an integral part of many manuscripts prepared from cruise results. To allow the description of potentially new species, and for identification of the sequences from the metabarcoding efforts obtained from the eDNA samples, we made a reference DNA barcode library of the specimens collected in the Cape Verde region. Barcode data is extremely valuable in identification of specimens, delimiting geographic distributions, and for matching up morphologically divergent life history stages. The nearly 475 specimens sampled have been extracted for total DNA and are in the queue for amplification and sequencing at GEOMAR and the Smithsonian Institution. Barcode data will be used in multiple ongoing projects focused on distribution of animals and species delimitation of larvaceans, polychaetes, pteropods, isopods and amphipods, as well as in efforts to compare barcodes with eDNA sequences.

The extremely delicate nature of many midwater animals requires extreme care when collecting them for scientific study. The submersible JAGO is capable of the most delicate collections of these animals and included collection of unique and valuable specimens of *Bathochordeus* (Larvacean, Chordata), *Lilyopsis* (Siphonophore, Cnidaria), *Drieschia* (scaleworm, Annelida), *Cystisoma* and *Rhabdosoma* (hyperiid amphipod, Crustacea).

The *Cystisoma*, a completely transparent animal about size of an elementary child's hand that has sheet-like eyes suspended in the vast cavity of it head, is of interest for the unique structure of its eyes. To understand the function and eventually the evolution of such eyes, we need to determine the anatomy of the visual centers of the brain and optic nerves and for this we need intact specimens. The valuable high-resolution photographs of this specimen and immune-staining study of it will be included in a manuscript comparing the anatomy of multiple hyperiid amphipod visual systems. *Rhabdosoma,* a stick-shaped relative of *Cystisoma* with tubular retinas allowing for a 360 degree field of view was thought to be relatively rare prior to our observations last February, but were numerous on one of the JAGO dives. The large collection of *Rhabdosoma* will allow detailed study of their highly compressed visual system and make a particularly interesting comparison to the expanded anatomy of *Cystisoma*.

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Two specimens of the holopelagic scaleworm *Drieschia* were collected and fixed for genetic and morphological work. This genus has never been included in a molecular study and is of particular interest because it is hypothesized to be second and unrelated example of a holopelagic group of scaleworms. These specimens will be key parts of a study of the evolutionary transitions from life on the sea floor to life in the water column in scaleworms and adaptations to life in the midwater and included in at least two manuscripts.

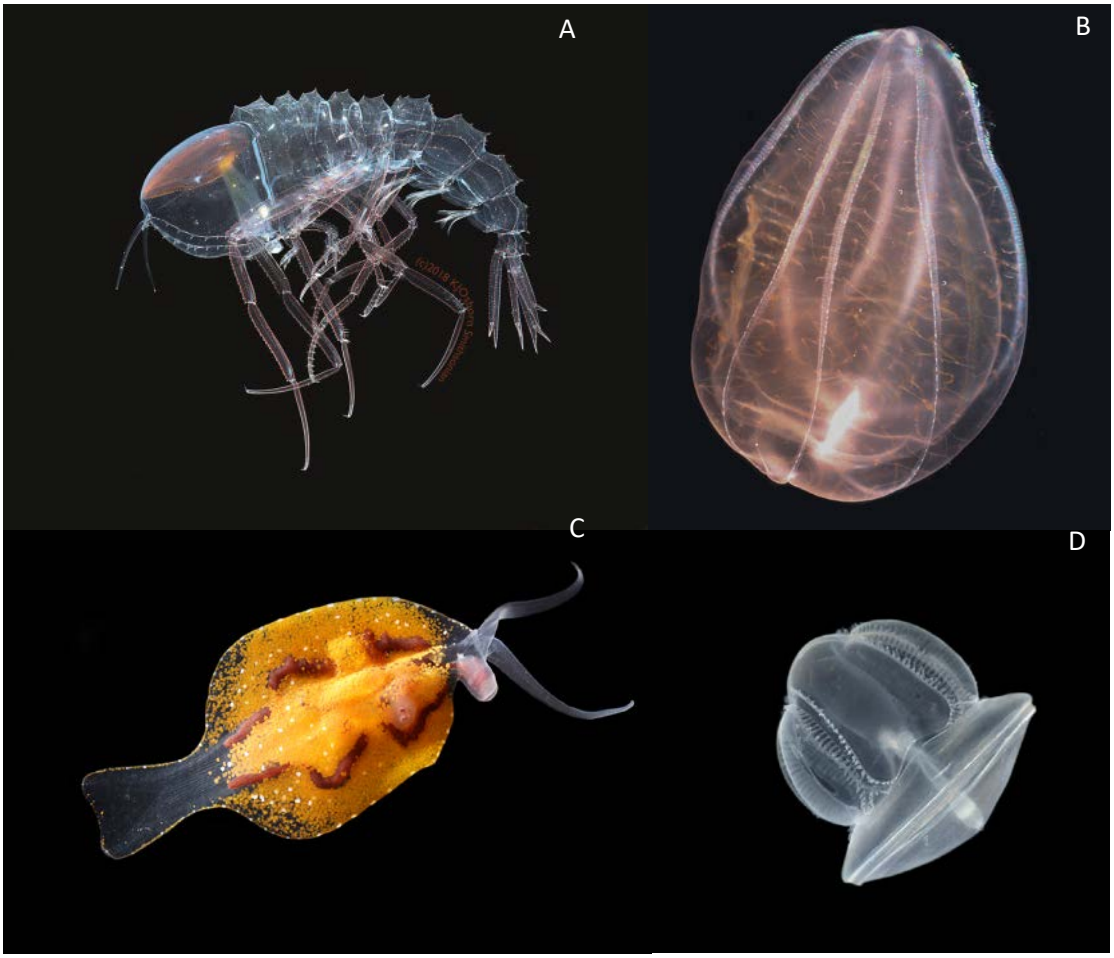

Figure 10: Scientific photographs of organisms that were captured during POS520. A) amphipod, *Cystisoma* B) ctenophore *Beroe* C) pelagic mollusc *Phylliroe* D) pelagic larva of an acorn worm.

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3.6 Pelagic in situ observation system PELAGIOS

By Henk-Jan Hoving and Helena Hauss

We performed pelagic video transects using the pelagic in situ observation system PELAGIOS (Figure 11), a towed camera system that is equipped with environmental sensors and that is used to perform horizontal pelagic video transects. It is specifically developed to visualize delicate, gelatinous organisms that are difficult to capture in nets. The system has been deployed successfully on several previous cruises (M119, MSM49, MSM61 and M138). The camera and LED lights are powered by a battery and using a telemetry, CTD data and video preview is transmitted via conducting cable to the ships' lab. The system can be deployed down to 3000m.

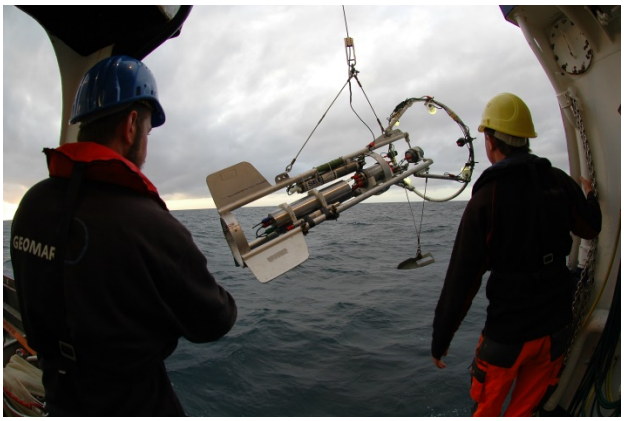

Figure 11: The PELAGIOS being deployed from POSEIDON.

PELAGIOS was deployed 9 times, and video was collected at depths similar to the eDNA sampling and the Multinet maxi casts. During POS520 we performed the deepest PELAGIOS tows to date, down to 2500 m. Transects lasted between 10-30 minutes, and a total of approximately 27 hours of video was obtained. All video is analyzed manually after the cruise to obtain detailed information on the biodiversity and distribution of observed fauna. For video annotation we use the MBARI developed software VARS (Video Annotation and Reference Software). This allows the reconstruction of species-specific distribution patterns. Observed fauna include ctenophores, hydromedusae, siphonophores, doliolids, appendicularians, fishes and examples of observed fauna are illustrated in Figure 12. When comparing the distribution data during day and night casts, it is possible to evaluate vertical migration behavior. In Figure 13 such behavior is illustrated for the pyrosome *Pyrosoma atlanticum*, which performs an extensive migration from 400-500 m of depth during the day to the upper 100 m at night. The use of PELAGIOS was nicely complemented by the deployments of the multinet, which sampled animals at the same depth as the video transects. Also the close up observations and collections by JAGO enabled the study of behavior and associations of organisms observed during video transects, as well as the collection of tissue for genetic validation of PELAGIOS observed species.

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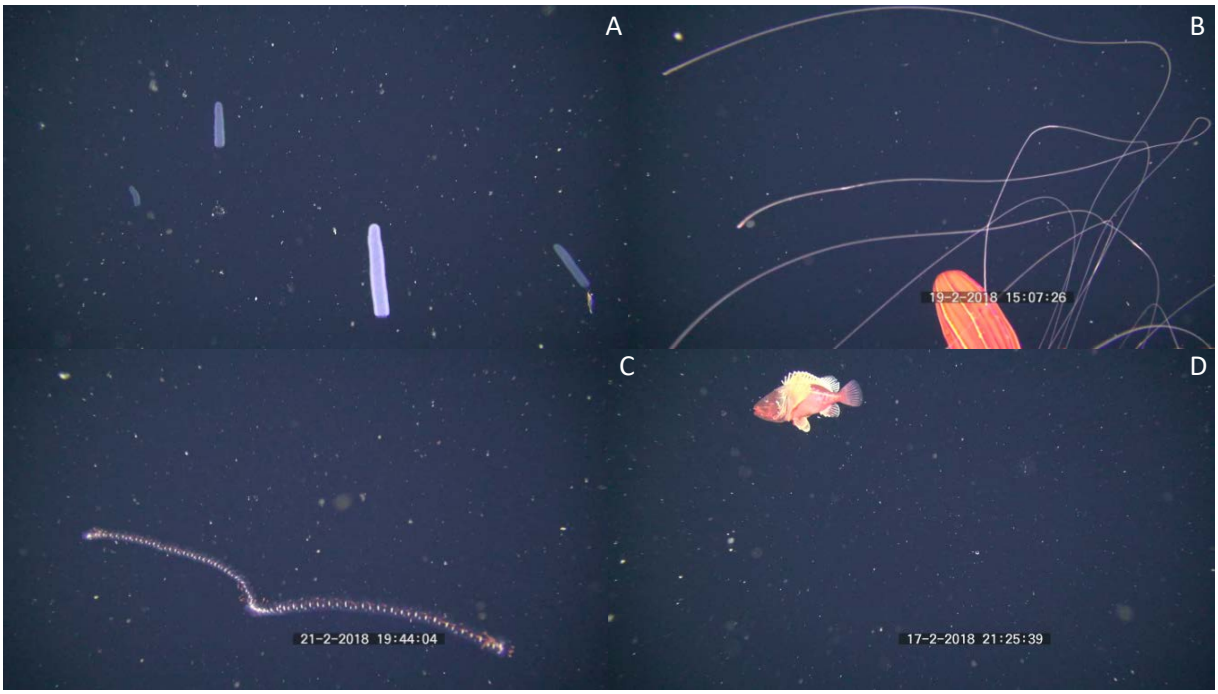

Figure 12: Framegrabs obtained from video from transects with PELAGIOS A) Pyrosomes in vertical swimming position migration at dusk to the upper 100 m, B) a large rare ctenophore *Tortuga red*, C) the doliolid *Doliolula*, D) a scorpaeniform fish *Setarches guentheri*

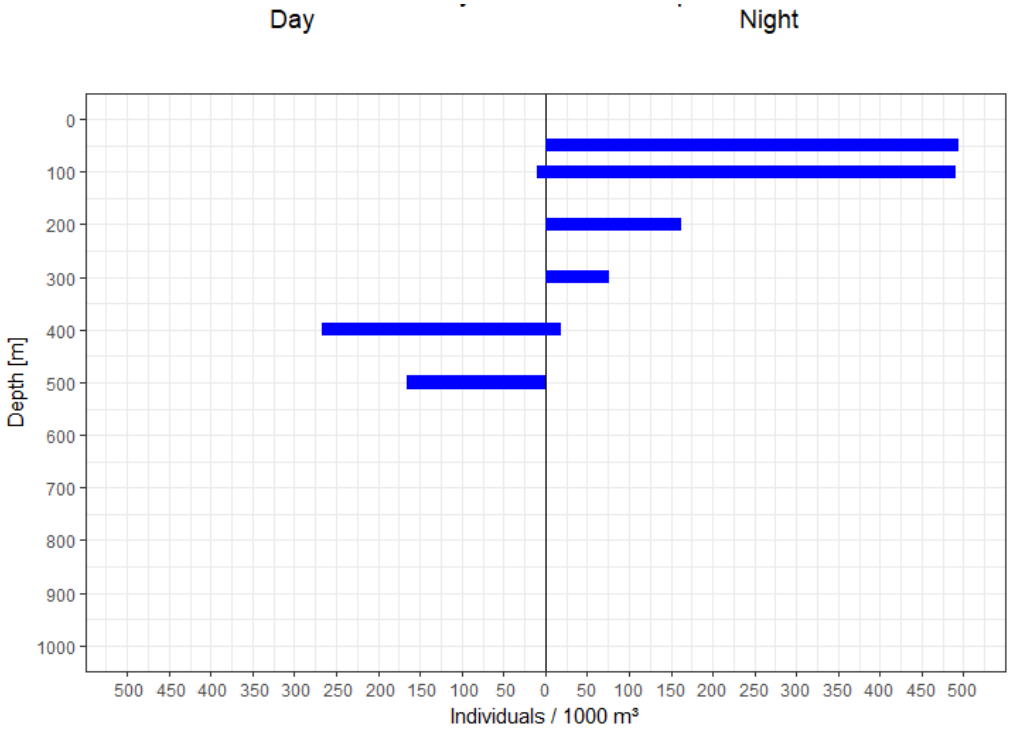

Figure 13: Pooled observations of pyrosomes obtained by PELAGIOS pelagic video transects during POS520. The day time distribution is depicted on the left and the night time distribution on the right, together showing a very clear vertical migration.

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3.7 Cape Verde epipelagic and upper mesopelagic fauna

By Bruce Robison

This report is based on observations made from the submersible JAGO between February 16 and 24, 2018 off the Cape Verde Islands (CV) in the eastern tropical North Atlantic. It comprises a brief qualitative comparison of the Cape Verdean midwater fauna with that of the midwater reference community in Monterey Bay, California (MB).

In general, the midwater fauna of the Cape Verde Islands is rich and diverse, indicative of an oceanic region where primary production is enhanced by proximity to the islands. Subjectively, the CV midwater community appears to be more diverse than that around Cocos Island in the eastern tropical Pacific, is similar in diversity to the community around the Hawaiian Islands, and is less diverse than that around the Galapagos Islands; three other pelagic habitats around oceanic islands that I have examined with undersea vehicles.

At the ecological level of initial consumers, copepods (particularly *Sapphirina*) *and* krill were plentiful off CV but we observed no large swarms of krill, which are common in MB. As is the case for many such comparisons, this difference may simply be due to the far greater number of opportunities for observations off Monterey and to the patchiness of krill. Gelatinous grazers were abundant, with salps and giant larvaceans occurring commonly during the JAGO dives. In contrast with MB, doliolids were relatively uncommon. The most striking difference at this trophic level was the great abundance of pyrosomes seen off CV. While this may have been an episodic bloom, the large numbers of pyrosomes observed from the surface down to 300+ m exceeded their historical peak abundance in MB.

Secondary consumers were roughly comparable between the two regions, although the numbers of individuals in each taxonomic category were generally lower off the CV islands. A case in point are the small physonect and calycophoran siphonophores, which feed on krill and copepods in MB but which, like their prey, were less abundant off CV. Other gelatinous predators of crustacean zooplankton included chaetognaths, lobate ctenophores and a variety of medusae. Predators of gelatinous grazers were principally gelata themselves; chief among them was the narcomedusa *Solmissus*. Present, but relatively less abundant in this trophic category was the ctenophore *Beroe.* Hard-bodied (non-gelatinous) secondary consumers included the micronektonic myctophid fishes and *Cyclothone*, sergestid shrimps, and small squid.

Direct comparison of counterpart taxa showed some substantial differences between CV and MB. The CV midwater fauna included many more cestid ctenophores and *Cyclothone* than are commonly observed in MB. Likewise, the abundance of the hyperiid amphipod *Phronima* was remarkably high, throughout the entire CV depth range surveyed. Myctophid fishes also appeared to be more common off CV but this may be an artifact of the quiet, electric thrusters of JAGO, whereas these fishes usually avoid the noisy hydraulic thrusters of the ROVs used in the MB surveys. In contrast, micronektonic squid appeared to be less common off CV than in MB.

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Largely missing from the CV fauna were the trachymedusa *Colobonema,* the narcomedusa *Aegina,* and the coronate medusa *Atolla,* at least within the depth range surveyed.

Nektonic species also showed some substantial differences between the two regions. Off Monterey, the market squid *Doryteuthis* and the hake *Merluccius* are highly abundant and support commercial fisheries. No direct counterparts were observed off CV. However, slender paralepidid fishes and a robust *Sudis*-like paralepidid were quite common.

Diel vertical migrations are an integral aspect of the CV midwater community, however two somewhat anomalous patterns were observed. First, while pyrosomes are known to undertake such migrations elsewhere, they were seen to orient vertically during their ascents off CV, apparently pumping water out of the terminal opening of the colony for directed propulsion. Second, a surprising number of myctophid fishes, sergestid shrimp, and small squids did not migrate to the epipelagic at night but instead remained at depths below 250 m, at approximately the same depths they occupy during the day.

The ecological structure of the Cape Verde Islands upper midwater community is similar to that in Monterey Bay and in other regions in terms of niches and the relative proportions of certain constituent types. Species composition, of course, is somewhat different but the fundamental characteristics of the community are familiar.

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4. Media and public outreach activities during and after POS520

By JAGO-Team (Karen Hissmann, Jürgen Schauer, Peter Striewski) + cruise participants

The fact that RV POSEIDON and submersible JAGO operated close to the coast in calm waters, especially in the first working area off Santo Antao, offered an ideal opportunity for media activities with a shore-based team. The aim was to use this opportunity to obtain professional photo images and video footages of the scientific work performed on a research vessel and underwater images of the submerged submersible for public outreach purposes.

The Communication and Media Department of GEOMAR contracted for this task the professional freelance photographer and cameraman Ulrich Kunz (www.kunzgalerie.de). Uli Kunz has profound skills in underwater imagery and has joined numerous research cruises and JAGO campaigns before. He was accompanied by the research diver Philipp Schubert. Together they were based on land in a small guesthouse in the Bay of Tarrafal and used a boat shuttle provided by local fishermen to come on board POSEIDON. This set-up worked very well and is an example for how media activities can be integrated in a research cruise, which is performed close to land, without occupying space and bunks primarily assigned for scientific participants.

Since the POS520 cruise started with a delay of one day and Uli Kunz' time window for participating was per se very tight due to his other obligations, the team had only 1 ½ day at location. In this very short time, Uli Kunz took photographs and short underwater video clips of the submersible, mainly by free water diving, in day and night time light. The local diving base could not provide diving tanks for scuba diving because they were all rented out to other customers. Despite these restrictions Uli Kunz produced outstanding photographs, mainly of JAGO under water and half-and-half images. His images were already and will be multiply used by GEOMAR in public outreach items like posters, flyers, brochures etc. The video clips of the de- and ascending submersible in the deep blue water off Santo Antao were already incorporated into various short video films produced by GEOMAR and in a 30-minutes TV-reportage broadcasted by the Norddeutscher Rundfunk NDR about the submersible and its team.

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Fig. 14. Underwater photographs of JAGO taken by Uli Kunz off Santo Antao during POS520 on behalf of GEOMAR

During the course of the cruise, several participants wrote contributions about their work and research objectives on board the POSEIDON for Oceanblogs.org, the blog portal of Kiel Marine Sciences, jointly hosted by GEOMAR and Future Ocean. A total of seven contributions referring to POS520 can be read on www.oceanblogs.org/capeverde

After the cruise, the submersible team stayed for three more days in Mindelo to participate with JAGO in the Open Marine Science Day conducted at the Ocean Science Centre Mindelo (OSCM) on March 3rd, 2018. The submersible was presented there to the public. Many visitors, including numerous children, took the chance for a personal look inside the submersible. A poster, written in English and Portuguese, highlighted the JAGO dive of the young Cape Verdean scientist who participated in the cruise. In addition, a Powerpoint slideshow with a broad potpourri of photographs that were taken during POS520 was beamed on a large screen. The submersible was transported from the FS POSEIDON to the OSCM and back on a pick-up truck. Inside the OSCM, the submersible was lifted and moved around by the overhead gantry crane.

Fig. 15. Submersible JAGO and the JAGO-Team at the Ocean Science Centre Mindelo during the Open Marine Science Day 2018

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5: Station list

Event	Gear	Date and Time in [UTC]	Date and Time out [UTC]	Latitude	Longitude	Bottom Depth [mbsl]
1-1	CTD	2018-02-15 12:08:24.0	2018-02-15 12:45:34.0	16.97486	-25.344708	1000.7
2-1	JAGO	2018-02-15 14:02:36.0	2018-02-15 16:37:01.0	16.9738	-25.345548	1012.8
3-1	MSN Midi	2018-02-15 17:01:51.0	2018-02-15 18:11:13.0	16.96854	-25.348313	1089.7
4-1	MSS	2018-02-15 21:12:04.0	2018-02-16 03:00:24.0	16.85646	-25.472088	2570.3
10-1	ADCP	2018-02-16 03:15:26.0	2018-02-16 07:39:52.0	16.97749	-25.344428	951.1
11-1	JAGO	2018-02-16 09:10:31.0	2018-02-16 13:13:16.0	16.97418	-25.3447	1012.8
12-1	PELAGIOS	2018-02-16 14:05:00.0	2018-02-16 17:25:23.0	16.94262	-25.34831	1222.3
13-1	CTD	2018-02-16 17:39:52.0	2018-02-16 18:00:51.0	16.93465	-25.353037	1336.1
14-1	JAGO	2018-02-16 20:47:33.0	2018-02-17 00:41:46.0	16.97423	-25.344932	1014.8
15-1	MSS	2018-02-17 01:00:10.0	2018-02-17 02:50:03.0	16.99696	-25.347365	753.6
16-1	ADCP	2018-02-17 02:51:01.0	2018-02-17 09:29:36.0	16.9743	-25.34857	997.5
17-1	CTD	2018-02-17 09:39:06.0	2018-02-17 10:26:04.0	16.97407	-25.34645	1022.5
17-2	PELAGIOS	2018-02-17 10:34:25.0	2018-02-17 14:57:12.0	16.97364	-25.347917	1003.5
17-3	MSN Maxi	2018-02-17 15:16:07.0	2018-02-17 19:13:12.0	16.9515	-25.366928	1276.5
17-5	CTD	2018-02-17 19:36:33.0	2018-02-17 20:15:15.0	16.97858	-25.347637	980
17-6	PELAGIOS	2018-02-17 20:33:57.0	2018-02-17 23:10:50.0	16.97665	-25.350648	1013.5
17-7	MSN Maxi	2018-02-17 23:43:21.0	2018-02-18 01:04:40.0	16.97554	-25.353595	1046.8
18-1	ADCP	2018-02-18 01:23:21.0	2018-02-18 08:41:27.0	16.93819	-25.359177	1349.3
19-1	JAGO	2018-02-18 09:18:16.0	2018-02-18 13:16:50.0	16.96503	-25.342997	1033.9
20-1	MSN Maxi	2018-02-18 13:38:07.0	2018-02-18 15:20:03.0	16.97247	-25.345053	1033.2
21-1	JAGO	2018-02-18 20:53:20.0	2018-02-19 00:59:30.0	16.96734	-25.340913	1005.2
22-1	MSS	2018-02-19 01:28:17.0	2018-02-19 05:31:08.0	16.97934	-25.341815	908.2
23-1	ADCP	2018-02-19 05:35:58.0	2018-02-19 08:15:06.0	16.93728	-25.357207	1406.5
24-1	JAGO	2018-02-19 08:59:31.0	2018-02-19 13:07:36.0	16.96441	-25.342653	1031.3

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25-1	PELAGIOS	2018-02-19 13:28:21.0	2018-02-19 15:48:20.0	16.9838	-25.351897	935.3
26-1	JAGO	2018-02-19 20:49:23.0	2018-02-20 00:53:53.0	16.96389	-25.344153	1057.4
27-1	MSS	2018-02-20 01:29:36.0	2018-02-20 03:29:45.0	16.97149	-25.333217	471.1
28-1	CTD	2018-02-20 09:01:17.0	2018-02-20 10:41:39.0	16.86187	-25.521962	2678.8
28-2	PELAGIOS	2018-02-20 10:51:15.0	2018-02-20 15:54:27.0	16.84319	-25.505817	2760.8
28-3	MSN Midi	2018-02-20 17:18:39.0	2018-02-20 18:07:48.0	16.8634	-25.519213	2657.5
29-1	MSN Maxi	2018-02-20 18:22:46.0	2018-02-20 22:02:55.0	16.86136	-25.510597	2651
29-2	PELAGIOS	2018-02-20 23:06:27.0	2018-02-21 03:45:08.0	16.85614	-25.514728	2664.6
29-3	MSN Midi	2018-02-21 04:47:17.0	2018-02-21 05:30:29.0	16.85965	-25.517953	2659
29-4	CTD | 400 m	2018-02-21 05:40:18.0	2018-02-21 05:58:09.0	16.85989	-25.511585	2653.7
30-1	CTD | 600 m	2018-02-21 16:50:40.0	2018-02-21 17:16:58.0	15.24907	-25.001667	4192.9
30-2	MSS	2018-02-21 17:28:31.0	2018-02-21 18:35:27.0	15.25136	-24.999137	4189
31-1	PELAGIOS	2018-02-21 19:29:17.0	2018-02-21 20:58:46.0	15.3439	-25.01935	4118
32-1	ADCP	2018-02-22 01:27:56.0	2018-02-22 08:47:16.0	14.89461	-24.541857	1426.6
33-1	JAGO	2018-02-22 08:58:10.0	2018-02-22 13:06:14.0	14.77538	-24.374325	1473.3
34-1	CTD | 1000 m	2018-02-22 13:17:00.0	2018-02-22 13:53:17.0	14.79105	-24.386687	960.6
34-2	PELAGIOS	2018-02-22 14:01:57.0	2018-02-22 15:58:32.0	14.78971	-24.386588	1003.5
35-1	MSS	2018-02-22 16:21:47.0	2018-02-22 19:01:01.0	14.7634	-24.390625	1958.2
37-1	JAGO	2018-02-22 20:48:27.0	2018-02-23 01:02:20.0	14.79221	-24.38708	908.4
38-1	MSS	2018-02-23 02:34:01.0	2018-02-23 05:58:22.0	14.68981	-24.3819	3313.1
41-1	CTD	2018-02-23 08:23:07.0	2018-02-23 08:44:52.0	14.78972	-24.388148	983.1
42-1	MSN Midi	2018-02-23 08:58:25.0	2018-02-23 09:40:38.0	14.79077	-24.386965	952.3
43-1	MSN Maxi	2018-02-23 11:17:01.0	2018-02-23 15:00:46.0	14.65243	-24.36938	3685.2
44-1	PELAGIOS	2018-02-23 16:25:20.0	2018-02-23 19:37:30.0	14.63865	-24.379218	3723.1
45-1	MSN Midi	2018-02-23 20:30:43.0	2018-02-23 21:23:35.0	14.77471	-24.385305	1533.2
46-1	MSN Maxi	2018-02-23 22:37:49.0	2018-02-24 00:58:08.0	14.64527	-24.37496	3718.2
47-1	MSS	2018-02-24 01:48:14.0	2018-02-24 02:59:04.0	14.791	-24.354172	965.4
48-1	ADCP	2018-02-24 03:13:30.0	2018-02-24 08:34:53.0	14.78981	-24.386562	979.5

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49-1	JAGO	2018-02-24 08:59:24.0	2018-02-24 13:10:42.0	14.77701	-24.385545	1421.9
50-1	MSS	2018-02-24 17:01:41.0	2018-02-24 19:02:31.0	14.78521	-24.397778	1210.3
51-1	JAGO	2018-02-24 20:48:51.0	2018-02-25 01:08:56.0	14.77788	-24.383423	1417.2
52-1	MSS	2018-02-25 06:11:15.0	2018-02-25 09:07:01.0	14.94813	-25.099233	4173
54-1	CTD	2018-02-25 10:35:01.0	2018-02-25 11:14:11.0	15.34254	-25.100433	4173.2
54-2	MSN Midi	2018-02-25 11:21:56.0	2018-02-25 12:12:43.0	15.33881	-25.107188	4170.7
54-3	MSN Maxi	2018-02-25 12:29:12.0	2018-02-25 15:48:27.0	15.33765	-25.120805	4181.7
55-2	MSS	2018-02-25 15:52:31.0	2018-02-25 18:41:30.0	15.54	-25.102767	4126.5
57-1	CTD	2018-02-25 19:46:47.0	2018-02-25 20:09:02.0	15.30004	-25.049435	4189
58-1	MSN Midi	2018-02-25 20:18:07.0	2018-02-25 21:09:38.0	15.30108	-25.051668	4197.8
58-2	MSN Maxi	2018-02-25 21:25:39.0	2018-02-26 00:36:10.0	15.30548	-25.054462	4191.9
59-1	MSS	2018-02-26 01:22:56.0	2018-02-26 02:36:17.0	15.30052	-25.050432	4184.9
60-1	JAGO	2018-02-26 08:54:24.0	2018-02-26 10:40:45.0	14.77385	-24.387705	1605.5
61-1	JAGO	2018-02-26 11:08:54.0	2018-02-26 13:05:14.0	14.77188	-24.378233	1607.7
62-1	Glider	2018-02-26 13:59:37.0	2018-02-26 14:14:32.0	14.6945	-24.37255	3170.3
63-1	CTD	2018-02-26 14:22:49.0	2018-02-26 14:46:21.0	14.68778	-24.363528	3297
64-1	JAGO	2018-02-26 20:49:54.0	2018-02-27 01:05:43.0	14.68622	-24.362917	3291.8
65-1	CTD | 3000m	2018-02-27 22:24:17.0	2018-02-28 00:44:06.0	17.58261	-24.283585	3593.1
65-2	CTD | 500m	2018-02-28 01:48:30.0	2018-02-28 02:27:57.0	17.58441	-24.284423	3593.3
65-3	MSN Midi	2018-02-28 02:37:40.0	2018-02-28 03:30:10.0	17.58539	-24.282665	3593
65-4	MSN Maxi	2018-02-28 03:54:00.0	2018-02-28 08:00:05.0	17.5862	-24.280275	3594.8
66-1	MSN Midi	2018-02-28 09:15:48.0	2018-02-28 10:08:57.0	17.5835	-24.28363	3593.3
66-2	MSN Maxi	2018-02-28 10:30:00.0	2018-02-28 15:27:25.0	17.58848	-24.283952	3593.7

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